SMITH CREEK

Water Quality Improvement Plan

A plan to reduce bacteria and sediment in Smith Creek

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In Cooperation With:
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Virginia Department of Conservation and Recreation (DCR)
DCR Mid-Atlantic Highlands Action Program

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Natural Resources Conservation Service
Valley Conservation Council
Friends of the North Fork Shenandoah River
Northern Shenandoah Valley Regional Commission
Shenandoah Riverkeeper
Mountain Valley Retreat Center

For additional information, please contact:

Virginia Department of Environmental Quality (VADEQ)
Valley Regional Office, Harrisonburg: Tara Sieber, (540) 574-7870
Virginia Department of Conservation and Recreation (VADCR)
Staunton Office: Nesha Mizel, (540) 332-9238

10 Things You Can Do To Help Smith Creek

Everyone lives in a watershed, which includes a region of land area that drains to a particular body of water, such as a lake or stream. This means that everyone can affect the health of the water they use and enjoy every day. However, the health of our water depends on you, as a watershed resident, to manage and care for your property responsibly.

1. Restore and maintain a vegetated streamside buffer (aka "riparian buffer") to reduce stream bank erosion and keep fertilizer and animal waste out of streams.
2. Fence livestock away from streams and provide them with clean, alternative water sources which will improve their health and keeps bacteria and sediment out of streams.
3. Plant cover crops and use rotational grazing to reduce erosion.
4. Work with you local Soil and Water Conservation District or Natural Resource Conservation Service office to develop a farm management plan and to install "best management practices" to conserve and protect soil and water, to benefit your livestock, and your wallet.
5. Have crop, garden and lawn soils tested through your local Virginia Cooperative Extension office and use fertilizers at calculated application rates to prevent runoff and stream pollution.
6. Avoid dumping anything in sink holes which can pollute groundwater and ultimately surface waters. If you have a sink hole that someone used as a dump in the past, you can seek financial assistance from the VA Department of Conservation and Recreation to clean it out.
7. Pump out the solids that accumulate in the bottom of your septic tank every three to five years to ensure proper functioning and to prevent pollution to streams and ground water.
8. Landscape with native plants, including wildflowers, shrubs, and trees, which is pleasing to the eye and contributes to healthy watersheds by reducing the need for nutrient additives and extra watering.
9. Minimize impervious surface areas, such as pavement, to reduce stormwater runoff.
10. Protecting farms and forests from intensive development helps sustain natural and cultural resources and supports local economies that are dependent on agricultural and forestal land uses. Conservation easements and other protection tools are available to landowners who wish to voluntarily protect their land and related resources.

Technical and Financial Resources to Help You

For help with riparian buffers, fencing livestock out of streams, planting cover crops and implementing rotational grazing and farm management plans:

USDA Natural Resources Conservation Service

Rockingham County:
1934 Deyerle Ave.
Harrisonburg, VA 22801
(540)433-9126

Shenandoah County
722 East Queen Street
Strasburg, VA 22657
(540)465-2424

For help with soil testing on your property:

Virginia Cooperative Extension Service

For help with sinkhole clean-outs and protection:

Virginia Department of Conservation and Recreation
Staunton Regional Office
44 Sangers Lane, Suite 102
Staunton, VA 24401
(540)332-9991

For help with septic system maintenance:

Virginia Department of Health

For help with landscaping with native plants:

Virginia Native Plant Society
400 Blandy Farm Lane, Unit 2
Boyce, VA 22620
(540)837-1600

Virginia Department of Forestry
P.O. Box 121
Woodstock, VA 22664
(540)459-3151

For help with land conservation:

Valley Conservation Council
18 Barristers Row
Staunton, VA 24401
(540)886-3541

Virginia Outdoors Foundation
11 E. Beverly Street
Staunton, VA 24401
(540)886-2460

1) INTRODUCTION

Background : Total Maximum Daily Loads (TMDLs)

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

A TMDL was developed for Smith Creek in June 2004 when water quality monitoring showed:

1) Smith Creek was violating the State's water quality standard for bacteria, which is based on the concentration of *E. coli* in the water (the *E.coli* bacteria count should not exceed a geometric mean of 126 cfu per 100 mL of water for two or more samples taken over a 30-day period, and it should not exceed 235 cfu per 100 mL at any time). *E. coli* comes from the gut of warm-blooded animals, and can pose a threat to human health including gastrointestinal illness following injestion, or infection.

2) Smith Creek was 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 Smith Creek was not meeting this designation. The primary stressor on the aquatic community was identified as sediment.

The Smith Creek TMDL specified the maximum bacteria and sediment loads that creek can handle and still meet the water quality standard for bacteria while also supporting a healthy and diverse aquatic population.

Smith Creek TMDL Implementation Plan

Once a TMDL is developed, measures must be taken to reduce pollution levels in the stream. A TMDL Implementation Plan describes those measures, which can include the use of better treatment technology and the installation of best management practices (BMPs), to be implemented in order to meet the water quality goals established by the TMDL. There are nine components included in the 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 bacteria and sediment 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/or the sources and authorities that will be relied upon to implement the watershed-based plan.
5. 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. A schedule for implementing the management measures identified in the plan
7. Goals and milestones for implementing management measures or other control actions
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

2) REVIEW OF TMDL STUDY

Characteristics of the Smith Creek Watershed

The Smith Creek watershed (all of the land that drains to Smith Creek) is located in the Shenandoah River Basin in Shenandoah and Rockingham counties, with a small portion of the headwaters located in the City of Harrisonburg, Virginia (Figure 1). The watershed is approximately 67,900 acres in size and land use is predominantly forest and agricultural. Approximately 50% of the watershed is forested and 47% is agricultural. Residential and commercial development account for less than 4% of the watershed. Smith Creek flows north from its headwaters to its confluence with the North Fork Shenandoah River.

