Water Quality Improvement Plan

CROOKED, STEPHENS, WEST RUNS & WILLOW BROOK

A plan to reduce bacteria in the water

Technical Document

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Prepared by
VA Department of Environmental Quality

In Cooperation with
Local Stakeholders
Virginia Tech Biological Systems Engineering

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1. INTRODUCTION

1.1 Background

The Clean Water Act (CWA) that became law in 1972 requires that all U.S. streams, rivers, and lakes meet their state's water quality standards. The CWA also requires that states conduct monitoring to identify polluted waters or those that do not meet standards. Through this required program, the state of Virginia has found that many streams do not meet state water quality standards for protection of the five beneficial uses: fishing, swimming, shellfish, aquatic life, and drinking.

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

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

1.2 Designated Uses and Applicable Water Quality Standards

Water quality standards are designed to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et

seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.)." Virginia Water Quality Standard 9 VAC 25-260-10 (Designation of uses.) states:

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.

1.2.1 Bacteria Water Quality Criterion (9 VAC 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 Crooked Run and Willow Brook were initially listed as impaired was based on fecal coliform. For a non-shellfish supporting water body to be in compliance with Virginia fecal coliform standard for contact recreational use, VADEQ specified the following criteria (Virginia Water Quality Standard 9 VAC 25-260-170):

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

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

Sufficient fecal coliform bacteria standard violations were recorded at VADEQ water quality monitoring stations to indicate that the recreational use designations were not

being supported in Crooked Run and Willow Brook (VADEQ, 2002, 2006). Most of the VADEQ's ambient water quality monitoring is done on a monthly or quarterly basis. This sampling frequency does not provide the two or more samples within 30 days needed for use of the geometric mean part of the standard. Therefore, VADEQ used the 400 cfu/100 mL standard in the 2004 and 2006 Section 303(d) assessments for the fecal coliform bacteria monitoring data.

Studies have shown that there is a stronger correlation between the concentration of *Escherichia coli (E. coli)* and the incidence of gastrointestinal illness than there is with fecal coliform (USEPA, 1986), so the state transitioned from a fecal coliform standard to an *E. coli* standard in 2008. All freshwaters were subject to the *E. coli* standard described below, and until June 30, 2008, the interim fecal coliform standard described below also applied to any sampling stations with fewer than 12 *E. coli* samples (State Water Control Board, 2006):

Interim Fecal Coliform Criterion: *Fecal coliform bacteria shall not exceed a geometric mean of 200 fecal coliform bacteria per 100 mL of water for two or more samples over a calendar month nor shall more than 10% of the total samples taken during any calendar month exceed 400 fecal coliform bacteria per 100 mL of water. This criterion shall not apply for a sampling station after the bacterial indicators described in subdivision 2 of this subsection [E. coli criterion] have a minimum of 12 data points or after June 30, 2008, whichever comes first.*

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

As a part of VADEQ's triennial review of water quality standards, revisions to the applicable bacteria standard were proposed in March 2008. The proposed revisions removed the interim fecal coliform criterion and revised the *E. coli* criterion to remove the instantaneous single sample maximum of 235 cfu/100ml. The revised criterion consists of only the *E. coli* geometric mean criterion of 126 cfu/100ml. This standard was the basis of the impairment listings for both Stephens and West Runs in 2010. In addition, since this revised standard was approved by the State Water Control Board in October 2008, it was considered the applicable water quality standard for the development of the Crooked, Stephens, West Runs and Willow Brook bacteria TMDLs in

2014. In addition to meeting the geometric mean criterion, the TMDL was also developed to meet the *E. coli* instantaneous target concentration of 235 cfu/100ml with a violation rate of less than 10.5%. Meeting this target provided consistency with VADEQ assessment guidance (VADEQ, 2014).

1.3 Attainability of Designated Uses

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 bacteria standard described in Section 1.2 of this report is to be met during all stream flow levels and was established to protect bathers from ingestion of potentially harmful bacteria. However, many headwater streams are small and shallow during base flow conditions when surface runoff has minimal influence on stream flow. Even in 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 extensively for swimming, Virginia has approved a process for re-designation of the swimming use for secondary contact in cases of: 1) natural contamination by wildlife, 2) small stream size, and 3) lack of accessibility to children, as well as due to widespread socio-economic impacts resulting from the cost of improving a stream to a “swimmable” status.

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

In some streams for which TMDLs have been developed, water quality modeling indicates that even after removal of all of the sources of *E. coli* (other than wildlife), the stream will not attain standards. In such a case, after demonstrating that the source of *E. coli* contamination is natural and uncontrollable by effluent limitations and BMPs, the

state may decide to re-designate the stream's use for secondary contact recreation or to adopt site specific criteria based on natural background levels of *E. coli*. 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. REQUIREMENTS FOR IMPLEMENTATION PLANS

There are a number of state and federal 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 has three sections that discuss a) the requirements outlined by the WQMIRA that must be met in order to produce an IP that is approvable by the Commonwealth, b) the EPA recommended elements of IPs, and c) the required components of an IP in accordance with Section 319 guidance.

2.1 State Requirements

The TMDL IP is a requirement of Virginia's 1997 Water Quality Monitoring, Information, and Restoration Act (§62.1-44.19:4 through 19:8 of the Code of Virginia), or WQMIRA. WQMIRA directs the SWCB to "develop and implement a plan to achieve fully supporting status for impaired waters." In order for IPs to be approved by the Commonwealth, they must meet the requirements as outlined by WQMIRA. WQMIRA requires that IPs include the following (VADEQ and VADCR, 2003):

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

2.2 Federal Recommendations

Section 303(d) of the CWA and current EPA regulations do not require the development of implementation strategies. The EPA 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 time line for implementing these measures,
- legal or regulatory controls,
- the time required to attain water quality standards, and
- a monitoring plan and milestones for attaining water quality standards.

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

2.3 Requirements for Section 319 Fund Eligibility

The 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 "Supplemental Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories in FY 2003" identifies the following nine elements that must be included in the IP to meet the 319 requirements:

1. Identify the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed-based plan;
2. Estimate the load reductions expected 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 if progress is being made towards attaining water quality standards; if not, identify the criteria for determining if the watershed-based plan needs to be revised; and
9. Establish a monitoring component to evaluate the effectiveness of the implementation effort.

3. REVIEW OF TMDL DEVELOPMENT

3.1 Background

Segments of Crooked Run (VAV-B56R_CRO01A00) and Willow Brook (VAV-B55R_WL001A06) were first listed as impaired on Virginia's 2002 and 2006 Section 303(d) Report on Impaired Waters, respectively, due to water quality violations of the fecal coliform standard. Segments of Stephens (VAV-B55R_STV01A00) and West Runs (VAV-B55R_WST01A00), both tributaries of Crooked Run, were also listed due to water quality violations of the *E. coli* standard on Virginia's 2010 305(b)/303(d) Water Quality Assessment Integrated Report. The Virginia Department of Environmental Quality (VADEQ) has described the impaired segments as presented in **Error! Reference source not found.** and **Error! Reference source not found.**.

Table 3.1 Impaired stream segments addressed in the Crooked Run TMDL implementation plan

Impaired Segment	Size	Initial Listing Year	Description
Crooked Run (VAV-B56R_CRO01A00)	8.87 miles	2002	extending from the Lake Frederick Dam downstream to its confluence with the Shenandoah River
Willow Brook (VAV-B55R_WL001A06)	3.95 miles	2006	extending from its headwaters downstream to its confluence with the Shenandoah River
Stephens Run (VAV-B55R_STV01A00)	0.95 miles	2010	extending from its confluence with an unnamed tributary downstream to its confluence with Crooked Run
West Run (VAV-B55R_WST01A00)	6.12 miles	2010	extending from its headwaters downstream to its confluence with Crooked Run

Crooked Run and its tributaries (Stephens and West Runs) and Willow Brook are located primarily in Frederick and Warren County, Virginia with a small portion of the Crooked Run watershed in Clarke County. All four watersheds are part of the Shenandoah River Basin. There watersheds total approximately 34,678 acres (54 miles^2). Forest and pasture are the predominant land uses in the watersheds (Table 3.2, Figures 3.2).

According to the 2012 Census of Agriculture, the average farm in Frederick County is 148 acres, and 139 acres in Warren County. Over 60% of primary farm operators in both counties identified their primary occupation as something other than farming. The average net cash income for a farm in Frederick County was estimated at $5,167, and -$5,083 in Warren County (USDA, 2012).

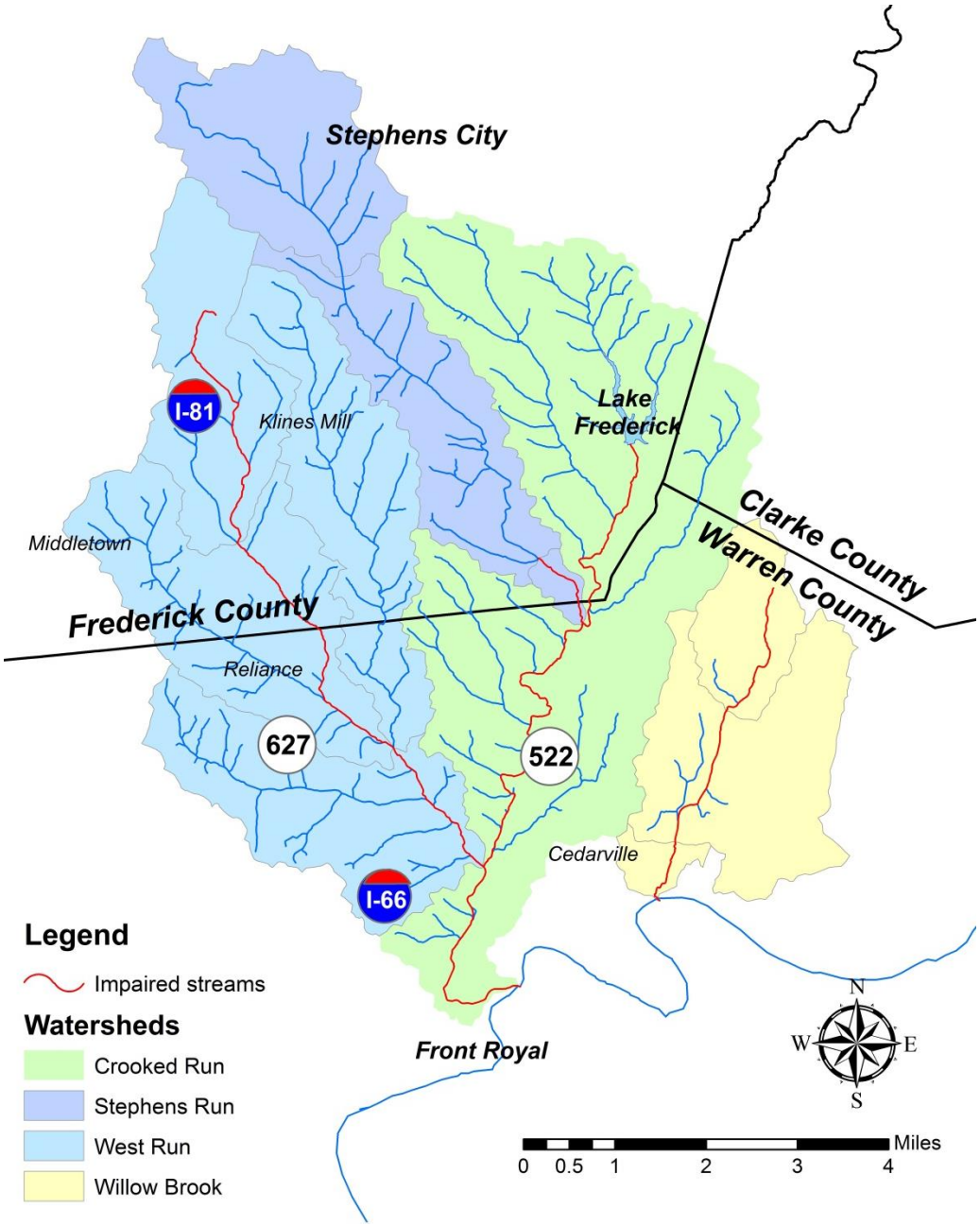

Figure 3.1 Location of the Crooked Run and Willow Brook watersheds and impaired stream segments.

Table 3.1 Land use acreages and percent total watershed acreage by land use category.

Land use	*Crooked Run Watershed Acres (% total)*	*West Run Watershed Acres (% total)*	*Stephens Run Watershed Acres (% total)*	*Willow Brook Watershed Acres (% total)*	*TOTAL Watershed Acres (% total)*
Forest	*5,221 (44%)*	*5,328 (42%)*	*1,360 (24%)*	*781 (18%)*	*12,690 (37%)*
Cropland	*428 (4%)*	*509 (4%)*	*395 (7%)*	*98 (2%)*	*1,430 (4%)*
Pasture	*3,758 (31%)*	*4,525 (36%)*	*2,203 (39%)*	*2,415 (55%)*	*12,901 (37%)*
Hayland	*675 (6%)*	*1,181 (9%)*	*605 (11%)*	*574 (13%)*	*3,035 (9%)*
Low intensity developed	*1,484 (12%)*	*1,024 (8%)*	*935 (17%)*	*557 (13%)*	*4,000 (12%)*
High intensity developed	*132 (1%)*	*11 (<1%)*	*50 (1%)*	*0 (0%)*	*193 (<1%)*
Water	*183 (1%)*	*36 (<1%)*	*18 (<1%)*	*1 (0%)*	*238 (<1%)*
Transportation	*77 (1%)*	*35 (1%)*	*29 (<1%)*	*0 (0%)*	*191 (<1%)*
TOTAL	***11,958***	***12,699***	***5,595***	***4,426***	***34,678***

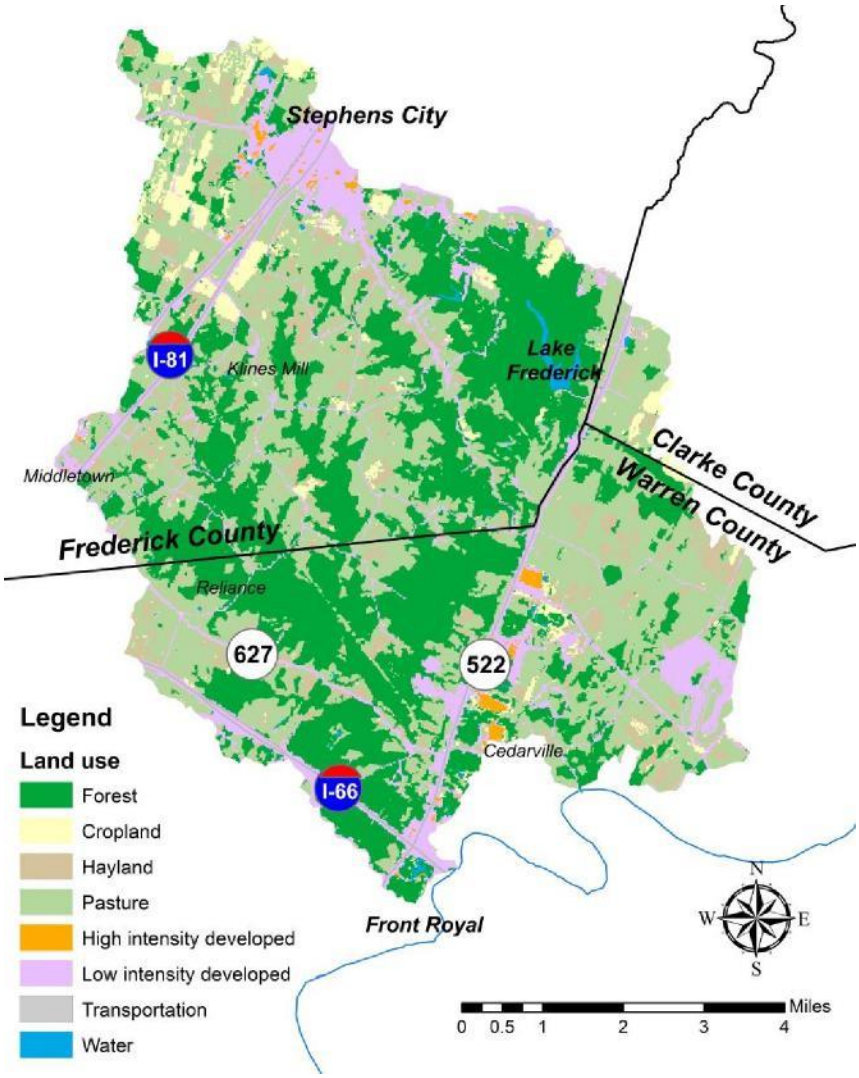

Figure 3.2 Land uses in the Crooked Run and Willow Brook watersheds.

Virginia Tech's Department of Biological Systems Engineering was contracted by the Virginia Department of Environmental Quality (VADEQ) to develop the Shenandoah Tributaries TMDL, which included Crooked, Stephens and West Runs and Willow Brook in 2013, and the TMDL study was completed in September 2014 (VADEQ, 2014). This TMDL study includes several additional watersheds (Borden Marsh Run, Happy Creek, Long Branch, Manassas Run) that are not a part of this TMDL implementation plan. These watersheds were not included in order to keep the implementation plan at a scale that allows for comprehensive implementation and measurable water quality improvements. The TMDL study is posted at www.deq.virginia.gov.

3.2 Water Quality Monitoring Data

Data collected from four water quality monitoring stations along Crooked Run and its tributaries and Willow Brook were used to list these streams as impaired by fecal bacteria and/or *E.coli* and to develop the bacteria TMDLs for the streams. Table 3.2 provides a summary of the data collected from these stations and Figure 3.3 shows the locations of the stations.

Table. 3.2 DEQ water quality monitoring stations in the Crooked Run and Willow Brook watersheds.

Station ID	Stream Name	Description	Number of Samples	Violation Rate	Period of Record
1BCRO002.75	Crooked Run	Off Rt. 627	104	15.4%	2005-2015
1BSTV000.20	Stephens Run	Near Rt. 639 Bridge	101	12.9%	2003-2015
1BWLO000.71	Willow Brook	Near Rt. 658 Bridge	43	34.9%	2004-2014
1BWST000.20	West Run	Near Rt. 609 Bridge	75	17.3%	2005-2014

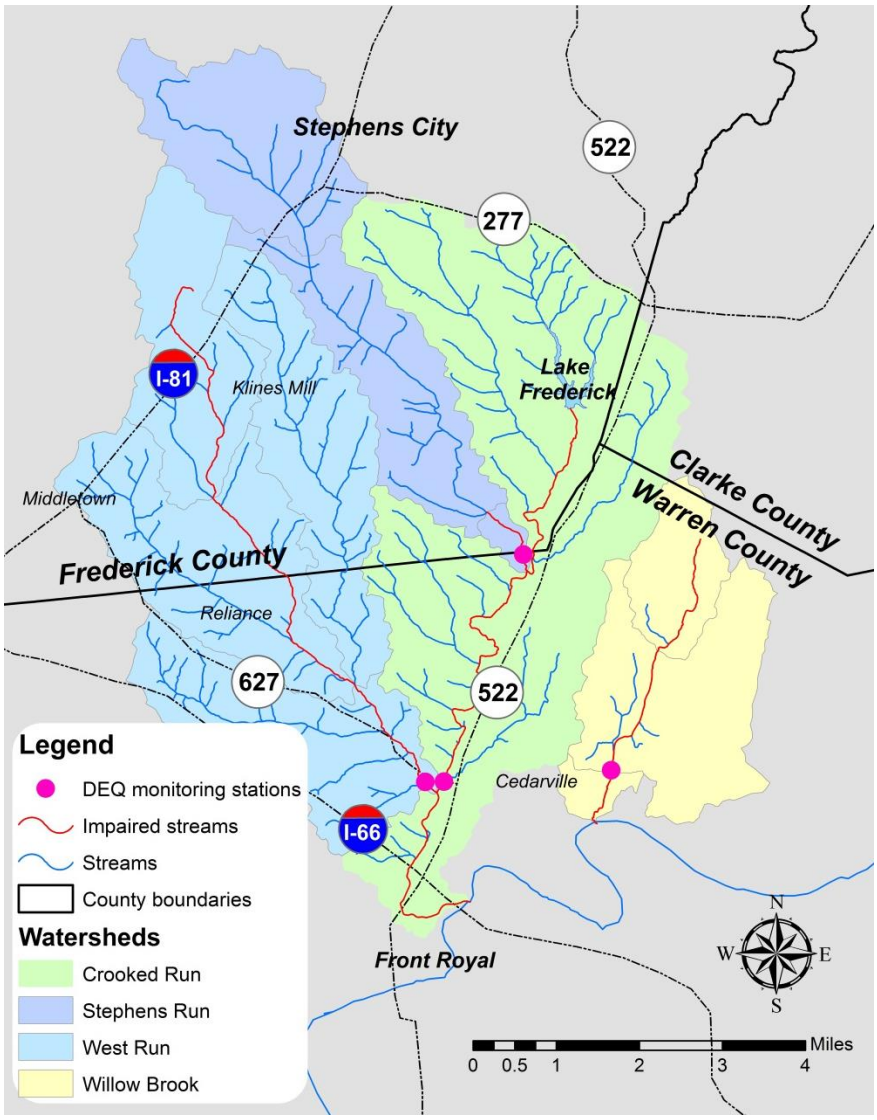

Figure 3.3 VADEQ monitoring stations in Crooked, Stephens, West Runs & Willow Brook

3.3 Water Quality Modeling

The Hydrologic Simulation Program – FORTRAN (HSPF) version 12 (Bicknell et al., 2005; Duda et al., 2001) was used to model fecal coliform transport and fate in the watersheds. ArcGIS 10 GIS software was used to display and analyze landscape information for the development of input for HSPF. The HSPF watershed model simulates pollutant accumulation, die-off, and washoff 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. In the Shenandoah Tributaries bacteria TMDL, a source assessment of fecal coliform bacteria was performed for the watersheds. Fecal coliform was then simulated as a dissolved pollutant using the HSPF model, and concentrations were translated to *E. coli* concentrations using VADEQ's translator equation (VADEQ, 2003).

To clearly identify sources of fecal coliform, each watershed was divided up into smaller subwatersheds (Figure 3.4). The sources and their respective fecal coliform contributions were identified for each smaller subwatershed based on land use and climate data, and human, livestock and wildlife populations. The HSPF model was then used to simulate the transport of these pollutant loads to the streams.

