Roanoke River Bacteria and Sediment TMDL Implementation Plan

Part I

Submitted by

Virginia Department of Environmental Quality

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Abbreviations and Acronyms

Altern.	Alternative
BMP	Best management practice
BRLC	Blue Ridge Land Conservancy
CCS	Council of Community Services
CDBG	Community Development Block Grant
CDC	Centers for Disease Control
cfu	colony forming unit
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CVC	Clean Valley Council
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
E. coli	*Escherichia coli*
FORVA	Friends of the Rivers of Virginia
FRPP	Farm and Ranch Lands Protection Program
FSA	Farm Service Agency
FTE	Full Time Equivalent
GIS	Geospatial Information System
GRP	Grassland Reserve Program
GWLF	Generalized Watershed Loading Functions
HSPF	Hydrologic Simulation Program FORTRAN
IP	Implementation plan
lbs	pounds
LID	low impact development
LU	land use
MS4	municipal separate storm sewer system
N/A	not applicable
NFWF	National Fish and Wildlife Foundation
NLCD	National Land Cover Database
NPS	nonpoint source
NRCS	Natural Resources Conservation Service
PDC	Planning District Commission
PWS	public water supply
QAPP	quality assurance project plan
RRCO	Roanoke River Conservation Overlay District
RT	Reforestation of Timberlands
RVARC	Roanoke Valley-Alleghany Regional Commission
SERCAP	Southeast Rural Community Assistance Project, Inc.
SLAF	Virginia Stormwater Local Assistance Fund
SMLA	Smith Mountain Lake Association
SWCD	soil and water conservation district

SWPPP	Stormwater pollution prevention plan
TDN	total digestible nutrients
TMDL	Total Maximum Daily Load
TU	Trout Unlimited
U&CF	Urban and Community Forestry
UAA	Use Attainability Analysis
UAL	Unit Area Load
URRR	Upper Roanoke River Roundtable
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
VADCR	Virginia Department of Conservation and Recreation
VADEQ	Virginia Department of Environmental Quality
VCE	Virginia Cooperative Extension
VDACS	Virginia Department of Agriculture and Consumer Services
VDH	Virginia Department of Health
VDOF	Virginia Department of Forestry
VDOT	Virginia Department of Transportation
VOF	Virginia Outdoors Foundation
VPDES	Virginia Pollutant Discharge Elimination System
WQIF	Water Quality Improvement Fund
WQMIRA	Water Quality Monitoring, Information, and Restoration Act
WRP	Wetlands Reserve Program
WVWA	Western Virginia Water Authority
yr	year

EXECUTIVE SUMMARY

Monitoring performed by the Commonwealth of Virginia identified waterbodies within the Roanoke River watershed that did not meet the *Escherichia coli* (*E. coli*) standards and therefore did not protect the recreation beneficial use. In addition, monitoring also identified portions of the mainstem of the Roanoke River not attaining the aquatic life use based on impaired benthic macroinvertebrate communities. The bacteria impaired segments were first listed as impaired on one of Virginia's 303(d) Total Maximum Daily Load (TMDL) Priority List and Reports starting in 1996. The benthic impaired segments were first listed as impaired on Virginia's 1996 303(d) Total Maximum Daily Load Priority List and Report. TMDLs were developed and approved for these impaired segments in 2004 and 2006. These TMDLs developed bacteria and sediment reductions necessary to meet the *E. coli* and aquatic life water quality standards. The goal of the Roanoke River TMDL Implementation Plan (IP) is to restore water quality within the Roanoke River and associated tributaries, to achieve full supporting status for the impaired segments, and to de-list the impaired segments from the Virginia 303(d) List of Impaired Waters for bacteria and aquatic life impairments.

State and Federal Requirements

The Virginia Water Quality Monitoring, Information, and Restoration Act (WQMIRA) directs Virginia Department of Environmental Quality (VADEQ) to "develop and implement a plan to achieve fully supporting status for impaired waters." To meet the requirements of WQMIRA, an IP must include the date of expected achievement of water quality objectives, measureable goals, corrective actions, and costs, benefits, and environmental impact of addressing the impairment. The federal requirements outline the minimum elements of an approvable IP. These include implementation actions and management measures, a timeline implementation, legal or regulatory controls, time required to attain water quality standards, and a monitoring plan and milestones for attaining water quality standards. Requirements for Section 319 funding eligibility were also considered.

Review of TMDL Development

The Roanoke River TMDL IP addresses bacteria and benthic impairments within ten subwatersheds located within the Counties of Roanoke, Montgomery, Botetourt, and Bedford as well as the Cities of Roanoke and Salem. Development of the two bacteria TMDLs used the *E. coli* water quality standards of a geometric mean concentration of 126 colony forming units (cfu)/100 ml and a single sample concentration of 235 cfu/100 ml. In addition to the segments listed as impaired on the Virginia 303(d) list, this IP includes several bacteria impaired segments that have bacteria source assessments but were not specifically included in a previous TMDL project. During development of the benthic TMDL, a stressor analysis identified sedimentation as the most probable cause of the benthic macroinvertebrate community impairment. Using a reference watershed approach, the numeric TMDL endpoint for the impaired watershed was established based on the sediment loading rate in a similar, but non-impaired reference watershed.

The allocation scenarios for meeting the bacteria and sediment TMDLs were updated during the IP development based on a determination of allocation loads and reductions for bacteria impaired segments that did not have an individual established TMDL, land use changes, and corrections to the instream erosion loads. Development of the allocation scenarios considered bacteria land uses and sources including developed, cropland, pasture/hay, forest, water/wetlands, and other land uses and input from livestock and wildlife direct loading and failing septic systems. Sediment loads and allocations for the benthic impairments were based on the NLCD 2006 land use distribution including developed, cropland, pasture/hay, forest, water/wetlands, and other land uses as well as loading from instream erosion.

The reductions in bacteria loading include 100% reductions for livestock direct and failing septic system loads. The sediment allocations include an overall 74% reduction in sediment loading to meet the TMDL endpoint. Sediment loading from all land use sources and instream erosion would require a reduction of approximately 75%. The allocation scenarios used in this IP are presented in Tables E-1 and E-2.

Table E-1: Load Reductions for *E. coli*

2006 Land Use/Source	Back Creek	Carvin Creek	Glade/ Layman-town Creek	Lick Run	Mason Creek	Mud Lick Creek, Murray Run, and Ore Branch	Peters Creek	Roanoke River 1	Roanoke River 2	Tinker Creek
Developed	98.9%	90.2%	96.3%	98.5%	98.9%	99.6%	98.9%	96.5%	98.2%	98.6%
Cropland	98.9%	-	96.3%	-	98.9%	99.6%	-	96.5%	98.2%	99.8%
Pasture/Hay	98.9%	90.2%	96.3%	91%	98.9%	99.6%	98.9%	96.5%	98.2%	99.8%
Forest	98.9%	85.2%	91.5%	0%	98.9%	99.6%	98.9%	96.5%	98.2%	95%
Water/Wetlands	0%	85.2%	91%	0%	0%	0%	-	0%	0%	95%
Other	98.9%	90.2%	96.3%	-	98.9%	99.6%	98.9%	96.5%	98.2%	98%
Livestock Direct	100%	-	100%	-	100%	100%	-	100%	100%	100%
Wildlife Direct	64.5%	75%	70%	0%	65.1%	87.9%	53.7%	67.1%	66%	0%
Failing Septic Systems	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total	**90.1%**	**86.8%**	**94.1%**	**96.9%**	**87.6%**	**99%**	**95%**	**83.3%**	**96.4%**	**98.9%**

Table E-2: Load Reductions for Sediment

2006 Land Use Category		Percent Reduction
Land Sources	Developed	75.1%
	Cropland	75.1%
	Pasture/Hay	75.1%
	Forest	75.1%
	Water/Wetlands	-
	Other	75.1%
Instream Erosion		75.1%
Point Sources		0%
Total		**74.2%**

Public Participation

Public participation in the development of an IP is important in order to educate and inform the local stakeholders about the issues and to solicit input on appropriate solutions. Participation involved public meetings, steering committees, and smaller working groups for agricultural, business, government, and residential stakeholders. The public meetings were held to educate the Public about the need for watershed cleanup, introduce the Roanoke River TMDL IP and the IP development process and progress, and highlight ways for the Public to get involved with the IP. The intent of the working groups was for the stakeholders to provide their specialized input concerning the watershed and best management practices. The working groups made recommendations for their areas of interest with education and outreach being primary recommendations for most groups. The information and suggestions provided by each working group were used to develop the IP as applicable. The establishment of a business working group during the Roanoke River TMDL IP was a first for any IP in the Commonwealth. The steering committee meetings were a forum to consider the issues and recommendations of all the working groups as well as funding sources and involvement of the public. Representatives from each of the working groups presented the main comments and suggestions from their group. Additionally, technical aspects of the IP development process were discussed.

Implementation Actions

Implementation actions necessary to reduce the bacteria and sediment loads and associated costs and pollutant removal efficiencies were identified through extensive stakeholder input, public participation, and review of land use/source data and pollutant delivery mechanisms. Published reference materials used include the Virginia Agricultural Cost Share Best Management Practices (BMP) Manual, Virginia Stormwater BMP Clearinghouse, and the Virginia Stormwater Management Handbook.

Quantifiable BMPs proposed in this implementation plan are grouped by the land use (i.e., agricultural, residential, or urban) or pollution source with which the BMPs are associated such as livestock or pet waste. The proposed BMPs were quantified to meet both the bacteria and sediment reductions called for in the TMDLs. In this analysis, bacteria loads required greater reductions than sediment loads needed to meet the TMDLs. TMDL IPs are designed to meet TMDL pollutant reduction targets within a watershed based on land use as defined by TMDL studies. IPs may be utilized by localities for pollutant reduction strategies; however they are not considered a requirement for permit compliance. Further, IPs do not prescribe specific BMPs for localities to implement to meet their MS4 permit requirements. Site-specific analysis is required prior to the siting, design, and implementation of the BMPs.

Table E-3 presents the various BMPs proposed in the Roanoke River TMDL IP. They include residential BMPs, detention pond retrofits, street sweeping, stormwater BMPs, Livestock Exclusion Systems and Manure Management, cropland BMPs, pasture BMPs, and stream restoration. The cost associated with each BMP and the distribution of BMPs across the three stages is also presented in Table E-3. In addition to proposed BMPs, there were several innovative BMPs proposed by stakeholders that did not have enough information to be quantified but have been included in the plan. They include pet waste composters, enhanced erosion and sediment control, educational programs, tracking of septic haulers, Adopt-an-Inlet program, recognition for installation of residential water quality improvements, residential environmental stewardship programs, and outreach opportunities. Technical assistance for agricultural, residential, and non-MS4 urban BMPs was also evaluated and proposed.

The main benefit of implementation of the various control measures is the improvement of the water quality of the Roanoke River and its tributaries. Reducing bacteria and sediment loads in the Roanoke River watershed will protect human health and safety, promote healthy aquatic communities, improve agricultural production, and add to the economic vitality of communities through enhancement of residential property, reduction in flood losses, and opportunities for outdoor recreation. The cost-effectiveness for each BMP category considers the pollutant loads reduced per $1,000 or additionally in the case of sediment, the cost per 1,000 pounds of sediment reduced.

Table E-3: Roanoke River TMDL IP Part I - Proposed BMPs and Costs per BMP			
Best Management Practice	Unit	Cost Per Unit	Number of Units
Residential BMPs			
Septic System Pump-Out (RB-1)	Pump Out	$300	2,255
Sewer Connection (Targeted Areas and RB-2)	System	$9,500	2,427
Repaired Septic System (RB-3)	System	$3,600	1,648
Septic System Installation/Replacement (RB-4)	System	$6,000	1,783
Alternative Waste Treatment System Installation (RB-5)	System	$16,000	166
Pet Waste Management Education Program	Program	$5,000	Program Per Subwatershed and Stage
Pet Waste Station	Unit	$4,180	98
Existing BMPs and Detention Pond Retrofits			
Infiltration Trench	System	$6,000	234
Constructed Wetlands	System	$2,900	263
Street Sweeping (additional miles to be swept annually)**	Curb Mile	$520	8,675
Stormwater BMPs			
Bioretention	Acre Treated	$10,000	11,700.0
Rain Gardens	Acre Treated	$5,000	2,340.0
Infiltration Trench	Acre Treated	$6,000	2,329.0
Manufactured BMPs	Acre Treated	$20,000	2,824.0
Constructed Wetland	Acre Treated	$2,900	34,371.0
Detention Pond	Acre Treated	$3,800	1,960.0
Permeable Paver	Acre Treated	$240,000	45.0
Vegetated Swale	Acre Treated	$18,150	1,350.0
Rain Barrel	System	$150	2,407
Riparian Buffer: Forest	Acre Installed	$3,500	205.0
Riparian Buffer: Grass/Shrub	Acre Installed	$360	205.0
Urban Tree Canopy/Landuse Conversion	Acre Converted	$3,500	398.0
Livestock Exclusion Systems and Manure Management			
Livestock Exclusion (CRSL-6)	System	$27,000	13
Livestock Exclusion (SL-6T/LE1-T)	System	$21,000	183
Livestock Exclusion with Reduced Setback (LE-2T)	System	$17,000	21
Small Acreage Grazing System (SL-6AT)	System	$9,000	10
Stream Protection/Fencing (WP-2T)	System	$21,000	5
Manure Storage (WP-4)	System	$58,000	4
Cropland BMPs			
Continuous No-Till (SL-15)	Acre Installed	$100	151.0
Small Grain Cover Crop (SL-8)	Acre Installed	$30	122.0
Permanent vegetative cover on cropland (SL-1)	Acre Installed	$175	5.0
Sod Waterway (WP-3)	Acre Installed	$1,600	11.0
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre Installed	$1,000	5.0
Pasture BMPs			
Reforestation of Erodible Pasture (FR-1)	Acre Installed	$560	1,710
Pasture Management (EQIP 528, SL-10T, SL-9)	Acre Installed	$75	16,737
Vegetative Cover on Critical Areas (SL-11)	Acre Installed	$1,200	3,061
Wet Detention Pond	Acre Treated	$150	1,465
Stream Restoration			
Stream Restoration	Feet	$300	68,879

Goals and Milestones of the Roanoke River TMDL IP

The primary goals of the Roanoke River TMDL IP are to restore water quality in the impaired waterbodies and de-list the impaired segments from the Virginia 303(d) List of Impaired Waters for bacteria and aquatic life impairments. This IP describes specific implementation and water quality milestones, the link between implementation and water quality improvement, a timeline for implementation, and tracking and monitoring to measure implementation of achievements.

Implementation milestones establish the amount of control measures installed within prescribed timeframes, while water quality milestones establish the corresponding improvements in water quality that can be expected as the implementation milestones are met. The implementation of control measures proposed in the Roanoke River TMDL IP will take place over three stages in a 15 or 20 year timeline. Implementation actions for smaller and/or more rural subwatersheds will occur over a 15-year timeline. The first two stages will be implemented over six years each; the final stage will be implemented over three years. This approach is proposed for the *Carvin Creek, Peters Creek, Mason Creek, and Back Creek* subwatersheds. Implementation actions for larger and/or more urbanized subwatersheds will occur over a 20-year timeline. The first two stages will be implemented over eight years each; the final stage will be implemented over four years. This approach is proposed for the *Glade Creek, Tinker Creek, Lick Run, Mud Lick/Murray/Ore Branch, Roanoke River 1 and Roanoke River 2* subwatersheds.

For each timeline, the first stage focuses on implementing the more cost-effective and commonly implemented actions such as livestock exclusion practices, crop and pasture BMPs, and septic system repairs. The delisting goal is achieved for *Carvin Creek*, *Back Creek*, *Lick Run,* and *Roanoke River 2* watersheds in stage 2. The third stage goal, while implementing the remainder of the more expensive BMPs, is to reach the goal of delisting the bacteria impaired segments for *Glade Creek; Mud Lick Creek, Murray Run and Ore Branch; Mason Creek; Peters Creek; Roanoke River 1, and Tinker Creek* and not violate the bacteria geometric mean criterion required by the TMDLs. All 10 watersheds at the end of stage 3 while at a bacteria violation rate of less than 10.5% for the single sample maximum do not meet the single sample maximum criterion (0% violation rate) required by the TMDLs because of bacteria loadings attributed to wildlife sources. The IP addresses implementation actions to reduce the man-induced sources of bacteria and does not address wildlife reductions both direct and indirect in the TMDLs.

Implementations milestones in Stages I and II also address the required sediment reductions from the TMDLs.

The Hydrologic Simulation Program FORTRAN (HSPF) model was used to determine the percent exceedance of the geometric and single sample maximum water quality criterion for each stage (or milestone) for each subwatershed. In addition, the instream average annual bacteria loading (cfu/year) at each milestone was determined (Table E-3). Table ES-4 depicts the sediment reductions (tons/year) obtained from implementing BMPs at each stage. The total sediment reduction required to meet the benthic TMDL is 19,649 tons per year (Section 3.3.3). From the implementation of the BMPs necessary to meet the bacteria TMDL reductions, the benthic TMDL is estimated to be attained in the 13th year of the 20 year TMDL IP timeline.

Table E-4: Water Quality Milestones - Bacteria Criteria Exceedances and Average Annual *E. coli* Load (cfu/yr) per IP stage

Stage	Exceedance Criteria	Back Creek	Carvin Creek	Glade Creek	Lick Run	Mason Creek	Mud Lick Creek, Murray Run, Ore Branch	Peters Creek	Roanoke River 1	Roanoke River 2	Tinker Creek
Stage I	% Exceedance Geometric Mean (126 cfu/100 mL)	7%	0%	51%	0%	5%	1%	0%	1%	0%	23%
	% Exceedance Single Sample Maximum (235 cfu/100 mL)	22%	18%	40%	16%	23%	20%	23%	18%	14%	34%
	Average Annual *E. coli* Load at end of stage (cfu/yr)	3.32E+13	2.67E+13	3.06E+13	2.77E+13	1.19E+13	4.96E+13	1.67E+13	6.14E+13	5.79E+13	5.43E+13
Stage II	% Exceedance Geometric Mean (126 cfu/100mL)	2%	0%	18%	0%	4%	1%	0%	1%	0%	17%
	% Exceedance Single Sample Maximum (235 cfu/100 mL)	11%	15%	28%	14%	21%	19%	21%	18%	11%	25%
	Average Annual Load *E. coli* at end of stage (cfu/yr)	1.89E+13	1.45E+13	1.11E+13	1.24E+13	6.31E+12	2.61E+13	6.90E+12	4.31E+13	2.98E+13	2.57E+13
Stage III	% Exceedance Geometric Mean (126 cfu/100 mL)	0%	0%	0%	0%	1%	1%	0%	1%	0%	0%
	% Exceedance Single Sample Maximum (235 cfu/100 mL)	10%	10%	10%	10%	10%	19%	10%	18%	10%	10%
	Average Annual Load *E. coli* at end of stage (cfu/yr)	1.11E+13	8.05E+12	3.11E+12	5.76E+12	1.93E+12	2.00E+13	2.78E+12	3.35E+12	1.87E+13	7.20E+12

Table E-5: Water Quality Milestones - Cumulative Sediment Reductions by IP Stage (tons/year) and Percentage Attainment of TMDL Goal

Subwatershed	Stage I	Stage II	Stage III
Carvin Creek	1,392	2,494	2,514
Glade Creek	2,310	2,616	2,655
Lick Run	988	1,255	1,298
Mason Creek	1,189	2,136	2,159
Mud Lick, Murray Run, and Ore Branch	1,862	2,196	2,247
Peters Creek	746	896	920
Roanoke River 1	2,726	4,813	4,864
Roanoke River 2	1,428	1,787	1,842
Tinker Creek	1,781	3,371	3,425
Total	**14,422**	**21,564**	**21,924**
Percent of TMDL Reductions Attained	**73%**	**100%**	**100%**

Part of the staged implementation process includes the targeting of more specific locations for BMP implementation. Specific analysis within the Roanoke River TMDL IP targeted subwatersheds for on-site sewage disposal, urban riparian zone creation, urbanized area for maximum reductions via stormwater BMPs, and livestock exclusion practices.

Implementation tracking and monitoring are two actions used to evaluate changes in the watershed and progress toward meeting water quality milestones. Implementation actions should be tracked to ensure that BMPs are adequately installed and maintained. BMP tracking would include quantification of the various BMPs identified in the IP and a reporting of the applicable units that are installed in each subwatershed. VADEQ would focus monitoring efforts on the original listing stations for both the bacteria and benthic impairments.

Stakeholders Roles and Responsibilities

Stakeholders are individuals or groups who live or have land management responsibilities in the watershed, including federal, state and local government agencies, businesses, special interest groups, and citizens. Stakeholder participation and support is essential for improving water quality and removing streams from the impaired waters list. These stakeholders worked together to develop the Roanoke River TMDL IP through meeting attendance, comments and suggestions on various aspects of the plan, and through the provision of watershed and water quality data. In the future, many will also play a role in the implementation of the control measures described in the IP.

Federal government stakeholders include the U.S. Environmental Protection Agency (EPA) and the Natural Resources Conservation Service (NRCS). EPA oversees the Clean Water Act programs and NRCS provides technical expertise and financial resources to both private stakeholders and government agencies for conservation of natural resources.

Currently, there are six state agencies that have a major role in regulating and/or overseeing statewide activities that impact water quality. These include: VADEQ, Virginia Department of Conservation and Recreation (VADCR), Virginia Department of Agriculture and Consumer Services (VDACS), Virginia Department of Health (VDH), Virginia Department of Forestry (VDOF), and Virginia Cooperative Extension (VCE). VADEQ is the lead state agency in the TMDL process. The other agencies administer water quality related programs and provide technical and financial assistance for water quality improvement projects and BMPs. VADEQ, VADCR, and VDH participated in the TMDL IP development process.

Local government groups work closely with state and federal agencies throughout the TMDL process; these groups possess insights about their community that may help to ensure the success of TMDL implementation. Soil and water conservation districts (SWCDs) work closely with watershed residents such as farmers, ranchers and other land users on understanding and implementing conservation practices. Planning District Commissions (PDCs) promote the efficient development of the regional physical, social, and economic resources. PDCs focus much of their efforts on water quality planning, and often contract TMDL development and implementation projects. Specifically, the Roanoke Valley-Alleghany Regional Commission (RVARC) contracted the Roanoke River TMDL IP. City and county government staff work closely with PDCs and state agencies to develop and implement TMDLs, promote education and outreach to stakeholders on the TMDL process, and can enact ordinances that reduce water pollutants and support BMPs.

Community watershed and conservation groups offer opportunities for river and land conservation groups to share ideas and coordinate preservation efforts. These groups have a valuable knowledge of the local watershed and river habitat that is important to the implementation process and are also a showcase site for citizen action. Citizens and businesses are involved in the TMDL and IP processes through participation in public meetings, assistance with public outreach and education, provision of local watershed history, and/or implementation of BMPs on their property to help restore water quality. Community civic groups perform a wide range of community service including environmental projects where they assist in the public participation process, educational outreach, and with implementation activities in local watersheds. Animal clubs and associations provide a resource to assist and promote conservation practices among farmers and other land owners especially in rural areas and urban areas where pet waste has been identified as a source of bacteria in water bodies.

Integration with Other Watershed Plans

Water quality issue and improvement in the Roanoke River watershed is a component of many different organizations, programs and activities. Examples of these voluntary and regulatory efforts include watershed implementation plans, TMDLs, Roundtables, Water Quality Management, Erosion and Sediment Control Regulations, Stormwater Management Programs, Source Water Assessment Programs, local comprehensive and strategic plans, and local environmentally-focused organizations. Efforts in the Roanoke River watershed that coincide with the goals of the Roanoke River TMDL IP include various watershed-wide plans, local comprehensive plans, MS4 TMDL action plans, legal authority, and monitoring.

Frequently regional and local plans and programs focus on watershed attributes such as natural resources, water quality and quantity, stormwater, and public education. These endeavors focus resources on protecting and improving the natural environment and educating the public about watershed problems. MS4 TMDL action plans, associated with MS4 permits, limit and prevent discharge of pollutants into the stormwater system in order to protect water quality. MS4 permittees can use the TMDL IP as a resource for development of their respective action plans. However, the IP does not provide prescriptive actions for permittees to meet their MS4 requirements. Mandatory ordinances regulating stormwater management and erosion and sediment control are common throughout the Roanoke River watershed. The City of Roanoke has enacted a Stormwater Utility Ordinance with fees dependent on installation and maintenance of stormwater BMPs. Voluntary citizen monitoring programs educate the public about water quality issues and can assist in the listing or delisting of impaired waters, TMDL development, tracking the progress of implementation plans, and identifying waters for potential future VADEQ monitoring.

