Crab Creek Watershed Bacteria and Sediment TMDL Implementation Plan Technical Report

Prepared by
The Crab Creek IP Steering Committee
In Cooperation With
The Virginia Tech Department of Biological Systems Engineering &
The Virginia Department of Environmental Quality

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List of Abbreviations

The following abbreviations are used throughout this document.

BMP – Best Management Practice

BSE – Biological Systems Engineering Department (Virginia Tech)

CREP – Conservation Reserve Enhancement Program

CRP- Conservation Reserve Program

CWA – Clean Water Act, the origin of the Total Maximum Daily Load Program

CWSRF – Clean Water State Revolving Fund

EQIP – Environmental Quality Incentives Program

FTE – Full Time Equivalent

GWLF - Generalized Watershed Loading Functions model

HSPF – Hydrological Simulation Program-FORTRAN

IP – Implementation Plan

LA – Load Allocation, the load allocated to nonpoint and background sources in the Total Maximum Daily Load Study

MOS – Margin of Safety, a load that represents uncertainty in the modeling process

NPS – nonpoint source, referring to diffuse sources of pollution, such as from runoff

NRCS – Natural Resources Conservation Service

SWCB – State Water Control Board

SWCD –Soil and Water Conservation District

TMDL – Total Maximum Daily Load (Study)

USCB – United States Census Bureau

USEPA – United States Environmental Protection Agency

VAC – Virginia Administrative Code

VCE – Virginia Cooperative Extension

VADCR – Virginia Department of Conservation and Recreation

VADEQ – Virginia Department of Environmental Quality

VDH – Virginia Department of Health

VDOF – Virginia Department of Forestry

VDGIF – Virginia Department of Game and Inland Fisheries

VDOT – Virginia Department of Transportation

VPDES – Virginia Pollutant Detection and Elimination System

VT – Virginia Tech

WLA – Waste Load Allocation, the load allocated to point sources

WQIF – Water Quality Improvement Fund

WQMIRA – Water Quality Monitoring, Information and Restoration Act

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EXECUTIVE SUMMARY

Crab Creek, which is located entirely in Montgomery County, is part of the New River basin. All 12 miles of Crab Creek, from its headwaters to its confluence with the New River, are impaired for violations of the fecal coliform bacteria water quality standard and the General Standard (benthic). The Virginia Department of Environmental Quality (VADEQ) first listed Crab Creek on the 1996 303(d) list for these impairments and completed the corresponding TMDL studies in 2004. The purpose of this Implementation Plan (IP) is to describe the actions needed to achieve water quality goals in the Crab Creek watershed and achieve fully supporting status for Crab Creek.

Review of the Crab Creek TMDLs

The Crab Creek watershed is located in Montgomery County and the Town of Christiansburg. It flows generally west to its confluence with the New River. The Crab Creek watershed comprises approximately 12,400 acres of land area with 42% characterized as developed, 33% agriculture and 24% forested according to 2012 National Agricultural Statistics Service (NASS) and 2006 National Land Cover Database (NLCD) geospatial data. Over 40 % of the Crab Creek watershed is located within the town limits of Christiansburg. The 2004 TMDL estimated a population of 15,711 in the watershed using US Census data. All 12 miles of Crab Creek, from its headwaters to its confluence with the New River, are impaired for violations of the (fecal coliform) bacteria water quality standard and the General Standard (benthic). VADEQ first listed Crab Creek on the 1996 303(d) list for these impairments and completed the corresponding TMDL studies in 2004.

The 2004 TMDL identified the primary sources of bacteria in Crab Creek as nonpoint source pollution, specifically agricultural runoff from pasture and croplands, straight pipes and sewer overflows, and direct deposition of livestock manure in streams. Other nonpoint sources of bacteria include failing septic systems, pet waste, forests, commercial and barren lands, and wildlife. A stressor analysis identified sediment as the most probable stressor for aquatic life in Crab Creek. The 2004 TMDL identified the primary sources of sediment in Crab Creek as channel erosion, pastureland, and cropland. Additional nonpoint sources of sediment include forest and disturbed forest, MS4, transitional, residential, and commercial land uses.

The TMDL study included evaluations of several allocation scenarios for meeting both the bacteria and sediment TMDLs. The final allocation scenarios for meeting the bacteria and sediment TMDLs in Crab Creek were updated during Implementation Plan development based on BMP implementation, land use changes, and corrections to the channel erosion load. These final allocation scenarios used in this Implementation Plan are located in Table ES-1 (bacteria) and Table ES-2 (sediment).

Table ES-1. Allocation scenario used in the Crab Creek Implementation Plan for meeting the Crab Creek bacteria TMDL

	Percent Reduction in Bacteria Loading					Percent Violations	
Stage	**Cattle Direct Deposition**	**Residential / Urban**	**Pasture**	**Cropland**	**Straight Pipes/ SSOs**	**GM > 126 cfu/ 100ml**	**Single Sample > 235 cfu/100ml**
1	100	76	60	31	100	0	12.80
2	100	80	88	31	100	0	10.35

Table ES-2. Sediment allocation scenario for meeting the Crab Creek sediment goals

Sediment Source	Existing Condition	Allocations			
		Stage 1		Stage 2	
Categories	**(T/yr)**	**(%)**	**(T/yr)**	**(%)**	**(T/yr)**
LDR-PER	29.830	0	29.830	5	28.339
HDR-PER	0.083	0	0.083	0	0.083
COM-PER	7.074	0	7.074	0	7.074
Transitional	63.624	0	63.624	0	63.624
Forest	25.463	0	25.463	0	25.463
Disturbed Forest	84.852	0	84.852	0	84.852
Pastureland	1,276.101	32	867.749	37	803.944
Cropland	505.871	17	419.873	17	419.873
LDR-IMP	16.858	0	16.858	5	16.015
HDR-IMP	1.141	0	1.141	0	1.141
COM-IMP	0.005	0	0.005	0	0.005
Water	0.000	0	0.000	0	0.000
MS4-Existing (minus WLA of 55.14)	43.348	3	42.047	15	36.846
MS4-Future	20.652	3	20.032	15	17.554
Active Ag BMPs[1]	*-281.96*		*-281.96*		*-281.960*
Active Ag BMPs[2]	*-84.60*		*-84.6*		*-84.600*
Active Urban BMPs[2]	*-22.25*		*-22.25*		*-22.254*
NPS Load	**1,686.09**		**1,189.82**		**1,116.00**
Channel Erosion[3]	2,944.37	71	853.868	71	853.868
Total	**4,630.46**		**2,043.69**		**1,969.87**
Target Allocation Load (TMDL - MOS - WLA)					**1,971.26**
Target In-stream Load (All Sources-MOS)					**2,047.63**

[1]Credited during TMDL development
[2]Credited since TMDL development
[3]Credited 2,233 linear ft of stream restoration- Diamond Hills project

The allocation scenario for Stage 1 bacteria includes load reductions of 100% from direct deposition by livestock – Livestock (DD), 60% from pasture, 31% from cropland, 76% reduction

from residential and urban sources (Res./Urban), and 100% from straight pipes and Sanitary Sewer Overflow (SSO) loads. The allocation scenario for Stage 2 requires increasing overall reductions of the residential and urban load to 80% and pasture load reductions to 88%. This final allocation scenario will result in no violations of the *E.coli* geometric mean criterion and less than 10.5% violations of the *E.coli* single sample maximum criterion. On attainment of these water quality milestones, Crab Creek would be delisted for *E.coli*.

The sediment allocation scenario for meeting the Crab Creek TMDL requires total load reductions of 5% from low-density residential pervious, 5% from low-density residential impervious, 37% from pastureland, 17% from cropland, 15% from the existing MS4 load (not including the MS4 load attributed to the WLA), 15% from the future MS4 load, and 71% from channel erosion (Table ES-2). These source reductions will result in a 57% overall reduction in sediment load which will meet both the Implementation Plan Target Modeling Load and the original TMDL.

Goals and Milestones

The ultimate goal of the Implementation Plan is to improve water quality in order to protect the use of Crab Creek for recreational activities such as swimming and for aquatic life. The proposed timeline for achieving restored water quality in Crab Creek is ten years with implementation actions divided into two stages. The first stage (Stage 1) will take six years and the second stage (Stage 2) will take an additional four years. This staged approach concentrates early efforts on the most cost-efficient control measures and targets sources with the most interest from stakeholders.

Two types of milestones have been created for evaluating progress during each stage. Water quality milestones establish the goals for observing improvements in water quality while the implementation milestones outline the extent of BMPs to be installed. Generally, the Stage 1 water quality goal for TMDL Implementation Plans is based on reducing the number of violations of the single sample standard to 10% or less; however, the TMDL determined this goal would require reductions greater than 60% from land-based urban and agricultural loads. Thus, the Stage 1 water quality milestone for bacteria in the Crab Creek, as recommended in the 2004 TMDL, was to reduce violations of the single sample standard to equal or less than 16.10% and to reduce violations of the geometric mean standard to equal or less than 3.33%. The Stage 1 was modified from this recommendation during Implementation Plan development based on further feedback from watershed stakeholders. The modified Stage 1 reductions to bacteria reduce violations of the single sample standard to equal or less than 12.80% and result in zero violations of the geometric mean standard (Table ES-3). The Stage 2 water quality milestone for bacteria is to reduce violations of the single sample standard to equal or less than 10.5% and to reduce violations of the geometric mean standard to 0%. This condition will meet Virginia's water quality standards for bacteria and allow for the delisting of Crab Creek from Virginia's 303(d) List of Impaired Waters.

Table ES-3. Implementation goals for reducing bacteria in the Crab Creek watershed and the corresponding sediment reductions

Objective	Stage 1	Stage 2
Bacteria (*E.coli*)		
% Violations of the Geomean Standard	0.00%	0.00%
% Violations of the Instantaneous Standard	12.80%	10.35%
Average Annual Load (cfu/yr)	$1.40x10^{15}$	$9.44x10^{14}$
Sediment		
% Reduction	55%	57%
Average Annual Load (T/yr)	2,120.06	2,046.24

The agricultural BMPs installed for Stage 1 bacteria reductions will also help meet the sediment reductions needed from pasture. Additional stormwater BMPs and streambank stabilization practices implemented during Stage 1 will help meet the Stage 1 goal of reducing the sediment load in Crab Creek by 55%. During Stage 2, additional stormwater and pasture BMPs will be implemented to meet both the TMDL and the IP Target Allocation Load for sediment (Table ES-4).

Table ES-4. Implementation goals for reducing sediment in the Crab Creek watershed

Load Summary	Crab Creek Sediment (T/yr)	Reduction Required (T/yr)	Reduction Required (% of existing load)
TMDL Existing Load	6,307	4,088	64.8
TMDL Projected Future Load	7,197	4,978	69.2
TMDL	2,551		
IP Projected Future Load	4,814	2,766	57.0
IP Target In-stream Load[1]	2,047		
IP Target Allocation Load[2]	1,971		

[1] Corrected TMDL minus MOS

[2] Corrected TMDL minus the WLA and the MOS

Progress towards these goals can be assessed during the implementation process by tracking the development and execution of programs, policies, and practices (implementation actions) and through continued water quality monitoring. Improvements in water quality will be measured through monitoring of bacteria concentrations and the aquatic community throughout the watershed.

Implementation Actions

Potential control measures, their costs, and pollutant removal effectiveness estimates were identified through a review of the TMDL report, through input from the TMDL IP Work Groups, from a literature review, and from modeling. Because the TMDL watersheds contains a combination of residential and agricultural land uses, implementation actions to address the required pollutant reductions include a variety of control measures which target each pollutant source.

The quantity of corrective measures, or implementation actions, needed to meet the source load reductions was determined through spatial analysis and the model used in the TMDL study. The

recommended residential management practices needed to attain the necessary reductions in both sediment and bacteria include

- pumping out 565 septic tanks,
- identifying and replacing 4 straight pipes,
- repairing or replacing 316 failing septic systems,
- replacing 36 failing septic systems with alternative on-site waste treatment systems,
- connecting 7 failing septic systems to public sewer,
- placing 15 pet waste stations in the watershed,
- distributing 50 pet waste digesters and/or composters,
- implementing a pet waste education program,
- treating 69 acres with rain gardens,
- treating 3.5 acres with bioretention filters,
- treating 7 acres with bioswales,
- treating 55.5 acres with forested riparian buffers,
- treating 95 acres with grass/shrub riparian buffers,
- treating 82 acres with detention and 100 acres with extended detention,
- treating 12.5 acres with manufactured BMPs,
- treating 15.5 acres with a combination of detention and manufactured BMPs,
- treating 0.5 acres with constructed wetlands and/or wet ponds,
- treating 1.5 acres with infiltration practices, and
- treating 1 acre with vegetated open channels.

The recommended agricultural management practices include

- installing 45 livestock exclusion systems,
- treating 3,265 acres of pasture with grazing land management systems,
- reforesting 28 acres of erodible pasture,
- planting 29 acres of critical areas with permanent vegetative cover,
- installing 20 heavy use area protection systems,
- applying continuous no-till to 5 acres, and
- implementing 20 acres of small grain cover crop.

In addition to these residential and agricultural practices, streambank stabilization practices should be installed on 11,254 linear feet of streams within the watershed to reduce the sediment load from channel erosion. Technical assistance will be needed to educate, design and install both residential and agricultural practices in the watershed. Additional outreach and education efforts will also be required to educate watershed residents about these practices.

Associated costs for each implementation action were estimated from the Virginia Department of Conservation and Recreation (VADCR) agricultural BMP database, from previous TMDL IPs, and from discussions with local stakeholders. The total estimated cost for implementation is $10,388,725.

Stakeholders and their Roles

Stakeholders are individuals who live or have land management responsibilities in the watershed, including private individuals, residential and agricultural landowners, government agencies, businesses, and special interest groups. Stakeholder participation and support is essential for

achieving the goals of this TMDL effort (i.e., improving water quality and removing streams from the impaired waters list).

The Virginia Department of Environmental Quality (VADEQ) is the lead state agency in the TMDL process. VADEQ will continue monitoring in the watershed to evaluate water quality throughout the implementation period. Additional monitoring support will be provided through the Virginia Save Our Streams program, Radford University, Christiansburg High School, and the New River Conservancy (formerly the National Committee for the New River). The Skyline SWCD will provide cost-share funds, lead education and technical efforts, and track the agricultural and residential implementation practices. The USDA Natural Resources Conservation Service (NRCS) will also assist private landowners by providing funding through federal programs and offering technical assistance with installation of implementation practices. Administrative support for the residential and urban practice needs may also be provided by the New River Valley Planning District Commission. Additional targeting and prioritization efforts could be led by the New River Land Trust.

The Town of Christiansburg has taken great strides to improve the quality of water entering Crab Creek from land within the Town and they should continue their efforts to address stormwater, erosion and sediment, and sanitary sewer overflows. As Montgomery County transitions to a Phase II MS4, they will have similar responsibilities in the watershed. The Virginia Department of Transportation should also continue implementing their MS4 program requirements as they relate to the Crab Creek watershed.

Integration with Other Watershed Plans

Like most watersheds in Virginia, water quality improvements in the Crab Creek watershed are a component of many different organizations, programs and activities. Such efforts include, but are not limited to, watershed implementation plans, TMDLs, Roundtables, Water Quality Management Plans, Erosion and Sediment Control Regulations, Stormwater Management Programs, Source Water Assessment Programs, local comprehensive and strategic plans, and local environmentally-focused organizations. These efforts should be evaluated to determine their potential impacts on the implementation goals outlined in this clean-up plan. Often, these efforts are related or collaborative, but this is not always the case. Coordination of local programs can increase participation and prevent redundancy. Initiatives coinciding with TMDL implementation efforts in this watershed include the New River Livability Initiative Study and the Town of Christiansburg's Comprehensive Plan and Vision 2020.

Potential Funding Sources

Funding sources that may be available to support implementation include:

- Federal
    - Clean Water Act 319 Incremental Funds
    - Conservation Reserve Program (CRP)
        - Conservation Reserve Enhancement Program (CREP)
    - Conservation Stewardship Program (CSP)
    - Environmental Quality Incentives Program (EQIP)
    - Agricultural Lands Easement Program
    - United States Fish and Wildlife Service grants

- State
    - Virginia Agricultural Best Management Practices (BMPs) Cost-Share Program
    - Virginia Agricultural Best Management Practices Loan Program
    - Virginia Agricultural Best Management Practices Tax Credit Program
    - Virginia Clean Water Revolving Loan Fund
    - Virginia Forest Stewardship Program
    - Virginia Outdoors Foundation and the Open Space Lands Preservation Trust Fund
    - Virginia Small Business Environmental Assistance Fund Loan Program
    - Virginia Stormwater Assistance Fund (SLAF)
    - Virginia Water Quality Improvement Fund (WQIF)
- Regional and Private Sources
    - Community Development Block Grants (CDBG)
    - Community Foundation of the New River Valley
    - National Fish and Wildlife Foundation
        - Five Star and Urban Waters Restoration Grant Program
    - Norcross Wildlife Foundation
    - Southeast Rural Community Assistance Project (SERCAP)
    - Virginia Environmental Endowment
    - Wetland and Stream Mitigation Banking

1. INTRODUCTION

1.1 Background

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

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

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

Section 303(d) requires that, if a particular water body is listed as "impaired," the state must develop a "total maximum daily load" for any pollutant that exceeds water quality standards in that water body. The "total maximum daily load" or TMDL is essentially a water pollution budget. A TMDL study defines the maximum amount of pollutant each source in the watershed can contribute to the water body, so that the water body remains in compliance with applicable water quality standards.

Virginia's 1997 Water Quality Monitoring, Information and Restoration Act (WQMIRA) states in section 62.1-44.19:7 that the "Board shall develop and implement a plan to achieve fully supporting status for impaired waters." This means that after a TMDL is developed for an impaired water, an Implementation Plan (IP) must be developed and implemented with the goal of meeting the water quality standards for the water body. The IP presented in this document characterizes implementation actions that will achieve the water quality goals in Crab Creek.

1.2 Designated Uses

According to 9 VAC 25-260-5 of Virginia's State Water Control Board Water Quality Standards, the term 'water quality standards' means

> *"...provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law and the federal Clean Water Act."*

The 'Designation of Uses' of all waters in Virginia is defined in the Code of Virginia (9 VAC 25-260-10) (SWCB, 2011):

> *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.

Bacteria pollution is a serious threat to the uses of the state's waters for primary contact recreation such as swimming and boating. On August 8, 1994, the Virginia Department of Health (VDH) was notified that campers and counselors at a Shenandoah Valley summer camp developed severe gastrointestinal illness. It was confirmed that *E. coli* 0157:H7, a type of fecal bacteria commonly found in the intestines of humans and animals, was the causative agent (CDC 1995). In Franklin County, Virginia, a 1997 outbreak of illnesses involving three children was attributed to *E. coli* (0157:H7) in Smith Mountain Lake. The children came in contact with the bacteria while swimming in the lake, and a two-year-old child almost died as a result of the exposure (Roanoke Times 1997a, 1997b, 1998b). In August 1998, seven children and two adults at a day-care center in rural Floyd County were infected with *E. coli* (0157:H7). Upon investigation, two of the property's wells tested positive for total coliform (Roanoke Times 1998a, 1998c). On June 6, 2000, Crystal Spring (Roanoke, Virginia's second largest water source) was shut down by the VDH for *E. coli* contamination (Roanoke Times 2000).

These are not isolated cases. Throughout the United States, the Centers for Disease Control (CDC) estimates that at least 73,000 cases of illnesses and 61 deaths per year are caused by *E. coli* 0157:H7 bacteria (CDC 2001). Other fecal pathogens (*e.g., E. coli* 0111) are responsible for similar illnesses. In addition, the presence of other bacterial and viral pathogens is indicated by the presence of fecal bacteria. Whether the source of contamination is human or livestock waste, the threat of these pathogens appears more prevalent as both populations increase.

The General Standard is meant to protect the health of aquatic life, and also to serve as a fallback monitoring program to identify problems that are not detected by the ambient monitoring system (*e.g.*, pollutant discharges that are intermittent in occurrence, isolated incidents of pollutant discharge, and discharge of pollutants that are not normally measured through the ambient monitoring system). The health of the aquatic life is measured through assessment of the benthic macroinvertebrate (benthic) community, which is integral to the food chain that supports higher-level organisms. An unhealthy aquatic community will impact local and downstream fisheries. Additionally, an aquatic community that is already impacted will not be a good indicator of pollutant problems in the stream. The specific pollutant being addressed for this General Standard TMDL Implementation Plan, sediment, is an indicator that soil is being lost from upland areas and/or stream banks. This should be a concern for landowners, who want to maintain the productivity of their land or protect their property from erosion.

1.3 Water Quality Standards and Criteria

The applicable water quality criteria for fecal bacteria impairments are contained in section 9 VAC 25-260-170. At the time the Crab Creek TMDL was completed, the criteria for bacteria included two parts: (1) the *Escherichia coli* (*E. coli*) bacteria concentrations for fresh water shall not exceed a geometric mean of 126 colony forming units (cfu) per 100 mL of water, and (2) the *E. coli* concentrations for freshwater shall not exceed 235 cfu per 100 mL at any time (single-sample criteria). If the water body exceeds the single sample maximum more than 10% of the time, the water body is classified as impaired and a TMDL must be developed and implemented to bring the water body into compliance with the water quality standard. If the sampling frequency is one sample or less per 30 days, the single-sample criterion is applied; for a greater

sampling frequency, the geometric mean criterion is applied. Most of the ambient water quality monitoring conducted by VADEQ is done on a monthly or bimonthly 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 235 per 100 mL part of the standard in the assessment of the *E. coli* bacteria monitoring data.

The **General Standard,** as defined in Virginia state law 9 VAC25-260-20, states:

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

The General Standard is implemented by VADEQ through application of the Rapid Bioassessment Protocol II (RBP). Using the RBP, the health of the benthic macroinvertebrate community is typically assessed through the measurement of eight biometrics (Table 1-1). These biometrics gauge different aspects of the community's overall health. Surveys of the benthic macroinvertebrate community performed by VADEQ are assessed at the family taxonomic level.

Each biometric measured at a target station is compared to the same biometric measured at a reference (non-impaired) station to determine each biometric score. These scores are then summed and used to determine the overall bioassessment (*e.g.*, non-impaired, moderately impaired, or severely impaired).

Table 1-1. Components of the RBP assessment

Biometric	Benthic Health[1]
Taxa Richness	↑
Modified Family Biotic Index	↓
Scraper to Filtering Collector Ratio	↑
EPT / Chironomid Ratio	↑
% Contribution of Dominant Family	↓
EPT Index	↑
Community Loss Index	↓
Shredder to Total Ratio	↑

[1] An upward arrow indicates a positive response in benthic health when the associated biometric increases

2. STATE AND FEDERAL REQUIREMENTS FOR IMPLEMENTATION PLANS

2.1 Background

Once a water body is listed as impaired and a subsequent TMDL study has been conducted, then the state, in conjunction with watershed stakeholders, must develop and implement a strategy that will limit the pollutant loadings to those levels allocated in the TMDL. Such a strategy, also known as an Implementation Plan (IP), must contain corrective actions that when implemented will reduce pollutant loadings to bring the water body into compliance with the relevant standard(s).

2.2 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:

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

2.3 Federal Recommendations

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

2.4 Requirements for Section 319 Fund Eligibility

Beyond the regulatory requirements listed above, the CWA was amended in 1987 to establish the Nonpoint Source (NPS) Management Program in Section 319 of that act. Through that program, States, Territories, and Native American Tribes can receive grant monies for a variety of activities, including the restoration of impaired stream segments. Although there are several sources of money to help with the TMDL implementation process, Section 319 funds are most relevant to TMDL implementation. Therefore, the requirements to obtain these funds are discussed in this chapter. The Virginia Department of Environmental Quality (VADEQ) strongly suggests that these USEPA recommendations be addressed in the IP (in addition to the required components as described by WQMIRA).

The USEPA develops guidelines that describe the process and criteria to be used to award CWA Section 319 NPS 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 from NPS management measures;
3. Describe the NPS management measures that will need to be implemented to achieve the identified load reductions;
4. Estimate the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement the watershed-based plan;
5. Provide an information/education component that will be used to enhance public understanding of the project and encourage the public's participation in selecting, designing, and implementing NPS management measures;
6. Provide a schedule for implementing the NPS management measures identified in the watershed-based plan;
7. Describe interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented;
8. Identify a set of criteria for determining if load reductions are being achieved and progress is being made towards attaining water quality standards, and if not, the criteria for determining if the watershed-based plan needs to be revised; and
9. Establish a monitoring component to evaluate the effectiveness of the implementation efforts.

2.5 Staged Implementation

In general, the Commonwealth of Virginia intends for NPS pollutant TMDL reductions to be implemented in a staged or phased fashion. Staged implementation is an iterative process whereby management measures are implemented incrementally, initially targeting those sources and/or practices that are expected to produce the greatest water quality improvement. Staged implementation includes on-going monitoring to continuously assess progress toward attaining water quality standards. For example, a promising best management practice in agricultural areas of a watershed with bacteria impairment is livestock exclusion from streams. This has been shown to be very effective in lowering bacteria concentrations in streams, by reducing the opportunity for cattle to defecate directly in the stream and by providing additional buffering in the riparian zone. This practice has the additional benefit of reducing stream bank erosion.