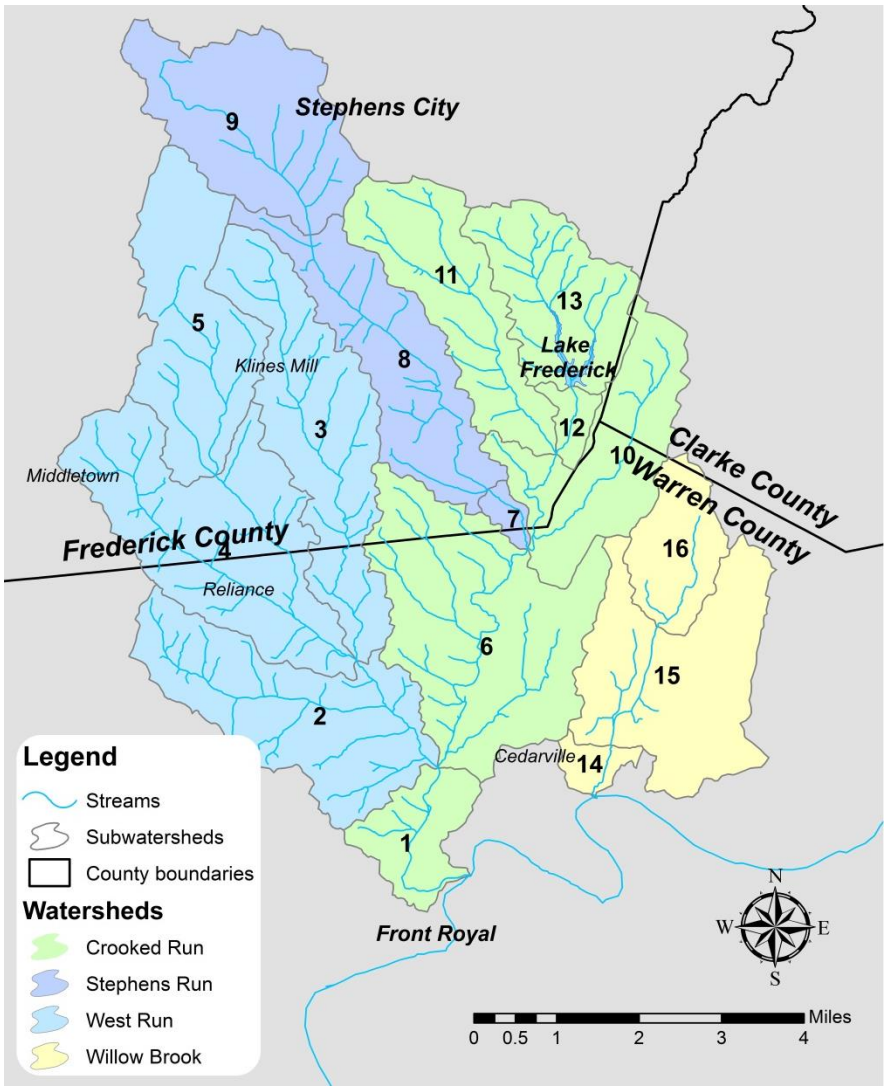

Figure 3.4 Subwatersheds used for TMDL development

3.4 Bacteria Source Assessment

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

3.4.1 Point Sources

A TMDL's waste load allocation accounts for the portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. Point sources of fecal coliform bacteria in the watersheds include all municipal and industrial plants that treat human waste, as well as private residences that fall under general permits. These point sources are required to maintain a fecal coliform discharge concentration no greater than 200 cfu/100mL. Virginia issues Virginia Pollutant Discharge Elimination System permits for point sources. There are currently 89 point sources permitted to discharge bacteria in the watersheds, 79 of which are single family home permits. The point sources of bacteria in the watersheds are listed in Table 3.4, along with their permitted discharges and load allocations in the TMDLs. The waste load allocation for each point source was set at the permitted load.

Table 3.4 Permitted bacteria point sources in the Crooked, Stephens, West Runs and Willow Brook watersheds.

Permit Number	Facility Name	Sub-watershed	Design Flow (mgd*)	Permitted *E. coli* Conc. (cfu/100 mL)	*E. coli* Load (cfu/year)
VA0061964	Forest Lakes Estates STP	11	0.150	126	2.61×10^{11}
VA0092703[b]	RSW Regional Jail WWTP	6	0.020	126	3.48×10^{10}
VA0090247	Jacksons Chase WWTP	2	0.020	126	3.48×10^{10}
VA0088811	Sandys MHC LLC STP	13	0.040	126	6.97×10^{10}
VA0023370	DOC White Post Correctional Unit 7	10	0.037	126	6.45×10^{10}
VA0080080	Crooked Run STP	12	0.250	126	4.35×10^{11}
VA0086100[b]	Bierer STP	6	0.350	126	6.09×10^{11}
VA0089095[b]	Pioneer Trailer Park	11	0.0055	126	9.58×10^{9}
3 Gen. Permits	Single Family Homes	1	0.003	126	5.23×10^{9}
10 Gen. Permits	Single Family Homes	2	0.010	126	1.74×10^{10}
14 Gen. Permits	Single Family Homes	3	0.014	126	2.44×10^{10}
15 Gen. Permits	Single Family Homes	4	0.015	126	2.61×10^{10}

Permit Number	Facility Name	Sub-watershed	Design Flow (mgd*)	Permitted *E. coli* Conc. (cfu/100 mL)	*E. coli* Load (cfu/year)
10 Gen. Permits	Single Family Homes	5	0.010	126	1.74×10^{10}
4 Gen. Permits	Single Family Homes	6	0.004	126	6.97×10^{9}
13 Gen. Permits	Single Family Homes	8	0.013	126	2.26×10^{10}
1 Gen. Permit	Single Family Homes	10	0.001	126	1.74×10^{9}
15 Gen. Permits	Single Family Homes	11	0.015	126	2.61×10^{10}
7 Gen. Permits	Single Family Homes	13	0.007	126	1.22×10^{10}
1 Gen. Permit	Single Family Homes	15	0.001	126	1.74×10^{9}

3.4.2 Nonpoint sources

Nonpoint source pollution originates from sources across the landscape (e.g., agriculture and urban 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 leaking sewer lines or livestock directly defecating in a stream). Nonpoint sources of bacteria in the watersheds included residential sewage treatment systems, land application of waste, livestock, wildlife, and domestic pets. During TMDL development, bacteria loads were represented either as land-based loads (where they were deposited on land and available for wash off during a rainfall event) or as direct loads (where they were directly deposited into the stream). Land-based nonpoint sources are represented as an accumulation of bacteria on the land, where some portion is available for transport in runoff. The amount of accumulation and availability for transport vary with land use type and season. The maximum accumulation was adjusted seasonally to account for changes in die-off rates, which are dependent on temperature and moisture conditions. Direct loads such as straight pipes are modeled similarly to point sources since they do not require a runoff event for delivery to the stream. Both point and nonpoint sources of bacteria in the watersheds are summarized in Tables 3.5-3.8.

Table 3.5 Annual fecal coliform bacteria load in the Crooked Run watershed by source.

Source Type	Source	Annual Fecal Coliform Load ($x10^{12}$ cfu/yr)	Percentage of Annual Load (%)
Land-based	Cropland	65	1%
Land-based	Pasture	4,433	89%
Land-based	Hayland	47	<1%
Land-based	Developed	363	7%
Land-based	Transportation	1	<1%
Land-based	Forest	89	2%
Direct	Straight pipes	<1	<1%
Direct	Livestock in stream	4	<1%
Direct	Wildlife in stream	2	<1%
All	Total	**5,004**	**100%**

Table 3.6 Annual fecal coliform bacteria load in the Stephens Run watershed by source.

Source Type	Source	Annual Fecal Coliform Load ($x10^{12}$ cfu/yr)	Percentage of Annual Load (%)
Land-based	Cropland	**28**	**1%**
Land-based	Pasture	**2,219**	**85%**
Land-based	Hayland	**88**	**3%**
Land-based	Developed	**235**	**9%**
Land-based	Transportation	**1**	**<1%**
Land-based	Forest	**26**	**1%**
Direct	Straight pipes	**<1**	**<1%**
Direct	Livestock in stream	**1**	**<1%**
Direct	Wildlife in stream	**1**	**<1%**
All	Total	**2,599**	**100%**

Table 3.7 Annual fecal coliform bacteria load in the West Run watershed by source.

Source Type	Source	Annual Fecal Coliform Load ($x10^{12}$ cfu/yr)	Percentage of Annual Load (%)
Land-based	Cropland	**21**	**<1%**
Land-based	Pasture	**4,277**	**94%**
Land-based	Hayland	**19**	**<1%**
Land-based	Developed	**142**	**3%**
Land-based	Transportation	**1**	**<1%**
Land-based	Forest	**84**	**2%**
Direct	Straight pipes	**<1**	**<1%**
Direct	Livestock in stream	**7**	**<1%**
Direct	Wildlife in stream	**2**	**<1%**
All	Total	**4,554**	**100%**

Table 3.8 Annual fecal coliform bacteria load in the Willow Brook watershed by source.

Source Type	Source	Annual Fecal Coliform Load ($x10^{12}$ cfu/yr)	Percentage of Annual Load (%)
Land-based	Cropland	**10**	**<1%**
Land-based	Pasture	**2,696**	**97%**
Land-based	Hayland	**8**	**<1%**
Land-based	Developed	**44**	**2%**
Land-based	Transportation	**<1**	**<1%**
Land-based	Forest	**12**	**<1%**
Direct	Straight pipes	**<1**	**<1%**
Direct	Livestock in stream	**6**	**<1%**
Direct	Wildlife in stream	**2**	**<1%**
All	Total	**2,777**	**100%**

In addition to considering total land based loads of bacteria in the watershed, their relative contributions towards in stream bacteria concentrations must also be considered during TMDL development and implementation planning. While livestock in the stream is a comparatively small bacteria load when compared to pasture, land based loads require precipitation events to transport fecal coliform to the stream. In addition, not all of the load is available for wash off since bacteria die off over time. Therefore, the relative contributions of land based and direct sources to instream water quality are often considerably different than overall watershed loads. Table 3.9 shows how each of these sources impacts *E.coli* concentrations in the streams.

Table 3.9 Relative daily contributions of *E.coli* sources to the overall *E.coli* concentration for existing conditions in Crooked, Stephens, West Runs and Willow Brook

Source	Crooked Run	Stephens Run	West Run	Willow Brook
Nonpoint source loadings from forest	1%	<1%	<1%	<1%
Nonpoint source loadings from cropland	<1%	<1%	<1%	<1%
Nonpoint source loadings from pasture	41%	44%	42%	37%
Nonpoint source loadings from hayland	1%	2%	<1%	2%
Nonpoint source loadings from developed	7%	11%	3%	2%
Nonpoint source loadings from transportation	<1%	<1%	<1%	<1%
Direct nonpoint source loading from livestock in stream	28%	16%	36%	41%

Source	Crooked Run	Stephens Run	West Run	Willow Brook
Direct nonpoint source loading from wildlife in stream	15%	19%	13%	17%
Interflow and groundwater contribution	<1%	<1%	<1%	<1%
Straight pipes discharges to stream	2%	5%	2%	<1%
Permitted point source loadings	4%	<1%	1%	<1%

3.5 TMDL Allocation Scenarios

3.5.1 Bacteria Allocation Scenario and TMDL Expression

The TMDL includes reduction scenarios needed to meet the *E. coli* water quality standard. In order to develop the TMDLs for *E. coli*, fecal coliform bacteria data collected in prior years from the streams needed to be converted to *E. coli* concentrations. VADEQ has developed a procedure to be followed in this situation. The needed modeling was conducted using fecal coliform loadings as the bacteria source in the watershed. Then an equation developed by VADEQ was used to convert the daily average fecal coliform concentrations output by the model to daily average *E. coli* concentrations. The equation is:

$$E.\ coli \text{ concentration} = 2^{-0.0172} \times (\text{FC concentration})^{0.91905}$$

where the bacteria concentrations (*E. coli* and FC) are in cfu/100 mL. After applying the equation to the output from the LSPC model, daily *E. coli* loads were determined by multiplying the simulated daily average *E. coli* concentrations by the average daily flow. The average annual load was determined by summing the daily loads and dividing by the number of years in the allocation period.

Different scenarios were evaluated to identify scenarios for implementation that meet the calendar-month geometric mean bacteria standard (126 cfu/100 mL for *E. coli*) with zero violations. The MOS (margin of safety) was implicitly incorporated into each TMDL by conservatively estimating several factors affecting bacteria loadings, such as animal numbers, production rates, and contributions to streams. A preferred scenario was selected by a technical advisory committee for each watershed during the TMDL

development process (Table 3.10). The TMDLs for Crooked, Stephens, West Runs and Willow Brook were derived from the preferred reduction scenarios identified in the TMDL (Table 3.11). An implicit margin of safety is included in the TMDL equations.

Table 3.10 *E. coli* loading reduction (%) scenarios needed to meet the *E. coli* geometric mean standard.

Watershed	Livestock direct deposit	Pasture	Cropland	Straight pipes & failing septic	Developed	% Violation of *E. coli* standard (Geometric Mean)
Crooked Run	74%	45%	15%	100%	10%	0.00%
Stephens Run	44%	42%	15%	100%	10%	0.00%
West Run	85%	50%	15%	100%	0%	0.00%
Willow Brook	95%	45%	15%	100%	0%	0.00%

Table 3.11 TMDL equations for Crooked, Stephens, West Runs and Willow Brook expressed as an average annual and an average daily load.

Watershed	Annual Wasteload Allocation (WLA) (cfu/yr)	Daily Wasteload Allocation (WLA) (cfu/day)[1]	Annual Load Allocation (LA) (cfu/yr)	Daily Load Allocation (LA) (cfu/day)	Margin of Safety (MOS)	Annual TMDL (cfu/yr)	Daily TMDL (cfu/day)[2]
Crooked Run	2.22E+12	6.05E+9	6.39E+13	6.94E+11	Implicit	6.61E+13	7.00E+11
Stephens Run	3.07E+11	8.41E+8	1.39E+13	1.29E+11	Implicit	1.42E+13	1.29E+11
West Run	5.80E+11	1.59E+9	2.24E+13	2.92E+11	Implicit	2.30E+13	2.94E+11
Willow Brook	2.33E+11	6.38E+8	1.13E+13	1.02E+11	Implicit	1.15E+13	1.03E+11

During the TMDL development process, the technical advisory committee also selected a Stage 1 scenario (Table 3.12). The goal of the Stage 1 scenario is to reduce the bacteria loadings from controllable sources such that violations of the single-sample maximum criterion (235 cfu/100mL) are less than 10.5 percent. Implementation of practices included in Stage 1 is expected to result in the removal of the creeks from the impaired waters list.

Table 3.12 *E. coli* loading reduction (%) scenarios needed to achieve the delisting goal.

Watershed	Livestock direct deposit	Pasture	Cropland	Straight pipes & failing septic	Developed	% Violation of *E. coli* standard (Geometric Mean)
Crooked Run	45%	40%	10%	100%	5%	10.40%
Stephens Run	20%	34%	10%	100%	5%	10.40%
West Run	78%	43%	10%	100%	0%	10.30%
Willow Brook	80%	35%	10%	100%	0%	10.40%

3.6 Implications of the TMDLs on the Implementation Plan

Based on the bacteria reductions developed for the TMDL, 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. While wildlife contribute *E. coli* to the streams, reductions from these sources are not necessary in order to meet the TMDL. Therefore, wildlife contributions of *E. coli* in the watersheds will not be addressed by this implementation plan. All efforts will be directed at controlling anthropogenic sources.

4. PUBLIC PARTICIPATION

Collecting input from the public on conservation and outreach strategies to include in the TMDL Implementation Plan was a critical step in this planning process. Since the plan will be implemented by watershed stakeholders on a voluntary basis, local input and support are the primary factors that will determine the success of this plan.

4.1 Public Meetings

A public meeting was held on the evening of January 28, 2016 at Lord Fairfax Community College to kick off the development of the implementation plan. This meeting served as an opportunity for local residents to learn more about the problems facing the creeks and work together to come up with new ideas to protect and restore water quality in their community. This meeting was publicized through a press release published in local papers, email announcements, invitations mailed to riparian landowners, and signs and flyers posted throughout the watersheds. Approximately 25 people attended the meeting.

The meeting began with a brief presentation on existing water quality conditions in the streams and what types of actions and information could be included in the implementation plan to improve water quality. Following the presentation, attendees split up into two working groups: a residential group and an agricultural group. The working groups discussed how residential and agricultural land use practices are affecting the quality of these streams and then reviewed different land use management practices that could be included in the cleanup plan. TMDL staff from Virginia's Department of Environmental Quality facilitated these discussions.

The final public meeting was held on June 29, 2016 at the North Warren Fire Hall. Approximately 35 people attended.

4.2 Agricultural Working Group

The role of the Agricultural Working Group was to review conservation practices and outreach strategies from an agricultural perspective, identify any obstacles (and solutions)

related to BMP implementation, and to provide estimates on the type, number, and costs of BMPs.

During their first meeting on January 28, 2016, the agricultural working group discussed the general state of agriculture in the watershed noting that suburban encroachment has been identified as a real problem in the area. The Willow Brook watershed has been subject to far less development pressure than the other watersheds and is more likely to stay in agricultural land use in the future. It was noted that more small organic farms are coming into the region, but that start up costs for larger operations are cost prohibitive. Many farms in the area are leased (at least 50%). Many of the landowners in the region are older and no longer farm their own land. It was noted that it's hard to even find land to lease in the region, and that it's very competitive when property comes up to lease. The group agreed that long term leases are much better for farmers than short term (1 year agreements), 5-10 years was noted as ideal. There are a number of absentee landowners in the area as well. DEQ staff asked participants about potential partners for outreach activities. Participants suggested VA Cooperative Extension along with the local Farm Bureaus.

In order to gage local interest in different BMP options and identify the most suitable livestock exclusion fencing systems for inclusion in the plan, a survey was distributed to meeting participants. Everyone was asked to rank a series of BMPs along with a series of obstacles to livestock exclusion. The results are summarized in the two tables below:

Table 4.1 Potential best management practices for consideration. Average rankings are shown below (7 total) with 1 being the highest priority practice and 7 being the very lowest priority.

Best management practice	Description	Rank (1-7)
Streamside livestock exclusion fencing	Excluding livestock from streams with fencing, providing alternative water sources or limited access points to the stream	1
Rotational grazing	Establishing a series of grazing paddocks with cross fencing and rotating livestock to maximize forage production while preventing overgrazing	5

Best management practice	Description	Rank (1-7)
Forested streamside buffers	Planting trees and shrubs in strips (35 foot minimum) along streams adjacent to pasture and cropland	2
Grassed streamside buffers	Planting grasses in strips (35 foot minimum) along streams adjacent to pasture and cropland)	3
Forestation of crop, pasture or hayland	Convert existing pasture, crop or hayland to forest (hardwood or conifers,	4
Continuous no-till	Cropland is planted and maintained using no-till methods, only effective in reducing bacteria for cropland receiving manure applications (not commercial fertilizer)	5
Manure composting/storage facilities (equine)	Construction of planned system designed to manage solid equine waste from areas where horses are concentrated either through composting or storage	6

Table 4.2 Obstacles to streamside livestock exclusion. Average rankings are shown below (5 total) with 1 being the most common obstacle to address and 5 being the least common obstacle.

Obstacle	Rank (1-5)
The cost of installing fencing and off stream water is too high, even with cost share assistance from federal and state programs	1
Cannot afford to give up the land for a 35 foot buffer	3
General maintenance of fencing is time consuming and expensive	2
Grazing land is rented with short term leases and landowners are not interested in installing and/or maintaining streamside fencing and off stream water	4
People do not trust the government and do not want to work through state and federal cost share programs to installing fencing systems	3

A second agricultural working group meeting was held at the Front Royal Volunteer Fire Department on March 8, 2016. The group reviewed summaries of the extent of BMP implementation that would be needed to remove the creeks from the impaired waters list and discussed obstacles to implementation. Livestock stream exclusion systems available

through state and federal cost share programs were discussed, and it was noted that these programs have issues with funding drying up after staff go out and solicit applications to complete projects. The group discussed the different types of fencing systems and their pros and cons. One participant discussed how he felt that these programs are designed to encourage farmers to improve water quality to benefit the general public, in which case the practices offered through them should be funded at 100% of the cost. Farmers are not typically generating a significant income from farming these days, making their 25% share of the cost of many of these practices very difficult to come up with. Water levels have been much lower in streams in the area in recent years as well. It was suggested that how often a stream has flowing water in it should be considered when developing these estimates and prioritizing projects. Several participants agreed that higher flowing segments streams should be targeted first along with the worst areas where livestock have access. Maintenance of fencing was discussed as a significant issue for farmers. The group reviewed component costs for fencing systems. It was noted that not everyone uses 5-strand high tensile wire for fencing. Four or five strand barbed wire can be very effective too, and typically costs less.

One participant suggested working with the Department of Corrections to both maintain fences and put them up. This could decrease the cost of installing the initial fencing and also save farmers time and money when it comes to maintenance. One participant explained that there are only three farms located along Willow Brook where the creek is actually flowing. Two of these farms have already excluded their cattle from the stream, leaving only one farm in the watershed to install fencing before the whole stream is excluded from livestock. It was noted that the water quality issue in Willow Brook is really driven by livestock in the stream rather than runoff based on the soils found in the watershed and the hydrology.

A participant asked the group whether they thought participation in livestock exclusion programs would increase if Soil and Water Conservation Districts had a program in place to replace washed out fences still within their contract period. Participants thought that this would certainly help. It was noted that losing the buffer strip for agricultural production is definitely a concern, but that the cost of installing and maintaining the fences are the real issues of concern. It was also mentioned that stream channels move

over time, presenting another challenge to fencing them out. It was noted that rotational grazing is a profitable practice that allows a farmer to stock more cattle while also avoiding overgrazing pastures. Adequate rain is really important for rotational grazing, and it is more labor intensive, which may be why it is not more commonly used in the area. In addition, some types of cattle are harder on fences then others, making is difficult to maintain cross fencing and move the herd between paddocks. Another participant noted that adopting rotational grazing requires a real mindset shift in management, which not all farmers are ready to make. Bobby Clark with Cooperative Extension has been holding a series of workshops on how to increase the number of days you can graze and reduce the days that you have to feed hay. It would be worthwhile to see if this sort of workshop could be offered in the Crooked Run watershed in order to increase the use of rotational grazing in the area. Bobby has also been working on a "fencing school" for farmers. DEQ staff asked the group about the presence of highly denuded or eroding pastures in the watersheds. It was agreed that there are a few of these situations present in the area. A representative from the Soil and Water Conservation District noted that often times, these areas are addressed through livestock exclusion projects.

The group moved on to discuss best management practices for cropland. The group thought that an estimate of 90% of fields planted with cover crops to date was too high and that there is room to do more. One participant noted that they plant a cover crop every 2-3 years rather than annually. Soil and Water Conservation District staff noted that it's likely that many farmers don't realize that they can get cost share from the district for this practice, meaning that it's probably under reported.

DEQ staff asked the group to vote on an appropriate timeline for implementation of the practices discussed at the meeting. The group voted on 5, 10 and 15 years to complete the practices. Ten years received the majority of the votes and was thus selected as the implementation timeline for agricultural best management practices.

4.3 Residential Working Group

The primary role of the Residential Working Group (RWG) was to discuss methods needed to reduce human and pet sources of bacteria entering the creeks, recommend

methods to identify and correct or replace failing septic systems and straight pipes, and provide input on the BMPs to include in the plan.

At their first meeting on January 28th, the residential working group discussed septic system maintenance needs in the community. Participants felt that more education and outreach efforts are necessary to address septic system maintenance needs. Education on septic systems and alternative waste treatment systems could be targeted towards realtors and homebuilders in addition to homeowners in the watershed. One participant suggested that the VA Department of Health should work with local realtors to require the inclusion of the capacity of septic systems in real estate transactions. It was noted that there are many challenges associated with working in karst/shale topography with respect to septic systems and alternative waste treatment systems. The percentage of alternative systems is higher than average in the watersheds because this topography makes it difficult to install a conventional drainfield. Participants estimated that the cost of an alternative system can be as high as $35,000 while conventional systems are usually around $8000. It costs $300 to inspect a septic system and pumpouts are typically around $300. Fear was identified as an important barrier to participation in assistance or education programs. Any sort of outreach should emphasize the voluntary nature of the program. Another barrier to participation in assistance programs will be the cost of hooking up to public sewer. In Frederick County, this is around $25,000 plus the cost of labor and materials to connect to the sewer line. Homeowners associations and public service boards hold public meetings every so often, which could be a good opportunity for outreach.

The group discussed potential partner organizations for rain garden installations in the watersheds including Front Royal Tree Stewards and the Garden Club of Warren County. Master Naturalists/Gardeners would probably not be the best partner for this particular implementation piece, but they could help with some residential education.

DEQ staff asked participants about opportunities for pet waste stations in the watersheds. Lake Frederick already has pet waste stations set up in the surrounding area, and some Homeowners Associations include pet waste disposal in their covenants/agreements. It

was noted that peer pressure is a critical component in getting pet owners to pick up after their pets. A local newspaper education campaign was suggested as a way to educate people about septic systems and pet waste. The campaign could make the connection between groundwater science, septic system maintenance and financial cost share. Coliscan monitoring was suggested as a good tool for making upstream downstream comparisons to convince landowners to exclude their livestock. McKay Springs was identified as a particular location that needs some additional monitoring. Another participant suggested launching a drinking water campaign. "Taste of the Shenandoah" could work with participating businesses and local Chambers of Commerce to stress local resources, health and taking care of our children by caring for our water. Local schools could also be involved in monitoring and outreach. They could play an important role in recruiting local service organizations such as Boy Scouts and Girl Scouts. Envirothon could be another tool to reach out to the local community.

It was noted that there is a need for sanitary facilities at Lake Frederick for fishermen after peak fishing season. Currently facilities are not available year round.