Potential Funding Sources

Funding sources that may be available to support the Roanoke River TMDL IP include:

Federal

- Federal Clean Water Act Section 319 Incremental Funds
- United States Fish and Wildlife Service (USFWS) grants
- Roanoke Logperch Annual Grant – XXX
- United States Department of Agriculture (USDA) – Farm Service Agency (FSA)
    - Conservation Reserve Program (CRP)
    - Conservation Reserve Enhancement Program (CREP)
- USDA – Natural Resources Conservation Service (NRCS)
    - Conservation Stewardship Program (CSP)
    - Environmental Quality Incentives Program (EQIP)
    - Agricultural Lands Easement Program

State

- Virginia Agricultural Best Management Practices (BMPs) Cost-Share Program
- Virginia Agricultural Best Management Practices Loan Program
- Virginia Agricultural Best Management Practices Tax Credit Program
- Virginia Clean Water Revolving Loan Fund
- Virginia Department of Environmental Quality Citizen Water Monitoring Grant Program
- Virginia Outdoors Foundation (VOF)
- Virginia Department of Forestry
    - Urban and Community Forestry Assistance Program (U&CF)
    - Virginia Forest Stewardship Program
- Virginia Department of Environmental Quality
    - Virginia Small Business Environmental Compliance Assistance Loan Fund
    - Virginia Stormwater Local Assistance Fund (SLAF)
    - Virginia Water Quality Improvement Fund

Regional and Private

- Community Development Block Grant (CDBG)
- Foundation for Roanoke Valley
- National Fish and Wildlife Foundation (NFWF)
- Five Star and Urban Waters Restoration Grant Program
- Southeast Rural Community Assistance Project (SERCAP)
- Virginia Environmental Endowment
- Wetland and Stream Mitigation Banking

1.0 Introduction

The Clean Water Act (CWA) requires that streams, rivers, and lakes within the United States meet specified water quality standards and that states conduct monitoring to identify waterbodies that are polluted and do not meet these standards. When streams fail to meet the standards, Section 303(d) of the CWA and the U.S. Environmental Protection Agency's (EPA) Water Quality Management and Planning Regulation (40 CFR Part 130) requires states to develop a Total Maximum Daily Load (TMDL) for each pollutant. A TMDL determines the maximum amount of pollutant loading that a waterbody can receive without exceeding the appropriate water quality standards. Once a TMDL is developed states work with local stakeholders to develop an implementation plan to address the pollutant sources impairing the waterbodies and meet the TMDL. The ultimate goal is to delist the polluted waterbody from the impaired waters list.

Required monitoring performed by the Commonwealth of Virginia identified waterbodies within the Roanoke River watershed that did not meet the *Escherichia coli* (*E. coli*) standards and therefore did not protect the recreation beneficial use. In addition, monitoring identified portions of the mainstem of the Roanoke River not attaining the aquatic life use based on impaired benthic macroinvertebrate communities. TMDLs were developed and approved for these impaired segments in 2004 and 2006 (VADEQ 2004, 2006a, 2006b). Since the development of the TMDLs, other segments, specifically bacteria impaired segments, were found to be impaired (VADEQ, 2010) and are incorporated within this IP. Including these bacteria impaired segments is feasible because loads can be developed via the model (used in the development of the TMDLs) for those areas as they are upstream of the TMDL. In addition, VADEQ, via their 2014 Integrated Assessment, has identified six segments which have been officially nested into the Roanoke River Benthic TMDL (VADEQ, 2006b) as having benthic communities impaired by sediment. While they have been officially nested as having sediment impairments, this IP does not specifically address these segments in terms of identifying TMDL loads or IP actions to mitigate the pollution. See Appendix C for the benthic nesting rationale.

Due to the large watershed sizes in the TMDL reports, the Roanoke River TMDL Implementation is being split into two parts. This report addresses the first part of the plan. Part

One of the Roanoke River TMDL Implementation Plan (herein referred to as the implementation plan or "IP") addresses the following waterbodies identified as impaired because they do not support the primary contact recreation beneficial use due to *E. coli* exceedances: Carvin Creek; Glade Creek; Lick Run; Tinker Creek; Back Creek; Mason Creek; Mud Lick Creek, Murray Run, Ore Branch; Peters Creek; Roanoke River 1; and Roanoke River 2 (Figure 1-1); and benthic impaired portions of the mainstem Roanoke River found in Roanoke River 1 and 2 (Figure 1-2). The second part of the Roanoke River TMDL IP (currently in preparation as a separate report) will address impairments upstream from the first part of the plan, in the North and South Forks of the Roanoke River.

1.1 Purpose of the Implementation Plan

After development and approval of a TMDL, certain actions and measures must be implemented in order to reduce the bacteria load and excess sediment in the impaired waterbodies and to work towards meeting the *E. coli* and aquatic life (benthic macroinvertebrate) water quality standards, respectively. The TMDLs provide the foundation for pollutant reduction measures and actions. This Roanoke River TMDL IP describes the measures and details a phased process necessary to reduce the bacteria and sediment sources contributing to the impaired waterbodies. These measures include better treatment technology, best management practices (BMPs), educational programs, and regulations or ordinances. The purpose of the Roanoke River TMDL IP is to reduce bacteria and sediment to the levels stated in the TMDLs and to restore the waterbodies to conditions that support the primary contact recreation use and attain the aquatic life use standard. The staged IP should allow for cost-effective reduction in bacteria and sediment as well as improve a locality's opportunities to receive financial and other assistance during implementation.

1.2 Implementation Plan Components

The specific components discussed in the Roanoke River TMDL IP include:

- State and federal requirements for implementation plans;
- Review of the bacteria and benthic TMDL development studies including descriptions of the watersheds and associated land use, the impairments, the water quality monitoring

performed and data collected, modeling details, pollutant sources and existing loads, updated allocations and load reductions based on new landuse data, and the incorporation of the impaired segments not specifically separated out in the established TMDL;

- Public participation process including steering committee, working group, and public meetings;
- Implementation actions including identification of existing or future BMPs and management activities, determination of BMP reduction efficiencies, quantification of type and numbers of new control measures required, and cost/benefit analysis;
- Measurable goals and milestones for attaining water quality standards including timelines for implementation and corresponding achievement of water quality improvements, number and type of implementation measures installed in each timeframe, and monitoring of these milestones;
- Roles and responsibilities of watershed stakeholders including outreach and educational actions;
- Description of other watershed plans and ongoing activities that could support implementation efforts; and
- Potential funding sources for implementation actions.

1.3 Impairment Listing

The Roanoke River TMDL IP addresses the impaired segments for two bacteria TMDLs and one benthic TMDL (VADEQ 2004, 2066a, 2006b). The study area used for the development of control measures for bacteria impairments is slightly different than the study area used for the benthic impairments. The bacteria impairment study area extends to Smith Mountain Lake whereas the benthic impairment study area ends at Niagara (Figures 1-1 and 1-2).

1.3.1 Bacteria Impairment

For the Roanoke River bacteria TMDL IP, the study area covers approximately 317 square miles including 10 subwatersheds with 34 impaired segments. It is located in Bedford, Botetourt, Franklin, Montgomery, and Roanoke Counties and the Cities of Salem and Roanoke (Figure 1-1). The impaired segments were all first listed as impaired on one of Virginia’s 303(d) Total

Maximum Daily Load Priority List and Reports. Table A-1 in Appendix A summarizes the details of the impaired segments as listed in the 2010 305(b)/303(d) Water Quality Integrated Assessment.

Not every impaired segment listed in Table A-1 has an established TMDL. However, each segment was directly or indirectly incorporated during hydrologic and water quality modeling performed for the two established bacteria TMDL studies. These TMDL studies are: *Fecal Coliform Total Maximum Daily Load Development for Glade Creek, Tinker Creek, Carvin Creek, Laymantown Creek, and Lick Run* (March, 2004) and *Bacteria TMDLs for Wilson Creek, Ore Branch and Roanoke River Watersheds, VA* (February, 2006). Chapter 4 provides additional discussion of the incorporation of the impaired segments without an established TMDL.

1.3.1.1 Applicable Water Quality Standards

Water quality standards consist of designated uses for a water body and water quality criteria necessary to support those designated uses. According to Virginia Water Quality Standards (9 VAC 25-260-5), the term “water quality standards means provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.).”

1.3.1.2 Designated Uses

According to Virginia Water Quality Standards (9 VAC 25-260-10):

> “*All state waters, including wetlands, are designated for the following uses: recreational uses, e.g., swimming and boating; the propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them; wildlife; and the production of edible and marketable natural resources, e.g., fish and shellfish.*”

The listed segments defined in Table A-1 in Appendix A do not support recreation uses, based on the water quality monitoring data.

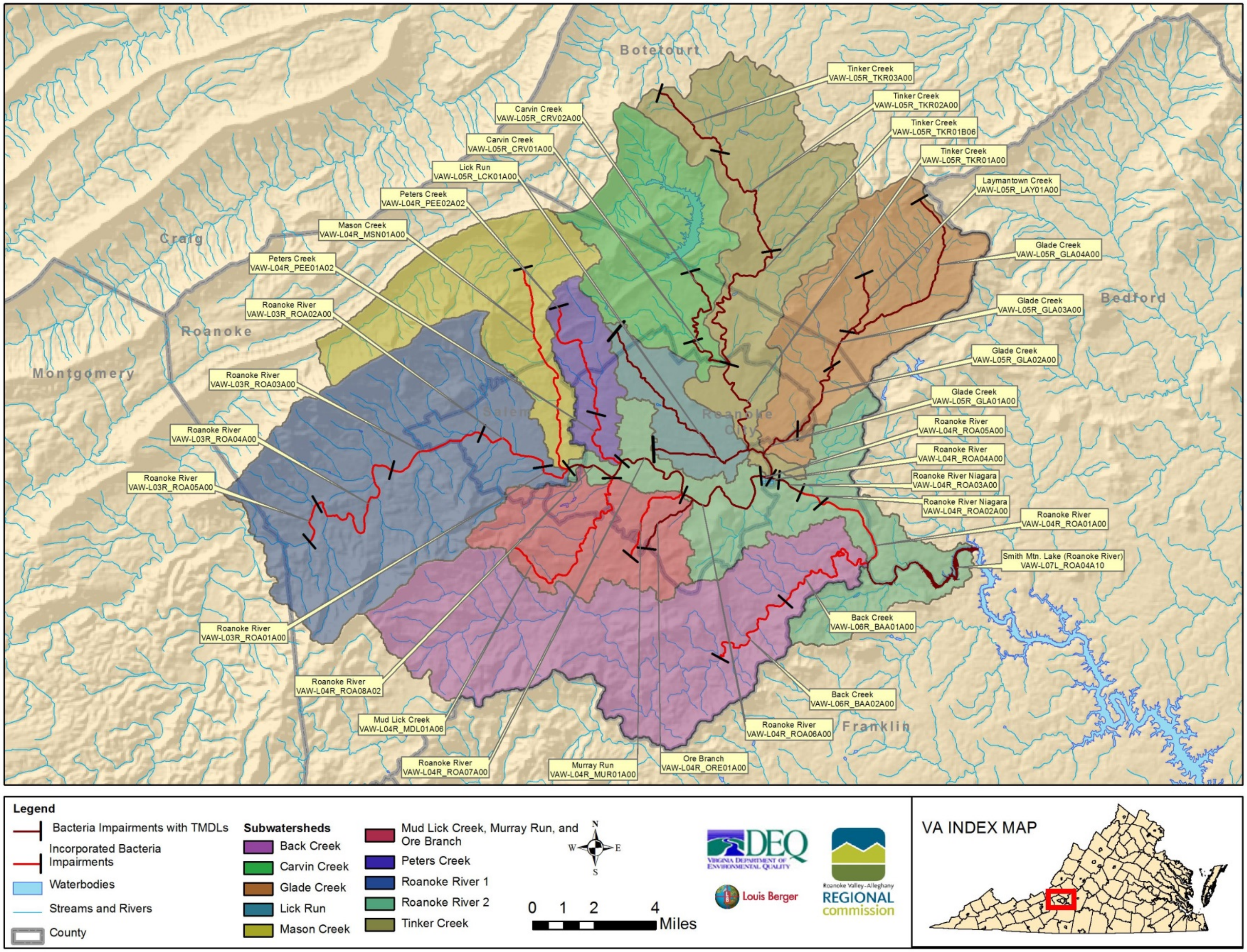

Figure 1-1. Bacteria Impaired Watersheds and Segments

1.3.1.3 Applicable Water Quality Criteria

The water quality standards were stated in terms of fecal coliform bacteria when each of the impaired segments was initially listed. However, effective February 1, 2010, VADEQ specified a new bacteria standard in 9 VAC 25-260-170.A. These standards replaced the existing fecal coliform standard of 9 VAC 25-260-170. For a waterbody to be in compliance with Virginia bacteria standards for primary contact recreation in freshwater, the current criteria are as follows:

> *"E. coli bacteria shall not exceed a monthly geometric mean of 126 CFU/100 ml in freshwater. If there are insufficient data to calculate monthly geometric means in freshwater, no more than 10% of the total samples in the assessment period shall exceed 235 E. coli CFU/100 ml."*

1.3.1.4 Wildlife Contributions

The previously established bacteria TMDLs demonstrate that the existing wildlife loads in each subwatershed are all greater, or almost so, than the allocated bacteria loads. This indicates that removal of all bacteria sources, except wildlife, would not allow the stream to attain the required water quality standards. Most of the current estimates of bacteria loading from wildlife alone would cause exceedances in the water quality standards.

Neither the Commonwealth of Virginia nor EPA is proposing the elimination of wildlife to allow for the attainment of water quality standards. Not only is this an impractical action but the reduction of wildlife or the changing of natural background conditions is not the intended goal of a TMDL IP.

Addressing bacteria loads from wildlife is neither feasible nor addressed in this implementation plan. Therefore, the Roanoke River TMDL IP intends to use an adaptive implementation approach consisting of an iterative process to enhance the existing monitoring plan as well as to implement reasonable and practicable control actions. If, after implementation of these control actions, exceedances of the water quality standard persist due to wildlife loadings, then a special study called a Use Attainability Analysis (UAA) may become necessary. A UAA could address the removal and re-designation of the existing designated use. The UAA collects and analyzes various factors (e.g., physical, chemical, biological, chemical, and economic) affecting the attainment of the designated use as described in the federal regulations under 40 CFR §131.10(g).

1.3.2 Benthic Impairment

For the benthic TMDL IP, the study area covers approximately 363 square miles with six impaired segments, all located on the mainstem of the Roanoke River. The watershed is located in Bedford, Botetourt, Floyd, Montgomery, and Roanoke Counties and the Cities of Salem and Roanoke (Figure 1-2). The impaired segments are all on the mainstem Roanoke River. Segments of the Roanoke River were first listed as impaired on Virginia's 1996 303(d) Total Maximum Daily Load Priority List and Report. Table A-2 in Appendix A summarizes the details of the six impaired segments as listed in the 2010 305(b)/303(d) Water Quality Integrated Assessment. Each benthic impaired segment was incorporated during modeling performed for the established TMDL, *Benthic TMDL Development for the Roanoke River, Virginia* (March, 2006). This report will focus on the lower portion of the benthic subwatershed, also known as the Part I benthic watershed.

1.3.2.1 Applicable Water Quality Standards

Water quality standards consist of designated uses for a waterbody and water quality criteria necessary to support those designated uses. According to Virginia Water Quality Standards (9 VAC 25-260-5), the term water quality standards "means provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.)."

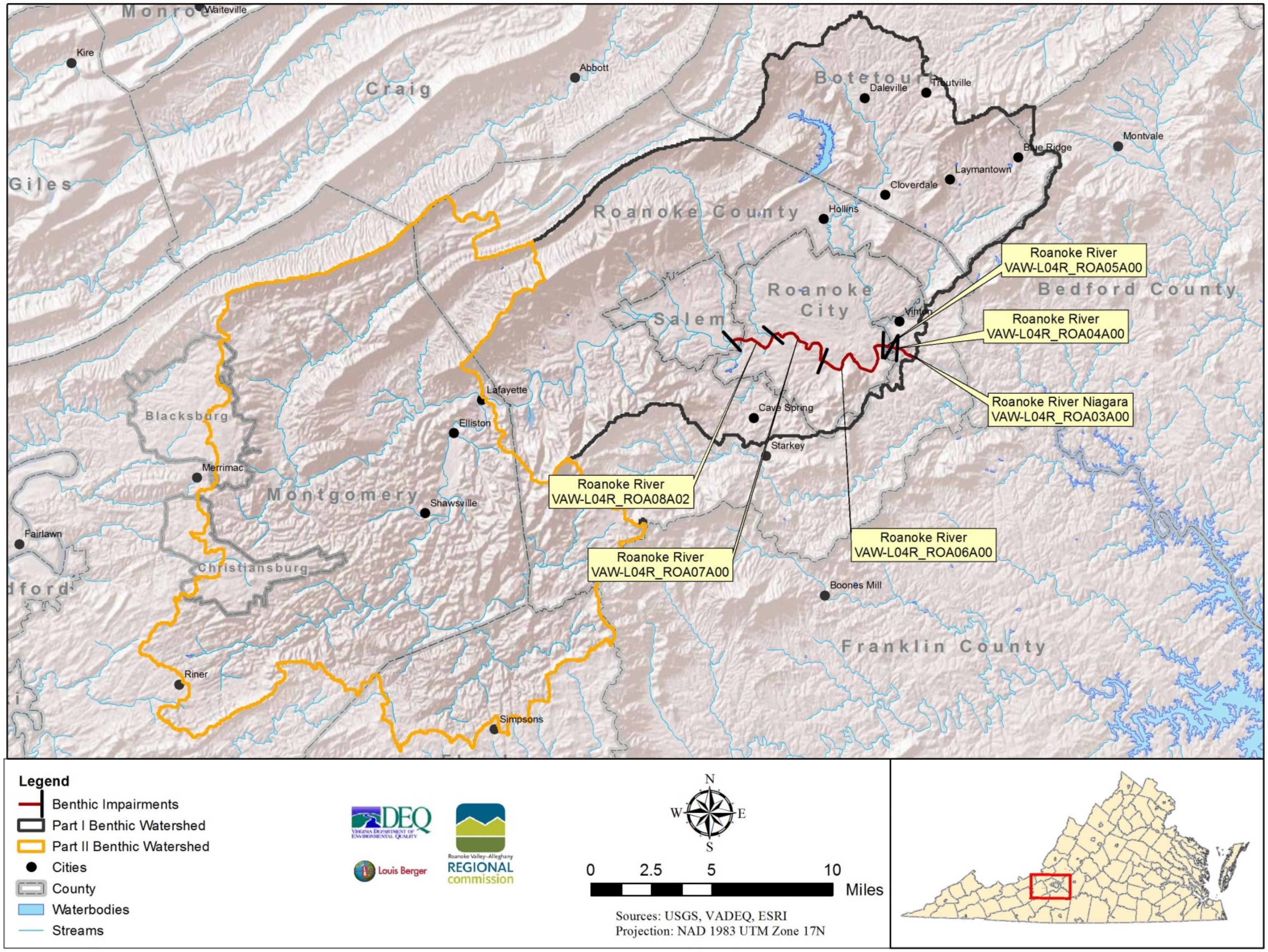

Figure 1-2. Benthic Part I and II Watersheds and Impaired Segments

1.3.2.2 Designated Uses

According to Virginia Water Quality Standards (9 VAC 25-260-10):

> "*All state waters, including wetlands, are designated for the following uses: recreational uses, e.g., swimming and boating; the propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them; wildlife; and the production of edible and marketable natural resources, e.g., fish and shellfish*."

The listed segments defined in Table A-2 in Appendix A do not support the propagation and growth of aquatic life in the Roanoke River, based on the biological assessment surveys conducted on the river.

1.3.2.3 Applicable Water Quality Criteria

The General Standard defined in Virginia Water Quality Standards (9 VAC 25-260-20) provides general, narrative criteria for the protection of designated uses from substances that may interfere with attainment of such uses. The General Standard states:

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

2.0 State and Federal Requirements for Implementation Plans

There are a number of state and federal requirements and recommendations for TMDL IPs. The goal of this chapter is to clearly define these and explicitly state if the elements are a required component of an approvable IP or are merely a recommended topic that should be covered in a thorough IP. This chapter has three sections that discuss the a) requirements outlined by the Water Quality Monitoring, Information, and Restoration Act (WQMIRA) that must be met in order to produce an IP that is acceptable and approvable by the Commonwealth, b) EPA recommended elements of IPs, and c) required components of an IP in accordance with Section 319 guidance.

2.1 State Requirements

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

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

2.2 Federal Requirements

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

The listed elements in EPA (1999) include:

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

2.3 Requirements for Section 319 Funding Eligibility

EPA develops guidelines that describe the process and criteria to be used to award Clean Water Act Section 319 nonpoint source grants to states. Congress amended the CWA in 1987 to establish the 319 Nonpoint Source Management Program. Under Section 319, States, Territories, and Indian Tribes receive grant money, which supports a wide variety of activities including the restoration of impaired waters. The guidance is subject to revision and the most recent version should be considered for IP development. The "Supplemental Guidelines for the Award of Section 319 Nonpoint Source Grants to States and Territories in FY 2003" identifies the following nine elements that must be included in the IP to meet the 319 requirements:

1. Identify the causes and sources of groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed-based plan;
2. Estimate the load reductions expected to achieve water quality standards;
3. Describe the nonpoint source (NPS) management measures that will need to be implemented to achieve the identified load reductions;
4. Estimate the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement the watershed-based plan;
5. Provide an information/education component that will be used to enhance public understanding of the project and encourage the public's participation in selecting, designing, and implementing NPS management measures;
6. Provide a schedule for implementing the NPS management measures identified in the watershed based plan;

7. Describe interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented;
8. Identify a set of criteria for determining if loading reductions are being achieved and progress is being made towards attaining water quality standards, and if not, the criteria for determining if the watershed-based plan needs to be revised; and
9. Establish a monitoring component to evaluate the effectiveness of the implementation efforts.

For more information on the requirements for Section 319 fund eligibility, refer to:

- *http://www.deq.state.va.us/Programs/Water/WaterQualityInformationTMDLs/NonpointSourcePollutionManagement.aspx*
- *http://water.epa.gov/polwaste/nps/cwact.cfm*

3.0 Review of TMDL Development

The Roanoke River TMDL IP addresses bacteria and benthic impairments within ten subwatersheds located within the Counties of Botetourt and Roanoke and the Cities of Roanoke and Salem. The impairments were originally encompassed within three TMDL study watersheds (i.e., two bacteria watersheds and one benthic watershed) (VADEQ 2004, 2006a, 2006b). In addition, this chapter assigns allocations to the bacteria-impaired segments that were not specifically included in the previously developed bacteria TMDL reports (VADEQ 2004, 2006a) because these segments were listed as impaired after completion of the TMDLs. These segments are referred to as nested impairments. Pollutant load allocations for these nested impairments were established by the Hydrologic Simulation Program FORTRAN (HSPF) model, which was used in the original TMDL development, and are described in Section 3.1.1.3.1.

This chapter includes a review, update and summary of the bacteria and benthic TMDL development studies. Additionally, because of significant land use changes between 1992 (i.e., the year of the original TMDL land use data) and 2006 (i.e., the year of the most current available land use data at initiation of this IP), pollutant load allocations were adjusted using the 2006 National Land Cover Database (NLCD) for all impairments included in this IP to give a more realistic and practical basis for implementation.

3.1 Update of TMDL Allocation Loads

The original TMDLs were developed in 2004 and 2006 using 1992 land use data (VADEQ, 2004, 2006a, 2006b). Current land use distributions have changed since that time. Therefore, prior to commencing development of the Roanoke River TMDL IP, adjustments had to be made to the bacteria and benthic TMDLs to reflect the land uses changes. Additionally, the original benthic TMDL (VADEQ, 2006b) sediment allocation loads were revised because of calculations used during that period overestimating instream erosion rates. This error was subsequently discovered as future benthic TMDLs were developed.

3.1.1 Bacteria Load Revision

3.1.1.1 Original Water Quality Modeling

Both bacteria TMDL studies used the HSPF model to simulate the hydrology and bacteria fate and transport in the various reaches of the Roanoke River watershed. HSPF is a hydrologic, watershed-based water quality model that explicitly accounts for specific physical conditions of the watershed, variations in rainfall and climate, and various bacteria sources. Development of the two bacteria TMDLs used the *E. coli* water quality standards of a geometric mean concentration of 126 colony forming units (cfu)/100 ml and a single sample concentration of 235 cfu/100 ml.

During the original development of the two bacteria TMDLs, the project areas were divided into smaller subwatersheds to represent the local watershed conditions and to improve the accuracy of the model. Using the existing conditions within these subwatersheds, the model was run until allocation scenarios were obtained by iteratively running the model while adjusting source contributions until the model runs resulted in attainment of the *E. coli* water quality standards.

