Water Quality Improvement Plan

Middle River
Moffett Creek
Jennings Branch
Polecat

A plan to reduce bacteria and sediment in the water

December 10, 2009

Prepared by

The Virginia Department of Conservation and Recreation

In Cooperation with

The Virginia Department of Environmental Quality

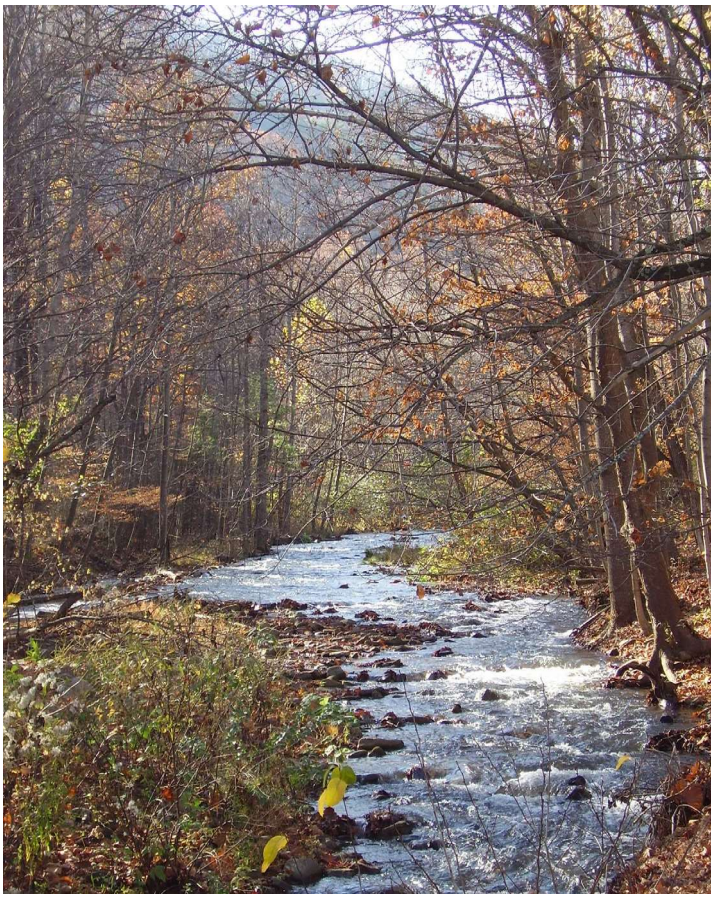
Virginia Tech Department of Biological Systems Engineering

Local Stakeholders

Acknowledgements

We would like to acknowledge the following organizations for their support for and participation in the development of this plan:

Augusta County Service Authority
Augusta County Health Department
Churchville Public Library
Department of Environmental Quality
Department of Game and Inland Fisheries
Headwaters Soil and Water Conservation District
Natural Resources Conservation Service
Shenandoah RC&D



For additional information, please contact:
Virginia Department of Conservation and Recreation (VADCR)
Staunton Office: Nesha McRae, (540) 332-9238

EXECUTIVE SUMMARY

Water Quality Problems in Middle River, Moffett Creek and Polecat Draft

A Total Maximum Daily Load (TMDL) Study was developed for the rivers and creeks in 2004 when water quality monitoring showed:

1) All of the creeks were violating the State's water quality standard for bacteria.
2) Upper Middle River and Moffett Creek were violating the general standard for aquatic life use. The primary stressor on the aquatic communities was identified as sediment.

Middle River, Jennings Branch, Moffett Creek and Polecat Draft TMDL Implementation Plan

Once a TMDL is developed for a stream, the next step is to create a plan identifying how the pollutant reductions identified in the TMDL can be achieved. A TMDL Implementation Plan describes actions that can be taken by landowners in the watersheds, which can include the use of better treatment technology and the installation of best management practices (BMPs), that will ultimately result in improved water quality in the stream. Jennings Branch is included in this plan because while it is not impaired by bacteria, it is contributing bacteria to the impaired streams. Collecting input from the public on conservation and outreach strategies to include in the TMDL Implementation Plan was a critical step in this planning process.

Sources of Bacteria in the Watersheds

Agricultural runoff, direct deposition of manure in streams by livestock, and wildlife have been identified as the primary sources of bacteria. Non-point sources of bacteria in the watersheds include failing septic systems and straight pipes, livestock (including manure application loads), wildlife, and domestic pets. Point sources including individual residences can contribute bacteria and sediment to streams through their discharges.

Table ES-1. Goals for bacteria reductions. Note: DD=direct deposit

Watershed	Fecal Coliform Reduction from Source Category (%)						
	Cattle DD	Cropland	Pasture	Forest/ Water	Wildlife DD	Straight Pipes	Residential/ Urban
Upper Middle	100%	99.9%	99.9%	99%	0%	100%	99.9%
Jennings Branch	100%	99.9%	99.9%	71%	0%	100%	99.9%
Moffett Creek	100%	99.9%	99.9%	93%	36%	100%	99.9%
Middle Middle	100%	99.9%	99.9%	71%	0%	100%	99.9%
Lower Middle	100%	99.9%	99.9%	71%	0%	100%	99.9%
Polecat Draft	100%	99.9%	99.9%	0%	6%	100%	83%

Sources of Sediment in Upper Middle River and Moffett Creek

Based on the results of the TMDL study, the sediment in Upper Middle River and Moffett Creek is primarily coming from pasture and cropland. These land uses contribute sediment loads through erosion and build-up/washoff processes. Pasture and cropland are particularly susceptible to erosion due to less vegetative coverage, which can occur when crop fields are left without cover and pastures are overgrazed.

Table ES-2. Goals for sediment reductions in Upper Middle River and Moffett Creek

Sediment Reduction from Source Category (%)		
Watershed	**Pasture**	**Cropland**
Upper Middle	56.5%	53%
Moffett Creek	66%	40%

Implementation Actions

A series of on-the-ground implementation actions have been compiled in this plan. It is expected that the implementation of these practices to the extent defined in the plan will result in the restoration of the impaired streams. These actions are listed by land use type below and are quantified by watershed.

Livestock Direct Deposit

The TMDL study specifies that the direct deposit of waste into the stream from livestock must be eliminated in the watersheds in order to meet the water quality standard for *E. coli*. This makes some form of exclusion of livestock from streams necessary. Farmers who wish to exclude their livestock from the stream have several options through state and federal cost share programs. Table 3 shows an estimated breakdown of the types of fencing systems that could be installed in the watersheds to achieve the livestock exclusion goals.

Table ES-3. Livestock exclusion BMPs

Exclusion system	Linear Feet of Livestock Exclusion					
	Upper Middle	**Jennings Branch**	**Moffett Creek**	**Middle Middle**	**Lower Middle**	**Polecat Draft**
LE-1T	44,392	9,465	12,201	31,770	27,675	7,819
LE-2T	22,196	4,733	6,099	15,886	13,838	3,910
WP-2T	11,098	2,366	3,050	7,943	6,919	1,955
CRP	17,757	3,786	4,881	12,709	11,071	3,128
CREP	126,518	26,976	34,770	101,881	78,876	22,284
TOTAL	221,961	47,326	61,001	170,189	138,379	39,096

Pasture

One pasture practice that will help water quality is improved pasture management, which includes the establishment of rotational grazing systems and rotational loafing lot systems. Streamside plantings of trees, shrubs and grasses, also known as riparian buffers, can help filter bacteria and sediment out of runoff from pastures. These vegetated strips can be installed in combination with livestock exclusion fencing, which will protect the plantings from grazing by livestock.

Table ES-4. Pasture BMPs

BMP		BMP Acres					
		Upper Middle	Jennings Branch	Moffett Creek	Middle Middle	Lower Middle	Polecat Draft
Riparian buffer	35 ft width	589	31	40	105	91	26
	20 ft width	33	2	2	6	5	1
	10 ft width	21	1	1	4	3	1
Improved pasture management		28,786	4,988	7,606	17,986	12,358	2,089

Residential/Urban Areas

Since state law requires that failing septic systems and straight pipes be corrected once identified, this plan includes a 100% reduction in bacteria from straight pipes and failing septic systems. In addition to failing septic systems and straight pipes, pet waste is a key source of bacteria from residential areas in the watersheds. The development of a pet waste education program will help to reduce the amount of bacteria from pet waste entering the streams. Pet waste digesters could also be installed in areas of more dense residential development such as Churchville. These digesters allow homeowners with smaller yards to compost their pet's waste and apply it to flower gardens as a fertilizer.

Table ES-5. Residential BMPs

BMP	Upper Middle	Jennings Branch	Moffett Creek	Middle Middle	Lower Middle	Polecat Draft	TOTAL
Septic system repair	172	83	43	179	70	20	567
Septic system replacement	170	83	42	173	66	19	553
Alternative waste treatment system	19	10	5	17	6	2	59
Pet waste education program	---	0.5	---	---	0.5	---	1
Pet waste digester	---	25	---	---	25	---	50

Cropland

Bacteria from the spreading of manure on cropland can end up in a stream unless the appropriate management practices are in place. Sediment can run off of cropland when soils are exposed, and it will make its way to the stream unless filtering practices like riparian buffers are in place to trap it.

Table ES-6. Cropland BMPs needed

BMP	Units	Upper Middle	Jennings Branch	Moffett Creek	Middle Middle	Lower Middle	Polecat Draft	Total
Poultry litter storage	system	5	4	4	4	4	2	22
Beef manure storage	system	6	4	5	5	5	2	27
Cropland buffers	acres	3.8	0.2	5.4	7.8	14.6	3.3	35.1
Continuous no-till	acres	508	108	156	329	589	71	1,761

Streambank restoration

The agricultural working group recommended that streambank restoration be included as a management strategy in the implementation plan. Consequently, three demonstration projects have been recommended, two in Upper Middle River and one in Moffett Creek. Both of these watersheds have benthic impairments due to excess sediment. It is expected that each of these projects will include approximately 500 linear feet of streambank.

Education and Outreach

In order to get landowners involved in implementation, it will be necessary to initiate education and outreach programs and provide technical assistance with best management practices. Outreach to local Ruritan clubs has shown to be a successful way to distribute information about agricultural programs. In addition, farm tours and demonstration projects will serve as good tools to share information on best management practices with farmers. The Headwaters Soil and Water Conservation District has recently begun making cold calls to property owners. While this strategy is time consuming, it has proved effective in reaching new farmers. Stream clean ups could serve as a way to locate straight pipes, and also educate riparian landowners on the importance of septic system maintenance. There may also be opportunities to collaborate with the Augusta County Health Department on mailings of outreach materials.