Sources of Bacteria in Smith Creek

Agricultural runoff and wildlife have been identified as the primary sources of bacteria. Nonpoint sources of bacteria include failing septic systems and straight pipes, livestock (including manure application loads), wildlife, and domestic pets. Point sources, such as municipal sewage treatment plants, can contribute bacteria loads to surface waters through effluent discharges. At the time of the TMDL study, there were 38 point source permits in the Smith Creek watershed, including a Municipal Separate Storm Sewer System (MS4) permit that was issued to the City of Harrisonburg to help control impacts caused by stormwater runoff from urban areas.

Sources of Sediment in Smith Creek

Sediment sources can be divided into point and nonpoint sources. The sediment in Smith Creek comes primarily from non point source pollution. The major sources of sediment are agricultural land and urban land. Agricultural lands, such as cropland and pasture/hay areas, can contribute excessive sediment loads through erosion and build-up/washoff processes. Agricultural lands are particularly susceptible to erosion due to less vegetative coverage. Point sources in the Smith Creek watershed also discharge sediment to the stream.

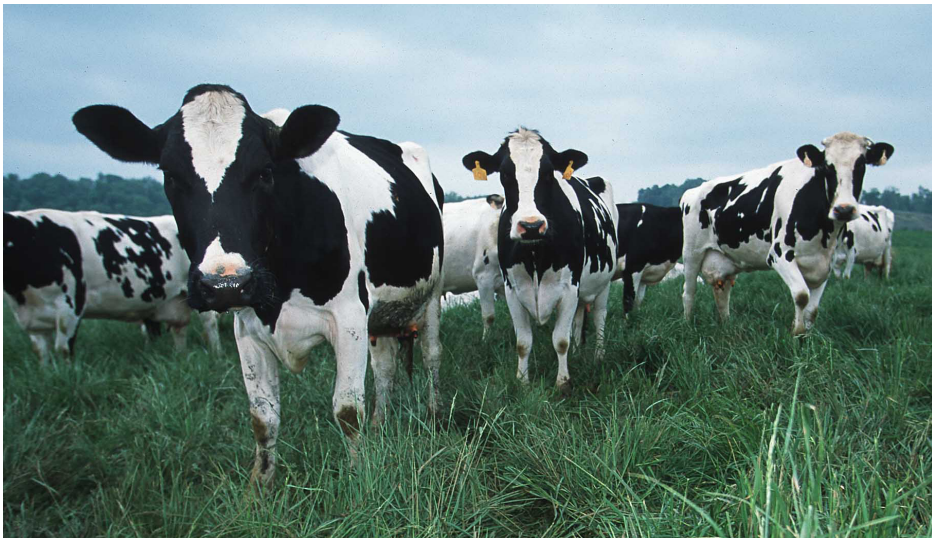


Photo: Jeff Vanuga, NRCS (2002)

Goals for Reducing Bacteria

The TMDL study completed for Smith Creek in 2004 identified goals for reducing bacteria from different sources in the watershed. 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 in Smith Creek

Direct (Instream) Sources			**Indirect (Land based) Sources**			
Straight Pipes	Livestock	Wildlife	Cropland	Pasture	Urban	Forest
100%	95%	0%	92%	92%	95%	0%

Goals for Reducing Sediment

Sediment was identified as the primary pollutant stressing the benthic community (aquatic insects that live at the bottom of the stream). 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 Smith Creek TMDL. The recommended sediment reduction scenario for Smith Creek is shown in Table 2. No reduction in sediment coming from forest lands was called for based on the assumption that some sediment would enter the stream from the forest under natural, undisturbed conditions. Also, 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 Smith Creek

Source	**Sediment load (lbs/yr)**	**% Reduction**
Forest	299,718	0%
Pasture/Hay	19,040,555	22%
Crop	4,221,267	22%
Transitional	363,059	22%
Urban	77,623	22%
MS4	334,069	22%
Point source	19,798	0%