3.1.1.2 HSPF Model Adjustments

In the bacteria TMDL studies (VADEQ 2004, 2006a) the 1992 NLCD was used to develop the land use distributions, perform hydrology and water quality calibrations, and to develop the allocations. However, most subwatersheds experienced changes in land use distributions between 1992 and 2006. The 2006 NLCD land use data were used to capture these changes and adjust the various bacteria sources and allocations. Additionally, several impaired segments within this IP do not have an established TMDL; steps taken to determine allocation loads and reductions for these impaired segments are explained below, as applicable.

3.1.1.3 HSPF Modeling Update - Land Use

The 2006 NLCD land use categories are different from the 1992 NLCD categories and a direct comparison/adjustment of the bacteria load from each specific 1992 NLCD land use category is not feasible. Therefore, in the update to the TMDL allocation, land uses were reclassified into more general categories. Differences between 1992 and 2006 land use categorizations are found in Table 3-1.

Table 3-1: Land Use Category Reclassification

Reclassified Land Use Type	1992 NLCD Land Use	2006 NLCD Land Use
Developed	Commercial/Industrial/ Transportation	High Intensity Developed
	High Intensity Residential	Medium Intensity Developed
	Low Intensity Residential	Low Intensity Developed
		Open Space Developed
Cropland	Row Crops	Cultivated Crops
Pasture/Hay	Pasture/Hay	Pasture/Hay
Forest	Deciduous Forest	Deciduous Forest
	Evergreen Forest	Evergreen Forest
	Mixed Forest	Mixed Forest
Water/Wetlands	Emergent Herbaceous Wetlands	Emergent Herbaceous Wetlands
	Open Water	Open Water
	Woody Wetlands	Woody Wetlands
Other	Quarries/Strip Mines/Gravel Pits	Barren Land
	Transitional	Grassland/Herbaceous
	Urban/Recreational Grasses	Shrub/Scrub

Overall, developed land increased from 1992 to 2006 whereas cropland, pasture/hay, forest, and water/wetland land use decreased (Table 3-2). The land use changes impact the 1992 existing and allocated loads and therefore these loads were adjusted to reflect the 2006 land use conditions (in Unit Area Load [UAL – cfu/acre]). The adjusted loads are presented for each subwatershed in Section 3.2. The following approach was used:

- Develop a 1992 UAL for each land use category and source using the 1992 land use distribution and the 1992 bacteria allocations.
    - For the direct bacteria sources, use agricultural land area to develop the UAL for direct livestock and use forested area to develop the UAL for direct wildlife.
    - For direct septic loads, use the same loads presented in the TMDL. It was assumed that the increase in developed land would not increase direct septic loads because either new development is connected to the sewer network or has newly installed septic systems, which should still be functioning properly. Although not changing the direct septic load, updated housing data from municipalities were used to re-estimate failing septic systems in this IP.

- Estimate the 2006 existing conditions and allocation loads for bacteria using the 1992 UALs and the 2006 land use distributions.
- Adjust the allocations and reductions to ensure that the 2006 total bacteria allocated load is the same for each subwatershed as the load developed during the TMDL study using the 1992 NLCD data.

Table 3-2: Roanoke River Implementation Bacteria Land Use Changes (acres)

Subwatershed	Land Use	Devel-oped	Cropland	Pasture /Hay	Forest	Water/ Wetlands	Other	Total
Carvin Creek	NLCD 1992	2,408	26	1,285	13,621	680	153	18,173
	NLCD 2006	4,228	0	541	12,641	717	46	18,174
	% Change	**76%**	**-100%**	**-58%**	**-7.2%**	**5.4%**	**-70%**	**0%**
Glade Creek & Laymantown Creek	NLCD 1992	2,698	131	5,442	12,616	41	213	21,140
	NLCD 2006	7,118	67	4,020	9,904	21	11	21,141
	% Change	**164%**	**-49%**	**-26%**	**-22%**	**-48%**	**-95%**	**0%**
Lick Run	NLCD 1992	5,442	6.7	529	688	5.9	0	6,670
	NLCD 2006	6,499	0	59	110	1.1	0	6,670
	% Change	**19%**	**-100%**	**-89%**	**-84%**	**-82%**		**0%**
Tinker Creek	NLCD 1992	4,091	164	9,499	11,543	72	223	25,591
	NLCD 2006	9,171	27	7,219	9,068	51	59	25,594
	% Change	**124%**	**-84%**	**-24%**	**-21%**	**-30%**	**-74%**	**0%**
Back Creek	NLCD 1992	1,513	167	3,706	31,989	37	191	37,603
	NLCD 2006	6,905	63	2,836	27,557	20	222	37,603
	% Change	**356%**	**-63%**	**-24%**	**-14%**	**-47%**	**16%**	**0%**
Mason Creek	NLCD 1992	1,446	99	1,024	16,213	16	48	18,846
	NLCD 2006	3,768	9.1	523	14,412	3.7	132	18,846
	% Change	**161%**	**-91%**	**-49%**	**-11%**	**-78%**	**177%**	**0%**
Mud Lick Creek, Murray Run, & Ore Branch	NLCD 1992	5,217	20	953	6,449	33	428	13,100
	NLCD 2006	9,684	4.5	185	3,240	4.2	34	13,152
	% Change	**86%**	**-78%**	**-81%**	**-50%**	**-87%**	**-92%**	**0.4%**
Peters Creek	NLCD 1992	2,089	10	909	2,760	4.0	9.6	5,781
	NLCD 2006	3,808	0	180	1,772	0	13	5,773
	% Change	**82%**	**-100%**	**-80%**	**-36%**	**-100%**	**38%**	**-0.1%**
Roanoke River 1	NLCD 1992	7,255	387	3,474	163,079	458	1184	175,837
	NLCD 2006	24,722	40	1,589	153,979	308	1293	181,931
	% Change	**241%**	**-90%**	**-54%**	**-5.6%**	**-33%**	**9.2%**	**3.5%**
Roanoke River 2	NLCD 1992	37,103	70	2,182	271,905	1,975	3,473	316,708
	NLCD 2006	85,923	3.6	1,462	237,248	1,274	205	326,116
	% Change	**132%**	**-95%**	**-33%**	**-13%**	**-36%**	**-94%**	**3%**
Average Change		**144%**	**-85%**	**-52%**	**-26%**	**-53%**	**-21%**	

3.1.1.3.1 Impaired Segments without an Established TMDL

Several impaired segments and associated subwatersheds did not have an individual TMDL developed within the two established bacteria TMDL reports. However, bacteria source assessments were developed for these impaired segments within this IP. Segments, as defined in Table A-1 in Appendix A, without an established TMDL include Back Creek, Mason Creek, Mud Lick Creek, Murray Run, Peters Creek, and Roanoke River 1 – VAW-L03R (five segments). The following steps describe the approach used to develop existing conditions and allocations for *E. coli* for these segments and their subwatersheds:

- Develop 1992 existing conditions fecal coliform loads for each impaired segment without an established TMDL by running the calibrated HSPF model with the bacteria source assessments.
- Convert the 1992 existing conditions fecal coliform loads obtained from the model output into 1992 *E. coli* loads.
- Develop individual 1992 allocation loads for each impaired segment without an established TMDL by using the estimated level of *E. coli* reductions for either Ore Branch or Roanoke River as guides. The bacteria reductions for the Ore Branch TMDL were used as reference conditions for Mud Lick Creek and Murray Run. The bacteria reductions for the Roanoke River – VAW-L04R were used as reference conditions for Back Creek, Mason Creek, Peters Creek, and Roanoke River 1 – VAW-L03R. It was assumed that the level of bacteria reductions required for Ore Branch and Roanoke River are similar to those required for the impaired segments without established TMDLs in order to meet the bacteria water quality standards.
- Adjust the 1992 *E. coli* existing conditions and allocations loads developed, in the previous steps, for the impaired segments without an established TMDL to the 2006 land use conditions. Use a similar approach to that described in Section 3.1.1.3 for bacteria load adjustments to the 2006 land use.

3.1.2 Sediment Load Revision

3.1.2.1 Original Water Quality Modeling

The Generalized Watershed Loading Functions (GWLF) model was used to simulate runoff and sediment loads within the watershed for the benthic TMDL (VADEQ, 2006b). A reference watershed approach was used to establish the numeric TMDL endpoint for the Roanoke River. Using this approach, the TMDL endpoint for an impaired watershed was established based on conditions in a similar, but non-impaired reference watershed. In terms of benthic impairment caused by excessive sediment, the TMDL endpoint is the sediment loading rate in the non-impaired reference watershed. Reduction of the sediment loading rate in the impaired watershed to levels comparable to the reference watershed is assumed to be sufficient for recovery of the benthic community in the impaired watershed. Instream erosion was estimated based on the streambank lateral erosion rate equation introduced by Evans et al. (2003).

The watershed draining to the VADEQ biomonitoring station at river mile 224.5 on the Roanoke River was selected as the reference watershed for the benthic TMDL development.

3.1.2.2 GWLF Model Adjustments

Review of modeling files and data used during the development of the Roanoke River benthic TMDL indicated that the recommended sediment reduction level (69.5%) developed with the 1992 NLCD data was slightly overestimated mainly due to an error in the estimation of the instream erosion loads in the impaired and reference watershed. Additionally, land use distributions within the benthic TMDL watershed changed from 1992 to 2006 necessitating load allocation adjustments to reflect these changes.

The first step in updating the Roanoke River benthic TMDL was to correct the instream erosion loads for the impaired and reference watersheds and recalculate the annual average sediment loadings and sediment reduction necessary for meeting the sediment endpoint using the 1992 NLCD data. Since the development of the benthic TMDL for the Roanoke River watershed using the 1992 NLCD data, there was a significant land use change with a drastic increase in urban areas and a corresponding decrease in forested and agricultural areas. Similar to the adjustments performed for the bacteria impaired segments, the sediment loads were adjusted to the 2006 NLCD land use distribution.

The steps used in the adjustment of the sediment allocations for the Roanoke River (VAW-L04R) for instream erosion and the 2006 NLCD land use data were as follows:

- Adjust the instream erosion rates to the 2006 land use distribution. The most sensitive variable to the instream erosion rates was the percent of urban areas that increased from 1992 to 2006.

- Adjust the land-based sediment loads using a sediment Unit Area Loads (UAL) and similar approach as the one used for the bacteria impairments in Section 3.1.1.3.

3.2 Bacteria TMDL Subwatersheds

The effective study area for the bacteria portion of the IP covers ten subwatersheds with 34 impaired segments (Figure 3-1). This study area encompasses two previously developed bacteria TMDLs as well as impaired segments that were not specifically included in a previous TMDL project. Specifically, the VADEQ (2004) TMDL report included all bacteria impaired segments in Carvin Creek, Glade Creek, Laymantown Creek, Lick Run, and Tinker Creek subwatersheds and developed TMDLs for each. Table A-1 in Appendix A defines the impaired segments covered under this IP.

In 2006, VADEQ implemented a bacteria TMDL study that developed specific bacteria TMDLs for Wilson Creek, Ore Branch and the Roanoke River (VADEQ 2006a). Although specific TMDLs were only developed for those three watersheds, the drainage area included within the developed TMDL study area encompassed bacteria impaired segments and drainage areas for the mainstem of the Roanoke River as well as impaired segments for Mud Lick Creek, Mason Creek, Murray Run, Ore Branch, Peters Creek, and Back Creek.

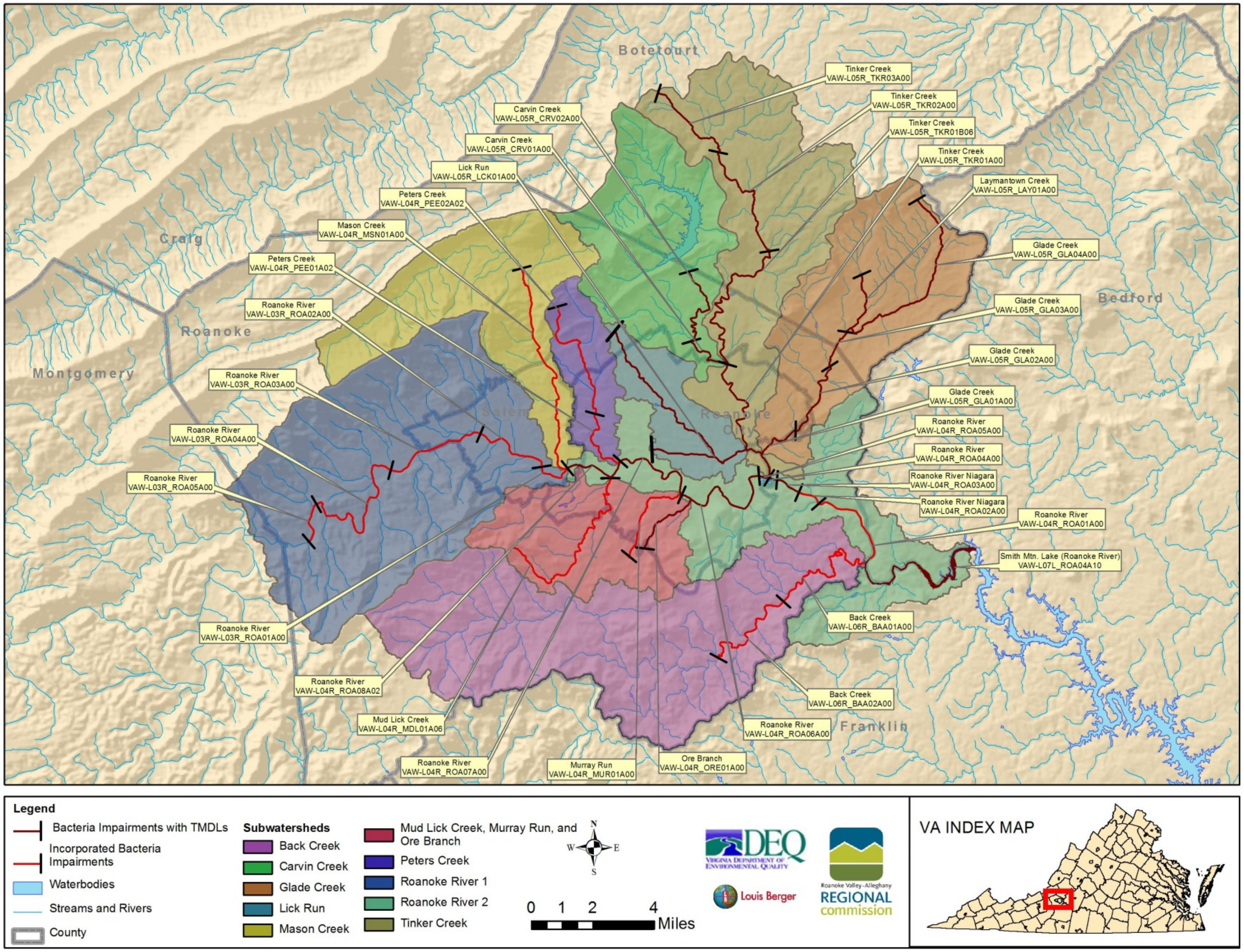

Figure 3-1. Bacteria Subwatersheds and Impaired Segments

3.2.1 Carvin Creek

<u>Description of Watershed and Impairment</u>

Carvin Creek headwaters are located in southwestern Botetourt County (Figure 3-2). From there the creek flows through Roanoke County into the City of Roanoke to its confluence with Tinker Creek. The drainage area of this subwatershed is approximately 18,174 acres. The dominant NLCD 2006 land uses consist of forest (70%) and developed land (23%). The majority of the forest land occurs in the upper and middle portions of the watershed. The developed land is located in the lower third of the watershed.

Carvin Creek was first listed as impaired in Virginia's 2002 Section 303(d) TMDL Priority List and Report due to exceedances of Virginia's water quality standard for fecal coliform bacteria. Since the initial listing, *E. coli* standards were established, and subsequent listings were based on exceedances of *E. coli* data. Due to these exceedances, the primary contact recreation use was not supported along 5.3 miles of the waterbody (Table 3-3). Development of the TMDL was based on the *E. coli* water quality standard.

Table 3-3: Impairment Summary for Carvin Creek

Assessment Unit	Length (miles)	Boundaries	Cause
VAW-L05R_CRV01A00	1.79	Carvin Creek mainstem from its confluence with Tinker Creek upstream to the mouth of Deer Branch.	*Escherichia coli*
VAW-L05R_CRV02A00	3.55	Carvin Creek mainstem from the mouth of Deer Branch upstream to an unnamed tributary upstream of I-81.	

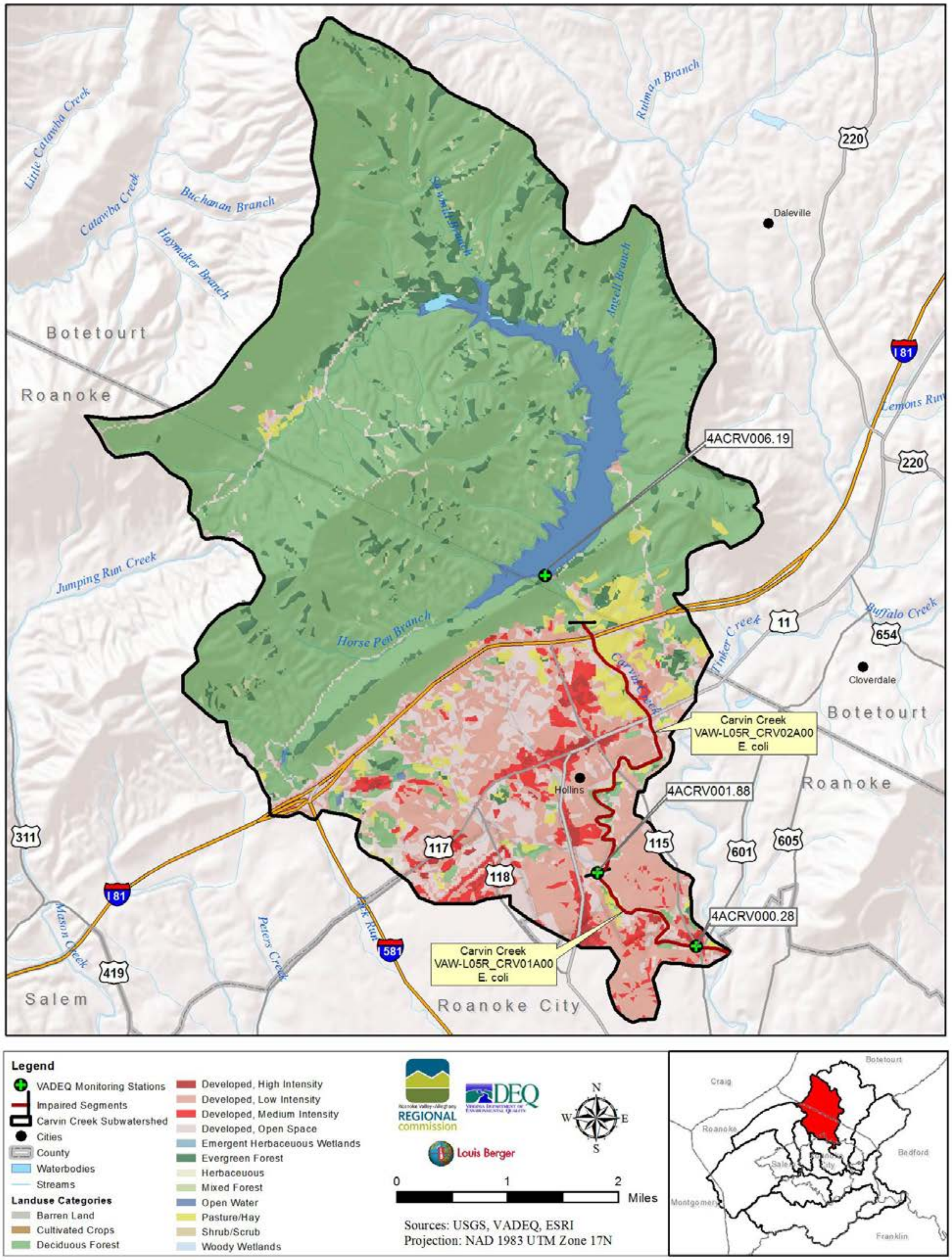

Figure 3-2. Carvin Creek Subwatershed

<u>Bacteria Sources</u>

The primary contributor to bacteria loading in the Carvin Creek subwatershed is nonpoint source runoff from forested and developed land uses (Figure 3-3).

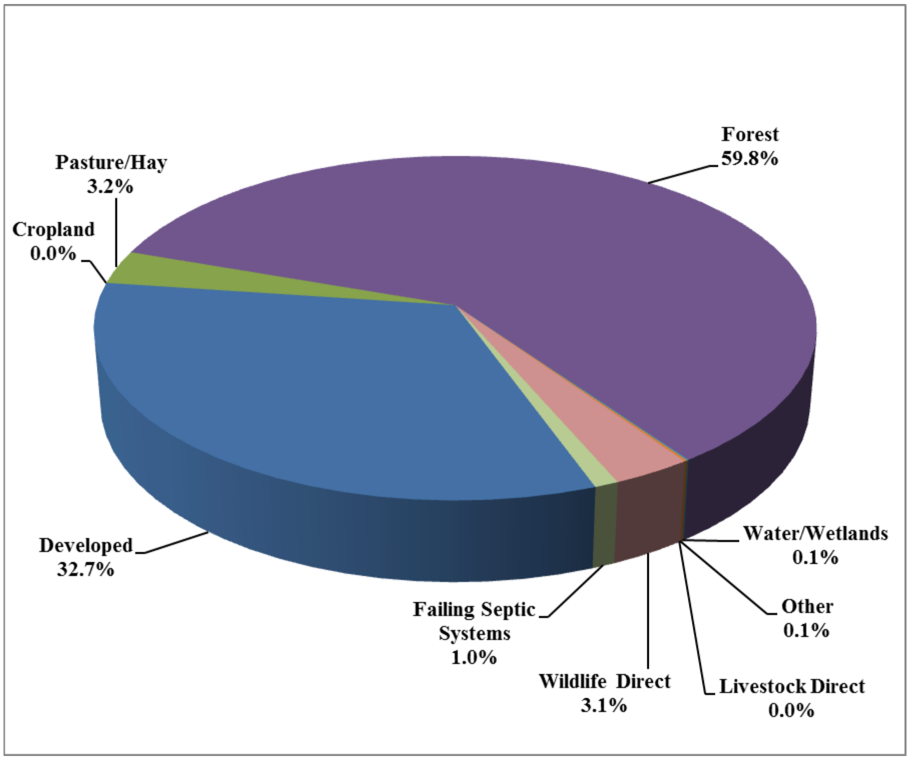

Figure 3-3. Bacteria Sources in Carvin Creek Subwatershed

<u>Bacteria Allocation Summary/Load Reduction</u>

Reductions from bacteria sources are presented in the load allocation table for the Carvin Creek subwatershed (Table 3-4). The existing *E. coli* loads from forested land are from indirect wildlife deposition.

Table 3-4: Carvin Creek Load Allocation for *E. coli*

2006 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	1.31E+15	1.29E+14	90.2%
Cropland	-	-	-
Pasture/Hay	1.27E+14	1.25E+13	90.2%
Forest	2.40E+15	3.57E+14	85.2%
Water/Wetlands	2.77E+12	4.12E+11	85.2%
Other	5.26E+12	5.18E+11	90.2%
Livestock Direct	-	-	-
Wildlife Direct	1.26E+14	3.16E+13	75%
Failing Septic Systems	3.84E+13	0.00E+00	100%
Total	**4.02E+15**	**5.31E+14**	**86.8%**

3.2.2 Glade Creek

Description of Watershed and Impairment

The headwaters of Glade Creek are located in southeastern Botetourt County (Figure 3-4). The creek flows through portions of Roanoke County and the City of Roanoke as well as the Towns of Vinton and Coyner Springs before its confluence with Tinker Creek. Laymantown Creek, a tributary of Glade Creek, joins the larger waterbody within Botetourt County. The Glade Creek/Laymantown Creek subwatershed drains approximately 21,141 acres. The dominant 2006 NLCD land uses are forest (47%), pasture/hay (19%), and developed (34%). The forest land is concentrated on the eastern and western boundaries of the watershed with the agricultural land surrounding the streams and developed land occurring mainly in the lower portion of the watershed.

The Glade Creek impairment was first listed in Virginia's 1998 Section 303(d) TMDL Priority List and Report due to exceedances of Virginia's water quality standard for fecal coliform bacteria; this original impairment was extended in 2002. Laymantown Creek was first listed as impaired in the 2002 Section 303(d) Priority List and Report, also due to fecal coliform exceedances. The entire Glade Creek watershed, including the Laymantown Creek tributary, contains five impaired segments for a total of 14.6 miles (Table 3-5). Glade Creek is separated into four impaired segments totaling 12.6 miles which include the creek from its headwaters to its confluence with Tinker Creek. The Laymantown Creek impairment is 2.1 miles long. Due to these exceedances, the primary contact recreation use was not supported along these 14.6 miles. Development of the TMDL was based on the *E. coli* water quality standard.