Costs and Benefits

It was estimated that it would require $50,000/year to support one technical full time position. It was determined that two full time positions would be needed in order to complete the implementation effort within a 16 year period. This estimate was based on the typical productivity rate of conservation technicians working in SWCD's within the Shenandoah Valley region with respect to landowner outreach and sign-ups for BMPs. Consequently, the total estimated cost to provide technical assistance during implementation is expected to be approximately $100,000 per year for 16 years.

The costs of residential BMP implementation were estimated based primarily on input from the Augusta County Health Department. In addition, cost data from other watersheds in Augusta, Rockingham and Shenandoah Counties where residential septic system maintenance programs have been implemented in the past 8 years were used to refine estimates. The costs of agricultural best management practices included in the implementation plan were estimated based on data for Augusta and Rockingham Counties collected from the VADCR Agricultural BMP Database. Cost estimates were further refined following discussions with stakeholders.

Table ES-7. Total estimated costs of full BMP implementation

Watershed	Agricultual BMPs	Residential BMPs	Total BMP Cost
Upper Middle	$6,188,123	$2,037,000	$8,225,123
Jennings Branch	$1,463,366	$993,375	$2,456,741
Moffett Creek	$1,909,227	$510,000	$2,419227
Middle Middle	$4,182,667	$2,043,375	$6,226,042
Lower Middle	$865,218	$222,000	$1,087,218
Polecat Draft	$3,356,886	$777,000	$4,133,886
TOTAL	$17,965,487	$6,582,750	$24,548,237

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

A list of potential funding sources available for implementation has been developed. Detailed descriptions can be obtained from the Headwaters Soil and Water Conservation District (SWCD), VADCR, Natural Resources Conservation Service (NRCS), and Virginia Cooperative Extension (VCE). Some of the most commonly used funding sources include: Virginia Agricultural Best Management Practices Cost-Share and Tax Credit Programs, Virginia Agricultural Best Management Practices Loan Program, Conservation Reserve Enhancement Program (CRP/CREP), Virginia Water Quality Improvement Fund, Environmental Quality Incentives Program (EQIP), Southeast Rural Community Assistance Project (SE/R-CAP), Chesapeake Bay Watershed Initiative, Virginia Natural Resources Commitment Fund, and Clean Water State Revolving Fund.

Partners And Their Role In Implementation

Voluntary Implementation Efforts

The majority of practices recommended in this plan are related to agriculture, which is the predominant land use in the watersheds. This makes participation from local farmers a key factor to the success of this plan. In addition to local farmers, participation from homeowners is also critical to the success of this plan. Though the amount of bacteria that is coming from failing septic systems and straight pipes is minimal compared to livestock, human waste carries with it pathogens that can cause health problems above and beyond those associated with livestock waste. Landowners in the watershed will serve as the key partner in this effort. Without their participation, the goals in this plan cannot be achieved.

Agricultural and Residential Education Programs

The Headwaters Soil and Water Conservation District (SWCD) will be in charge of initiating contact with farmers to encourage the installation of BMPs. District staff will also conduct outreach activities in the watershed to encourage participation in conservation programs. The Headwaters SWCD has been receiving funding from the VA DCR for a full time agricultural technician to work with producers in several watersheds in Augusta County including Middle River, Jennings Branch, Moffett Creek and Polecat Draft. Targeted cost share funding for best management practices has also been provided to the Headwaters SWCD for agricultural BMPs in these watersheds. These funds have been available since Summer 2006.

A residential education program consisting of educational materials about pet waste and a pet waste digester program could be run through a partnership between the Headwaters SWCD, the Augusta County Service Authority and the Augusta County SPCA. These organizations could assist in the distribution of information on the importance of picking up after your pet including the potential for contamination of drinking water for homeowners with wells.

Monitoring Water Quality

Improvements in water quality will be determined by monitoring conducted by the VA Department of Environmental Quality's (DEQ) ambient and biological monitoring programs. Each stream will have one sampling site that will be visited once a month by DEQ monitors. DEQ will also continue to monitor the biological health of Upper Middle River and Moffett Creek by sampling the benthic community in the Fall or Spring once a year. In addition, Friends of the Shenandoah River and Virginia Save Our Streams have a strong network of volunteer monitors who collect both chemical and biological data on streams throughout the Shenandoah Valley. These data may be used to judge progress in reaching implementation milestones.

Introduction

The Clean Water Act (CWA) requires that all of our streams, rivers, and lakes meet the state water quality standards.

The CWA also requires that states conduct monitoring to identify polluted waters that do not meet standards. Through this program, the state of Virginia has found that many streams do not meet state water quality standards for protection of the five beneficial uses: recreation, the production of edible and marketable natural resources, aquatic life, wildlife, and drinking. When streams fail to meet standards they are placed on the state's impaired waters list, and the state must then develop a Total Maximum Daily Load (TMDL) for each pollutant. A TMDL is a "pollution budget" for a stream. That is, it sets limits on the amount of pollution that a stream can tolerate and still maintain water quality standards. In order to develop a TMDL, background concentrations, point source loadings, and non-point source loadings are considered. Non-point source pollution occurs when pollutants are transported across the land to a body of water when it rains. Point source pollution occurs when pollutants are directly discharged into a stream. Through the TMDL process, states establish water-quality based controls to reduce pollution and meet water quality standards.

Water Quality Problems in Middle River, Moffett Creek and Polecat Draft

TMDLs were developed for Middle River, Moffett Creek and Polecat Draft in 2004 when water quality monitoring showed:

1) The creeks are all violating the State's water quality standard for bacteria, which was based on the concentration of fecal coliform in the water until 2003 (the fecal coliform bacteria count should not exceed a geometric mean of 200 cfu per 100 mL of water for two or more samples taken over a 30-day period, and it should not exceed 400 cfu per 100 mL at any time). In 2003, Virginia switched to an *E. coli* water quality standard after it was found that there was a more positive correlation between contact with *E. coli* and gastrointestinal illness or infection. Consequently, the TMDL was developed for *E. coli*. The *E. coli* standard that became effective January 15, 2003 states that the *E. coli* bacteria count should not exceed a geometric mean of 126 cfu per 100 mL for two or more samples taken over a 30-day period, and it should not exceed 235 cfu per 100 mL at any time.

2) Upper Middle River and Moffett Creek were violating the general standard for aquatic life use. This standard states that all state waters should support "the propagation and growth of a balanced indigenous population of aquatic life..." Based on biological monitoring conducted by the Virginia Department of Environmental Quality (VADEQ), it was concluded that these creeks were not meeting this designation. The primary stressor on the aquatic communities was identified as sediment.

The TMDLs specified the maximum bacteria and sediment (only in Upper Middle River and Moffett Creek) that creeks can handle and still meet the water quality standard for bacteria while also supporting a healthy and diverse aquatic population.

Creating a TMDL Implementation Plan

Once a TMDL is developed for a stream, the next step is to create a plan that identifies how the pollutant reductions identified in the TMDL can be achieved. A TMDL Implementation Plan describes actions that can be taken by landowners in the watersheds that will result in improved water quality in the stream. There are nine components included in an implementation plan:

1. Causes and sources of bacteria and sediment that will need to be controlled to meet the water quality standards
2. Reductions in pollutants needed to achieve water quality standards
3. Management measures (BMPs) that will need to be implemented to achieve the pollutant reductions
4. Technical and financial assistance needed, associated costs, and the authorities that will be relied upon to implement the plan
5. An information/education component that will be used to enhance public understanding on the project and encourage participation in selecting and implementing best management practices
6. A schedule for implementation of the practices identified in the plan
7. Goals and milestones for implementing best management practices
8. A set of criteria for determining if bacteria and sediment reductions are being achieved and if progress is being made towards attaining water quality standards
9. A monitoring program to evaluate the effectiveness of the implementation effort

Review Of TMDL Studies

Watershed Characteristics

Middle River, Jennings Branch, Moffett Creek and Polecat Draft are located in Augusta County Virginia in the Shenandoah River Basin. Land use in the watersheds is predominantly agricultural and forest. According to the 2007 Census of Agriculture, Augusta County ranked second in the state for the total value of agricultural products sold. The County also ranked second statewide for turkey and cattle/calve inventory, which were 1.5 million and 100,808 respectively.

The segment of Upper Middle River that is impaired by fecal coliform bacteria extends from the headwaters down to its confluence with Jennings Branch (24.1 miles), while the benthic impairment includes 15.71 miles of the stream. The impaired segment (benthic and fecal coliform) of Moffett Creek begins at