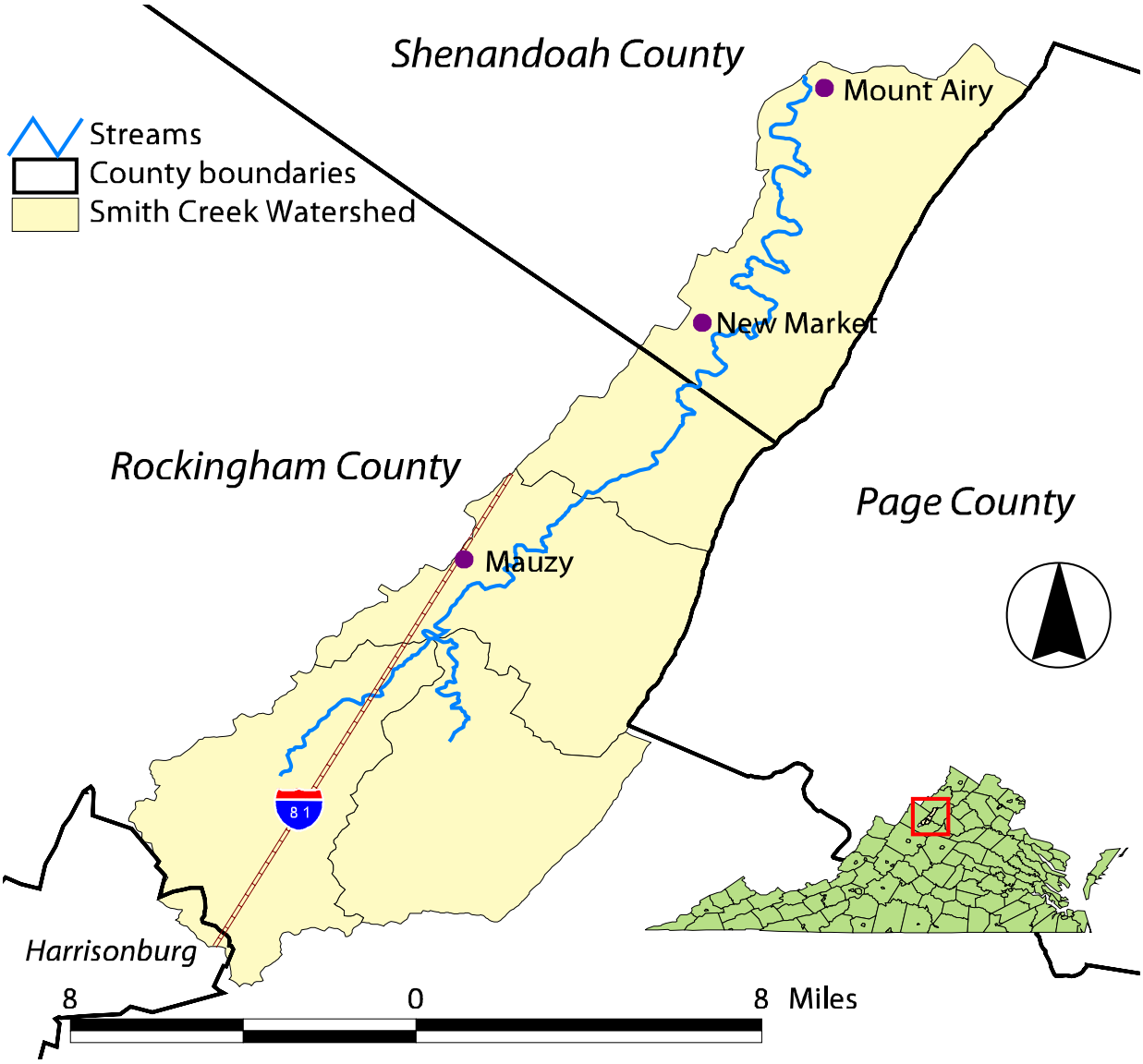


Figure 1. Location of the Smith Creek watershed

3) IMPLEMENTATION ACTIONS

Photo: Mike Phillips, Shenandoah Valley SWCD

An important part of the implementation plan is the identification of specific actions needed to improve water quality in the watersheds. Since this plan is designed to be implemented by landowners on a voluntary basis, it is necessary to identify 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 have been identified for implementation, we must also develop an estimate of the number of each action that would be needed in order to meet the water quality goals established during the TMDL study.

Management Actions Selected through Stakeholder Review

In addition to the management actions that were directly prescribed by the TMDL, such as livestock exclusion and straight pipe removal, a number of measures were needed to control fecal bacteria and sediment from land-based sources. Various scenarios were developed and presented to working groups, who considered both their economic costs and the water quality benefits that they produced. 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 to estimate needs are listed in Table 3.

Quantifying Practices by Pollutant Source

This section provides a summary of what is needed to achieve the pollutant load reductions specified in the TMDL. Best management practices that were installed since the completion of the TMDL study were credited towards the final extent needed of each practice.

Table 3. Best management practices and associated pollutant reductions

BMP	% Reduction		Source
	Bacteria	Sediment	
Agricultural BMPs			
Grass riparian buffer*	40%	40%	1, 2
Forested riparian buffer*	40%	40%	1, 2
Reforestation of erodible pasture	simulated	simulated	3
Critical area stabilization	simulated	simulated	3
Contour stripcropping	1-P factor	1-P factor	2,19
Cover crop	20%	20%	2, 4
Manure injection	90%	N/A	5
Manure storage facility: beef & dairy	75%	N/A	10
Poutry litter storage facility	99%	N/A	8
Turkey litter storage facility	75%	N/A	10
Livestock exclusion fencing	100%	N/A	6
Adaptive livestock exclusion fencing	100%	N/A	6
Improved pasture management	92%	92%	2, 7
Winter feeding facility	75%	N/A	11
Agricultural sinkhole protection	-------	--------	-------
Suburban/Urban BMPs			
Pet waste education program	75%	N/A	8
Street sweeping	22%	22%	2, 9
Rain garden*	85%	85%	2, 6
Bioretention filter*	85%	85%	2, 6
Enhanced erosion and sediment mgmt.	N/A	40%	1
Residential Wastewater BMPs			
Septic tank pumpout	5%	N/A	6
Connection to public sewer	100%	N/A	6
Septic system repair	100%	N/A	6
Septic system replacement	100%	N/A	6
Septic system replacement w/pump	100%	N/A	6
Alternative waste treatment system	100%	N/A	6

*Includes reductions from upstream runoff: buffers - 4x buffer area; rain gardens - 6x; bioretention filters - 20x.
1 – EPA-CBP, 2008.
2 - Bacteria efficiency assumed equal to sediment efficiency.
3 - Based on differential loading rates to different land uses.
4 – EPA-CBP, 2006.
5 – Alberta Government, Agriculture and Rural Development, 2005.
6 - By definition.
7 - Based on simulated unit area sediment load difference between "fair" and "good" pasture.
8 – MapTech, Inc. 2006.
9 – Curtis, M.C., 2002.
10 – EPA-CBP, 2003.
11 - Scraped manure transferred to manure storage, so bacteria reduction estimated same as WP-4.
19 – Contour strip-cropping has a variable effectiveness based on its slope range, Wischmeier and Smith, 1978.