Table 3-5: Impairment Summary for Glade Creek/Laymantown Creek				
Assessment Unit	**Stream Name**	**Length (miles)**	**Boundaries**	**Cause**
VAW-L05R_GLA01A00	Glade Creek	1.55	Glade Creek mainstem from the Glade Creek mouth on Tinker Creek upstream to the Berkley Rd. crossing.	*Escherichia coli*
VAW-L05R_GLA02A00	Glade Creek	2.84	Glade Creek mainstem from the Berkley Rd. Crossing on upstream to the confluence of Cook Creek.	*Escherichia coli*
VAW-L05R_GLA03A00	Glade Creek	1.33	Glade Creek mainstem from the Cook Creek mouth upstream to the confluence of Coyner Spring Branch.	*Escherichia coli*
VAW-L05R_GLA04A00	Glade Creek	6.85	Glade Creek mainstem from the mouth of Coyner Spring Branch upstream to its headwaters.	*Escherichia coli*
VAW-L05R_LAY01A00	Layman-town Creek	2.07	Laymantown Creek mainstem from an outlet of a small pond downstream to the Laymantown Creek mouth on Glade Creek.	*Escherichia coli*

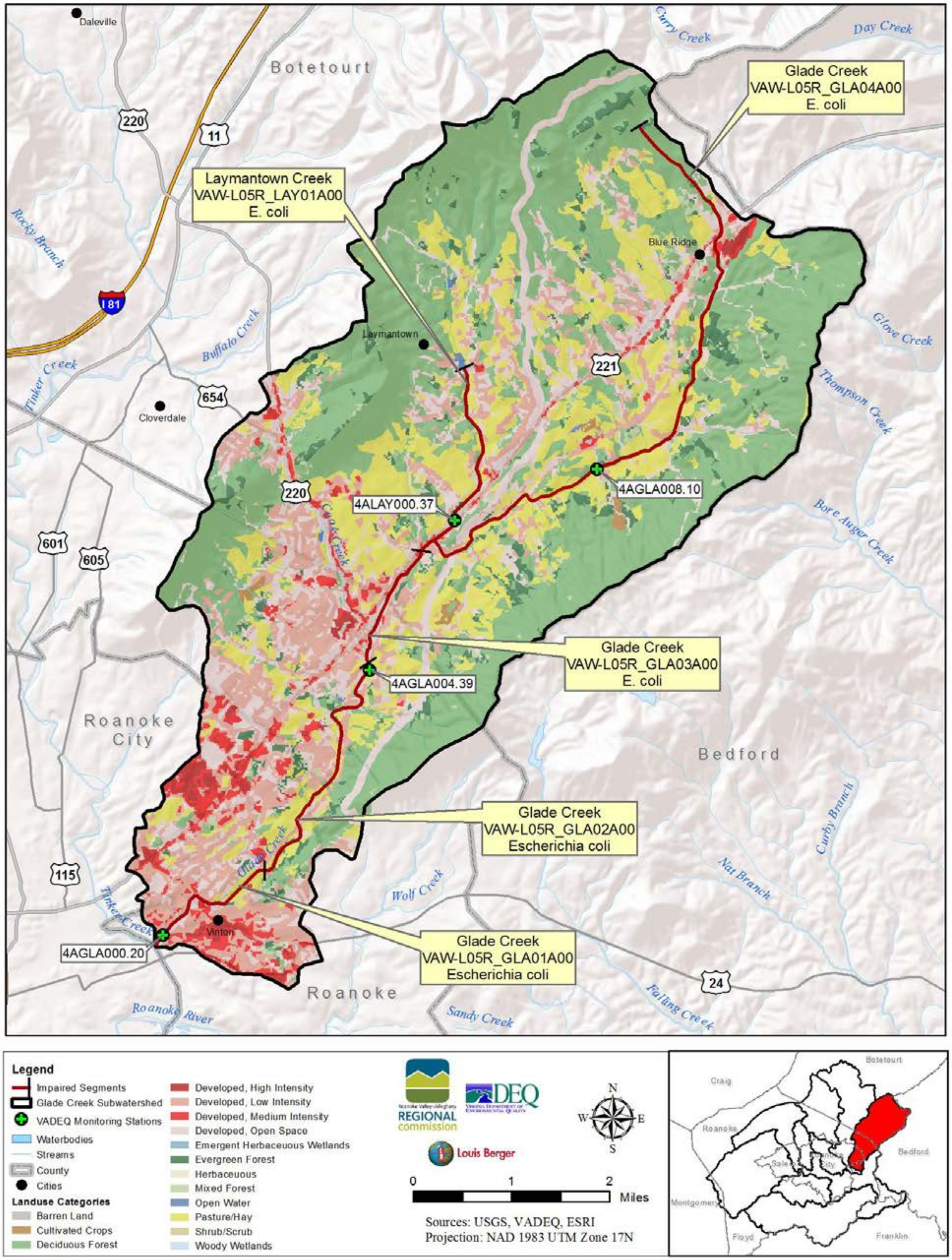

Figure 3-4. Glade/Laymantown Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Glade Creek/Laymantown Creek subwatershed is nonpoint source runoff from forested, developed, and pasture/hay land uses (Figure 3-5).

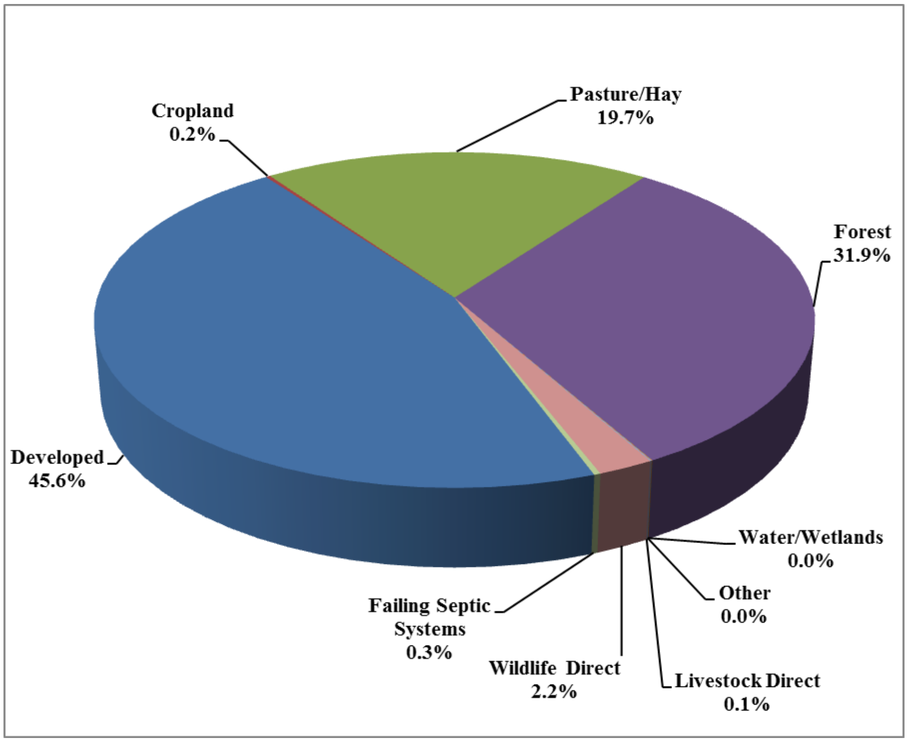

Figure 3-5. Bacteria Sources in Glade Creek/Laymantown Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Glade Creek/Laymantown Creek subwatershed (Table 3-6).

Table 3-6: Glade Creek/Laymantown Creek Load Allocation for *E. coli*

2006 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	2.65E+15	9.95E+13	96.3%
Cropland	1.24E+13	4.67E+11	96.3%
Pasture/Hay	1.15E+15	4.30E+13	96.3%
Forest	1.85E+15	1.58E+14	91.5%
Water/Wetlands	4.51E+11	4.06E+10	91%
Other	2.07E+12	7.77E+10	96.3%
Livestock Direct	3.03E+12	0.00E+00	100%
Wildlife Direct	1.30E+14	3.89E+13	70%
Failing Septic Systems	1.51E+13	0.00E+00	100%
Total	**5.82E+15**	**3.40E+14**	**94.1%**

3.2.3 Lick Run

Description of Impairment

Lick Run headwaters are located in southwestern Botetourt County from where it flows from Shaffer's Crossing downstream to its confluence with Tinker Creek (Figure 3-6). Lick Run drains into Tinker Creek before it meets the Roanoke River. The subwatershed drains approximately 6,670 acres. The dominant 2006 NLCD land use is developed land (97%). Specifically, Lick Run largely consists of urbanized land with a small amount of pasture in the headwaters to the north and some forest along the stream in the central portion (Figure 3-6).

Lick Run was first listed as impaired in Virginia's 2002 Section 303(d) TMDL Priority List and Report due to exceedances of Virginia's water quality standard for fecal coliform bacteria. Due to these exceedances, the primary contact recreation use was not supported along 9.4 miles of the waterbody (Table 3-7). Development of the TMDL was based on the *E. coli* water quality standard.

Table 3-7: Impairment Summary for Lick Run

Assessment Unit	Length (miles)	Boundaries	Cause
VAW-L05R_LCK01A00	9.37	Lick Run mainstem from near Shaffer's Crossing downstream to the mouth of Lick Run on Tinker Creek.	*Escherichia coli*

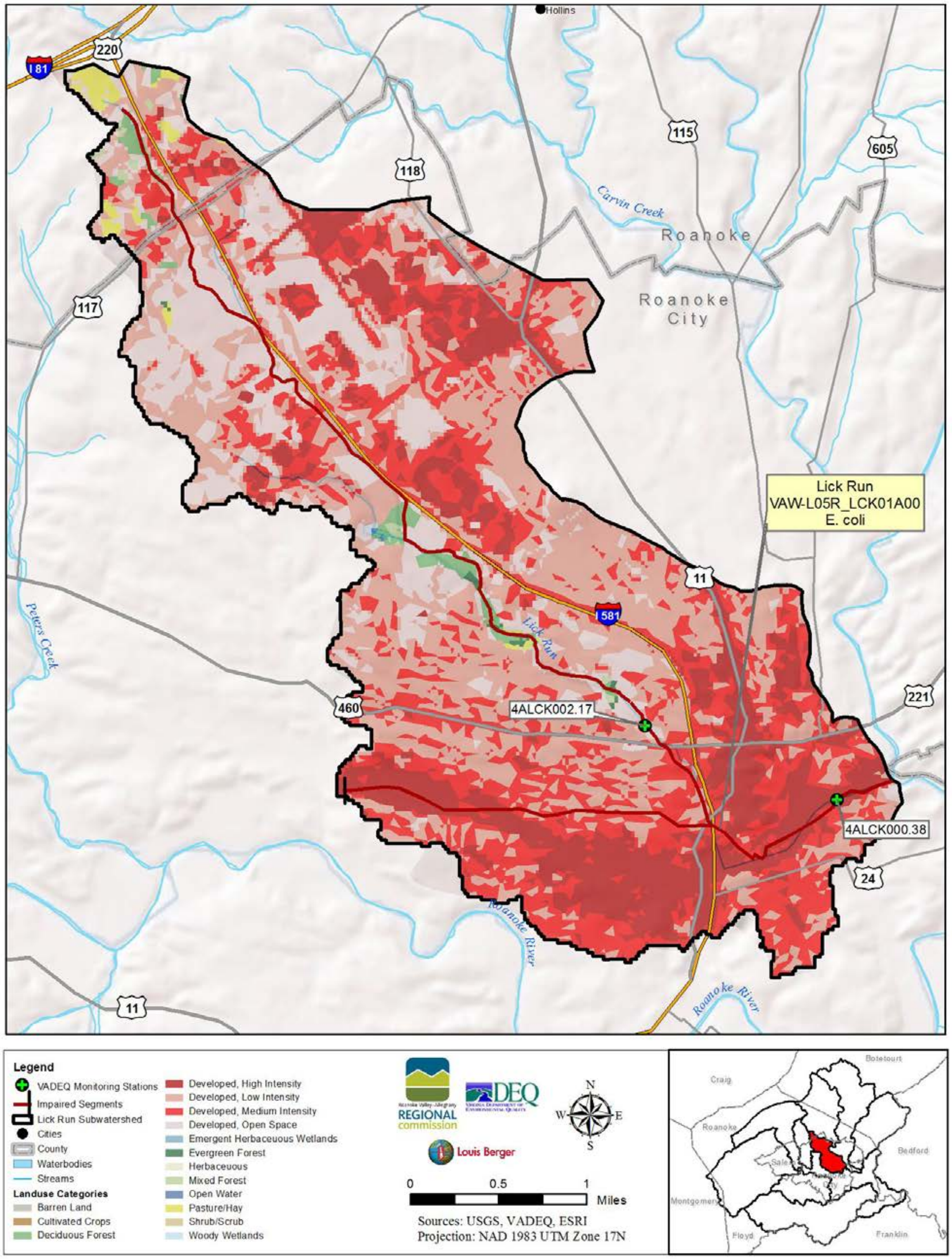

Figure 3-6. Lick Run Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in Lick Run subwatershed is nonpoint source runoff from developed land use (Figure 3-7).

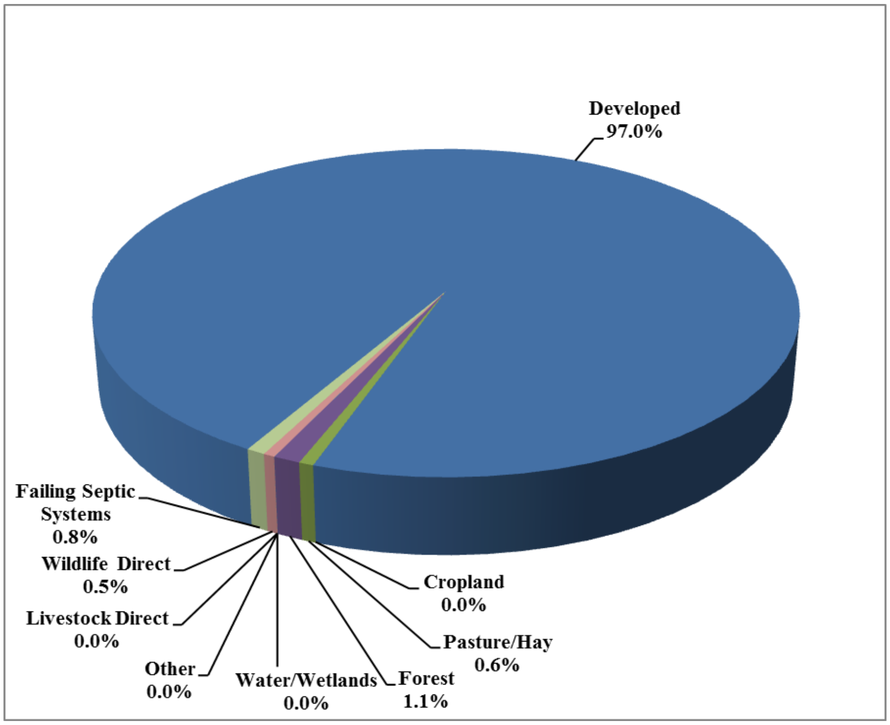

Figure 3-7. Bacteria Sources in Lick Run Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Lick Run subwatershed (Table 3-8).

Table 3-8: Lick Run Load Allocation for *E. coli*

2006 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	1.76E+15	2.70E+13	98.5%
Cropland	-	-	-
Pasture/Hay	1.09E+13	9.84E+11	91%
Forest	2.01E+13	2.01E+13	0%
Water/Wetlands	8.46E+10	8.46E+10	0%
Other	-	-	-
Livestock Direct	-	-	-
Wildlife Direct	8.57E+12	8.57E+12	0%
Failing Septic Systems	1.40E+13	0.00E+00	100%
Total	**1.81E+15**	**5.67E+13**	**96.9%**

3.2.4 Tinker Creek

Description of Watershed and Impairment

The Tinker Creek headwaters are located in southwestern Botetourt County (Figure 3-8). The creek flows through portions of Roanoke County and the City of Roanoke before its confluence with the Roanoke River. Tinker Creek has several tributaries. The Tinker Creek subwatershed drains approximately 25,594 acres. The dominant 2006 NLCD land uses include developed land (36%), forest (35%), and pasture/hay (28%). The upper part of the watershed near the headwaters is dominated by pasture, the central portion by pasture and woodland, and the lower part by urban or residential land uses.

Tinker Creek was first listed as impaired in Virginia's 1998 Section 303(d) TMDL Priority List and Report due to exceedances of Virginia's water quality standard for fecal coliform bacteria. Tinker Creek is separated into four impaired segments which include the creek from the headwaters to the mouth (Table 3-9). Due to these exceedances, the primary contact recreation use was not supported along 19.3 miles of the waterbody. Development of the TMDL was based on the *E. coli* water quality standard.

Table 3-9: Impairment Summary for Tinker Creek

Assessment Unit	Length (miles)	Boundaries	Cause
VAW-L05R_TKR01A00	5.34	Tinker Creek mainstem from its confluence with the Roanoke River upstream to the mouth of Carvin Creek.	*Escherichia coli*
VAW-L05R_TKR01B06	6.54	Tinker Creek mainstem from the Carvin Creek mouth upstream to the confluence of Buffalo Creek.	
VAW-L05R_TKR02A00	4.34	Tinker Creek mainstem from the mouth of Buffalo Creek upstream to the Roanoke City diversion tunnel located just upstream of the USGS stream gaging station.	
VAW-L05R_TKR03A00	3.12	Tinker Creek mainstem from the Roanoke City diversion tunnel to Carvin Cove on upstream to its headwaters.	

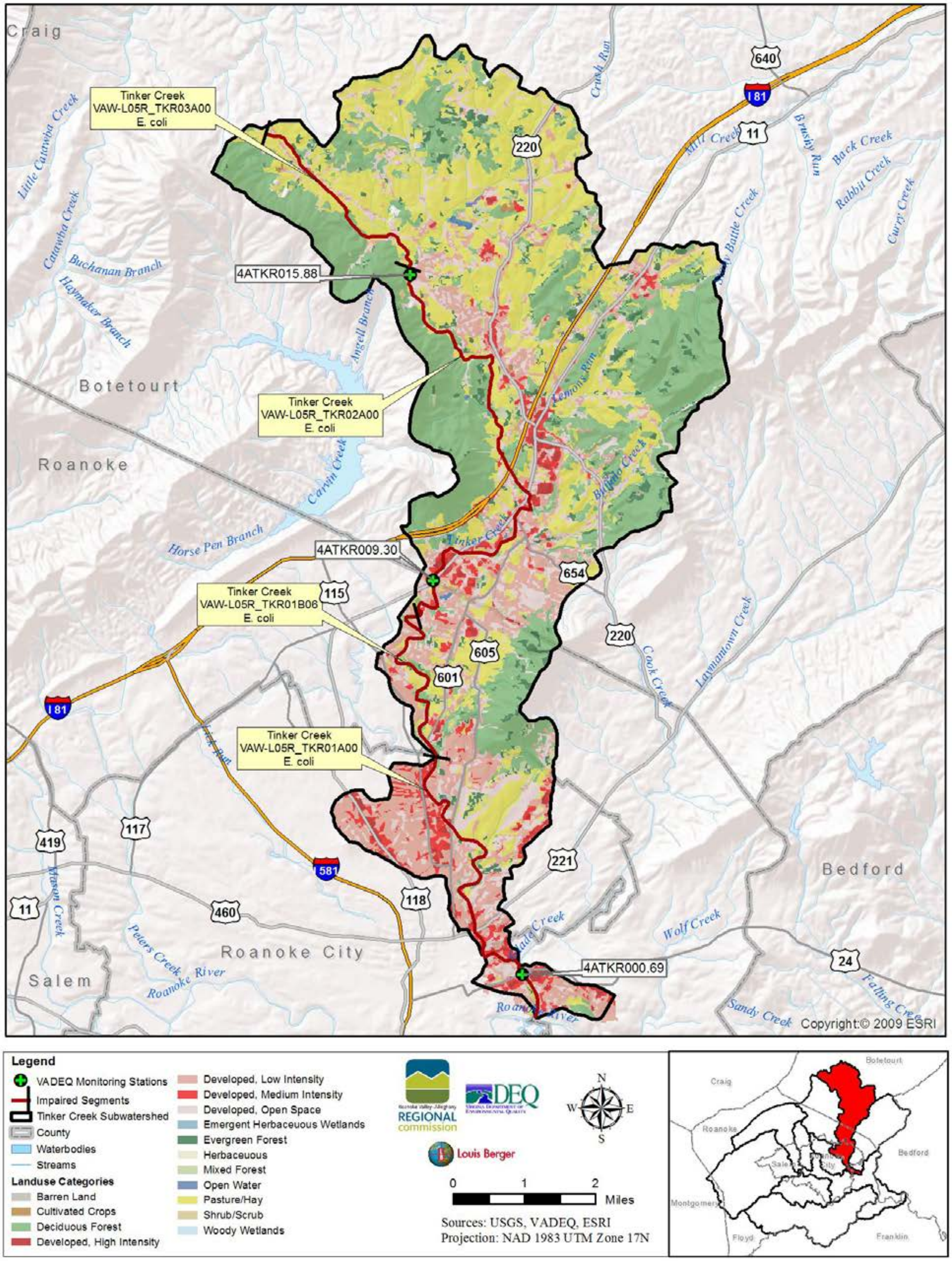

Figure 3-8. Tinker Creek Subwatershed

<u>Bacteria Sources</u>

The primary contributor to bacteria loading in the Tinker Creek subwatershed is nonpoint source runoff from developed and pasture/hay land uses (Figure 3-9).

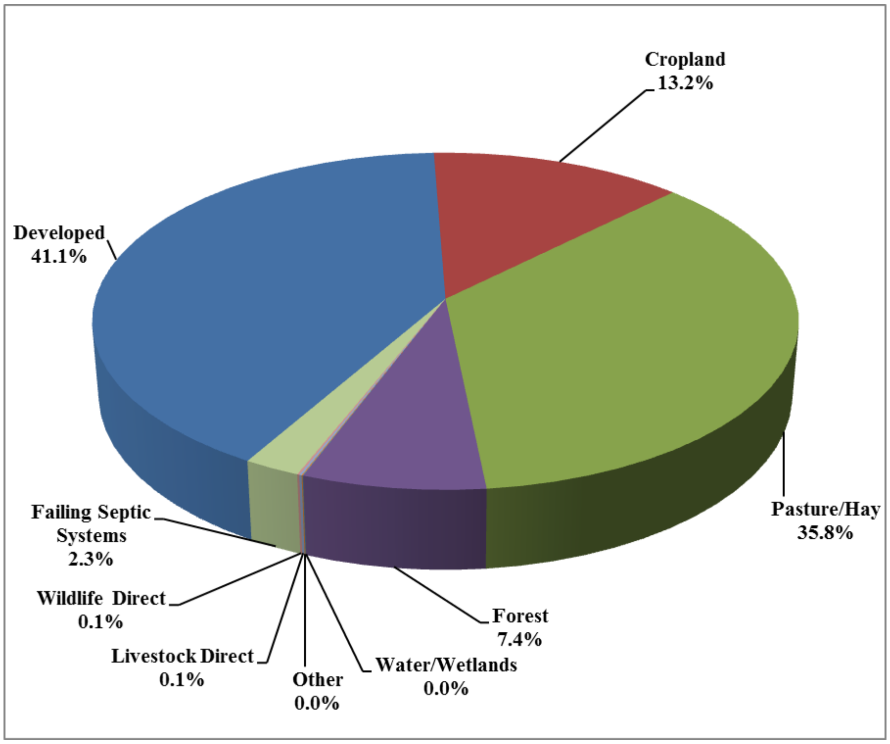

Figure 3-9. Bacteria Sources in Tinker Creek Subwatershed

<u>Bacteria Allocation Summary/Load Reduction</u>

Reductions from bacteria sources are presented in the load allocation table for the Tinker Creek subwatershed (Table 3-10).

Table 3-10: Tinker Creek Load Allocation for *E. coli*

2006 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	1.50E+15	2.08E+13	98.6%
Cropland	4.82E+14	9.64E+11	99.8%
Pasture/Hay	1.31E+15	2.62E+12	99.8%
Forest	2.71E+14	1.36E+13	95%
Water/Wetlands	8.02E+11	4.01E+10	95%
Other	1.66E+12	3.32E+10	98%
Livestock Direct	3.73E+12	0.00E+00	100%
Wildlife Direct	3.23E+12	3.23E+12	0%
Failing Septic Systems	8.38E+13	0.00E+00	100%
Total	**3.66E+15**	**4.12E+13**	**98.9%**

3.2.5 Back Creek (Nested TMDL)

<u>Description of Watershed and Impairment</u>

The headwaters of Back Creek are located in southwestern Roanoke County (Figure 3-10). The creek flows in an easterly direction before flowing into the Roanoke River close to the Roanoke County-Bedford County line. The subwatershed mainly falls within Roanoke County as well as small portions of Franklin County and the City of Roanoke; it drains approximately 37,603 acres. The dominant 2006 NLCD land uses include forest (73%) and developed land (18%). Most of the subwatershed is forest; however, there is some developed land in the north-central part and pasture/hay scattered throughout.