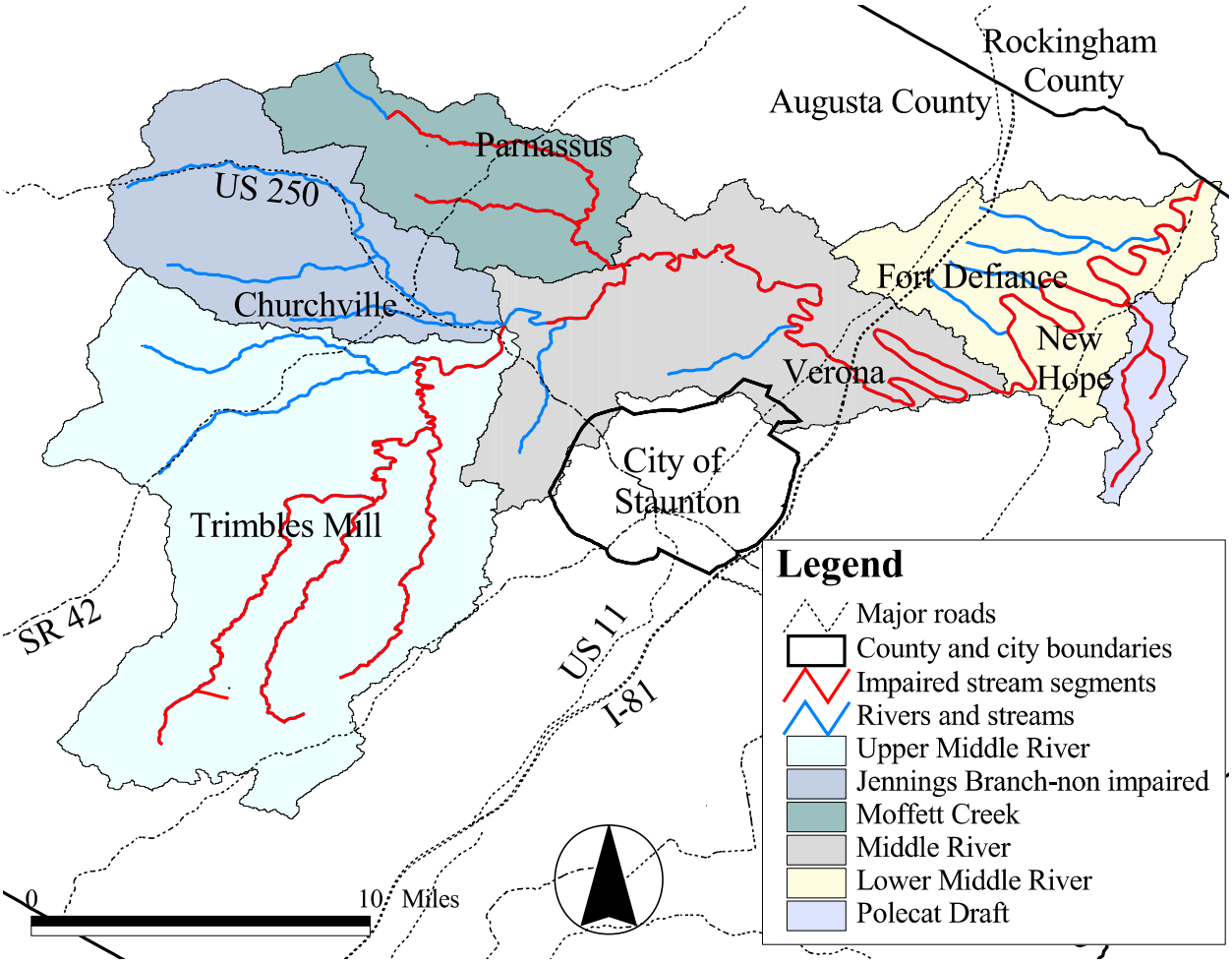


Figure 1. Location of the watersheds

the creek's confluence with Tunnel Branch and extends down to its confluence with Middle River (8.73 miles). The impaired segment of the Lower Middle River begins at the Middle River's confluence with Christians Creek and continues for 18.12 miles downstream to the creek's confluence with the North River. In 2008, this impaired segment was extended upstream from Christians Creek to the quarry located just below the confluence of Middle River with Whiskey Creek east of Churchville (25.49 miles). Polecat Draft is impaired from its headwaters to its confluence with Middle River (7.28 miles).

Sources of Bacteria in the Watersheds

Agricultural runoff, direct deposition of manure in streams by livestock, and wildlife have been identified as the primary sources of bacteria in the creeks. Non-point sources of bacteria in the watersheds include failing septic systems and straight pipes, livestock (including manure application loads), wildlife, and domestic pets. Point sources including individual residences can contribute bacteria and sediment to streams through their discharges. There are currently 17 point sources permitted to discharge fecal coliform bacteria in the watersheds.

Sources of Sediment in Upper Middle River and Moffett Creek

Based on the TMDL study results, the major sources of sediment in Upper Middle River and Moffett Creek are pasture and cropland. These land uses can contribute sediment to rivers and streams through erosion and build-up/washoff processes. Agricultural lands are particularly susceptible to erosion when vegetative cover is minimal such as when pastures are overgrazed or crop fields are tilled and left uncovered. In addition, there are seven point sources in the Upper Middle River watershed that are permitted to discharge sediment to the river.

Goals for Reducing Bacteria

The TMDL studies completed for the creeks identified goals for reducing bacteria from the different sources in the watersheds. These goals are based on what it would take to never violate the water quality standard for *E. coli* (Table 1). This standard is designed to protect human health and reduce the risk of illness or infection upon primary contact with the water (e.g. swimming or splashing in the creek).

Table 1. Goals for bacteria reductions. Note: DD=direct deposit of bacteria into the water

Watershed	Fecal Coliform Reduction from Source Category (%)						
	Cattle DD	Cropland	Pasture	Forest/ Water	Wildlife DD	Straight Pipes	Residential/ Urban
Upper Middle	100%	99.9%	99.9%	99%	0%	100%	99.9%
Jennings Branch	100%	99.9%	99.9%	71%	0%	100%	99.9%
Moffett Creek	100%	99.9%	99.9%	93%	36%	100%	99.9%
Middle Middle	100%	99.9%	99.9%	71%	0%	100%	99.9%
Lower Middle	100%	99.9%	99.9%	71%	0%	100%	99.9%
Polecat Draft	100%	99.9%	99.9%	0%	6%	100%	83%

Goals for Reducing Sediment in Upper Middle River and Moffett Creek

Sediment was identified as the primary pollutant stressing the benthic community (aquatic insects that live at the bottom of the stream) in Upper Middle River and Moffett Creek. When too much sediment gets into the stream, it alters the stream bottom by filling in the spaces between gravel and other materials in the stream. This harms aquatic insects that live in the spaces by eliminating their habitat. In order to correct this problem, sediment reduction goals were developed for the Upper Middle River and Moffett Creek TMDLs. The recommended sediment reduction scenarios are shown in Table 2. Sediment loads from point sources were not reduced because these facilities are currently meeting their pollutant discharge limits and other permit requirements.

Table 2. Goals for sediment reductions in Upper Middle River and Moffett Creek

Sediment Reduction from Source Category (%)		
Watershed	Pasture	Cropland
Upper Middle	56.5%	53%
Moffett Creek	66%	40%

Public Participation

Collecting input from the local community on conservation and outreach strategies to include in the TMDL Implementation Plan was a critical step in this planning process.

Public meetings were held on the evenings of July 16, 2009 at the Churchville Fire Hall and December 10, 2009 at the Augusta County Government Center in Verona to kick-off and conclude the implementation planning process. Both meetings served as opportunities for local residents to learn more about the creeks, and to work together to come up with new ideas to protect and restore water quality in their community. A draft implementation plan and presentation was distributed to attendees at the final public meeting. In addition, informational pamphlets describing programs associated with Headwaters SWCD, VADCR, and VADEQ were made available.

The role of the Agricultural Working Group was to review conservation practices and outreach strategies from an agricultural perspective. During the first agricultural working group meeting on July 16th, the group discussed existing obstacles to livestock exclusion including maintenance and cost issues. Several landowners expressed concerns that Polecat Draft was going to be included in the implementation plan since it frequently is dry. It was agreed that this watershed would be considered to be a lower priority while the Upper Middle River watershed was identified as a high priority for implementation efforts. A second agricultural working group meeting was held on September 23rd at the Churchville Library. The group reviewed the agricultural best management practices to be included in the implementation plan along with their costs. They also discussed targeting strategies by subwatershed and reviewed education and outreach strategies. The group agreed that it will probably take around 10-20 years to complete the

agricultural implementation goals for Middle River with the fencing and improved pasture management goals being the hardest to achieve. The group discussed possible alternatives to fencing including portable shade structures and off stream water sources. It was agreed that these options may need to be explored if we find that fencing goals cannot be met. While portable shade and off stream watering will not eliminate direct deposit of manure by livestock in streams, it was suggested that this combination of practices would reduce the amount of time livestock spend in the streams. Participants also expressed an interest in implementing some stream bank restoration projects in the watersheds where the banks were undercut or denuded. The group discussed outreach strategies that would be best to reach farmers. Cold calls, farm tours and demonstration projects were identified as the most successful mechanisms. Informational mailings were not seen as very helpful tools.

The primary role of the Residential Working Group was to discuss methods needed to reduce human and pet sources of bacteria entering the creeks. Two meetings were held in July and September 2009. The residential working group discussed septic system maintenance needs in the community and options for pet waste management. Participants felt that more education and outreach efforts on septic system maintenance needs will be important. They also thought that residential development should be focused in areas of the watersheds where the land is suitable for a conventional septic system rather than using alternative systems in areas where the soil does not perk. The group agreed that pet waste digesters were not a good management strategy for most landowners in the watersheds. Several participants expressed an interest in getting a grant and having a residential cost share program run by the Health Department and the Augusta County Service Authority. The group recommended that rather than targeting outreach efforts at particular watersheds, we should focus on landowners who live on the creek. When addressing issues with straight pipes, we should focus on sections of the creeks that we are able to float with a canoe or a kayak. Regarding outreach, on participant suggested working with local Ruritan Clubs to distribute educational materials. The group also agreed that the Health Department would be an excellent partner with respect to distributing informational materials.

The Government Working Group met in August 2009 to discuss existing programs and technical resources that may enhance implementation efforts. The group discussed both state and federal agricultural cost share programs, and NRCS and Headwaters SWCD staff made recommendations based on their experiences working with landowners in the watersheds. Strategies for targeting and integrating planning efforts were reviewed including the potential for targeting the Augusta County's Source Water Protection Zones with BMPs, and focusing the Shenandoah RC&D's Flexible Fencing Program in the watersheds. The group agreed that the SWCD would be prioritizing any funds and projects that they receive from the Shenandoah RC&D.

The Steering Committee met in November 2009 to discuss the agenda for the final public meeting and to review the draft public document outlining the implementation plan. The group reviewed summaries of each of the working group discussions and provided comments on the draft public document. The steering committee recommend that a 1-page fact sheet be developed for the project. The committee also developed a list of recommended speakers and presentation topics for the final public meeting.

Implementation Actions


Photo: Mike Phillips, NRCS

An important part of the implementation plan is the identification of specific actions that will improve water quality in the watersheds.

This section provides a summary of what is needed to achieve the pollutant load reductions specified in the TMDLs. Since this plan is designed to be implemented by landowners on a voluntary basis, it is necessary to identify actions including management strategies that are both financially and technically realistic and suitable for this particular community. As part of this process, the costs and benefits of these actions must be examined and weighed. Once the best actions were identified for implementation, estimates of the number of each action that would be needed in order to meet water quality goals were developed.