The group reviewed overall residential priorities and ranked them with one being the highest priority:

1. Straight pipes and failing septic systems
2. Homeowner education
3. Connection to public sewer

A second residential working group meeting was held on April 7, 2016 Lord Fairfax Community College. The group discussed the opportunities, estimates of repairs and replacements of failing septic systems and straight pipes, along with associated outreach strategies. It was suggested that the expected life span of a septic system be noted in outreach materials. Outreach could be targeted to homes within a specific distance from the stream or from springs when doing mailings.

It was noted that Warren County used an anti-litter grant to purchase pet waste stations for parks and other public properties in the county. The county requires kennels to

double bag waste from their operations and take it to the transfer station for disposal. It is handled as commercial waste, which puts local kennels under more strict controls. In Warren County, if you have five or more dogs, you have to have a permit. It is suspected that the number of properties with five or more dogs is vastly underreported. The group thought that these properties are probably having the greatest impact on water quality with respect to pet waste runoff. However, these types of properties are often very difficult to manage since they usually include a few acres, making pet waste pickup more challenging for the pet owners. The group suggested identifying with Homeowners Associations neighborhoods to target with pet waste stations since these areas may have the resources needed to ensure that the stations are stocked with bags and that trash is collected regularly. Staff from Warren County noted that the only development in their portion of the watershed with an HOA is the Blue Ridge Shadows Golf Course. DEQ staff asked the group whether they thought that there would be any interest in pet waste composters for private residences in the watershed. Staff from Warren County and VA Master Naturalists agreed that interest in these has been shown to date, and that it would be a good idea to include a small amount in the plan.

Several neighborhoods at the northern end of the Stephens Run watershed were identified for pet waste stations along with the Forest Lakes Estates development in Crooked Run. All of these developments are located in Frederick County. The group suggested working with the Garden Club or the Native Plant Society to select attractive riparian plants for residential buffers.

The group discussed potential locations for stormwater management BMPs in the Crooked and Stephens Run watersheds. The group suggested working with Sherando Park and Sherando High School on stormwater practices. The high school has a great agricultural department along with horticultural groups, who would likely be interested in helping to maintain a stormwater BMP such as a rain garden or bioretention filter. The group discussed several commercial properties that could be good sites for stormwater retrofits. The following commercial/industrial properties in Warren County were identified as potential BMP retrofit sites:

- Holiday Inn, Front Royal

- Sysco Systems
- Ferguson
- VA Inland Port
- Economic Development Authority (estimated 70-80 acre drainage area, adjacent to Sysco)

Participants did not think that the golf course would be interested.

The group discussed opportunities to partner with local organizations on education and outreach. VA Master Naturalists would probably be interested; however, it will be important to adopt a watershed wide approach rather than just focusing on outreach to a few specific property owners as this is their priority. The Native Plant Society would be a good partner for riparian buffer plant selection. Local realtors could be good sources of information about neighborhoods in the watershed. Civic clubs such as Rotary and Ruritans could be another great partner in outreach. While Lord Fairfax SWCD could be a great partner in outreach for both agricultural and residential practices, additional staffing at the SWCD office would be needed in order to support this sort of targeted outreach by the SWCD. They currently have a new Stormwater Committee, which is led by a new district director from Frederick County. Other potential partners suggested included:

- Northern Shenandoah Valley Regional Commission
- Frederick County Builders Association (Top of VA)
- Warren County Builders Association
- Local realtor associations (used to do a local realtor forum)
- Chamber of Commerce

The group discussed an appropriate timeline for completion of the septic, pet waste and stormwater BMPs. The cost of the alternative waste treatment systems needed in the watersheds was noted as an obstacle to completing the work on a tight timeline. The group voted on a 5, 10 or 15 year timeline for the project and agreed upon 10 years.

4.4 Steering Committee

The Steering Committee met on May 24, 2016 at Lord Fairfax Community College to discuss plans for the final public meeting and to review the draft implementation plan prior to the final public meeting on June 29, 2016. The group provided comments on the draft plan and helped to develop a final agenda for the meeting.

5. 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 particular community. As part of this process, the costs and benefits of these practices must be examined and weighed. Once the best practices have been identified for implementation, we must also develop an estimate of the number of each practice that would be needed in order to meet the water quality goals established during the TMDL study.

5.1 Identification of Best Management Practices

Potential best management practices, their associated costs and efficiencies, and potential funding sources were identified through review of the TMDL, input from the working groups, and literature reviews. Measures that can be promoted through existing programs were identified, as well as those that are not currently supported by existing programs and their potential funding sources. Some best management practices had to be included in order to meet the water quality goals established in the TMDL, while others were selected through a process of stakeholder review and analysis of their effectiveness in these watersheds. These measures are discussed in sections 5.1.1 and 5.1.2, respectively.

5.1.1 Control Measures Implied by the TMDL

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

Livestock Exclusion

In order to meet the bacteria reductions in direct deposition from livestock, some form of stream exclusion is necessary. Fencing is the most obvious choice; however, the type of fencing, distance from the stream bank, and most appropriate management strategy for the fenced pasture are less obvious. While it is recognized that farmers will want to minimize the cost of fencing and the amount of pasture lost, the inclusion of a streamside buffer strip helps to reduce bacteria, sediment and nutrient loads in runoff. The

incorporation of effective buffers (35 foot minimum width) could reduce the need for more costly control measures. From an environmental perspective, the best management scenario would be to exclude livestock from the stream bank 100% of the time and establish permanent vegetation in the buffer area. This prevents livestock from eroding the stream bank, provides a buffer for capturing pollutants in runoff from the pasture, and establishes (with the growth of streamside vegetation) one of the foundations for healthy aquatic life. From a livestock-production perspective, the best management scenario is one that provides the greatest profit to the farmer. Obviously, taking land (even a small amount) out of production is contrary to that goal. However, a clean water source has been shown to improve milk production and weight gain. Clean water will also improve the health of animals (*e.g.*, cattle and horses) by decreasing the incidence of waterborne illnesses and exposure to swampy areas near streams. State and federal conservation agencies including DCR and the Natural Resources Conservation Service have incorporated livestock exclusion practices into their agricultural cost share programs that offer farmers greater flexibility in fencing options. This flexibility allows farmers with limited pasture acreage to exclude livestock from the stream while not sacrificing a significant amount of land for grazing.

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 identified for correcting straight pipes and failing septic systems included: repair of an existing septic system, installation of a septic system, and installation of an alternative waste treatment system. It is anticipated that a significant portion of straight pipes will be located in areas where an adequate site for a septic drain field is not available. In these cases, the landowner will have to consider an alternative waste treatment system.

5.1.2 Control Measures Selected through Stakeholder Review

In addition to the control measures that were directly prescribed by the TMDLs, a number of measures were needed to control fecal bacteria and sediment from land-based sources. Various scenarios were developed and presented to working groups. All scenarios began with the best management practices that were prescribed by the TMDL such as livestock exclusion and eliminating straight pipes. Next, series of established

best management practices were examined by the working groups, who considered both their economic costs and the water quality benefits that they produced. The majority of these practices are included in state and federal agricultural cost share programs that promote conservation. In addition, innovative and site specific practices suggested by local producers and technical conservation staff were considered

The final set of BMPs identified and the efficiencies used in this study to estimate needs are listed in Table 5.1.

Table 5.1 Best management practices and associated pollutant reductions

BMP Type	Description	Bacteria Reduction Efficiency	Reference
Direct deposit	Livestock exclusion from waterway	100%	1
Pasture	Streamside buffer (35 feet)	52.69%	2, 5
Pasture	Improved pasture management	50%	3
Pasture	Permanent vegetative cover on critical areas	LU change	4
Pasture	Reforestation of highly erodible pasture/cropland	LU change	4
Cropland	Small grain cover crops	20%	5
Cropland	Continuous no-till	64%	2, 5
Cropland	Streamside buffer (35 ft)	52.69%	2, 5
Straight pipes/Septic	Septic tank pumpout	5%	7
Straight pipes/Septic	Connection to public sewer	100%	1
Straight pipes/Septic	Septic system repair	100%	1
Straight pipes/Septic	Septic system replacement	100%	1
Straight pipes/Septic	Alternative waste treatment system	100%	1
Residential/ Developed	Pet waste disposal station	75%	6
Residential/ Developed	Pet waste composter/digester	100%	1
Residential/ Developed	Pet waste education program	50%	6
Residential/ Developed	Riparian buffer	50%	2,5
Residential/ Developed	Rain garden	55%	2,5
Residential/ Developed	Bioretention filter	55%	2,5
Residential/ Developed	Detention basin retrofit with constructed	50%	2,5,8

References

1. Removal efficiency is defined by the practice
2. Bacteria efficiency assumed to be equal to sediment efficiency.
3. VADCR and VADEQ. 2003. Guidance manual for Total Maximum Daily Load Implementation Plans. Available at: www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/TMDLImplementationPlanGuidanceManual.aspx
4. Based on differential loading rates to different land uses.
5. Chesapeake Assessment Scenario Tool - BMP effectiveness values by land use and HGMR and pollutant
6. Adapted from Swann, C. 1999. A survey of residential nutrient behaviors in the Chesapeake Bay. Widener Burrows, Inc. Chesapeake Bay Research Consortium. Center for Watershed Protection. Ellicott City, MD. 112 pp
7. Bacteria efficiency assumed equal to nitrogen removal efficiency - Chesapeake Assessment Scenario Tool - BMP effectiveness values by land use and HGMR and pollutant
8. Retrofit efficiency calculated by subtracting the existing BMP efficiency of 10% for dry detention basins from the increased efficiency of wet ponds and wetlands of 60% to simulate the impact of the BMP restoration project. Should treatment areas for individual basins in Crooked and Stephens Runs be identified, the Retrofit Removal Rate Adjustor Curves developed by the Chesapeake Bay Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Projects should be used to predict subsequent reductions.

5.2 Quantification of Control Measures

The quantity of control measures recommended during implementation was determined through spatial analyses, modeling alternative implementation scenarios, and using input from the working groups. Data on land use, stream networks, and elevation were used in spatial analyses to develop estimates of the number of control measures recommended overall, in each watershed, and within smaller subwatersheds. Data from the VADCR Agricultural BMP Database and the Lord Fairfax SWCD showing where best management practices are already in place in the watersheds were considered when developing these estimates. In addition, census data were used in order to quantify septic system repairs and replacements needed in order to meet the reductions specified in the TMDL. Estimates of the amount of residential on-site waste treatment systems, streamside fencing and number of full livestock exclusion systems were made through these analyses. The quantities of additional control measures were determined through modeling alternative scenarios and applying the related pollutant reduction efficiencies to their associated bacteria loads.

Implicit in the TMDL is the need to avoid increased delivery of pollutants from sources that 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 failing septic systems, sewer line overflows and leaks.

5.2.1 Agricultural Control Measures

Livestock Exclusion BMPs

The delisting reduction scenario shown in Table 3.12 includes recommendations of a 45% reduction in direct deposition of manure in Crooked Run, a 20% reduction in Stephens Run, a 78% reduction in West Run, and a 80% reduction in Willow Brook. In addition, a 50% reduction in bacteria from pasture is needed in Crooked Run, a 34% reduction in Stephens Run, a 43% reduction in West Run, and a 35% reduction in bacteria from pasture in Willow Brook. Consequently, this plan includes recommendations for livestock exclusion practices implemented in conjunction with improved pasture management. To estimate fencing needs, the perennial stream network was overlaid with land use using GIS mapping software (ArcView v.10.1). Stream segments that flowed through or were adjacent to land use areas that had a potential for supporting cattle (*e.g.,* pasture) were identified using 2011 VBMP Orthophotography and the 2011 National Hydrography Dataset (NHD) streams layer. If the stream segment flowed through the land-use area, it was assumed that fencing was needed on both sides of the stream. If a stream segment flowed adjacent to the land-use area, it was assumed that fencing was required on only one side of the stream. Not every land-use area identified as pasture has livestock on it at any given point in time. However, it is assumed that all pasture areas have the potential for livestock access. Following GIS analyses of fencing needs, the VADCR Agricultural BMP Database was queried to identify the amount of livestock exclusion systems already in place in the watershed (Table 5.2). Any fencing installed was subtracted from the length of potential fencing in the watershed (Table 5.3). A map of potential streamside fencing required for streams in the watersheds is shown in Figure 5.1.

Table. 5.2 Livestock exclusion systems in the watershed tracked through the VADCR Agricultural BMP database: *December 1998 – September 2013*. NOTE: Table does not include data from systems that were not installed through government cost share programs. CRP and EQIP data were not available.

Subwatershed	Practice	Extent installed (linear ft)	Total # of practices
Crooked Run	Stream exclusion with grazing land management (SL-6)	1,450	2
Stephens Run	CREP Grazing land protection	3,280	2
Stephens Run	Stream exclusion with grazing land management (SL-6)	2,936	4
Stephens Run	Streambank protection fencing (WP-2)	14,120	1
West Run	Stream exclusion with grazing land management (SL-6)	2,115	2
West Run	Streambank protection fencing (WP-2)	1,473	1
Willow Brook	Stream exclusion with grazing land management (SL-6)	11,788	5
All	**TOTAL**	**37,162**	**17**

Table 5.3 Stream fencing needs summary (Stage 1).

Watershed	Sub-watershed	Total potential fencing	Fencing needed to meet goal (ft)	Fencing still needed to meet goal (miles)
Crooked Run	1	1,774	798	0.15
Crooked Run	6	13,324	5,996	1.14
Crooked Run	10	36,098	16,244	3.08
Crooked Run	11	5,684	2,558	0.48
Crooked Run	12	4,389	1,975	0.37
Crooked Run	13	7,211	3,245	0.61
Crooked Run (45% exclusion goal)	***Subtotal***	***68,480***	***30,816***	***6***
Stephens Run	7	1,769	354	0.07
Stephens Run	8	20,682	4,136	0.78
Stephens Run	9	13,397	2,679	0.51
Stephens Run (20% exclusion goal)	***Subtotal***	***35,848***	***7,169***	***1***
West Run	2	28,060	21,887	4.15
West Run	3	16,677	13,008	2.46
West Run	4	13,354	10,416	1.97
West Run	5	11,233	8,762	1.66
West Run (78% exclusion goal)	***Subtotal***	***69,324***	***54,073***	***10***
Willow Brook	15	2,212	1,770	0.34
Willow Brook (80% exclusion goal)	***Subtotal***	***2,212***	***1,770***	***0.34***
All	***TOTAL***	***175,864***	***93,828***	***17.8***

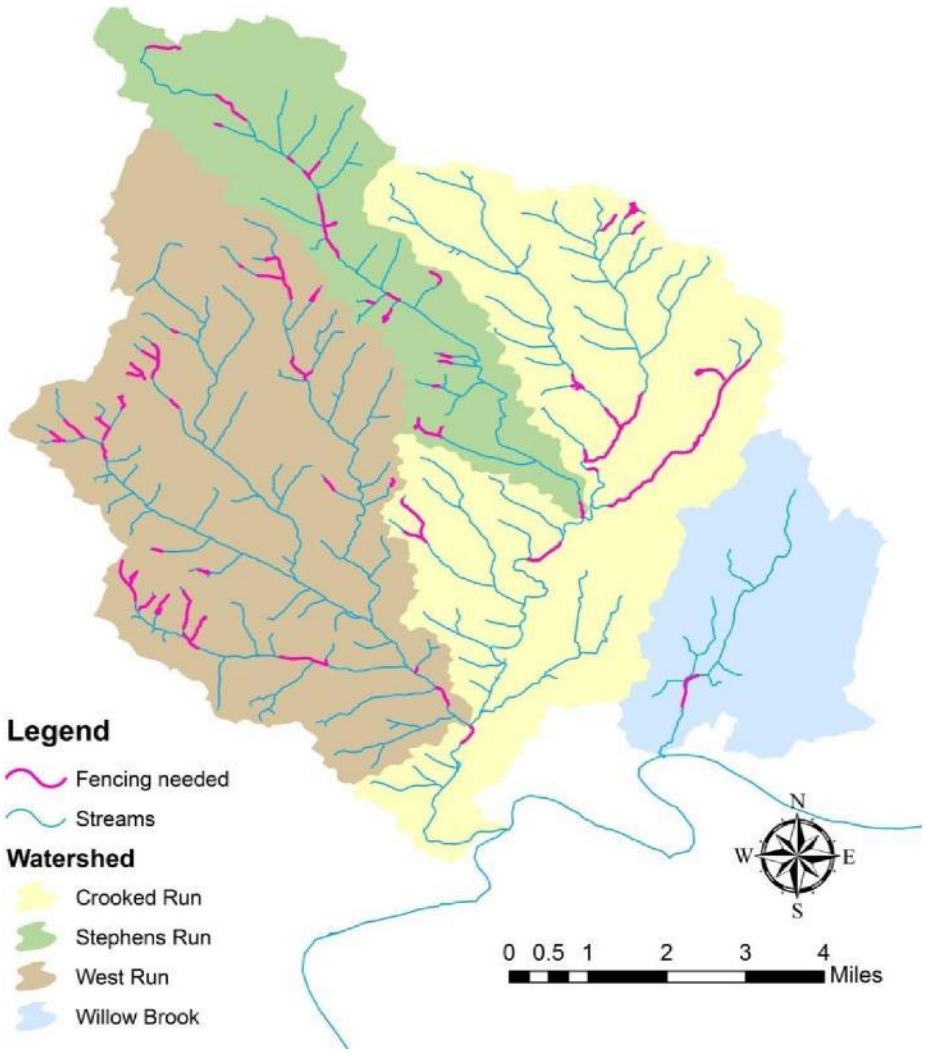

Figure 5.1 Potential stream exclusion fencing by subwatershed

It is expected that the majority of livestock exclusion fencing will be accomplished through the VA Agricultural BMP Cost Share Program and federal NRCS cost-share programs. Some applicable cost-shared BMPs for livestock exclusion in the programs are the SL-6 (Stream Exclusion with Grazing Land Management Practice), the LE-1T (Livestock Exclusion with Riparian Buffers for TMDL Implementation), the LE-2T (Livestock Exclusion with Reduced Setback for TMDL Implementation), and CREP (the

Conservation Reserve Enhancement Program). In order to determine the appropriate mix of these practices to include in the implementation plan, tax parcel data was utilized in conjunction with local data from the VADCR Agricultural BMP Database to determine typical characteristics (e.g., streamside fencing length per practice) of livestock exclusion systems in the region. In addition, input was collected from the Agricultural Working Group, NRCS and the Lord Fairfax SWCD regarding typical components of each system, associated costs, and preferred fencing setbacks. These characteristics were then utilized to identify the mix of fencing practices available through state and federal cost share programs to include in the implementation plan (Table 5.4).

The Stream Exclusion with Grazing Land Management Practice (SL-6) offers 75% cost share for off stream watering, establishment of a rotational grazing system, stream crossings, and stream exclusion fencing with a 35 foot setback (required). The LE-1T (Livestock Exclusion with Riparian Buffers for TMDL Implementation) is very similar to the SL-6 except that 85% cost share is provided and applicants may not receive funding to install hardened winter feeding pads. It was estimated that approximately 55% of fencing in the watershed would be installed using these practices.

The Livestock Exclusion with Reduced Setback Practice (LE-2T) only requires a 10 foot setback for stream fencing. Cost share is provided for stream fencing and cross fencing, stream crossings, and off stream waterers at a rate of 50%. It was estimated the 15% of livestock exclusion would be accomplished through the LE-2T practice.

The WP-2T system includes streamside fencing, hardened crossings, and a 35-ft buffer from the stream. This practice includes an up-front cost share payment of 50 cents per linear foot of fence installed to assist in covering anticipated fencing maintenance costs. In cases where a watering system already exists, a WP-2T system is a more appropriate choice. Despite the additional payment for maintenance costs, this practice is seldom used because it does not provide cost share for the installation of a well, this was reflected in the number of systems noted in the Ag BMP Database in Warren and Frederick Counties. Consequently, it was estimated that only 10% of fencing in the watersheds would be accomplished using the WP-2T practice.

Fencing through the Conservation Reserve Enhancement Program (CREP) was also included in implementation scenarios. For those who are willing to install a 35 foot buffer or larger and plant trees in the buffer, USDA-NRCS's CREP is an excellent option. This practice provides cost share and incentive payments ranging from 50% to 115% for fencing and planting materials. It is estimated that 20% of fencing in the watersheds will be installed through CREP.

Table 5.4 Estimate of full streamside exclusion fencing systems needed by subwatershed to meet Phase 1 implementation goals for de-listing

Watershed	Sub-watershed	SL-6/LE-1T (linear ft.)	SL-6/LE-1T (systems)	WP-2T (linear ft.)	WP-2T (systems)	CREP (linear ft.)	CREP (systems)	LE-2T (linear ft.)	LE-2T (systems)
Crooked Run	1	439	0.50	80	0.04	160	0.18	120	0.14
Crooked Run	6	3,298	0.74	600	0.08	1,199	0.27	899	0.20
Crooked Run	10	8,934	1.73	1,624	1	3,249	0.63	2,437	0.47
Crooked Run	11	1,407	0.25	256	0.02	512	0.09	384	0.07
Crooked Run	12	1,086	0.25	198	0.02	395	0.09	296	0.07
Crooked Run	13	1,785	0.74	324	0.05	649	0.27	487	0.20
Crooked Run	***Subtotal***	***16,949***	***4.2***	***3,082***	***1.2***	***6,163***	***1.5***	***4,622***	***1.1***
Stephens Run	7	195	0.11	35	0.00	71	0.03	53	0.03
Stephens Run	8	2,689	0.88	0	0.00	827	0.32	620	0.24
Stephens Run	9	1,742	0.88	0	0.00	536	0.32	402	0.24
Stephens Run	***Subtotal***	***4,625***	***1.87***	***35***	***0.00***	***1,434***	***0.67***	***1,075***	***0.51***
West Run	2	12,038	4.29	2,189	1.00	4,377	1.56	3,283	1.17
West Run	3	7,154	3.43	1,301	1.00	2,602	1.25	1,951	0.94
West Run	4	5,729	3.00	1,042	1.00	2,083	1.09	1,562	0.82
West Run	5	4,819	1.29	876	0.11	1,752	0.47	1,314	0.35
West Run	***Subtotal***	***29,740***	***12.01***	***5,407***	***3.11***	***10,815***	***4.37***	***8,111***	***3.28***
Willow Brook	15	1,770	1	0	0.00	0	0.00	0	0.00
Willow Brook	***Subtotal***	1,770	1	0	0.00	0	0.00	0	0.00
All	***TOTAL***	***53,083***	***19.09***	***8,524***	***4.32***	***18,412***	***6.56***	***13,809***	***5.05***

Land Based Agricultural BMPs

In order to meet the bacteria and sediment reductions outlined in the TMDLs, best management practices to treat land-based sources of the pollutants must also be included in implementation efforts. Table 5.5 provides a summary of land based agricultural BMPs by watershed needed to achieve water quality goals.

Riparian Buffers

For modeling purposes, it was assumed that a typical vegetative buffer would be able to receive and treat runoff from an area two times its width. For example, a buffer that was 35 feet wide and 1,000 feet long would treat runoff from an area that was 70 feet wide and 1,000 feet long. Once you move beyond two times the buffer width, it was assumed that the runoff would be in the form of channelized flow rather than the sheet flow that a buffer can trap. The 100-foot buffers were paired with livestock exclusion projects accomplished through CREP so that landowners could maximize financial incentives for taking the larger portion of pasture out of production.