Livestock Direct Deposit

Photo: Mike Phillips, Shenandoah Valley SWCD

The TMDL study specifies a 95% reduction in bacteria from direct deposit of waste into the stream from livestock. In order to meet the bacteria reductions in direct deposition from livestock, some form of exclusion is necessary. While farmers will want to minimize the cost of fencing and the amount of pasture lost, any fencing installed through the use of cost-share programs should be located at least 35 feet from the stream bank. Currently, the Shenandoah Resource Conservation and Development Council is working with the Shenandoah Valley Soil and Water Conservation District to implement an alternative fencing program in Rockingham County. The goal of this pilot program is to provide assistance to producers who are unable or unwilling to install fencing that meets Natural Resource Conservation Service (NRCS) specifications due to such circumstances as repeated flooding and lack of land to dedicate to a 35 foot buffer. Significant interest in this pilot program has been expressed in the watershed. Consequently, a portion of the livestock exclusion fencing included in the implementation plan is listed as alternative fencing (no cost share). Funding from the existing pilot program will not be available to support all of this fencing, meaning that additional funding will need to be secured in order to provide financial assistance with this alternative program. It is estimated that 913,150 linear feet of fencing needed in order to exclude 95% of the stream from livestock access. Approximately 26% of this fencing (241,402 linear feet) would be accomplished through alternative fencing with a 10 foot setback, and approximately 74% (671,748 linear feet) would be accomplished through traditional fencing practices with a 35 foot buffer. The traditional fencing was divided between SL-6 practices and WP-2T practices. These livestock exclusion practices are included in the state cost share program. The SL-6 practice includes exclusion fencing, cross fencing for rotational grazing and the installation of an off stream watering system. The WP-2T practice includes exclusion fencing and hardened stream crossings. Estimates of the number of each type of fencing system that will be installed were developed based on the average length of fencing typically included in each type of system.

Straight Pipes and Failing Septic Systems

The 100% reduction in loads from straight pipes and failing septic systems is a legal requirement. The options identified for correcting straight pipes and failing septic systems included: repair of an existing septic system, installation of a septic system, and installation of an alternative waste treatment system. The percentages of households served by failing septic systems and straight pipes in Smith Creek watershed, obtained from the TMDL report were estimated as 4% and 0.5%, respectively, of the non-sewered households in each sub-watershed. Table 4 gives a summary of residential BMPs needed to remediate this source of bacteria. "System pumpouts" may not necessarily solve existing problems, but are needed for routine maintenance to prevent future problems, and will also provide a means to begin a dialogue with homeowners whose systems may need maintenance or repairs done on their septic system. In addition to these BMPs, an educational effort will be important for successful implementation.

Table 4 The extent of residential wastewater BMPs

BMP	Extent installed since TMDL*	Additional extent needed
Septic tank pumpout	61	1,108
Connection to public sewer	0	7
Septic system repair	9	8
Septic system replacement	0	13
Septic system replacement including pump	0	6
Alternative waste treatment system	2	70

*Control measures installed by Friends of the North Fork Shenandoah River in 2003-2004.

Cropland

Runoff from cropland is a source of both bacteria and sediment. Bacteria comes from the spreading of stored manure and from wildlife, while sediment in the stream results from combinations of slope, soil conditions, vegetative cover, and rainfall intensity. Bacteria from manure can be reduced either by source reduction or filtering measures (buffers), while sediment can be reduced by measures that increase vegetative cover, reduce effective slope lengths, or provide filtering (Table 5). While the "manure injection" control measure currently appears to be too expensive for widespread application, this control measure is specified on a small fraction of the cropland acreage (< 1%) to encourage future consideration of this measure in the watershed.

Table 5 The extent of cropland BMPs

BMP		Units	Installed since TMDL	Additional extent needed	% bacteria reduction	% sediment reduction
Grass riparian buffers		acres	24	4	0.3%	2%
Forested riparian buffers		acres	323	0	3%	26%
Critical area stabilization		acres	177	3	1%	7%
Contour stripcropping		acres	0	52	1%	1%
Cover crops		acres	3,433	0	N/A	28%
Manure injection		acres	0	20	1%	N/A
Manure storage facility	Beef	no.	3	4	21%	N/A
	Dairy	no.	5	1	25%	N/A
	Poultry	no.	12	3	40%	N/A
	Turkey	no.	2	0	1%	N/A
				Total reduction	**92%**	**64%**

Pasture

The BMPs needed to meet TMDL load reductions for both bacteria and sediment are shown in Table 6. This collective set of control measures provides the needed 92% bacteria and 22% sediment load reductions. One pasture practice that is expected to have a substantial impact on water quality is improved pasture management. It is anticipated that this improved management will take the form of both rotational grazing systems and rotational loafing lot systems. Vegetated livestock exclusion buffers were also included in the implementation strategy to treat runoff from pasture. These buffers will act as a filter, trapping bacteria and sediment before it runs in to the stream.

Table 6 The extent of pasture BMPs

BMPs		**Units**	**Installed since TMDL**	**Additional extent needed**	**% bacteria reduction**	**% sediment reduction**
Livestock exclusion buffers		acres	42	436	3%	2%
Reforestation of erodible pasture		acres	23	21	0.1%	0.3%
Improved pasture management		acres	678	20,235	67%	37.5%
Winter feeding facility		no.	0	15	8%	N/A
Agricultural sinkhole protection		no.	0	40	N/A	N/A
Manure storage facility	Beef	no.	3	4	3%	N/A
	Dairy	no.	5	1	4%	N/A
	Poultry	no.	12	3	6%	N/A
	Turkey	no.	2	0	0.1%	N/A
				Total reduction	**92%***	**40%**

Developed Areas

Pet waste is the dominant source of bacteria in built-up areas in the Smith Creek watershed, which include urban/residential areas and transitional areas. Construction activities such as clearing and grading on transitional areas are the largest source of sediment. Several control measures used to reduce pollutant loads in built-up areas were determined only to be practical in areas of concentrated populations, such as cities and towns. These concentrated population centers in the Smith Creek watershed include a portion of the City of Harrisonburg and the Town of New Market. The BMPs applicable to these population centers are shown in Table 7. The City of Harrisonburg is currently implements a pet waste education and disposal program. Street sweeping is already practiced in the New Market and Harrisonburg areas and is performed 6 and 4 times a year respectively. This implementation plan calls for a 50% reduction in sediment from public impervious areas, which can be met either by increasing the area swept, by increasing the efficiency of the sweepers, or by increasing the sweeping frequency.