Management Actions Selected through Stakeholder Review

While management actions such as livestock exclusion and straight pipe removal were directly prescribed by the TMDLs, a number of additional measures were needed to control bacteria and sediment from land-based sources. Various scenarios were developed and presented to the working groups, who reviewed both economic costs and the water quality benefits. The majority of these best management practices (BMPs) 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 Table 3.

Table 3. BMP bacteria and sediment reduction efficiencies

BMP Type	Description	Bacteria Reduction Efficiency	Sediment Reduction Efficiency	Reference
Res	Septic tank pumpout	5%	N/A	2
Res	Septic system repair	100%	N/A	1
Res	Septic system replacement	100%	N/A	1
Res	Alternative waste treatment system	100%	N/A	1
Res	Pet waste digester	50%	N/A	1
Res	Pet waste education program	50%	N/A	3
Ag	Improved pasture management	50%	41.5%	5,8
Ag	Riparian buffer	50%	50%	2
Ag	Grassed buffer filter strip	50%	40%+LU Conversion*	2,6,8
Ag	Streambank stabilization	N/A	2.55 lbs/ft/yr	7
Ag	Livestock exclusion	100%	N/A	1
Ag	Poultry litter storage	99%	N/A	5
Ag	Manure storage	80%	N/A	2,4
Ag	Continuous no-till	N/A	Land use conversion	6

*LU=Land use conversion in model simulation, reduction=95.2% on pasture, 85.1% on cropland

1. Removal efficiency is defined by the practice
2. VADCR. 2003. Guidance manual for Total Maximum Daily Load Implementation Plans. Accessed August 14, 2009.
3. Modified from Swann, C. 1999. A survey of residential nutrient behaviors in the Chesapeake Bay. Widener Burrows, Inc. Chesapeake Bay Research Consortium. Center for Watershed Protection. Ellicott City, MD. 112pp.
4. MapTech Inc. 2001. Fecal coliform and NO3 TMDL Implementation Plan for Dry River, Muddy Creek, Pleasant Run and Mill Creek, Virginia. Prepared for the Virginia Department of Conservation and Recreation and the Virginia Department of Environmental Quality. July 15, 2001.
5. MapTech Inc. 2006. Water quality implementation plan for Blacks Run and Cooks Creek (Fecal coliform and Aquatic Life TMDLs). Prepared in coordination with the Virginia Department of Conservation and Recreation and the Virginia Department of Environmental Quality. May 25, 2006. Accessed: August 14, 2009.
6. Chesapeake Bay Model version 4.3 BMP efficiencies
7. Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy. Commonwealth of Virginia. 2005.
8. Effectiveness quantified through land use change in Generalized Watershed Loading Function (GWLF) model simulations

Livestock Direct Deposit


Photo: Mike Phillips, NRCS

The TMDL study specifies a 100% reduction in the direct deposit of waste into the stream by livestock, making some form of stream fencing necessary.

To estimate fencing needs, information on the stream network was compared with land use data. Stream segments that flowed through or were adjacent to pasture were identified. If the stream segment flowed through a pasture, it was assumed that fencing was needed on both sides of the stream. If a stream segment flowed adjacent to a pasture, it was assumed that fencing was required on only one side of the stream. Not every pasture has livestock on it at any given point in time. However, it is assumed that all pasture areas have the potential for livestock access, meaning that livestock exclusion fencing should be installed. The VADCR Agricultural BMP Database was utilized in conjunction with input from SWCD and NRCS staff to determine typical characteristics (e.g., average length of fencing installed per fencing project) of the different livestock exclusion systems offered through the state and federal agricultural cost share programs so that the number of different systems needed could be accurately estimated. In addition, data on stream fencing already in place was collected for each watershed and subtracted from the total fencing needed.

Farmers who wish to exclude their livestock from the stream have several options through state and federal cost share programs. Incentive payments vary based on the width of the streamside buffer that is installed between the fence and the stream, and the type of fencing that is installed. The portion of fencing that will be accomplished using a variety of available fencing practices based on historical data and input from farmers and agricultural conservation professionals.

Farmers who cannot afford to give up a significant amount of land for a streamside buffer can receive 50% cost share for the installation of exclusion fencing with a ten foot setback, cross fencing, and to provide an alternative water source for their livestock. It is estimated that 15% of the total fencing needed in the watersheds will be installed using this particular practice (code LE-2T). If a landowner can afford to give up 35 feet for a buffer along the stream, then they are eligible to receive cost share at a rate of 85% to cover the costs of the stream fencing, cross fencing and providing alternative water. It is estimated that 15% of the total fencing will be installed using this particular practice (code LE-1T). For producers who are not interested in installing an alternative water source, there is a stream protection practice that provides cost share for fencing with a 35 foot riparian buffer and hardened crossings with access points for livestock to get water. This practice (code WP-2T) also provides an up front incentive payment for fence maintenance in the amount of $0.50/linear foot of fence. It is estimated that 5% of fencing will be installed using this practice. In addition, it is expected that the Conservation Reserve Program will be utilized by farmers. For farmers who are willing to install a moderate riparian buffer, there is the CRP practice, which requires a 20 foot setback from the stream in order to receive cost share for fencing and off stream watering. It is estimated the approximately 8% of fencing would be installed using the CRP practice. For those who are willing to install a 35 foot buffer or larger and plant trees in the buffer, the Conservation Reserve Enhancement is an excellent option. This practice provides cost share ranging from 50% to 115% for fencing, planting materials, and alternative water source development. It is estimated that 57% of fencing will be installed through this program (Table 4).

Table 4. Livestock exclusion BMPs

Exclusion system	Linear Feet of Livestock Exclusion					
	Upper Middle	Jennings Branch	Moffett Creek	Middle Middle	Lower Middle	Polecat Draft
LE-1T	44,392	9,465	12,201	31,770	27,675	7,819
LE-2T	22,196	4,733	6,099	15,886	13,838	3,910
WP-2T	11,098	2,366	3,050	7,943	6,919	1,955
CRP	17,757	3,786	4,881	12,709	11,071	3,128
CREP	126,518	26,976	34,770	101,881	78,876	22,284
TOTAL	221,961	47,326	61,001	170,189	138,379	39,096

Additional Management Strategies

Photo: Bobby Whitescarver, NRCS

Evaluating alternatives to livestock exclusion

During both of the agricultural working group meetings, considerable concern was expressed by landowners regarding the 100% livestock exclusion goal in the TMDL. Despite the reduced setback requirements for streamside fencing in new state and federal cost share practices, landowners thought that there would still be situations where stream fencing would be highly impractical for a farmer. The group recommended that a combination of portable shade structures and off-stream watering be evaluated as a way to significantly reduce the amount of time livestock spend in the stream Native warm season grasses and control of fescue based fungi were recommended as additional strategies for reducing livestock body temperature, thereby reducing the amount of time cattle spend in the stream. Currently, the state agricultural BMP cost share program offers a tax credit for the development of an off-stream water source. However, working group participants argued that farmers will need additional financial assistance. The benefit of off stream watering and portable shade structures to water quality, specifically bacteria, is not well-known. Consequently, it is unlikely that state and federal conservation agencies will provide cost share for these practices. However, a pilot project to study the effects of these practices on water quality in the Middle River could be conducted. If livestock exclusion goals have not been achieved by the end of the project timeline, this combination of practices could be evaluated as an alternative.

Streambank restoration

During the second agricultural working group meeting, several participants expressed an interest in implementing some streambank restoration projects in the watersheds, particularly in the Upper Middle River watershed. This could include grading back streambanks where they have become severely incised and planting vegetation along the banks to hold eroding soil in place. The Upper Middle River and Moffett Creek watersheds were identified as the most suitable locations for streambank stabilization projects since they both have benthic impairments due to excess sediment. Consequently, three streambank restoration projects are included in the implementation plan, two in Upper Middle River and one in Moffett Creek. It is expected that each of these projects would include approximately 500 feet of streambank.

Straight Pipes and Failing Septic Systems

Since state law requires that failing septic systems and straight pipes be corrected once identified, this plan includes a 100% reduction in bacteria coming from these sources.

Estimates of the percentages of households served by failing septic systems and straight pipes in the watersheds are shown in Table 5. These estimates were developed as part of the TMDL study in 2004. They are based on the age of homes in the watershed, and in the case of straight pipes, the proximity of homes to the stream. Estimates of needed repairs and replacements of failing systems with conventional and alternative systems were based on input from the Health Department and observations from septic system maintenance projects in the area (Table 6).

Table 5. Estimated septic system failures and straight pipes in the watersheds.

BMP	Upper Middle	Jennings Branch	Moffett Creek	Middle Middle	Lower Middle	Polecat Draft	TOTAL
Total septic systems	1,540	715	421	1,493	572	175	567
Failing septic systems	345	166	87	359	140	40	553
Straight pipes	16	9	3	9	2	1	59

Table 6. Residential wastewater treatment BMPs

BMP	Upper Middle	Jennings Branch	Moffett Creek	Middle Middle	Lower Middle	Polecat Draft	TOTAL
Septic system repair	172	83	43	179	70	20	567
Septic system replacement	170	83	42	173	66	19	553
Alternative waste treatment system	19	10	5	17	6	2	59

Implementation Actions for Pasture

Runoff from pastures in the watersheds can carry with it bacteria from manure on the pasture, and can also pick up sediment on its way to the stream.

One pasture practice that will help water quality is improved pasture management through rotational grazing systems and rotational loafing lot systems. Vegetated buffers were also included in the implementation plan to treat runoff from pasture. These buffers will act as filters, trapping bacteria and sediment before it runs into the stream. When considering the effectiveness of a vegetated buffer in trapping pollutants, it is important to consider the area that will be draining to the buffer. In this plan, it was assumed that a typical buffer would be able to receive and treat runoff from an area four times its width. For example, a buffer that was 35 feet wide and 1,000 feet long would treat runoff from an area that was 140 feet wide and 1,000 feet long. Once you move beyond four times the buffer width, it was assumed that the runoff would be in the form of channelized flow rather than the sheet flow that a buffer can effectively trap (Table 7). Consequently, it is important to consider pasture management practices that reduce the transport of bacteria and sediment from upland pastures as well as those in close proximity to the stream.