Grazing Systems and Improved Pasture Management

Establishment of rotational grazing systems for cattle was recommended in conjunction with livestock exclusion projects. The majority of fencing programs will provide cost share for the establishment of cross fencing and alternative watering sources in order to establish these systems. In cases where livestock exclusion is not necessary, improved pasture management was prescribed. Like a grazing system, improved pasture management allows a farmer to better utilize grazing land and associated forage production. Improved pasture management includes:

- Implement a current nutrient management plan
- Maintain adequate soil nutrient and pH levels
- Manage livestock rotation to paddock subdivisions to maintain minimum grazing height recommendations and sufficient rest periods for plant recovery
- Maintain adequate and uniform plant cover (≥ 60%) and pasture stand density
- Locate feeding and watering facilities away from sensitive areas
- Manage distribution of nutrients and minimize soil disturbance at hay feeding sites by unrolling hay across the upland landscape in varied locations

- Designate a sacrifice lot/paddock to locate cattle for feeding when adequate forage is not available in the pasture system. Sacrifice lot/paddock should not drain directly into ponds, creeks or other sensitive areas and should not be more than 10% of the total pasture acreage.
- Chain harrow pastures to break-up manure piles after livestock are removed from a field at least twice a year to uniformly spread the manure load, or manage manure distribution through rotational grazing

Cropland Management Practices

A series of cropland management practices are included to control cropland runoff contributing bacteria to the streams. Continuous no-till is a practice that is becoming widely adopted in the region. By reducing tillage of the soil, farmers are able to conserve valuable soil and fertilizer and increase organic matter, which is an important factor in determining soil quality. Cover crops are planted on an annual basis in order to prevent soil erosion following harvest of crops like corn and soybeans when the soil would typically be left exposed.

Table 5.5 Land based agricultural BMPs needed to reach the TMDL

Land use	BMP	Crooked Run (acres)	Stephens Run (acres)	West Run (acres)	Willow Brook (acres)	TOTAL (acres)
Pasture	Improved pasture management	2,528	1,291	3,250	1,399	8,468
Pasture	Grazing land management	181	108	217	117	623
Pasture	Reforestation of highly erodible pasture	112	44	134	72	362
Pasture	Permanent vegetation on critical areas	1.1	0.4	1.4	0.7	4
Cropland	Cover crops (annual acreage)	37	27	49	9	122
Cropland	Permanent vegetative cover on cropland	13	12	15	3	43
Cropland	Continuous no till	4	8	10	1	23
Cropland	Riparian buffers (grass)	0.1	0.15	0.1	0.07	0.42

5.2.2 Residential Control Measures

Failing Septic Systems and Straight Pipes

All straight pipes and failing septic systems must be identified and corrected during implementation based on preexisting legal requirements. Table 5.6 shows the estimated number of failing septic systems and straight pipes by watershed. The number of potential failing septic systems and straight pipes in the watersheds were estimated in the TMDL using 2010 U.S. Census Bureau block demographics. The number of failing septic systems in the watershed was estimated based on the age of homes and standard failure rates for septic systems of that age. Homes with septic systems were broken into three age categories (prior to 1970, 1970-1989, or after 1989) based on 2010 census block group data. The percentage of homes within each age category was calculated for each census block group and these percentages were applied to the homes in each subwatershed based on the block group that had the greatest coverage of the sub-watershed. Septic system failure rates for houses pre-1970, 1970-1989, and post- 1989 were assumed to be 40%, 20%, and 3%, respectively.

Straight pipe numbers and possible locations were calculated as a 10% fraction of the total number of old and middle age, unsewered houses with stream access. Based on this criterion, it was estimated that there are seven straight pipes in the watersheds.

Table 5.6 Failing septic systems and straight pipes in the watersheds

Watershed	Total Septic Systems	Estimated Failing Septic Systems	Estimated Straight Pipes
Crooked Run	665	113	1
Stephens Run	837	189	3
West Run	632	138	3
Willow Brook	200	45	0
TOTAL	**2,334**	**485**	**7**

Based on data collected from several existing septic system cost share programs in nearby counties (Augusta and Rockingham) and input from local Health Department staff, it was estimated that 70% of failing septic systems could be corrected with a repair, the remaining 30% would need to be replaced. Of the systems that need to be replaced, a portion will require alternative waste treatment systems due to the geology present at the

site, or a lack of space necessary for a conventional drainfield. Table 5.7 shows a breakdown of the septic system and straight pipe replacements based on input from the Frederick County Health Department. Based on existing conditions in the watersheds, it was estimated that approximately 76% of septic system replacements would be done with alternative waste treatment systems, 20.5% could be done using conventional septic systems, and the remaining 3.5% could be corrected by connecting the home to public sewer (excluding the West Run and Willow Brook watersheds where there are no known opportunities to connect to public sewer). Because homes with straight pipes are more likely to have conditions that do not allow for installation of a conventional drainfield (older homes, smaller lots, home is located close to the stream), it was estimated that only 22% of straight pipes in the watershed could be corrected with the installation of a conventional system. Of the remaining straight pipes, it was estimated that 78% would need to be replaced with an alternative waste treatment system. A septic tank pumpout program was also discussed as a good way to heighten local awareness of septic system maintenance needs and to locate failing septic systems. Such a program could be implemented on a limited basis, targeting homes in close proximity to the creeks and to springs. The estimates shown in Table 5.7 are based on pumping out septic tanks for 25% of households in each watershed.

Table 5.7 Repairs and replacements of failing septic systems and straight pipes

Watershed	Septic system repair	Connect to public sewer	Replace with conventional system	Replace with conventional system w/ pump	Replace with alternative system	Septic tank pumpout
Crooked Run	79	2	4	3	26	166
Stephens Run	132	3	6	4	44	209
West Run	97	0	6	4	33	158
Willow Brook	32	0	2	1	10	50
TOTAL	**340**	**5**	**18**	**12**	**113**	**583**

Residential Stormwater and Pet Waste

In order to treat bacteria running off of bacteria and developed land, BMPs to reduce and filter residential and urban runoff are necessary. According to the TMDL, 5% reductions in residential bacteria sources (excluding failing septic systems and straight pipes) are

needed in the Crooked and Stephens Run watersheds in order to remove the streams from the impaired waters list. These are the only two watersheds where reductions in bacteria from residential and developed areas are needed in order to remove the streams from the impaired waters list. This is largely due to the fact that the other watersheds have little to no high density development and a limited degree of low density residential development. A pet waste education program could be implemented in order to encourage pet owners to pick up after their pets. This program could include newspaper articles, radio ads, postcard mailings and brochures to be distributed at local events and businesses frequented by pet owners. A limited number of pet waste digesters/composters are included in the plan based on local interest expressed to date in the watershed regarding composting of pet waste. In addition, several potential locations were identified for pet waste stations. These stations will include baggies and trash receptacles, and could be located in densely developed areas with Homeowners Associations that could help with the cost of emptying the receptacles and keeping bags stocked. Potential sites for pet waste stations included: Northern Stephens Run apartment complex, a new development west of 641 in Stephens Run, Sherando Park, and Forest Lakes Estates in Crooked Run.

In addition to pet waste management BMPs, a series of residential and urban stormwater BMPs were identified including rain gardens, bioretention filters, and detention basin retrofits. Rain gardens are small landscape features designed to catch runoff from paved surfaces and rooftops and filter out pollutants as the runoff moves down through a special soil mix. Bioretention filters are similar in function, but generally require more complex design work due to their capacity to handle a greater drainage area. These practices are typically used more often in commercial developments. There is also the potential to complete retrofits of several large regional stormwater basins to increase their capacity to filter bacteria and other pollutants out of stormwater runoff. With input from locality staff, several potential retrofit sites were identified in addition to potential rain garden and bioretention filter sites (Figure 5.2). These larger basin retrofits would be a highly cost effective way to treat stormwater runoff while also improving existing infrastructure. The Native Plant Society and Master Naturalists were identified as two great partners in planting rain gardens and installing attractive residential riparian buffers. A summary of

residential/urban stormwater and pet waste BMPs needed for de-listing of Stephens and Crooked Run is provided in Table 5.9.

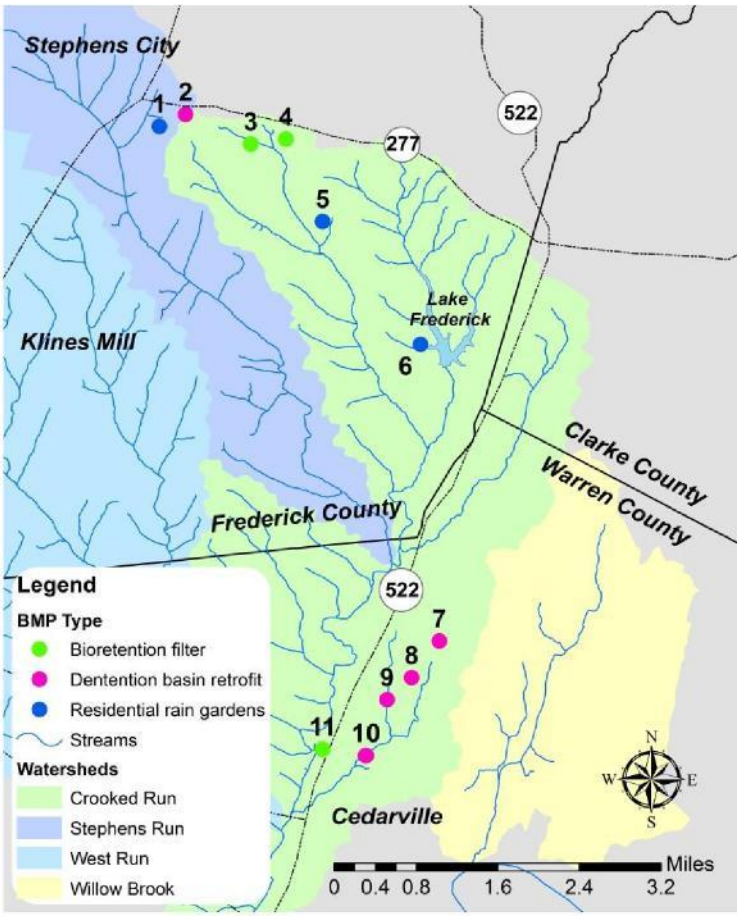

Figure 5.2. Potential stormwater BMP locations in Stephens and Crooked Run. *See Table 5.8 for corresponding site descriptions.*

Table 5.8. Potential stormwater BMP site descriptions.

No.	Site description
1	Ridgefield Ave. subdivision
2	Food Lion/Goodwill
3	Sherando High School
4	Sherando Park
5	Forest Lakes Estates
6	Lake Frederick Estates
7	Ferguson Enterprises
8	Economic Development Authority
9	Sysco North East Distribution

No.	Site description
10	VA Inland Port
11	Holiday Inn, Front Royal

Table 5.9. Residential/urban stormwater and pet waste BMPs needed by watershed.

BMP	Units	Crooked Run	Stephens Run
Riparian buffers	acres	0.5	1.5
Rain gardens	acres treated	2	4
Bioretention filters	acres treated	2	2
Detention basin retrofits	acres treated	60	10
Pet waste education program	program	1	1
Pet waste station	stations	2	6
Pet waste composter/digester	composter	10	10

5.3 Technical Assistance and Education

In order to get landowners involved in implementation, it will be necessary to initiate education and outreach strategies and provide technical assistance with the design and installation of various best management practices. There must be a proactive approach to contact farmers and residents to articulate exactly what the TMDL means to them and what practices will help meet the goal of improved water quality. The working groups recommended several education/outreach techniques, which will be utilized during implementation.

The following general tasks associated with agricultural and residential programs were identified:

Agricultural Programs

- Make contact with landowners in the watersheds to make them aware of cost-share assistance, and voluntary options that are available to agricultural producers interested in conservation.
- Provide technical assistance for agricultural programs (e.g., survey, design, layout).
- Give presentations at local Farm Bureau events including annual membership meetings. Provide information for distribution with semiannual newsletters.

- Organize educational programs for farmers including farm tours in partnership with VA Cooperative Extension and Farm Bureau.
- Work with NRCS and Lord Fairfax SWCD to conduct door to door outreach regarding agricultural BMPs
- Work with VA Cooperative Extension to hold rotational grazing workshops and "fencing school" programs in the watersheds. These have been offered in other areas in the northern Valley and have been well received by the agricultural community
- Contact the VA Department of Corrections to explore options for inmate assistance with livestock exclusion fencing and maintenance. Consider partnering with a nonprofit organization or local government entity.
- Work with county Boards of Supervisors representatives to contact vast agricultural landowners in the watersheds to discuss water quality issues and potential management strategies
- Handle and track cost-share
- Assess and track progress toward BMP implementation goals
- Coordinate use of existing agricultural programs and suggest modifications

Residential Programs

- Identify straight-pipes and failing septic systems (*e.g.*, contact landowners in older homes, septic pump-out program)
- Handle and track cost-share
- Develop and distribute educational materials (e.g., septic system maintenance guide). Emphasize the voluntary nature of residential septic cost share program
- Encourage a partnership between the Department of Health and local realtors to share the capacity of a home's septic system with potential buyers
- Conduct outreach at homeowners association and public service board meetings
- Partner with the Front Royal Tree Stewards and the Garden Club of Warren County on residential rain garden projects
- Launch a newspaper campaign about septic system maintenance. Emphasize the connection between proper maintenance, groundwater science and financial assistance available
- Work with volunteers to conduct Coliscan monitoring in the watersheds, make upstream/downstream water quality comparisons to encourage landowners to participate in cost share programs. McKay Springs was identified as a particular location needing additional monitoring
- Launch a drinking water campaign, "Taste of the Shenandoah." Work with local businesses and the Chamber of Commerce to stress local resources, health and taking care of our children by taking care of our water. Consider involving local schools in monitoring and outreach. Recruit local service organizations such as the Boy Scouts and Girl Scouts
- Use the annual Envirothon competition as an opportunity for community outreach
- Assess progress toward implementation goals

A critical component in the successful implementation of this plan is the availability of knowledgeable staff to work with landowners on implementing conservation practices. While this plan provides a general list of practices that can be implemented in the watershed, property owners face unique management challenges including both design challenges and financial barriers to implementation of practices. Consequently, technical assistance from trained conservation professionals is a key component to successful BMP implementation. Technical assistance includes helping landowners identify suitable BMPs for their property, designing BMPs and locating funding to finance implementation.

The staffing level needed to implement the agricultural and residential components of the plan was estimated based on discussions with stakeholders and the staffing levels used in similar projects. Staffing needs were quantified using full time equivalents (FTE), with one FTE being equal to one full-time staff member. Based on the size of the watersheds, the extent of implementation needed, and the overall project timeline, an estimate of 1 FTE was used for technical assistance. This estimate was based on similar implementation projects in other watersheds where on staff member is administering both the residential septic/pet waste and agricultural programs. It is expected that locality staff would be directly involved in any urban stormwater BMPs, serving as the project lead on any of these efforts with support from the Lord Fairfax SWCD.

6. COSTS AND BENEFITS

6.1 Agricultural BMPs

The costs of agricultural best management practices included in the implementation plan were estimated based on data for Clarke and Warren Counties from the VADCR Agricultural BMP Database, the NRCS and Lord Fairfax SWCD cost lists for BMP components.

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-6, LE-1T, LE-2T, and CREP. The cost of fence maintenance was identified as a deterrent to participation. Financial assistance possibilities for maintaining fences include an annual 25% tax credit for fence maintenance, and an upfront incentive payment on $0.50 per linear foot to maintain stream fencing as part of the WP-2T practice. Typically the average cost of fence maintenance is significantly higher. In developing the cost estimates for fence maintenance shown in Table 6.1, a figure of $3.50/linear foot of fence was used. It was estimated that approximately 10% of fencing would need to be replaced over the 10 year timeline of this project.

The majority of agricultural practices recommended in the implementation plan 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. Consequently, both the potential cost to landowners and the cost to state and federal programs must be considered. Table 6.1 shows total agricultural BMP costs by watershed.

6.2 Residential BMPs

The costs of recommended residential septic BMPs were estimated using input from the Frederick County Health Department and the residential working group (Table 6.2). Residential stormwater and pet waste BMP cost estimates were developed based on the costs of similar projects in the region with input from the residential working group and local government staff (Table 6.3)

Total BMP implementation costs are shown in Table 6.4. In Table 6.5, implementation costs are shown for two stages of implementation. These stages and the associated timeline are explained in greater detail in Chapter 7, Section 7.1.

Table 6.1 Agricultural BMP implementation costs by watershed

Practice	Cost share code	Units	Unit cost	Crooked Run	Stephens Run	West Run	Willow Brook	TOTAL
Livestock exclusion with riparian buffers	CREP	system	$42,090	$76,976	$23,447	$205,000	$0	$305,422
Livestock exclusion with riparian buffers	WP-2T	system	$11,312	$15,873	$0	$32,296	$0	$48,169
Livestock exclusion with riparian buffers	SL-6/LE-1T	system	$36,320	$184,001	$66,148	$425,077	$31,592	$706,819
Livestock exclusion with reduced setback	LE-2T	system	$27,595	$49,027	$16,772	$113,902	$0	$179,702
Exclusion fence maintenance (10 yrs)	N/A	feet	$3.50	$10,786	$2,509	$18,925	$619	$32,840
Improved pasture management	EQIP (529,512), SL-10T	acres	$100	$252,800	$129,100	$325,000	$139,900	$846,800
Grazing land management	SL-9	acres	$225	$40,725	$24,300	$48,825	$26,325	140,175
Permanent vegetation on critical areas (pasture)	SL-11	acres	$2,570	$2,827	$1,028	$3,598	$1,799	$9,252
Reforestation of erodible pasture	FR-1	acres	$185	$20,720	$8,140	$24,790	$13,320	$66,970
Long term vegetative cover on cropland	SL-1	acres	$300	$715	$660	$825	$165	$2,365
Continuous no-till	SL-15A	acres	$100	$220	$440	$550	$55	$1,265
Riparian buffers on cropland (grass)	WQ-1	acres	$165	$17	$25	$15	$12	$68
Small grain cover crops	SL-8B	acres	$55	$2,035	$1,485	$2,695	$495	$6,710
--	**--**	**--**	**Total Estimated Costs**	**$656,721**	**$274,055**	**$1,201,499**	**$214,282**	**$2,346,557**

Table 6.2 Residential septic BMP implementation costs by watershed

Practice	Cost share code	Units	Unit cost	Crooked Run	Stephens Run	West Run	Willow Brook	TOTAL
Septic tank pumpouts	RB-1	pumpout	$325	$49,875	$62,775	$47,400	$15,000	$175,050
Connection to public sewer	RB-2	system	$12,430	$22,126	$43,009	$0	$0	$65,135
Septic system repair	RB-3	repair	$2,000	$158,200	$264,600	$193,200	$63,000	$679,000
Septic system replacement	RB-4	system	$8,000	$30,320	$50,548	$48,000	$14,400	$143,200
Septic system replacement w/pump	RB-4P	system	$12,000	$31,920	$49,080	$51,480	$16,200	$148,680
Alternative waste treatment system	RB-5	system	$25,000	$641,000	$1,098,000	$817,500	$247,500	$2,804,000
--	--	--	Total Estimated Costs	**$933,441**	**$1,567,944**	**$1,157,580**	**$356,100**	**$4,015,065**

Table 6.3 Residential/developed stormwater and pet waste BMPs

Practice	Cost share code	Units	Unit cost	Crooked Run	Stephens Run	West Run	Willow Brook	TOTAL
Riparian buffers	N/A	acres	$3,500	$1,750	$5,250	$0	$0	$7,000
Bioretention filters	N/A	ac treat.	$10,000	$20,000	$20,000	$0	$0	$40,000
Rain gardens	N/A	ac treat.	$10,000	$20,000	$40,000	$0	$0	$60,000
Detention basin retrofits	N/A	ac treat.	$3,500	$210,000	$35,000	$0	$0	$245,000
Pet waste education program	N/A	program	$2,000	$1,000	$1,000	$0	$0	$2,000
Pet waste stations	PW-1	station	$350	$700	$2,100	$0	$0	$2,800
Pet waste composters/digesters	PW-2	digester	$100	$1,000	$1,000	$0	$0	$2,000
--	--	--	Total Estimated Costs	**$254,450**	**$104,350**	**$0**	**$0**	**$358,800**

Table 6.4 Total BMP implementation costs by watershed

BMP Type	Crooked Run	Stephens Run	West Run	Willow Brook	TOTAL
Agricultural	$945,848	$448,275	$1,349,563	$279,621	$3,023,931
Residential Septic	$933,441	$1,567,944	$1,157,580	$356,100	$4,015,065
Stormwater/Pet Waste	$254,450	$104,350	N/A	N/A	$358,800
TOTAL	**$2,133,739**	**$2,120,570**	**$2,507,143**	**$635,721**	**$7,397,173**

Table 6.5 Staged BMP implementation costs by watershed.

Stage	Crooked Run	Stephens Run	West Run	Willow Brook	TOTAL
Stage 1 (Yrs 1-10)	$1,844,713	$1,946,349	$2,359,079	$570,382	$6,720,523
Stage 2 (Yrs 11-15)	$289,026	$174,220	$148,064	$65,340	$676,650
TOTAL	**$2,133,739**	**$2,120,570**	**$2,507,143**	**$635,721**	**$7,397,173**

6.5 Technical Assistance

Technical assistance costs were estimated for one full time position for Stage 1 (years 1-10) of the project using a cost of $60,000/position per year. A half time position was used to calculate costs for the last five years of the project since the residential and urban programs will have been completed by this point in the project. These figures are based on the existing staffing costs included in the Virginia Department of Environmental Quality's grant agreements for similar implementation projects in the region. Based on the 15 year timeline of this plan (described in great detail in the Implementation Timeline section of this plan), this would make the total cost of technical assistance approximately $750,000. When factored into the cost estimate for BMP implementation shown in Table 6.3, this would make the total cost of implementation approximately $8.15M.

6.6 Benefit Analysis

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

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

6.6.1 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, 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. Additional economic costs and benefits analyses of these practices at the local level was identified as a much needed outreach tool by the steering committee and agricultural working group.

Restricting livestock access to streams and providing them with clean water source has been shown to improve weight gain and milk production in cattle (Zeckoski 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 6.6 shows an example of how this can translate into economic gains for producers. Fresh clean water is the primary nutrient for livestock with healthy cattle consuming, on a daily basis, close to 10% of their body weight during winter and 15% of their body weight in summer. Many livestock illnesses can be spread through contaminated water supplies. For instance, coccidia can be delivered through feed, water and haircoat contamination with manure (VCE, 2000). In addition, horses drinking from marshy areas or areas where wildlife or cattle carrying Leptospirosis have access tend to have an increased incidence of moonblindness associated with Leptospirosis infections (VCE, 1998b). A clean water source can prevent illnesses that reduce production and incur the added expense of avoidable veterinary bills.

Table 6.6 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	Price	Increased revenue due to off stream waterer
500 lbs/calf	5% or 25 lbs	$0.60 per lb	$15/calf

In addition to reducing the likelihood of animals contracting waterborne illnesses by providing a clean water supply, streamside fencing excludes livestock from wet, swampy environments 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 an improved pasture management system in conjunction with installing clean water supplies will also provide economic benefits for the producer. Improved pasture management can allow a producer to feed less hay in winter months, 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.

6.6.2 Residential Practices

The residential programs will play an important role in improving water quality, since human waste can carry with it human viruses in addition to the bacterial and protozoan pathogens that all fecal matter can potentially carry. In terms of economic benefits to homeowners, 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 ($225) in comparison to repairing or replacing an entire system ($6,000 to $22,500). 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 to the benefits to individual landowners, the economy of the local community will be stimulated through expenditures made during implementation, and the infusion of dollars from funding sources outside the impaired areas. Building contractors and material suppliers who deal with septic system pump-outs, private sewage system repair and installation, fencing, and other BMP components can expect to see an increase in business during implementation. Additionally, income from maintenance of these systems should continue long after implementation is complete. As will be discussed in greater detail in Chapter 9, a portion of the funding for implementation can be expected to come from state and federal sources. This portion of funding represents money that is new to the area and will stimulate the local economy. In general, implementation will provide not only environmental benefits to the community, but economic benefits as well, which, in turn, will allow for individual landowners to participate in implementation.

6.6.3 Residential and Urban Stormwater

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 addition, urban BMPs have a number of economic benefits to localities. Increased retention of stormwater on site can lower peak discharges, thereby reducing the drainage infrastructure needed to prevent flooding. This can result in cost savings to local

governments through reduced engineering and land acquisition costs, and reduced materials and installation costs for stormwater culverts and streambank armoring to prevent scour. Lastly, implementation of urban 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.

6.6.4 Watershed Health and Associated Benefits

Focusing on reducing bacteria 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 Chapter 9).

7. MEASUREABLE GOALS AND MILESTONES

Given the scope of work involved with implementing this TMDL, full implementation and de-listing from the Virginia Section 305(b)/303(d) list could be expected within 15 years provided that full funding for technical assistance and BMP cost share were available. Described in this section are a timeline for implementation, water quality and implementation goals and milestones, and strategies for targeting of best management practices.