Data were collected on Back Creek for the 303(d) assessment of impaired segments in the subwatershed. Back Creek exceeded water quality standards for bacteria at two stations. Specifically, three out of 19 samples at one station exceeded the 400 cfu/100 ml fecal coliform single sample maximum in 2004. In 2008, two out of 12 samples at the other station exceeded the 235 cfu/100 ml *E. coli* single sample maximum.

Two segments of Back Creek were first listed as impaired in Virginia's 2004 Section 303(d) TMDL Priority List and Report due to exceedances of Virginia's water quality standard for fecal coliform bacteria. Due to these exceedances, the primary contact recreation use was not supported along 9.9 miles of the waterbody (Table 3-11).

Table 3-11: Impairment Summary for Back Creek

Assessment Unit	**Length (miles)**	**Boundaries**	**Cause**
VAW-L06R_BAA01A00	5.65	Back Creek mainstem from the WQS designated end of the public water supply (PWS) section, ~0.83 miles upstream of the Rt. 116 crossing downstream to the Back Creek mouth; as determined from the 795 ft. Smith Mountain Lake pool elevation.	*Escherichia coli*
VAW-L06R_BAA02A00	4.22	Back Creek mainstem waters from just below the Rt. 220 crossing (~0.5 mi), Red Hill at the mouth of an unnamed tributary to Back Creek on downstream to the WQS designated end of the PWS section, ~0.83 miles upstream of the Rt. 116 crossing.	

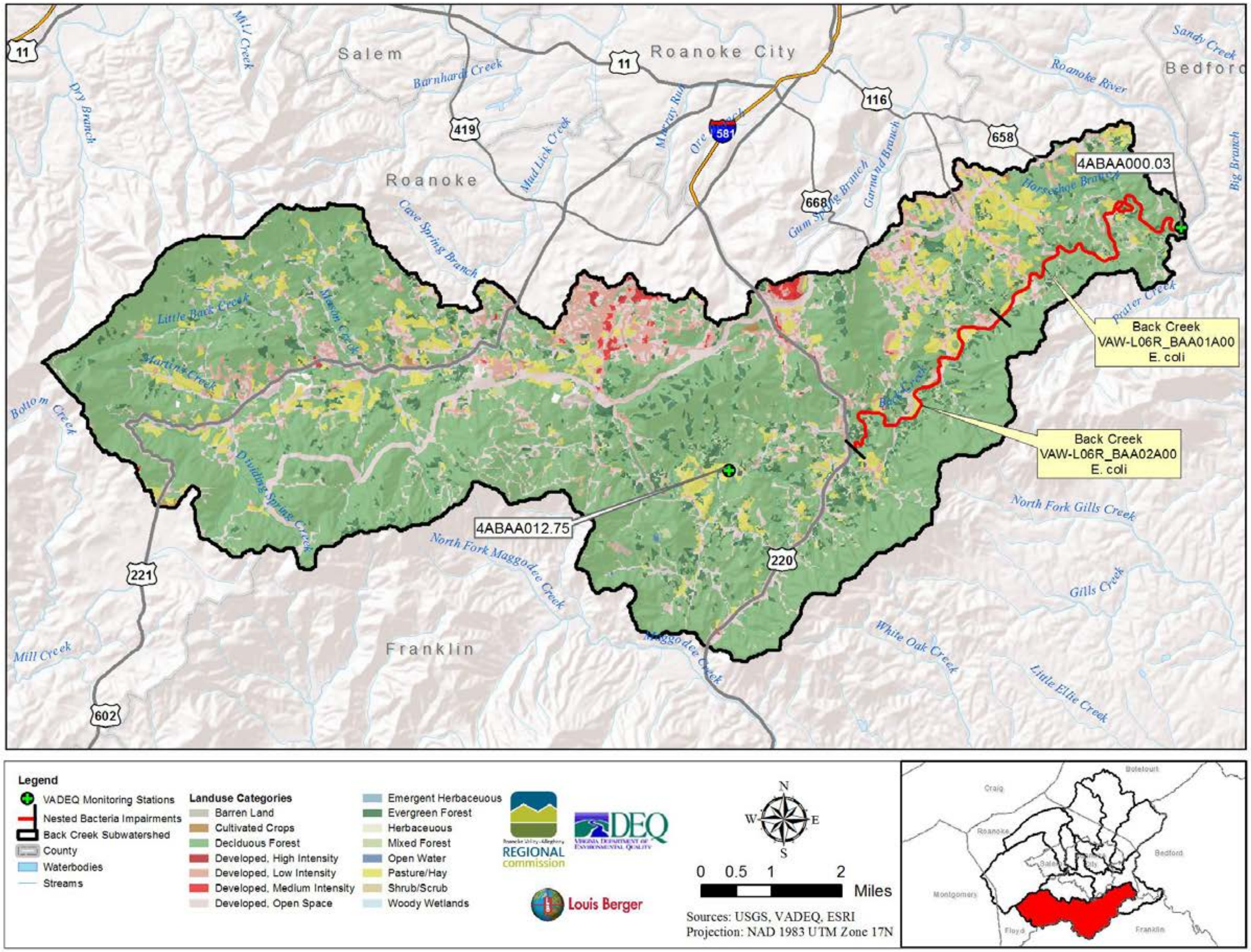

Figure 3-10. Back Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Back Creek subwatershed is nonpoint source runoff from developed land use and wildlife direct sources (Figure 3-11).

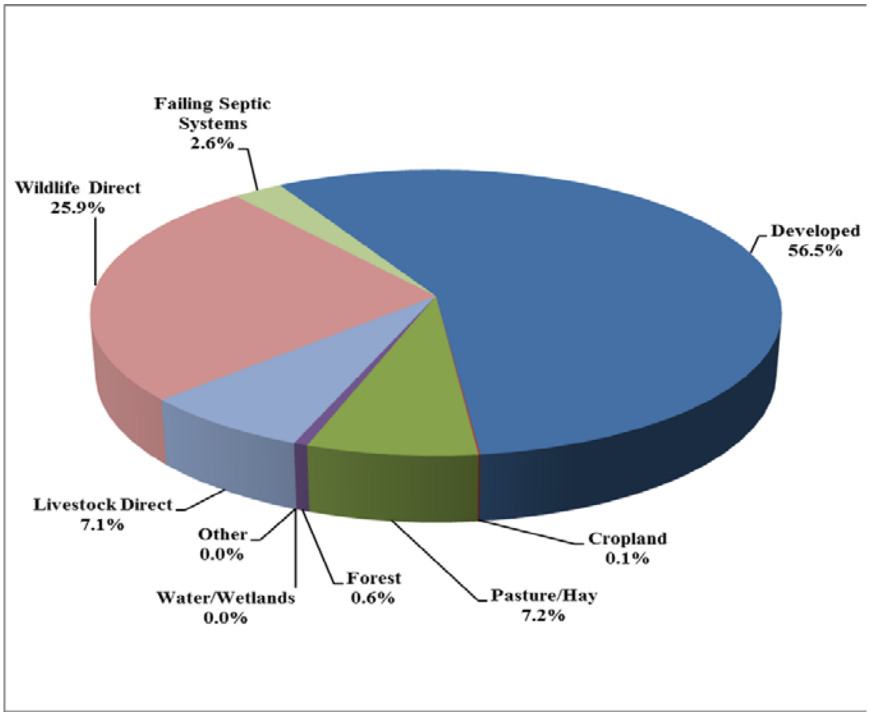

Figure 3-11. Bacteria Sources in Back Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Back Creek subwatershed (Table 3-12).

Table 3-12: Back Creek Load Allocation for *E. coli* Allocation

2006 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	5.01E+13	5.51E+11	98.9%
Cropland	7.13E+10	7.84E+08	98.9%
Pasture/Hay	6.36E+12	6.99E+10	98.9%
Forest	5.19E+11	5.71E+09	98.9%
Water/Wetlands	1.20E+08	1.20E+08	0%
Other	4.55E+08	5.00E+06	98.9%
Livestock Direct	6.33E+12	0.00E+00	100%
Wildlife Direct	2.30E+13	8.16E+12	64.5%
Failing Septic Systems	2.33E+12	0.00E+00	100%
Total	**8.87E+13**	**8.79E+12**	**90.1%**

3.2.6 Mason Creek (Nested Watershed)

Description of Watershed and Impairment

The headwaters of Mason Creek are located in northwestern Roanoke County (Figure 3-20). The creek flows through Roanoke County and a small portion of the City of Salem before its confluence with the Roanoke River (Figure 3-12). The drainage area of the subwatershed is approximately 18,846 acres. The dominant 2006 NLCD land uses include forest (77%) and developed (20%). The developed land is concentrated in the lower subwatershed while forest land dominates the middle and upper portions with small areas of pasture scattered throughout.

Data were collected on Mason Creek for the 303(d) assessment of the impaired segment in the subwatershed. One water quality monitoring station on Mason Creek had exceedances. Specifically, seven out of 32 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum in 2008 and 2010. The 2006 Integrated Report listed the same station with five out of 20 samples exceeding the *E. coli* single sample maximum.

One segment of Mason Creek was first listed as impaired in Virginia's 2002 Section 303(d) TMDL Priority List and Report due to exceedances of Virginia's water quality standard for fecal coliform bacteria. Due to these exceedances, the primary contact recreation use was not supported along 7.6 miles of the waterbody (Table 3-13).

Table 3-13: Impairment Summary for Mason Creek

Assessment Unit	Length (miles)	Boundaries	Cause
VAW-L04R_MSN01A00	7.56	Mason Creek mainstem from its confluence with the Roanoke River upstream to near the Mason Cove Community.	*Escherichia coli*

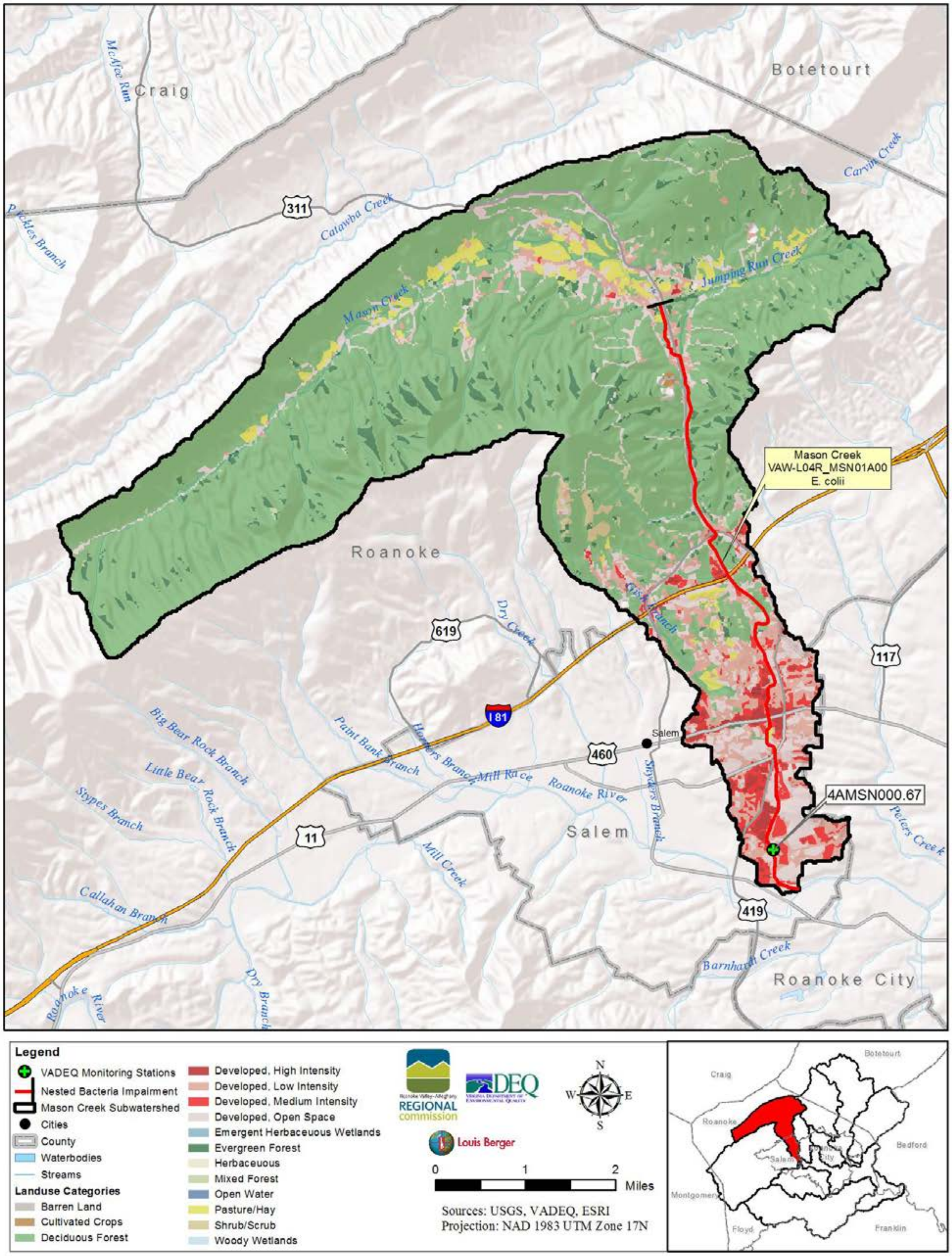

Figure 3-12. Mason Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Mason Creek subwatershed is nonpoint source runoff from developed land use and wildlife direct sources (Figure 3-13).

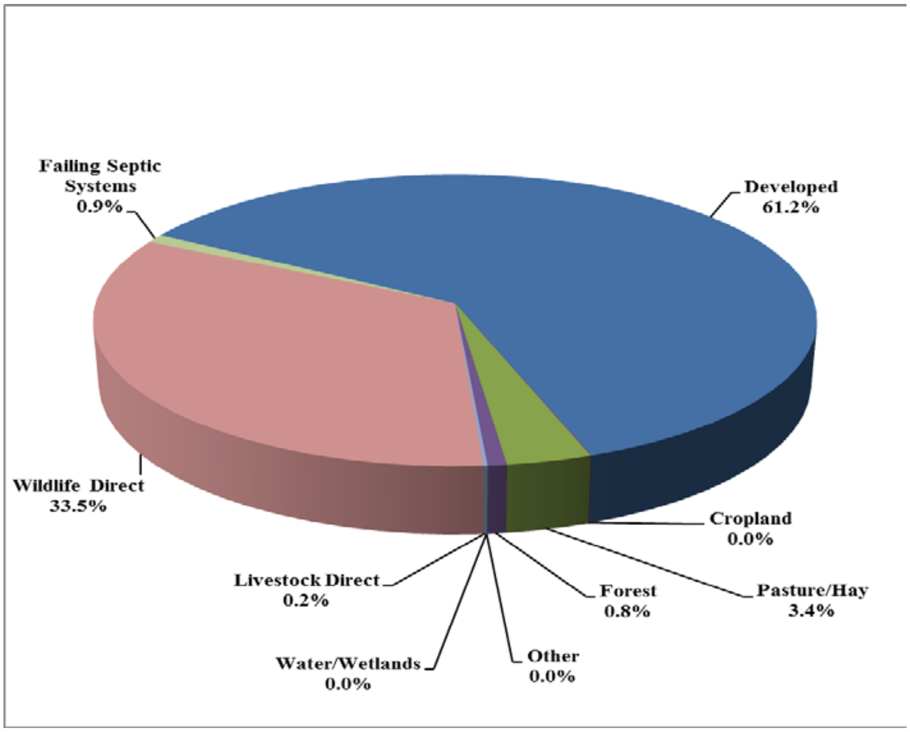

Figure 3-13. Bacteria Sources in Mason Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Mason Creek subwatershed (Table 3-14).

Table 3-14: Mason Creek Load Allocation for *E. coli*

2006 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	2.17E+13	2.48E+11	98.9%
Cropland	1.02E+10	1.12E+08	98.9%
Pasture/Hay	1.21E+12	1.33E+10	98.9%
Forest	2.71E+11	2.98E+09	98.9%
Water/Wetlands	2.23E+07	2.23E+07	0%
Other	6.64E+08	7.30E+06	98.9%
Livestock Direct	5.63E+10	0.00E+00	100%
Wildlife Direct	1.19E+13	4.16E+12	65.1%
Failing Septic Systems	3.34E+11	0.00E+00	100%
Total	**3.55E+13**	**4.42E+12**	**87.6%**

3.2.7 Mud Lick Creek, Murray Run, and Ore Branch (Partially Nested Watershed)

Description of Watershed and Impairment

The Mud Lick Creek, Murray Run, and Ore Branch subwatershed is located in the City of Roanoke and central Roanoke County and drains approximately 13,197 acres (Figure 3-14). The headwaters of Murray Run and Ore Branch both begin in Roanoke County and flow in a northeasterly direction before their confluences with the Roanoke River in the City of Roanoke. Mud Lick Creek joins the Roanoke River upstream of Murray Run and Ore Branch. The dominant 2006 NLCD land uses consist of developed land (73.4%) and forest (24.6%). Developed land dominates throughout the subwatershed except on the southeastern subwatershed boundary and in the headwaters of Mud Lick Creek on the western boundary where forest and pasture/hay are present.

Ore Branch has water quality monitoring data collected for 303(d) assessment as well as data collected specifically to aid TMDL development. Data were collected for Mud Lick Creek and Murray Run solely for the 303(d) assessment of the impaired segments in these subwatersheds.

The Ore Branch segments was first listed as impaired in Virginia's 1998 Section 303(d) TMDL Priority List and Report due to exceedances of Virginia's water quality standard for fecal coliform bacteria. Mud Lick Creek and Murray Run were first listed as impaired in Virginia's 2006 and 2004, respectively, Section 303(d) TMDL Priority Lists and Reports due to exceedances of Virginia's water quality standard for fecal coliform bacteria. Due to these exceedances, the primary contact recreation use was not supported along a total of 12.9 miles (Table 3-15). Mud Lick Creek and Murray Run were nested with the Ore Branch watershed due to the similar watershed conditions for each of the small tributaries to the Roanoke River.

Table 3-15: Impairment Summary for Mud Lick Creek, Murray Run, and Ore Branch

Assessment Unit	Stream Name	Length (miles)	Boundaries	Cause
VAW-L04R_MDL01A06	Mud Lick Creek	7.27	Mud Lick Creek from its confluence on the Roanoke River upstream to its headwaters.	*Escherichia coli*
VAW-L04R_MUR01A00	Murray Run	3.22	Murray Run mainstem from its headwaters to its mouth on the Roanoke River.	Fecal coliform
VAW-L04R_ORE01A00	Ore Branch	2.42	Ore Branch mainstem headwaters near Hunting Hills downstream to its confluence with the Roanoke River.	*Escherichia coli*

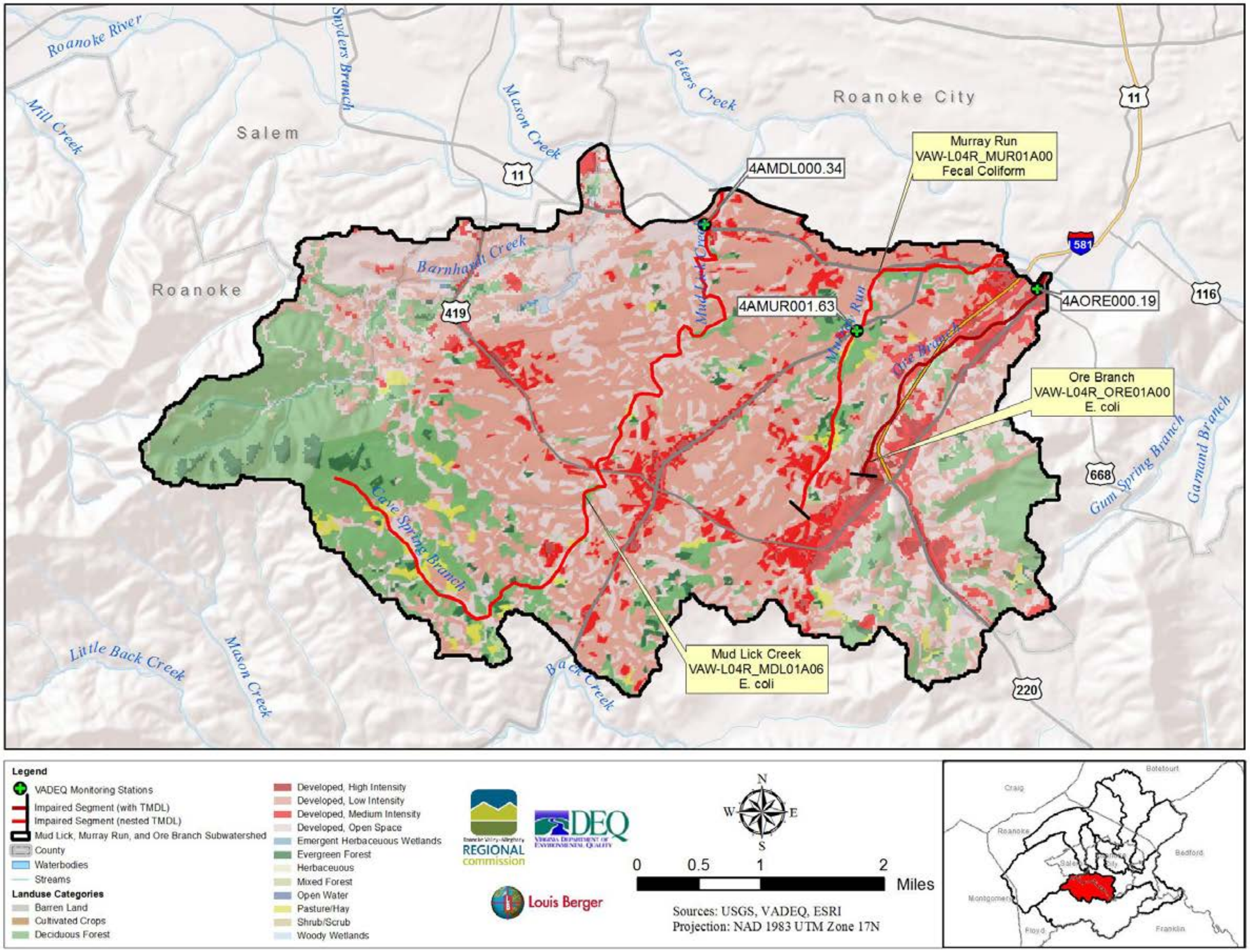

Figure 3-14. Mud Lick Creek, Murray Run, and Ore Branch Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Mud Lick Creek, Murray Run, and Ore Branch subwatershed is nonpoint source runoff from developed land use (Figure 3-15).

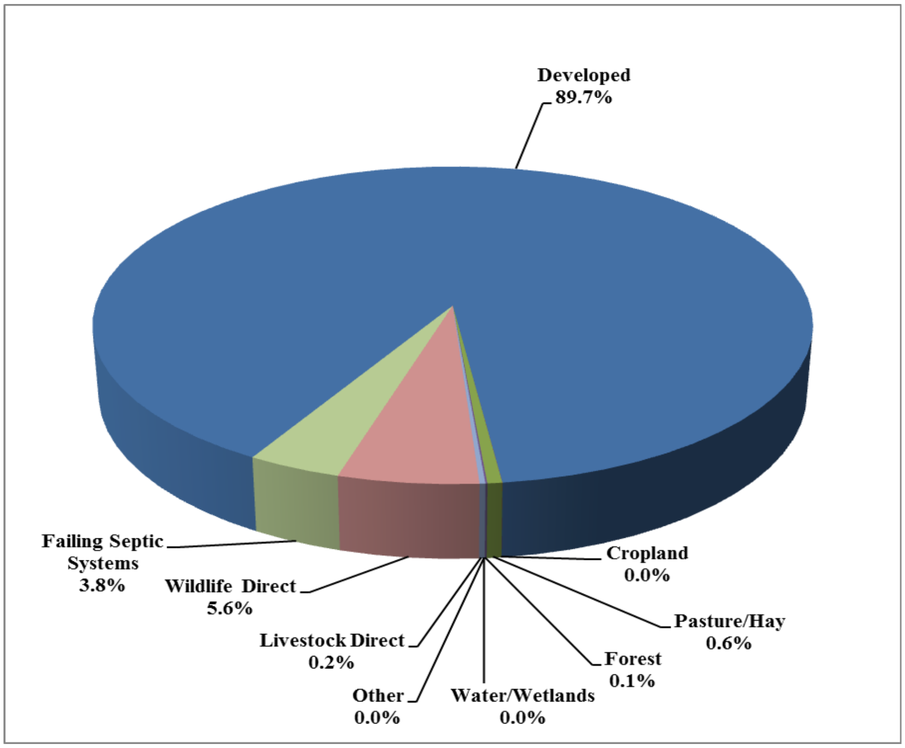

Figure 3-15. Bacteria Sources in Mud Lick Creek, Murray Run, and Ore Branch Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Mud Lick Creek, Murray Run, and Ore Branch subwatershed (Table 3-16).