Table 7. Pasture BMPs

BMP		BMP Acres					
		Upper Middle	Jennings Branch	Moffett Creek	Middle Middle	Lower Middle	Polecat Draft
Riparian buffer	35 ft width	589	31	40	105	91	26
	20 ft width	33	2	2	6	5	1
	10 ft width	21	1	1	4	3	1
Improved pasture management		28,786	4,988	7,606	17,986	12,358	2,089

Implementation Actions for Cropland


Photo: Jeff Vanuga, NRCS (2002)

Sediment can run off of cropland when soils are exposed to rainfall, and will make its way to the stream unless filtering practices like riparian buffers are in place to trap it.

Bacteria from the spreading of manure on cropland can end up in a stream unless the appropriate management practices are in place. Bacteria from manure spread on cropland can be reduced either by decreasing the source of the bacteria (spreading less manure or storing it longer so that bacteria will die off) or by the use of filtering practices (buffers), while sediment can be reduced by practices that increase vegetative cover and decrease soil disturbance, or provide filtering benefits (Table 8).

Table 8. Cropland BMPs needed

BMP	Units	Upper Middle	Jennings Branch	Moffett Creek	Middle Middle	Lower Middle	Polecat Draft	TOTAL
Poultry litter storage	system	5	4	4	4	4	2	22
Beef manure storage	system	6	4	5	5	5	2	27
Cropland buffers	acres	3.8	0.2	5.4	7.8	14.6	3.3	35.1
Continuous no-till	acres	508	108	156	329	589	71	1,761

Implementation Actions for Residential Areas

In order to address bacteria from domestic pets entering the stream, some form of pet waste management will be necessary.

A pet waste education program will help pet owners better understand the importance of picking up after their pets, whether it be in their own backyard, their neighbor's yard, or in public parks. This could include the installation of pet waste disposal stations in public parks where people walk their dogs. The installation of pet waste digesters by private homeowners will also assist in meeting goals to reduce bacteria from pet waste in the stream. The residential working group recommended that while this practice could be implemented in a small number of homes, it is unlikely that many residents in the watersheds would be interested. A pet waste digester is a compact unit that can be installed in a backyard by digging a small hole, which the unit is then fitted into. Pet waste is collected and added to the digester along with water and an enzyme that aids in the digestion of bacteria found in the waste. After sufficient time has been allowed for the breakdown of the material, it can then be applied to flower gardens and around trees as a fertilizer. There are some limitations of these digesters, including the fact that they do not operate below freezing temperatures. It is recognized that they will be impractical for homeowners who own several acres where their pets are free to roam. However, in areas of more compact residential development such as Verona and Churchville, it is expected that they could serve as a useful pet waste management strategy. Consequently, it was estimated that 25 pet waste digesters would be installed in the Jennings Branch and "Middle" Middle River watersheds (Table 9).

Table 9. Residential BMPs

BMP	Upper Middle	Jennings Branch	Moffett Creek	Middle Middle	Lower Middle	Polecat Draft	TOTAL
Pet waste education program	---	0.5	---	---	0.5	---	1
Pet waste digester	---	25	---	---	25	---	50

Education and Outreach

Photo: Lynn Betts, NRCS (2000)

In order to get landowners involved in implementation, it will be necessary to initiate education and outreach strategies and provide assistance with the design and installation of best management practices.

There must be a proactive approach to contact farmers and residents to articulate exactly what the TMDL means to them and what practices will help meet the goal of improved water quality. The working groups recommended several education/outreach techniques, which will be utilized during implementation. Outreach at county fairs has been successful in other watersheds in the past. There are also opportunities for joint events with the Virginia Cooperative Extension Service. Presentations at local Ruritan and Rotary clubs were mentioned as a good way to reach farmers as well. Residential working group participants noted that it will be important to conduct a mailing promoting programs to assist homeowners with septic system maintenance and the correction of straight pipes. Mailings for agricultural programs were not considered as effective. While making cold calls to farms are time consuming, this was identified as one of the most effective ways to reach farmers.

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

Agricultural Programs

- Make contact with landowners in the watersheds to make them aware of implementation goals, cost-share assistance, and voluntary options that are available to agricultural producers interested in conservation
- Provide technical assistance for agricultural programs (e.g., survey, design, layout).
- Develop and distribute educational materials

- Organize educational programs (e.g., County Fair, presentations at VCE events or club events)
- Handle and track cost-share
- Assess and track progress toward BMP implementation goals
- Coordinate use of existing agricultural programs and suggest modifications

Residential Programs

- Identify straight-pipes and failing septic systems (e.g., contact landowners in older homes, septic pump-out program)
- Handle and track cost-share
- Develop educational materials & programs
- Organize educational programs (e.g., demonstration septic pump-outs, pet waste control)
- Distribute educational materials (e.g., informational pamphlets on TMDL IP and on-site sewage disposal systems).
- Assess progress toward implementation goals

The staffing level needed to implement the agricultural and residential components of the plan were estimated based on discussions with stakeholders and the staffing levels used in similar projects. Staffing needs were quantified using full time equivalents (FTE), with one FTE being equal to one full-time staff member. It was determined that 2 FTEs would be needed to provide the technical assistance needed for agricultural and residential implementation.

Implementation Costs



Costs: Agricultural BMPs

The costs of agricultural best management practices included in the implementation plan were estimated based on data for Augusta County from the VADCR Agricultural BMP Database and considerable input from Headwaters SWCD and NRCS staff. When sufficient data were available, the search of the agricultural database for best management practices and their associated costs was limited to 2000 through 2008 so that estimates were as current as possible.

The total cost of livestock exclusion systems includes not only the costs associated with fence installation, repair, and maintenance, but also the cost of developing alternative water sources for LE-1T, LE-2T, CREP and CRP practices and installing hardened crossings for WP-2T practices. The cost of fence maintenance was identified as a deterrent to participation. Financial assistance possibilities for maintaining fences include an annual 25% tax credit for fence maintenance, and an up front incentive payment on $0.50 per linear foot to maintain stream fencing as part of the WP-2T practice. Typically the average cost of fence maintenance is significantly higher. In developing the cost estimates for fence maintenance, a figure of $3.50/linear foot of fence was used. It was estimated that approximately 10% of fencing would need to be replaced over the timeline of this plan.

The majority of agricultural practices recommended in the implementation plan are included in state and federal cost share programs. These programs offer financial assistance in implementing the practices and may also provide landowners with an incentive payment to encourage participation. For example, the CP-33 practice (Creation of Upland Bird Habitat) offers farmers an incentive payment of $100/acre and covers up to 90% of the costs of implementing the practice. Consequently, when assessing costs it is important to consider both the potential cost to the landowner as well as the cost to state and federal programs. Table 10 shows total agricultural BMP costs by watershed.

Table 10. Estimated agricultural BMP costs by watershed.

Practice	Cost share code	Units	Unit cost	Cost by watershed					
				Upper Middle	Jennings Branch	Moffett Creek	Middle Middle	Polecat Draft	Lower Middle
Livestock exclusion with riparian bufers	CREP	system	$25,460	$1,193,017	$254,376	$327,873	$853,827	$210,132	$725,610
	CRP	system	$23,500	$320,990	$68,442	$88,217	$229,729	$56,538	$199,750
	LE-1T	system	$23,500	$489,008	$104,267	$134,393	$349,977	$86,132	$293,750
	WP-2T	system	$5,084	$43,402	$9,254	$11,928	$31,062	$7,645	$22,878
Livestock exclusion with reduced setback	LE-2T	system	$15,000	$384,164	$81,912	$105,579	$274,941	$67,665	$239,501
Livestock exclusion fence maintenance (16 yrs)	N/A	feet	$3.50	$77,686	$16,564	$21,350	$55,599	$13,683	$48,432
Streambank stabilization	WP-2A	feet	$100	$10,000	$0	$5,000	$0	$0	$0
Improved pasture management	N/A	acres	$107	$3,080,102	$533,716	$813,842	$1,924,502	$223,523	$1,322,199
Cropland buffers	CP-33,WQ-1	acres	$258*	$1,005	$73	$1,368	$2,005	$861	$3,791
Continuous no-till	SL-15A	acres	$100	$50,749	$10,762	$15,677	$32,925	$7,040	$58,974
Poultry litter storage	WP-4,EQIP	facility	$38,000	$190,000	$152,000	$152,000	$152,000	$76,000	$152,000
Dry manure storage	WP-4,EQIP	facility	$58,000	$348,000	$232,000	$232,000	$290,000	$116,000	$290,000

*CP-33 and WQ-1 practice cost average (50:50)

Costs: Residential BMPs

The costs of recommended residential BMPs were estimated using:

1) Cost data from other watersheds in Augusta, Rockingham and Shenandoah Counties where residential septic system maintenance programs have been implemented in the past 8 years.
2) Cost data from the Shenandoah Valley Soil and Water Conservation District, who completed a grant to distribute pet waste digesters to Rockingham County residents in 2008.
3) Input from the Augusta County Health Department and Residential Working Group.

These costs are shown for each watershed in Table 11. Total BMP implementation costs are shown in Table 12.

Costs: Technical Assistance

Technical assistance costs were estimated for 2 full time positions using a cost of $50,000 per position per year. This figure is based on the existing staffing costs included in the Virginia Department of Conservation and Recreation's grant agreement with the Headwaters Soil and Water Conservation District to provide technical assistance to landowners in TMDL implementation watersheds. Based on the 16 year timeline of this plan (described in great detail in the Implementation Timeline section of this plan), this would make the total cost of technical assistance approximately $1,600,000. When factored into the cost estimate for BMP implementation shown in Table 12, this would make the total cost of implementation approximately $26.4 million.