7.1 Milestone Identification

The end goals of implementation are restored water quality of the impaired waters and subsequent de-listing of the waters from the Commonwealth of Virginia's Section 305(b)/303(d) list within 10 years. Progress toward end goals will be assessed during implementation through tracking of best management practices through the Virginia Agricultural 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 of the TMDLs within 15 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. For instance, the TMDL study indicated runoff from pasture contributes approximately 41% of the total bacteria load in Crooked Run. Concentrating on implementing pasture management practices within the first several years may provide the highest return on water quality improvement with less cost to landowners. Implementation has been divided up into two stages: 2017-2026 and 2027-2031. Tables 7.1 - 7.4 show implementation and water quality improvement goals for *E. coli* bacteria for each watershed in each implementation stage.

Table 7.1a Staged implementation and water quality goals for Crooked Run

BMP Type	Description	BMP code	Units	Stage 1	Stage 2
Livestock stream exclusion	Livestock exclusion with riparian buffers	SL-6/LE-1T	feet/ systems	18,167/4	11,707/3
Livestock stream exclusion	Livestock exclusion with riparian buffers	WP-2T	feet/ systems	1,344/0	866/0
Livestock stream exclusion	Livestock exclusion with riparian buffers	CREP	feet/ systems	6,606/2	4,257/1
Livestock stream exclusion	Livestock exclusion with reduced setback	LE-2T	feet/ systems	4,955/1	3,193/1
Livestock stream exclusion	Fence maintenance	N/A	Feet	3,107	2,002
Pasture	Improved pasture management	SL-10T, EQIP (529,512)	acres	2,528	386
Pasture	Grazing land management	SL-9	acres	181	0,38
Pasture	Reforestation of erodible pasture	FR-1	acres	112	0
Pasture	Permanent vegetative cover on critical areas	SL-11	acres	1.1	0
Cropland	Small grain cover crops	SL-8B	acres	37	0
Cropland	Long term vegetative cover	SL-1	acres	13	0
Cropland	Continuous no till	SL-15A	acres	4	0
Cropland	Riparian buffers (grass)	WQ-1	acres	0.1	0
Residential	Septic tank pumpouts	RB-1	pumpout	166	0
Residential	Connection to public sewer	RB-2	connection	2	0
Residential	Septic system repair	RB-3	repair	79	0
Residential	Septic system replacement	RB-4	system	4	0
Residential	Septic system replacement with pump	RB-4P	system	3	0
Residential	Alternative waste treatment	RB-5	system	26	0
Residential	Riparian buffers	N/A	acres	0.5	0
Residential	Rain gardens	N/A	ac. treated	2	0
Residential	Bioretention filters	N/A	ac. treated	2	0
Residential	Detention basin retrofits	N/A	ac. treated	60	0
Residential	Pet waste education program	N/A	program	1	0
Residential	Pet waste stations	PW-1	station	2	0
Residential	Pet waste composter/digester	PW-2	composter	10	0

Water Quality Goals	Stage 1	Stage 2
Average annual *E. coli* load (cfu/yr)	7.22×10^{13}	6.64×10^{13}
% Violation of the Single Sample *E. coli* criterion (235 cfu/100mL) Existing condition = 10.2%	10.4%	9.2%
% Violation rate of the Geometric Mean *E. coli* standard (126 cfu/100mL)	3.3%	0.0%

Table 7.1b Percent of land use (LU) receiving BMP by stage in Crooked Run

BMP Type	Description	BMP code	Units	Stage 1: % LU	Stage 2: % LU
Livestock stream exclusion	Livestock exclusion with riparian buffers	SL-6/LE-1T	feet/ systems	25%	16%
Livestock stream exclusion	Livestock exclusion with riparian buffers	WP-2T	feet/ systems	5%	3%
Livestock stream exclusion	Livestock exclusion with riparian buffers	CREP	feet/ systems	9%	6%
Livestock stream exclusion	Livestock exclusion with reduced setback	LE-2T	feet/ systems	7%	4%
Livestock stream exclusion	Fence maintenance	N/A	Feet	N/A	N/A
Pasture	Improved pasture management	SL-10T, EQIP (529,512)	acres	70%	12%
Pasture	Grazing land management	SL-9	acres	5%	0%
Pasture	Reforestation of erodible pasture	FR-1	acres	3%	1%
Pasture	Permanent vegetative cover on critical areas	SL-11	acres	0.03%	0%
Cropland	Small grain cover crops	SL-8B	acres	9%	0%
Cropland	Long term vegetative cover	SL-1	acres	3%	0%
Cropland	Continuous no till	SL-15A	acres	1%	0%
Cropland	Riparian buffers (grass)	WQ-1	acres	0.07%	0%
Residential	Septic tank pumpouts	RB-1	pumpout	25%	0%
Residential	Connection to public sewer	RB-2	connection	2%	0%
Residential	Septic system repair	RB-3	repair	69%	0%
Residential	Septic system replacement	RB-4	system	4%	0%
Residential	Septic system replacement with pump	RB-4P	system	3%	0%
Residential	Alternative waste treatment	RB-5	system	23%	0%
Residential	Riparian buffers	N/A	acres	0.06%	0%
Residential	Rain gardens	N/A	ac. treated	0.1%	0%
Residential	Bioretention filters	N/A	ac. treated	0.1%	0%
Residential	Detention basin retrofits	N/A	ac. treated	4%	0%
Residential	Pet waste education program	N/A	program	5%	0%
Residential	Pet waste stations	PW-1	station	0.14%	0%
Residential	Pet waste composter/digester	PW-2	composter	0.5%	0%

Table 7.2a Staged implementation and water quality goals for Stephens Run

BMP Type	Description	BMP code	Units	Stage 1	Stage 2
Livestock stream exclusion	Livestock exclusion with riparian buffers	SL-6/LE-1T	feet/ systems	4,625/2	4,732/2
Livestock stream exclusion	Livestock exclusion with riparian buffers	WP-2T	feet/ systems	35/0	860/0
Livestock stream exclusion	Livestock exclusion with riparian buffers	CREP	feet/ systems	1,434/1	1,721/1
Livestock stream exclusion	Livestock exclusion with reduced setback	LE-2T	feet/ systems	1,075/1	1,291/1
Livestock stream exclusion	Fence maintenance	N/A	Feet	717	860
Pasture	Improved pasture management	SL-10T, EQIP (529,512)	acres	1,291	385
Pasture	Grazing land management	SL-9	acres	108	0
Pasture	Reforestation of erodible pasture	FR-1	acres	44	22
Pasture	Permanent vegetative cover on critical areas	SL-11	acres	0.4	0
Cropland	Small grain cover crops	SL-8B	acres	27	0
Cropland	Long term vegetative cover	SL-1	acres	12	0
Cropland	Continuous no till	SL-15A	acres	8	0
Cropland	Riparian buffers (grass)	WQ-1	acres	0.15	0
Residential	Septic tank pumpouts	RB-1	pumpout	209	0
Residential	Connection to public sewer	RB-2	connection	3	0
Residential	Septic system repair	RB-3	repair	132	0
Residential	Septic system replacement	RB-4	system	6	0
Residential	Septic system replacement with pump	RB-4P	system	4	0
Residential	Alternative waste treatment	RB-5	system	44	0
Residential	Riparian buffers	N/A	acres	1.5	0
Residential	Rain gardens	N/A	ac. treated	2	0
Residential	Bioretention filters	N/A	ac. treated	4	0
Residential	Detention basin retrofits	N/A	ac. treated	10	0
Residential	Pet waste education program	N/A	program	1	0
Residential	Pet waste stations	PW-1	station	6	0
Residential	Pet waste composter/digester	PW-2	composter	10	0

Water Quality Goals	Stage 1	Stage 2
Average annual *E. coli* load (cfu/yr)	1.56×10^{13}	1.44×10^{13}
% Violation of the Single Sample *E. coli* criterion (235 cfu/100mL) Existing condition = 10.2%	10.3%	9.3%
% Violation rate of the Geometric Mean *E. coli* standard (126 cfu/100mL)	3.3%	0.0%

Table 7.2b Percent of land use (LU) receiving BMP by stage in Stephens Run

BMP Type	Description	BMP code	Units	Stage 1: % LU	Stage 2: % LU
Livestock stream exclusion	Livestock exclusion with riparian buffers	SL-6/LE-1T	feet/ systems	11%	13.2%
Livestock stream exclusion	Livestock exclusion with riparian buffers	WP-2T	feet/ systems	0%	0%
Livestock stream exclusion	Livestock exclusion with riparian buffers	CREP	feet/ systems	4%	4.8%
Livestock stream exclusion	Livestock exclusion with reduced setback	LE-2T	feet/ systems	3%	3.6%
Livestock stream exclusion	Fence maintenance	N/A	Feet	N/A	N/A
Pasture	Improved pasture management	SL-10T, EQIP (529,512)	acres	60%	19%
Pasture	Grazing land management	SL-9	acres	5%	0%
Pasture	Reforestation of erodible pasture	FR-1	acres	2%	1%
Pasture	Permanent vegetative cover on critical areas	SL-11	acres	0.02%	0%
Cropland	Small grain cover crops	SL-8B	acres	7%	0%
Cropland	Long term vegetative cover	SL-1	acres	3%	0%
Cropland	Continuous no till	SL-15A	acres	2%	0%
Cropland	Riparian buffers (grass)	WQ-1	acres	0.12%	0%
Residential	Septic tank pumpouts	RB-1	pumpout	25%	0%
Residential	Connection to public sewer	RB-2	connection	1%	0%
Residential	Septic system repair	RB-3	repair	69%	0%
Residential	Septic system replacement	RB-4	system	4%	0%
Residential	Septic system replacement with pump	RB-4P	system	3%	0%
Residential	Alternative waste treatment	RB-5	system	23%	0%
Residential	Riparian buffers	N/A	acres	0.3%	0%
Residential	Rain gardens	N/A	ac. treated	0.4%	0%
Residential	Bioretention filters	N/A	ac. treated	0.2%	0%
Residential	Detention basin retrofits	N/A	ac. treated	1%	0%
Residential	Pet waste education program	N/A	program	5%	0%
Residential	Pet waste stations	PW-1	station	1%	0%
Residential	Pet waste composter/digester	PW-2	composter	1%	0%

Table 7.3a Staged implementation and water quality goals for West Run

BMP Type	Description	BMP code	Units	Stage 1	Stage 2
Livestock stream exclusion	Livestock exclusion with riparian buffers	SL-6/LE-1T	feet/ systems	29,740/12	2,659/1
Livestock stream exclusion	Livestock exclusion with riparian buffers	WP-2T	feet/ systems	5,407/3	485/0
Livestock stream exclusion	Livestock exclusion with riparian buffers	CREP	feet/ systems	10,815/4	971/0
Livestock stream exclusion	Livestock exclusion with reduced setback	LE-2T	feet/ systems	8,111/3	728/0
Livestock stream exclusion	Fence maintenance	N/A	Feet	5,407	485
Pasture	Improved pasture management	SL-10T, EQIP (529,512)	acres	3,250	733
Pasture	Grazing land management	SL-9	acres	217	45
Pasture	Reforestation of erodible pasture	FR-1	acres	134	0
Pasture	Permanent vegetative cover on critical areas	SL-11	acres	1.4	0
Cropland	Small grain cover crops	SL-8B	acres	49	0
Cropland	Long term vegetative cover	SL-1	acres	15	0
Cropland	Continuous no till	SL-15A	acres	10	0
Cropland	Riparian buffers (grass)	WQ-1	acres	0.09	0
Residential	Septic tank pumpouts	RB-1	pumpout	158	0
Residential	Connection to public sewer	RB-2	connection	0	0
Residential	Septic system repair	RB-3	repair	97	0
Residential	Septic system replacement	RB-4	system	6	0
Residential	Septic system replacement with pump	RB-4P	system	4	0
Residential	Alternative waste treatment	RB-5	system	33	0

Water Quality Goals	Stage 1	Stage 2
Average annual *E. coli* load (cfu/yr)	2.55×10^{13}	2.30×10^{13}
% Violation of the Single Sample *E. coli* criterion (235 cfu/100mL) Existing condition = 10.2%	10.4%	9.3%
% Violation rate of the Geometric Mean *E. coli* standard (126 cfu/100mL)	3.3%	0.0%

Table 7.3b Percent of land use (LU) receiving BMP by stage in West Run

BMP Type	Description	BMP code	Units	Stage 1: % LU	Stage 2: % LU
Livestock stream exclusion	Livestock exclusion with riparian buffers	SL-6/LE-1T	feet/ systems	42.9%	3.9%
Livestock stream exclusion	Livestock exclusion with riparian buffers	WP-2T	feet/ systems	7.8%	0.7%
Livestock stream exclusion	Livestock exclusion with riparian buffers	CREP	feet/ systems	15.6%	1.4%
Livestock stream exclusion	Livestock exclusion with reduced setback	LE-2T	feet/ systems	11.7%	1%
Livestock stream exclusion	Fence maintenance	N/A	Feet	N/A	N/A
Pasture	Improved pasture management	SL-10T, EQIP (529,512)	acres	75%	18%
Pasture	Grazing land management	SL-9	acres	5%	0%
Pasture	Reforestation of erodible pasture	FR-1	acres	3%	1%
Pasture	Permanent vegetative cover on critical areas	SL-11	acres	0.03%	0%
Cropland	Small grain cover crops	SL-8B	acres	10%	0%
Cropland	Long term vegetative cover	SL-1	acres	3%	0%
Cropland	Continuous no till	SL-15A	acres	2%	0%
Cropland	Riparian buffers (grass)	WQ-1	acres	0.05%	0%
Residential	Septic tank pumpouts	RB-1	pumpout	25%	0%
Residential	Connection to public sewer	RB-2	connection	0%	0%
Residential	Septic system repair	RB-3	repair	69%	0%
Residential	Septic system replacement	RB-4	system	4%	0%
Residential	Septic system replacement with pump	RB-4P	system	3%	0%
Residential	Alternative waste treatment	RB-5	system	23%	0%

Table 7.4a Staged implementation and water quality goals for Willow Brook

BMP Type	Description	BMP code	Units	Stage 1	Stage 2
Livestock stream exclusion	Livestock exclusion with riparian buffers	SL-6/LE-1T	feet/ systems	1,770/1	332/0
Livestock stream exclusion	Livestock exclusion with riparian buffers	WP-2T	feet/ systems	0	0
Livestock stream exclusion	Livestock exclusion with riparian buffers	CREP	feet/ systems	0	0
Livestock stream exclusion	Livestock exclusion with reduced setback	LE-2T	feet/ systems	0	0
Livestock stream exclusion	Fence maintenance	N/A	Feet	287	0
Pasture	Improved pasture management	SL-10T, EQIP (529,512)	acres	1,399	590
Pasture	Grazing land management	SL-9	acres	117	0
Pasture	Reforestation of erodible pasture	FR-1	acres	72	24
Pasture	Permanent vegetative cover on critical areas	SL-11	acres	0.7	0
Cropland	Small grain cover crops	SL-8B	acres	9	0
Cropland	Long term vegetative cover	SL-1	acres	3	0
Cropland	Continuous no till	SL-15A	acres	1	0
Cropland	Riparian buffers (grass)	WQ-1	acres	0.07	0
Residential	Septic tank pumpouts	RB-1	pumpout	50	0
Residential	Connection to public sewer	RB-2	connection	0	0
Residential	Septic system repair	RB-3	repair	32	0
Residential	Septic system replacement	RB-4	system	2	0
Residential	Septic system replacement with pump	RB-4P	system	1	0
Residential	Alternative waste treatment	RB-5	system	10	0

Water Quality Goals	Stage 1	Stage 2
Average annual *E. coli* load (cfu/yr)	1.35×10^{13}	1.15×10^{13}
% Violation of the Single Sample *E. coli* criterion (235 cfu/100mL) Existing condition = 10.2%	10.4%	9.5%
% Violation rate of the Geometric Mean *E. coli* standard (126 cfu/100mL)	10.0%	0.0%

Table 7.4b Percent of land use (LU) receiving BMP by stage in Willow Brook

BMP Type	Description	BMP code	Units	Stage 1: % LU	Stage 2: % LU
Livestock stream exclusion	Livestock exclusion with riparian buffers	SL-6/LE-1T	feet/ systems	80%	15%
Livestock stream exclusion	Livestock exclusion with riparian buffers	WP-2T	feet/ systems	0%	0%
Livestock stream exclusion	Livestock exclusion with riparian buffers	CREP	feet/ systems	0%	0%
Livestock stream exclusion	Livestock exclusion with reduced setback	LE-2T	feet/ systems	0%	0%
Livestock stream exclusion	Fence maintenance	N/A	Feet	N/A	N/A
Pasture	Improved pasture management	SL-10T, EQIP (529,512)	acres	60%	26%
Pasture	Grazing land management	SL-9	acres	5%	0%
Pasture	Reforestation of erodible pasture	FR-1	acres	3%	1%
Pasture	Permanent vegetative cover on critical areas	SL-11	acres	0.03%	0%
Cropland	Small grain cover crops	SL-8B	acres	9%	0%
Cropland	Long term vegetative cover	SL-1	acres	3%	0%
Cropland	Continuous no till	SL-15A	acres	1%	0%
Cropland	Riparian buffers (grass)	WQ-1	acres	0.22%	0%
Residential	Septic tank pumpouts	RB-1	pumpout	25%	0%
Residential	Connection to public sewer	RB-2	connection	0%	0%
Residential	Septic system repair	RB-3	repair	69%	0%
Residential	Septic system replacement	RB-4	system	4%	0%
Residential	Septic system replacement with pump	RB-4P	system	3%	0%
Residential	Alternative waste treatment	RB-5	system	23%	0%

7.2 Water Quality Monitoring

Improvements in water quality will be evaluated through water quality monitoring conducted at VADEQ monitoring stations located in the watersheds as shown below in Figure 7.1. Descriptions of these stations are provided in Table 7.5. The map shows stations that are part of VADEQ'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.

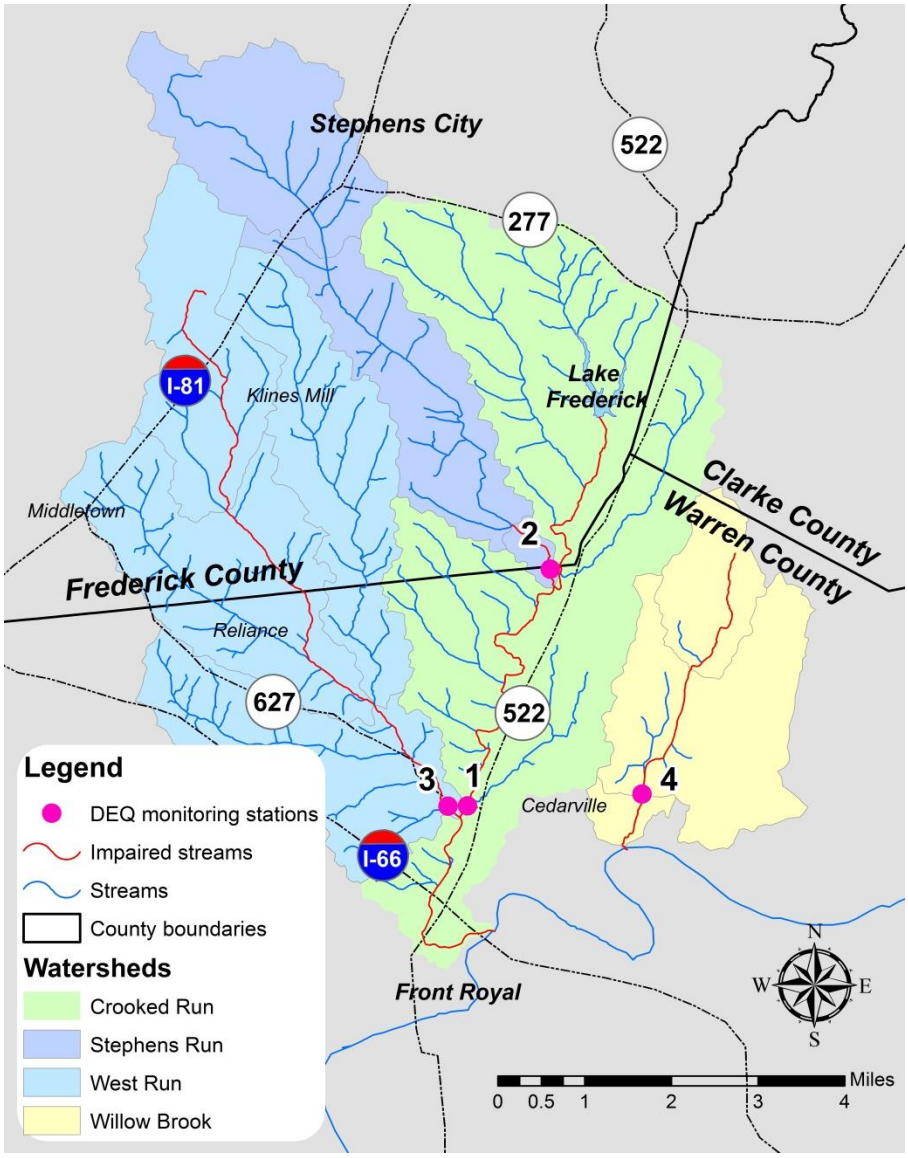

Figure 7.1. VADEQ *E. coli* monitoring stations following TMDL IP completion

Table 7.5. VADEQ station location descriptions

Station	Stream	River mile	Description
1	Crooked Run	2.75	Off of Route 627
2	Stephens Run	0.20	Near Route 639 Bridge
3	West Run	0.20	Near Route. 609 Bridge
4	Willow Brook	0.71	Near Route 658 Bridge

Monitoring will begin no sooner than the second odd numbered calendar year following the initiation of TMDL implementation. Beginning implementation monitoring after 2 to 3 years of TMDL 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 other month for two years. After two years of bi-monthly 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, or any other stations associated with this implementation plan have three or more exceedances of 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.

Intensive, one-year monthly sampling may occur within any single calendar year. It is generally preferred to conduct sampling over a two year period to help minimize the effect of fluctuating climate conditions related to dry and wet events.

There is the potential for additional monitoring at a subset of stations in the watersheds where continual VADEQ monitoring is conducted on a bi-monthly basis beginning on the next odd number calendar year after the initiation of implementation. This will require an additional funding source and can only be accomplished with sufficient resources to support needs of the data users, and only if watershed conditions and stakeholder support are suitable to this strategy. These monitoring stations will be located in the watersheds based on TMDL implementation funds, either state, federal, or other sources, becoming available.

Citizen monitoring is another very useful tool for measuring improvements in water quality. The Friends of the Shenandoah River (FOSR) has an extensive water quality monitoring program throughout the Shenandoah River watershed including a number of stations in the project area watersheds. Currently, FOSR is analyzing samples collected

from these station for nitrogen, phosphorous, dissolved oxygen, pH, temperature and turbidity. However, *E. coli* could be included within these testing parameters in order to assist in evaluating water quality improvements associated with BMP implementation in the watersheds. Additional funding for *E. coli* testing would be necessary since FOSR is a volunteer-based, nonprofit organization. FOSR has Level 3 certification, meaning that the data that they collect can be used for the purposes of listing or de-listing a stream (removing it from the impaired waters list). Therefore, they could serve as a key partner in evaluating project success. Consequently, DEQ worked closely with FOSR during implementation planning to develop a proposed monitoring plan through which FOSR could identify reaches of streams that could be improved through additional livestock exclusion, and to show water quality improvements resulting from these practices. Monitoring activities would include:

1. Bacterial sampling monthly during non-flood events and collecting one additional bacterial sample in June, July, August, and September at each site. Sampling would occur during the implementation plan and 2 years after the implementation period.
2. Each site would be photographed during sampling to show stream bank and bottom conditions, water clarity and plant growth or lack of plant growth, land use, and if cattle are in the stream upstream of the sampling site within sight of the sampling location.
3. Water temperature, dissolved oxygen concentration, specific conductance, and pH would be measured when the bacterial samples are collected.
4. Stream discharge would be measured 4 times at each sampling site at different stream stages in order to understand the hydrology and bacteria sources of Crooked Run and Willow Brook. The discharge measurements would be made early (within the 1st year) in the monitoring

FOSR staff developed a monitoring program budget during the planning process. Based on the sampling frequency described above, FOSR could complete a four year monitoring program at seven sites within the watersheds for approximately $21,000. These funds would have to be secured through grants, foundations and other private funding sources in order to implement the program, which project partners are committed to pursue.