There are many benefits of staged implementation, including:

1. tracking water quality improvements as they occur;
2. providing a measure of quality control, given the uncertainties that exist in any implementation plan;
3. providing a mechanism for developing public support;
4. helping to ensure the most cost-effective practices are implemented initially; and
5. allowing for the evaluation of the adequacy of the TMDL in achieving the water quality standard.

With successful development and implementation of IPs, Virginia will be well on the way to restoring impaired waters and enhancing the value of this important resource. Additionally, development of an approved IP will improve a locality's chances for obtaining monetary assistance during implementation.

3. REVIEW OF THE CRAB CREEK TMDLS

3.1 Background

A TMDL is calculated as follows:

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

where WLA is the waste load allocation (point sources), LA is the load allocation (nonpoint sources), and MOS is the margin of safety. A TMDL study determines the TMDL for the pollutant and, after accounting for MOS, allocates that loading between point sources (WLA) and nonpoint sources (LA).

This chapter reviews the development of fecal bacteria and general standard TMDLs and corresponding load allocations for Crab Creek. The TMDLs are described in the 2004 TMDL report: Fecal Bacteria and General Standard Total Maximum Daily Load Development for Crab Creek.

3.2 Description of Impairments

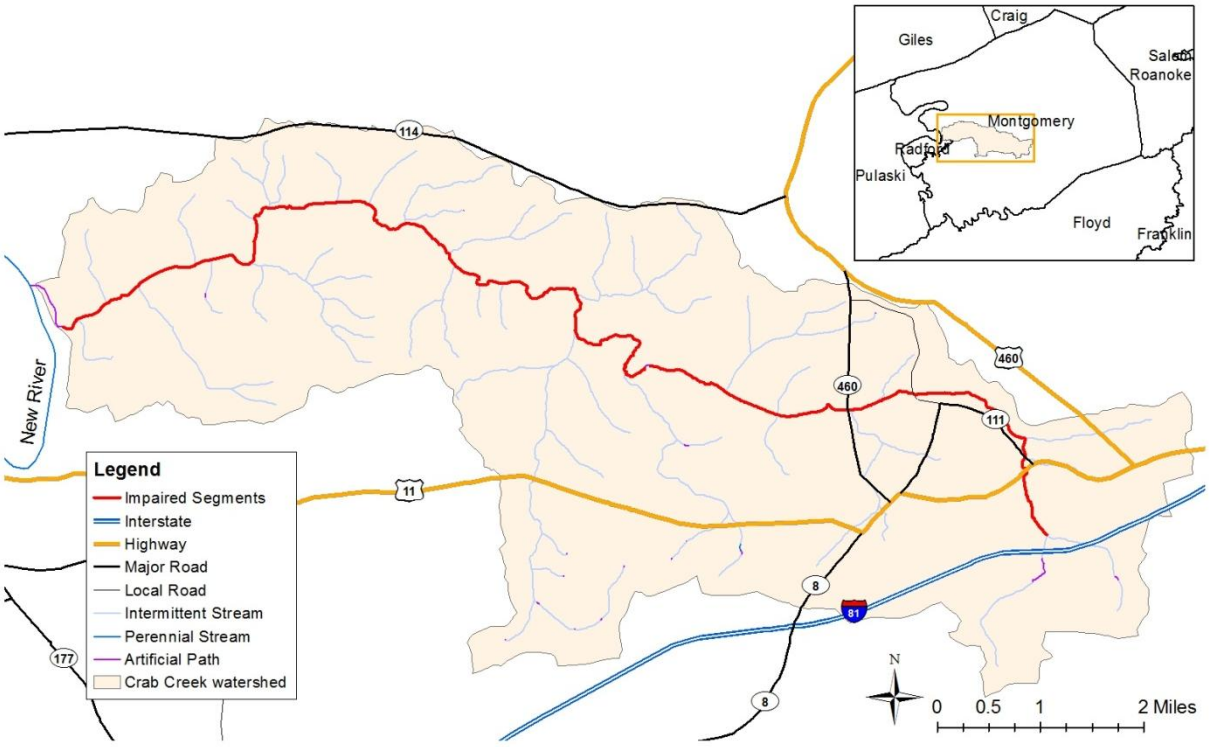

Figure 3-1. Location of the Crab Creek watershed and its impairments

The entire 12 miles of Crab Creek, from its headwaters to its confluence with the New River, is impaired for violations of the (fecal coliform) bacteria water quality standard and the General Standard (benthic) (Figure 3-1). Crab Creek was first listed as impaired on Virginia's 1*996 303(d) Report on Impaired Waters* due to water quality violations of the fecal coliform bacteria standard and general standard.

3.3 Watershed Characteristics

The Crab Creek watershed (HUC12 - 050500011801, DEQ HUC listing code VAW-N18R, and Virginia HUC 6 - NE58) is located in Montgomery County and the Town of Christiansburg. It flows generally west to its confluence with the New River. The Crab Creek watershed comprises approximately 12,400 acres of land, all within the Central Appalachian Ridges and Valleys ecoregion. Over 40 % of the Crab Creek watershed is located within the town limits of Christiansburg. At the time of TMDL development, the land use distribution was approximately 18% developed, 49% agriculture and 32% forested. The 2004 TMDL estimated a population of 15,711 in the watershed using US Census data.

3.4 Water Quality Monitoring

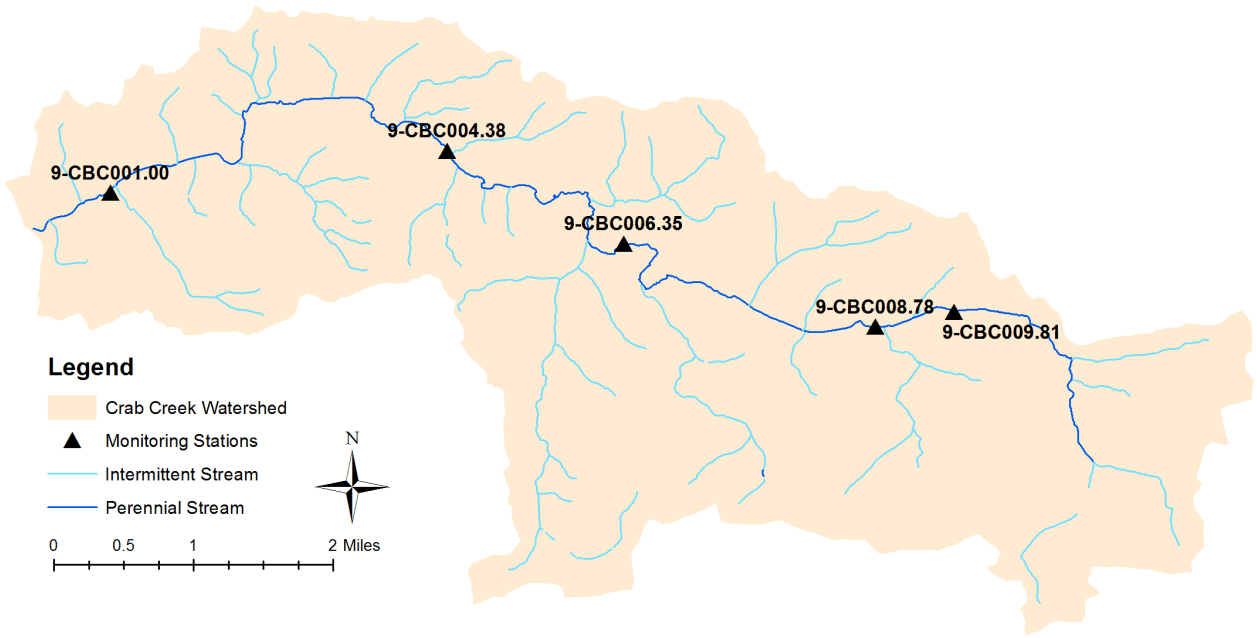

Figure 3-2. Locations of Crab Creek VADEQ monitoring stations

The bacteria TMDL was based on monitoring at five VADEQ in-stream water quality monitoring stations: 9-CBC001.00, 9-CBC004.38, 9-CBC006.35, 9-CBC008.78, 9-CBC009.81 (Figure 3-2). Exceedances of the single sample maximum were reported throughout the monitoring period and in all flow regimes. Table 3-1 lists the stations, indicator organism, violation rate of appropriate water quality criterion, and the period of record.

Table 3-1. Monitoring stations used to develop the bacteria TMDL for Crab Creek

Station ID	Indicator Organism	# of Samples	Violations[1] (%)	Period of Record
9-CBC001.00	Fecal coliform	9	11	Jan 1990 – May 2002
9-CBC001.00	*E.coli*	12	33	Nov 2002 – Oct 2003
9-CBC004.38	Fecal coliform	138	53	Jan 1990 – May 2002
9-CBC004.38	*E.coli*	12	42	Nov 2002 – Oct 2003
9-CBC006.35	Fecal coliform	132	49	Jan 1990 – May 2002
9-CBC008.78	Fecal coliform	1	100	Jan 1990 – May 2002
9-CBC009.81	Fecal coliform	5	40	Jan 1990 – May 2002

[1] Violations are based on the fecal coliform instantaneous criterion (400 cfu/100mL) or the current *E. coli* single sample maximum criterion (235 cfu/100mL)

The benthic TMDL was based on monitoring conducted by VADEQ at three benthic monitoring stations: 9CBC001.00, 9CBC004.38, 9CBC006.35. Crab Creek was first listed in 1996 as being moderately impaired based on the RBPII assessment method. Results from all three stations consistently indicated impaired conditions (Table 3-2). The benthic community in Crab Creek displayed seasonality, with Stream Condition Index (SCI) scores generally higher in the fall than in the spring. Until December 1998, the Christiansburg sewage treatment plant discharged to Crab Creek just upstream from monitoring station CBC00.438. The resulting improvement in SCI scores at Station CBC001.00 and Station CBC004.38 can be seen in Table 3-3. Habitat assessments of Crab Creek considered in the 2004 TMDL also indicated sub-optimal conditions with the primary problem being the lack of riparian vegetation (VADEQ 2004).

Table 3-2. The RBPII biological assessment scores used in the Crab Creek sediment TMDL

Station	Year	Spring Score	Spring Assessment	Fall Score	Fall Assessment
9-CBC001.00	1998	4.35	Severely Impaired	36.36	Severely Impaired (BPJ)
	1999	4.17	Severely Impaired	21.74	Moderately Impaired
	2000	30.43	Moderately Impaired	43.48	Moderately Impaired
	2001		(not sampled)		(not sampled)
	2002	73.91	Slightly impaired	63.64	
9-CBC004.38	1998		(not sampled)	22.73	Severely Impaired (BPJ)
	1999	37.50	Moderately Impaired	47.83	Moderately Impaired
	2000	39.13	Moderately Impaired	34.78	Moderately Impaired
	2001		(not sampled)		(not sampled)
	2002	65.22	Slightly impaired	59.09	Slightly Impaired
9-CBC006.35	1998	30.43	Moderately Impaired	22.73	Moderately Impaired
	1999	50.00	Moderately Impaired	52.17	Slightly Impaired
	2000	47.83	Slightly impaired (BPJ)	34.78	Moderately Impaired
	2001		(not sampled)		(not sampled)
	2002	52.17	Moderately Impaired	59.09	Slightly Impaired

3.5 Water Quality Modeling

The US Geological Survey (USGS) Hydrologic Simulation Program - Fortran (HSPF) water quality model was selected as the modeling framework to simulate existing conditions and perform TMDL allocations for fecal coliform. In establishing the existing and allocation conditions, seasonal variations in hydrology, climatic conditions, and watershed activities were explicitly accounted for in the model. Due to the lack of continuous stream flow data for Crab Creek, the paired-watershed approach, with additional refinement using instantaneous flow measurements, was used to calibrate the HSPF model. Through this approach, the HSPF model was calibrated using data from a hydrologically similar watershed, where continuous stream flow was available. The Upper Tinker Creek watershed was compared to the Crab Creek watershed and chosen as an appropriate watershed for a paired-watershed calibration. The hydrologic comparison of the watersheds was established by examining the land use distribution, total drainage area, channel and watershed characteristics, and hydrologic soil group. The HSPF input parameters for the Upper Tinker Creek watershed were used as base input parameters for Crab Creek when calibrating Crab Creek with the flow values from USGS Station #03171170 (Crab Creek at STP near Christiansburg, VA). The calibrated parameters from the model (*e.g.*, lower zone storage), in conjunction with physically derived parameters (*e.g.*, land slope and slope

length) specific to Crab Creek, were used as initial representation of the watershed. This representation was then refined through calibration to instantaneous flow measurements collected for Crab Creek primarily during base-flow conditions. For purposes of modeling watershed inputs to in-stream water quality, the Crab Creek drainage area was divided into five subwatersheds. The water quality calibration and validation were conducted using monitored data collected at VADEQ monitoring stations between October 1993 and September 2003.

Virginia does not have existing in-stream criteria for sediment; therefore, a reference watershed approach was used to define allowable TMDL loading rates in the Crab Creek watershed. This approach pairs two watersheds: one that is supportive of their designated use(s) and one whose streams are impaired. The Toms Creek watershed was selected as the TMDL reference for Crab Creek. The TMDL sediment load was defined as the modeled sediment load for existing conditions from the non-impaired Toms Creek watershed, area-adjusted to the Crab Creek watershed. The Generalized Watershed Loading Function (GWLF) model (Haith et al. 1992) was used for comparative modeling for both Crab Creek and Toms Creek.

While developing allocation scenarios for bacteria, an implicit margin of safety (MOS) was used. Conservative assumptions, the use of a detailed watershed model (HSPF), and other considerations were used in developing the bacteria TMDL, such that an explicit MOS was not necessary. In the sediment TMDL, the margin of safety was explicitly set to 10% to account for the large uncertainty in developing benthic TMDLs.

3.6 Sources of Bacteria

Potential sources of bacteria considered in the development of the TMDL included both point source and non-point source (NPS) contributions.

3.6.1 Point Sources

The TMDL WLA accounts for the portion of a receiving water's loading capacity that is allocated to one of its existing or future permitted point sources of pollution. Point sources of fecal coliform bacteria include all municipal and industrial plants that treat human waste and are issued individual permits by VADEQ, as well as private residences that fall under Virginia Pollutant Discharge Elimination System (VPDES) general permits. Point sources permitted to discharge in the Crab Creek watershed through the Virginia Pollutant Discharge Elimination System (VPDES) as of the 2004 TMDL are listed in Table 3-3. After 1998, the Town of Christiansburg STP, Permit VA0061751, no longer discharged to Crab Creek. There is currently one Municipal Separate Storm Sewer System (MS4) permit held by the Town of Christiansburg (VAR040025) and one held by the Virginia Department of Transportation (VDOT – VAR040016).

Table 3-3. Permitted point sources in the Crab Creek watershed as identified in the 2004 TMDL

Facility	VPDES #	Design Discharge (MGD)	Permitted for Fecal Control
Marshall Concrete Products Inc. – Christiansburg	VAG110015	.001	No
Town of Christiansburg	VAR051370	Stormwater	No
VDOT – Salem District – Rte. 81 0081-060-119 C501	VAR100229	Stormwater	No
VDOT – Christiansburg (4541)	VAR101126	Stormwater	No
Depot Street School Residence	VAR102138	Stormwater	No
Oaktree Townhomes Phase VI	VAR102140	Stormwater	No
Holy Spirit Catholic Church	VAR102148	Stormwater	No
New River Medical Assoc. Medical Office Park	VAR102164	Stormwater	No
Edgemont of Diamond Hill	VAR102279	Stormwater	No
Lions Gate	VAR102308	Stormwater	No
Hunters Ridge Phase III	VAR103014	Stormwater	No
Oak Tree Professional Park	VAR103064	Stormwater	No
Hans Meadow Drainage Improvements	VAR103090	Stormwater	No
Oak Tree Townhouses	VAR103349	Stormwater	No
Federal Express Corp – WALA Station	VAR520312	Stormwater	No

3.6.2 Nonpoint Sources

Nonpoint source (NPS) pollution originates from diffuse sources on the landscape (e.g., agriculture and urban) and is strongly affected by precipitation events – runoff from rain or snowmelt. In some cases, a precipitation event is not required to deliver NPS pollution to a stream (e.g., direct deposition of fecal matter by wildlife or livestock and contamination from leaking sewer lines or straight pipes). NPSs were assessed during TMDL development through an extensive analysis of land use coupled with a consideration for delivery mechanisms (e.g., direct loadings to the stream or land-based loadings that require a precipitation event for delivery of the pollutants to the stream from pervious and impervious surfaces).

The 2004 TMDL identified the primary nonpoint sources of bacteria in Crab Creek as straight pipes and sewer overflows, agricultural runoff, and direct deposition of livestock manure in streams (Table 3-4). Other sources of bacteria include failing septic systems, pet waste, and wildlife.

Table 3-4. Fecal bacteria sources in the Crab Creek impairment reported in the 2004 TMDL

Source	Total Annual Loading for Existing Run ($x10^{10}$ cfu/yr)	% of Total Loading
Land Based		
Residential[1]	41,100	8%
Commercial	1,150	0%
Barren	67	0%
Cropland	74,200	14%
Livestock Access	9,180	2%
Pasture	154,000	29%
Forest	13,600	3%
Direct		
Livestock Access	93,000	17%
Wildlife	262	0%
Straight Pipes and Sewer Overflows	152,000	28%
Total	**538,559**	

[1]Includes domestic animal populations which were estimated in 2004 as 3,712 dogs and 4,156 cats

3.7 Sources of Sediment

3.7.1 Stressor Analysis

TMDLs must be developed for a specific pollutant(s). Benthic assessments are very good at determining if a particular stream segment is impaired or not but, they usually do not provide enough information to determine the cause(s) of the impairment. The process outlined in the Stressor Identification Guidance Document (EPA 2000) was used to separately identify the most probable stressor(s) for Crab Creek. A list of candidate causes was developed from published literature and VADEQ staff input. Chemical and physical monitoring data provided evidence to support or eliminate potential stressors. Individual metrics for the biological and habitat evaluation were used to determine if there were links to a specific stressor(s). Land use data as well as a visual assessment of conditions along the stream provided additional information to eliminate or support candidate stressors. This stressor analysis identified sediment as the Most Probable Stressor for aquatic life in Crab Creek.

3.7.2 Point Sources

There were 12 construction permit dischargers and 3 industrial stormwater dischargers permitted within the watershed at the time of TMDL development (Table 3-5). One MS4 permit had been issued to the Town of Christiansburg and two permits were held by the Virginia Department of Transportation. For construction permit dischargers, the modeled runoff was taken as the maximum annual runoff depth (cm) for transitional land uses. Future loads for MS4 permits were calculated as the urban impervious area load for the segment of Crab Creek located within the Town of Christiansburg. The calculated future load was reduced based on the assumption that

the baseline load plus any additional load from increases in impervious area would be reduced by 50%.

Table 3-5. VPDES point source facilities and permitted TSS load

Crab Creek Point Sources		Existing Conditions				Future Conditions
VPDES ID	Name	Runoff (cm)	Area (ha)	Conc. (mg/L)	TSS (T/yr)	TSS (T/yr)
Construction Stormwater Discharge Permits						
VAR100229	VDOT-Salem District	29.90	8.50	100	2.54	2.54
VAR101126	VDOT – Christiansburg (4541)	29.90	2.99	100	0.90	0.90
VAR102138	Depot Street School Residence	29.90	0.917	100	0.27	0.27
VAR102140	Oaktree Townhouses Phase VI	29.90	2.83	100	0.85	0.85
VAR102148	Holy Spirit Catholic Church	29.90	1.00	100	0.30	0.30
VAR102164	New River Medical Assoc. Medical Office Park	29.90	2.02	100	0.61	0.61
VAR102279	Edgemont of Diamond Hill	29.90	19.02	100	5.69	5.69
VAR102308	Lions Gate	29.90	5.38	100	1.61	1.61
VAR103014	Hunters Ridge Phase III	29.90	1.09	100	0.33	0.33
VAR103064	Oak Tree Professional Park	29.90	3.24	100	0.97	0.97
VAR103090	Hans Meadow Drainage Improvements	29.90	0.809	100	0.24	0.24
VAR103349	Oak Tree Townhouses	29.90	12.38	100	3.70	3.70
Industrial Stormwater Discharge Permits						
VAR051370	Town of Christiansburg	60.60	13.63	30	2.479	2.479
VAG110015	Marshall Concrete	60.60	3.24	30	0.589	0.589
VAR520312	Federal Express Corp-WALA Station	60.60	0.809	30	0.147	0.147
Total Point Source Loads					21.23	21.23
MS4 Permits						
VAR040025	Town of Christiansburg				55.14	27.57
VAR040016	VDOT (load included in Town of CHBG)					
Total MS4 Source loads					55.14	27.57
Total Point Source Loads + MS4 Source Loads					76.38	48.76

3.7.3 Nonpoint Sources

Sediment is delivered to the Crab Creek watershed through surface runoff (rural and urban areas), streambank erosion, point sources, and natural erosive processes. The sediment process is a natural and continual process that is often accelerated by human activity. During runoff events (natural rainfall or irrigation), sediment is transported to streams from land areas (*e.g.*, agricultural fields, lawns, forest, etc.). Rainfall energy, soil cover, soil characteristics, topography, and land management affect the magnitude of sediment loading. Agricultural management activities such as overgrazing (particularly on steep slopes), high tillage operations, livestock concentrations (along stream edge and uncontrolled access to streams), forest harvesting, and construction (roads, buildings, etc.) accelerate erosion at varying degrees. During dry periods, sediment from air or traffic builds up on impervious areas and is transported to streams during runoff events.

The 2004 TMDL identified the primary nonpoint sources of sediment in Crab Creek as channel erosion, pastureland, and cropland (Table 3-6).

Table 3-6. Future projected sediment loads for the Crab Creek watershed by land use (from the 2004 TMDL)

Sediment Source	Area (acres)	Sediment (T/yr)	Sediment (T/acre)
LDR-PER	2,975.3	29.830	0.010
HDR-PER	7.8	0.083	0.011
COM-PER	762.8	7.074	0.009
Transitional	169.0	63.624	0.376
Forest	2,809.0	25.463	0.009
Disturbed Forest	86.9	84.852	0.976
Pastureland	3,627.1	1,276.101	0.352
Cropland	333.9	505.871	1.515
LDR-IMP	206.2	16.858	0.082
HDR-IMP	14.1	1.141	0.081
COM-IMP	0.1	0.005	0.050
Water	5.9	0.000	0.000
MS4-Existing	1,204.8	98.488	0.082
MS4-Future	252.6	20.652	0.082
Active Ag BMPs[1]		-281.96	
NPS Load		**1,741.20**	
Channel Erosion		2,944.37	
Point Source Loads		21.23	
Total	**12,455.4**	**4,706.81**	

[1] Credited during TMDL development

3.8 TMDL Allocations and Load Reductions

3.8.1 Bacteria

Various pollutant reduction scenarios were evaluated to meet the state water quality standard for *E. coli*, the 30-day geometric mean target (126 cfu/100 mL), with zero violations (a requirement of the TMDL). An implicit MOS was used in these bacteria TMDLs by using conservative estimations of factors that would affect bacteria loadings in the watershed (e.g., animal numbers, production rates, contributions to the stream). These factors were estimated in such a way as to represent the greatest amount of bacteria from each source in the watershed. The portion of *E. coli* that may come from permitted discharge sources, including NPS sources under an MS4 permit, was included in the Waste Load Allocation (WLA) and not given a load reduction during TMDL development. The WLA will be addressed through the Virginia Pollutant Discharge Elimination System (VPDES) Program administered by the Virginia Department of Environmental Quality.

The final allocation scenarios from the TMDL are shown in Table 3-7. Normally, the Stage 1 implementation goal is to reduce the bacteria loadings from controllable sources (excluding wildlife) such that violations of the single sample criterion (235 cfu/100 mL) are less than 10.5 percent. However, in this case, meeting that goal would require a 99% reduction in land-based bacteria loads so Scenario 4 was selected as the Stage 1 bacteria goal during TMDL development. Also in the TMDL study, violations of the instantaneous standard could not be eliminated without reductions to the land-based wildlife load. Reductions to wildlife fecal bacteria are not addressed in this plan.