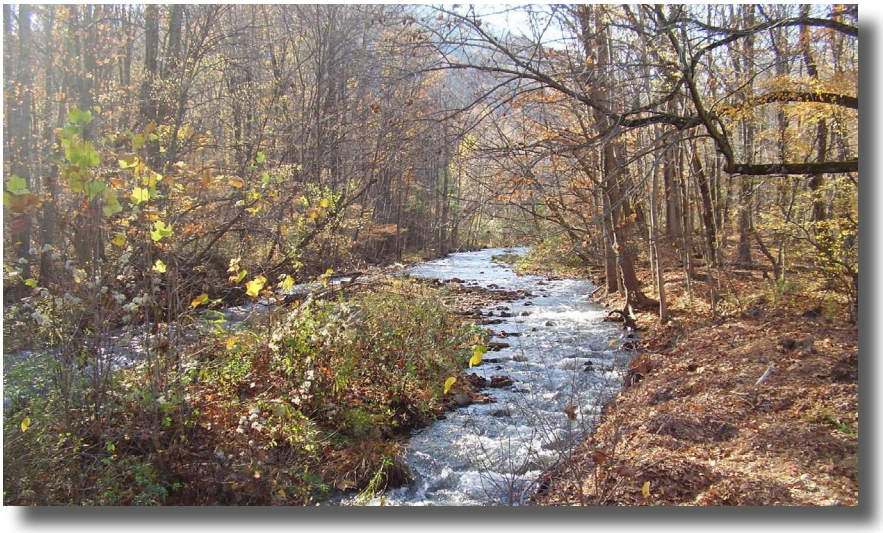
Table 11. Estimated residential BMP implementation costs.

Practice	Unit cost	Cost by Watershed					
		Upper Middle	Jennings Branch	Moffett Creek	Middle Middle	Polecat Draft	Lower Middle
Pet waste education prgm.	$3,750	$0	$1,875	$0	$1,875	$0	$0
Pet waste digesters	$60	$0	$1,500	$0	$1,500	$0	$0
Septic system repair (RB-3)	$3,000	$516,000	$249,000	$129,000	$537,000	$60,000	$210,000
Septic system replacement (RB-4)	$6,000	$876,000	$426,000	$216,000	$888,000	$102,000	$342,000
Alternative waste treatment system (RB-5)	$15,000	$645,000	$315,000	$165,000	$615,000	$60,000	$225,000

Table 12. Total estimated costs of full BMP implementation

Watershed	Agricultual BMPs	Residential BMPs	Total BMP Cost
Upper Middle	$6,188,123	$2,037,000	$8,225,123
Jennings Branch	$1,463,366	$993,375	$2,456,741
Moffett Creek	$1,909,227	$510,000	$2,419227
Middle Middle	$4,182,667	$2,043,375	$6,226,042
Lower Middle	$865,218	$222,000	$1,087,218
Polecat Draft	$3,356,886	$777,000	$4,133,886
TOTAL	$17,965,487	$6,582,750	$24,548,237

Implementation Benefits



The primary benefit of implementing this plan will be cleaner water in Middle River, Moffett Creek, Jennings Branch and Polecat Draft. Specifically, *E. coli* contamination in the creeks will be reduced to meet water quality standards, and sediment loading into Upper Middle River and Moffett Creek will be reduced to support a healthy aquatic community. It is hard to gage the impact that reducing *E. coli* contamination will have on public health, as most cases of waterborne infection are not reported or are falsely attributed to other sources. However, the incidence of infection from *E. coli* sources through contact with surface waters should be reduced considerably following the implementation of the measures outlined in this plan.

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

Benefits: Agricultural Practices

Restricting livestock access to streams and providing them with clean water source has been shown to improve weight gain and milk production in cattle (VCE, 2007). Studies have shown that increasing livestock consumption of clean water can lead to increased milk and butterfat production and increased weight gain (Landefeld et al, 2002). Table 13 shows an example of how this can translate into economic gains for producers.

In addition, keeping cattle in clean, dry areas has been shown to reduce the occurrence of mastitis and foot rot. The VCE (1998) reports that mastitis costs producers $100 per cow in reduced quantity and quality of milk produced. Installation of streamside fencing and well managed loafing areas will reduce the amount of time that cattle have access to these areas.

Implementing an improved pasture management system in conjunction with a clean water source will also provide economic benefits for the producer. Standing forage utilized directly by the grazing animal is always less costly and of higher quality than the same forage harvested with equipment and fed to the animal.

Table 13. Example of increased revenue due to installing off-stream waterers (Surber et al., 2005)

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

Note: Table from VCE: Streamside Livestock Exclusion (2007)

Benefits: Residential Practices

The residential program will play an important role in improving water quality since human waste can carry human viruses in addition to bacterial and protozoan pathogens. In terms of economic benefits to homeowners, an improved understanding of on-site sewage treatment systems, including knowledge of what steps can be taken to keep them functioning properly, will give homeowners the tools needed for extending the life of their systems and reducing the overall cost of ownership. The average septic system will last 20 to 25 years if properly maintained. Proper maintenance includes: knowing the location of the system components and protecting them (e.g., not driving or parking on top of them), not planting trees where roots could damage the system, keeping hazardous chemicals out of the system, and pumping out the septic tank every 3 to 5 years. The cost of proper maintenance, as outlined here, is relatively inexpensive ($225 per pumpout) in comparison to repairing or replacing an entire system ($6,000 to $22,500).

In addition to the benefits to individual landowners, the economy of the local community will be stimulated through expenditures made during implementation, and the infusion of dollars from funding sources outside the impaired areas. Building contractors and material suppliers who deal with septic system pump-outs, private sewage system repair and installation, fencing, and other BMP components can expect to see an increase in business during implementation.

In general, implementation will provide not only environmental benefits to the community, but economic benefits as well, which in turn, will allow for individual landowners to participate in implementation.

Implementation Timeline

The end goal of implementation is restored water quality in Middle River, Moffett Creek and Polecat Draft. It is expected that this will occur over a 16-year period of implementation. Two types of milestones will be used to evaluate progress over the 16 year period: *implementation milestones and water quality milestones*. The implementation milestones establish goals for the extent of the different best management practices installed within certain time frames, while the water quality milestones establish the corresponding goals for improvements in water quality.

The timeline for implementation has been divided into four stages with each stage spanning a period of four years. Resources and finances will be concentrated on the most cost-efficient best management practices first. Watersheds that were identified as a higher priority by landowners (e.g. Upper Middle River) will be addressed first, while watersheds that were assigned a lower priority such as Polecat Draft will be addressed in the later stages of the timeline. Tables 14-19 show implementation and water quality improvement goals for *E. coli* bacteria for each watershed in each implementation stage. It is expected that Upper Middle River, Moffett Creek and Middle Middle River will be removed from the impaired waters list for violations of the *E. coli* standard by the end of Stage 2. In order to be removed from the impaired waters list, a stream cannot violate the *E. coli* standard more than 10.5% of the time. Lower Middle River would achieve this goal by the end of Stage 3, and Polecat Draft at the end of Stage 4. Table 20 provides the associated sediment reductions expected to occur in Stages 1 and 2 of implementation in Moffett Creek and Upper Middle River.

Table 14. Timeline for implementation in Upper Middle River

Land use	BMP	Units	Stage 1	Stage 2	Stage 3	Stage 4
Pasture	Riparian buffer: CREP	systems	24	23	0	0
	Riparian buffer: CRP	systems	7	7	0	0
	Riparian buffer: LE-1T	systems	11	10	0	0
	Riparian buffer: LE-2T	systems	13	13	0	0
	Stream protection: WP-2T	systems	5	4	0	0
	Improved pasture management	acres	14,396	14,396	0	0
Pasture and Cropland	Poultry litter storage: WP-4/EQIP	facilities	2	3	0	0
	Dry manure storage: WP-4/EQIP	facilities	3	3	0	0
	Streambank stabilization: WP-2A	linear ft	0	1,000	0	0
Cropland	Cropland buffer: CP-33/WQ-1	acres	1.9	1.9	0	0
	Continuous no-till: SL-15A	acres	254	254	0	0
Residential	Septic system repairs: RB-3	repairs	43	129	0	0
	Septic system replacement: RB-4	systems	48	122	0	0
	Alternative waste treatment: RB-5	sytems	11	8	0	0
% Violation of instantaneous standard (current = 38%)			17	2	2	2
% Violation of geometric mean standard (current = 80%)			52	0	0	0

Table 15. Timeline for implementation in Jennings Branch

Land use	BMP	Units	Stage 1	Stage 2	Stage 3	Stage 4
Pasture	Riparian buffer: CREP	systems	0	5	5	0
	Riparian buffer: CRP	systems	0	2	1	0
	Riparian buffer: LE-1T	systems	0	2	2	0
	Riparian buffer: LE-2T	systems	0	3	3	0
	Stream protection: WP-2T	systems	0	1	1	0
	Improved pasture management	acres	0	2,494	2,494	0
Pasture and Cropland	Poultry litter storage: WP-4/EQIP	facilities	0	2	2	0
	Dry manure storage: WP-4/EQIP	facilities	0	2	2	0
Cropland	Cropland buffer: CP-33/WQ-1	acres	0	0	0.3	0
	Continuous no-till: SL-15A	acres	0	54	54	0
Residential	Septic system repairs: RB-3	repairs	20	21	42	0
	Septic system replacement: RB-4	systems	24	20	39	0
	Alternative waste treatment: RB-5	systems	7	1	2	0
	Pet waste education program	program	0	0	1	0
	Pet waste digesters	digesters	0	0	25	0
% Violation of instantaneous standard (current = 9%)			7	6	6	6
% Violation of geometric mean standard (current = 42%)			37	13	0	0

Table 16. Timeline for implementation in Moffett Creek

Land use	BMP	Units	Stage 1	Stage 2	Stage 3	Stage 4
Pasture	Riparian buffer: CREP	systems	7	6	0	0
	Riparian buffer: CRP	systems	2	2	0	0
	Riparian buffer: LE-1T	systems	3	3	0	0
	Riparian buffer: LE-2T	systems	4	3	0	0
	Stream protection: WP-2T	systems	1	1	0	0
	Improved pasture management	acres	3,804	3,804	0	0
Pasture and Cropland	Poultry litter storage: WP-4/EQIP	facilities	2	2	0	0
	Dry manure storage: WP-4/EQIP	facilities	2	2	0	0
	Streambank stabilization	linear ft	0	500	0	0
Cropland	Cropland buffer: CP-33/WQ-1	acres	2.7	2.7	0	0
	Continuous no-till: SL-15A	acres	78	78	0	0
Residential	Septic system repairs: RB-3	repairs	10	33	0	0
	Septic system replacement: RB-4	systems	12	30	0	0
	Alternative waste treatment: RB-5	systems	3	2	0	0
% Violation of instantaneous standard (current = 34%)			16	0	0	0
% Violation of geometric mean standard (85%)			63	5	5	5