Sediment from transitional areas in the Smith Creek watershed comes primarily from stormwater runoff over areas where land has been disturbed and vegetative cover removed. Some of these areas may have had transient erosion and sediment (E&S) permits, or may have been disturbed prior to the issuance of a permit, or may represent smaller areas of disturbance that do not require a permit. The small reductions called for to meet the required 22% sediment load reductions are expected to be met through an increased efficiency with existing resources within individual local E&S programs and educational programs targeted at developers and contractors.

Table 7 The extent of urban BMPs

BMP	Units	Installed since TMDL	Additional extent needed	% bacteria reduction	% sediment reduction
Forested riparian buffers	acres	0	44	4%	12%
Pet waste program	no.	1	1	24%	N/A
Street sweeping	acres	37	7	1%	2%
Rain gardens	acres	0	109	28%	116%
Bioretention filters	acres	0	45	38%	159%
			Total reduction	**95%**	**289%**

4) EDUCATION AND TECHNICAL ASSISTANCE

Photo: Lynn Betts, NRCS (2000)

Through discussions with stakeholder groups, the following educational tasks were identified for Smith Creek. Most of these opportunities rely on voluntary watershed partnerships for their accomplishment.

Residential Programs

- Promote benefits of properly installed and maintained septic systems.
- Conduct a sanitary septic system survey to better target residential wastewater treatment.
- Utilize the VA Cooperative Extension's Household Water Quality and Master Naturalist Programs to educate homeowers about well and septic system management and conservation landscaping.
- Educate urban residents about the needs and benefits of pet waste control.
- Use the new LEED certified New Market library building as a demonstration site for field trips & tours

Schools/Youth Program

- Provide materials for conservation and natural resources management to local area schools and identify opportunities in the watershed for field trips, guest speakers, and community projects.
- Provide implementation effort materials to local VCE 4-H and agricultural extension agents.
- Contact County School Superintendents, and identify ways to include natural resource conservation in Standards of Learning.

Developer, Engineer, and Contractor Programs

- Make a presentation at a Shenandoah Valley Builders Association meeting on Conservation Landscaping
- Develop a contractor guidance handout to prevent sediment control problems and require the responsible land disturber during development to be the contractor, not the engineer.
- Prepare a presentation for single-family home developers to encourage the appropriate use of runoff control measures.
- Prepare and distribute periodic Stakeholder E&S reports and the "Citizen's Guide to E&S Control".

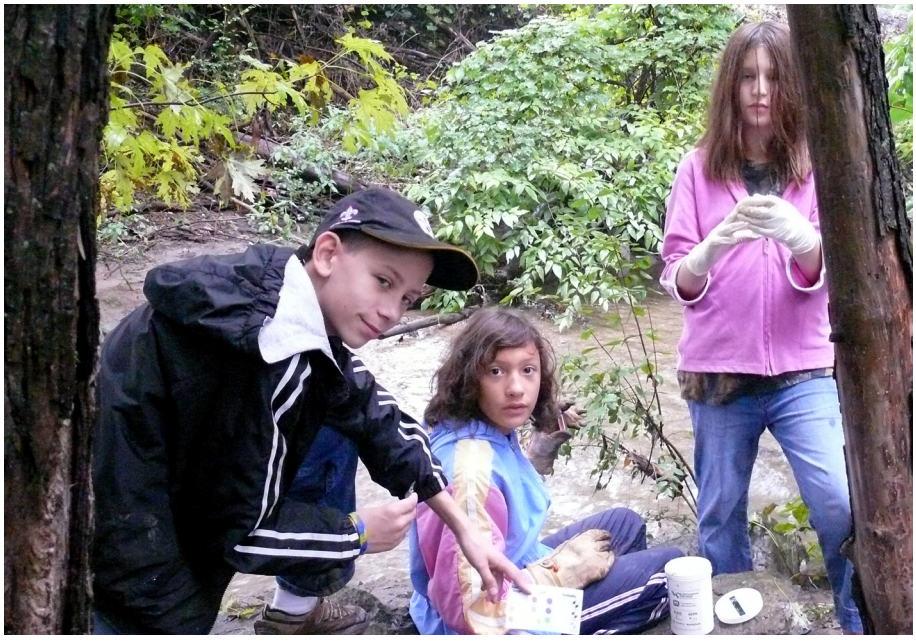
Technical Assistance

Technical assistance is required to assist with stakeholder recruitment, to coordinate with BMP contractors, to provide public education about the implementation plan, and to track installation of BMPs and corresponding water quality improvements. The amount of, and costs for, technical assistance were estimated in consultation with personnel from the Shenandoah Valley and Lord Fairfax SWCDs and the Public Works Planner from the City of Harrisonburg.

Municipal Officials Program

-Include state Nonpoint Education for Municipal Officials (NEMO) representatives in developing local land use plans sensitive to natural resource protection.

-Support development of local stormwater ordinances.



5) COSTS OF IMPLEMENTATION

Agricultural BMPs

The agricultural BMPs needed to meet the TMDL pollutant reductions are summarized in Table 8 together with their unit costs and total costs. Unit costs were estimated from the DCR state agricultural cost-share database for Rockingham and Shenandoah counties, from the 2008 USDA-NRCS cost list for Virginia, from literature values, and from discussions with focus group members.