7.3 Targeting

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

7.3.1 Livestock Exclusion

Excluding livestock from streams can be very resource intensive with varying results with respect to water quality depending on characteristics of the site where livestock are excluded. Therefore, a targeting strategy was developed in order to maximize potential water quality benefits of livestock stream exclusion installed in the watersheds. As part of this process, each watershed was divided up into a series of smaller subwatersheds, and an analysis of the water quality benefits of livestock exclusion was performed for each subwatershed based on 1) the extent of pasture next to the stream 2) the number of livestock in the watershed and 3) the proximity of the stream segment to the headwaters. Based on input from the agricultural working group, the subwatersheds that included the mainstem of each stream were assigned a higher priority than subwatershed that included the headwaters, which tend to have a greater number of intermittent stream segments that are not commonly accessed by livestock or used for recreation by the local community. The subwatersheds were then ranked in ascending order based on the ratio of bacteria loading per fence length, and proximity to the headwaters (Figure 7.2). The ratio of livestock to pasture next to the stream constituted 50% of the ranking, while proximity to headwaters constituted the other 50%. So for example, a subwatershed closest to a watershed outlet with the highest ratio of livestock to pasture next to the stream would be assigned the highest priority for livestock exclusion. This prioritization may prove useful should the demand for technical and financial assistance with livestock exclusion in the watersheds exceed the capacity of local conservation partners to assist landowners.

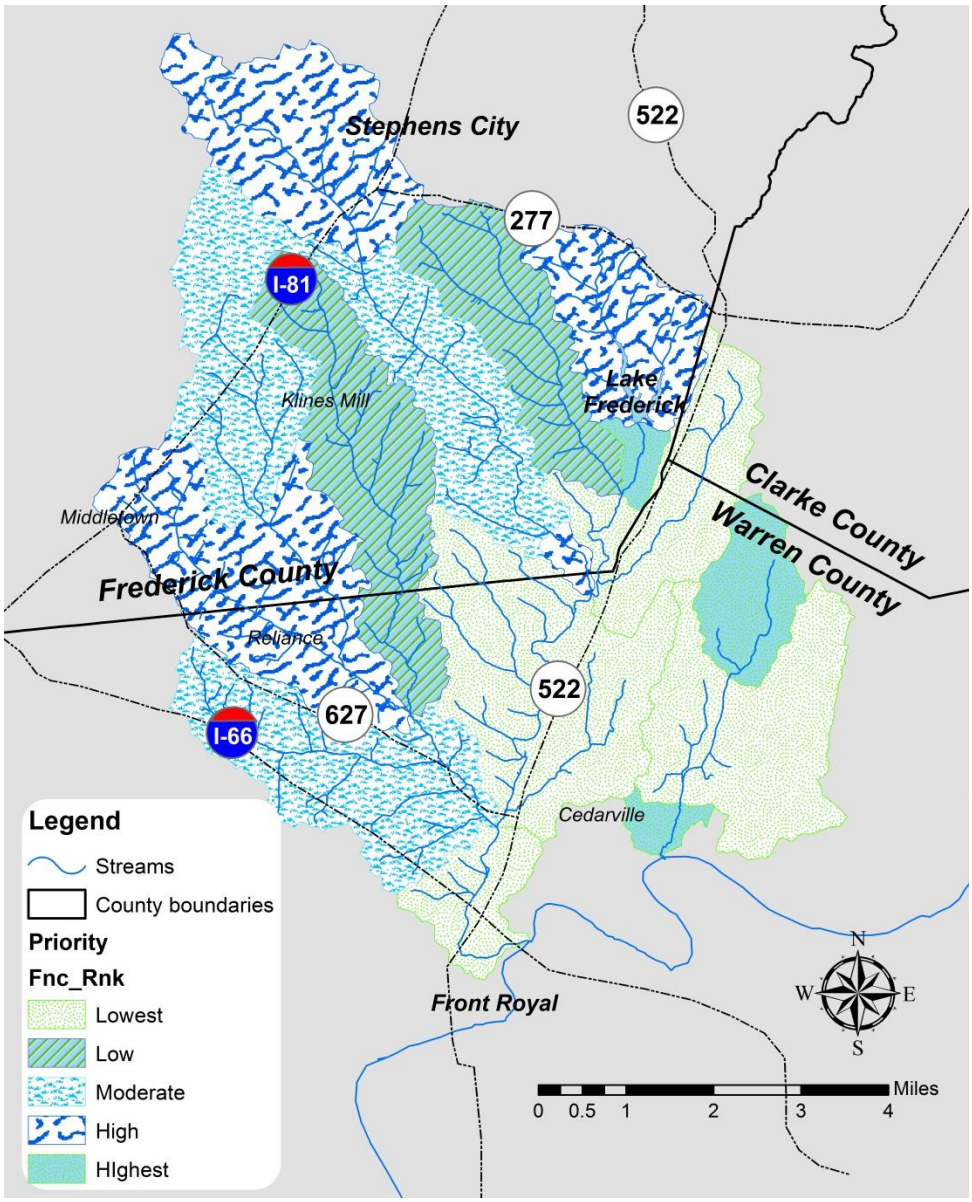

Figure 7.2. Fencing prioritization by subwatershed: Crooked, Stephens, West Runs and Willow Brook

7.3.2 Residential Septic

Outreach to encourage landowners to properly maintain septic systems is frequently conducted through mailings to homeowners including postcards and brochures. Experience with septic system maintenance outreach and cost share programs in the region has shown that often times, landowners must be contacted 2-4 times before they follow up on opportunities for technical and financial assistance with septic system

maintenance. This can prove costly when conducting mailings in large watersheds like

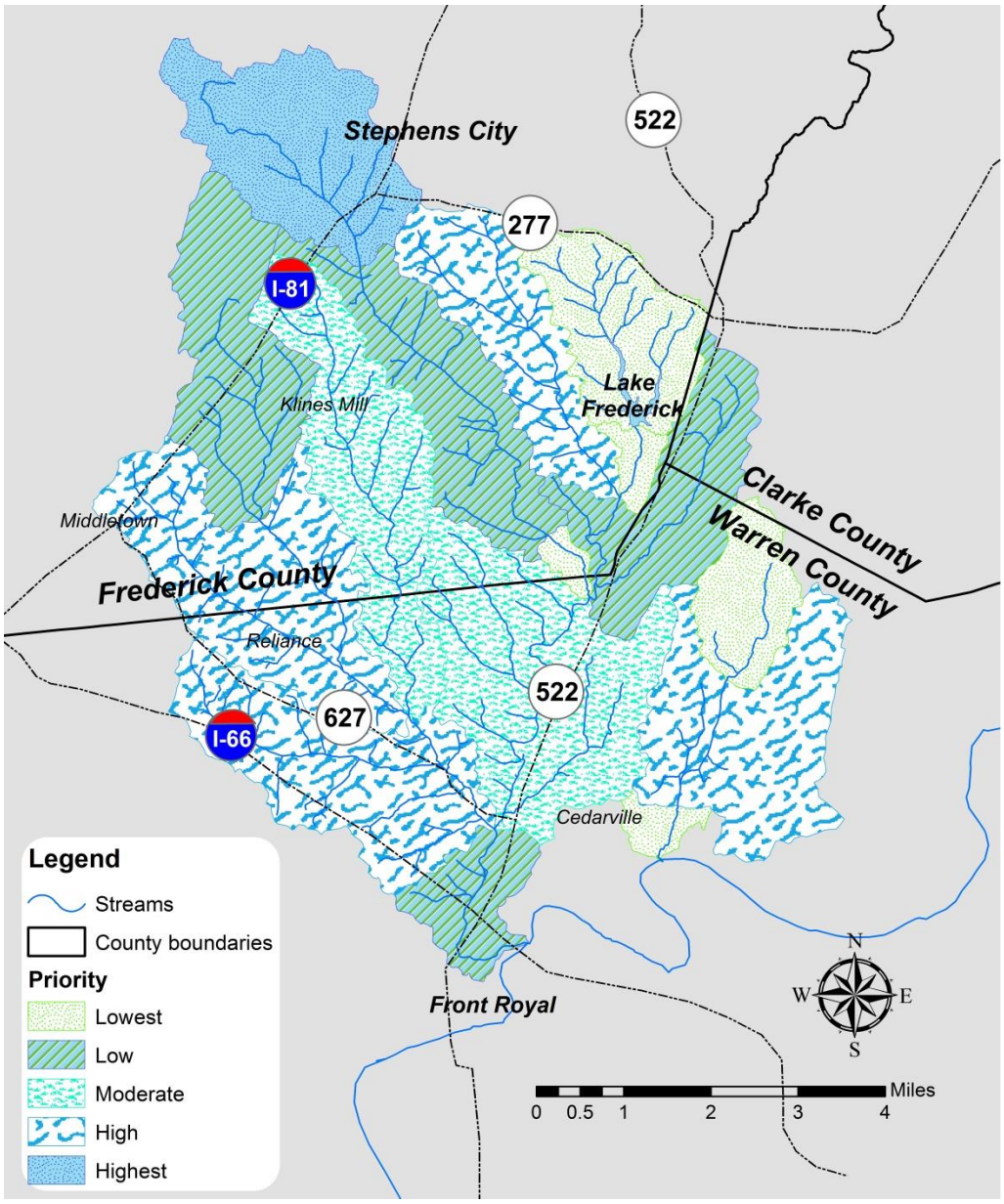

Figure 7.3. Residential septic BMP prioritization by subwatershed.

Crooked Run where there are approximately 2,900 households (including Stephens and West Runs). Identifying areas in the watershed with older homes and aging septic systems to target with outreach materials can be helpful in maximizing response rates from homeowners and corrections of failing septic systems. In order to prioritize subwatersheds for septic system maintenance outreach, subwatersheds were ranked based on the estimated number of failing septic systems (Figure 7.3). This information was taken from the Shenandoah River Tributaries TMDL study, which used the age of homes

to predict septic system failure rates. The rankings shown in Figure 7.3 could be used for follow up outreach after a large watershed mailing if funds were not available for repeated watershed-wide mailings. The residential working group discussed additional targeting strategies including multiple mailings starting with property owners in high priority subwatersheds that live within a certain distance of the stream. These homeowners could be contacted first with offers of assistance since correcting these systems would offer the greatest opportunity for water quality improvement.

8. STAKEHOLDERS AND THEIR ROLE IN IMPLEMENTATION

Achieving the goals of this plan is dependent on stakeholder participation and strong leadership on the part of both community members and conservation organizations. The Lord Fairfax Soil and Water Conservation District covers all of the project area subwatersheds with respect to administration of the VA Agricultural BMP Cost Share Program. Additional partners will be necessary in order to address residential implementation needs including the Warren and Frederick County Health Departments. The following sections in this chapter describe the responsibilities and expectations for the various components of implementation.

8.1 Partner Roles and Responsibilities

8.1.1 Watershed Landowners

The majority of practices recommended in this plan are related to agriculture since it is a predominant land use in the watersheds. Participation from local farmers is thus a key factor to the success of this plan. Consequently, it is important to consider characteristics of farms and farmers in the watersheds that will affect the decisions farmers make when it comes to implementing conservation practices on their farms. For example, the average size of farms is an important factor to consider, since it affects how much land a farmer can give up for a riparian buffer. The average age of a farmer, which was 58 in Virginia in 2012, may also influence their decision to implement best management practices, 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 best management practices. Table 8.1 provides a summary of relevant characteristics of farmers and producers in Warren and Frederick Counties from the 2012 Agricultural Census. These characteristics were considered when developing implementation scenarios, and should be utilized to develop suitable education and outreach strategies.

Table 8.1 Characteristics of farms and farmers in Frederick and Warren Counties

Characteristic	Frederick	Warren
Number of farms	681	346
Land in farms (acres): full owners	38,157	26,806
Rented land in farms (acres): part owners	30,274	10,615
Owned land in farms (acres): part owners	27,590	7,903
Operators identifying farming as their primary occupation	251	149
Operators identifying something other than farming as their primary occupation	430	197
Average age of primary operator	60	59
Average size of farm (acres)	148	139
Average market value of farmland and buildings ($/acre)	$5,903	$7,138
Average net cash farm income of operation ($)	$5,167	-$5,083
Average farm production expenses ($)	$49,850	$24,194
Farms with internet access	452	273

In addition to local farmers, participation from homeowners, local government staff and 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. Residential property owners will need to ensure that their septic systems are regularly pumped and inspected (every 3-5 years). Though the amount of bacteria coming from failing septic systems and straight pipes is minimal compared to livestock, human waste carries with it pathogens that can cause considerable health problems

8.1.2 Lord Fairfax Soil and Water Conservation District (SWCD) and Natural Resource Conservation Service (NRCS)

Both the SWCD and NRCS are continually reaching out to farmers in the watersheds and providing them technical assistance with conservation practices. Currently, dedicated staff is not available to work solely in the watersheds that are covered in this plan, meaning that agricultural BMP implementation goals cannot be met without additional resources. SWCD and NRCS staff responsibilities include promoting available funding for BMPs, and providing assistance in the design and layout of agricultural BMPs.

SWCD and NRCS staff can assist with conducting outreach activities in the watersheds to encourage participation in conservation programs; however, staff time for targeted outreach is limited due to existing workloads. Should funding for additional staff become available for outreach in these watersheds, the Lord Fairfax SWCD would be well suited to administer an agricultural BMP program. During implementation planning, representatives from the Lord Fairfax SWCD noted that they would be interested in pursuing funds for implementation efforts in 2-3 years after staff has worked through a significant backlog of livestock exclusion practices. In addition, the SWCD has recently developed an urban BMP program and is prepared to work with landowners to pursue grant opportunities through the VA Conservation Assistance Program (VCAP) to implement stormwater BMPs in the region. Consequently, the SWCD could play an important role in working with Frederick and Warren Counties to implement priority stormwater BMPs in the watersheds.

Dedicated staff is currently not available to lead efforts to correct failing septic systems and straight pipes. A residential septic system maintenance cost share program could be administered by a number of different entities including the Lord Fairfax SWCD, the VA Department of Health, or one of the localities in the watersheds.

8.1.3 Frederick and Warren 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 Frederick and Warren County key partners in long term implementation efforts. Approximately 2.4% of the total watershed is located in Clarke County, making the county a partner in implementation moving forward, but in a more limited capacity based on the watershed area. Currently, both Frederick and Warren Counties administer conservation easement programs, which have helped to encourage land conservation across the counties. Two agricultural forestal districts have been established in the watersheds, the Rockland District in Warren County and the Double Church District in Frederick County. This designation protects agricultural and forest land from development. Based on feedback from the agricultural working group, suburban encroachment is a significant issue in the watershed, with the number of large working farms in the area significantly declining in recent years. Local government support of

land conservation will become increasingly important as greater numbers of conservation measures are implemented across the watersheds. Both counties will also serve as key partners in residential stormwater BMP outreach and implementation. In addition, they may assist with the promotion of pet waste BMPs including composters and pet waste stations.

8.1.4 Virginia Department of Environmental Quality

The Virginia Department of Environmental Quality (DEQ) has a lead role in the development of TMDL-IPs to address non-point 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 (non-point source) components of TMDL-IPs. DEQ will work closely with project partners including the Lord Fairfax Soil and Water Conservation District to track implementation progress for best management practices. 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 steering committee 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 Crooked Run and Willow Brook and their tributaries in order to assess water quality and determine when restoration has been achieved and the streams can be removed from Virginia's impaired waters list.

8.1.5 Virginia Department of Conservation and Recreation

The Virginia Department of Conservation and Recreation (DCR) administers the Virginia Agricultural Cost Share Program, working closely with Soil and Water Conservation Districts to provide cost share and operating grants needed to deliver this program at the local level. 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.

8.1.6 Virginia Department of Health

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

8.1.7 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:

- Frederick & Warren County Builders Associations
- VA Cooperative Extension (VCE)
- Friends of the Shenandoah River
- VA Master Naturalists
- Local Ruritan and Rotary Clubs
- Northern Shenandoah Valley Regional Commission
- Frederick and Warren County Farm Bureaus
- Friends of the North Fork Shenandoah River
- VA Master Gardeners
- Garden Club of Warren County
- Local realtor associations
- Native Plant Society

8.2 Integration with Other Watershed Plans

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

8.2.1 Frederick and Warren County Comprehensive Plans

Both Frederick and Warren Counties have adopted Comprehensive Plans intended to guide development and natural resource management within their jurisdictions. Both plans stress the importance of the preservation of rural areas, and encourage development in development core areas. Frederick County has identified water quality and stormwater management as two priority natural resource issues to focus on through 2030. The county's comprehensive plan stresses the importance of streamside buffers, proper maintenance of alternative waste treatment systems, and a collaborative approach to educating the community about the role that citizens play in protecting and improving water quality. Frederick County also identified bioretention filters as a critical tool in stormwater management in the region with respect to treating large impervious areas such as parking lots. Low impact development and green infrastructure planning are both included in the plan as key stormwater management strategies as well (Frederick County, 2011). For more information: http://www.fcva.us/departments/o-z/planning-development/planning-documents-plans/2030-comprehensive-plan

Similarly, Warren County has included the protection of surface waters as a key objective in its comprehensive plan. Other related objectives in the plan include evaluation of problems related to failing septic systems, requirement of regular septic pumpouts and alternative waste treatment system maintenance using state recommendations, protection of wetlands, springs and groundwater from contamination, and protection of the natural function of waterways through preservation of natural vegetation. The county's Comprehensive Plan stresses the importance of county-wide education and outreach

regarding the relationship between local land use decisions and local ecology (Warren County, 2013). For more information: http://www.warrencountyva.net/resources3/county-plans/comprehensive-plan.html#

8.2.2 Virginia's Phase II Chesapeake Bay Watershed Implementation Plan

Virginia's Watershed Implementation Plan (WIP) outlines a series of BMPs, programs and regulations that will be implemented across the state in order to meet nitrogen, phosphorous, and sediment loading reductions called for in the Chesapeake Bay TMDL, completed in December 2010. The TMDL is designed to ensure that all pollution control measures needed to fully restore the Bay are in place by 2025, with at least 60 percent of the actions completed by 2017. A number of the BMPs included in this implementation plan are also found in Virginia's WIP. Consequently, Frederick and Warren Counties will be able to track and receive credit for progress in meeting Phase II WIP goals while also working towards implementation goals established in this plan to improve local water quality. For more information about Virginia's Phase II WIP, please visit VADEQ's Bay TMDL web page: http://www.deq.virginia.gov/Programs/Water/ChesapeakeBay.aspx

8.2.3 Frederick and Warren County Conservation Easement and Ag Forestal District Programs

In 2005, Frederick County established a Conservation Easement Authority in order to protect and preserve farm and forest land, historic sites and water resources. Ten years later, the county reported that they had over 8,000 acres of land in conservation easements. The county also worked with Potomac Conservancy to produce a series of educational videos for landowners in 2015, which explain the benefits of conservation easements. Warren County also has established a conservation easement program, with a current total of 11,351 acres under easement to date. Conservation easement programs allow the counties to co-hold easements that protect agricultural and forested lands in perpetuity. In addition, both counties offer programs that allow landowners to establish Ag Forestal Districts. In Frederick County, one of these districts has been established in the watershed, the Double Church District, which includes 934 acres of land. This designation will remain in place from 2015 through 2020, after which point it may be

renewed. The Rockland District has been established in the Warren County portion of the watersheds, and is the largest of the county's three districts at 9,464 acres. These rural conservation areas are protected from development for a limited period of time and in return, landowners can take advantage of property tax incentives. The preservation of agricultural land in the watersheds will help to extend the life span of agricultural BMPs installed by landowners, while protection of forest land will provide numerous water quality benefits including the filtration of pollutants from adjacent developed lands.

8.2.4 Additional Natural Resource Management and Conservation Planning

There are a number of organizations working to implement natural resource management and land conservation plans in the watersheds. The Virginia Department of Game and Inland Fisheries is currently working to implement the "Northern Bobwhite Quail Action Plan for Virginia," which includes a series of recommended management practices that will also help to improve water quality by reducing runoff and filtering out pollutants before they reach the stream. Trout Unlimited has a "Trout in the Classroom" program to engage local schools and students in learning about the importance of clean water and high quality aquatic habitat to support trout and other aquatic species. This type of outreach and education will also support the water quality improvement goals included in this plan. Whenever possible, efforts should be made to integrate the implementation of these and other conservation-related plans that will impact water quality with this plan for Crooked Run and Willow Brook and their tributaries.

8.3 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 the regulatory authority to levy fines and take legal action against those in violation of permits. Beginning in 1994, animal waste from confined animal facilities that hold in excess of 300 animal units (cattle and hogs) has been managed through a Virginia general pollution abatement permit. These operations are required to implement a number of practices to prevent surface and groundwater contamination. In response to increasing demand from the public to develop new regulations dealing with animal waste, the Virginia General Assembly passed legislation in 1999 requiring DEQ to develop regulations for the management of poultry waste in operations having more than 200 animal units of poultry (about 20,000 chickens) (ELI, 1999). On January 1, 2008 DEQ assumed regulatory oversight of all land application 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 to 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 sites, 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. In relation to these TMDLs, VDH has the responsibility of enforcing actions to correct or eliminate failed septic systems and straight pipes.

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

8.4 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. TMDL implementation plans are not required in the Federal Code; however, Virginia State Code does include the development of implementation plans for impaired streams. EPA largely ignored the nonpoint source section of the Clean Water Act until citizens began to realize that regulating only point sources was no longer maintaining water quality

standards. Lawsuits from citizens and environmental groups citing EPA for not carrying out the statutes of the CWA began as far back as the 1970s and have continued until the present. In Virginia in 1998, the American Canoe Association and the American Littoral Society filed a complaint against EPA for failure to comply with provisions of §303d. The suit was settled by Consent Decree, which contained a TMDL development schedule through 2010. It is becoming more common for concerned citizens and environmental groups to turn to the courts for the enforcement of water quality issues.

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

9. FUNDING

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, DCR, NRCS, and VCE.

9.1 Virginia Agricultural Best Management Practices Cost-Share Program

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.

9.2 Virginia Agricultural Best Management Practices Tax Credit Program

For all taxable years, any individual or corporation engaged in agricultural production for market, who has in place a soil conservation plan approved by the local SWCD, is allowed a credit against the tax imposed by Section 58.1-320 of an amount equaling 25% of the first $70,000 expended for agricultural best management practices by the individual. Any practice approved by the local SWCD Board must be completed within the taxable year in which the credit is claimed. The credit is only allowed for expenditures made by the taxpayer from funds of his/her own sources. The amount of the credit cannot exceed $17,500 or the total amount of the tax imposed by this program (whichever is less) in the year the project was completed. If the amount of the credit exceeds the taxpayer's liability for such taxable year, the excess may be carried over for credit against income taxes in the next five taxable years until the total amount of the tax credit has been taken. This program can be used independently or in conjunction with other cost-share programs on the stakeholder's portion of BMP costs. It is also approved for use in supplementing the cost of repairs to streamside fencing.

9.3 Virginia Agricultural Best Management Practices Loan Program

Loan requests are accepted through VADEQ. The interest rate is 3% per year and the term of the loan coincides with the life span of the practice. To be eligible for the loan, the BMP must be included in a conservation plan approved by the local SWCD Board. The minimum loan amount is $5,000; there is no maximum limit. Eligible BMPs include 23 structural practices such as animal waste control facilities, loafing lot management systems, and grazing land protection systems. The loans are administered through participating lending institutions.

9.4 Virginia Small Business Environmental Assistance Fund Loan Program

The Fund, administered through VADEQ, is used to make loans or to guarantee loans to small businesses for the purchase and installation of environmental pollution control equipment, equipment to implement voluntary pollution prevention measures, or equipment and structures to implement agricultural BMPs. The equipment must be needed by the small business to comply with the federal Clean Air Act, or it will allow the small business to implement voluntary pollution prevention measures. The loans are available in amounts up to $50,000 and will carry an interest rate of 3%, with favorable repayment terms based on the borrower's ability to repay and the useful life of the equipment being purchased or the life of the BMP being implemented. There is a $30 non-refundable application processing fee. The Fund will not be used to make loans to small businesses for the purchase and installation of equipment needed to comply with an enforcement action. To be eligible for assistance, a business must employ 100 or fewer people and be classified as a small business under the federal Small Business Act.