Table 3-7. TMDL allocation scenarios for bacteria with 2004 loading estimates in the Crab Creek watershed

	Percent Reduction in Loading from 2004 Condition						**Percent Violations**	
Scenario Number	Direct Wildlife	NPS Wildlife	Direct Livestock	NPS Pasture/ Livestock	Res./ Urban	Straight Pipe/ Sewer Overflow	GM >126 cfu/ 100ml	Single Sample >235 cfu/100ml
1	0	0	0	0	0	0	76.7	27.8
2	0	0	0	0	0	100	73.3	27.8
3	0	0	90	50	50	100	11.7	17.6
4	0	0	100	60	60	100	3.33	16.1
5	0	0	100	99	99	100	0	1.92
6	0	99	100	99	99	100	0	1.53
7	99	99	100	99	99	100	0	1.53
8	0	99	100	99.95	99.95	100	0	0

3.8.2 Sediment

The Crab Creek benthic TMDL was developed for sediment, with Toms Creek as the reference watershed. The target TMDL load for Crab Creek is the average annual load from the area-adjusted Toms Creek watershed under existing conditions. The benthic TMDL for Crab Creek includes three components – WLA, LA, and MOS. The margin of safety was explicitly set to 10% to account for uncertainty in developing benthic TMDLs. The WLA was calculated as the sum of various point source loads and 50% of the MS4 load (the TMDL assumed that stormwater BMPs will be implemented with maximum effectiveness reducing the NPS loads from Phase II MS4 permit areas by 50%.) It was assumed that the implementation of stormwater BMPs would reduce the load by a maximum of 50%.

The TMDL study anticipated that active development, including commercial and housing, would continue near Christiansburg over the next 20 to 25 years. Therefore, changes in land use were estimated by modeling future loads as part of the allocation process. The broad based land use change that was modeled resulted in the percentage developed land increasing from 8% to 11.3%. The reductions required to meet the TMDL considering future growth are shown in Table 3-8.

Table 3-8. Required sediment reductions for the Crab Creek watershed as calculated in the 2004 TMDL

Load Summary	Crab Creek (T/yr)	Reductions Required	
		T/yr	% of existing load
Existing Load	6,307	4,088	64.8
Projected Future Load	7,197	4,978	69.2
TMDL	2,551		
Target Modeling Load	2,219		

Two sediment reduction alternatives were presented in the TMDL and are listed in Table 3-9.

Table 3-9. Source reductions needed to meet the sediment TMDL for Crab Creek

Sediment Source Categories	Existing Condition (T/yr)	Allocations			
		Alternative 1		Alternative 2	
		(%)	(T/yr)	(%)	(T/yr)
LDR-PER	14.66	0	14.66	0	14.66
HDR-PER	0.04	0	0.04	0	0.04
COM-PER	3.48	0	3.48	0	3.48
Transitional	31.27	0	31.27	0	31.27
Forest	34.37	0	34.37	0	34.37
Disturbed Forest	114.55	0	114.55	0	114.55
Pastureland	1,996.80	72	547.80	51	978.43
Cropland	761.81	0	761.81	41	449.47
LDR-IMP	2.69	0	2.69	0	2.69
HDR-IMP	0.02	0	0.02	0	0.02
COM-IMP	3.72	0	3.72	0	3.72
Water	0.00	0	0.00	0	0.00
MS4-Existing	55.14	50	27.57	50	27.57
MS4-Future	22.35	50	11.18	50	11.18
NPS Load	**3,040.90**		**1,553.15**		**1,671.44**
Active Ag BMPs	-281.96		-281.96		-281.960
Channel Erosion	4,416.56	79.1	923.06	82	794.98
Point Source Loads	21.23		21.23		21.23
Total	**7,196.73**		**2,215.48**		**2,205.69**
Target Allocation Load (TMDL-MOS-MS4s-Point Sources)			**2,219**		**2,219**

Significant reductions appear feasible through the implementation of aggressive measures to minimize streambank erosion through improved stormwater control in urban areas, installation of riparian buffers, and livestock exclusion from streams. Alternative 1 requires sediment reductions from pastureland (72%), channel erosion (79.1%), and MS4 permitted areas. The reductions could be achieved through riparian buffers, livestock exclusion from streams, stormwater management and improved pasture management. Alternative 2 requires a 41% reduction from cropland, a 51% reduction from pastureland, a 82% reduction of channel erosion, and reductions from MS4 permitted areas. During Implementation Plan development,

stakeholders identified Alternative 2 as the preferred allocation scenario, primarily because it addresses sediment from cropland sources.

4. CHANGES AND PROGRESS SINCE THE TMDL STUDY

4.1 BMP Implementation

Since the 2004 TMDL, progress has been made in the Crab Creek watershed to reduce both bacteria and sediment pollution through the implementation of BMPs (Table 4-1). Information on agricultural BMPs installed since 2004 was gathered from the Virginia Agricultural Cost Share Tracking Program and represents BMPs implemented since 2004 that received cost-share funding. It does not represent additional agricultural BMPs that landowners implemented voluntarily without participation in a state and/or federally sponsored cost-share program. In addition to agricultural BMPs, the Town of Christiansburg reported stormwater BMPs implemented post-TMDL within Town boundaries.

Table 4-1. BMPs installed in the Crab Creek watershed since the 2004 TMDL

Land Use Category	BMP Name	Extent Installed (practices or systems, unless otherwise noted)	Acres Benefitted
Agriculture	Stream Exclusion With Grazing	10,664 feet	320.0
	Land Management		
	Legume Cover Crop	2	247.1
	Animal Waste Storage Facility	1	(115 animals)
Urban	Bio-retention	3	9.60
	Bioretention Basin	1	4.25
	Bioretention Filter	3	10.33
	Detention	37	1,159.29
	Detention	21	TBD
	Detention & Manufactured BMP	1	0.29
	Extended Detention	6	170.91
	Infiltration	3	1.29
	Infiltration Basin	1	TBD
	Manufactured BMP	3	3.84
	Underground Detention	5	22.40
	Street Sweeping[1]	2	164.89

[1] Estimated 164.89 acres (approximately 170 lane miles) treated by the Town of Christiansburg

4.2 Land Use Changes

During plan development, stakeholders agreed that land use conversion from agriculture and forest to development most likely proceeded quicker since completion of the TMDL than the study anticipated. Available data from the 2012 National Agricultural Statistics Service (NASS) and 2006 National Land Cover Database (NLCD) geospatial databases confirmed this issue and thus, the allocation scenarios for sediment were modified. Table 4-2 lists the land use change estimates for the watershed used in the TMDL and in this IP.

Table 4-2. Land use changes in the Crab Creek watershed

Land Use	Crab Creek TMDL – Existing Conditions (2003-2004)	Crab Creek TMDL – 25 yr Projected Growth	2012 NASS-NLCD Land Use Layer

	Acres	*%*	*Acres*	*%*	*Acres*	*%*
Agriculture	6,158.55	49	5,572.33	45	3,961.004	32
Developed	2,248.52	18	2,942.09	24	5,592.657	45
Forest	4,042.27	32	3,909.38	31	2,895.897	23

4.3 Sediment TMDL Modifications

Since TMDL development, a GWLF modeling software error was uncovered that overestimated channel erosion load. In the TMDL study, sediment load from channel erosion sediment was simulated as 4,417 tons/year in Crab Creek and 823 tons/year in the reference watershed Toms Creek. The corrected channel erosion loads are 2,944 tons/year in Crab Creek and 549 tons/year in Toms Creek. The original TMDL for Crab Creek was 2,551 tons/year with a target modeling load of 2,219 tons/year. Re-calculating the TMDL with the corrected channel erosion loads results in a target in-stream load (TMDL minus the MOS) of 2,047.63 and a target allocation load (TMDL minus the WLA and the MOS) of 1,971.26.

The corrected channel erosion load and the updated land use categorization resulted in changes in the overall sediment load, the TMDL, the target load (TMDL – MOS), and the required percent reductions. The WLA of 77 tons/year calculated during the 2004 TMDL study remains the same. The implementation plan preserves the unit-area sediment loads (UALs) for each land use category simulated in the TMDL study. A summary of the categorized areas, associated sediment loads, load reductions from BMP implementation since TMDL development (summarized in Section 4.1), and target sediment loads used for implementation planning are shown in Table 4-3.

For implementation planning, therefore, our beginning sediment load is 4,706.81 tons/year and our target sediment load for the load allocation is 1,971.26 tons/year, which requires an overall reduction of 57%. Implementation planning will proceed with the revised estimate of percent reduction for three main reasons: 1) The IP is being developed in a staged approach using sediment load reduction as a surrogate measure for benthic health improvement, 2) the reference watershed approach sets a “relative” target load based on the reference watershed, and 3) the revised TMDL load more accurately represents current conditions in the watershed.

During implementation planning, the recommended percent reductions from each sediment source in the allocation scenario changed significantly from the TMDL study. The changes in land use, BMPs installed since the TMDL study, and the reductions needed to meet the Stage 1 bacteria water quality goal were considered when selecting the final allocation scenario for the sediment TMDL. The BMPs installed since the TMDL study resulted in an estimated reduction of sediment load of 6% from agricultural land uses and 19% from MS4 areas in the watershed. The Diamond Hills stream restoration currently in development will result in an estimated 2,233 linear feet of stream restoration which was credited toward the streambank stabilization goal. The agricultural BMPs prescribed to meet the Stage 1 bacteria goals result in a 32% reduction of sediment from pasture and a 17% reduction from cropland. The level of effort that the Town of Christiansburg has already put forth in the installation of BMPs, the potential for additional BMPs, and costs were weighed when selecting the percent reductions from MS4 areas and channel erosion.

Table 4-3. Changes in area, sediment loads, and targeted % reductions for Crab Creek

Sediment Source	Existing Condition	Allocations			
		Stage 1		Stage 2	
Categories	**(T/yr)**	**(%)**	**(T/yr)**	**(%)**	**(T/yr)**
LDR-PER	29.830	0	29.830	5	28.339
HDR-PER	0.083	0	0.083	0	0.083
COM-PER	7.074	0	7.074	0	7.074
Transitional	63.624	0	63.624	0	63.624
Forest	25.463	0	25.463	0	25.463
Disturbed Forest	84.852	0	84.852	0	84.852
Pastureland	1,276.101	32	867.749	37	803.944
Cropland	505.871	17	419.873	17	419.873
LDR-IMP	16.858	0	16.858	5	16.015
HDR-IMP	1.141	0	1.141	0	1.141
COM-IMP	0.005	0	0.005	0	0.005
Water	0.000	0	0.000	0	0.000
MS4-Existing (minus WLA of 55.14)	43.348	3	42.047	15	36.846
MS4-Future	20.652	3	20.032	15	17.554
Active Ag BMPs[1]	*-281.96*		*-281.96*		*-281.960*
Active Ag BMPs[2]	*-84.60*		*-84.6*		*-84.600*
Active Urban BMPs[2]	*-22.25*		*-22.25*		*-22.254*
NPS Load	**1,686.09**		**1,189.82**		**1,116.00**
Channel Erosion[3]	2,944.37	71	853.868	71	853.868
Total	**4,630.46**		**2,043.69**		**1,969.87**
Target Allocation Load (TMDL - MOS - WLA)					**1,971.26**
Target In-stream Load (All Sources-MOS)					**2,047.63**

[1]Credited during TMDL development
[2]Credited since TMDL development
[3]Credited 2,233 linear ft of stream restoration- Diamond Hills project

5. PUBLIC PARTICIPATION

An essential step in crafting a TMDL implementation plan and then implementing that plan is input from and engagement of a broad range of stakeholders (individuals, agencies, organizations, and businesses who have an interest in improving water quality and a familiarity with local conditions). Public participation involves a dialogue between local stakeholders and government agencies and a discussion of available resources that can be devoted to TMDL implementation, such as funding and technical support. This collaborative process also helped build understanding and trust among participants who need to maintain close working relationships in order to meet the plan's water quality goals. Public participation occurred via a series of public meetings, Table5-1.

Table 5-1. Crab Creek Implementation Plan meetings and public participation

Meeting Date	Meeting Type	# of Attendees
November 12, 2013	Watershed Field Tour	5
November 12, 2013	IP Kick-off Meeting	17
November 12, 2013	Agricultural Working Group	12
November 12, 2013	Residential Working Group	5
January 10, 2014	Government Working Group	14
March 13, 2014	Agricultural & Residential Working Groups	13
August 27, 2014	Steering Committee	19
October 7, 2014	Final Public Meeting	9

VADEQ held a public kick-off meeting for the plan on November 12, 2013 at the Montgomery County Government Building in Christiansburg. The meeting was publicized through a press release published in local papers, email announcements, and flyers posted throughout the watersheds. Approximately 17 people attended the meeting. The meeting served as an opportunity for local residents to learn about water quality in Crab Creek, become familiar with the TMDL and clean-up process, and provide feedback on local watershed concerns and opportunities. A presentation by VADEQ staff preceded meetings of the Agricultural and Residential Working Groups.

Agricultural, residential, and government working groups were formed to discuss implementation and outreach strategies suitable for different land uses in the watershed. Each working group consisted of stakeholders who were familiar with land use management issues specific to their particular working group focus area. The agricultural and residential working groups met twice during the development of the clean-up plan while the government working group met just once.

The Agricultural Working Group reviewed conservation practices and outreach strategies from an agricultural perspective. During the first agricultural working group meeting, held as a break out session during the first public meeting in November, the group discussed how land change within the watershed may have proceeded quicker than accounted for in the TMDL. Much of the conversation focused on livestock exclusion practices, including how to best contact potential participants. Additional BMPs considered for the Crab Creek watershed included conversion of

erodible pasture to forest, critical area treatment, and cover crops. Streambank stabilization practices were also discussed with reservation due to the recent revocation of NRCS engineering support for Soil and Water Conservation District (SWCD) projects. The stakeholders also noted that no dairies are located in the watershed and that the fields receiving biosolids are required to have a nutrient management plan that should prevent runoff to nearby waterbodies.

The Residential Working Group identified strategies to reduce bacteria from human sources and pet waste as well as to reduce sediment from residential and urban settings. At their first meeting in November, the residential working group talked about known stormwater and wastewater issues within the Town of Christiansburg and work being done by the Town to address these issues. The group emphasized rain gardens as a way to address stormwater and educate the public about water quality improvement efforts given previous low turnouts for these types of meetings. Further outreach could be conducted to improve citizen turnout by advertising on the Town's Facebook and directly to Homeowner Associations. Lastly, the group discussed ongoing monitoring efforts in the watershed by citizen groups and monitoring resource needs after the IP is completed.

The Government Working Group facilitated a conversation about water quality in the Crab Creek watershed between local governments, regional organizations and representatives of state and federal agencies. Approximately 13 people attended the Government Working Group meeting on January 10, 2014 at the Christiansburg Town Hall. The group reviewed conservation practices and outreach strategies as well as identified technical and financial resources needed to carry out implementation. They discussed septic systems and straight pipes at length, specifically barriers to reaching potential participants and strategies for fine-tuning the estimates for both numbers and practices needed to address the problem. Representatives of the Town discussed their responsibilities as an MS4 permittee which includes educational efforts, street sweeping, and a current stream restoration project. Stakeholders, specifically the Skyline Soil and Water Conservation District (SWCD), already conduct pet waste education programs, but saw potential in expanding efforts, adding more waste stations, and perhaps even creating a dog park within the Town. Discussion of agricultural sources and practices emphasized strategies eligible for state cost-share funds and the potential difficulties with reaching the smaller farms within the watershed. Other issues of note included well water quality, wetland restoration, what VDOT is doing to address their erosion issues in the watershed, potential funding sources, and stakeholder roles in implementation.

The Steering Committee met on August 27th at the Christiansburg Town Hall to discuss plans for the final public meeting and to review a draft of the implementation plan. A final public meeting was held on October 7, 2014 at the Christiansburg Town Hall to present the implementation plan. A 30-day public comment period on the draft plan was held from October 8 until November 7, 2014. Comments received during this period were addressed by VADEQ.

6. IMPLEMENTATION MEASURES

An important element of the TMDL implementation plan is to encourage voluntary implementation of control measures designed to reduce pollutant loads. To encourage voluntary implementation, information must be obtained on the types of control measures that can achieve the pollutant reduction goals specified in the TMDL as practically and cost-effectively as possible. In other words, control measures that provide "the biggest bang for the buck" are targeted.

6.1 Selection of Practices

While management actions such as livestock exclusion and correction of failing septic systems were directly prescribed by the TMDL, additional measures will be needed to control bacteria and sediment coming from land-based sources and channel erosion. Various scenarios were developed and presented to the working groups, who reviewed both the economic costs and the water quality benefits. The majority of agricultural BMPs in this plan are included in state and federal agricultural cost share programs that promote conservation. In addition, innovative management practices suggested by local producers and technical conservation staff were considered. The final set of practices identified and the efficiencies used in this study are listed in Appendix A. It should be noted that an adaptive management strategy will be utilized in the implementation of this plan. BMPs that are easiest to implement, provide the greatest water quality benefits, and offer the greatest economic return to landowners will be implemented first. The effectiveness of these practices will be continually evaluated, and adjustments of actions will be made as appropriate. As new technologies and innovative BMPs to address bacteria and sediment become available, these practices should also be evaluated for implementation in the watersheds.

6.2 Straight Pipes and Failing Septic Systems

Septic systems can be a safe and effective method for treating domestic wastewater as long as they are sized, sited and properly maintained. A number of factors can cause septic systems to fail, including unsuitable soil conditions, improper design and installation, and inadequate maintenance (EPA 2014). In some cases, wastewater illegally discharges from homes directly to streams or the land surface through what is known as a "straight pipe". Spillage of human waste from straight pipes and failing septic systems into streams can have a variety of negative effects including the spread of diseases which make waterways unsafe for recreation. State laws require both failing septic systems and straight pipes be corrected once identified which would translate to a 100% reduction in bacteria from these sources.

Table 6-1 shows the estimated number of households in the Crab Creek watershed with failing septic systems and straight pipes as identified in the 2004 TMDL. The failing septic system estimate factored in the age of homes in the watershed, and in the case of straight pipes, the proximity of homes to streams. The TMDL projected the number of households in the watershed to 2003 based on the Montgomery County growth rates which resulted in 1,713 septic systems. The TMDL also projected an increase in the number of septic systems to 1,882 by 2008. During IP development, 2010 Census data (USCB 2010) and a map of the sewer network provided by the Town of Christiansburg were used to estimate current population, household and septic system numbers within the watershed. It was determined that the population, the total number of households, and the number of households on sewer have increased since the TMDL study.

However, the estimated number of households on septic systems appears to be comparable to the 2008 estimate included in the TMDL study.

Practices for treating failing septic systems and straight pipes were chosen based on input from the local Virginia Health Department staff and stakeholders as well as research from previous IPs. Based on existing conditions in the watershed, it was estimated that 66% of failing septic systems would require repairs, 22% replacements with a conventional system, 10% replacement with an alternative waste treatment system, and 2% replacement with a connection to public sewer.

Table 6-1. Estimated failing septic systems, straight pipes and residential practices needed in the Crab Creek watershed

Failing Septic Systems	Straight Pipes	Pump-outs	Connection to Sewer	Repairs	Septic System Replacements	Alternative Waste Treatment Systems
359	4	565	7	237	81	38

Stakeholders identified septic system pump-outs as a practice to offer residents as an educational tool and as a way to further identify failing systems. This program could receive cost-share funding as an incentive for homeowner participation; it could also target homeowners closest to identified streams or those with financial burdens. The number of pump outs listed in Table 6-1 was calculated as 30% of the 2008 estimate of households in the watershed with septic systems. Stakeholders also identified the cost of connecting to sewer as a practice that could be bolstered by the availability of cost-share funding. In the Town of Christiansburg, once a homeowner's septic system fails they are required to connect to the public sewer system. This is not a requirement for Montgomery County homeowners, but the sewer system does extend in places (generally along Crab Creek) into the county. Based on this feedback, it was estimated that 2% of failing septic systems could be replaced by connections to public sewer.

6.3 Sanitary System Overflows (SSOs)

Sanitary sewer systems collect and transport sewage from homes and commercial buildings to publicly owned treatment works (POTW). Unintentional discharges of raw sewage occur in almost every system of this type due to a variety of causes including blockages, line breaks, sewer defects that allow stormwater and groundwater infiltration, improper operation and maintenance, power failures, inadequate design and vandalism. Known as sanitary sewer overflows (SSOs), these discharges release untreated sewage which can impact local water quality.

Christiansburg's sanitary sewer system consists of approximately 155 miles of sewer main and 4,207 manhole structures (Town of Christiansburg 2014). As a requirement of the Town of Christiansburg's Wastewater Treatment Facility VPDES permit (#VA0061751), they are required to report any SSOs within five days to VADEQ. The 2004 Crab Creek TMDL calls for a 100% reduction of these releases.

Since the development of the Crab Creek TMDL in 2004, the Town of Christiansburg has implemented a number of collection system improvements designed to reduce the potential for sanitary sewer overflows (SSOs). These improvements included the development of a GIS-based collection system mapping program to store specific collection system component

information; the implementation of a grease trap maintenance monitoring program to reduce the potential for grease-related back-ups and overflows; active SSO identification and reporting to support problem area identification; sewer shed-specific evaluation and rehabilitation; and general system repairs and maintenance.

In conjunction with a 2011 Letter of Agreement with DEQ, the Town conducted an evaluation of Inflow and Infiltration (I/I) sources in the College Street area, a section of the collection system that experienced SSOs during heavy precipitation events. The investigation included flow monitoring, wet weather observations, manhole inspections, smoke testing, and closed circuit television (CCTV) inspections. The College Street system was monitored as a whole, and additionally was subdivided into sub-basins to more effectively locate sources of I/I. The Town performed 296 dry weather manhole inspections and 303 wet weather inspections out of the 318 manholes in the College Street area. During the course of this work, thirteen manholes were rehabilitated by Town staff in order to eliminate obvious inflow contributors. The Town also performed smoke testing on almost 46,000 feet of line (or 70% of the College Street sewer lines) and performed CCTV inspections on 16,790 feet of sewer. Based upon this work, the Town contracted with a sewer rehabilitation contractor to rehabilitate 1,850 linear feet of sanitary sewer utilizing cured-in-place pipe technology and rehabilitated 43 manholes. This work was completed in 2013.

The ongoing and completed work performed in the College Street area and in other areas of the Town's collection system since 2004 represents the replacement of more than 10,000 feet of sewer line, the rehabilitation of another 6,000 feet of existing line, and the rehabilitation or replacement of more than 100 manholes. Collectively these improvements have significantly reduced sanitary sewer overflow potential.

The Town continues to perform preventive maintenance work within its collection system. The Public Works Department routinely maintains approximately 28,000 linear feet of collection lines every year. This maintenance includes point repair, routine cleaning/jetting, and CCTV inspection. In addition, the Town recently contracted with two firms to provide root control and grease treatment within selected sections of the collection system. In 2013, approximately 12,000 feet of sewer pipe was treated in several different drainage areas, and a pilot project with a grease control treatment was conducted on more than 3,000 feet of sewer line located in the Roanoke Street area. These routine maintenance procedures have proven to reduce the number of SSO and the Town plans to continue and improve its preventive maintenance program.

The Town is also currently revising the Sewer Use and Building Code sections of the Town Code to add Fats, Oil and Grease (FOG) permitting requirement as well as revising and expanding the current FOG monitoring and enforcement policies. The Town envisions that this policy revision will reduce the probability of SSO events. A GIS component to the FOG program will identify the location of residential, commercial, and industrial land use and specific restaurants for parcels served within each pump station or other sanitary sewer system monitoring location.

In addition to its ongoing collection system maintenance program, the Town has future plans to develop a system-wide sewer model of its major pipe network to include known SSO locations. Once developed and calibrated, the Town will utilize the model as a tool to aid in developing a

long-term sanitary sewer capital improvements plan (CIP). The CIP will prioritize work that will further reduce the frequency of SSOs.

6.4 Pet Waste

Studies show that approximately 60-70% of pet owners claim to clean up after their dogs most or all of the time while the remaining 30-40% rarely or never pick up their dog's waste (Hardwick 1997). Left on the ground, pet waste can easily be washed by runoff into storm drains or nearby waterbodies. Pet waste not only carries bacteria, viruses, and parasites that can threaten the health of humans and wildlife, but it can also deposit nutrients that promote algal growth. Studies show that up to 95% of fecal matter could potentially be eliminated from an urban watershed if all dog owners simply picked up after their pets (Alderserio et al. 1996; Trail et al. 1993).

A pet waste education program increases public awareness about these water quality issues and encourages pet owners to properly dispose of their pet's waste at home and in public dog walking areas. The Skyline SWCD already provides some pet waste education to children as part of their school-based outreach. A fully implemented pet waste education program will include the development and distribution of educational materials, installation of pet waste stations in key locations (local parks, Huckleberry Trail, etc.), and the promotion of other pet waste BMPs such as pet waste digesters or composters. Pet waste digesters and composters allow pet owners to safely collect and compost pet waste outside. There are several types available with varying degrees of required maintenance. For example, the Doggie Dooley system is a septic tank digester inserted in the ground and covered with a lid.

A "pooper-scooper" ordinance is another effective solution that may be considered in the Crab Creek watershed. Many communities have pooper-scooper laws that mandate pet waste cleanup. Some of these laws specifically require anyone who takes an animal off their property to carry a bag, shovel, or scoop. Any waste left by the animal must be collected immediately. Some of these laws also include fines that can offset some of the program costs. In addition to postings, many communities have established dog parks. The use of vegetated buffers, pet waste stations, and the thoughtful siting of parks away from drainageways, streams, and steep slopes could help control the impacts of dog waste on receiving waters (NVPDC 2005). Self-governance principles also predict that owners are more likely to properly dispose of pet waste in these chosen areas (Mattisof and Noonan 2012). Dog parks can also be convenient locations for concentrating education efforts for maximum pet owner exposure.