Table 8 Agricultural BMP costs

BMP		Units	Cost/ Unit	Cost source	Extent needed	Total Cost
Livestock Exclusion BMPs						
Livestock exclusion fencing (SL-6)*		system	$36,456	16	150	$5,468,438
Livestock exclusion fencing (WP-2T)*		system	$11,864	16	36	$427,104
Adaptive fencing		lin. ft.	$1.50	16	241,402	$362,103
Cropland BMPs						
Grass riparian buffers		acres	$237	12	4	$831
Contour stripcropping		acres	$175	12	53	$9,290
Critical area stabilization		acres	$1,355	12	3	$4,363
Manure injection		acres	$146	16	20	$2,920
Manure storage facility	Beef	no.	$27,139	17	4	$108,555
	Dairy	no.	$88,736	17	1	$88,736
	Poultry	no.	$25,833	17	3	$77,498
Pasture BMPs						
Reforestation of erodible pasture		acres	$1,355	12	21	$28,432
Improved pasture management		acres	$107	8	20,235	$2,165,156
Winter feeding facility		no.	$24,192	14, 16	15	$362,880
Agricultural sinkhole protection		no.	$2,500	---------	40	$100,000
Total Ag BMP cost = $9,206,304						

* SL-6 practice includes the installation of a well and cross fencing, WP-2T only includes fencing and hardened crossings

Cost Sources for Table 8

8 - MapTech, Inc. 2006. Water Quality Implementation Plan for Blacks Run and Cooks Creek.
12 - USDA-NRCS, 2007. Virginia Average Cost List for FY08.
13 - Headwaters SWCD BMPs for VA Agriculture. Agronomic Practices. Maximum rate paid for non-harvested small grain.
14 - Southwestern Illinois RC&D, Inc. 2004. Livestock Winter Feeding Stations.
15 - 2005 Shenandoah River Tributary Strategy.
16 - SWCD estimate.
17 - DCR agricultural cost-share database.

Developed Area BMPs

The urban BMPs are summarized in Table 9. Unit costs were estimated using the Blacks Run TMDL Implementation Plan and the 2005 Shenandoah River Tributary Strategy.

Table 9 Developed are BMP costs

BMP	Units	Cost/Unit	Cost source	Extent needed	Total Cost
Forested riparian buffers	acres	$1,284	15	44	$56,718
Pet waste program	no.	$3,750	8	1	$3,750
Street sweeping	acres	N/A		7	
Rain gardens	acres	$5,000	8	109	$545,850
Bioretention filters	acres	$10,000	8	45	$450,000
Total Urban BMP Cost = $1,060,068					

8 - MapTech, Inc. 2006. Water Quality Implementation Plan for Blacks Run and Cooks Creek.
15 - 2005 Shenandoah River Tributary Strategy.

Residential BMPs

The residential wastewater control measures quantified earlier in this chapter are summarized in Table 10, together with unit costs and implementation costs. Unit costs for these practices were obtained from the Blacks Run TMDL implementation plan. The one exception was the estimate for system pumpouts, which was based on focus group discussions with local Soil and Water Conservation District and Virginia Department of Health personnel.

Table 10 Residential wastewater BMP costs

BMP	BMP Code	Units	Cost/ Unit*	Extent needed	Total Cost
Septic tank pumpout	RB-1	no.	$275	1,108	$304,679
Connection to public sewer	RB-2	no.	$5,600	7	$39,200
Septic system repair	RB-3	no.	$3,000	8	$24,000
Septic system replacement	RB-4	no.	$7,000	13	$91,000
Septic system replacement including pump	RB-4P	no.	$9,000	6	$54,000
Alternative waste treatment system	RB-5	no.	$20,000	70	$1,400,000
Total Residential BMP Cost = $1,912,879					

Technical assistance needs were calculated based on the personnel required for installation of the agricultural control measures in each SWCD, the residential wastewater and urban BMPs. For planning purposes, one full-time employee was budgeted as $50,000/yr, including benefits. Agricultural technical assistance needed was estimated to be one full time staff person for the Shenandoah Valley SWCD and one half time staff person for the Lord Fairfax SWCD over 10 years of implementation, amounting to $75,000 per year. The residential and urban technical assistance was estimated to require a 3/4 time position for the first 5 years of implementation, and a half time position during the second 5 years, amounting to $40 ,000 per year in years 1-5, and $28,750 per year in years 6-10 .

The total estimated cost for the needed BMPs in the Smith Creek watershed is $12.18M . The full cost for implementation of this plan including technical assistance will be $13.24M.

6) BENEFITS OF IMPLEMENTATION

The primary benefit of implementation is cleaner water in Smith Creek. Specifically, fecal contamination in Smith Creek will be reduced to meet water quality standards, and the aquatic communities in these streams will be restored. It is hard to determine the impact that reducing fecal contamination will have on public health, as most cases of waterborne infection are not reported or are falsely attributed to other sources. However, because of the reductions needed, the incidence of infection from fecal sources through contact with surface waters should be reduced considerably. Many of the BMPs intended to reduce sediment also increase infiltration, which will decrease peak flows downstream.

Benefits to Agricultural Producers

A clean water source has been shown to improve weight gain and milk production in cattle. Many livestock illnesses can be spread through contaminated water supplies. For instance, coccidia can be delivered through feed, water and haircoat contamination with manure (VCE, 2000). A clean water source can prevent illnesses that reduce production and incur the added expense of avoidable veterinary bills. Streamside fencing excludes livestock from wet, swampy environments as are often found next to streams where cattle have regular access. Keeping cattle in clean, dry areas has been shown to reduce the occurrence of mastitis and foot rot. The VCE (1998a) reports that mastitis costs producers $100 per cow in reduced quantity and quality of milk produced. Installation of streamside fencing and well managed loafing areas will reduce the amount of time that cattle have access to wet swampy areas that typically harbor mastitis causing bacteria. Improved pasture management can allow a producer to feed less hay in winter months, increase stocking rates by 30 to 40%, and consequently, improve the profitability of the operation.

Benefits to Homeowners

The residential programs will play an important role in improving water quality, since human waste can carry with it human viruses in addition to the bacterial and protozoan pathogens that all fecal matter can potentially carry. In terms of economic benefits to homeowners, an improved understanding of on-site sewage treatment systems (OSTS) 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 septic system 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 in locations where roots could damage the system
- Keeping hazardous chemicals out of the system
- Pumping out the septic tank every 3 to 5 years

The cost of proper maintenance is relatively inexpensive in comparison to repairing or replacing an entire system.