Table 3-16: Mud Lick Creek, Murray Run, and Ore Branch Load Allocation for *E. coli*

2006 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	7.40E+13	2.96E+11	99.6%
Cropland	5.13E+09	2.05E+07	99.6%
Pasture/Hay	4.87E+11	1.95E+09	99.6%
Forest	6.08E+10	2.43E+08	99.6%
Water/Wetlands	5.18E+07	5.18E+07	0%
Other	6.57E+07	2.63E+05	99.6%
Livestock Direct	1.91E+11	0.00E+00	100%
Wildlife Direct	4.64E+12	5.61E+11	87.9%
Failing Septic Systems	3.10E+12	0.00E+00	100%
Total	**8.25E+13**	**8.59E+11**	**99%**

3.2.8 Peters Creek (Nested Watershed)

Description of Watershed and Impairment

The headwaters of Peters Creek are located in Roanoke County (Figure 3-16). The creek flows south until its confluence with the Roanoke River within the City of Roanoke. The subwatershed has a drainage area of approximately 5,773 acres. The dominant 2006 NLCD land uses include developed land (66%) and forest (31%). The developed land is concentrated in the central and lower portions of the subwatershed while forest dominates the upper portion surrounding the headwaters of Peters Creek.

Data were collected on Peters Creek for the 303(d) assessment of the impaired segments in the subwatershed. In 2008 and 2010, eleven out of 32 samples at one of the water quality monitoring stations on Peters Creek exceeded the 235 cfu/100 ml *E. coli* single sample maximum. The 2006 Integrated Report listed the same station with ten out of 20 samples exceeding the *E. coli* single sample maximum. The original impaired waters listing showed exceedances of the fecal coliform geometric mean.

Two segments on Peters Creek were first listed as impaired in Virginia's 2002 Section 303(d) TMDL Priority List and Report due to exceedances of Virginia's water quality standard for fecal coliform bacteria. Due to these exceedances, the primary contact recreation use was not supported along 7.1 miles of the waterbody from the headwaters to its confluence with the Roanoke River (Table 3-17).

Table 3-17: Impairment Summary for Peters Creek

Assessment Unit	Length (miles)	Boundaries	Cause
VAW-L04R_PEE01A02	2.52	Peters Creek mainstem from its confluence with the Roanoke River upstream to the Melrose Avenue Bridge (Rt. 11/460).	*Escherichia coli*
VAW-L04R_PEE02A02	4.62	Peters Creek mainstem from the Melrose Avenue Bridge (Rt. 11/460) upstream to its headwaters.	

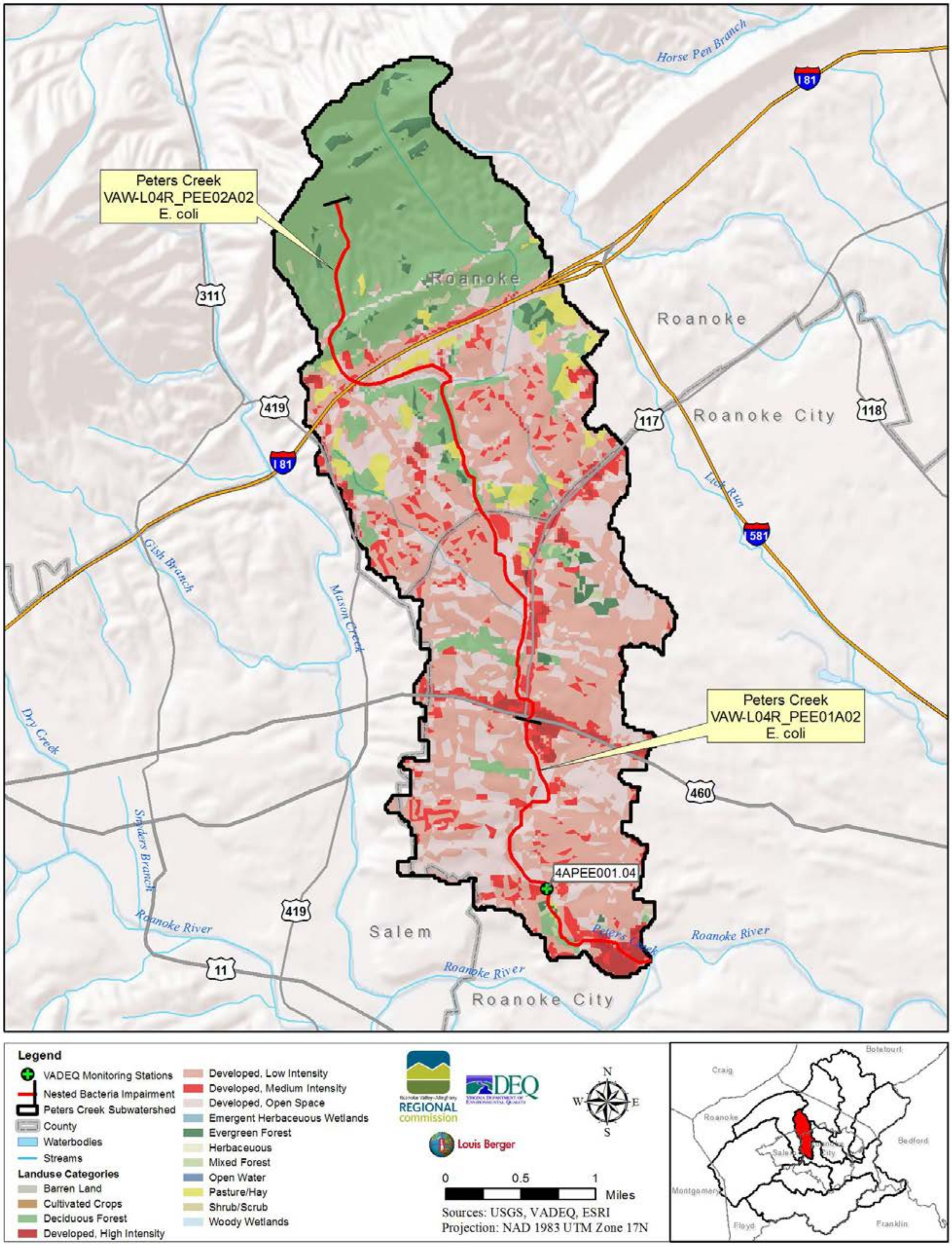

Figure 3-16. Peters Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Peters Creek subwatershed is nonpoint source runoff from developed land use (Figure 3-17).

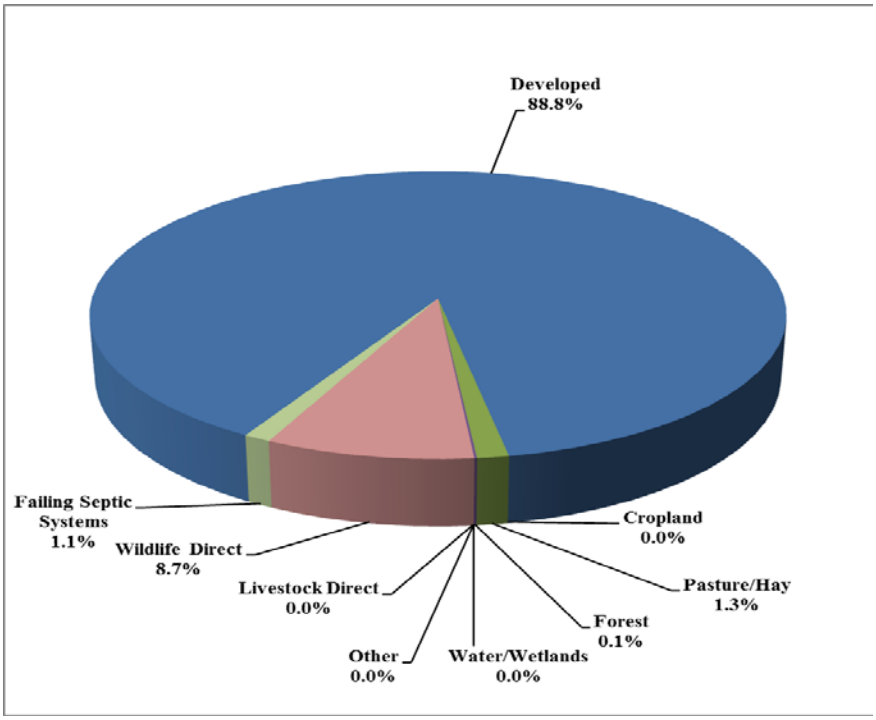

Figure 3-17. Bacteria Sources in Peters Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Peters Creek subwatershed (Table 3-18).

Table 3-18: Peters Creek Load Allocation for *E. coli*

2006 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	2.66E+13	2.92E+11	98.9%
Cropland	-	-	-
Pasture/Hay	3.95E+11	4.35E+09	98.9%
Forest	3.34E+10	3.67E+08	98.9%
Water/Wetlands	-	-	-
Other	3.21E+07	3.53E+05	98.9%
Livestock Direct	-	-	-
Wildlife Direct	2.60E+12	1.20E+12	53.7%
Failing Septic Systems	3.36E+11	0.00E+00	100%
Total	**2.99E+13**	**1.50E+12**	**95%**

3.2.9 Roanoke River 1 (Nested Watershed)

Description of Watershed and Impairment

The Roanoke River 1 subwatershed includes several segments of the mainstem Roanoke River from the Roanoke County Spring Hollow Reservoir intake to the Mason Creek confluence (Figure 3-18). The Roanoke River 1 reach flows west to east crossing through parts of Montgomery and Roanoke Counties and the City of Salem, draining approximately 40,415 acres. The dominant NLCD 2006 land uses include forest (68%) and developed land (26%). The developed land is concentrated in the eastern portion of the subwatershed.

Five segments within the Roanoke River 1 subwatershed were first listed as impaired in Virginia's 2004 Section 303(d) TMDL Priority Lists and Reports due to exceedances of Virginia's water quality standard for fecal coliform bacteria. Due to these exceedances, the primary contact recreation use was not supported along 14.3 miles of the waterbody from the Roanoke County Spring Hollow Reservoir intake downstream to the mouth of Mason Creek (Table 3-19).

Table 3-19: Impairment Summary for Roanoke River 1

Assessment Unit	Length (miles)	Boundaries	Cause
VAW-L03R_ROA01A00	1.20	Roanoke River mainstem from the Mason Creek mouth upstream to the Rt. 419 Bridge.	*Escherichia coli*
VAW-L03R_ROA02A00	2.67	Roanoke River mainstem from the Rt. 419 Bridge upstream to the City of Salem downtown intake on the Roanoke River.	
VAW-L03R_ROA03A00	3.41	Roanoke River mainstem from the Salem City WTP downtown intake upstream to the Big Bear Branch mouth on the Roanoke River.	
VAW-L03R_ROA04A00	5.60	Roanoke River mainstem from the Big Bear Rock Branch mouth upstream to end of the WQS designated public water supply (PWS) section just downstream of an unnamed tributary at Dixie Caverns.	
VAW-L03R_ROA05A00	1.40	Roanoke River mainstem from the end of the WQS designated public water supply (PWS) section just downstream of an unnamed tributary at Dixie Caverns upstream to the Roanoke County Spring Hollow Reservoir intake.	

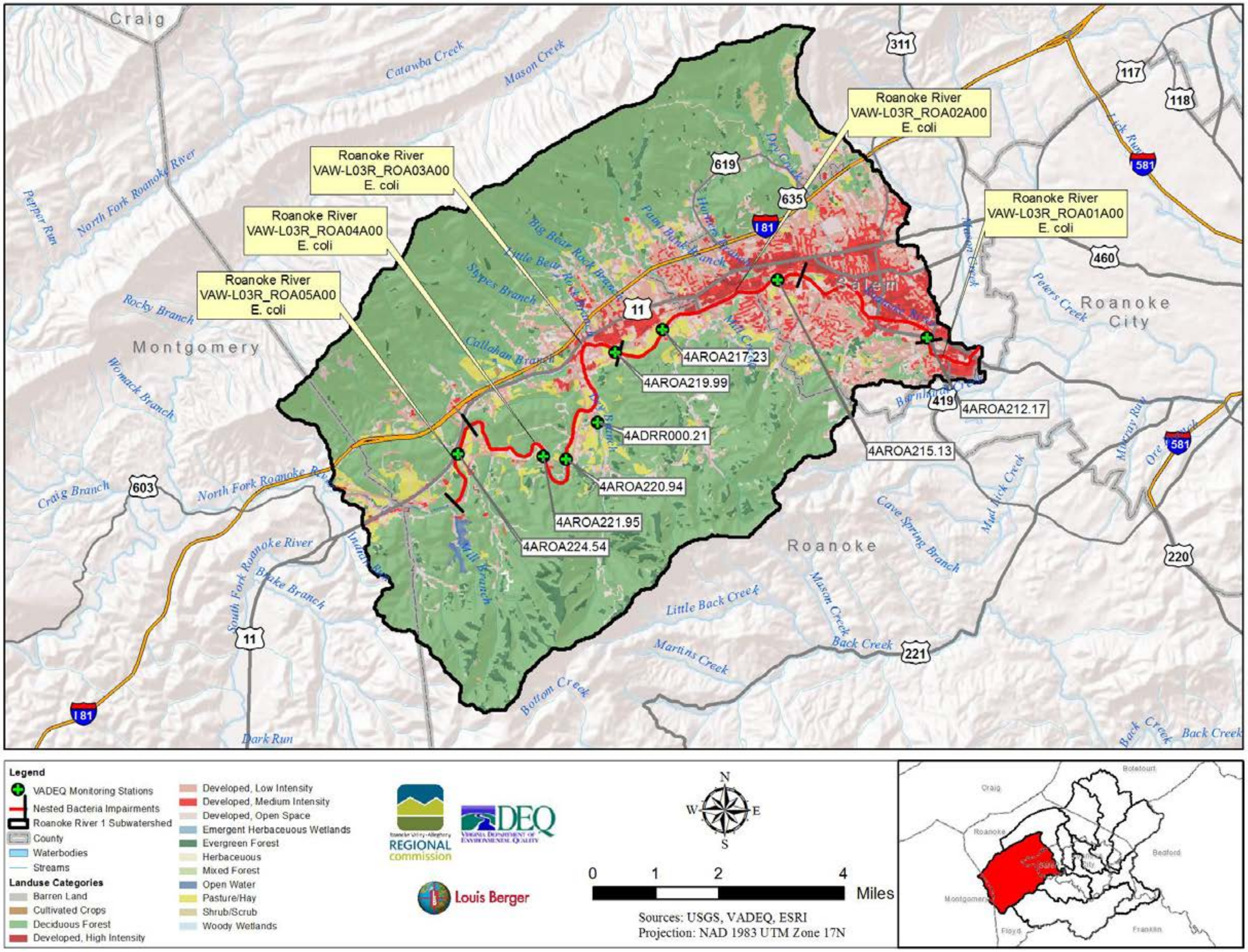

Figure 3-18. Roanoke River 1 Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Roanoke River 1 subwatershed is nonpoint source runoff from developed land use and wildlife direct sources (Figure 3-19).

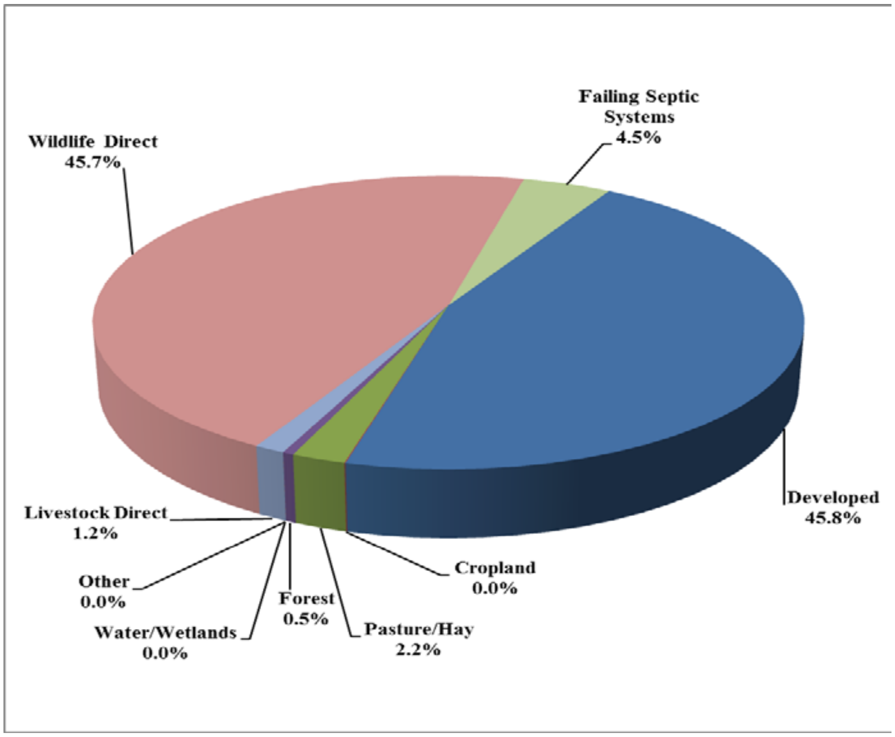

Figure 3-19. Bacteria Sources in Roanoke River 1 Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Roanoke River 1 subwatershed (Table 3-20).

Table 3-20: Roanoke River 1 Load Allocation for *E. coli*			
2006 Land Use/Source	**Annual Average *E. coli* Loads (cfu/year)**		**Percent Reduction**
	Existing	**Allocation**	
Developed	2.55E+13	8.93E+11	96.5%
Cropland	2.50E+10	8.75E+08	96.5%
Pasture/Hay	1.23E+12	4.30E+10	96.5%
Forest	2.52E+11	8.81E+09	96.5%
Water/Wetlands	3.11E+08	3.11E+08	0%
Other	7.13E+08	2.49E+07	96.5%
Livestock Direct	6.94E+11	0.00E+00	100%
Wildlife Direct	2.55E+13	8.37E+12	67.1%
Failing Septic Systems	2.51E+12	0.00E+00	100%
Total	**5.57E+13**	**9.32E+12**	**83.3%**

3.2.10 Roanoke River 2

Description of Watershed and Impairment

The Roanoke River 2 subwatershed includes several segments of the mainstem Roanoke River from the mouth of Mason Creek to the Back Creek confluence as well as the Roanoke River when it forms Smith Mountain Lake (Figure 3-20). The Roanoke River 2 reach generally flows in a west to east direction crossing through parts of Bedford, Franklin, and Roanoke Counties and the City of Roanoke; it drains approximately 22,055 acres. The dominant 2006 NLCD land uses consist of forest (46%) and developed land (45%) with a small amount of pasture/hay (6.6%). Development is concentrated in the western portion of the subwatershed while forest and pasture/hay fields dominate in the central and eastern portions.

Nine segments within the Roanoke River 2 subwatershed were first listed as impaired on either the 1996 or the 2002 Section 303(d) TMDL Priority List and Report due to exceedances of Virginia’s water quality standard for fecal coliform bacteria. Due to these exceedances, the primary contact recreation use was not supported along 15.3 miles of the Roanoke River from the mouth of Mason Creek downstream to the mouth of Falling Creek including and 350 acres of the Roanoke arm of Smith Mountain Lake (Table 3-21).

Table 3-21: Impairment Summary Roanoke River 2				
Assessment Unit	**Stream Name**	**Length (miles)**	**Boundaries**	**Cause**
VAW-L07L_ROA04A10	Smith Mtn. Lake (Roanoke River)	350 (acres)	Roanoke River from the Back Creek confluence downstream to the mouth of Falling Creek.	*Escherichia coli*
VAW-L04R_ROA01A00	Roanoke River	3.14	Roanoke River mainstem waters from Niagara Dam downstream to the mouth of Back Creek (PWS section 6i).	
VAW-L04R_ROA02A00	Roanoke River Niagara	0.78	These are the Roanoke River mainstem impounded waters of the Niagara Dam (PWS section 6i).	
VAW-L04R_ROA03A00	Roanoke River Niagara	0.86	Roanoke River mainstem from near the backwaters of the Niagara Impoundment upstream to the end of the WQS designated public water supply (PWS section 6i) segment. The upstream ending of the PWS segment from SML 795 ft. pool elevation.	
VAW-L04R_ROA04A00	Roanoke River	0.25	Roanoke R. mainstem from near the backwaters of Niagara Impoundment upstream to the Tinker Creek confluence on the Roanoke River (section 6). The upstream ending of the WQS designated public water supply (PWS) segment from SML 795 ft. pool elevation.	
VAW-L04R_ROA05A00	Roanoke River	0.35	Roanoke River mainstem from the Western Virginia Water Authority Roanoke Regional Water Pollution Control Plant downstream to the Tinker Creek confluence (WQS section 6).	
VAW-L04R_ROA06A00	Roanoke River	4.33	Roanoke River mainstem from the Murray Run mouth downstream to the Western Virginia Water Authority Roanoke Regional Water Pollution Control Plant.	
VAW-L04R_ROA07A00	Roanoke River	3.31	Roanoke River mainstem from the Peters Creek mouth downstream to the Murray Run confluence on the Roanoke River.	
VAW-L04R_ROA08A02	Roanoke River	2.21	Roanoke River mainstem from the Mason Creek mouth downstream to the confluence of Peters Creek on the Roanoke River.	

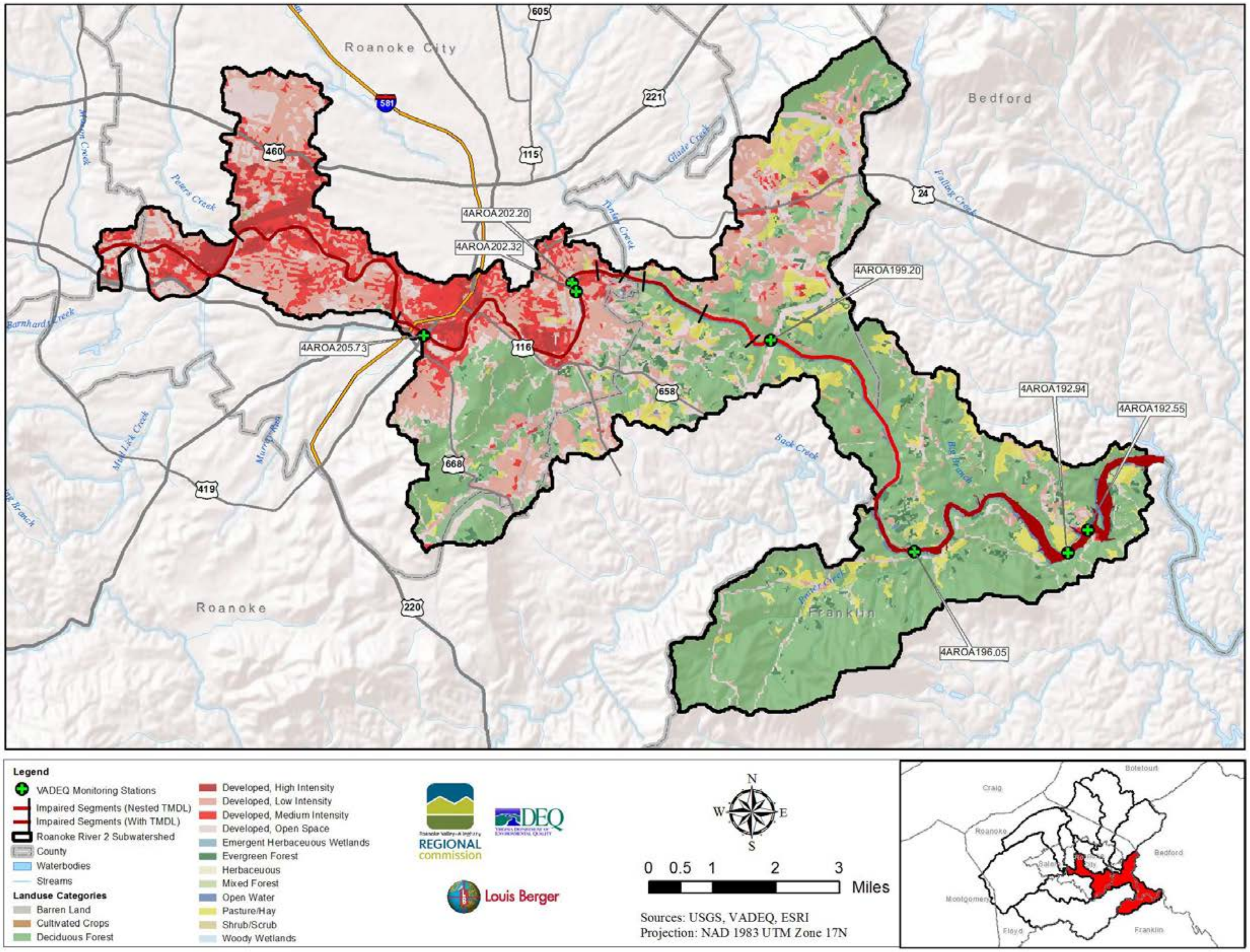

Figure 3-20. Roanoke River 2 Subwatershed

<u>Bacteria Sources</u>

The primary contributor to bacteria loading in the Roanoke River 2 subwatershed is nonpoint source runoff from developed land uses and failing septic systems (Figure 3-21).