6.5 Urban Stormwater

Impervious surfaces (roads, parking lots, and sidewalks) are made from materials that unlike soil prevent water from percolating down into the ground. During storms, these surfaces carry the water, along with any materials (bacteria, sediment, trash, fertilizers, etc.) it picks up along the way, to storm drains and nearby waterbodies. Measure known as BMPs or stormwater treatment practices (STPs), mitigate these impacts by storing and filtering runoff before it can affect downstream water bodies. The Crab Creek watershed needs BMPs that address both stormwater quality and quantity in order to reduce urban bacteria and sediment loads. In Virginia, local jurisdictions, like the Town of Christiansburg, are the primary provider of stormwater services, but these practices can and should be applied to any developed area in the watershed needing stormwater control.

Urban stormwater BMPs are diverse and continuing to grow. Ultimately, BMP selection for a specific site will depend upon its physical and financial feasibility as well as other factors such as pollutant removal efficiency, maintenance needs, aesthetics, and wildlife habitat function. This IP includes a selection of potential BMPs based on their common usage, high cost-effectiveness, and stakeholder feedback. Stormwater BMPs considered in this plan include detention and extended detention basins, manufactured BMPs, constructed wetlands and wet ponds, riparian buffers, infiltration, bioswales, bioretention filters (including rain gardens), vegetated open channels, street sweeping, and enhanced erosion and sediment controls. However, the various Working Groups recognized that other BMPs, some of which are already listed in the Virginia Stormwater BMP Clearinghouse, may be better suited for specific projects in the Crab Creek watershed. These BMPs should be evaluated for their bacteria and sediment pollutant reduction capacity and considered among the many options available.

6.5.1 Low Impact Development (LID) BMPs

Low impact development (LID) is about managing rainfall at the source using smaller-scale controls rather than the traditional method of channeling stormwater through pipes to large-scale holding areas. LID mimics natural hydrology by allowing rainwater to infiltrate, filter, evaporate, and accumulate at the source. These types of control measures should be considered because they are flexible and can easily be integrated into urban sites. LID techniques also tend to cost less to construct because they require less grey infrastructure than traditional, conventional stormwater controls.

Infiltration practices include dry wells, infiltration trenches, and infiltration basins (VADEQ 2011). Dry wells are small, stone-filled pits that store and infiltrate pre-filtered runoff from small (less than one acre) areas like the roof of a single-family home. Trenches temporarily store runoff so it can infiltrate into the ground in stone-filled surface or underground trenches. They are suitable for drainage areas less than ten acres whereas basins may be suitable for drainage areas of 5 to 50 acres. Infiltration basins are impoundment structures constructed over permeable soil, but unlike detention basins, they are not designed to release any stormwater as surface flow.

Bioretention filters use a landscaped, conditioned soil bed to capture and eventually filter rainwater to an underdrain that connects to the larger storm drain system. They range in size depending on the area of impervious surface they are designed to treat, but generally they are used on sites of five acres or less. Small-scale bioretention filters designed for individual lots are generally referred to as rain gardens. By maximizing rainwater infiltration, bioretention areas reduce runoff and provide high pollutant removal efficiencies. They can also provide secondary benefits, including enhanced aesthetics, noise control, wind protection, and wildlife habitat (EPA 1999). Stakeholders suggested schools as good sites for rain gardens because of the additional teaching and learning opportunities.

Other examples of LID include vegetated roofs, permeable pavement and pavers, rain barrels, and rain gutter disconnects.

6.5.2 Pollution Prevention/Good Housekeeping

In addition to structural BMPs, local municipalities can implement or enhance certain activities to address the impacts of stormwater on bacteria and sediment loads in Crab Creek. Over time, streets and parking lots accumulate pollutants including sediment, debris, trash, road salt, and

even waste that can be carried by runoff to nearby surface waters. Street sweeping can minimize these loads while also improving roadway aesthetics. The effectiveness of a street sweeping program will depend upon the equipment, its operation and maintenance, sweeping schedule, waste storage and disposal. Bacteria and sediment loads may be reduced further by the regular cleaning of storm drain systems

All localities are required by law to develop a program to reduce pollutants in stormwater runoff from construction sites disturbing one or more acres. These programs generally begin with an ordinance that requires the implementation of erosion and sediment BMPs as well as procedures for reviewing site plans, responding to public concerns, site inspections, and enforcement. Programs must meet the minimum standards set forth in the Virginia Erosion and Sediment Control Law, Regulations, and Certification Regulations (effective July 1, 2013), but Enhanced Erosion and Sediment Controls may be an option for permittees in watersheds with known sediment issues to reduce their loads. Municipalities can "enhance" their program several ways such as designating a smaller threshold for construction sites requiring E&S plans, mandating faster site stabilization, adding staff to ensure proper enforcement of existing program components, and increasing the frequency of inspections in watersheds with sediment impaired streams. (Clark et al. 2014).

6.5.3 Green Infrastructure

In addition to small-scale structural BMPs, urban stormwater could potentially be addressed through the development of green infrastructure. Green infrastructure is both the interconnected green space network managed for its natural resource values and the process of promoting systematic and strategic land conservation for the good of nature and people. The scale of green infrastructure ranges from small urban rain gardens to greenways to large tracts of undeveloped land. Green infrastructure can address several different water issues including stormwater management, flood mitigation, and water quality. For example, Milwaukee, Wisconsin developed a conservation plan for important floodplain areas to complement traditional stormwater management techniques and improve water quality (Benedict and McMahon 2006). Local efforts to create walking paths, trails, and greenways could also expand to include conservation corridors and the protection of water resources.

6.6 Channel Erosion

Streambank erosion is a natural process, but alterations to the stream system can greatly accelerate the process resulting in erosion rates far greater than those typically seen. Channel erosion is estimated to contribute about 61% of the sediment reaching Crab Creek from nonpoint sources, making streambank stabilization efforts critical. Significant reductions could be made through the implementation of improved stormwater management in urban areas, installation of riparian buffers throughout the watershed, and livestock exclusion from streams. However, additional stream mitigation will be needed to meet the in-stream channel erosion reductions identified in the Crab Creek TMDL.

Due to the variability in streambank form and needs, streambank stabilization and restoration techniques must be selected on a site-by-site basis. Resource needs will depend on the specific technique(s), ranging from low tech, landowner friendly projects (live plantings) to relatively high-cost designs requiring professional design services (channel re-shaping). The 2004 Virginia Stream Restoration and Stabilization Best Management Practices Guide provides an in-depth

review of the permitting issues, planning and design principles, costs, and best management practices associated with stream restoration projects (VADCR 2004).

In 2009, the Town of Christiansburg initiated a stream preservation and restoration program to improve the function and water quality of degraded streams throughout the Town. The first site chosen for restoration was the Diamond Hills Park creek site near Independence Boulevard in the northeast portion of the Crab Creek watershed (Figure 6-1). Construction on the project began in late 2013 and at its completion will restore 2,233 linear feet of impaired stream channel that drains directly into Crab Creek. This project is estimated to remove approximately 874 tons of sediment per year from Crab Creek (Town of Christiansburg 2013). When completed, the Diamond Hills Park will be protected in perpetuity by the Town as green space and future plans include a trail network.

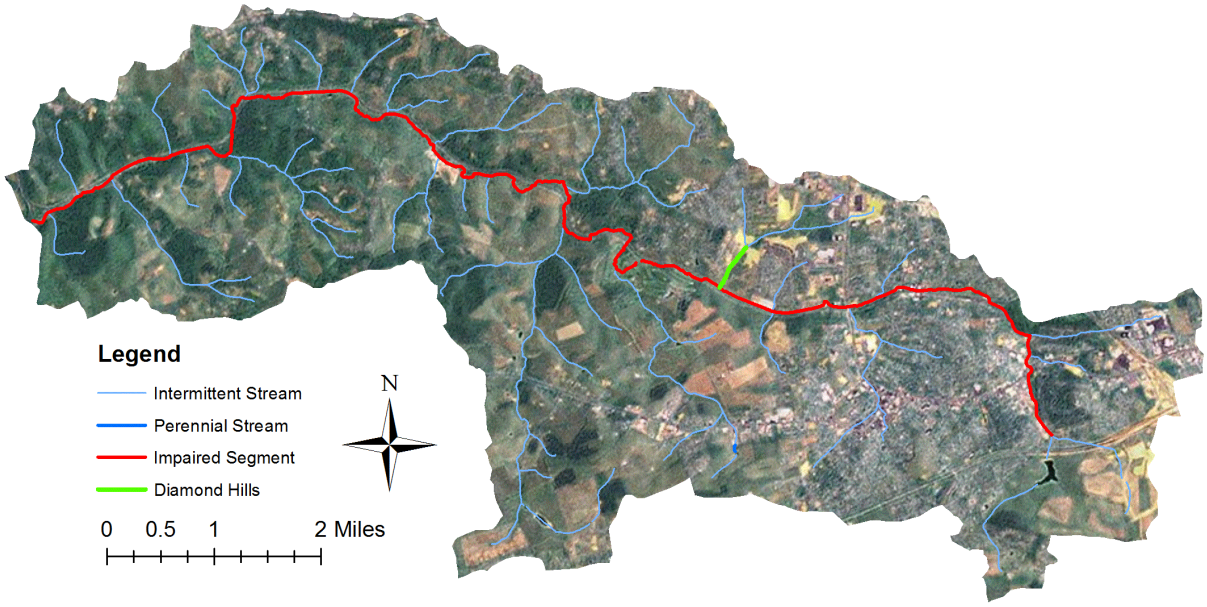

Figure 6-1. Diamond Hills stream restoration location

6.7 Direct Deposition

When livestock, especially cattle, have uncontrolled access to streams, they often deposit their feces nearby or directly into the stream. Their waste contains fecal bacteria, an indicator of other disease-causing bacteria that can harm human health. Additionally, the livestock tend to congregate around the water source, trampling the stream banks and overgrazing the riparian vegetation which further contributes to stream sedimentation issues. The 2004 TMDL study specified a 100% reduction in the direct deposition of waste into the stream by livestock. This will be accomplished by limiting livestock access to streams with fencing and providing alternative water sources.

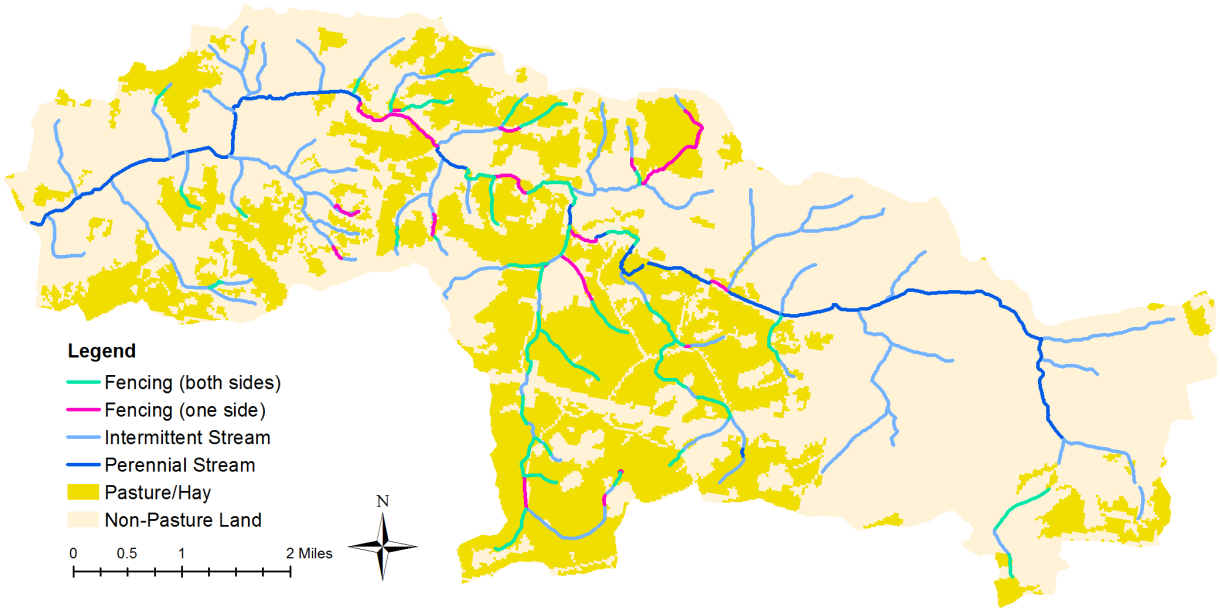

Figure 6-2. Potential areas for stream exclusion fencing in the Crab Creek watershed

A GIS analysis of hydrologic and land use data was conducted to assess potential fencing needs in the watershed. Perennial and intermittent stream segments flowing through pastureland were identified and evaluated against aerial imagery to detect land uses categorized as pasture but serving an alternative purpose (i.e. golf course). Fencing lengths were calculated for both sides of a stream segment if it flowed through identified pastureland and only for one side if it flowed adjacent to pasture and another land use (Figure 6-2). While not every pasture has grazing livestock at every single point in time, it was assumed that all pasture areas have the potential for livestock access. Stream feet within pasture, current fencing extent, and estimated stream exclusion fencing needs on perennial streams are listed in Table 6-2.

Table 6-2. Stream exclusion fencing needs (feet)

Stream Length	Fencing installed after TMDL[1]	Remaining IP Fencing
29,553	10,664	18,889

[1] Four systems have been installed and recorded in the VADCR BMP Cost-share database since the 2004 TMDL study

Landowners have a growing number of cost-share options for livestock exclusion fencing systems. The most common resources for fencing systems in Virginia are the state Agricultural BMP Cost-share program administered by local Soil and Water Conservation Districts (SWCDs) and the National Resource Conservation Service (NRCS) cost-share program. The most applicable cost-share BMPs for livestock exclusion in the Crab Creek watershed are the SL-6T (stream exclusion with grazing land management), LE-1T (Livestock Exclusion with Riparian Buffers for TMDL Implementation), LE-2T (Livestock Exclusion with Reduced Setback for TMDL Implementation), and WP-2T (Stream Protection for TMDL Implementation) offered through the Virginia BMP Cost-Share Program. Technical specifications and cost-share rates vary by practice as shown in Table 6-3. Local District, NRCS, and Farm Service Agency (FSA) personnel provided feedback on the typical distribution of systems among the available cost-share practices as well as the average cost of systems associated with the different practices. Data

were also pulled from the VADCR BMP Cost-share database for comparison to these estimates and to help account for the fencing systems put into place in the watershed since the 2004 TMDL. Based on data from the VADCR Agricultural BMP database, 10,664 feet of stream exclusion fencing has been implemented in the Crab Creek watershed (see Table 4-1).

Table 6-3. Comparison of Virginia cost-share program livestock exclusion practices

Practice Code	Required Buffer Distance (feet)	Cost-share Rate	Components Eligible for Cost-share Payment				
			Permanent Stream Crossing	Cross Fencing	Alternate Water Supply	Restricted Crossing	Hardened Access or Crossing
SL-6T	35	100%	X	X	X	X	
LE-1T	35	85%	X	X	X	X	
LE-2T	10	50%	X	X	X	X	
WP-2T	35	75%	X				X

Based on stakeholder feedback, this plan estimates that 85% of needed exclusion systems will be installed as a Stream Exclusion with Grazing Land Management (SL-6T) practice or Livestock Exclusion with Riparian Buffer practice (LE-1T). VADCR is currently marketing the SL-6T practice at 100% cost-share for two years (fiscal years 2014 and 2015) after which time the cost-share percentage will be reduced. All participant enrollments received during the two-year period will be honored as cost-share becomes available even if enrollment outpaces available funding.

The LE-1T practice has consistently been marketed at 85% which could make it the preferable choice when the SL-6T cost-share is reduced. The remaining systems will likely be a mixture of Livestock Exclusion with Reduced Setback (LE-2T) and Stream Protection (WP-2T) practices.

This IP quantifies fencing along both perennial and intermittent streams. The highest priority should be given to livestock exclusion systems on perennial streams to achieve the most impact on reducing bacteria loads; therefore, all perennial stream fencing is included in Stage 1. Stage 2 includes the estimates for livestock exclusion on the intermittent streams within the Crab Creek watershed.

6.8 Pastureland

Pasture lands provide forage for grazing by domestic livestock, commodities which contribute largely to Virginia's economic prosperity (VDACS 2014). Improper pastureland management can lead to soil compaction and overgrazing which encourage erosion and runoff. Grazing animals deposit manure on any available pastureland, but waste tends to be most concentrated near feeding and watering areas. Poorly located or managed areas can quickly become barren, increasing the possibility of contaminated runoff (Alderfer and Robinson 1947). Pasture runoff carries both bacteria from the livestock waste and sediment from the eroding soils to nearby streams. Pastureland BMPs can greatly reduce these pollutant loads as well as improve overall pastureland production.

Grazing Land Management encompasses several cost-share practices (EQIP 528 or SL-10T) and generally refers to the controlled harvest of vegetation with grazing or browsing animals, managed with the intent to achieve a specified objective. Grazing management may address

stocking rates, rest periods, intensity, frequency, duration and season of grazing to promote ecologically and economically stable plant communities. In addition to reducing bacterial and sediment pollution, these practices can help improve soil and animal health as well as potentially increase profitability. The Reforestation of Erodible Crop and Pastureland practice (FR-1) offers an incentive to change land use on eroded pasture to one that will better control soil and nutrient loss from surface runoff. Permanent Vegetative Cover on Critical Areas (SL-11) provides cost-sharing and tax credits for land shaping and planting of permanent vegetative cover that will significantly reduce erosion and improve water quality. In areas frequently and intensively used by people, animals, or vehicles, the Heavy Use Area Protection (NRCS 561) practice may be used to establish vegetative cover, surface with suitable materials, and/or install structures like roofs.

6.9 Cropland

When exposed to rainfall, cropland fertilized with manure and biosolids applications may contribute additional bacteria and sediment to runoff. Filtering practices such as riparian buffers can help trap those pollutants before they reach local streams. Reducing soil tillage, increasing soil organic content, and improving soil cover can also help reduce the amount of runoff and soil loss during rain events. Certain practices may also help reduce the levels of bacteria in the manure prior to application such as increasing storage times and during application by reducing manure use.

Farmers in Montgomery County already employ some of these BMPs as confirmed by the Skyline SWCD. While a few of these cropland and other agricultural practices are documented in the VADCR Cost-share database, other practices are not included because they are undertaken voluntarily by the producers. Thus, Agricultural Working Group members helped establish some baseline estimates for the watershed. In preparing this plan, it was estimated that 70% of cropland currently employs cover crops and that only 6% of cropland is currently in high tillage.

Farmers till their land to aerate, warm, and shape soil as well as to bury crop residue and remove weeds. Beyond these benefits though, tilling results in many other negative effects like soil compaction, loss of organic matter, disruption of soil organisms, and increased soil erosion and runoff. No-till farming, in contrast, minimizes soil disruption, but requires different management techniques to maintain crop yields. The Continuous No-Till System practice (SL-15A) provides a per-acre payment for farmers who stop tilling their soil.

Although cover crops have been used by farmers for centuries, the practice had recently been replaced by the widespread increase in fertilizer and herbicide use. Farmers are generally moving back toward the use of cover crops because of the benefits associated with improved soil quality, enhanced fertility, decreased field maintenance, and erosion control. Two types of cover cropping practices were considered in this plan, harvestable and small grain. The small grain cover crop practice (SL-8B) was selected because it provides cost-share and tax credits to participating farmers for establishing vegetative cover, specifically grains like winter rye and winter wheat, on cropland for protection from erosion and the reduction of nutrient losses to groundwater (VACS Manual 2014). In this practice, the cover crop is killed or grazed, but not harvested.

6.10 Technical Assistance

The implementation plan will require the involvement of many landowners throughout the watershed, many of which will have no prior knowledge of water quality issues and BMPs. A survey of producers by the National Institute of Food and Agriculture found the most effective educational programs required dedicated personnel, a resource currently in decline (Luloff et al. 2012). Individuals are needed to help identify, educate and involve landowners as well as help design and install the actual BMPs. Therefore, technical assistance resources are a key component of this clean-up plan.

Technical Assistance Tasks

- Assist in and approve design of BMPs for residential and/or agricultural land uses
- Inspect completed cost-share practices and document site visits
- Verify landowner match requirement
- Complete paperwork for cost-share payments
- Track and report practice implementation
- Educate and provide outreach to the general public about the implementation plan and other ways to improve local water quality

The plan estimates technical assistance needs based on the scope of BMPs identified in this plan, discussions with local stakeholders, and levels included in similar implementation projects. The plan calls for two technical assistance positions: one for agricultural practices and one for residential/urban practices. The Skyline SWCD showed interest in managing the agricultural position. The residential/urban position would potentially work on septic system, pet waste, and stormwater implementation practices. While they could also be employed through the District, a better fit may be the New River Valley Planning District Commission (NRVPDC) or the New River Conservancy (formerly the National Committee for the New River).

6.11 Education and Outreach

Skyline SWCD and NRCS representatives already provide outreach, technical and financial assistance to farmers in the Crab Creek watershed to encourage the installation of agricultural BMPs. Additional information on agricultural implementation practices could be distributed through the Virginia Cooperative Extension, local businesses (Southern States), and community events. Bulk mailings to target properties where specific practices are needed would also be an inexpensive and effective way to reach the farming community.

Additionally, Skyline SWCD already provides educational programming to school children about water quality and water quality practices, such as cleaning up after pets. The Town of Christiansburg's wastewater treatment plant also conducts tours and offered the property as a potential location for additional outreach activities. The school system was identified as a willing partner for outreach activities and as a way to reach many citizens throughout the watershed. Christiansburg High School students currently have an opportunity to participate in a class which conducts biological, chemical, and physical monitoring throughout the Crab Creek watershed. These monitoring efforts both teach students about the watershed and provide additional data collection opportunities for understanding water quality throughout the watershed.

Stakeholders recommended creating educational campaigns for promoting both residential septic and pet waste efforts. VDH was suggested as a partner in locating failing septic systems and straight pipes, and SERCAP was mentioned as a potential source for additional funding. Other septic system maintenance education programs have utilized websites, displays, handouts, educational videos, utility bill inserts, public service announcements and workshops (often referred to as "septic socials"). In addition to improving water quality, a pet waste outreach campaign can empower community members to take action and build further support for water quality improvement efforts. A pet waste campaign could include brochures distributed with County dog licenses and at local veterinarian offices, messages delivered through local media (TV, radio, newspapers, etc.), flyers, informational meetings, a website, educational materials, and participation incentives such as dog waste kits.

7. IMPLEMENTATION COSTS

7.1 Residential BMP Costs

The total cost for residential septic system, straight pipe, and pet waste practices totals $2,240,000 as shown in Table 7-1. The costs for residential practices were estimated using input from local Virginia Department of Health (VDH) staff and the Skyline SWCD as well as information from other recent TMDL Implementation Plans in Virginia. All of the following residential practices will be prioritized for implementation during Stage 1, which encompasses the first six years of implementation efforts.

Table 7-1. Estimated residential BMPs and costs

Control Measure	BMP Code	Units	Unit Cost	Total	Total Cost
Failing Septic Systems					
Septic Tank Pump-out	RB-1	system	$300	565	$169,500
Connection to Public Sewer	RB-2	system	$5,000	7	$35,000
Septic Tank System Repair	RB-3	system	$3,500	237	$829,500
Septic Tank System Installation/Replacement	RB-4	system	$7,500	79	$592,500
Alternative On-site Waste Treatment System	RB-5	system	$15,000	36	$540,000
Straight Pipes					
Septic Tank System Installation/Replacement	RB-4	system	$7,500	2	$15,000
Alternative On-site Waste Treatment System	RB-5	system	$15,000	2	$30,000
Pet Waste Management					
Pet Waste Stations[1]		system	$1,300	15	$19,500
Pet Waste Digesters/Composters		system	$100	50	$5,000
Pet Waste Education Program		program	$4,000	1	$4,000
				Total	**$2,240,000**

[1] Unit cost based on purchasing system as well as the estimated cost of trash can liners, waste bags, and maintenance for 10 years

The number of pet waste stations needed was estimated by analyzing the number of parks and miles of trails within the watershed. It was estimated that a total of 15 pet waste stations are needed in the watershed (Table 7-2). Over a lifespan of 5 years, each pet waste station will cost about $1,300 considering the cost of the station hardware, waste can liners, waste bag refills, and maintenance. Pet waste digesters/composters could be placed in the watershed at veterinary clinics, kennels, or private residences. These systems are most applicable to residences in urban areas with small lots that allow for easy retrieval of pet waste. This plan estimates that at least 50 units could be placed in the watershed at an average cost of $100 per system.

Table 7-2. Locations identified for future placement of pet waste stations.