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, sewage system repair and installation, fencing, and other BMP components can expect to see an increase in business during implementation. Additionally, income from maintenance of these systems should continue long after implementation is complete.

7) GOALS AND MEASURABLE MILESTONES

The goals of TMDL implementation are to restore the water quality in the impaired stream segments in Smith Creek watershed so that it complies with water quality standards and to remove these segments from the Commonwealth of Virginia's 303(d) List of Impaired Waters. Implementation milestones establish the portion of implementation actions to be taken within certain time frames. Water quality milestones establish the corresponding improvements in water quality that can be expected as the implementation milestones are achieved.

The implementation of BMPs will be accomplished in stages, addressing the pollutant sources with the largest impact on water quality first. This staged approach is based on meeting water quality goals over a fifteen-year period. The first two stages include implementation milestones based on the installation of a series management practices (Table 11). If all of the practices are installed during the first two stages, full attainment of water quality goals and removal from the Section 303(d) list will occur by the end of the last 5-year period (Stage III) after the practices have reached maturation (e.g. trees planted in buffers have established strong root structures). The costs associated with Stage I and Stage II implementation efforts are summarized in Table 12. .

Table 11 Staged Implementation Goals for Smith Creek

BMP		Units	Since TMDL	Stage I: Years 1-5	Stage II: Years 6-10
Livestock Exclusion BMPs					
Livestock exclusion fencing (SL-6)		systems	10	90	60
Livestock exclusion fencing (WP-2T)		systems	1	21	15
Adaptive fencing		lin. ft.	0	144,079	97,323
Cropland BMPs					
Grass riparian buffers		acres	24	0	4
Critical area stablilization		acres	177	0	3
Contour stripcropping		acres	0	21	32
Manure injection		acres	0	0	20
Manure storage facility	Beef	no.	3	0	4
	Dairy	no.	5	0	1
	Turkey	no.	12	0	3
	Poultry	no.	2	0	0
Pasture BMPs					
Reforestation of erodible pasture		acres	23	11	11
Improved pasture management		acres	678	10,118	10,118
Winter feeding facility		no.	0	8	7
Agricultural sinkhole protection		no.	0	20	20
Urban BMPs					
Forested riparian buffers		acres	0	19	26
Pet waste program		no.	1	1	0
Street sweeping		acres	37	0	7
Rain gardens		acres	0	44	65
Bioretention filters		acres	0	18	27
Residential Wastewater BMPs					
Septic tank pumpouts		no.	61	277	831
Connection to public sewer		no.	0	7	0
Septic system repair		no.	9	8	0
Septic system replacement		no.	0	13	0
Septic system replacement including pump		no.	0	6	0
Alternative waste treatment system		no.	2	70	0

Table 12 Staged implementation costs

BMP Type	Stage I Cost	Stage II Cost	Total Cost
Livestock exclusion BMPs	$3,744,534	$2,513,111	$6,257,645
Cropland BMPs	$3,716	$288,475	$292,191
Pasture BMPs	$1,340,330	$1,316,138	$2,656,468
Urban BMPs	$425,302	$631,016	$1,060,068
Residential BMPs	$1,684,370	$228,510	$1,912,880
Technical Assistance	$575,000	$493,750	$1,068,750
Total Stage I Cost = $7,773,251			
Total Stage II Cost = $5,470,999			
Total Implementation Cost = $13,244,251			

Tracking BMP Implementation

Agricultural BMPs will be tracked through the Virginia Agricultural Cost-Share Program. Residential wastewater BMPs will be tracked cooperatively through Soil and Water Conservation Districts and Virginia Department of Health. Urban BMPs will be tracked in cooperation with the town of New Market and the City of Harrisonburg. Enhanced erosion and sediment control management for transitional areas will be tracked through the Rockingham County and Shenandoah County Erosion and Sediment Control Programs.

The monitoring program will be based on state DEQ bacteria and biological monitoring at the existing monitoring sites listed in Table 13. DEQ will conduct monthly or bi-monthly ambient and bacteria sampling for *E. coli* at each of the existing bacteria monitoring sites in Smith Creek. Biological sampling at the one DEQ station will be performed at least every other year spring and fall. These samples will be collected and evaluated based on protocol used by DEQ in the Spring and Fall. It is recommended that DEQ re-establish a bacteria monitoring site on Dry Branch, which historically has had frequent bacteria standard violations.

The Friends of the North Fork Shenandoah River have indicated their willingness to assist with volunteer monitoring in additional locations. Monitoring will continue throughout the process to document progress towards goals and evaluate the effectiveness of the implementation actions.

Table 13 Existing DEQ Water Quality Monitoring Sites

Station ID	Stream name	Station description	County	Monitoring type
1BDFK000.76	Dry Fork	Route 806 bridge	Rockingham	bacteria
1BMTR000.93	Mountain Run	Route 620 bridge	Rockingham	bacteria
1BSMT001.42	Smith Creek	Route 730 Bridge	Shenandoah	bacteria
1BSMT004.60	Smith Creek	Route 620 bridge	Shenandoah	bacteria
1BSMT019.26	Smith Creek	Route 796 bridge	Rockingham	bacteria
1BSMT026.41	Smith Creek	Route 717 bridge	Rockingham	bacteria
1BSMT006.62	Smith Creek	Route 620 bridge	Rockingham	biological

8) STAKEHOLDERS AND THEIR ROLE IN IMPLEMENTATION

Achieving the goals of this plan dependens on stakeholder participation and strong leadership on the part of both community members and conservation organizations. The following sections in this chapter describe the responsibilities and expectations for the various components of implementation.