9.5 Virginia Water Quality Improvement Fund

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

9.6 Conservation Reserve Program (CRP)

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

9.7 Conservation Reserve Enhancement Program (CREP)

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

The landowner can obtain and complete CREP application forms at the FSA center. The forms are forwarded to local NRCS and SWCD offices 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.

9.8 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. Approximately 65% of the EQIP funding for the state of Virginia is directed toward "Priority Areas." These areas are selected from proposals submitted by a locally led conservation work group. Proposals describe serious and critical environmental needs and concerns of an area or watershed, and the corrective actions they desire to take to address these needs and concerns. The remaining 35% of the funds are directed toward statewide priority concerns of environmental needs. EQIP offers 5 to 10-year contracts to landowners and farmers to provide 75% cost-share assistance, 25% tax credit, and/or incentive payments to implement conservation practices and address the priority concerns statewide or in the priority area. Eligibility is limited to persons who are engaged in livestock or agricultural production. Eligible land includes cropland, pasture, and other agricultural land in priority areas, or land that has an environmental need that matches one of the statewide concerns.

9.9 Wildlife Habitat Incentive Program (WHIP)

WHIP is a voluntary program for landowners who want to develop or improve wildlife habitat on private agricultural lands. Participants work with NRCS to prepare a wildlife habitat development plan. This plan describes the landowner's goals for improving wildlife habitat and includes a list of practices and a schedule for installation. A 10-year contract provides cost-share and technical assistance to carry out the plan. In Virginia,

these plans are prepared to address one or more of the following high priority habitat needs: early grassland habitats that are home to game species such as quail and rabbit as well as other non-game species like meadowlark and sparrows; riparian zones along streams and rivers that provide benefits to aquatic life and terrestrial species; migration corridors which provide nesting and cover habitats for migrating songbirds, waterfowl and shorebird species; and decreasing natural habitat systems which are environmentally sensitive and have been impacted and reduced through human activities. Cost-share assistance of up to 75% of the total cost of installation (not to exceed $10,000 per applicant) is available for establishing habitat. Types of practices include: disking, prescribed burning, mowing, planting habitat, converting fescue to warm season grasses, establishing riparian buffers, creating habitat for waterfowl, and installing filter strips, field borders and hedgerows. For cost-share assistance, USDA pays up to 75% of the cost of installing wildlife practices.

9.10 Wetland Reserve Program (WRP)

This program is a voluntary program to restore and protect wetlands on private property. The program benefits include providing fish and wildlife habitat, improving water quality, reducing flooding, recharging groundwater, protecting and improving biological diversity, and furnishing recreational and esthetic benefits. Sign-up is on a continuous basis. Landowners who choose to participate in WRP may receive payments for a conservation easement or cost-share assistance for a wetland restoration agreement. The landowner will retain ownership but voluntarily limits future use of the land. The program offers landowners three options: permanent easements, 30-year easements, and restoration cost-share agreements of a minimum 10-year duration. Under the permanent easement option, landowners may receive the agricultural value of the land up to a maximum cap and 100% of the cost of restoring the land. For the 30-year option, a landowner will receive 75% of the easement value and 75% cost-share on the restoration. A ten-year agreement is also available that pays 75% of the restoration cost. To be eligible for WRP, land must be suitable for restoration (formerly wetland and drained) or connect to adjacent wetlands. A landowner continues to control access to the land and may lease the land for hunting, fishing, or other undeveloped recreational activities. At

any time, a landowner may request that additional activities be added as compatible uses. Easement participants must have owned the land for at least one year.

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

The mission of this project is to promote, cultivate, and encourage the development of water and wastewater facilities to serve low-income residents at affordable costs and to support other development activities that will improve the quality of life in rural areas. Staff members of other community organizations complement the SE/R-CAP staff across the region. They can provide (at no cost): on-site technical assistance and consultation, operation and maintenance/management assistance, training, education, facilitation, volunteers, and financial assistance. Financial assistance includes $1,500 toward repair/replacement/ installation of a septic system and $2,000 toward repair/replacement/installation of an alternative waste treatment system. Funding is only available for families making less than 125% of the federal poverty level.

9.12 National Fish and Wildlife Foundation

The National Fish and Wildlife Foundation administers the Chesapeake Bay Stewardship Fund, which is dedicated to the protection and restoration of the Chesapeake Bay. The Stewardship Fund is supported through partnerships with government agencies and private corporations, and typically awards $8 million to $12 million per year through two competitive grant programs and a technical assistance program. Larger "Innovative Nutrient and Sediment Reduction Grants" are available to nonprofits, local governments and state agencies, while smaller "Small Watershed Grants" are available to nonprofits and local governments. A request for grant proposals is typically issued in the spring of each year, and awards are made in the late summer/early fall. Additional information on the program may be found at: http://www.nfwf.org/chesapeake/Pages/home.aspx.

9.13 Regional Conservation Partnership Program

The Regional Conservation Partnership Program (RCPP) was authorized through the 2014 Farm Bill. This 5-year program promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. NRCS provides assistance to producers through partnership agreements and through program contracts or easement agreements. The RCPP competitively awards funds to conservation projects

designed by local partners specifically for their region. Eligible partners include agricultural or silvicultural producer associations, farmer cooperatives, state or local governments, municipal water treatment entities, conservation-driven nongovernmental organizations and institutions of higher education. Under RCPP, eligible landowners of agricultural land and non-industrial private forestland may enter into conservation program contracts or easement agreements under the framework of a partnership agreement. The Chesapeake Bay watershed is one of the eight "Critical Conservation Areas" identified for this program. These areas receive 35% of program funding.

9.14 Virginia Natural Resources Commitment Fund

The fund was established in the Virginia Code as a sub fund of the Water Quality Improvement Fund in 2008. Monies placed in the fund are to be used solely for the Virginia Agricultural BMP Cost Share Program as well as agricultural needs for targeted TMDL implementation areas.

9.15 Clean Water State Revolving Fund

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

9.16 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 Army Corps of Engineers.

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APPENDICES

APPENDIX A: Working Group Meeting Minutes

Crooked, Stephens and West Runs and Willow Brook Water Quality Improvement Plan
Agricultural Working Group Meeting: Lord Fairfax Community College
January 28, 2016

PARTICIPANTS

Sandra Ritenour	Debbie Staples
David Beahm	Doug Stanley
Matt Wolanski	David Nichols
Wayne Webb	Dick Hoover
Greg Huffman	Bud Nagelvoort
Mac McComas	Nesha McRae (DEQ)
Billy Staples	Don Kain (DEQ)

MEETING SUMMARY

Nesha McRae, from the Virginia Department of Environmental Quality (VADEQ) provided an overview of the role of the agricultural working group in the planning process. She explained that the group is typically made up of local farmers, Soil and Water Conservation District and Natural Resources Conservation District staff, along with representatives from other organizations that work in agricultural conservation in the region. The group moved on to discuss the general status of agriculture in the Crooked, Stephens and West Runs and Willow Brook watersheds today. Suburban encroachment was identified as a real problem in the area. One participant stated that he thought that farming in the region would soon be a thing of the past due to an influx of people from the D.C. metro area. Another participant responded that he thought this view was too pessimistic and that Clarke County had implemented a number of planning and zoning ordinances and programs to protect local agriculture. Another participant stated that he thought that the Willow Brook watershed has been subject to far less development pressure than the other watersheds and that it was more likely to stay in agricultural land use. It was also noted that the Friends of the Shenandoah River received a grant to implement BMPs and do water quality monitoring in the Willow Brook watershed. The report that was produced as part of this project might be helpful in developing the implementation plan. DEQ staff explained that it makes sense to focus BMP implementation in areas that are more likely to remain in agricultural since those practices are more likely to stay in place beyond the typical ten year contract period.

Representatives from the Lord Fairfax SWCD noted that they have been working to develop an urban BMP program in order to address stormwater pollution resulting from increased urban and residential development in the region.

It was noted that more small organic farms are coming into the region, but that start up costs for larger operations are cost prohibitive. The Jet Farm, a 500-acre farm on Crooked Run has been for sale for the past 10 years. Many farms in the area are leased (at least 50%). Many of the landowners in the region are older and no longer farm their own land. It was noted that it's hard to even find land to lease in the region, and that it's very competitive when property comes up to lease. The group agreed that long term leases are much better for farmers than short term (1 year agreements), 5-10 years was noted as ideal. There are a number of absentee landowners in the area as well. DEQ staff explained that work has been underway in Augusta and Rockingham Counties to help farmers negotiate better lease agreements. Typically, these agreements are only for one year, making a farmer who is leasing land reluctant to pay for any sort of management infrastructure on the property. If a longer lease agreement can be reached, the farmer may be more interested in implementing BMPs such as livestock exclusion systems. It was also noted that there has been an increase in the use of poultry litter in the watershed on both crop and hay land.

DEQ staff asked participants about potential partners for outreach activities. Participants suggested VA Cooperative Extension along with the local Farm Bureaus. It was noted that DEQ staff had reached out to local Farm Bureau leaders, but they were not in attendance. Participants agreed that phone calls were necessary in order to get better participation in meetings. Several participants offered to assist DEQ staff in identifying and contacting key farmers in the region for the next working group meeting. If the group was successful in getting more farmers to the table for the meeting, some additional background information like what was shared at the public meeting could be reviewed at the next working group meeting as well. Nesha agreed to work with David Beahm (Warren County Administrator) to follow up with farmers for the next meeting. Letters to landowners can also be effective, but some may require follow up correspondence in order to really get involved. It was also noted that door to door outreach efforts from NRCS had proved successful in the region. DEQ staff asked the group about local interest in conducting citizen monitoring for *E. coli* bacteria. This has proven to be a good way to get the community involved and keep people informed in other regions.

In order to gage local interest in different BMP options and identify the most suitable livestock exclusion fencing systems for inclusion in the plan, a survey was distributed to meeting participants. Everyone was asked to rank a series of BMPs along with a series of obstacles to livestock exclusion. The results are summarized in the two tables below:

Table 1. Potential best management practices for consideration. Average rankings are shown below (7 total) with 1 being the highest priority practice and 7 being the very lowest priority.

Best management practice	Description	Rank (1-7)
Streamside livestock exclusion fencing	Excluding livestock from streams with fencing, providing alternative water sources or limited access points to the stream	1
Rotational grazing	Establishing a series of grazing paddocks with cross fencing and rotating livestock to maximize forage production while preventing overgrazing	5

Best management practice	Description	Rank (1-7)
Forested streamside buffers	Planting trees and shrubs in strips (35 foot minimum) along streams adjacent to pasture and cropland	2
Grassed streamside buffers	Planting grasses in strips (35 foot minimum) along streams adjacent to pasture and cropland)	3
Forestation of crop, pasture or hayland	Convert existing pasture, crop or hayland to forest (hardwood or conifers,	4
Continuous no-till	Cropland is planted and maintained using no-till methods, only effective in reducing bacteria for cropland receiving manure applications (not commercial fertilizer)	5
Manure composting/storage facilities (equine)	Construction of planned system designed to manage solid equine waste from areas where horses are concentrated either through composting or storage	6

Table 2. Obstacles to streamside livestock exclusion. Average rankings are shown below (5 total) with 1 being the most common obstacle to address and 5 being the least common obstacle.

Obstacle	Rank (1-5)
The cost of installing fencing and off stream water is too high, even with cost share assistance from federal and state programs	1
Cannot afford to give up the land for a 35 foot buffer	3
General maintenance of fencing is time consuming and expensive	2
Grazing land is rented with short term leases and landowners are not interested in installing and/or maintaining streamside fencing and off stream water	4
People do not trust the government and do not want to work through state and federal cost share programs to installing fencing systems	3

Nesha asked the group about other potential meeting locations in the watershed for the future and meeting times. Participants suggested having the meetings as early in March as possible since farmers will be getting busy in mid March. The group agreed that 6:30 p.m. was a good time for a meeting.

Crooked, Stephens and West Runs and Willow Brook Water Water Quality Improvement Plan
Agricultural Working Group Meeting #2
Front Royal Volunteer Fire Department
March 8, 2016

Participants

Josh Gully
Dick Hoover (LFSWCD)
Tony Tringale
Don Kain (DEQ)
Ben Weddel
H.B. Simpson (LFSWCD)
Dana Gochenour (LFSWCD)
Tom Sayre (Warren BOS)
Bud Nagelvoort (LFSWCD)
Taryn Logan (Warren County)
Sandra Ritenour
David Beahm (Warren County)
Rachel Mahoney
Dave Morfit (Farm Bureau)
Mark Unger
Mack McComas
Dan Murray (Warren BOS)
Linda Glavis (Warren BOS)
Wayne Webb (FOSR)
Matt Wolanski (VADOF)
Paul Anderson
Nesha McRae (DEQ)

Meeting Summary

The meeting began with a review of background information about the project due to the fact that there were several new participants in attendance. A fact sheet about the water quality improvement plan and the study of the streams that was completed in 2014 was circulated. DEQ staff explained that monitoring has shown that these streams are often violating our water quality standard for *E. coli* bacteria. We monitor *E. coli* because it is a good indicator of whether there may be other pathogens in the water that could make people sick. The Department of Environmental Quality completed a study of the creeks in 2014. As part of this study, an inventory of bacteria in the watersheds was completed, and then used along with existing water quality data to estimate the reductions needed from each bacteria source in order for the creeks to meet our water quality standard for *E. coli.* This study helped us come up with a goal, and the plan that we are working on now will help determine how that goal can actually be reached. The group reviewed the different sources of bacteria in the watersheds along with the reductions needed from each source to meet the water quality standard.

Nesha McRae (DEQ) shared highlights from the previous agricultural working group meeting and presented the survey results to the group regarding best management practices to include in the plan along with obstacles to livestock exclusion. The group moved on to discuss livestock stream exclusion estimates and the types of fencing systems available through state and federal cost share programs. One participant noted that these programs have issues with funding drying up after staff go out and solicit applications to complete projects. The group discussed the different types of fencing systems and their pros and cons. DEQ staff asked for feedback on the

extent of each different type of system proposed, explaining that the fencing needed was divided up between the different types of practices based on the results of the "barriers to livestock exclusion" survey. One participant noted that he had concerns about brush growing up in streamside buffers and how it can be managed. Another participant discussed how he felt that these programs are designed to encourage farmers to improve water quality to benefit the general public, in which case the practices offered through them should be funded at 100% of the cost. Farmers are not typically generating a significant income from farming these days, making their 25% share of the cost of many of these practices very difficult to come up with. Water levels have been much lower in streams in the area in recent years as well. It was suggested that how often a stream has flowing water in it should be considered when developing these estimates and prioritizing projects. Several participants agreed that higher flowing segments streams should be targeted first along with the worst areas where livestock have access. Maintenance of fencing was discussed as a significant issue for farmers. The group reviewed component costs for fencing systems. It was noted that not everyone uses 5-strand high tensile wire for fencing. Four or five strand barbed wire can be very effective too, and typically costs less.

One participant suggested working with the Department of Corrections to both maintain fences and put them up. This could decrease the cost of installing the initial fencing and also save farmers time and money when it comes to maintenance. One participant noted that currently, farmers can't work with the Department of Corrections directly as private citizens. Nesha offered to follow up and see if an organization like Friends of the Shenandoah River or Lord Fairfax SWCD could contract with them. One participant explained that there are only three farms located along Willow Brook where the creek is actually flowing. Two of these farms have already excluded their cattle from the stream, leaving only one farm in the watershed to install fencing before the whole stream is excluded from livestock. It was noted that the water quality issue in Willow Brook is really driven by livestock in the stream rather than runoff based on the soils found in the watershed and the hydrology.

A suggestion was made that Soil and Water Conservation Districts need a system of checks and balances when reviewing applications for cost share in order to ensure that the money is going where it is most needed first. Representatives from the Lord Fairfax SWCD explained that they have a detailed ranking criterion in place for applications in order to make sure that the sites causing the greatest water quality problems are dealt with first. A participant asked the group whether they thought participation in livestock exclusion programs would increase if Soil and Water Conservation Districts had a program in place to replace washed out fences still within their contract period. Participants thought that this would certainly help. It was also noted that Soil and Water Conservation Districts should consider funding the installation of fencing that serves as both a stream exclusion fence and a boundary fence. Representatives from Lord Fairfax SWCD noted that if the fence is excluding livestock from the stream, they are generally not concerned if it is also acting as a boundary fence, but also said that every farm is different so they would have to see the situation before making a decision on it. It was noted that losing the buffer strip for agricultural production is definitely a concern, but that the cost of installing and maintaining the fences are the real issues of concern. It was also mentioned that stream channels move over time, presenting another challenge to fencing them out. Water gates can also be a big issue with flooding, and are very expensive to install. A representative from the Soil and Water Conservation District noted that they typically work with a farmer to install permanent fence posts in these situations and then have them run a couple of strands of hot wire across the creek.

This is a good solution when cattle are being moved around regularly and won't be lingering down in this area.

The group moved on to discuss rotational grazing and how common it is in the watershed. It was noted that this is a profitable practice that allows a farmer to stock more cattle while also avoiding overgrazing pastures. Adequate rain is really important for rotational grazing, and it is more labor intensive, which may be why it is not more commonly used in the area. In addition, some types of cattle are harder on fences then others, making is difficult to maintain cross fencing and move the herd between paddocks. Another participant noted that adopting rotational grazing requires a real mindset shift in management, which not all farmers are ready to make. Bobby Clark with Cooperative Extension has been holding a series of workshops on how to increase the number of days you can graze and reduce the days that you have to feed hay. It would be worthwhile to see if this sort of workshop could be offered in the Crooked Run watershed in order to increase the use of rotational grazing in the area. Bobby has also been working on a "fencing school" for farmers. Nesha offered to follow up with him on these different outreach opportunities.

DEQ staff asked the group about the presence of highly denuded or eroding pastures in the watersheds. It was agreed that there are a few of these situations present in the area. A representative from the Soil and Water Conservation District noted that often times, these areas are addressed through livestock exclusion projects.

The group moved on to discuss best management practices for cropland. Nesha asked the group what percentage of cropland in the watersheds has cover crops planted once corn or soybeans are harvested. The Soil and Water Conservation District doesn't have a great feel for this since they have cut back their cover crop program over the past two years to only offer tax credits. They expect that as a result, the practice is underreported. However, the group thought that an estimate of 90% of fields planted with cover crops to date was too high and that there is room to do more. One participant noted that they plant a cover crop every 2-3 years rather than annually. Nesha also asked participants about the use of continuous no till in the watersheds. In looking at the historic BMP data set for the state cost share program run through the Soil and Water Conservation District, implementation of this practice has been low/non existent in the watersheds. Soil and Water Conservation District staff noted that it's likely that many farmers don't realize that they can get cost share from the district for this practice, meaning that it's probably under reported as well.

DEQ staff asked the group to vote on an appropriate timeline for implementation of the practices discussed at the meeting. The group voted on 5, 10 and 15 years to complete the practices. Ten years received the majority of the votes and was thus selected as the implementation timeline for agricultural best management practices.

Nesha asked for a few volunteers to serve on the steering committee, Mac McComas, Mark Unger, Sandra Ritenour and Dana Gochenour said that they would consider serving on the committee. Nesha announced that the Residential Working Group Meeting would be held on April 7 (5:30 p.m. at Lord Fairfax Community College in the Executive Board Room) and the meeting was adjourned at 8:15.

Crooked, Stephens and West Runs and Willow Brook Water Quality Improvement Plan
Residential Working Group Meeting: Lord Fairfax Community College
January 28, 2016

PARTICIPANTS

Joe Lehnen (DOF)
Terry Lay (FOSR)
KatieShoemaker (EEE Consulting)
James Pinsky (LFSWCD)
Larry Stacy
Phil VanAlsburg
Dan Murray
Tom Sayre
Tara Sieber (VADEQ)
HB Simpson (LFSWCD)
Janice Atkinson
Tim Stowe
Larry Atkinson

MEETING SUMMARY

Tara Sieber, from the Virginia Department of Environmental Quality (VADEQ) provided an overview of the role of the residential working group in the planning process. She explained that the group is typically made up of local residential property owners, local Health Department staff, and representatives from other interested citizens groups in the region. The group moved on to discuss septic system maintenance needs and the degree of awareness in the area regarding what is involved in maintaining these systems. The group agreed that there is a considerable lack of awareness of septic system maintenance requirements. Participants thought that education on septic systems and alternative waste treatment systems could be targeted towards realtors and homebuilders in addition to homeowners in the watershed.

The group discussed alternative waste treatment systems. It was noted that independent verification of designs should be required and that architects should not be allowed to just sign off on system designs. One participant suggested that the VA Department of Health should work with local realtors to require the inclusion of the capacity of septic systems in real estate transactions. The Friends of the Shenandoah River has worked with homeowners on septic tank pumpout programs in the past, which provided assistance with the cost of pumpouts. It was noted that there are many challenges associated with working in karst/shale topography with respect to septic systems and alternative waste treatment systems. The percentage of alternative systems is higher than average in the watersheds because this topography makes it difficult to install a conventional drainfield. One participant asked whether peat moss systems could be considered alternative waste treatment systems. If the system is approved as designed by the Health Department, then homeowners can install it, this includes peat moss systems. Participants estimated that the cost of an alternative system can be as high as $35,000 while conventional systems are usually around $8000. It costs $300 to inspect a septic system and pumpouts are typically around $300.

The group moved on to discuss straight pipes and failing septic systems. Participants wanted to know where people are allowed to walk when walking the stream. DEQ staff explained that the

"ordinary high water mark," which is where water usually flows in a streambed is generally considered property of the Commonwealth. However, there are areas where Kings Grants exist and landowners actually own the stream bottom. A lot depends on individual property owners. A few participants identified fear as an important barrier to participation in assistance or education programs. Any sort of outreach should emphasize the voluntary nature of the program. A participant asked if a visible plume is created in a stream as a result of a straight pipe discharge. It was noted that there could be excess algal growth due to high nutrient levels around the pipe. Another participant suggested using aerial thermal imagery to determine where straight pipes are located since the discharge will probably be warmer than the stream water. Another barrier to participation in assistance programs will be the cost of hooking up to public sewer. In Frederick County, this is around $25,000 plus the cost of labor and materials to connect to the sewer line. Homeowners associations and public service boards hold public meetings every so often, which could be a good opportunity for outreach.

The group discussed potential partner organizations for rain garden installations in the watersheds including Front Royal Tree Stewards and the Garden Club of Warren County. Master Naturalists/Gardeners would probably not be the best partner for this particular implementation piece, but they could help with some residential education.

DEQ staff asked participants about opportunities for pet waste stations in the watersheds. Lake Frederick already has pet waste stations set up in the surrounding area, and some Homeowners Associations include pet waste disposal in their covenants/agreements. Warren County will be opening a dog park in 2018 (Rockland Park). It was noted that peer pressure is a critical component in getting pet owners to pick up after their pets.

Participants discussed other outreach opportunities regarding septic systems and pet waste. A local newspaper education campaign was suggested. The campaign could make the connection between groundwater science, septic system maintenance and financial cost share. Coliscan monitoring was suggested as a good tool for making upstream downstream comparisons to convince landowners to exclude their livestock. Friends of the Shenandoah River is already doing some bacteria testing in West Virginia. They already have an excellent monitoring network that they are willing and able to expand. McKay Springs was identified as a particular location the needs some additional monitoring. Another participant suggested launching a drinking water campaign. "Taste of the Shenandoah" could work with participating businesses and local Chambers of Commerce to stress local resources, health and taking care of our children by caring for our water. Local schools could also be involved in monitoring and outreach. They could play an important role in recruiting local service organizations such as Boy Scouts and Girl Scouts. Envirothon could be another tool to reach out to the local community. It was noted that the Army Corps of Engineers has a station in Winchester and might be able to provide assistance with labor to install septic systems at a reduced price, the National Guard was suggested as another potential source of assistance with labor.