Location	# Stations	Details[1]
Circle Park	1	Neighborhood park on Ellett Drive
Depot Park	1	On Depot St. with walking/jogging path
Downtown Park	1	Paved walking trail to library
Harkrader Sports Complex	1	Encircled by a 0.4 mile paved walking track
Kiwanis Park	1	Located off Roanoke Street, behind Southern States
Town and Country Park	1	Neighborhood park on Summit Ridge Road
Wall Street Park	1	Neighborhood park located on Wall Street, off Radford Street
Huckleberry Trail	3	Total = 10, 737 ft; Existing = 1,483 ft; Design = 9,254 ft
Trail near George Edward Via NW	1	Proposed walkway = 5,455 ft
Holmes St. NE to Mill Ln. NE	1	Proposed walkway = 2,491 ft
Aspen St. SE to Falling Branch	2	Proposed walkway = 6,578 ft
Dog Park	1	Proposed, no location
Total	15	

[1] Details derived from the Town of Christiansburg Parks and Recreation website and trail maps. Trail lengths are estimated.

A Pet Waste Education program for the watershed would cost approximately $4,000. This would cover the cost of outreach efforts to educate landowners about this particular water quality issue. Lack of knowledge of the connection between pet waste and water quality issues has been recognized as one of the main barriers in getting pet owners to clean up their dog's waste (Syferd 1995). Outreach efforts may include creating and distributing flyers, posters, waste bag samples, cost-share for the purchase of digesters/composters, advertisements, and display materials.

7.2 Stormwater BMP Costs

Stormwater BMP cost estimates were developed using stakeholder input, information from other recent Implementation Plans and other available literature. The estimated total cost for stormwater BMPs is $1,604,250. Table 7-3 lists the urban and residential stormwater BMPs and their associated costs. Stormwater BMPs installed during Stage 1 will meet the sediment reduction goal from MS4 permitted areas, and combined with the Residential BMPs will meet the Stage 1 bacteria goals from residential and urban sources. While there is no specific bacteria reduction goal for MS4-related loads, many of these stormwater BMPs will be placed within the MS4 area, resulting in potential reductions to the MS4 bacteria load.

Table 7-3. Urban and residential stormwater BMP costs (units in acres treated)

BMP	Units	Avg. Cost	# of BMPs			Costs		
			Stage 1	Stage 2	Total	Stage 1	Stage 2	Total
Rain Gardens (MS4)	acres treated	$5,000	2	57	59	$10,000	$285,000	$295,000
Rain Gardens (non-MS4)	acres treated	$5,000		10	10	$0	$50,000	$50,000
Bioretention Filters	acres treated	$20,000	1.5	2	3.5	$30,000	$40,000	$70,000
Bioswales	acres treated	$15,000	1	6	7	$15,000	$90,000	$105,000
Riparian Buffers - Forested	acres treated	$3,500	0.5	55.5	55.5	$1,750	$192,500	$194,250
Riparian Buffers - Grass/Shrubs (MS4)	acres treated	$500		75	75		$37,500	$37,500
Riparian Buffers - Grass/Shrubs (non-MS4)	acres treated	$500		20	20		$10,000	$10,000
Detention	acres treated	$2,000	25	57	82	$50,000	$114,000	$164,000
Extended Detention	acres treated	$2,000	40	60	100	$80,000	$120,000	$200,000
Manufactured BMPs	acres treated	$15,000	2.5	10	12.5	$37,500	$150,000	$187,500
Detention and Manufactured BMPs	acres treated	$16,000	0.5	15	15.5	$8,000	$240,000	$248,000
Constructed Wetlands/Wet Ponds	acres treated	$8,000	0.5		0.5	$4,000		$4,000
Infiltration	acres treated	$20,000	0.5	1	1.5	$10,000	$20,000	$30,000
Vegetated Open Channels	acres treated	$9,000	0.5	0.5	1	$4,500	$4,500	$9,000
							Total Cost	**$1,604,250**

7.3 Streambank Stabilization BMP Costs

Streambank stabilization estimates shown in Table 16 were based on similar watershed clean-up plans and input from the Crab Creek working groups. The estimated total cost for streambank stabilization efforts is $3,376,200. All streambank stabilization practices have been prioritized for implementation during the first stage of work based on stakeholder feedback. Streambank stabilization practices are applicable to all land uses in the watershed. More complex stream restoration projects would be applicable in the watershed to support sediment reduction efforts and stakeholders estimated the cost of full stream channel restoration at $200-$300 per linear foot. However, the increased unit cost may result in a greater sediment removal rate than just basic stabilization efforts, making restoration projects a potentially cost-effective option. The

Diamond Hills project being undertaken by the Town of Christiansburg (Section 6.6) was credited for 2,233 linear feet of streambank stabilization during plan development.

Table 7-4. Streambank stabilization estimates for the Crab Creek watershed

Control Measure	Unit	Unit Cost	Units Needed		Total Cost	
			Stage 1	Stage 2	Stage 1	Stage 2
Streambank Stabilization	linear ft.	$300	11,254		$3,376,200	$0

7.4 Agricultural BMP Costs

The total cost of agricultural BMPs needed in the Crab Creek watershed is $2,088,275. This includes $1,356,400 for practices to address direct deposition through livestock exclusion systems, $730,875 for pastureland practices, and $1,000 for cropland practices. Costs associated with each of the agricultural BMPs needed in the watershed were estimated using data from the VA Agricultural BMP Tracking Program and feedback from Skyline SWCD and NRCS staff. The majority of recommended practices are eligible for state and federal cost share programs. These programs offer landowners financial assistance for implementing practices and may include with some practices incentive payments to further encourage participation. The per system costs shown for each practice in Table 7-5 include the total practice cost which is comprised of both the expected cost share payment and the landowner's cost responsibility. The Stage 1 1ivestock exclusion goal is based on fencing needs estimated for perennial streams and 25% of intermittent streams, while the Stage 2 estimate covers the additional intermittent stream miles that may need exclusion systems.

Table 7-5. Estimated agricultural BMPs needed to reduce bacteria and sediment in the Crab Creek watershed and their costs

Control Measure	BMP Code	Units	Average Unit Cost	Stage 1		Stage 2		Total Units	Costs		
				Units	% LU Treated	Units	% LU Treated		Stage 1	Stage 2	Total
Livestock Exclusion											
Livestock Exclusion with Riparian Buffers	SL-6T, LE-1T	system	$32,800	16	85%	22	21%	38	$524,800	$721,600	$1,246,400
Livestock Exclusion with Reduced Setback	LE-2T	system	$20,000	2	10%	2	3%	4	$40,000	$40,000	$80,000
Stream Protection System	WP-2	system	$10,000	1	5%	2	1%	3	$10,000	$20,000	$30,000
Pasture											
Grazing Land Management System	EQIP 528, SL-10T	acres	$75	3,265	95%			3,265	$244,875		$244,875
Reforestation of Erodible Pasture	FR-1	acres	$1,000			28	0.5%	28		$28,000	$28,000
Permanent Vegetative Cover on Critical Areas	SL-11	acres	$2,000			29	0.5%	29		$58,000	$58,000
Heavy Use Area Protection	EQIP 561	system	$20,000			20	4%	20		$400,000	$400,000
Cropland											
Continuous No-till	SL-15A	acres	$20	5	2%			5	$100		$100
Small Grain Cover Crop	SL-8B	acres	$45	20	6%			20	$900		$900
									Total Cost		**$2,088,275**

7.5 Technical Assistance Costs

Technical Assistance costs were based on the types and extent of practices included in the Implementation Plan. It was estimated that one full-time (FTE) position would be needed during Stage 1 and ½ FTE would be needed during Stage 2 for the residential/urban practices and that one full-time (FTE) position would be needed during both Stage 1 and Stage 2 for the agricultural practices (Table 7-6). Stage 1 includes the first six years of implementation and Stage 2 covers the next four years. A cost estimate of $60,000 per year per full-time position was used based on existing staffing costs for TMDL Implementation projects across the Commonwealth.

Table 7-6. Technical assistance costs for implementation efforts in the Crab Creek watershed

BMP Category	Stage 1	Stage 2	Total
Agricultural	$360,000	$240,000	$600,000
Residential/Urban	$360,000	$120,000	$480,000
Total	**$720,000**	**$360,000**	**$1,080,000**

7.6 Total Implementation Cost

In total, it is estimated that meeting the TMDLs and achieving water quality standards in the Crab Creek watershed will cost $10,388,725 as shown in Table 7-7. These costs are broken down into the two stages of implementation as well as into the categories summarized above: residential, stormwater, streambank stabilization, agricultural, and technical assistance.

Table 7-7. Total estimated cost for the Crab Creek Implementation Plan

	Residential BMPs	Stormwater BMPs	Stream Stabilization BMPs	Agricultural BMPs	Technical Assistance	Total
Stage 1	$2,240,000	$250,750	$3,376,200	$820,675	$720,000	$7,407,625
Stage 2	$0	$1,353,500	$0	$1,267,600	$360,000	$2,981,100
Total	**$2,240,000**	**$1,604,250**	**$3,376,200**	**$2,088,275**	**$1,080,000**	**$10,388,725**

8. IMPLEMENTATION BENEFITS

The ultimate goal of this clean-up plan is to meet water quality standards in Crab Creek that support human recreational use and the propagation of aquatic life. Reducing bacteria and sediment loads in Crab Creek will protect human health and safety, promote healthy aquatic communities, improve agricultural production, and add to the economic vitality of the community.

8.1 Human Health and Safety

Human, livestock, and wildlife waste can carry viruses and bacteria that are harmful to human health. Throughout the United States, the Centers for Disease Control (CDC) estimates that at least 73,000 cases of illnesses and 61 deaths per year are caused by *E. coli* 0157:H7 bacteria (CDC, 2001). Other fecal pathogens (*e.g., E. coli* 0111) are responsible for similar illnesses. Reducing the presence of bacteria in the watershed should considerably reduce the chances of infection from *E. coli* sources through contact with Crab Creek's surface waters. In addition to preventing infection and disease, strategies in this plan addressing stormwater could help mitigate and prevent future flooding.

8.2 Healthy Aquatic Communities

Excessive sediment can smother a stream by killing aquatic flora and clogging the spaces in between river bed substrate that usually provide habitat for benthic macroinvertebrates (Harrison et al. 2007). Accumulation of sediment may also lead to changes in the composition of the benthic macroinvertebrate community, favoring tolerant taxa over intolerant types. These "bugs" are often a major food source for many species of freshwater fish and a decrease in their availability can ripple up the food chain. Thus, the health of the whole aquatic ecosystem is dependent in part upon its physical habitat.

Reducing sediment in the Crab Creek watershed will help restore the health of aquatic communities for the benefit of the flora, fauna and human residents. For example, streamside buffers will help reduce erosion and provide shade for fisheries which will in turn provide more stock for local anglers. In 2011 alone, approximately $3.5 billion was spent on wildlife recreation in Virginia (USDOI et al. 2011). Buffers can also improve habitat for wildlife that also benefit from having access to a healthy, thriving aquatic community.

8.3 Agricultural Production

This plan recognizes that each and every farmer faces their own unique management challenges. Thus, some of the BMPs in this plan may be more suitable and more cost-effective for one landowner than for another in the watershed. Similarly, the benefits of implementing these practices will vary, but can be estimated based on general research.

Restricting cattle access to streams and providing them with a clean water source can improve weight gain and milk production (Zeckoski et al. 2007; Landefeld et al. 2002). Increasing weight as well as milk and butterfat production can translate into economic gains for producers as shown in Table 8-1 (Zeckoski et al. 2007). Additionally, keeping cattle in clean, dry areas has been shown to reduce the occurrence of mastitis and foot rot. The Virginia Cooperative Extension estimates mastitis costs producers $150 per cow in reduced milk production quantity and quality (Jones and Balley 2009).

Table 8-1. Production gains associated with provision of clean water for dairy cattle[1]

Typical calf sale weight	Additional weight gain with access to clean water	Price	Increased revenue
500 lb/calf	5% (25lb)	$0.60/lb	$15/calf

[1] Zeckoski et al., 2007

8.4 Community Economic Vitality

Healthy watersheds provide many ecosystem services necessary for a community's well-being. These services include, but are not limited to, water filtration and storage, air filtration, carbon storage, energy, nutrient cycling, removal of pollutants, soil formation, recreation, food and timber. Many of these services are hard to quantify in terms of dollars and are often under-valued (Bockstael et al. 2000). However, it is understood that many of these services are difficult to replace and often expensive to artificially engineer. Efforts to restore the Crab Creek watershed to a healthier state will reduce the financial burden on residents, businesses, and municipalities who currently bear the cost of damages caused by a degraded aquatic system such as flooding. Stormwater infrastructure that keeps stormwater runoff onsite can reduce losses from flood damage by $6,700-$9,700 per acre (Medina et al. 2011.) Urban stormwater BMPs can also help increase stormwater retention and lower peak discharges, thereby reducing the pressure on and need for stormwater infrastructure. This will in turn lower engineering, land acquisition, and material costs for municipalities and private enterprises.

Once the IP is complete, organizations in the watershed will be eligible to apply for competitive funding to help cover some of the costs associated with installing the BMPs. These potential funds along with matching funds from other sources will benefit many local contractors involved in the repair and installation of septic systems, building of fencing systems, and installation of stormwater structures. In a 2009 study, researchers estimated that every $1 million invested in environmental efforts such as reforestation, land and watershed restoration, and sustainable forest management, would create approximately 39 jobs (Heintz et al. 2009).

Individual homeowners and residents could also see financial benefits from these efforts. Implementation activities in the plan will help give homeowners the knowledge and tools needed for extending the life of their septic systems. The overall cost of ownership could also be reduced by advocating regular pump outs which cost about $300 compared to the $6,000-$25,000 cost of a repair or replacement system. The additional services provided by new stormwater BMPs could raise the market value of nearby homes 0-5% (Braden and Johnston 2004). Another study in the Chesapeake Bay area found that lower fecal coliform concentrations correlates with increased property values (Leggett and Bockstael 2000).

9. GOALS AND MILESTONES

9.1. Implementation Goals

The goals of TMDL implementation are to restore the water quality in the impaired stream segments in the Crab Creek watershed so that they comply with water quality standards and to de-list Crab Creek from the Commonwealth of Virginia's 303(d) List of Impaired Waters. Progress towards these goals can be assessed during the implementation process by tracking the number/type of control measures that are installed and programs or policies developed and executed (implementation actions) and continued water quality monitoring. Improvements in water quality will be measured through monitoring of bacteria concentrations and quality of the aquatic life community throughout Crab Creek.

9.2. Implementation Milestones and Water Quality Goals

The implementation of control measures will be accomplished in stages. In general, the Commonwealth intends that the needed control measures be implemented in a progressive process that first addresses the pollutant sources with the largest impact on water quality. This staged approach is based on meeting water quality goals over a ten-year period. The proposed timeline for achieving restored water quality in Crab Creek has been divided into two stages: **Stage 1 (first six years)** and **Stage 2 (next four years)**. This staged approach concentrates early efforts on the most cost-efficient control measures and sources with the most interest from stakeholders. For example, the TMDL study indicated that 17% of the total bacteria load in Crab Creek is the result of direct deposition of manure into streams by livestock. Concentrating resources on livestock exclusion fencing systems may provide the highest return on water quality improvement with the least cost to landowners because of the very beneficial cost-share options currently available for this practice. The benefits of staged implementation are 1) as stream monitoring continues, it allows for water quality improvements to be recorded as they are being achieved; 2) it provides a measure of quality control, given the uncertainties which exist in any implementation plan; 3) it provides a mechanism for developing public support; 4) it helps to ensure that the most cost-effective practices are implemented initially; and 5) it allows for the evaluation of the adequacy of the TMDL in achieving the water quality standard.

Two types of milestones have been created for evaluating progress during each stage. Water quality milestones establish the goals for observing improvements in water quality while the implementation milestones outline the extent of BMPs to be installed. For the Crab Creek watershed, the Stage 1 bacteria reductions recommended in the 2004 TMDL include a 100% reduction in direct deposition by livestock – Livestock (DD), 60% reduction in pastureland nonpoint source pollution – Pasture (NPS), 60% reduction in residential and urban sources, and 100% reduction in straight pipe and sewer overflow loads water. During implementation planning these Stage 1 goals were modified by the agricultural and residential working groups. The agricultural working group decided to add cropland practices during Stage 1. The residential working group chose to implement the stormwater BMPs and streambank stabilization practices during Stage 2 to meet the TMDL for sediment.

Reductions in bacteria from wildlife would be necessary to meet the TMDL for *E. coli* (i.e. 0% violations of the single sample and geometric mean standards*).* Since reductions to wildlife fecal bacteria are not addressed in this implementation plan, the Stage 2 bacteria milestone is to reduce violations of the single sample standard to equal or less than 10% and to reduce violations of the

geometric mean standard to 0%. In addition, the Stage 2 sediment milestone is to reduce the sediment load to meet the sediment TMDL (Table 9-1). This condition will meet Virginia's water quality standards for bacteria and allow for the delisting of Crab Creek from Virginia's 303(d) List of Impaired Waters.

Table 9-1. Crab Creek sediment loads and required reductions

Load Summary	Crab Creek Sediment (T/yr)	Reduction Required (T/yr)	Reduction Required (% of existing load)
TMDL Existing Load	6,307	4,088	64.8
TMDL Projected Future Load	7,197	4,978	69.2
TMDL	2,551		
IP Projected Future Load	4,814	2,766	57.0
IP Target In-stream Load[1]	2,047		
IP Target Allocation Load[2]	1,971		

[1] Corrected TMDL minus MOS
[2] Corrected TMDL minus the WLA and the MOS

The implementation milestones outline the extent of BMPs to be installed during each stage of implementation. Stage 1 covers the first six years of implementation and Stage 2 covers the final four years of implementation. Table 9-2 lists the control measures needed to meet the Stage 1 implementation milestones and water quality milestones for the Crab Creek watershed. Table 9-3 lists the additional control measures needed to meet the Stage 2 implementation and water quality milestones.

9.3 Reasonable Assurance

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

Efforts to address the bacteria and aquatic life (benthic) impairments in Crab Creek will be carried out primarily through the use of voluntary BMPs and education targeting nonpoint sources. Available cost-share programs will be utilized to the greatest extent possible to provide positive incentives to watershed stakeholders. Conservation technicians are already on staff at the Skyline SWCD to assist producers in implementing agricultural BMPs. The Steering Committee is encouraged to seek grant funding to provide additional monies to increase participation from stakeholders that would otherwise be reluctant to participate.

Taken together, all of these planning components comprise a reasonable assurance that implementation will progress as planned and will lead to restoration of water quality in Crab Creek.

Table 9-2. Practices needed to meet bacteria and sediment TMDL milestones in Stage 1

Control Measure	Units	# Units Needed	Cost
Residential/Urban			
Septic Pump-out	system	565	$169,500
Connection to Public Sewer	system	7	$35,000
Septic Tank System Repair	system	237	$829,500
Septic Tank System Installation/Replacement	system	81	$607,500
Alternative On-site Waste Treatment System	system	38	$570,000
Pet Waste Stations	system	15	$19,500
Pet Waste Digester/Composter	system	50	$5,000
Pet Waste Education Program	program	1	$4,000
Rain Gardens	acres treated	2	$10,000
Bioretention Filters	acres treated	1.5	$30,000
Bioswales	acres treated	1	$15,000
Riparian Buffers (Forested)	acres treated	0.5	$1,750
Detention	acres treated	25	$50,000
Extended Detention	acres treated	40	$80,000
Manufactured BMPs	acres treated	2.5	$37,500
Detention and Manufactured BMPs	acres treated	0.5	$8,000
Constructed Wetlands/Wet Ponds	acres treated	0.5	$4,000
Infiltration	acres treated	0.5	$10,000
Vegetated Open Channels	acres treated	0.5	$4,500
Streambank Stabilization	linear feet	11,254	$3,376,200
Agricultural			
Livestock Exclusion with Riparian Buffers	system	16	$524,800
Livestock Exclusion with Reduced Setback	system	2	$40,000
Stream Protection System	system	1	$10,000
Grazing Land Management System	acres	3,265	$244,875
Continuous No-till	acres	5	$100
Small Grain Cover Crop	acres	20	$900
Stage 1 Water Quality Milestones			
Bacteria (*E.coli*)			
% Violations of the Geomean Standard		0.00%	
% Violations of the Single Sample Standard		12.80%	
Average Annual Load (cfu/yr)		$1.40x10^{15}$	
Sediment			
% Reduction		55%	
Average Annual Load (T/yr)		2,120.06	

Table 9-3. Practices needed to meet bacteria and sediment TMDL milestones in Stage 2

Control Measure	Units	# Units Needed	Cost
Residential/Urban			
Rain Gardens	acres treated	76	$380,000
Bioretention Filters	acres treated	2	$40,000
Bioswales	acres treated	6	$90,000
Riparian Buffers (Forested)	acres treated	60.5	$211,750
Riparian Buffers (Grass/Shrub)	acres treated	100	$50,000
Detention	acres treated	67	$134,000
Extended Detention	acres treated	60	$120,000
Manufactured BMPs	acres treated	0.5	$7,500
Detention and Manufactured BMPs	acres treated	10	$160,000
Infiltration	acres treated	1	$20,000
Vegetated Open Channels	acres treated	0.5	$4,500
Agricultural			
Livestock Exclusion with Riparian Buffers	system	22	$721,600
Livestock Exclusion with Reduced Setback	system	2	$40,000
Stream Protection System	system	2	$20,000
Reforestation of Erodible Pasture	acres	28	$28,000
Permanent Vegetative Cover on Critical Areas	acres	29	$58,000
Heavy Use Area Protection	system	20	$400,000
Stage 2 Water Quality Milestones			
Bacteria (*E.coli*)			
% Violations of the Geomean Standard		0.00%	
% Violations of the Single Sample Standard		10.35%	
Average Annual Load (cfu/yr)		$9.44x10^{14}$	
Sediment			
% Reduction		57%	
Average Annual Load (T/yr)		2,046.24	

9.4. Implementation Tracking

Tracking of agricultural practices will be done by the Skyline SWCD through the existing VADCR BMP Tracking Program. Tracking information will include the locations and numbers of practices installed in the watershed. Additional tracking of residential practices implemented using cost-share funding could also be tracked by Skyline. Progress made by the Town of Christiansburg to reduce Sanitary Sewer Overflows (SSOs) will be tracked as an annual reporting requirement of their VPDES permit (starting after reissuance of their permit in 2015). Stormwater BMPs will be tracked as part of MS4 permit annual requirements. Any other grant funded projects, including educational program and outreach activities, will be tracked as a component of the grant application or contract. The Steering Committee will provide oversight and direction as needed during implementation.

9.5 Water Quality Monitoring

Virginia's 1997 Water Quality Monitoring, Information and Restoration Act (WQMIRA) requires that TMDL IPs include measurable goals and milestones for attaining water quality standards. Implicit in those milestones is the requirement of a method to measure progress. Post-Implementation Plan monitoring will help evaluate the effectiveness of implemented BMPs and

progress toward the water quality milestones listed in this plan. Commonly, there is a lag between the completion of the Implementation Plan and any measurable changes in water quality. This can be due to the time needed for watershed stakeholders to organize, secure funding, and establish BMPs. VADEQ implementation monitoring should begin no sooner than two years following the initiation of documented TMDL implementation. Beginning implementation monitoring after two or more years of implementation will help ensure that sufficient time has passed for remedial measures to have stabilized and BMPs to have become functional.

Since the main goal of implementation monitoring is to de-list the stream segments for all impairments; VADEQ will focus its monitoring resources on the original listing stations (Table 9-4). De-listing occurs when the original listing stations meet water quality criteria for the listed impairment(s). Thus, when significant implementation progress towards reducing bacteria and sediment loads in Crab Creek has been made, VADEQ will begin monitoring the initial listing stations for bacteria bimonthly for a period of four years. For the benthic impairment, VADEQ biologists will monitor the original listing stations in the spring and fall for approximately two years. If VADEQ is unable to de-list Crab Creek for bacteria and/or sediment in these timeframes, additional monitoring may be scheduled.

Table 9-4. VADEQ monitoring stations in the Crab Creek watershed

VADEQ Station ID	Station Type	Location
9-CBC001.00	Ambient, Biological	Route 663 Bridge, near Walton, Montgomery County
9-CBC004.38	Ambient, Biological	Route 660 bridge below Christiansburg STP
9-CBC006.35	Ambient, Biological	Old Route 661 Ford – Montgomery County
9-CBC008.78	Ambient, Biological	Route 460 bridge below Christiansburg
9-CBC009.81	Ambient	Route 111 in Downtown Christiansburg

Additional monitoring beyond what VADEQ can provide with its limited resources may be conducted in Crab Creek. Groups from organizations such as New River Valley Save Our Streams, Radford University, and Christiansburg High School have already begun citizen monitoring efforts in the Crab Creek watershed. These efforts are encouraged and stakeholders (also including the New River Conservancy) should work together to distribute monitoring resources throughout the watershed to best capture implementation needs and progress. The Town of Christiansburg has expressed interest in supporting additional citizen monitoring efforts to both capture data about their efforts to improve water quality and to provide the data necessary to prove water quality progress in Crab Creek.