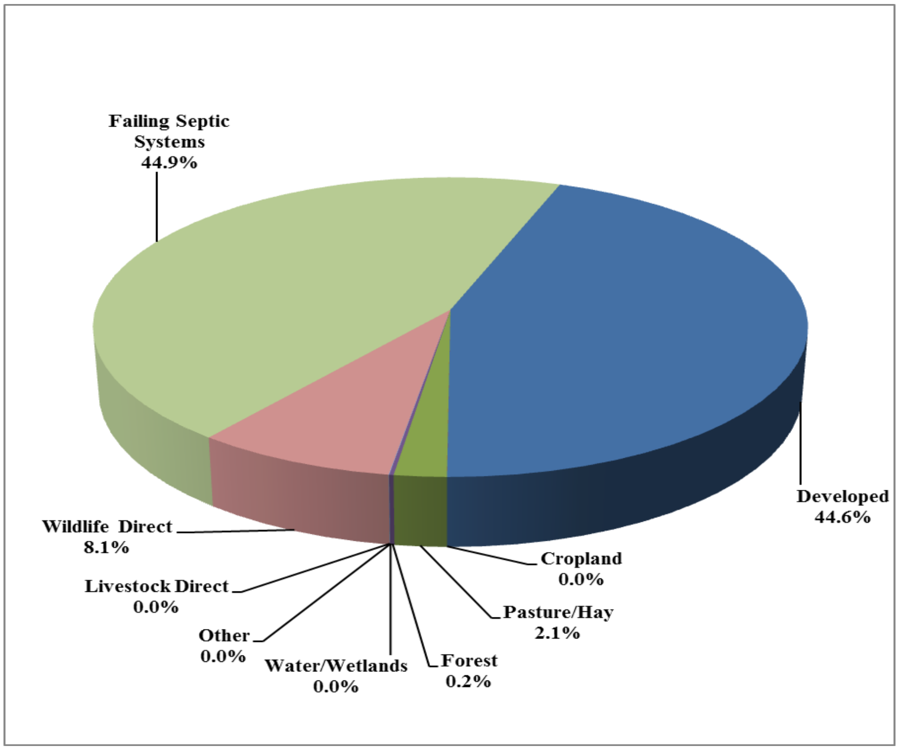

Figure 3-21. Bacteria Sources in Roanoke River 2 Subwatershed

<u>Bacteria Allocation Summary/Load Reduction</u>

Reductions from bacteria sources are presented in the load allocation table for the Roanoke River 2 subwatershed (Table 3-22).

Table 3-22: Roanoke River 2 Load Allocation for *E. coli*

2006 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	2.37E+13	4.39E+11	98.2%
Cropland	2.25E+09	4.16E+07	98.2%
Pasture/Hay	1.13E+12	2.09E+10	98.2%
Forest	9.33E+10	1.73E+09	98.2%
Water/Wetlands	9.28E+08	9.28E+08	0%
Other	5.31E+06	9.82E+04	98.2%
Livestock Direct	1.28E+10	0.00E+00	100%
Wildlife Direct	4.33E+12	1.47E+12	66%
Failing Septic Systems	2.39E+13	0.00E+00	100%
Total	**5.32E+13**	**1.94E+12**	**96.4%**

3.3 Benthic TMDL Watershed

The study area for the benthic portion of this IP encompasses a previously developed benthic macroinvertebrate community TMDL (Benthic TMDL) project for the mainstem Roanoke River (VADEQ 2006b). The stressor analysis process, which is the process utilized during TMDL development to identify the cause of the benthic macroinvertebrate community impairment, resulted in sedimentation as the most probable cause. The resulting Benthic TMDL project defined sediment-impaired segments on the mainstem Roanoke River. For this IP, the benthic TMDL study area was not divided into smaller subwatersheds, as described for the bacteria impairment study area, because the TMDL-defined sediment impairments are only on the mainstem Roanoke River and not on the tributary waterbodies. However, the inclusion of these tributaries and associated subwatersheds in the IP recognizes that even though the tributaries were not specifically identified as having a sediment impairment, they are contributing to the mainstem Roanoke River sediment load. In subsequent sections, the entire contributing benthic TMDL study area will be referred to as the benthic impairment watershed.

3.3.1 Description of Watershed and Impairment

The Roanoke River benthic impairment watershed delineated in the benthic TMDL includes sections of Roanoke, Montgomery, Floyd, and Botetourt Counties, as well as the Cities of Roanoke and Salem (Figure 3-22). The drainage area of this watershed is approximately 335,518 acres (525 square miles). The impaired segments are located on the mainstem of the Roanoke River and flow through the City of Roanoke.

The TMDL study area was divided into two parts for the development of the IP. Part I of the IP is described in this document and prepares actions for the lower, or more downstream, portions of the total study area (Figure 3-22). The Part I benthic impairment study area includes portions of Botetourt, Roanoke, and Bedford Counties as well as the Cities of Roanoke and Salem. The drainage area of this watershed is approximately 161,046 acres (252 square miles). The boundaries of the benthic impaired watershed and the bacteria impaired watershed as used in this IP are different due to the location of impaired segments.

The dominant land use types in this benthic impairment watershed are forest (51%) and developed land (39%) with a small amount of land in pasture/hay (9.3%). Forest land occurs throughout the watershed except within the Cities of Roanoke and Salem where developed land use dominates. Pasture/hay land use is present in the headwaters of the watershed and within the Glade and Tinker Creek subwatersheds in Botetourt County (Figure 3-22).

The Roanoke River was first listed as impaired on Virginia's 1996 Section 303(d) TMDL Priority List and Report due to exceedances of Virginia's General Standard (benthic impairment). The benthic impairment described for Part I within this IP includes six impaired segments totaling 11.3 miles (Table 3-23).

Table 3-23: Benthic Impairment Summary

Assessment Unit	Stream Name	Length (miles)	Boundaries	Cause
VAW-L04R_ROA03A00	Roanoke River, Niagara	0.86	Roanoke River mainstem from near the backwaters of the Niagara Impoundment upstream to the end of the WQS designated public water supply (PWS section 6i) segment. The upstream ending of the PWS segment from SML 795 ft. pool elevation.	Sediment
VAW-L04R_ROA04A00	Roanoke River	0.25	Roanoke R. mainstem from near the backwaters of Niagara Impoundment upstream to the Tinker Creek confluence on the Roanoke River (section 6). The upstream ending of the WQS designated public water supply (PWS) segment from SML 795 ft. pool elevation.	
VAW-L04R_ROA05A00		0.35	Roanoke River mainstem from the Western Virginia Water Authority Roanoke Regional Water Pollution Control Plant downstream to the Tinker Creek confluence (WQS section 6).	
VAW-L04R_ROA06A00		4.33	Roanoke River mainstem from the Murray Run mouth downstream to the Western Virginia Water Authority Roanoke Regional Water Pollution Control Plant.	
VAW-L04R_ROA07A00		3.31	Roanoke River mainstem from the Peters Creek mouth downstream to the Murray Run confluence on the Roanoke River.	
VAW-L04R_ROA08A02		2.21	Roanoke River mainstem from the Mason Creek mouth downstream to the confluence of Peters Creek on the Roanoke River.	

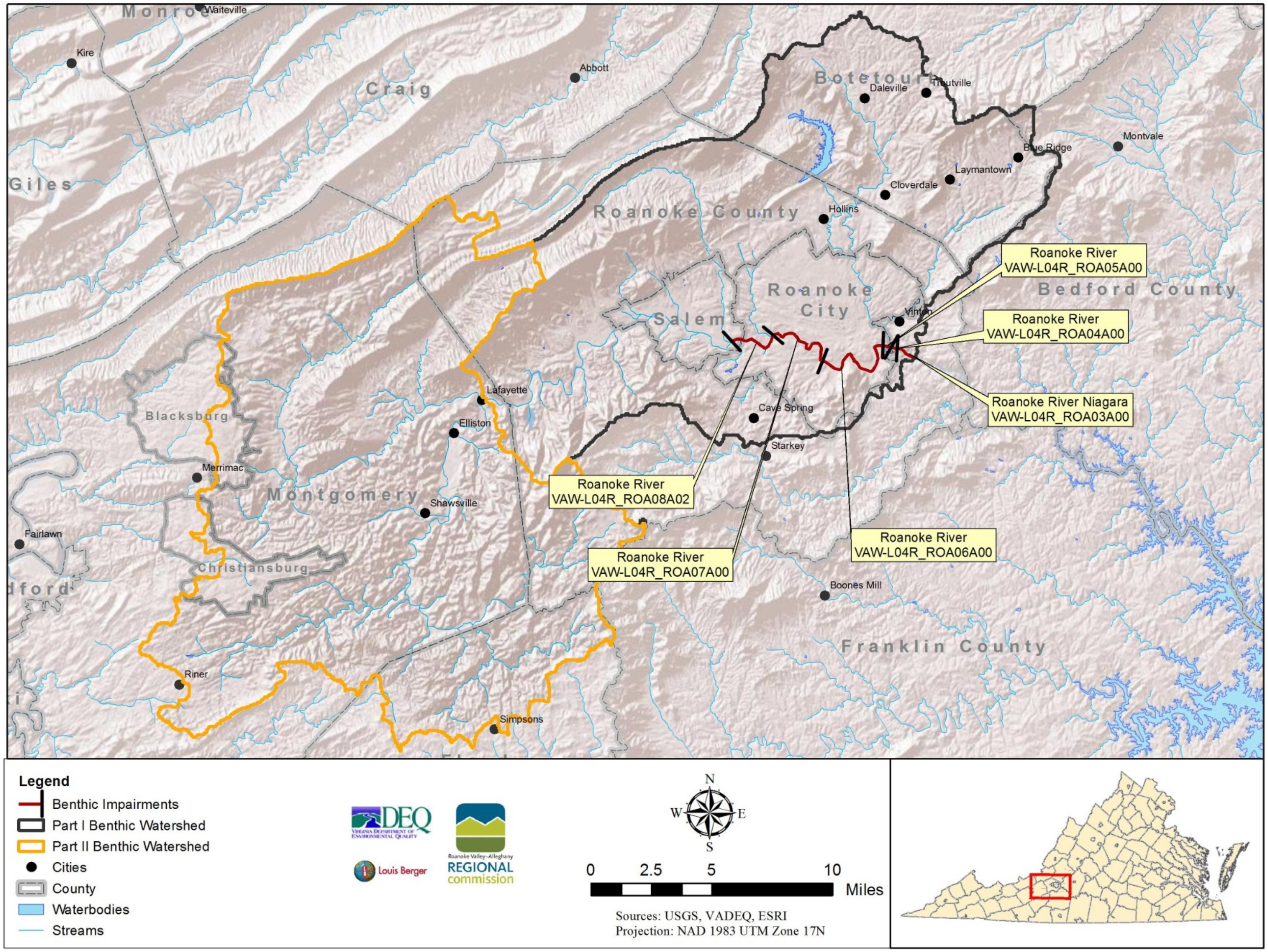

Figure 3-22. Benthic Watersheds in Part I and Part II Implementation Plans

3.3.2 Stressor Analysis

During development of the Roanoke River benthic TMDL several water quality parameters were evaluated to determine the most probable stressor causing the impaired benthic macroinvertebrate community. These parameters included dissolved oxygen, temperature, pH, metals, and organic and other toxic compounds. Sediment was identified as the most probable stressor.

Habitat quality is evaluated using several components to determine an integrated habitat score. The scores for the Roanoke River impaired segments showed diminished habitat quality as evidenced by increased substrate embeddedness and minimal riparian vegetation. These observations in combination with other habitat component scores indicated that there was little stream protection from sediment entering the waterbody and increased sediment loading instream. In addition, higher water temperatures in the impaired reaches suggested the presence of developed land characterized by reduced riparian vegetation and more impervious surfaces. The many stormwater permits located in the City of Roanoke portion of the benthic impaired watershed further signified high stormwater runoff. The stressor analysis determined that excessive sedimentation was the primary stressor to the benthic community and the resulting TMDL study calculated necessary sediment load reductions for the Roanoke River.

Sediment is delivered to the Roanoke River through stormwater runoff, channel and streambank erosion, as well as background geological processes. Natural sediment generation is accelerated through land-disturbing activities related to agricultural, urban, and forest land uses. During rain events, exposed sediment particles can be dislodged from the soil and carried in runoff from both pervious and impervious surfaces in the watershed to the stream. Streambank instability from decreased riparian vegetation, increased stormwater runoff, and livestock trampling causes streambank failure and erosion and increases sediment loading. Sediment loading can also result from improperly installed or maintained erosion and sediment control practices.

3.3.3 Sediment Allocation Summary/Load Reduction

Sediment loads and allocations for the Roanoke River benthic impairments based on the NLCD 2006 land use distribution are presented in Table 3-24. These allocations were used as the basis for the sediment portion of the IP in the Roanoke River (VAW-L04R). The allocations include an overall 74% reduction in sediment loading to meet the TMDL endpoint; all land use sources would require 75% reductions in sediment loading. Sediment from instream erosion also would need to be reduced by 75%. There are no loads from water/wetland land uses and therefore no reductions are required.

Table 3-24: Roanoke River Load Allocation for Sediment

2006 Land Use Category		Existing Load (tons/year)	Allocated Load (tons/year)	Percent Reduction
Land Sources	Developed	7,465	1,862	75.1%
	Cropland	95	24	75.1%
	Pasture/Hay	561	140	75.1%
	Forest	396	99	75.1%
	Water/Wetlands	-	-	-
	Other	393	98	75.1%
Instream Erosion		17,268	4,307	75.1%
Point Sources		295	295	0%
	Total	**26,473**	**6,824**	**74.2%**

4.0 Public Participation

Public participation in the development of any watershed implementation plan is important in order to educate and inform the local stakeholders about the issues and to solicit input on appropriate solutions. Meetings with the public, steering committees, and working groups (agricultural, business, government, and residential) were held to achieve these goals. Table 4-1 shows the date of each meeting as well as the specific type, location, and number of attendees. Minutes and notes from the steering committee and working group meetings were available on online throughout the duration of IP development as well as in Appendix B.

Table 4-1: Meetings during Development of the Roanoke River TMDL Implementation Plan

Date	Meeting Type	Atten-dance	Location
04/10/2013	Steering Committee #1	27	Blue Ridge Regional DEQ – Roanoke Office 3019 Peters Road, Roanoke, VA 24019
06/11/2013	Public Meeting #1	57	Roanoke Civic Center 710 Williamson Road, Roanoke, VA 24016
06/20/2013	Business Working Group #1	15	Blue Ridge Regional DEQ – Roanoke Office 3019 Peters Road, Roanoke, VA 24019
06/20/2013	Agricultural and Residential Working Groups #1	17	
08/27/2013	Government Working Group #1	20	
11/21/2013	Steering Committee #2	32	
2/27/2014	Business Working Group #2	13	
2/27/2014	Agricultural and Residential Working Groups #2	14	
2/28/2014	Government Working Group #2	26	
8/20/2014	Steering Committee #3	28	
	Steering Committee #4		To be held
	Public Meeting #2		To be held

Stakeholders within a watershed include agencies, organizations, businesses, and individuals. Each of these stakeholders has knowledge and interest about existing watershed and water quality issues, conditions, resources, and management activities. By holding different types of meetings, each of these varied groups can provide their specialized input concerning the watershed and best management practices. The informational aspect of the meetings highlight the ongoing progress in the development process as well as the resultant outcomes, thus allowing for public input at several levels of plan development. Public participation could lead to citizen involvement in the watershed cleanup process through knowledge about available pollutant prevention measures.

4.1 Public Meetings

The first public meeting for the Roanoke River watershed cleanup plan was held on June 11, 2013. This open house kicked off the implementation process and featured information booths, hosted by various watershed stakeholders, and presentations about implementation activities in other watersheds. The topics presented included water quality education, advocacy, stormwater, water quality improvement and were hosted by local state and local government entities and private groups. The main objective of the meeting was to introduce the Roanoke River TMDL implementation plan and provide information to the public concerning the reasons the watershed must be cleaned up, the plan development process, and ways for the public to get involved. Input, comments, and questions were solicited from the public and stakeholders. Working group information and sign-in sheets were also available.

VADEQ staff welcomes a guest at the Roanoke River Watershed Open House.

4.2 Agricultural/Residential Working Groups

The agricultural and residential working groups meetings were held on June 20, 2013 with 17 participants and February 27, 2014 with 14 participants. The working groups were given background information on the Roanoke River implementation plan and process. The residential working group discussed on-site sewage disposal systems (including known problem areas), pet waste issues, stormwater issues, and agricultural BMPs. In terms of on-site sewage disposal systems, group members conveyed concerns that it can be difficult to identify straight pipe locations, the lack of ordinances requiring septic system maintenance, the percentage of homes on sanitary sewer, the lack of tracking of septage haulers, and the known neighborhoods with septic system problems. Group members reported that maintenance is a problem with pet waste stations, there are existing pet waste educational campaigns and that pet waste composters are a new concept to the area. In terms of the agricultural discussion, members expressed a lack of tracking of non-cost share agricultural practices, additional source of bacteria with livestock markets, and then discussed the various BMPs to consider in the plan and the cost-share and stipulations associated with the BMPs.

Louis Berger staff presents background information to the Agricultural and Residential Working Group.

Over the course of the two meeting, the agricultural and residential working groups made recommendations for each of the areas of discussion. Education and outreach were some of the primary recommendations from this working group. Members suggested the IP include education and outreach for septic system maintenance, outreach and education on pet waste water quality issues and scoop the poop" campaigns, and to consider establishing a program to recognize residential environmental stewardship. For on-site sewage disposal systems, they suggested a tracking system for septage haulers and to target areas for sewer line extensions. For pet waste, members suggested to account for the existing pet stations, and to build in cost for maintenance of the stations. Group members recommended increased erosion and sediment control inspections in regards to stormwater. The agricultural recommendations included to be more inclusive of non-traditional farming constituents and to provide clarity on cost-share money availability and requirements. The working group meeting notes and the group report to the steering committee are included in Appendix B.

4.3 Business Working Group Meetings

Establishment of a working group dedicated specifically to business interests and contributions in the watershed was a first for any IP in the Commonwealth. The business working group met twice, first on June 20, 2013 with 15 participants and second on February 27, 2014 with 13 participants. The purpose of the business working group was to discuss problems contributing to excessive sediment and bacteria from commercial areas. The primary topics discussed at the meetings were water quality issues associated with stormwater runoff. Participants discussed and expressed concerns about the upcoming stormwater fees in the city of Roanoke, the financial burden of BMP implementation and maintenance, the details of the existing stormwater management infrastructure in the area, bacteria loads associated with pet waste and targeting of outreach, and the urban tree canopy data developed by RVARC.

The business working group made several recommendations to the steering committee. Their suggestions included to outline costs associated with BMP maintenance in the IP and to educate businesses about the importance of BMP maintenance. In relation to BMP maintenance education, the group suggested educational materials related to stormwater retrofits, proper disposal of oil and grease, and that vets/pet stores/zoos and the SPCA be specifically targeted to control pet waste. In terms of outreach, the group recommended to promote and expand programs that recognize businesses for excellence in environmental management practices and stewardship. The group suggested that recreational interests could be another avenue to reach out to citizens to gain support for the IP. A copy of the meeting minutes and the recommendations to the steering committee from the business working groups is included in Appendix B.

4.4 Government Working Group Meetings

The government working groups were held on August 27, 2013 with 20 participants and February 28, 2014 with 26 participants. The working groups were presented with background information on the Roanoke River implementation plan project with mention of a project extension to include the North Fork and South Fork Roanoke River watersheds. The discussions focused on several broad topics initially introduced in the other working groups including on-site sewage disposal systems, pet waste, stream restoration, stormwater programs, and agricultural programs.

For onsite sewage disposal systems, discussion specifically surrounded the cost-share for septic systems, grey water from straight pipes, sanitary sewer hookup ordinances, and that the septic system failures and straight pipe numbers were considered too conservative. Sewer overflows due to grease and bacteria from leaking dumpsters were highlighted as issues. Concerns that were specifically reported included stormwater utility fees, cost-share/funding, and the need for outreach and education for septic system maintenance and straight pipes. For pet waste, the discussion focused on the need for pet waste BMP removal efficiency, the maintenance of pet waste stations and their mistaken identity for trash cans, and their existing pet waste educational campaigns. The discussions on stream restoration focused on the planned or ongoing stream restoration projects in the watersheds and clarification on what the activity of stream restoration entailed. The discussion related to stormwater was the most in-depth discussion for both government working group meetings. Topics discussed included the practicality of retrofitting of detention ponds, concerns over the MS4 wasteload allocations, the importance of soil infiltration and the karst topography present in the area, street sweeping, and the City of Roanoke's stormwater utility fee. Finally, the agricultural programs and concerns discussed included the importance of livestock exclusion practices that BMPs need to be presented in whole numbers for tracking purposes, the purposeful lack of prescriptiveness and not spatially identifying all BMPs in the IP, and concerns of BMP tracking and crediting. There was also discussion on the fostering of relationships across the watershed so that all members are informed of watershed wide activities.

During and after much discussion, the government working group made recommendations to the steering committee. In general the group expressed the need to detail the BMP types, units and efficiencies in the IP for all BMP types (agricultural, stormwater, residential). For on-site sewage disposal systems, the group requested the methods in which the failing septic systems were estimated be included in the plan, and that local governments may be a partner in getting educational and grant information out to the public. For pet waste, group members suggested that the plan should include costs for maintenance of stations. For stream restoration, the group recommended referencing the Virginia Stormwater Handbook for stream restoration techniques and to clearly define what stream restoration refers to in the IP. For stormwater, the group requested land conversion BMPs be included (utilizing the Urban Tree Canopy data), the need for technical assistance, more specific locality information related to MS4 permits and requirements associated with the MS4 TMDL action plans, and that street sweeping varies by locality and were willing to share the associated information. For agricultural programs, the group suggested an explanation of livestock exclusion BMPs, tracking of agricultural BMPs, and the potential interest of localities partnering with the SWCDs to be involved in agricultural-related water quality improvement projects. Some specific educational and outreach recommendations from the group include septic system maintenance and pet waste effects on water quality, and the roles and responsibilities of stakeholders in relation to all educational programs. Meeting notes and working group recommendations by the government working group are included in Appendix B.

4.5 Steering Committee Meetings

The first steering committee meeting was held on April 10, 2013 with 27 participants. Presentations included background information on watershed health, TMDLs, implementation plans, best management practices (BMPs), and funding sources with more detail provided on the TMDLs, associated load reductions, and existing BMPs within the upper Roanoke River watershed. Additional discussions highlighted possible working groups, outreach, and considerations in planning implementation such as funding and public participation.

The second steering committee meeting was held November 21, 2013 with 32 participants. The general topics included summaries of the previous working groups and ways to address the concerns emphasized during these meetings. In addition, a presentation was given on available BMPs, costs, and efficiencies. Discussion highlights from the stormwater BMP discussion include erosion and sediment controls, addition of other BMPs, stormwater ordinances, and references to current or future projects. Suggested BMPs included stream restoration, a variety of "pilot" BMP as examples of LID, BMP maintenance and retrofits, and monitoring and education. The main comments from the residential BMP discussion concerned septic system maintenance and associated educational possibilities, a list of regulatory controls, residential bioretention BMPs such as rain gardens, and if possible, examination of water quality monitoring stations to determine the best possible monitoring protocol for subsequent phases of the implementation plan. Particular mention was made of pet waste BMPs, especially those that target direct disposal and education. The agricultural BMP segment considered available BMPs and incentives.

The third steering committee meeting was held on August 20, 2014 with 28 participants. The general topics included summaries of the previous working groups and discussions related to the updated BMP scenarios and calculation methods. BMPs added since the last steering committee meeting included urban land use conversion, vegetated swales, permeable pavement, and rain barrels. An update included a proposed expansion of the street sweeping program in the IP for sediment reductions. Several concerns were brought up about street sweeping including the fact that Roanoke County does not own the roads in the county. Much of the discussion revolved around MS4 TMDL action plans. It was clarified that the TMDL implementation plan is meant to meet TMDL pollutant reduction targets within the watershed based on the land use. While the implementation plan can be used by localities for pollutant reduction strategies, the plan is not a requirement for MS4 permit compliance. The purpose of the implementation plan is not to provide prescriptive, site-specific BMPs for the localities to meet their MS4 permit requirements, but rather to provide a strategy to reduce the watershed-based bacteria and sediment loads.