It was noted that there is a need for sanitary facilities at Lake Frederick for fishermen after peak fishing season. Currently facilities are not available year round.

The group reviewed overall residential priorities and ranked them with one being the highest priority:

1. Straight Pipes and Failing Septics
2. Homeowner Education
3. Connection to public sewer

The group discussed future meetings and suggested avoiding Tuesday nights since they are Board of Supervisors meetings. An earlier time of 5-6 p.m. works well for people, or after 6:30 so that commuters can return home. Sunflower Cottage was noted as a good meeting location. Tara thanked participants and the meeting was adjourned.

Crooked Run Residential Working Group Meeting #2
Lord Fairfax Community College
April 7, 2016

Attendees
Wayne Webb (FOSR)
Richard Hoover (LFSWCD)
Joe Lehnen (VADOF)
Taryn Logan (Warren County)
David Beahm (Warren County)
Katie Shoemaker (3E Consulting)
Emily Ford (VA Master Naturalists)
Nesha McRae (VADEQ)
Antonia Rene Villeda (VADEQ)

Meeting Summary
Septic Systems and Straight Pipes
Nesha McRae began the meeting with a review of the summary that was prepared from the last residential working group meeting. Then the group moved on to discuss estimates of repairs and replacements of failing septic systems and straight pipes along with associated outreach strategies. It was suggested that the expected life span of a septic system be noted in outreach materials. Estimates included a large number of alternative waste treatment systems to replace failing septic systems due to the presence of karst topography in the watersheds. The group discussed targeting strategies for program outreach. It was explained that when resources to help landowners complete repairs and replacements of failing septic systems are limited, outreach can be targeted to particular portions of the watershed where the need is greatest. One potential strategy could be to focus on homes within a specific distance from the stream when doing mailings. It is likely that these homes have a great impact on water quality since the chance of effluent from their failing septic systems running off to the stream is greater than in upland areas. The group liked this idea and noted that proximity to springs should also be considered in targeting of outreach. The group reviewed a map showing subwatersheds with the greatest proportion of failing septic systems . DEQ staff explained that this map could be used for

additional targeting of outreach. The group liked the idea, but suggested that the total number of estimated failing septic systems be used for targeting rather than the proportion. The group reviewed cost estimates for correcting all of the failing systems. It was noted that the cost of alternative waste treatment systems was significantly driving up the cost of implementation ($2.8M out of the total $4M cost to repair or replace all failing septic systems and straight pipes in the watersheds).

Pet Waste Management

The group moved on to discuss pet waste management practices. It was noted that Warren County used an anti-litter grant to purchase pet waste stations for parks and other public properties in the county. DEQ staff asked participants about kennels in the watershed in terms of their handling of pet waste and whether there is room for improvement. Warren County requires kennels to double bag waste from their operations and take it to the transfer station for disposal. It is handled as commercial waste, which puts local kennels under more strict controls. Kennels are not a big issue in the watersheds. Cavalier Kennels is very well run and does not appear to have any significant room for improvement with respect to how pet waste is managed on the property. Cedarville Veterinary Clinic was not noted as having any issues with pet waste either. In Warren County, if you have five or more dogs, you have to have a permit. It is suspected that the number of properties with five or more dogs is vastly underreported. The group thought that these properties are probably having the greatest impact on water quality with respect to pet waste runoff. However, these types of properties are often very difficult to manage since they usually include a few acres, making pet waste pickup more challenging for the pet owners.

The group reviewed a map of the most densely developed portions of the watershed, which included aerial imagery. Potential neighborhoods for pet waste stations were discussed as DEQ staff explained that these stations would be most effective in densely developed areas with very small lots. These stations tend to be most effective when trash receptacles are included with the stations and serviced by a locality or private business with support from a Homeowners Association. The group recommended checking with Frederick County to see how the stations are serviced at Lake Frederick. It would also be a good idea to identify neighborhoods with Homeowners Associations since these areas may have the resources needed to ensure that the stations are stocked with bags and that trash is collected regularly. One participant noted that local realtors might have a good idea of which neighborhoods have Homeowners Associations (HOA). Staff from Warren County noted that the only development in their portion of the watershed with an HOA is the Blue Ridge Shadows Golf Course. DEQ staff asked the group whether they thought that there would be any interest in pet waste composters for private residences in the watershed. Staff from Warren County and VA Master Naturalists agreed that interest in these has been shown to date, and that it would be a good idea to include a small amount in the plan.

Several neighborhoods at the northern end of the Stephens Run watershed were identified for pet waste stations along with the Forest Lakes Estates development in Crooked Run. All of these developments are located in Frederick County. In addition, the group agreed that there might be an opportunity to install a 1.3 acre riparian buffer behind one of the developments in Stephens Run. It appears that there may be a walking trail along the river behind the development, making

it a great place for outreach (and possibly a source of pet waste). Joe Lehnen (DOF) noted that the Department of Forestry would probably be able to provide seedlings. VA Master Naturalists could help with a tree planting as well. DEQ staff noted that residential riparian buffers could be made more appealing to property owners if they fit into the residential landscape. The group suggested working with the Garden Club or the Native Plant Society to select attractive riparian plants for residential buffers.

Stormwater Management

The group moved on to discuss potential locations for stormwater management BMPs in the Crooked and Stephens Run watersheds. One participant asked about the possibility of working with a new development to go above and beyond required stormwater management controls. It was noted that while this is a great idea, the timing can be challenging to coordinate when grant funds are used to provide BMP cost share. Another participant noted that developers may be reluctant to commit to more even with the potential for additional funds. The maintenance requirements of stormwater BMPs are significant enough that some developers may be averse to committing to much more than what they are already required to do. The group reviewed a list of potential BMP locations and viewed them on the project area maps. It was noted that Riverton Commons already has a pretty sophisticated stormwater management treatment system and probably wouldn't be a good candidate for additional BMPs. The group discussed the idea of working with Sherando Park and Sherando High School on stormwater practices. The high school has a great agricultural department along with horticultural groups, who would likely be interested in helping to maintain a stormwater BMP such as a rain garden or bioretention filter. The group discussed several commercial properties that could be good sites for stormwater retrofits. DEQ staff explained that by enhancing the treatment efficiency of existing regional stormwater facilities with retrofits is probably one of the most cost effective ways to treat stormwater. The following commercial/industrial properties in Warren County were identified as potential BMP retrofit sites:

- Holiday Inn, Front Royal
- Sysco Systems
- Ferguson
- VA Inland Port
- Economic Development Authority (estimated 70-80 acre drainage area, adjacent to Sysco)

Participants did not think that the golf course would be interested.

Education and Outreach

The group discussed opportunities to partner with local organizations on education and outreach. VA Master Naturalists would probably be interested; however, it will be important to adopt a watershed wide approach rather than just focusing on outreach to a few specific property owners as this is their priority. The Native Plant Society would be a good partner for riparian buffer plant selection. Local realtors could be good sources of information about neighborhoods in the watershed. Civic clubs such as Rotary and Ruritans could be another great partner in outreach. While Lord Fairfax SWCD could be a great partner in outreach for both agricultural and residential practices, additional staffing at the SWCD office would be needed in order to support this sort of targeted outreach by the SWCD. They currently have a new Stormwater Committee,

which is led by a new district director from Frederick County. Other potential partners suggested included:

- Northern Shenandoah Valley Regional Commission
- Frederick County Builders Association (Top of VA)
- Warren County Builders Association
- Local realtor associations (used to do a local realtor forum, which could be a good outreach forum)
- Chamber of Commerce

Timeline

The group discussed an appropriate timeline for completion of the septic, pet waste and stormwater BMPs. The cost of the alternative waste treatment systems needed in the watersheds was noted as an obstacle to completing the work on a tight timeline. DEQ staff suggested that the timeline could note that the bulk of the alternative waste treatment systems would be installed later on in the project timeline rather than spreading implementation out evenly across each year. This would allow partners to continue to identify other funding sources for support and build local momentum. DEQ staff explained that typically, DEQ issues a request for proposals to implement plans like the one under development in Crooked Run, and funding is awarded for 2-2 ½ years. Applicants are asked to review the project timeline and adjust proposal deliverables based on the portion of project goals established for the 2-2 ½ year period. One participant asked who typically applies for funding. DEQ staff explained that usually, Soil and Water Conservation Districts serve as the primary applicant. They may establish subawards with localities or the local Health Department to complete stormwater or septic BMPs. The group voted on a 5, 10 or 15 year timeline for the project. There was one vote for 15 years, and the remainder of votes were for 10, which the group agreed upon.

Steering Committee

There will be one steering committee meeting before the final community meeting for the project. This group will review the draft plan and make recommendations for the content and structure of the final public meeting. Nesha McRae asked for volunteers to serve on the committee. Wayne Webb, Taryn Logan and Katie Shoemaker all volunteered to serve on the committee.

Nesha thanked everyone for their participation and the meeting was adjourned.

APPENDIX B: Public Outreach

First Public Meeting Invitation: Mailing to riparian landowners

January 5, 2016

Dear _____,

I am writing to invite you to a community meeting to kick off the development of a water quality improvement plan for Crooked, West and Stephens Runs and Willow Brook in Frederick, Warren and Clarke Counties. The Virginia Department of Environmental Quality (DEQ) will be holding a kick off meeting for the project on Thursday, January 28th from 6:30 – 8:30 p.m. at the Lord Fairfax Community College's Carl and Emily Thompson Conference Center (173 Skirmisher Lane, Middletown VA). ***In the event of inclement weather, the meeting will be postponed until February 3rd, to be held at the same time and location.*** Please call the number provided below to confirm postponement of the meeting.

Crooked, West and Stephens Runs and Willow Brook are on Virginia's list of "dirty waters" because they violate our water quality standard for bacteria. This means that the chances of someone getting sick after coming into contact with the water (*e.g.* water in the eyes, ears, mouth) are greater than we would like. The high levels of bacteria we are seeing in the water tell us that there is animal and human waste in the river. Failing septic systems, straight pipes, wildlife, and livestock are the main sources. Waste from humans, livestock, pets and wildlife can transmit diseases such as hepatitis A and giardiasis. The plan that we will develop can serve as a road map to help correct this problem. The plan follows a study of the creeks completed in 2014 by DEQ (formally known as a Total Maximum Daily Load (TMDL)). The study identified the sources of bacteria in the water and the reductions needed to make the creeks safe for swimming and other forms of recreation where people are having primary contact with the water.

Using local input, we will develop a plan that can be implemented voluntarily by stakeholders in the community. We hope to draw from experiences that local landowners have had implementing conservation practices and collect ideas on community outreach strategies. As a landowner along the one of these creeks, your participation in the development of this plan is critical to ensuring that it includes strategies that the local community can support. During the upcoming meeting, there will be a brief presentation explaining the planning process that we will use, followed by breakout sessions of an agricultural and a residential working group. The working groups will discuss specific strategies that agricultural and residential landowners could implement to help clean up the creeks. This will be an excellent opportunity to share your thoughts on the types of actions that should be included in the plan, and the best ways to reach out to landowners. We hope to see you on the 28th, please feel free to call with questions in the meantime.

Sincerely,

Nesha McRae, Non Point Source TMDL Coordinator, VADEQ

Phone: (540)574-7850; Email: nesha.mcrae@deq.virginia.gov

Final Public Meeting Invitation: Mailing to riparian landowners
June 14, 2016

Dear _____,

Over the past six months, The Virginia Department of Environmental Quality and partners have been working with your community to develop a plan to make Crooked, West and Stephens Runs and Willow Brook safe for swimming and recreating. We will present this draft plan at a community meeting and ice cream social on ***June 29th at 7:00 p.m. at the North Warren Volunteer Fire Hall's Celebration Hall (2nd Floor, 266 Rockland Court, Front Royal, Virginia).*** Partners will be setting up informational displays at the meeting, so this will be a great chance to learn about the help that is out there for landowners who want to do their part to clean up the river. In addition, locally made ice cream from C&C Frozen Treats will be served at the meeting thanks to generous sponsorships from the Warren County Farm Bureau and the Friends of the North Fork Shenandoah River.

Crooked, West and Stephens Runs and Willow Brook (located primarily in Warren and Frederick Counties) are on Virginia's list of "dirty waters" because they violate our water quality standard for bacteria. This means that the chances of someone getting sick after coming into contact with the water (*e.g.* water in the eyes, ears, mouth) are greater than we would like. The high levels of bacteria we are seeing in the water tell us that there is animal and human waste in the river. Failing septic systems, straight pipes, wildlife, and livestock are the main sources. Waste from humans, livestock, pets and wildlife can transmit diseases such as hepatitis A and giardiasis. The plan that we have developed can serve as a road map to correct this problem.

We made many efforts involve the community in creating this plan including agricultural and residential focus group meetings and the formation of a steering committee. The draft plan includes actions that landowners can take to help the river. Examples include replacing failing septic systems, excluding livestock from streams, and implementing rotational grazing systems. The plan also includes a timeline, education and outreach strategies, costs and benefits, and potential funding sources.

The meeting on June 29th will kick off a 30-day public comment period during which anyone can offer feedback on the plan (available after the 29th at http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/TMDL/TMDLImplementation/TMDLImplementationPlans.aspx).

As a landowner in the community, your participation in the implementation of this plan is very important. We hope that you will be able to join us to learn more about the creeks and enjoy some locally made ice cream!

Sincerely,

Nesha McRae, Non Point Source TMDL Coordinator, VADEQ

phone: 540-574-7850; email: nesha.mcrae@deq.virginia.gov

Press Release: First Public Meeting

Community Meeting to Discuss a Total Maximum Daily Load Implementation Plan for Crooked, Stephens and West Runs and Willow Brook in Frederick, Warren and Clarke County, VA

A public meeting to kick off the development of a water quality improvement plan for Crooked, Stephens and West Runs and Willow Brook will be held on Thursday, January 28, 2016 at 6:30 p.m. at the Lord Fairfax Community College's Carl and Emily Thompson Conference Center (173 Skirmisher Lane, Middletown, Virginia). In the event of inclement weather, the meeting will be postponed until February 3rd, but will still be held at the same time and location. Please call Nesha McRae (540-574-7850) to determine whether or not the meeting will be held as scheduled.

Crooked, Stephens and West Runs and Willow Brook were identified in Virginia's Water Quality Assessment Integrated Report as impaired for violations of the *E.coli* bacteria water quality standard. This poses a human health risk for people having primary contact with the water (swimming, splashing water into your eyes, ears or mouth). The high levels of bacteria we are seeing in the water tell us that there is animal and human waste in the river. Failing septic systems, straight pipes, wildlife, and livestock are the main sources. Waste from humans, livestock, pets and wildlife can transmit diseases such as hepatitis A and giardiasis.

Representatives from the Virginia Department of Environmental Quality will be working with local partners over the next several months to develop a bacteria reduction plan for the creeks. This plan is intended to serve as a road map to correct this problem and make the creeks safer for all forms of recreation. The plan follows a study of the creeks completed in 2014 by DEQ (formally known as a Total Maximum Daily Load (TMDL)). The study identified the sources of bacteria in the water and the reductions needed to make the creeks is safe for swimming and other forms of recreation where people are having primary contact with the water.

The water quality improvement plan will outline what is needed to reduce the sources of bacteria in the creeks, the costs and benefits of cleaning them up, along with measurable goals and an implementation timeline. Corrective actions (also known as best

management practices) may include replacing failing septic systems, removing straight pipes, and reducing polluted runoff from agricultural and residential areas. Best management practices for agricultural sources can include streamside livestock exclusion fencing, rotational grazing, streamside plantings of trees or grasses on cropland and pasture, and reforestation of erodible pasture and cropland. In urban and residential areas, practices such as rain gardens and pervious pavement help reduce polluted runoff. Encouraging residential property owners to maintain their septic systems and pick up after their pets also helps reduce the amount of bacteria that winds up in our rivers and streams.

Participating in developing the implementation plan is an opportunity for local residents and stakeholders to improve and preserve water resources, increase farm production, and increase property values in the community. Strong local public participation ensures a final implementation plan driven by local input. Community involvement in the creation of the plan and support of its implementation are critical factors in determining its success in improving local water quality.

The public comment period for the January 28th meeting will end on February 29, 2016. For additional information or to submit comments, contact Nesha McRae, at the Virginia Department of Environmental Quality, Valley Regional Office, P.O. Box 3000, Harrisonburg, VA, 22801, by phone (540) 574-7850 or by email nesha.mcrae@deq.virginia.gov.

Press Release: Final Public Meeting

Ice Cream Social and Community Meeting to Discuss a Total Maximum Daily Load Implementation Plan for Crooked, West and Stephens Runs and Willow Brook, Warren, Frederick and Clarke County, VA

A community meeting to present a water quality improvement plan for Crooked, West and Stephens Runs and Willow Brook will be held on Wednesday, June 29, 2016 at 7:00 p.m. in the North Warren Volunteer Fire Hall's Celebration Hall (2nd Floor, 266 Rockland Court, Front Royal, Virginia). Locally made ice cream from C&C Frozen Treats in Front Royal will be served at the meeting courtesy of the Warren County Farm Bureau and Friends of the North Fork Shenandoah River.

Crooked, West and Stephens Runs and Willow Brook (located primarily in Warren and Frederick Counties) are on Virginia's list of "dirty waters" because they violate our water quality standard for bacteria. This means that the chances of someone getting sick after coming into contact with the water (e.g. water in the eyes, ears, mouth) are greater than we would like. The high levels of bacteria we are seeing in the water tell us that there is animal and human waste in the river. Failing septic systems, straight pipes, wildlife, and livestock are the main sources. Waste from humans, livestock, pets and wildlife can transmit diseases such as hepatitis A and giardiasis.

Over the past six months, representatives from the Virginia Department of Environmental Quality have been working with local partners to develop a bacteria reduction plan for the creeks. This plan is intended to serve as a road map to correct this problem and make Crooked, West and Stephens Runs and Willow Brook safer for all forms of recreation. The plan follows a study of the river completed in 2014 by DEQ (formally known as a Total Maximum Daily Load (TMDL)). The study identified the sources of bacteria in the creeks and the reductions needed to make sure they are safe for swimming and other forms of recreation where people are having primary contact with the water.

The plan that will be presented at the meeting outlines what is needed to reduce the sources of bacteria in the river, their associated costs and benefits, along with measurable goals and an implementation timeline. Corrective actions (also known as best management practices) include replacing failing septic systems, removing straight pipes,

and reducing polluted runoff from agricultural and residential areas. Best management practices for agricultural sources can include streamside livestock exclusion fencing, rotational grazing, streamside plantings of trees or grasses on cropland and pasture, and reforestation of erodible pasture and cropland.

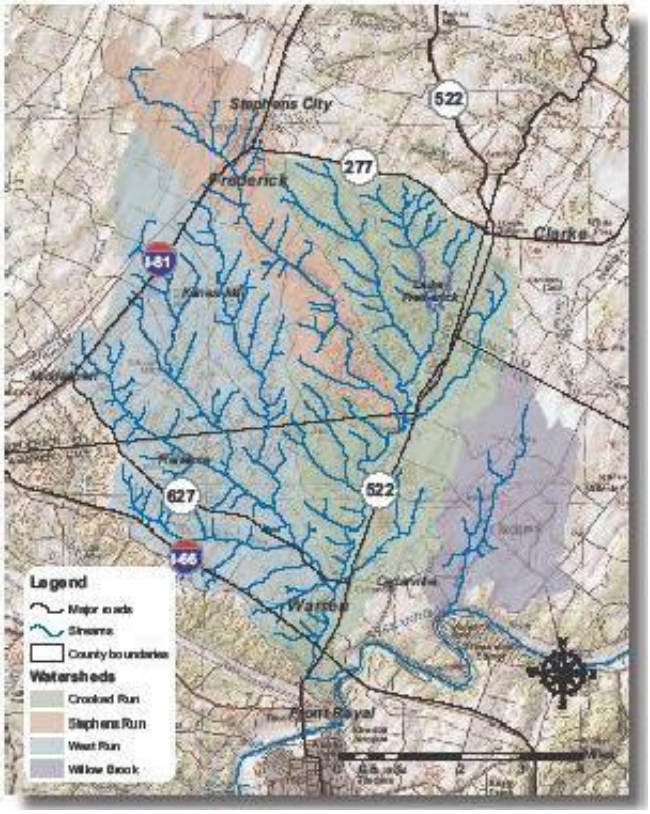
Participation in the implementation of this plan from local landowners will be critical to cleaning up the river. The plan will be implemented on a voluntary basis using existing federal and state incentive programs to encourage property owners to implement corrective actions. This meeting will be an excellent opportunity for landowners to learn more about the resources available to help them implement these actions.

During the meeting on June 29th, the draft plan will be presented to the community, and partners will have displays set up with information for landowners on how they can do their part to help clean up the river. This meeting will kick off a 30-day public comment period extending from June 30, 2016 to July 29, 2016 during which community members can offer suggested changes to the plan. For additional information or to submit comments, contact Nesha McRae, at the Virginia Department of Environmental Quality, Valley Regional Office, P.O. Box 3000, Harrisonburg, VA, 22801, by phone (540) 574-7850 or by email nesha.mcrae@deq.virginia.gov.

First Public Meeting Flyer

Community Meeting to develop a clean up plan for:

Crooked Stephens West Runs & Willow Brook



January 28, 2016
6:30 - 8:30 p.m.

Lord Fairfax Comm. College Carl & Emily Thompson Conference Center
173 Skirmisher Lane
Middletown, VA

Calling all Crooked Run Residents!!!

Over the next six months, The Virginia Department of Environmental Quality and partners will be working closely with interested local residents to develop a clean up plan for Crooked Run, its tributaries and Willow Brook. We are concerned about these creeks because monitoring is show-inghig h levels of fecal bacteria in the water. This means that people face a greater chance of illness or infection when they go swimming in the creeks or get water in their eyes, ears or mouth. Input from local residents is needed to figure out the best ways to address this problem in the creeks.

If you are interested in learning more about the issues facing Crooked Run and Willow Brook and what local landowners can do to help, please join us! In the event of inclement weather, the meeting will be postponed until February 3rd, to be held at the same time and location. Please call the number provided below to confirm postponement of the meeting.

For more information, contact:

Nesha McRae, VADEQ
(540) 574-7850; nesha.mcrae@deq.virginia.gov

Final Public Meeting Flier

Ice Cream Social & Community Meeting to present a clean up plan for

CROOKED, STEPHENS, WEST RUNS & WILLOW BROOK

June 29, 2016
7:00 - 8:30 p.m.

North Warren Fire Dept.
266 Rockland Court
Front Royal, VA

Calling all Crooked Run Community Residents:

Currently,. the Crooked, Stephens, West Runs and Willow Brook (located in Warren, Frederick and Clarke Counties) are considered unhealthy due to high amounts of fecal bacteria in the water. This means that people face a greater chance of getting sick when they go swimming in the creeks or get water in their eyes, ears or mouth. Over the past six months, The Virginia Department of Environmental Quality and partners have been working to develop a clean up plan for the creeks. Using input from local residents, a plan has been developed outlining what can be done to reduce the amount of fecal bacteria in the water and make the river safe for all kinds of recreation. The succes of the plan relies on voluntary actions from local landowners. At the meeting, participants will hear what they can do to help from local experts.

Come and *enjoy locally made ice cream* from C&C *Frozen Treats* sponsored by the *Warren* County *Farm Bureau and Friends of* the *North Fork Shenandoah River while* you /earn what you *can do* to *help Crooked,* Stephens, West *Runs and Willow Brook!*

For more information,
contact Nesha McRae, VADEQ
(540) 5747850
nesha.mcrae@deq.virgnia.gov

APPENDIX C: Public Comments

Response to Comments Document for Crooked, Stephens and West Runs and Willow Brook TMDL Implementation Plan Development

Introduction:

A final public meeting was held for the Crooked Run TMDL Implementation Plan on June 29, 2016. This project included the development of a series of implementation scenarios to meet the *E.coli* bacteria TMDLs for Crooked, Stephens and West Runs and Willow Brook in addition to incremental water quality milestones. The draft implementation plan was presented at the meeting and made available on the Virginia Department of Environmental Quality (DEQ) website at that time. A 30-day public comment period on the draft plan was held from June 30, 2016 until July 29, 2016. During the public comment period, no comments were received from the public.