9.6 Evaluation of Progress

During each periodic evaluation of implementation progress in the Crab Creek watershed, a reassessment of implementation priorities will be made by the Steering Committee to readjust and fine-tune the targeting approach in concert with the staged implementation approach. Periodic re-evaluation is especially critical during these times of economic uncertainty, where increasing energy prices and fluctuating market prices are bound to affect stakeholders in the agricultural sector and their willingness to commit resources for conservation, especially if they are struggling to maintain their viability as a farming enterprise.

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

9.7 Targeting

Staged implementation implies the process of targeting BMPs to get the "most bang for the buck" in the watershed. Implementation priorities for Stages 1 and 2 are listed in Table 9-5. Targeting different BMPs across the stages optimizes the use of limited resources by focusing on the most cost-efficient practices and those that present the least obstacles (acceptance by landowners, available cost-share, etc.). For example, stream exclusion practices (SL-6T, LE-1T, LE-2T, and WP-2T) are considered 100% effective at removing bacteria entering the stream through direct deposition by livestock. Moreover, the SL-6T practice is currently available at 100% cost-share for eligible landowners who enroll by July 2015. Thus, the stream exclusion systems needed to protect perennial streams have been prioritized in Stage 1. Similarly, practices that reduce bacteria from residential septic systems and straight pipes are also considered 100% efficient. The cost of these practices can often be offset by the procurement of grant funding, making them even more popular with local residents who directly benefit from maintaining or fixing their systems.

Table 9-5. Implementation priorities for meeting water quality goals in the Crab Creek watershed

Stage 1 Priorities	Stage 2 Priorities
• Straight pipes • Failing septic systems • Pet waste • Urban stormwater • Livestock exclusion systems on perennial streams • Grazing land management systems • Cropland practices including continuous no-till, and small grain cover crops • Streambank stabilization • Outreach and education • Agricultural and residential technical assistance	• Urban stormwater • Livestock exclusion systems on intermittent streams • Reforestation of erodible pasture • Permanent vegetative cover on critical areas • Heavy use area protection • Agricultural Technical Assistance

Additional targeting for education and outreach efforts could be refined through GIS analysis as proposed by the New River Land Trust (NRLT). Using ESRI's ArcGIS ModelBuilder, NRLT

could identify key properties within the watershed based on characteristics such as location, presence of active agricultural production, size, erodibility of soils, slope, etc. Their model is based on a similar study done in South Carolina's Catawba River Basin which used GIS analysis to target education and outreach efforts to specific types of properties. NRLT estimates the cost of such an effort, including staff time and actual outreach materials, to be around $9,300. This cost estimate is not included in the overall IP cost.

10. STAKEHOLDER ROLES AND RESPONSIBILITIES

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

10.1 Federal Government

Farm Service Agency (FSA)

The U.S. Department of Agriculture, Farm Service Agency is primarily tasked with the implementation of farm conservation and regulation laws around the country. They oversee a number of voluntary conservation-related programs that work to address a large number of farming and ranching related conservation issues, including drinking water protection, reducing soil erosion, wildlife habitat preservation, and the preservation and restoration of forests and wetlands. These programs include the Conservation Reserve Program (CRP) and the Conservation Reserve Enhancement Program (CREP).

Natural Resource Conservation Service (NRCS)

The U.S. Department of Agriculture, Natural Resources Conservation Service is the federal agency that works hand-in-hand with US citizens to conserve natural resources on private lands. NRCS assists private landowners with conserving their soil, water, and other natural resources. Local, state and federal agencies and policymakers also rely on the expertise of NRCS staff. NRCS is also a major funding stakeholder for impaired water bodies through CREP and the Environmental Quality Incentive Program (EQIP). For more information on NRCS, visit http://www.nrcs.usda.gov/.

United States Environmental Protection Agency (USEPA)

The United States Environmental Protection Agency (USEPA) 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.

10.2 State Government

In the Commonwealth of Virginia, water quality problems are dealt with through legislation, incentive programs, education, and legal actions.

Virginia Department of Environmental Quality

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

VADEQ is the lead agency in the TMDL process. The Code of Virginia directs VADEQ to maintain a list of impaired waters and develop TMDLs for these waters. VADEQ administers the TMDL process, including the public participation component, and formally submits the TMDLs to USEPA and the State Water Control Board for approval. VADEQ is also responsible for implementing point source WLAs, assessing water quality across the state, and conducting water quality standard related actions. The Code also requires the development of IPs for the TMDLs.

Virginia Department of Agriculture and Consumer Services

Through Virginia's Agricultural Stewardship Act, the VDACS Commissioner of Agriculture has the authority to investigate claims that an agricultural producer is causing a water quality problem on a case-by-case basis. 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 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. The enforcement of the Agricultural Stewardship Act is entirely complaint-driven. This Act is considered as a state regulatory tool that can support implementing conservation practices to address pollutant sources in TMDL impaired watersheds.

Virginia Department of Conservation and Recreation

The Department of Conservation and Recreation (DCR) will work closely with project partners including the Skyline Soil and Water Conservation District to track implementation progress and provide cost share for agricultural best management practices through the Virginia Agricultural Cost Share Program. In addition, DCR will provide support to improve the implementation process through utilization of existing authorities and resources.

Virginia Department of Forestry (VADOF)

The VADOF has prepared a manual to inform and educate forest landowners and the professional forest community on proper BMPs and technical specifications for installation of these practices in forested areas (http://www.dof.virginia.gov/wq/index-BMP-Guide). Forestry BMPs are directed primarily to control erosion. For example, streamside forest buffers provide nutrient uptake and soil stabilization, which can benefit water quality by reducing the amount of nutrients and sediments that enter local streams. VADOF's BMP program is voluntary.

Virginia Department of Game and Inland Fisheries (VDGIF)

The VDGIF manages Virginia's wildlife and inland fish to maintain optimum populations of all species to serve the needs of the Commonwealth; provides opportunity for all to enjoy wildlife, inland fish, boating, and related outdoor recreation; and promotes safety for persons and property in connection with boating, hunting and fishing. The VDGIF has responsibility for administering certain U.S. Fish and Wildlife Service funding programs. Personnel participate, review, and comment on projects processed through state and federal project and permitting review processes to insure the consideration for fish and wildlife populations and associated habitats.

Virginia Department of Health (VDH)

VDH is responsible for maintaining safe drinking water measured by standards set by EPA. Their duties also include septic system regulation and, in the past, regulation of biosolids land application. Like VDACS, VDH's program is complaint-driven. Complaints can range from a vent pipe odor that is not an actual sewage violation and takes very little time to investigate, to a

large discharge violation that may take many weeks or longer to effect compliance. In the scheme of this TMDL IP, VDH has the responsibility of enforcing actions to correct or eliminate failed septic systems and straight pipes, respectively. VDH staff also issue permits for the repair and installation of septic systems and the installation of alternative waste treatment systems.

Virginia Department of Transportation (VDOT)
The Virginia Department of Transportation's (VDOT's) Municipal Storm Sewer System Program (MS4) follows the six minimum control measures required by the Virginia MS-4 General Permit. The VDOT MS4 program strives to improve environmental compliance, quality and stewardship on VDOT land-disturbing activities through effective management, implementation, and enforcement of sound technical guidelines, criteria, and practices for stormwater management and erosion and sediment control.

Virginia Cooperative Extension (VCE)
Another state entity with responsibilities for activities that impact water quality in the watersheds is the Virginia Cooperative Extension (VCE). VCE is an educational outreach program of Virginia's land grant universities (Virginia Tech and Virginia State University), and a part of the national Cooperative State Research, Education, and Extension Service, an agency of the United States Department of Agriculture. VCE is a product of cooperation among local, state, and federal governments in partnership with citizens. VCE offers educational programs and technical resources for topics such as crops, grains, livestock, poultry, dairy, natural resources, and environmental management. VCE has published several publications that deal specifically with TMDLs. For more information on these publications and to find the location of county extension offices, visit http://www.ext.vt.edu/.

10.3 Regional and Local Government

Montgomery County
While not currently an MS4, it is anticipated that Montgomery County will become a Phase II MS4 in the near future. At that time, any part of the MS4 discharging to the Crab Creek watershed will be subject to the bacteria and sediment TMDLs. The County will need to develop an action plan that when implemented, will guide County stormwater programs.

New River Valley Planning District Commission
The New River Valley Planning District serves the local governments in the counties of Floyd, Giles, Montgomery, and Pulaski, and the City of Radford and their citizenry by providing a number of different services ranging from economic development to regional recycling. The purpose of the planning district commission is to promote regional cooperation, to coordinate the activities and policies of member local governments, and to provide planning assistance to local governments. The commission is financed by a combination of local, state, and federal funds. The commission provides natural resource planning assistance to local governments in the region. With funding from the Virginia Department of Forestry, the PDC began Green Infrastructure Planning in 2006, a natural resource planning method to map and prioritize water, forests, farmland, wildlife habitats, views, and recreation opportunities. The commission could serve as a grant project partner and/or manager during implementation.

Skyline Soil and Water Conservation District (SWCD)
During project implementation, the SWCD should continue and if possible expand outreach efforts in Crab Creek to both agricultural producers and community members. These organizations will be the primary technical and financial resource for implementing the agricultural practices in this plan. Their responsibilities include promoting BMP funding and benefits and assisting with BMP development on individual properties. Outreach activities should specifically encourage participation of Crab Creek farmers in the BMPs outlined in this plan to reduce bacteria and sediment loads. Outreach activities may include mailing newsletters, planning field days, and giving presentations. The Skyline SWCD has three staff members working throughout Floyd, Montgomery, and Pulaski counties. It is recommended that a technician be hired and devoted at least part-time to water quality efforts in the Crab Creek watershed.

Town of Christiansburg
The Town of Christiansburg has taken great strides to improve the quality of water entering Crab Creek from land within the Town. As an MS4 permittee, they have created a comprehensive stormwater management program to meet each of the six minimum control measures. In addition to current education and outreach efforts, they are also planning to develop and execute a Public Education and Outreach Plan (PEOP) that should address some of the outreach needs outlined within this plan regarding urban and residential practices. The Town's street sweeping program collected approximately 448 tons of debris in 2012. The recent purchase of a new street sweeper will most likely improve the program's efficiency as will any increases in sweeping frequency. Their Storm Sewer Cleaning Program will also support water quality improvement efforts by ensuring proper operation and maintenance of stormwater infrastructure. As the Town continues to create and expand their stormwater management program, they may want to consider options for procuring additional resources (EFC University of Maryland 2014). Mechanisms for financing stormwater services include general fund allocations, fees for permit review and inspections, property taxes and special assessments, grants, loans, and utility fees. Whatever mechanism or mechanisms are pursued will depend upon future resource needs as well as stakeholder support.

In addition to its ongoing collection system maintenance program (outlined in Section 6.3), the Town has future plans to develop a system-wide sewer model of its major pipe network to include known SSO locations. Once developed and calibrated, the Town will utilize the model as a tool to aid in developing a long-term sanitary sewer capital improvements plan (CIP). The CIP will prioritize work that will further reduce the frequency of SSOs within the Crab Creek watershed.

10.4 Businesses, Community Groups, and Citizens
While successful implementation depends on stakeholders taking responsibility for their role in the process, the primary role falls on the local groups that are most affected; that is, businesses, community watershed groups, and citizens. Virginia's approach to correcting non-point source pollution problems continues to be encouragement of participation through education and financial incentives; that is, outside of the regulatory framework. If, however, voluntary approaches prove to be ineffective, it is likely that implementation will become less voluntary and more regulatory.

Meadows Swim & Golf Club
As a neighbor of Crab Creek, the Meadows Swim & Golf Club, which encompasses a stretch of Crab Creek, could be a candidate for streambank stabilization efforts and a nutrient management plan. The Virginia Golf Course Superintendents Association (VGCSA) published an Environmental Best Management Practices for Virginia's Golf Courses manual that details how courses can implement BMPs specific to Virginia's environment while still preserving the quality experience for golfers. Potential incentives for golf courses implementing these practices include reduced environmental impact, improved turf quality, improved golf outing experiences, improved worker safety, efficient allocation of resources, and reduced maintenance expenditures. (VGCSA 2012).

New River Conservancy (formerly the National Committee for the New River)
The New River Conservancy works with landowners and citizens to conserve critical lands, restore riparian areas, and advocate for the protection of the New River throughout its multi-state watershed.

Save Our Streams
Virginia Save Our Streams (SOS) organizes citizens to monitor water quality of streams throughout the Commonwealth and also educates the public about importance of clean water. Currently, SOS has two monitoring sites within the Crab Creek watershed. Find more information about SOS at www.vasos.org.

Landowners
In addition to local farms, participation from homeowners and developers is also critical to the success of this plan. The plan calls for the extensive reduction of bacteria and sediment through the use of residential and urban BMPs. In order to meet the required reductions, private individuals will need to make significant changes in their behaviors including disposal of pet waste and proper septic system maintenance.

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

- Montgomery County schools
- Montgomery County Master Gardeners
- Montgomery County Master Naturalists
- New River Land Trust
- Radford University
- Trout Unlimited
- Virginia Farm Bureau
- Virginia Outdoors Foundation

11. INTEGRATION WITH OTHER WATERSHED PLANS

Like most watersheds in Virginia, water quality in the Crab Creek watershed is a component of many different organizations, programs and activities. Such efforts include, but are not limited to, watershed implementation plans, TMDLs, Roundtables, Water Quality Management Plans, Erosion and Sediment Control Regulations, Stormwater Management Programs, Source Water Assessment Programs, local comprehensive and strategic plans, and local environmentally-focused organizations. These efforts should be evaluated to determine their potential impacts on the implementation goals outlined in this clean-up plan. Often, these efforts are related or collaborative, but this is not always the case. Coordination of local programs can increase participation and prevent redundancy. Initiatives coinciding with TMDL Implementation efforts in this watershed include the:

New River Livability Initiative Study

The New River Livability Initiative was a three year regional planning process which provided an opportunity for the New River Valley's residents to develop a vision for the future and develop strategies that businesses, community organizations, local governments, and individuals can use to make this future vision a reality. The study considered all major factors influencing quality of life in the larger New River Valley including housing, transportation, energy, economic development, community health, arts and cultural heritage, and natural resources. One of the plan's listed goals is to improve and protect water resources. Strategies to meet this goal include: increase public understanding of activities that impact water quality by coordinating services and outreach efforts, develop comprehensive watershed management and regional stream restoration plans that pave the way for funding requests, expand outreach efforts with farmers and landowners to increase adoption of agricultural and forestry BMPs, incorporate stormwater BMPs into land use policies and development requirements, and where there are community health concerns, expand water quality monitoring of point-source polluters where there are specific community health concerns. Find the full draft report at http://nrvlivability.org/news/draft-plan-ready-review.

Town of Christiansburg Comprehensive Plan and Vision 2020

Approximately 63% of the Town of Christiansburg is drained by Crab Creek. The Town of Christiansburg's primary environment goal is to preserve and enhance the natural resources of the Town through education, regulation, and service provision. In addition to their TMDL requirements as an MS4 permittee, the Town's strategies for improving water quality that align with this plan include:

- closely regulate drainage and erosion on sites with steep slopes during and after the construction process,
- encourage environmental education courses in rain barrel building, rain garden planting, stormwater runoff reduction, and composting methods,
- expand the use of green infrastructure BMPs in the land development process.
- encourage the use of rain gardens, permeable pavement, green roofs, and urban tree canopy to reduce stormwater runoff,
- encourage on-site water infiltration systems using natural vegetation and natural filtration systems for new developments,
- encourage natural plantings on critical slopes to reduce erosion and runoff,

- encourage stream restoration projects,
- consider establishing stricter standards for buffers between water bodies and impervious surfaces and structures,
- create comprehensive watershed-based stormwater models to assess infrastructure needs and utilize the watershed models to identify system weaknesses and analyze proposed modifications to and improvements of system infrastructure,
- develop a stormwater taskforce with staff and citizens to address stormwater issues.
- create a permanent funding mechanism for stormwater management,
- consider adoption of more stringent stormwater regulations and the creation of a stormwater utility,
- continue to actively oversee and inspect construction of new stormwater management infrastructure,
- reduce stormwater runoff and prevent flooding at existing sites by requiring upgrades with redevelopment or rezoning,
- encourage improvements to stormwater facilities for existing neighborhoods through BMPs such as bioretention, rain gardens, and rain barrels,
- continue to enforce Town Code regarding illicit discharges in the stormwater system in an effort to keep storm drains free of debris and operating at maximum capacity.
- identify new strategies and resources to maintain maximum stormwater system capacity and operations,
- encourage the retention of existing trees and wooded lots and the planting of additional trees during development,
- implement riparian buffers to assist in water infiltration, soil stabilization, and bank restoration along rivers and creeks, and
- cooperate with state and federal agencies in the preservation of wetland areas.

12. POTENTIAL FUNDING SOURCES

This list of potential funding resources is a compilation of sources from other Virginia Implementation Plans as well as ideas from local stakeholders. Detailed descriptions of the agricultural cost-share programs can be obtained from the Skyline SWCD, VA Department of Conservation and Recreation, Natural Resources Conservation Service and the Virginia Cooperative Extension.

12.1 Federal

Federal Clean Water Act Section 319 Incremental Funds

Through Section 319 of the Federal Clean Water Act, Virginia is awarded grant funds to implement the nonpoint source programs. VADEQ reports annually to the EPA on the progress made in nonpoint source pollution prevention and control. Stakeholder organizations can apply on a competitive basis, for 319 grants to implement BMPs and educational components included in a TMDL IP.

USDA – FSA

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.

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. 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. Landowners can obtain and complete CREP application forms at their local FSA center.

USDA - NRCS

Conservation Stewardship Program

The Conservation Stewardship Program (CSP) is a voluntary program that encourages agricultural and forestry producers to address resource concerns by (1) undertaking additional conservation activities and (2) improving and maintaining existing conservation systems. CSP provides financial and technical assistance to help land stewards conserve and enhance soil, water, air, and related natural resources on their land. CSP is available to all producers, regardless of operation size or crops produced. Eligible lands include cropland, grassland, prairie land, improved pastureland, rangeland, nonindustrial private forest land, and agricultural land. NRCS makes CSP available on a nationwide basis through continuous sign-up, with announced cut-off dates for ranking and funding applications. CSP pays participants for conservation performance—the higher the performance, the higher the payment. It provides two possible types of payments. An annual payment is available for installing new conservation activities and maintaining existing practices. A supplemental payment is available to participants who also adopt a resource conserving crop rotation.

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.

Agricultural Lands Easement Program

The 2014 Farm Bill authorized $1 billion in funding for the new Agricultural Lands Easement program, which consolidates the former Farm and Ranch Lands Protection Program (FRPP), Grassland Reserve Program (GRP) and Wetlands Reserve Program (WRP) into a single program. This program will provide grants to purchase conservation easements that permanently restrict development on important farmland and reward landowners who participate in the program with permanent tax breaks.

Unites States Fish and Wildlife Service

The US Fish and Wildlife Service (USFWS) administers a variety of natural resource assistance grants to governmental, public and private organizations, groups and individuals. Natural resource assistance grants are available to state agencies, local governments, conservation organizations, and private individuals.

12.2 State

Virginia Agricultural Best Management Practices (BMPs) Cost-Share Program

The cost-share program is funded with state and federal monies through local Soil and Water Conservation Districts (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.

Virginia Agricultural Best Management Practices Loan Program

The purpose of the Virginia Land Conservation Loan Program is to provide a long term source of low interest financing for the conservation of land in Virginia in order to improve and/or protect the water resources of the Commonwealth. Additional benefits of the program include the protection of open space or natural values of the properties and/or the assurance of the availability of the land for agricultural, forestal, recreation, or open space use. Although these other benefits are of value, the principle focus and utilization of the Fund is on beneficial impact to water quality.

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.

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.

Virginia Clean Water Revolving Loan 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.

Virginia Department of Environmental Quality Citizen Water Monitoring Grant Program

The primary purpose of the Virginia Department of Environmental Quality Citizen Water Monitoring Grant Program is to provide funding for water quality monitoring groups and individuals to monitor the quality of Virginia's waters. The grant can be used in a variety of ways, including purchasing water quality monitoring equipment, training citizen volunteers, lab analysis costs, and promoting stream monitoring efforts in locations where DEQ is not currently collecting water quality samples. To be eligible for funding under the regular Citizen Monitoring Grant, a grantee must follow certain guidelines, including developing a quality assurance project plan (QAPP).

Virginia Forest Stewardship Program

The purpose of the Forest Stewardship Program is to encourage the long-term stewardship of nonindustrial private forest lands, by assisting the owners of such lands to more actively manage their forest and related resources. The Forest Stewardship Program provides assistance to owners of forest land and other lands where good stewardship, including agroforestry applications, will enhance and sustain the long term productivity of multiple forest resources. Special attention is given to landowners in important forest resource areas and those new to, or in the early stages of managing their land in a way that embodies multi-resource stewardship principles. The program provides landowners with the professional planning and technical assistance they need to keep their land in a productive and healthy condition. The planning assistance offered through the Forest Stewardship Program may also provide landowners with enhanced access to other USDA conservation programs and/or forest certification programs.

Private nonindustrial forest lands that are managed under existing Federal, State, or private sector financial and technical assistance programs are eligible for assistance under the Forest Stewardship Program. Forest resource management activities on such forest lands must meet, or be expanded or enhanced to meet the requirements of the Forest Stewardship Program. Participation in the Forest Stewardship Program is voluntary. To enter the program, landowners agree to manage their property according to an approved Forest Stewardship Management Plan. Landowners also understand that they may be asked to participate in future management outcome monitoring activities.

Virginia Outdoors Foundation

Conservation easements are voluntary agreements that allow individuals or groups to limit the type or amount of development on their property. Easements typically describe the resource they are designed to protect (e.g., agricultural, forest, historic, or open space). Conservation easements may indirectly contribute to water quality protection due to the restrictions on future development. The Virginia Outdoors Foundation is the state's largest holder of conservation easements. While their easements do not require riparian buffers, they do strongly encourage them along all streams, rivers, or other significant water resources on a conserved property. A gift of a permanent open-space easement may qualify as a charitable gift and be eligible for

certain state and federal tax benefits. In addition, there may be local property tax reductions and federal estate tax exemptions.VOF also administers the *Open Space Lands Preservation Trust Fund*, which assists landowners with the costs of conveying open-space easements and purchases all or part of the value of easements. Priority for funding is given to applications on family farms and for those with demonstrated financial need.

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.

Virginia Stormwater Assistance Fund (SLAF)
SLAF funds stormwater projects including: 1) new stormwater best management practices, 2) stormwater best management practices retrofits, 3) stream restoration, 4) low impact development projects, 5) buffer restorations, 6) pond retrofits, and 7) wetlands restoration. Eligible recipients are local governments, meaning any county, city, town, municipal corporation, authority, district, commission, or political subdivision created by the General assembly or pursuant to the Constitution or laws of the Commonwealth. The fund is administered by VADEQ.

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

12.3 Regional and Private Sources

Community Development Block Grants (CDBG)
The Community Development Block Grant (CDBG) program is a flexible program that provides communities with resources to address a wide range of unique community development needs. Over a 1, 2, or 3-year period, as selected by the grantee, not less than 70 percent of CDBG funds must be used for activities that benefit low- and moderate-income persons. In addition, each activity must meet one of the following national objectives for the program: benefit low- and moderate-income persons, prevention or elimination of slums or blight, or address community development needs having a particular urgency because existing conditions pose a serious and immediate threat to the health or welfare of the community for which other funding is not available.

Community Foundation of the New River Valley
The Community Foundation of the New River Valley awards grants twice a year. A typical grant amount is $500 to $2,000. Their fields of interest include the conservation and preservation of natural, historical and cultural resources. Additionally, their Community Impact Grant Program funds efforts that help to either launch a new program or substantially expand successful existing programs that strengthen community by addressing current or future needs and are sustainable and feature collaboration with other community organizations.

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

Five Star and Urban Waters Restoration Grant Program
The NFWF's Five Star and Urban Waters Restoration Program seeks to develop nation-wide-community stewardship of local natural resources, preserving these resources for future generations and enhancing habitat for local wildlife. Projects seek to address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development. The program requires the establishment and/or enhancement of diverse partnerships and an education/outreach component that will help shape and sustain behavior to achieve conservation goals. The Five Star program provides $20,000 to $50,000 grants with an average award size of $25,000. Grants that are in the $30,000-$50,000 range are typically two years and are in urban areas.

Funding priorities for this program include:

- On-the-ground wetland, riparian, in-stream and/or coastal habitat restoration
- Meaningful education and training activities, either through community outreach, participation and/or integration with K-12 environmental curriculum
- Measurable ecological, educational and community benefits
- Partnerships: Five Star projects should engage a diverse group of community partners to achieve ecological and educational outcomes

Norcross Wildlife Foundation
The Norcross Wildlife Sanctuary in Monson, Massachusetts was founded in 1939 by Arthur Norcross and the Norcross Wildlife Foundation was founded in 1964 after his passing. The Foundation provides grants to environmental conservation NGOs primarily for the purchase of office and field equipment as well as publications and other educational materials that have a practical, immediate use. Grant requests may be up to $10,000, but awards generally average less

than $5,000. Examples of funded projects include computers, cameras, GPS units, GIS software, data loggers, and water quality testing materials.