Table 17. Timeline for implementation in Middle Middle River

Land use	BMP	Units	Stage 1	Stage 2	Stage 3	Stage 4
Pasture	Riparian buffer: CREP	systems	0	9	8	17
	Riparian buffer: CRP	systems	0	3	2	5
	Riparian buffer: LE-1T	systems	0	4	4	7
	Riparian buffer: LE-2T	systems	0	5	5	9
	Stream protection: WP-2T	systems	0	2	2	3
	Improved pasture management	acres	0	4,497	4,498	8,995
Pasture and Cropland	Poultry litter storage: WP-4/EQIP	facilities	0	0	1	3
	Dry manure storage: WP-4/EQIP	facilities	0	0	1	4
Cropland	Cropland buffer: CP-33/WQ-1	acres	0	0	0	7.8
	Continuous no-till: SL-15A	acres	0	0	82	247
Residential	Septic system repairs: RB-3	repairs	44	45	90	0
	Septic system replacement: RB-4	systems	47	42	84	0
	Alternative waste treatment: RB-5	systems	8	3	6	0
	Pet waste education program	program	0	0	1	0
	Pet waste digesters	digesters	0	0	25	0
% Violation of instantaneous standard (current = 12%)			9	6	6	5
% Violation of geometric mean standard (current = 72%)			57	3	3	0

Table 18. Timeline for implementation in Polecat Draft

Land use	BMP	Units	Stage 1	Stage 2	Stage 3	Stage 4
Pasture	Riparian buffer: CREP	systems	0	0	4	4
	Riparian buffer: CRP	systems	0	0	1	1
	Riparian buffer: LE-1T	systems	0	0	2	2
	Riparian buffer: LE-2T	systems	0	0	3	2
	Stream protection: WP-2T	systems	0	0	1	1
	Improved pasture management	acres	0	0	1,045	1,045
Pasture and Cropland	Poultry litter storage: WP-4/EQIP	facilities	0	0	0	2
	Dry manure storage: WP-4/EQIP	facilities	0	0	0	2
Cropland	Cropland buffer: CP-33/WQ-1	acres	0	0	0	3.3
	Continuous no-till: SL-15A	acres	0	0	18	53
Residential	Septic system repairs: RB-3	repairs	5	5	10	0
	Septic system replacement: RB-4	systems	5	5	9	0
	Alternative waste treatment: RB-5	systems	1	0	1	0
% Violation of instantaneous standard (current = 46%)			46	46	30	6
% Violation of geometric mean standard (current = 92%)			92	92	72	3

Table 19. Timeline for implementation in Lower Middle River

Land use	BMP	Units	Stage 1	Stage 2	Stage 3	Stage 4
Pasture	Riparian buffer: CREP	systems	0	15	14	100
	Riparian buffer: CRP	systems	0	5	4	0
	Riparian buffer: LE-1T	systems	0	7	6	0
	Riparian buffer: LE-2T	systems	0	8	8	0
	Stream protection: WP-2T	systems	0	3	2	0
	Improved pasture management	acres	0	6,180	6,180	0
Pasture and Cropland	Poultry litter storage: WP-4/EQIP	facilities	0	2	2	0
	Dry manure storage: WP-4/EQIP	facilities	0	3	2	0
Cropland	Cropland buffer: CP-33/WQ-1	acres	0	7.3	7.3	0
	Continuous no-till: SL-15A	acres	0	295	295	0
Residential	Septic system repairs: RB-3	repairs	17	18	35	0
	Septic system replacement: RB-4	systems	17	16	33	0
	Alternative waste treatment: RB-5	systems	3	1	2	0
% Violation of instantaneous standard (current = 26%)			21	19	4	4
% Violation of geometric mean standard (current = 92%)			73	43	0	0

Table 20. Sediment loads by stage for Upper Middle River and Moffett Creek. Note: All BMPs will have been installed by the end of Stage 2 in these two watersheds

Watershed	Land Use	Existing load (T/yr)	TMDL load (T/yr)	Stage 1 load (T/yr)	Stage 2 load (T/yr)
Upper Middle River	Cropland	1,439	676	1433.5	1.428
	Pasture	10,355	4,504	5,996.7	1,865.7
Moffett Creek	Cropland	1,019	611	1,007.7	996.8
	Pasture	8,385	2,854	4,661.1	1,486.8

Table 21. Implementation costs by stage

Stage	Agricultural BMPs	Residential BMPs	Technical Assistance
Stage 1 (Years 1-4)	$4,048,402	$1,998,750	$400,000
Stage 2 (Years 5-8)	$7,376,065	$2,682,750	$400,000
Stage 3 (Years 9-12)	$3,806,918	$1,901,250	$400,000
Stage 4 (Years 13-16)	$2,734,101	$0	$400,000
Total	$17,965,486	$6,582,750	$1,400,000

Targeting Implementation

Implicit in the process of a staged implementation is targeting of best management practices. Targeting ensures optimum utilization of limited technical and financial resources. In order to determine where outreach efforts should be focused in the early stages of implementation, all of the watershed were ranked in terms of implementation priority based on the criteria below:

1) Landowner interest
2) Proximity to headwaters
3) Future land use and development plans/land conservation
4) Ecological value
5) Recreational use
6) Fencing efficiency (number of livestock excluded per foot of fence installed)
7) Water quality (impaired or not impaired)

Figure 2 shows the results of this prioritization process. It should be noted that technical and financial assistance should not be denied based on the priority ranking of the watershed where a landowner resides. The intent of prioritizing the watersheds for outreach and implementation is to provide conservation providers with some guidance on where their efforts may produce the greatest benefits with respect to both water quality and landowner interest.

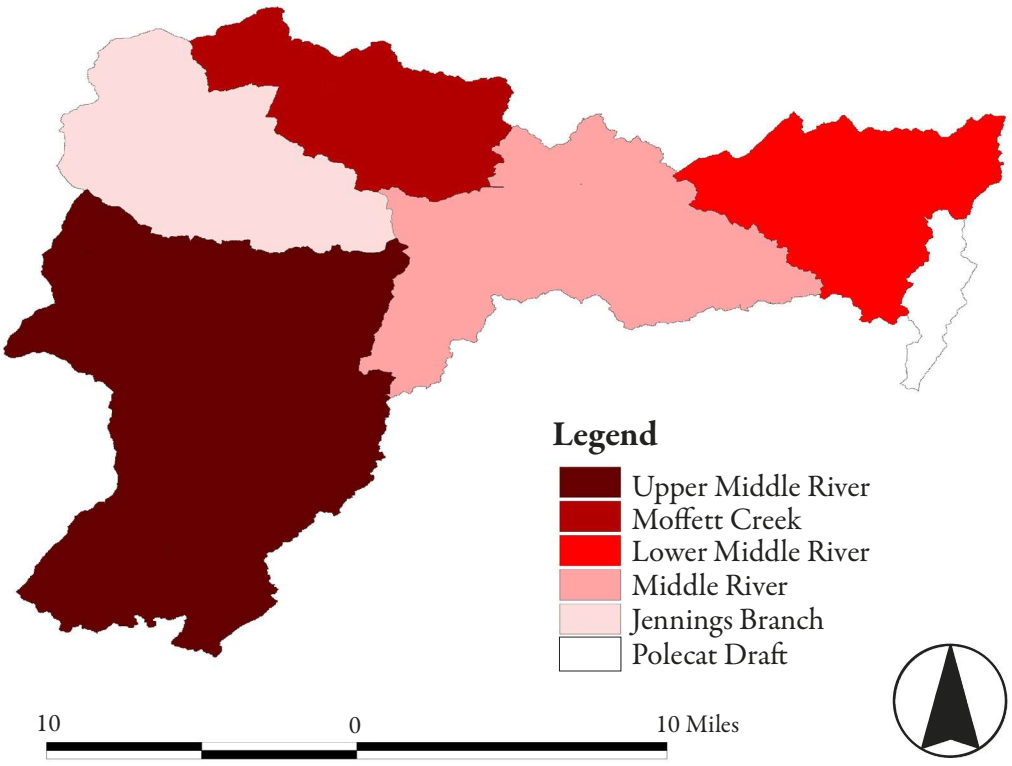


Figure 2. Watershed prioritization. Note: The watersheds are arranged by prioirity for implementation in the legend with the darker shades indicating a higher priority.

Partners And Their Role In Implementation

Voluntary Implementation Efforts

The majority of practices recommended in this plan are related to agriculture, which is the predominant land use in the watersheds. This makes participation from local farmers a key factor to the success of this plan. Consequently, Headwaters SWCD and NRCS conservation staff often consider characteristics of farms and farmers in the watersheds that will affect the decisions farmers make when it comes to implementing conservation practices. For example, the average size of farms is an important factor to consider, since it affects how much cropland or pasture a farmer can give up for a riparian buffer. The age of a farmer, which was 57 in Virginia in 2007, may also influence their decision to implement best management practices. If a farmer is close to retirement and will be relying on the sale of their land for income during retirement, it is less likely that the farmer would be willing or able to invest in best management practices. Table 22 provides a summary of relevant characteristics of farms and producers in Augusta County from the 2007 Agricultural Census. These characteristics were considered when developing implementation scenarios, and should be utilized to develop suitable education and outreach strategies.

Table 22. Characteristics of farms and farmers in Augusta County.

Characteristic	#
Number of farms	1,729
Full owners of farms	1,118
Part owners of farms	652
Tenants	97
Owned land in farms (acres)	72,918
Rented land in farms (acres)	82,596
Operators identifying farming as their primary occupation	854
Operators identifying something other than farming as their primary occupation	732
Average size of farm (acres)	166
Average value of farmland ($/acre)	$4,897
Average net cash farm income of operation ($)	$20,338
Average farm production expenses ($)	$96,292

In addition to local farmers, participation from homeowners is also critical to the success of this plan. Though the amount of bacteria that is coming from failing septic systems and straight pipes is minimal compared to livestock, human waste carries with it pathogens that can cause health problems above and beyond those associated with livestock waste.

Integration with Other Watershed Plans

Each watershed in the state is under the jurisdiction of a multitude of water quality programs and activities, many of which have specific geographic boundaries and goals. Coordination of the implementation project with these existing programs could make additional resources available and increase participation by local landowners.