Federal and State Government

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

VADEQ has responsibility for monitoring waters to determine compliance with state standards, and for requiring permitted point dischargers to maintain loads within permit limits. VADCR holds the responsibility for addressing nonpoint sources (NPS) of pollution. Historically, most VADCR programs have dealt with agricultural NPS pollution through education and voluntary incentive programs. Through Virginia's Agricultural Stewardship Act (ASA), the Commissioner of Agriculture has the authority to investigate claims that an agricultural producer is causing a water quality problem on a case-by-case basis (Pugh, 2001). If deemed a problem, the Commissioner can order the producer to submit an agricultural stewardship plan to the local soil and water conservation district. VDH is responsible for maintaining safe drinking water measured by standards set by the Environmental Protection Agency. VDH has the responsibility of enforcing actions to correct or eliminate failed septic systems and straight pipes.

Regional and Local Government

Regional and local government groups possess insights about their regional and local community that may help to ensure the success of TMDL implementation. Representatives from the each of the four municipalities located within the watershed have participated in the Smith Creek IP development. IP Planning team members also met individually with planning department staff in order to get the most up to date information about land planning goals and local government water quality initiatives, and to discuss future collaborative efforts among the jurisdictions pertaining to Smith Creek water quality improvements.

The Lord Fairfax and Shenandoah Valley Soil and Water Conservation Districts are local units of government that work to increase voluntary conservation practices among farmers. District staff will play a key role in providing technical assistance associated with the implementation of agricultural BMPs. The Central Shenandoah and Northern Shenandoah Valley Regional Commission Planning District Commissions promote the efficient development of the environment by assisting and encouraging local governmental agencies to plan for the future. Planning District Commissions focus much of their efforts on water quality planning, which is complementary to the TMDL process.

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. The primary role of citizens and businesses is simply to get involved in the TMDL process. This may include participating in public meetings, assisting with public outreach, providing input about the local watershed history, and/or implementing best management practices to help restore water quality. Since completion of the Smith Creek TMDL study, several groups have stepped forward to pursue conservation efforts in the watershed, which have contributed towards the implementation of conservation measures needed in the watershed.

The Shenandoah Valley has widely benefited from the work of several land trusts including the Valley Conservation Council, a private regional land trust, and the Virginia Outdoors Foundation, the state's primary conservation easement holder. For 18 years Valley Conservation Council has provided ongoing outreach efforts to connect landowners with the easement services of Virginia Outdoors Foundation and has targeted the Smith Creek watershed as a priority focus area in its strategic plan. Valley Conservation Council also holds a number of riparian easements with Valley Soil and Water Conservation Districts.

The Eastern Brook Trout Joint Venture is a unique partnership between state and federal agencies, regional and local governments, and conservation organizations to restore historic habitat for eastern brook trout. The Eastern Brook Trout Joint Venture assessed Smith Creek as a priority watershed for restoration and protection and has already directed Federal funds for this purpose. Trout Unlimited, through its partnership with the U.S. Fish and Wildlife Service and U. S. Forest Service, is keenly inter-

Photo: US Forest Service

ested in supporting the restoration of Smith Creek as part of its newly launched Interstate-81 Coldwaters Area Restoration Effort (I-81 CARE). I-81 CARE is a long-term large-scale campaign to reduce pollution and conserve, protect, and restore spring creeks and mountain head headwaters streams in the region served by I-81 in Virginia.

Community watershed groups like Friends of the North Fork of the Shenandoah River and the Shenandoah Valley Pure Water Forum offer a meeting place for river groups to share ideas and coordinate preservation efforts and are also a showcase site for citizen action. There is an existing but inactive Citizens Advisory Committee in the Smith Creek watershed that was involved with several National Fish and Wildlife Foundation and Virginia Water Quality Improvement Act – funded projects. This committee is presently being re-energized to address conservation and restoration opportunities. This group consists mainly of landowners and represents a key source of interested volunteers that should be involved in TMDL implementation.

New Partnerships

As part of a four-state (VA, PA, MD, WV) regional effort to bring focused support to resource restoration and conservation in the Mid-Atlantic Appalachian region, the Highlands Action Program identified the Smith Creek watershed as a unique project opportunity. Following a series of preliminary local discussions, the Highlands Action Program Liaison worked with the Environmental Protection Agency VADEQ, and VADCR to request EPA Region III "Healthy Waters Initiative" funds to the Smith Creek watershed planning process. As a result, support was received from the EPA Region III Healthy Waters Initiative in Spring 2008. The purpose of the Healthy Waters Initiative is to address the need for improved and coordinated actions that will speed up the pace of water body restoration and protection. The goal of the DEQ and DCR, the Healthy Waters Initiative managing agencies, is to use an expanded approach to plan development that will include citizen, community, and local government support.

Integration With Other Watershed Plans

Each watershed in the state is under the jurisdiction of many individual yet related water quality programs and activities, many of which have specific geographic boundaries and goals. These include but are not limited to TMDLs, Roundtables, Water Quality Management Plans, erosion and sediment control regulations, stormwater management, Source Water Protection Program, and local comprehensive plans. Coordination of the implementation project with these existing programs could result in additional resources and increased participation. The Rockingham and Shenandoah County Comprehensive Plans each contain strong goals and objectives making water quality improvements and land conservation priorities in areas that overlap with the Smith Creek watershed. Except for a small area located north of the Harrisonburg city limits, the Rockingham County plan places the majority of the county portion of the watershed within an "agriculture reserve" land use. Other than a small growth area to the east of New Market, Shenandoah County's portion of the watershed is designated for agricultural uses. The plan for the expansion of the New Market boundary to Smith Creek includes a riparian greenway.

9) POTENTIAL FUNDING SOURCES

A list of potential funding sources available for implementation has been developed. Detailed descriptions can be obtained from the Soil and Water Conservation Districts (SWCDs), VADCR, Natural Resources Conservation Service (NRCS), and Virginia Cooperative Extension (VCE).

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 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 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.

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.

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