Southeast Rural Community Assistance Project (SERCAP)
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.

Virginia Environmental Endowment
The Virginia Environmental Endowment is a nonprofit, independent grant-making foundation whose mission is to improve the quality of the environment by using its capital to encourage all sectors to work together to prevent pollution, conserve natural resources, and promote environmental literacy. Current grant-making priorities in Virginia include improving local rivers and protecting water quality throughout Virginia, Chesapeake Bay restoration, enhancing land conservation and sustainable land use, advancing environmental literacy and public awareness, and supporting emerging issues in environmental protection. Applications are accepted biannually with deadlines of June 15th and December 1st.

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 VADEQ and Army Corps of Engineers.

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Appendix A. Best Management Practice Efficiency Information

Management Practice	Extent Units	% Effectiveness		Effectiveness Source		Cost/ Unit
		Bacteria	Sediment	Bacteria	Sediment	
Agricultural						
Stream exclusion with grazing land management	system	100	NA	1	NA	$32,000
Livestock exclusion with reduced setback	system	100	NA	1	NA	$20,000
Stream protection	system	100	NA	1	NA	$10,000
Animal waste control facility - beef	system	40	40	2	5	$150,000
Animal waste control facility - dairy	system	40	40	2	5	$150,000
Continuous no-till system	acres	70	70	2	5	$20
Cover crops	acres	20	20	2	5	$45
Grazing land management	acres	50	30	3	5	$75
Heavy use area protection	system	40	40	2	5	$20,000
Loafing lot management system	system	40	40	2	5	$20,000
Permanent vegetative cover on critical areas	acres	75	75	4	4	$2,000
Reforestation of erodible crop and pastureland	acres	land use conversion		4	4	$1,000
Sediment retention, erosion or water control structures	acres treated	50	50	2	5	$138
Residential						
Septic system pump outs	#	5	NA	3	NA	$300
New sewer hookups	#	100	NA	1	NA	$5,000
Septic system repairs	#	100	NA	1	NA	$3,500
New septic systems	#	100	NA	1	NA	$7,500
Alternative septic systems	#	100	NA	1	NA	$15,000
Pet waste stations	#	100	NA	9	NA	$1,300
Pet waste composters	#	100	NA	1	NA	$75
Pet waste program	program	25	NA	6	NA	$4,000
Urban Stormwater						
Bioretention	acres treated	90	90	2	5	$20,000
Bioswales						$15,000
Constructed wetlands/wet ponds		60	60	2	5	$8,000
Detention		10	10	2	5	$2,000
Detention and Manufactured BMPs		82	82	2	7	$16,000
Extended Detention		60	60	2	5	$2,000
Infiltration		95	95	2	5	$20,000
Manufactured BMPs		80	80	2	5	$15,000
Rain gardens		90	90	2	5	$5,000
Riparian Buffers (Forested)		50	50	2	5	$1,000
Riparian Buffers (Grass/Shrub)		50	50	2	3	$500
Vegetated Open Channels		70	70	2	5	$9,000
Street sweeping		9	9	2	5	
Streambank						
Streambank stabilization	linear foot	NA	310 lbs/ft/yr	NA	8	$300

1 - Removal efficiency is defined by the practice

2 - Bacteria efficiency assumed equal to sediment efficiency

3 - VADCR and VADEQ. 2003. Guidance Manual for Total Maximum Daily Load Implementation Plans

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 - 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. 112pp.

7- Overlapping BMPs

8 - Chesapeake Bay Program. 2013. Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects

9 – Removal efficiency is defined by the practice, estimates 10 pets/day

Appendix B. Public Meeting Minutes

Crab Creek water quality improvement plan: Minutes for 1st Residential and Agricultural Workgroup Meeting.
Montgomery County Government Center Nov. 12, 2013, 7:00-9:00pm
Note: following the minutes is a summary of the tour of the upper Crab Creek watershed that preceded the public meeting.

Attendees:
Julio Stephens, Radford University/Nat.
Comm. for the New River (NCNR)
Brent Noell, Farm Service Agency (FSA)
Hunter Musser, NRCS
Roy Nester, Town of Christiansburg (TOC)
David Sutphin, TOC
Jim Lancianese, TOC
John Burke, Gay and Neel, Inc.
Cynthia Hancock, Skyline SWCD
Asa Spiller, VT- Save our Streams Program
Ashley Parks, VDOT contract env. engineer
Courtney Wait, NCNR
Jane Argentina, citizen
Diana Hackenburg, DEQ
Patrick Lizon, DEQ
Karen Kline, VT
Brian Benham, VT
Stacy Horton, DCR
A public meeting presentation was given about the planning process for the TMDL Implementation Plan (IP).water quality improvement planning process for Crab Creek after which attendees split into an agricultural workgroup and a residential/urban workgroup. Group discussions were facilitated by DEQ staff with the aid of agricultural and residential handouts provided by DEQ.

Residential/Urban Source Sector Discussion Summary:
 Diana Hackenburg, Department of Environmental Quality, welcomed everyone, and attendees introduced themselves. Diana provided a Residential Work Group Handout, delivered a brief overview of the meeting purpose, and described the role of the Residential Work Group.
 The Town of Christiansburg is aware of the sewer overflows and is working on the problem per Roy Nester, Project Manager in Christiansburg's Engineering Department. The Town is in the process of replacing older systems. The Town has information on all sewer lines either on paper or on GIS files.
 There are very few houses within the Town limits that are on septic systems in areas where sewer connections are available. According to Town ordinance, if a septic system is failing and a sewer connection is available, the homeowner has to connect to the sewer system.
 Julio Stephens, a member of the National Committee for the New River (NCNR) and a former employee at the Virginia Department of Health (VDH), mentioned that the cost estimates listed for septic system repair and replacement in Table 9 may be low. He recommended contacting local septic contractors to get more accurate numbers for this area. Mr. Stephens also recommended inviting local septic contractors and VDH to participate in

the Crab Creek water quality improvement efforts.
 Education and outreach will be an important component of the reducing bacteria from pet waste in the watershed. It was also suggested that the Huckleberry Trail would be a good place for educational materials. It was suggested that Town and Country Veterinary Clinic and Dr. Young's on N. Franklin Street could be contacted to find how they dispose of animal waste.
 Extensive runoff is occurring on the VDOT facility on Cambria Street. Ashley Parks, an environmental engineer at EEE Consulting, Inc. representing VDOT, said that a storm water evaluation was performed about six months ago. She'll talk with the manager at the facility about the problem. It was suggested that mud could be washing off of the machinery at the site.
 The Christiansburg Livestock Market could be a potential site for BMPs.
 Rainwater harvesting and rain gardens are suggested BMPs. Courtney Wait, NCNR, recommended rain gardens as a good educational tool. Montgomery County Public Schools should be contacted about developing rain gardens at some of the schools in Christiansburg.
 Ms. Hackenburg asked if the Save Our Streams (SOS) program is still active in the area. Asa Spiller noted that some monitoring in Crab Creek is planned soon.
 Mr. Spiller asked if the residents of the Crab Creek watershed are open to IP development. The reply was that based on the low attendance at Christiansburg public meetings, most residents are uninformed and uninterested in what is happening regarding water quality improvements. Jane Argentina, a resident, suggested finding some way to get the word out to people about the IP. Mr. Nester recommended informing Town residents through the Town's public relations office. Another suggestion was to use Christiansburg's Facebook page. Another idea was to contact Oak Tree Townhomes and other homeowners associations in the watershed.
 Ms. Hackenburg asked if anyone in the watershed was already providing watershed education. The Town does as a requirement for the MS4s, and the Skyline Soil and Water Conservation District (Cynthia Hancock) works with schools.
 The Diamond Hills Park Stream Restoration Project will begin this winter. This would be a good location for sign(s) with educational information.
 Funding is dependent on stakeholders getting involved. The stakeholders are the ones that will have to carry this IP forward. Mr. Nester noted that a jurisdiction with MS4s cannot apply for CWA Secion319 grants. However, individuals not associated with the MS4s can apply. There is no obvious opposition to the practices promoted by an IP; only thing to note is that Christiansburg is a business and industry friendly community.
 Ms. Wait offered that NCNR could look into working with Christiansburg High School to monitor *E. coli* at the stream restoration project. Mr. Spiller suggested that SOS volunteers may also be able to do some bug sampling with the students. Ms. Hackenburg noted that both of these ideas are valuable since a monitoring strategy is part of the IP.

<u>Agricultural Source Sector Discussion Summary:</u>
 Patrick Lizon, Department of Environmental Quality, welcomed everyone, and attendees introduced themselves. The discussion focused upon information and information needs identified within an Agricultural Work Group Handout provided by DEQ.
 The SWCD and NRCS noted that there are no longer any dairies in the watershed.
 The SWCD indicated that land use conversion may have occurred at a greater rate than projected in the TMDL. It was suggested that land use acreages be checked using GIS.
 Montgomery County has agricultural land zoning with certain protections against subdivision of zoned ag. lands. Agricultural lands must be registered with the county in order to receive zoning protections.
 The Skyline SWCD District is successful at spending funding and very busy since they cover

four counties.
 Allowing landowners to opt for livestock exclusion with reduced buffers (10 feet) would increase participation in the livestock exclusion cost-share practices through VA Agricultural cost-share program.
 For SL-6 practices, 100% cost-share is supposed to continue through program year PY2015. Sign-ups before the end of PY2015 will be funded eventually even if it takes several years before they receive a high enough ranking to fund through the SWCD.
 A need for greater consistency in the agricultural cost-share program was expressed. A lack of consistency in the program reduces interest by farmers. For example, the transition from 75% state cost-share to 100% on SL-6 and SL-6T practices and associated restrictions created frustration in the agricultural community.
 In terms of generating participation in the cost-share program, cold calls to farmers have a low rate of success, may be necessary to achieve a sufficient level of participation in the Crab creek watershed.
 There are probably many hobby farm properties in the watershed that contribute to bacteria loads. However, these properties tend to fall through the cracks. For example, VACS & NRCS practices require that stream water be replaced with an alternative water source. On some hobby farms there are no streams, so they are not eligible for cost-share practices, even if they are close enough to a stream that run-off from the property goes into a ditch which goes into a stream.
 Besides livestock exclusion systems, conversion of erodible pasture to forest, critical area treatment, cover crops are two practices that may receive participation and therefore help meet water quality goals in the watershed.
 In regards to the 3 biosolids land application sites in the watershed, the land application permit requires a nutrient management plan which includes practices that are supposed to prevent biosolids from reaching streams via run-off.
 It was pointed out that stream bank erosion is estimated to be the primary source of the excess sediment load to Crab Creek. The NRCS engineering job approval coverage for SWCD projects was recently revoked. This affects stream bank stabilization projects that require significant engineering work. There has been a move to get have engineering job approval for SWCDs covered under an engineer from VT, but until the new system is up and running stabilization efforts may be substantially hindered. However, stabilization projects that are more simple such as planting willows requires less approval to be authorized and therefore will be relatively unaffected by the engineering job approval change.
 The SWCD will try to find some farmers in the watershed who may be willing to attend the next agricultural workgroup.
 The SWCD will come up with cost estimates for the agricultural cost-share practices in the ag. handout and provide the information by the government workgroup mtg. or the next ag workgroup mtg.

Upper Crab Creek Watershed Tour Notes- 11/12/2013
Attendees: Roy Nester; Courtney Wait; Karen Kline; Diana Hackenburg; Patrick Lizon
 There is a Contech filtration unit @ O'Reilly's; the manufacturer estimates a 65% P removal for the system.
 New construction or re-development is required to use the DCR/DEQ storm water manual for BMP's
 The Town of Christiansburg uses the manufacturer estimates for pollutant removal and approves BMPs based on their phosphorous removal efficiency.
 An eroding hillslope was noted between O'Reilly's and a newer housing development atop the hill. E&S permits are required for construction sites greater than 10,000 ft². If erosion begins after the successful permit closure, the town does not have authority under E & S

regulations to require additional erosion control.
 Some VDOT interstate storm water runoff goes into the Crab Creek watershed; Roy doesn't know where their stormwater controls are located
 Near Interstate Exit 117 and adjacent to an industrial complex (where backcountry.com warehouse is located) there are large stormwater wetlands that were created for water quantity control but have been subsequently retrofitted for water quality control
 There's a large farm pond on the south side of the interstate near exit 117 but not much is known about its influence on downstream water quality.
 The vast majority of houses in the Crab creek watershed in Christiansburg are on sewer; if sewer is available home owners have to connect once system fails; it's roughly $2,000 - $3,000 to connect to sewer. Roy will check on getting GIS sewer layer.
 Industrial Park where New River Center for Energy… is located. This was just outside of the Crab Creek watershed. A 2 pond stormwater control system that is town owned; addresses quality and quantity; this system exceeds design specifications for the large industrial park it services.
 The railroad yard in town near the Cambria train station is a potentially large source of sediment; The Town does not have jurisdiction over runoff from railroads. Nobody knew if the railyard is covered under a stormwater permit, but this should be looked into.
 The Waffle House on Franklin built roughly in 2007 has a water quality treatment system that filters the first flush; run-off exceeding the design inflow bypasses the filtration system.
 Christiansburg does 20-30 annual inspections but wants owners to start participating more in inspections of their own systems.
 The Town is building deep pond in the commercial area by the Waffle house because they are removing a berm lower down the drainage in the Oak Tree subdivision to accommodate a stream restoration project on an (unnamed ?)Crab creek tributary. The stream restoration site (a mitigation project) is on town-owned property in the Oak Hill subdivision. Water and sewer lines are located along the stream, which constrains what can be done with the site. There was a school of small fish in the pool just upstream of the road crossing in the subdivision. Upstream of the road crossing, the Town has a stormwater maintenance easement along the stream, but the owner basically own up to the stream.
 On the edge of the Town limits Crab Creek was visible in a pasture, there was a lot of bank erosion occurring, upstream a little farther there is an old mill dam with a waterfall and a pasture immediately upstream with substantial streambank erosion. In the golf course there was also a lot of bank erosion evident from the road.
 The town owns the property where the original town water works is located along the creek and leases the land for grazing; again bank erosion was evident.
 There is a large auto salvage yard near silver lake road; it was pointed out that it may have a VPDES permit that may not have been in TMDL study.
 Town branch of Crab creek flows under the downtown Christiansburg area; it flows through a viaduct that is roughly 4 foot tall by 10 foot wide;
 There is currently no incentive for commercial businesses to "un-develop" excess impervious areas to better mitigate stormwater, i.e. removing excess parking area and planting vegetation.
 The Town has considered establishing storm water utility, but there are currently no plans to do so.

Crab Creek IP GovernmentWorking Group
Friday, January 10, 2014 10am-12:30pm
Attendees:
Becky Barlow, Virginia Department of

Conservation and Recreation (DCR)
John Burke, Gay and Neel, Inc.
Gary Coggins, Virginia Department of Health (VDH)
Diana Hackenburg, Virginia Department of Environmental Quality (VADEQ)
Cynthia Hancock, Skyline Soil and Water Conservation District
Stacy Horton, DCR
Carolyn Howard, Draper Aden Associates for Montgomery County
Karen Kline, Virginia Tech Department of Biological Systems Engineering
Patrick Lizon, VADEQ
Hunter Musser, Natural Resource Conservation Service (NRCS)
Ashley Parks, EEE Consulting for VDOT
Christy Straight, New River Valley Planning District Commission (NRVPDC)
Todd Walters, Town of Christiansburg
Christopher Webster, Town of Christiansburg

A brief round of introductions was made. Diana and Patrick explained the purpose of the meeting and reviewed the TMDL process. The discussion centered on items listed in the agenda such: as regulatory and non-regulatory programs in place to assist with TMDL implementation in urban, residential, and agricultural areas.

<u>On-site Sewage Disposal</u>

- Gary (VDH) stated that state regulations can impact on-site sewage disposal systems, but in this watershed there are no local or regional ordinances specifically impacting them. VDH has limitations in taking care of failing systems because they must rely for the most part on self-reporting by residents with septic problems or complaints by neighbors. Straight pipes can be difficult to visually locate find.
- Gary noted that hooking up to sewer can be cost prohibitive for many people.
- Gary (VDH) noted there are no pump-out ordinances in any of the relevant localities. However, if you live in the Town of Christiansburg and a sewer hookup is available, once your system fails, you cannot repair or pump. You have to hook up to the sewer system. Outside of the Town, there is no requirement to hook up to sewer when your system fails. This watershed is not in mandatory pump out zone for the Chesapeake Bay.
- The Town's sewer lines do extend into Montgomery County. The Town website should show the Town sewer connections and also potentially those in Montgomery County. The information could also potentially be retrieved from the Town's planning department. Generally, the sewer line follows Crab Creek.
- John Burke (Gay and Neel) asked if as a result, some areas with TMDLs or IPs have created a mandatory pump out cycle. In other states like Montana, they have an ordinance that requires landowners to pump out every 5 years. Other places have a tracking system that sends out reminders to landowners reminding them to pump out their systems on a regular basis. Hanover County has a 5-year pump out ordinance and Franklin County/Smith Mountain Lake has a 5-year septic pump-out ordinance that resulted from the Blackwater IP process.
- Cost-share funding is available through DEQ to repair, replace, or install alternative septic systems or to connect residents to sewer lines. Money is not available from DEQ to lay new sewer lines. Only watersheds with an IP are eligible to apply for this funding. A lot of times this money can be funneled

through Soil and Water Conservation Districts and Skyline does have experience with this type of grant project (Mill and Dodd Creeks). The grants are now on a two-year cycle and they are statewide competitive. If during the IP, it is recommended that certain areas or residents hook up to sewer, than it might make for a more competitive grant for funding later.

 Gary (VDH) stated that when funding is available, residents are more likely to seek assistance with fixing failing septic systems. The SWCD can publicize these septic programs and sign people up. However, they involve other people like VDH to provide the technical assistance. Districts are a good choice to administer and publish the program because people of think of the district as more friendly than other agencies. A lot of people come to the SWCD that have heard about the program because they want to understand it better before they come forward to VDH. VDH can work with partners including the SWCD to get the word out. VDH also has prosecutorial discretion to work with people. If there system is not posing an immediate threat, VDH tries to give the landowners that come forward themselves latitude to take care of the problem within their means. If it is an immediate threat, VDH has to take care of it right away, but if they come forward voluntarily that's generally different.

 The estimated total number of septic systems, number of failing septic systems, and number straight pipes in the watershed that are presented in the workgroup handouts is based on the 2004 TMDL study. The TMDL study relied upon census data and used research on septic system failure rates to estimate the potential number of failing systems in the Crab Creek watershed. It would be helpful if the local VDH has information such as applications that could influence or better estimate those numbers. VDH is trying to create a database to capture who is still on septic systems, but they are still not at that point. VDH does not have an internal GIS program. Gary noted they may be able to narrow down sewer and septic numbers by locality.

 The numbers for failing systems and straight pipes could be higher than other areas. Straight pipes are more likely to occur on lots with older homes. Unlike the number of straight pipes, the number of failing septic systems will probably grow as existing septic systems age. Older properties have been carved up into really small lots where the soils with drainage problems are hit and miss. The percent estimate of repairs and replacements might be off. Gary (VDH) would estimate fewer repairs and replacements and a higher percentage of alternative systems.

 Thirty years from first flush to first repair is the typical lifespan of a sewer system based on different data sources, including on-the-job anecdotes. Many factors come into play influencing that figure and that it can be exceeded. Regular maintenance also plays a part in a system's longevity. In the TMDL, they applied the age of the house to figure out the failure rate which is probably the most accurate way to estimate these numbers.

<u>Urban Runoff Programs and Activities</u>

 The Town of Christiansburg has MS4 status and Montgomery County will apply for MS4 status this year. What sort of requirements does the Town have for addressing sediment loads into the creek as part of their MS4 permit? The Town is going to the new requirements for sediment for new construction. A few stream restoration projects are underway to help reduce sediment loads from the Town. Section 6 of the permit addresses erosion control and there's also a separate section addressing TMDLs . Each MS4 permittee comes up with a TMDL action plan. The permittee looks at their allocation and comes up with a program to meet that allocation. That plan is turned into DEQ. Sediment requirements are written into the general permit while sediment and bacteria directly related to the TMDL allocation are located within that part of the permit. Each permittee creates a TMDL action plan. Even if the MS4 loads are aggregated in the TMDL, each permittee creates their own plan. They look at the percentage reductions and work to reduce their loads by that percentage rather than trying to disaggregate the different loads for a specific amount reduction. Attendees thought the railroads must also meet these requirements.

 MS4 permits require that permittees identify their intended pollution control activities, a schedule for implementation, and a mechanism for tracking implementation progress. Anyone can access the MS4

permittee's annual report for information on their related activities. This year, the permittees are required to post their annual report online.
 The Roanoke River IP is 3-4 months ahead of the Crab Creek IP. That project has documentation quantifying BMP reduction percentages for urban stormwater projects. The Center for Watershed Protection has also worked with West Virginia to also quantify BMP *E. coli* reduction efficiencies for urban stormwater practices.
 The MS4 permits only cover bacteria if the permittee has a TMDL waste load allocation. The waste load allocation becomes part of the MS4 permit. The permit is a tool for DEQ to make sure the localities work towards meeting the allocation. The MS4 permit recommends pet waste as a component of the permit.
 Do permittees pass down the requirements of the MS4 permits via fees or required practices to residents and/or businesses? Right now, the Town does not pass down these requirements except for the practices required for new construction. There are ways to charge the citizens such as stormwater fees like those being considered by other localities. There is the potential for Town ordinances that could impact water quality such as incentives to enhance riparian protection and restoration.
 There is an education component to the MS4 permits. Permittees have to make presentations and be involved in four public participation activities a year. There are also measures out there for quantifying the value of minimum control measures implemented by residents.
 The Town has a street sweeping program and they actually have a new sweeper. It would be useful to have any numbers available about the program and that a credit for the Town could be calculated from the new sweeper reduction efficiencies. Information about the street sweeping program is provided in the MS4 annual report.
 The Town currently has a stream restoration project underway on Crab Creek that should significantly reduce sediment impacts. They also have gotten grants for upstream work. The Town estimated the load reductions of these projects for inclusion their SLAF application. The BANCS protocol could be used on future projects to estimate load reductions.
 One of the things to be included in the plan is accounting for load reductions that have already occurred since the TMDL was completed. The plan should cover what load reductions are actually left to achieve. Projects that have already occurred need to be credited. Any information any of the agencies or stakeholders have on projects occurring since the TMDL would be helpful.
 Implementation plans, once eligible for grants, cannot be used to meet the conditions of an MS4 permit. They can target loads on properties that feed into a conveyance, but they grant money could not be used to improve the conveyance. Blacksburg and VA Tech had to work with this issue a lot.
 Patrick asked what will happen since Montgomery County will become an MS4 permittee, but that it does not have a waste load allocation. The TMDL allocated for future growth of point source pollution, but the Town's permit was the only one listed for the load allocation.

<u>Pet Waste</u>
 The Town does not have a scoop the poop ordinance. The Town considered putting out collection systems, especially on the Huckleberry Trial and in the parks. This is being discussed with the Parks and Recreation Department. The Town has approval in the conservation area of the stream restoration project to put in a trail. They talked about also putting in a collection system and educational signs about the project. Dog runs attract a lot of people which confines and controls waste. It could help the Town if they created a fenced area for dogs.
 When asked if the Town conducts pet waste education and outreach, Todd responded that they set up a booth at the wilderness trail days focused on stormwater and it might have included some pet waste information.
 Cynthia (Skyline SWCD) talks to kids in schools about picking up waste, including pet waste. It's a topic easily understood by the kids. In the county, the kids tend to say they don't pick up pet waste while in Blacksburg the kids tend to say they do pick up pet waste. Cynthia talks to about 3,000 kids a year. Third graders learn about soils and fourth graders about watersheds and the water cycle. She

takes 6th graders on field trips where they do stream testing as well as learn about BMPs and nonpoint source pollution. Partners include the local 4-H program. Lots of information and tools are already available to teach about watersheds and water quality, including the Enviroscape model.