Augusta County Comprehensive Plan

The Natural Resources Section of the Augusta County Comprehensive Plan prioritizes natural resource conservation by watershed. The Comprehensive Plan identifies Priority Agricultural Watersheds based on the percentage of land they have in Agricultural Conservation Areas. A portion of the Upper Middle River watershed (Eidson Creek), the Lower Middle watershed and the Moffett Creek watershed are listed as Priority Agricultural Watersheds. These watersheds should receive a high priority ranking for agricultural implementation since it is more likely that land in these areas will remain in agriculture.

Augusta County Agricultural Task Force

In 2005, an Agricultural Task Force was formed in order to provide the County with a review of existing ordinances and policies with respect to their support of agriculture in the region. Several of the recommendations provided in this report should be integrated into implementation efforts including:

- Establishment of a mentorship program for younger producers – principles of conservation based farming could be included in this program
- Establish a Purchase of Development Rights Program – agricultural conservation efforts should be targeted in agricultural zones and protected lands
- Conduct watershed surveys in cooperation with the Headwaters SWCD
- In addition, the report includes a list of significant agricultural events in the area. This list should be used to identify opportunities to distribute information to farmers about the best management practices included in this plan:

  - Virginia Cattleman's Convention
  - Virginia State Dairyman's Convention
  - Virginia Farm Show
  - Augusta County Fair
  - Virginia Beef Expo
  - Virginia Agricultural Expo
  - Breeders shows
  - Market Animal Show

Monitoring Water Quality

Improvements in water quality and implementation progress will be determined through monitoring conducted by the VA Department of Environmental Quality's ambient and biological monitoring programs. Each stream will be visited once a month by DEQ monitors (Figure 3). DEQ will also continue to monitor the biological health of Upper Middle River and Moffett Creek by sampling the benthic community in the Fall or Spring once a year. The results of this monitoring will be used to determine how effective implementation efforts to reduce sediment loading to the creeks has been. Other groups are also monitoring the streams. Friends of the Shenandoah River (FOSR) has a strong presence in the entire Shenandoah River Basin, including Augusta County. Their monitors collect water samples every

other week which are tested for water column toxics and then reported to DEQ. DEQ is able to use this data for listing and delisting streams as impaired in their biannual report to EPA. In addition, the US Geological Survey and the US Forest Service have several monitoring sites located in the Jennings Branch and Moffett Creek watersheds.

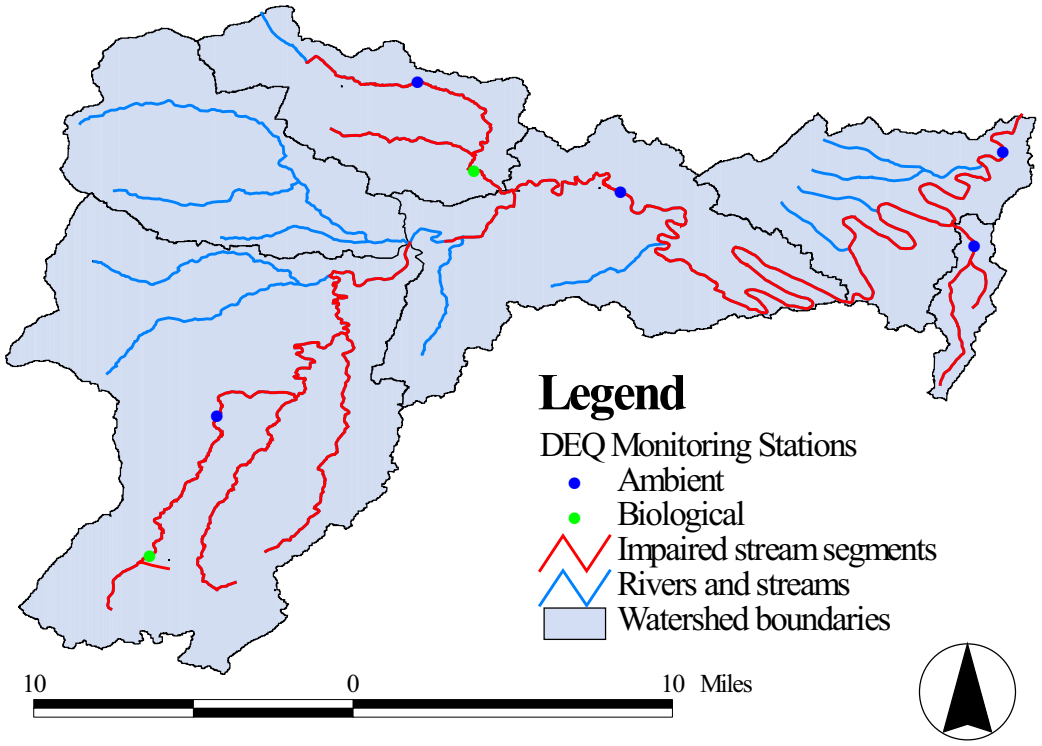


Figure 3. Virginia DEQ water quality monitoring stations in the Middle River, Moffett Creek and Polecat Draft

Agricultural and Residential Education and Outreach

During the implementation project, the Headwaters SWCD and NRCS will continue to reach out to farmers in the Middle River watersheds and provide them with technical and financial assistance with conservation practices. Their responsibilities include promoting available funding and the benefits of BMPs and providing assistance in the survey, design, and layout of agricultural BMPs. The SWCD and NRCS staff will conduct outreach activities in the watershed to encourage participation in conservation programs. Such activities include mailing out newsletters and organizing field days. The staff will work with other conservation organizations such as VA Cooperative Extension in these efforts. A residential education program consisting of educational materials about pet waste and a pet waste digester program could be run through a partnership between the Headwaters SWCD, the Augusta County Service Authority and the Augusta County SPCA. These organizations could assist in the distribution of information on the importance of picking up after your pet including the potential for contamination of drinking water for homeowners with wells.

Funding for Implementation

A list of potential funding sources available for implementation has been developed. Detailed descriptions can be obtained from the Headwaters SWCD, VADCR, Natural Resources Conservation Service (NRCS), and Virginia Cooperative Extension (VCE). While funding is being provided to the Headwaters SWCD for agricultural BMPs and technical assistance for farmers, an additional funding commitment is needed for the residential program. While the Headwaters SWCD is currently working with the Augusta County Service Authority to conduct septic system repairs and replacement, this project and associated funding comes to an end in 2009.

Virginia Agricultural Best Management Practices Cost-Share Program

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

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. The amount of the credit cannot exceed $17,500 or the total amount of the tax imposed by this program (whichever is less) in the year the project was completed. This program can be used 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 Agricultural Best Management Practices Loan Program

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

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 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. To be eligible for assistance, a business must employ 100 or fewer people and be classified as a small business under the federal Small Business Act.

Virginia Water Quality Improvement Fund

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

Conservation Reserve Program (CRP)

Through this program, cost-share assistance is available to establish cover of trees or herbaceous vegetation on cropland. To be eligible for consideration, the following criteria must be met: 1) cropland was planted or considered planted in an agricultural commodity for two of the five most recent crop years, and 2) cropland is classified as "highly-erodible" by NRCS. The payment to the participant is up to 50% of the cost for establishing ground cover.

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 and rental rates, and offering a flat rate incentive payment to place a permanent "riparian easement" on the enrolled area. Additional federal incentives can bring the effective cost share rate up to 115% of eligible expenses. Pasture and cropland adjacent to streams, seeps, springs, ponds and sinkholes are eligible to be enrolled. Buffers consisting of native, warm-season grasses on cropland, and mixed hardwood trees on pasture, must be established in widths ranging from the minimum of 30% of the floodplain or 35 feet, whichever is greater, to a maximum average of 300 feet. 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. The State of Virginia will make an additional payment to place a perpetual easement on the enrolled area.

Environmental Quality Incentives Program (EQIP)

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. 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.

Wildlife Habitat Incentive Program (WHIP)

WHIP is a voluntary program for landowners who want to develop or improve wildlife habitat on private agricultural lands. Participants work with NRCS to prepare a wildlife habitat development plan. This plan describes the landowner's goals for improving wildlife habitat and includes a list of practices and a schedule for installation. A 10-year contract provides cost-share and technical assistance to carry out the plan. Cost-share assistance of up to 75% of the total cost of installation (not to exceed $10,000 per applicant) is available for establishing habitat. Types of practices include: disking, prescribed burning, mowing, planting habitat, converting fescue to warm season grasses, establishing riparian buffers, creating habitat for waterfowl, and installing filter strips, field borders and hedgerows.

Wetland Reserve Program (WRP)

This program is a voluntary program to restore and protect wetlands on private property. Landowners who choose to participate in WRP may receive payments for a conservation easement or cost-share assistance for a wetland restoration agreement. The landowner will retain ownership but voluntarily limits future use of the land. To be eligible for WRP, land must be suitable for restoration (formerly wetland and drained) or connect to adjacent wetlands. A landowner continues to control access to the land and may lease the land for hunting, fishing, or other undeveloped recreational activities.

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

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

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. If the project does not fall into the criteria of any special grant programs, a proposal may be submitted as a general grant if it falls under the following guidelines: 1) it promotes fish, wildlife and habitat conservation, 2) it involves other conservation and community interests, 3) it leverages available funding, and 4) project outcomes are evaluated.

Chesapeake Bay Watershed Initiative

This initiative was authorized in the 2008 Farm Bill for 2009-2012. It provides technical and financial assistance to producers to implement practices that reduce sediment and nutrients to help protect and restore the Chesapeake Bay. Prioirity has been given to the Shenandoah and Potomac River Basins and selected watersheds that have impaired streams due to high levels of nutrients and sediment. Producers who live in an NRCS high priority Cheasapeake Bay watershed receive additional consideration in the funding ranking process.

Virginia Natural Resources Commitment Fund

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

Clean Water State Revolving Fund

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

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 which provides compensation for aquatic resources in financially and environmentally preferable ways. Not every site or property is suitable for mitigation banking. Wetlands and streams are complex systems, and their restoration, creation, enhancement, or preservation often requires specialized ecological and engineering knowledge. Likewise, the mitigation banking process requires experience to efficiently navigate. Mitigation banks are required to be protected in perpetuity, to provide financial assurances, and long term stewardship. The mitigation banking processes is overseen by the Inter-Agency Review Team (IRT) consisting of several state and federal agencies and chaired by DEQ and Army Corps of Engineers. For more information, contact the Army Corps of Engineers or VADEQ's Virginia Water Protection Program.

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