Agriculture

- There is money for agriculture BMPs in this watershed through NRCS. If a farmer is willing to come in and work with the government to do project they will get help and probably also funding. Hunter (NRCS) thinks the state program is the best it has ever been. If someone comes in and wants to fence the cattle out from water, they'll get money.
- EQIP is the NRCS's main program to address resource concerns on pasture land including animals in streams, animal waste (point source programs like feedlots, dairies), and cropland (with practices like no till). EQIP can also address forestry, but forestry does not seem to be an issue in this watershed. CREP is a good program too when it is available, but there are no sign ups right now as they are waiting on a new farm bill.
- There is a misconception out there about agricultural BMP programs. People are scared the government is going to come out and tell them how to farm. A large part of the district's programming is education. Even if the district can't provide cost-share to a landowner, they can provide field days and other education programs. The district staff works to help landowners that don't qualify for cost-share to develop small BMPs they can do on their own without those funds. The district does this work with both NRCS and the extension service. The district shows farmers how BMPs can benefit them as a way to draw them in.
- The Virginia Agricultural Cost-Share program (VACS) pays for a portion of a practice and the farmer pays for a portion. The farmer gets to choose their own contractors. There are requirements and installed practices have to pass an engineering inspection. All practices have a lifespan and maintenance requirement. They are subject to random inspection and there is accountability. There is also a tax credit program to cover 25% of the cost of installing some practices. If you can't use tax credit for your taxes, it now becomes cash.
- Buffers are a large component of farm management and of the cost-share program, but grazing practices are also really big in this area. Grazing systems are excellent for farms and currently are at 100% cost-share reimbursement for the next two years. The program does require a 35-ft buffer for 100% cost-share. Landowners have to fence out that required buffer, but that they are not required to plant it. CREP, a federal program the state and districts often piggyback with to create a full program for farmers, encourages a planted buffer. Usually, someone will sign up for CREP and then come to the district for further assistance. A reduced setback practice with just a 10-foot buffer is also available and has 50% cost-share.
- Properties within TMDL areas tend to float to the top of BMP cost-share program rankings. Having no live water on a property is a setback for landowners trying to get money. "Farmettes" could be an issue in this area because these small-size farms do not typically qualify for cost-share programs.
- Patrick asked if anyone had dealt much with conservation easements. When the New River Land Trust was younger, the District served as a co-holder for some of their easements. Now, the District works mainly with the Virginia Outdoors Foundation. A conservation easement is not something you can really persuade someone to do; they need to want to do it. The District has not really worked specifically with riparian buffer easements. Conservation easements do not always include provisions for stream exclusion. There is one large, 500+ acre easement in the watershed on Childress Farms.
- The district helps with agricultural stewardship act violations. The Agricultural Stewardship act is a mechanism where anyone can notify VDACS that someone in agriculture is causing a problem. It is then up to the commissioner whether they investigate an anonymous compliant. If you leave your name when making a complaint, they must investigate it. The District gets one or two complaints a year in their area. Usually, the complaints crop up after a big storm event. A district representative goes with the investigator to offer assistance to the landowner. Landowners have to meet a timeline to fix the issues or they pay fines. The timeline and fine requirements are written into the state code.

 There are no permitted operations in the watershed so no nutrient management regulations would apply here. The nutrient management plan program is otherwise voluntary and farms that do have a plan written do not always follow through with it. Childress Farms would be an example of a farm in the watershed with a nutrient management plan. On cropland, if the nutrient management plan is followed and the farmer understands the importance of year-round cover, then there should be no runoff problems. However, if no cover crops are used and fertilizer is applied on bare fields, then the fertilizer will ultimately seep down into the groundwater.
 Patrick noted that there are biosolids sites in the watershed and that each site should have a nutrient management plan. Those plans must be followed and they are typically written by the biosolids appliers. The Town does not have to apply biosolids, but they choose to do so with the cooperation of local farmers. Three sites in the watershed have been found where biosolids are currently applied at specific intervals and following specific rules. These sites are included in the watershed model.

Other Issues
 Attendees thought that the bacteria loading estimates in the TMDL could be much different because the watershed has changed so rapidly from agriculture to residential. The TMDL did include future land use projections, but these could have been off from what really occurred.
 The load allocation scenarios could be updated, but that would require a TMDL modification. The IP can address this situation by pointing out that the change in residential land use was probably even bigger than projected. More sewer and residential practices can be included in the IP to account for the speedier transition from agriculture to residential.
 There are springs, developed and undeveloped, in the watershed all throughout the Walton area. Fecal coliforms are found in the springs, sometimes right out of the collection boxes. Animals like salamanders and frogs hang out in the boxes and influence those findings. There are also a couple of old quarry sites in the watershed.
 VDH has no way to document if wells have bacteria present because wells are private. If they haven't been recently shocked, they probably have bacteria. Before a well goes into operation, it has to have a good test result, but after that there are no testing requirements. Wells are considered private property and therefore, the individual landowner's responsibility.
 John stated that the stormwater load assistance fund (SLAF) has $12 million more in funds for next year. SLAF is a state, DEQ-run, matching fund for municipalities with projects that address stormwater. It funds stormwater BMPs and the metric for choosing projects is phosphorus reductions.
 Gary noted that there are a lot of Christmas trees near the Bellevue Elementary School (Peppers Ferry and Walton). Bellevue is a growth development area in the Christiansburg comprehensive plan. The Cripple and Elk Creek IP addresses future conversion of agricultural lands to Christmas tree farms. Most of the farmers in this watershed couldn't afford to convert to Christmas trees.
 VDOT is working to address actions needed to meet their allocation for this TMDL within their action plans. VDOT does not wish to be written into the IPs because of further implications. Ashley stated that IPs can be viewed by DEQ and then potentially written into plans. VDOT has shared their action plan with the Town. Their program includes public involvement, outreach and street sweeping. However, they do not really want any of this in the IP. The Cambria VDOT site is included in their implementation plan. VDOT probably does not do much road sanding in this area.
 VSMP permit applications ask how you will address runoff in your project; however new projects do not have an allocation in the TMDL. The TMDL treats construction like a rolling allocation. In the TMDL, the current projects served as a place holder for future projects.
 There are wetlands in the watershed that could be restored. The Town's maintenance operations are currently located at an old treatment plant near Crab Creek. The Town just purchased a piece of land on Scattergood drive and the future plan is to move the building and operations up off of the creek to that location. They would then hope to bring that wetland area back to its natural glory. However, this is probably far, far away in the future.
 Gary noted that every time it rains a manhole above Hickcock overflows. There are a few repeat

overflows throughout the Town. Right now, the Town is under a consent order to take care of those overflows. They have replaced some lines on West Main Street which is a big sewer drainage area. The Town has reduced overflows significantly through work the past few years. There might be some money for these types of projects through the state revolving fund or through rural development funds.

 Todd also wondered in the last 10 years how many sewer connections have been made. The information could be derived from the Town's billing system. It might be almost impossible to get the number of residents on septic systems, but you might be able to get that number for just the annexed sections of Town. Todd will try to get this information by March.

 Attendees asked if monitoring has been conducted since the TMDL. Patrick replied that yes, DEQ has a six-year monitoring cycle. Also, once the implementation projects begin, monitoring will hopefully be more frequent.

Visible Erosion Problems

 Down Chrisman Mill road and across from golf course, there's a vacant piece of land that sold recently. The new owner has cattle in there that have access to the creek.

 Bank erosion was seen on the watershed field tour within the Meadows golf course. Attendees noted that it was a private course now owned by a group of investors. All golf courses should have a nutrient management plan in place.

 The town has an old water pump station leased to a farmer that could be a problem.

 Many sections of Crab Creek run right alongside the railroad which could be a problem.

 The railroad and creek intersection of the Huckleberry Trail extension is a great opportunity for future stream protection measures.

 A location off 2nd and Phlegar where a stream runs through people's backyards is highly eroded.

Roles and Responsibilities

 DEQ does not do the IP work after the plan is developed. Someone else will need to take the lead on applying for and managing implementation funding. DEQ tries to take a comprehensive approach to the IP so organizations can collaborate together and actual water quality improvements can be done in the watershed.

 Other potential partners for this plan include Indoor Plumbing Rehabilitation (IPR) programs or the Southeast Regional Community Assistance Project (SERCAP) because they can help with funding.

 Patrick asked if the district would have an interest in running a residential program. The District has done so in the past and would definitely be interested in the agriculture activities, but would need board approval for doing more residential activities. The District would need more hands to be effective. Pump-out funding was noted as the real carrot for people to get involved in these programs. Offering money for pump-outs helps with word-of-mouth. It works well when the district takes the lead on implementation because people are scared of the other government agencies. Mail-merge letters seem to work better than generic postcards for the District's outreach efforts.

 The urban components seem to fit within the MS4 program nicely and the district could be a partner on urban BMP efforts with the Town and County. For past projects, the district worked to flood people with information including by word of mouth, signs in yards, and mailers.

 If programs don't have a natural home, the PDC could help. However, the PDC does not have its own Indoor Plumbing Rehabilitation program as that funding is now with SERCAP. SERCAP can help with technical assistance or engineering needs on projects.

 The New River Roundtable is now officially defunct. Roundtables are a good way to bring together stakeholders and organize projects. There was talk among attendees about putting together a Crab Creek watershed group to further this work.

Next Steps

Minutes will be sent out in draft to the group and comments requested. The Government Working Group

will only meet this one time. A volunteer is still needed to represent the Government Working Group's findings at the upcoming Steering Committee meeting. The agricultural and residential working groups will each have another meeting sometime in March. If anyone has suggestions for advertising future public meetings, please contact Diana or Patrick.

Crab Creek TMDL IP Meeting – Agricultural & ResidentialWorking Group Meeting #2 Notes
March 13, 2014 6:30 – 8:30 pm Christiansburg Town Hall
Attendees
John Burke – Town of Christiansburg
Mary Dail - DEQ
Robbie Graham – Peppers FerryWWTP
Diana Hackenburg - DEQ
Ashley Hall –EEE (representing VDOT)
Cynthia Hancock – Skyline SWCD
Carolyn Howard – Draper Aden (representing Montgomery County)
Stacey Horton – DCR
Ryan Hendrix – Town of Christiansburg WWTP
Emma Jones - DEQ
Wayne Nelson – Town of Christiansburg
Asa Spiller – NRV Save Our Streams
Todd Walters – Town of Christiansburg

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Diana welcomed the group to the meeting and attendees introduced themselves. Diana went over impairments, background of the TMDLs and Implementation Plans and the Crab Creek project specifically. Diana went over BMPs installed since 2004 and showed photos of some of the BMPs. Diana explained the handouts. Diana explained the Stage 1 and Stage 2 water quality goals. Stage 1 and 2 goals can be adjusted based on feedback from this meeting.

<u>DISCUSSION</u>
General
- Ashley Hall – asked about the projected land use comparison. The data is from the 2012 NASS Cropland Data Layer which is produced using satellite imagery for the crop-specific data as well as additional sources including the imperviousness and canopy data layers from the USGS National Land Cover Database 2006 (NLCD 2006).
- Carolyn – Question about plan funding. Diana explained that once the plan is finalized, the area will be eligible for grant funding. Section 319 funding can be available on a competitive basis for agricultural BMPs as well as septic system practices, pet waste education and stormwater BMPs.
- Questions asked about 319 funding. Discussion about application process and how it is now competitive.
- Question about numbers of practices – how limiting can they be? Diana explained that the numbers needed to be in the ballpark. Mary added that it is also important to not limit your watershed by leaving practices out. At this stage it's important to be inclusive with types of BMPs.

Septic Systems and Straight Pipes
- Septic/Sewer Line Connections:

o Town of Christiansburg could run a report to see how many customers have water and not sewer to try and zoom in on eligible residents/areas to connect folks to public sewer.
o Connection to sewer costs can differ depending on how close the house is to an existing line. Attendees guessed that total costs of a sewer connection would be greater, perhaps closer to $5,000. The costs listed on the handout represent the total cost of the practice

(the sum of potential cost-share funding and the landowner's share).
o People will be opposed to the cost on their bill. As long as septic system is functioning, Town residents aren't required to connect to the sewer line. Cost-share availability may make it easier to get folks to sign up. Once sewer line is there, people will get their tanks pumped. Wayne says that haulers are good about notifying the Town of people requesting pump-outs.
 RB-5 should be with the Alternative On-site Waste Treatment System not FR-1.

Pet Waste

 Pet Waste Composters – the group was open to this idea. Diana explained that they could be used in areas as a pilot project.
 Huckleberry Trail area – pet waste bags and receptacles; could target Homeowners Associations
 There was interest among stakeholders to create a dog park or "companion area" in the watershed. While not common in Virginia IPs, this could be an option if it helps reduce pet waste somehow (e.g. providing a central location of education and outreach, concentrating waste away from water sources). Town of Christiansburg has been entertaining the idea of establishing a dog park, but is looking for a suitable location.
 From a WWTP standpoint, flushing pet waste doesn't matter. However, Town regulations may frown against throwing pet waste in trash. This should be looked into as throwing waste away in the trash is usually a recommended disposal method.

Other Practices

 Streambank Stabilization – need to determine if the units listed for streambank stabilization are meant for projects on all land uses or just for residential/urban land uses
 Stakeholders should think about if there are any known candidates for stabilization work within the watershed and how stabilization projects might be prioritized.
 Cynthia noted there are different variations on this practice. It can range from simple (live stakes) to complex (grading).
 Street Sweeping – Town will provide information, efficiency. They just upgraded equipment.
 BMP clearinghouse – John suggested listing all of the BMPs in the clearinghouse (i.e. green roofs) so that they recognized as strategies for reducing sediment and bacteria and so they are eligible for future funding.
 E&S Control – Town is looking at whether or not it can be enhanced. John is going to follow up with DEQ.

Sewer Overflows

 Ryan believes it's unreasonable to expect 100% of overflows would be corrected in Stage 1. Getting to a 100% reduction in overflows could potentially be spread out over the life of the implementation plan (across both Stage 1 and Stage 2). The Town and WWTP are working on overflows and they are making progress which should be mentioned in the clean-up plan. The Town of Christiansburg noted that funding needed to address the problem is tight right now.
o Diana would like from the Town of Christiansburg an estimate of the number of sewer overflows and the cost for preventing all future sewer overflows.

General Questions

 What happens if the goals of the plan are not being met, will the rubber meet the road on making this a requirement? Diana explained that the monitoring will tell us how well the plan is working along with the numbers of BMPs installed.
 Impact of Norfolk Southern – has that been considered in the plan? It is recognized as a concern of the stakeholders, but strategies for the plan have not been made specifically with the railroad in mind. It would be worth reaching out to them. Wayne said they have a contact for Norfolk Southern.
 Diana tried to reach out to The Meadows Golf Course & Swim Club and will continue to do so. Ryan suggested that their property would be a good candidate for streambank plantings/stabilization and/or a nutrient management plan.

 Question about point sources. TMDL IP addresses NPS. Point sources each have an allocated load for applicable pollutants which can be found in the 2004 TMDL.
 John Burke mentioned that stream restoration needs to be added to the list. Carolyn agreed and emphasized that it needs to be separate from streambank stabilization. Restoration costs are estimated at about $250-$300/linear foot. Cynthia could provide recent data to estimate those costs for agricultural stream restoration projects.
 How does the current Diamond Hills stream restoration project fit into the needed MS4 reductions? It has not yet been integrated into the plan, but data is now available and it will be considered. It was noted that channel erosion load reductions are considered in the plan separate from the needed MS4 load reductions.

Agriculture BMPs

 Livestock exclusion – Diana mentioned that the estimates are based on length of perennial streams. The option exists to add intermittent streams to the estimates. Cynthia mentioned that the wider the scope allows for more opportunities. Stakeholders generally agreed that intermittent should be included.
 Cynthia asked if the "Pasture Management" BMP in Table 7 corresponded with a specific costshare practice. Diana thinks it corresponds with Grazing Land Management Systems as listed in Table 4, but will check with Karen.
 Diana shared assumptions used to estimate BMPs needed for pasture and crop land uses (% conventional tillage able to be converted to conservation tillage, percentage converted to crop cover, % cropland in conservation tillage). District personnel will consider the assumptions and estimates to make sure they are accurate and feasible in this watershed.
 Most Agricultural BMPs have cost share associated (100% for livestock exclusion right now, others are usually 50-75% cost-share).

Follow up Monitoring

 Asa Spiller provided information about Save Our Streams monitoring efforts in the Crab Creek watershed. Asa and John Burke (Town) may work together to re-site one monitoring location to better capture ongoing water quality efforts.
 CourtneyWait of the National Committee for the New River said they have monitoring resources available for the watershed.
 John Burke suggested that we build in funding for citizen monitoring (equipment, training, etc.). Emphasized the desire to have high-level (Level III) data because it can be used to assess stream quality.
 Cynthia Hancock coordinates monitoring with school-age kids (Christiansburg Middle School teachers); she noted the SOL for 6th grade ties into water quality.
 There are Radford University and CHS students working on Crab Creek. Diana is working on collecting more information about their efforts.
 Ryan mentioned that the WWTP has space along the creek for school groups (and they could tour the plant while they're there).

Funding

 Need partnerships to leverage funding! Grants are looking for partnerships, matching funds.
 SWCDs have money available starting July 1st for their cost-share programs.
 NRPDC expressed interest at a previous meeting in managing parts of the project.

Next meeting will be Steering Committee (open to the public). Need a volunteer to represent each the AWG and RWG on the Steering Committee. Draft plan will be presented at the Steering Committee meeting.

Crab Creek Final Steering Committee meeting (Christiansburg Town Hall)
August 27, 2014

See sign in sheet for attendees –Diana Hackenburg, Chris Burcher, Karen Kline, Ashley Hall,

John Burke, Ronald Hall, Clark Payne, Wayne Nelson, Cynthia Hancock, Christopher Barbour, Stacy Horton, Hunter Mussey, Ryan Hendrix, Laura Walters, Lawrence Hoffman, Doug Burton, Randy Wingfield, Barry Helms, Christopher Webster

Diana introduction
Participant introductions
Diana presentation (*.ppt available on DEQ website)
- background
- Crab Creek meeting history
- IP modifications (land use and sediment loads updated)
- Question from EEE (Environmental, Engineering, and Educational)

Consulting/VDOT – where did street sweeping data come from? Karen answered but unsure of data source. **Follow up – we will check on data source for street sweeping source**
- Question EEE – how did we identify model error? Diana/Karen – Gene Yagow found it and BSE changed the target load; WLA stayed the same. Town C'burg – was it a math error and did DEQ fix it globally? Karen – yes. Question EEE –this was a LA from the GWLF? Karen –yes. Town of C'burg clarified modeling for audience re: comparing to Tom's Creek to get a 'standard' for high aquatic life scores. More discussion about error between EEE and Karen. **Bigger picture question from EEE – does TMDL need to be changed associated with this error? DEQ will not modify TMDL at this time. The IP will document that the TMDL channel erosion load allocation was modified and BMPs was quantified to attain the adjusted allocation. Town – does this affect the MS4? Karen/Diana – no, because that is the WLA for permits, this doesn't affect those, just LA. Question EEE – who did we notify at central office? Diana – Charlie Lunsford; and Liz McKercher was informed as well.
- Meeting summary slide [meeting notes are online]
- Ag group summary (Cynthia) – biggest thing was updating land use and 'microfarm' (small subsistence level farms) discussion. NOTE: May want to beef up this section of IP
- Residential group summary – stormwater and wastewater issues. Existing monitoring.
- Gov't group summary – technical and financial resources needed for stormwater and stream restoration. Septic/straight pipes and barriers to public. MS4 status. Pet waste. Dog park. Difficulties reaching microfarms.
- BMPs
- Diana gives summary, audience provides feedback

<u>SSOs (sanitary sewer overflows)</u>
Town contracted to study this and summarized for participants – Infiltration and inflow. Systematic approach to addressing this in town. First step is analysis: flow meters in various sections of receiving areas going to WWT. Then evaluate rain flows vs. base flows to evaluate which sections are receiving I/I. Then develop systematic approach to implement corrective actions. Goal is to reduce I/I by picking main problem areas. Funded by town. Had initial meeting and town is budgeting for the bigger project now. It was mentioned that TMDL load reduction is 100% but town will never be able to reach that. Town is aiming at 2 year storm as reduction goal, which is more realistic. Study will be used to develop capital improvement plan and identify 'where they are going to spend their money'. Diana – an explanation of the town's work is in the draft IP.

<u>Residential septic practices</u>
These have not changed since March. Question from town – is there a separation between county and town for residential septic issues? Karen – BSE could do it with structures data. Diana – we asked for those data but didn't get them. Town – we tried but data were sketchy. **Diana Chris and Karen can work on it.** Q – what kind of data? Karen – 911 data showing addresses. Town thinks they can provide data and will provide during the comment period if they intend to move forward with these changes. Note this for future TMDL IPs. Comment – most of town is likely to be on sewer anyway rendering this type of

analysis sort of moot. 2 state, 4 years total implementation planned for residential BMPs. Q EEE – is that condensed from last time? Wasn't it 10 years? Diana – we were but DEQ went with a shorter time frame that is aggressive. Town – these numbers in this timeframe are scary.

Pet waste

Town Q – it is challenging to show we reduced our load through actual monitoring and lower numbers in the streams. There has been talk about getting MS4 credit for outreach only and not the actual efforts (when the measured goals are not actually met). Diana – I'm not sure if the MS4 guidance will have any of that in it.

Stormwater

This is new stuff for this meeting. Residential and urban stormwater practices including homeowner BMPs as options to reduce loads. These specifically go to MS4 allocations. Town comment – this is for residences that are 'in an MS4' but actually discharge directly to crab creek and not to a storm sewer. [NOTE: discharge to either is possible] Diana – do these numbers look ok? Town – probably will be a lot more manufactured BMPs I assume. Diana – because of space? Popularity? Town – there are already more than these numbers (popular). One of the confusing things is if undeveloped land uses a BMP, then giving credit to them is a problem because it's a new land use. These seem to apply only to redevelopment. Town – extended detention; is that new? Diana – yes. Town – that's aggressive. Development at today's rate, even over 6 years, you wouldn't have that many (65) projects. Karen – but this is acres treated, not # of projects. Town – ok. That's probably obtainable. Diana if you think retrofits need to be another BMP we can do that. Town – we can't count a new development as a credit because it's really mitigating a change in land use. ISSUE – how does DEQ account for new construction vs. redevelopment or retrofitting. Karen – we can include this type of data in the IP document. Diana – we will look into retrofit opportunity for detention ponds. NOTE – look into more manufactured retrofit BMPs for places that may not have the space to implement larger BMPs that require more extra space.

Streambank restoration

In response to channel erosion, there are BMPs available to reduce this. This is a range of BMPs from minimal to full stream restoration. DEQ/BSE updated this based on prior meeting input. Town – I would like to bring up Norfolk Southern component. Any thoughts on their activity directly adjacent to Crab Creek and their potential for a significant impact; especially with respect to monitoring that area? Original TMDL does not address rail transportation land use as a sediment source. Therefore, under the TMDL/IP development planning process load is not addressed. The IP will acknowledge it as a concern raised by stakeholders. Full stream restoration cost estimate is $1.7M. Q – is that a 'turn key' cost? Karen – I don't think that would include the technical cost. Town – that is a very low cost estimate for that big a project. Even if it was not full restoration and simply stabilization. General comments that $150 per linear foot is way low. The James River association published a document that summarizes these costs. Diana – we looked at that and used it to get at $150 figure. We thought this was a decent estimate of costs generalizing for all variables in Crab Creek. What would y'all price this at? Answer – too many uncertainties, we prefer a range. Question – what has been use in other plans? Diana – I've seen both higher and lower. **Price will be considered** Q – did the Roanoke River plan separate by stabilization and full restoration? Karen – if you prefer it split out we need two numbers from you. Town – that total number is our justification for seeking grant money and it needs to be accurate. (question aimed at town officials) When it comes to an action plan, can these numbers be held against us? DEQ MS4 guidance – Ips may be used by localities for pollutant reduction strategies; however they are not considered a requirement for permit compliance. Further, IPs do not prescribe specific BMPs to implement to meet their MS4 permit requirements. Agricultural practices. BMPs. Used already-in-place systems in Crab Creek to generate these estimates. Chris/SSWCD – take out SL9, not an incentive to manage properly and very few put in for 7-8 years. Too strict management for state. SL-9 is actually a BMP instead of an incentive. It goes beyond an SL-6. Take out SL-9 altogether but include the grazing land management

system with the SL-6. DEQ has included the pasture management BMP, SL-10T in plae of SL-9. Karen – is that the same for LE-2T? Chris – it could be the same thing. Diana – are you using SL-6 and grazing land management together now? Chris – we're using grazing land management and stream exclusion together. Just don't use SL-9. But leave the 528 in. On that practice we only pay $25/acre if managed right. DEQ is using $75 acre cost since farmers are being enrolled in 3-year contracts in both the federal and state programs (i.e., 528 and SL-10T). And again, that's a BMP that is implemented AFTER the rotational grazing is put in. I would raise the FR-1 for both pines and hardwoods because it includes fence. Go up as high as $1500 (pines about $600). SL-11 needs to be raised also. Need to include grading and heavy equipment and fencing so it is established. Chris – rest look ok. SL-8B might go up also.

Technical assistance costs

Town – stage two should include some money for residential. Whether full-time or not can be discussed.** Chris – 6 years is even too long to accomplish ag and residential goals. If that's all we had to do; the MS4 and other stuff adds to it.

Slide showing **total cost**. $8.4M Town – the TMDL considered all permits as point loads which is an allowance for those loads. So the 2k load allowance is a small part of the total load, of which, the construction load is a big contributor. When there is a major storm the construction sites contribute way more load during a storm and may cause more of an overall problem. So we can't use TMDLs as leverage to reduce construction loads further. Which stinks. NOTE: can we better account for construction loads to help reduce the requirements of the TMDLs?

Tracking

Add that MS4 tracking plans (i.e., TMDL Action Plans) will quantify additional efforts.