5.0 Implementation Actions

Due to the detailed TMDL analysis and the high degree of complexity of the Roanoke River watershed and its impairments, implementation actions necessary to reduce the bacteria and sediment loads were identified through extensive stakeholder input, public participation, and review of land use/source data and pollutant delivery mechanisms. This chapter focuses on the controllable sources of bacteria and sediment loadings in the watershed. These controllable sources include direct deposition of bacteria by livestock, overland runoff from agricultural land (cropland and pasture), overland runoff from residential and urban land, failing septic systems and straight pipes, and streambank erosion. Described below is the following:

- Selection and quantification of appropriate implementation actions to reduce bacteria and sediment loading
- Steps needed toward meeting water quality standards
- Associated costs and benefits of the actions and technical assistance associated with implementing agricultural, residential, and non-MS4 urban BMPs.

The following chapter (Chapter 6) provides the IP actions for each watershed in a successional manner among three stages as an iterative process toward meeting water quality goals.

5.1 Identification of Control Measures

Proposed measures to control bacteria and sediment were identified through multiple sources. Several BMPs were suggested in the original TMDL reports including livestock exclusion, septic system BMPs, riparian buffers, and pet waste management (VADEQ 2004, 2006a, 2006b). Appropriate control measures were also identified through review of published materials such as stormwater BMP literature and the Virginia Agricultural Cost Share BMP Manual. Stakeholders at working group meetings provided input on existing and potential control measures. Additionally, some measures have been proposed in existing Virginia TMDL IPs with similar watershed conditions.

Quantifiable BMPs proposed in this IP are listed in Table 5-1 grouped by land use (i.e., agricultural, residential, or urban) or pollution source associated with the BMPs. Also listed are sediment and bacteria removal efficiencies of each BMP and associated source documents.

Table 5-1: Best Management Practice Efficiency				
BMP Type	**BMP**	**Sediment Removal Efficiency (%)**	**Bacteria Removal Efficiency (%)**	**Reference (Sediment/ Bacteria)**
Agricultural				
Livestock Exclusion/ Manure Storage	CREP Livestock Exclusion (CRSL-6)	56	100	1/2
	Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T)	56	100	1/2
	Small Acreage Grazing System (SL-6AT)	56	100	1/2
	Livestock Exclusion with Reduced Setback (LE-2T)	56	100	1/2
	Stream Protection/Fencing (WP-2T)	56	100	1/2
	Manure Storage (WP-4) - Dairy	N/A	80	3
	Manure Storage (WP-4) - Beef	N/A	80	3
Pasture	Vegetative Cover on Critical Areas (SL-11)	75	75	3
	Reforestation of Erodible Pasture (FR-1)	LU Conversion	LU Conversion	N/A
	Pasture Management (EQIP 528, SL-10T)	30	50	4
	Wet Detention Ponds for Pastureland	80	80	5
Cropland	Continuous No-Till (SL-15)	70	70[1]	3
	Small Grain Cover Crop (SL-8)	20	20	4
	Permanent Vegetative Cover on Cropland (SL-1)	75	75	3
	Sod Waterway (WP-3)	50	50	3
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	50	50	3
Residential				
Waste Treatment	Septic System Pump-Out (RB-1)	N/A	5	3
	Sewer Connection (Targeted Areas and RB-2)	N/A	100	2
	Repaired Septic System (RB-3)	N/A	100	2
	Septic System Installation/Replacement (RB-4)	N/A	100	2
	Alternative Waste Treatment System Installation (RB-5)	N/A	100	2
Pet Waste	Pet Waste Education Campaign	N/A	25	6
	Pet Waste Station	N/A	Included in Pet Waste Education Campaign	N/A
Urban				
Stormwater	Rain Barrel	6	N/A	7
	Permeable Pavement	80	N/A	5
	Infiltration Trench (including Retrofit)	75	90	5/8
	Bioretention	70	90	5/9
	Rain Gardens	70	70	10
	Vegetated Swale	65	0	5
	Constructed Wetland (including Retrofit)	50	80	5
	Manufactured BMP	80	80	11
	Wet Pond	50	70	5
	Detention Pond	50	30	5
	Riparian Buffer: Forest	70	57	3
	Riparian Buffer: Grass/Shrub	50	50	3
Other	Street Sweeping	Variable[2]	5.50E+08	12
	Urban Land use Conversion	LU Conversion	LU Conversion	N/A
	Stream Restoration	310 pounds /feet/year	N/A	Stakeholder Input

LU – Land use
CREP – Conservation Reserve Enhancement Program
[1]Based on sediment reduction
[2]Based on type of sweeping

BMP References (see column to the right):

1. Rivanna River Basin Commission. 2012. Moores Creek Bacteria Implementation Plan 2012 Update.
2. Removal efficiency is defined by the practice.
3. VADCR. 2003. Virginia Guidance Manual for Total Maximum Daily Load Implementation Plans. Available at: *http://www.deq.virginia.gov/Portals/0/DEQ/Water/TMDL/ImplementationPlans/ipguide.pdf*
4. USEPA-CBP. 2006. Nonpoint Source Best Management Practices that have been Peer-Reviewed and CBP-approved for Phase 5.0 of the Chesapeake Bay Program Watershed Model, Revised 1/18/06.
5. VADEQ. 2013. Virginia Stormwater Management Handbook. Available at: *http://www.deq.virginia.gov/fileshare/wps/2013_SWM_Handbook/*
6. Swann, C. 1999. A survey of residential nutrient behaviors in the Chesapeake Bay. Widener Burrows, Inc. Chesapeake Bay Research Consortium. Center for Watershed Protection. Ellicott City, MD. 112p.
7. James River Association. 2013. Linking Local TMDLs to the Chesapeake Bay TMDL in the James River Basin. Prepared by The Center for Watershed Protection. Available at: *http://www.jamesriverassociation.org/what-we-do/LinkingLocalTMDLstotheBayTMDL.pdf*
8. USEPA.2014. Best Management Practices: Bioretention. Accessed on 1/20/2014 at: *http://water.epa.gov/polwaste/npdes/swbmp/Bioretention-Rain-Gardens.cfm*
9. USEPA.2014. Best Management Practices: Infiltration Trench. Accessed on 1/20/2014 at: *http://water.epa.gov/polwaste/npdes/swbmp/Infiltration-Trench.cfm*
10. Hunt, W.F., J.T. Smith, and J. Hathaway. 2007. City of Charlotte Pilot BMP Monitoring Program, Mal Marshall Bioretention Final Monitoring Report. Prepared for the City of Charlotte.
11. VADCR. 2013. Spout Run Water Quality Improvement Plan.
12. VADCR. 2010. South River and Christians Creek Water Quality Improvement Plan.

The BMP pollutant reduction efficiency values reported in Table 5-1 are averages and are subject to revision based on actual conditions present at the sites where each BMP is implemented. This is a planning level document and more accurate reduction efficiencies would be dependent on site conditions, BMP design and implementation. Additional information pertaining to stormwater BMPs can be found on the Virginia Stormwater BMP Clearinghouse (*http://www.vwrrc.vt.edu/swc/*) and the Virginia Stormwater Management Handbook (*http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications.aspx*) websites.

Some BMPs identified during the IP development process could not be quantified for various reasons. These BMPs are discussed in more detail in Section 5.3.

5.2 Quantification of Control Measures

The first step in the process to determine the number of each type of BMP was to identify the existing BMPs including those established prior to 2003 and those established after 2003. The BMPs that were implemented before 2003 and their associated removal of pollutant loads were already taken into account in the development of the previous fecal coliform, bacteria, and sediment TMDLs for the Roanoke River and tributaries. In an ideal world, date of installation would be available for all BMPs, however, the majority of stormwater BMPs did not have a date of installation, so the separation of BMPs between those installed prior to TMDL development and those installed post-TMDL development were accounted for in an alternative manner. In order to account for some benefit from existing stormwater BMPs, VADEQ and stakeholders agreed that reductions from these existing BMPs should be accounted for in the IP by reducing their pollutant reduction efficiencies by 50%.

Following identification of existing BMPs and the assessment of their pollutant removal capabilities, additional BMPs were recommended to achieve the TMDL pollutant reduction goals. The quantification procedures for proposed agricultural, residential, and urban land use BMPs are detailed below. Specific locations for the proposed BMPs were not determined in this IP. Site-specific analysis is required prior to the siting, design, and implementation of the BMPs.

The BMPs proposed in the following sections will address both bacteria and sediment pollution in the Roanoke River watershed. The BMPs were quantified to meet both the bacteria and sediment reductions called for in the TMDLs. In this analysis, bacteria loads required greater reductions than sediment loads needed to meet the TMDLs.

5.2.1 Agricultural Control Measures

This section depicts the BMPs associated with agricultural activities. The following section will summarize the existing and proposed livestock exclusion BMPs, pasture BMPs, and cropland BMPs needed to meet the bacteria and sediment reductions called for in the TMDLs.

5.2.1.1 Livestock Exclusion (Existing/Proposed)

In the time period between the development of the TMDL and the TMDL IP, livestock exclusion BMPs have been implemented in two watersheds, Tinker Creek and Glade Creek. Table 5-2 presents the livestock exclusion BMPs implemented from the development of the TMDL modeling period (post-TMDL development) and include Stream Exclusion with Grazing Land Management (SL-6), Conservation Reserve Enhancement Program (CREP) Livestock Grazing (CRSL-6), and Streambank Protection (Fencing) (WP-2).

Table 5-2: Existing Livestock Exclusion BMPs

BMP	Tinker Creek			Glade Creek		
	Systems	Acres Treated	Stream Length Protected (feet)	BMP Count	Acres Treated	Stream Length Protected (feet)
Stream Exclusion with Grazing Land Management (SL-6)	6	174.9	5,913	1	30.0	1,800
CREP Livestock Exclusion (CRSL-6)	1	1.7	763	-	-	-
Streambank Protection (Fencing) (WP-2)	1	6.0	5,600	-	-	-
Bacteria Reduction from Existing BMPs (cfu/yr)	2.24E+11			2.69E+10		
Sediment Reduction from Existing BMPs (ton/yr)	4.70			0.69		

Livestock exclusion BMPs proposed in this IP include CREP Livestock Exclusion (CRSL-6), Livestock Exclusion with Grazing Land Management (SL-6T and LE-1T), Small Acreage Grazing System (SL-6AT), Livestock Exclusion with Reduced Setback (LE-2T), and Stream Protection/Fencing (WP-2T). The overall length of all livestock exclusion systems proposed throughout the Roanoke River watershed was determined using a GIS spatial analysis of aerial imagery, land use (NLCD 2006), and NHD stream layers. Using data from the NLCD 2006 land use layer and the aerial imagery, the length of perennial and intermittent streams with and without adequate riparian buffer was analyzed for all obvious pasture areas. Next, a distribution percentage for each type of livestock exclusion BMP was determined based on guidance from stakeholders, with specific percentages identified for several subwatersheds. These percentages ranged from 0% to 10% for CREP Livestock Exclusion; 75% to 85% for Livestock Exclusion with Grazing Land Management; and 5% each for Small Acreage Grazing System, Livestock Exclusion with Reduced Setback, and Stream Protection/Fencing. In each subwatershed, the length of each proposed BMP was calculated by multiplying the overall length of all proposed livestock exclusion systems (as described above) by the appropriate distribution percentage. This length was then divided by the average length (based on local practices as reported by the VADCR Agricultural BMP Database) of each livestock exclusion system BMP to arrive at the number of each type of livestock exclusion BMP proposed for each subwatershed (Table 5-2). The average length of each livestock exclusion system was calculated from the lengths of the existing systems within the Upper Roanoke River watershed.

Example of Livestock Exclusion

(Photograph courtesy of USFWS)

The quantification of proposed manure storage systems was based stakeholder input. Stakeholders reported that dairy manure storage was not necessary in the region, and very limited beef storage is necessary. Based on this input, there were two beef manure storage systems proposed for Glade Creek and Tinker Creek, which have the greatest coverage of pastureland (Table 5-3).

5.2.1.2 Proposed Pasture BMPs

The existing BMPs associated with livestock and pasture (i.e., the livestock exclusion BMPs), are summarized in Section 5.2.1.1.

The quantification of acres installed for the proposed pasture BMPs (Table 5-4) was based on the area of pasture located within each subwatershed and the pollutant reductions required from this land use. Vegetative Cover on Critical Areas (SL-11) was proposed for 5% to 20% of the pasture land; Reforestation of Erodible Pasture (FR-1) was proposed for 5% to 10% of the pasture land. Pasture Management (EQIP 528, SL-10T) was applied to the remaining acreage. Wet detention ponds, quantified as acres treated, were proposed if the necessary pollutant reductions on pasture land use could not be accomplished through the other BMPs.

Table 5-3: Proposed Livestock Exclusion BMPs (systems)											
BMP	**Back Creek**	**Carvin Creek**	**Glade/ Layman-town Creek**	**Lick Run**	**Mason Creek**	**Mud Lick Creek, Murray Run, and Ore Branch**	**Peters Creek**	**Roanoke River 1**	**Roanoke River 2**	**Tinker Creek**	**Total**
CREP Livestock Exclusion (CRSL-6)	-	1	4	N/A	1	-	-	2	1	4	**13**
Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T)	35	7	55	N/A	7	1	1	14	8	55	**183**
Livestock Exclusion with Reduced Setback (LE-2T)	4	1	6	N/A	1	-	-	2	1	6	**21**
Small Acreage Grazing System (SL-6AT)	2	-	3	N/A	-	-	-	1	1	3	**10**
Stream Protection/Fencing (WP-2T)	1	-	2	N/A	-	-	-	-	-	2	**5**
Manure Storage (WP-4) - Beef	-	-	2	N/A	-	-	-	-	-	2	**4**

N/A – not applicable

Table 5-4: Proposed Pasture BMPs (acres installed)											
BMP	**Back Creek**	**Carvin Creek**	**Glade/ Layman-town Creek**	**Lick Run**	**Mason Creek**	**Mud Lick Creek, Murray Run, and Ore Branch**	**Peters Creek**	**Roanoke River 1**	**Roanoke River 2**	**Tinker Creek**	**Total**
Vegetative Cover on Critical Areas (SL-11)	269	97	724	11	94	9	9	286	263	1,299	**3,061**
Reforestation of Erodible Pasture (FR-1)	142	54	402	6	52	9	18	159	146	722	**1,710**
Pasture Management (EQIP 528, SL-10T)	2,694	487	3,618	53	470	10	162	1,430	1,316	6,497	**16,737**
Wet Detention Ponds*	1,450	-	-	15	-	-	-	-	-	-	**1,465**

*acres treated

5.2.1.3 Cropland BMPs (Existing/Proposed)

Table 5-5 presents the four existing cropland BMPs which reduce bacteria, from manure applications, and sediment loading and were reported in the DCR Agricultural BMP Database. The bacteria and sediment reductions resulting from the post-TMDL development BMPs were calculated using the acreage in which the practice was installed, the amount of pollutant produced by each acre, and the pollutant reduction efficiency of the BMP.

Table 5-5: Existing Cropland BMPs Applicable to Bacteria and Sediment Removal

BMP	Tinker Creek		Roanoke River 2	
	BMP Count	Acres - Installed	BMP Count	Acres Treated
Permanent Vegetative Cover on Cropland (SL-1)	2	10.1	-	-
Protective cover for specialty crops (SL-8)	1	13.7	-	-
Harvestable Cover Crop (SL-8H)	1	47.4	-	-
Small Grain cover crop for Nutrient Management (SL-8B)	24	326.4	2	15.9
Bacteria Reduction From Existing BMPs (cfu/year)	1.68E+15		1.99E+09	
Sediment Reduction From Existing BMPs (ton/year)	58.4		2.0	

For Tinker Creek and Glade Creek, pollutant load reductions from the existing cropland BMPs were quantified and then subtracted from the pollutant load reductions called for in the TMDLs prior to proposing new cropland BMPs. For Tinker Creek, the BMPs implemented after the TMDL development already meet the load reductions called for in the TMDL. The acres installed by each proposed cropland BMPs (Table 5-6) was based on the amount of cropland located within each subwatershed and the pollutant reductions required from this land use. Continuous No-Till and Small Grain Cover Crop BMPs were the primary BMPs proposed for pollutant reductions from cropland. If the pollutant load reductions could not be met from the first two BMPs, other cropland BMPs were proposed using the following percentages: Permanent Vegetative Cover on Cropland on 5% of cropland area, Sod Waterway on 10% of cropland area, and Cropland Buffer/Field Borders on 5% of cropland area.

Table 5-6: Proposed Cropland BMPs (acres installed)											
BMP	**Back Creek**	**Carvin Creek**	**Glade/ Layman-town Creek**	**Lick Run**	**Mason Creek**	**Mud Lick Creek, Murray Run, and Ore Branch**	**Peters Creek**	**Roanoke River 1**	**Roanoke River 2**	**Tinker Creek**	**Total**
Continuous No-Till (SL-15)	62.6	-	50.0	-	9.1	2.5	-	25.0	1.0	-	272.5
Small Grain Cover Crop (SL-8)	62.6	-	45.0	-	9.1	0.3	-	5.0	0.2	-	127.8
Permanent vegetative cover on cropland (SL-1)	-	-	3.3	-	-	0.2	-	2.0	-	-	16.7
Sod Waterway (WP-3)*	-	-	6.7	-	-	0.4	-	4.0	-	-	16.7
Cropland Buffer/Field Borders (CP-33 and WQ-1)	-	-	3.3	-	-	0.2	-	2.0	-	-	5.6

*acres treated

5.2.2 Residential Bacteria Control Measures

5.2.2.1 Failing Septic Systems, Straight Pipes, Sewer Connections

Western VA Water Authority Sewerline Connection
(Photograph courtesy of VADEQ)

BMPs available to address failing septic and sewer systems consist of septic system pump-outs (RB-1), sewer connections (targeted areas and RB-2), septic system repairs (RB-3), septic system installation or replacement (RB-4), and alternative waste treatment system installation (RB-5). Quantification was based on a spatial and temporal analysis using data on the number of houses in each subwatershed, their proximity to streams, extent of the sewer system, and the application of a variable percentage of failing septic systems (including straight pipes) derived from the age of the houses (VADEQ, 2004 and Stakeholder Data). It was assumed during this quantification process that all houses in the Salem and 95% of the houses in the City of Roanoke are connected to the sewer system (as reported by stakeholders).

It was agreed upon by stakeholders that 10% of all existing septic systems should be pumped out on an annual basis. Septic system repair is suggested for all failing septic systems in houses built after 1964 whereas the installation or replacement of the failing septic systems are suggested for houses built before 1964. Installation of an alternative waste treatment system is recommended for 5% of houses with failing septic systems. Quantification of sewer connection as a BMP was based on consultation with the Virginia Department of Health using a targeted approach to tackle areas with previous or existing septic problems. In Roanoke County, specific areas mentioned included the neighborhoods of Ardmore, Summerdean, Cherokee Hills, Andrew Lewis Place, Loch Haven Road, Glenvar Heights, Bennett Springs, Miller Highlands, Mason Cove, Wildwood Road, Indian Grave Road/Clearbook, West Ruritan, and West River/Poor Mountain Road. In the City of Roanoke, the areas of Richard Avenue, Oak Road, VA Hospital area, Cove Road

(Fairhope), and Hershberger Road were noted as area to target septic problems. It should be noted that because of a grant the Western Virginia Water Authority (WVWA) received portions of the Cove Road (Fairhope) and Andrew Lewis Place areas are now partially connected to the sewer line. Table 5-7 details the number of septic system pump-outs, sewer connections, septic system repairs, new septic systems (install/replace), and alternative waste treatment systems for each subwatershed.

Table 5-5: Proposed Sewage Disposal BMPs (systems)

BMP	Total Septic Pumpout (RB-1)	Sewer Connection (Target Areas and RB-2)	Total Septic Repair (RB-3)	Total Septic Install /Replace (RB-4)	Total Alternative Waste Treatment System (RB-5)
Back Creek	432	94	328	352	34
Carvin Creek	22	181	16	18	2
Glade/ Layman- town Creek	597	265	511	429	45
Lick Run	2	112	1	5	0
Mason Creek	129	563	85	133	11
Mud Lick Creek, Murray Run, and Ore Branch	23	0	20	6	1
Peters Creek	12	94	8	16	1
Roanoke River 1	197	835	134	180	15
Roanoke River 2	153	39	86	86	8
Tinker Creek	688	244	459	558	49
Total	**2,255**	**2,427**	**1,648**	**1,783**	**166**

5.2.2.2 Pet Waste Reduction

Pet Waste Station
(Photograph courtesy of Scoopmasters.com)

BMPs proposed to reduce pet waste include pet waste stations and pet waste education programs. Several organizations in the Roanoke River watershed currently have pet waste education and removal programs. There are pet waste disposal stations in parts of the Roanoke River Greenway, in parks, along trails, and at urban plazas (Table 5-8 shows existing stations by subwatershed). The Mill Mountain Garden Club recently started a "Scoop the Poop" educational campaign to promote proper disposal of pet waste in the Roanoke Valley. Plans include asking citizens to take a "Scoop the Poop" pledge and the distribution of educational materials. The Upper Roanoke River Roundtable, in a partnership with the City of Roanoke, the County of Roanoke, and the Western Virginia Water Authority, has installed several pet waste stations containing bags and signage but no receptacles. The City of Salem also supports an online education and outreach campaign aimed at cleaning up pet waste. Several homeowner associations and neighborhoods have also initiated campaigns encouraging residents to pick up pet waste including education, outreach, signage, and stations.

Typical pet waste stations include pet waste trash bags, bag dispenser, a steel trashcan for waste disposal, and signage directing citizens about the importance of picking up after your pet. In terms of this IP, the pet waste stations include a supply of bag refills for a five year period. This plan is focused on placing pet waste disposal stations in locations where there is the likelihood of pet presence. Stakeholders recommended pet waste stations at parks, trails, and buildings and other developed sites. The strategy for placing pet waste stations was to install one station at each park and pet-friendly apartment, hotel, or rest stop within the Roanoke River watershed. If the park was of a larger size, then additional pet waste stations were proposed. Approximately one pet waste station was proposed per 0.5 to 1 mile of trail. Lastly, it was assumed that three pet waste education programs per subwatershed (one campaign for every stage in the IP) would be appropriate and feasible.

This strategy equates to one pet waste education program per IP stage (three stages per subwatershed; see Chapter 6, Section 1). The campaigns will include installation of signage in residential areas reminding citizens to pick up after their pets because of the water quality issues in the watershed, flyers mailed to residents explaining the detrimental effects of not picking up after pets, targeted campaigns at veterinarian clinics and kennels, and outreach through animal control officers and parks and recreational staff. Table 5-8 details the number of pet waste education campaigns, existing pet waste stations (based on available data), and proposed pet waste stations for each subwatershed.

Table 5-7: Existing and Proposed Pet Waste BMPs (units)

BMP	Pet Waste Education Campaign	Pet Waste Station	
		Existing	Proposed
Back Creek	3	-	5
Carvin Creek	3	-	7
Glade/ Laymantown Creek	3	-	6
Lick Run	3	9	19
Mason Creek	3	-	6
Mud Lick Creek, Murray Run, and Ore Branch	3	2	14
Peters Creek	3	2	1
Roanoke River 1	3	7	11
Roanoke River 2	3	15	22
Tinker Creek	3	1	7
Total	10	36	98

5.2.3 Urban Control Measures (Existing/Retrofits/Proposed)

5.2.3.1 Stormwater

When it rains, runoff from impervious surfaces, i.e. roads, parking lots, and sidewalks, picks up pollutants (such as bacteria and sediment) along the way. In addition, the velocity of water going to the stream has been increased from the surfaces. This causes increased erosion in the streams as well. Stormwater BMPs consist of practices which mitigate these impacts by filtering and storing stormwater runoff before it reaches the waterbodies. In the Roanoke River TMDL IP, both water quantity and water quality need to be addressed by implementing stormwater BMPs.

Some BMPs such as rain barrels and rain gardens work on a small scale whereas others such as detention ponds and constructed wetlands filter stormwater from larger areas. This IP has proposed a wide ranging selection of stormwater BMPs that range from LID techniques, which mimic natural hydrology by allowing rainwater to infiltrate/filter/evaporate at the source, and the traditional BMP techniques which channel and pipe stormwater to large scale holding areas.

Existing Stormwater BMPs

The Cities of Roanoke and Salem, the Town of Vinton, and the County of Roanoke provided VADEQ stormwater BMP information. Based on these data, there are approximately 900 existing stormwater management BMPs within the Roanoke River watershed that drain approximately 13,800 acres (Table 5-9). Most of these BMPs consist of detention ponds and underground detention. Other BMPs that drain larger areas but are fewer in number include extended detention ponds and bioretention basins. There are some local initiatives that improve stormwater, but weren't quantified in terms of reductions of bacteria and sediment. The "No Mow Zone" program is an initiative of the Trout Unlimited and Glade Creek Restoration Committee which intends to encourage landowners to not mow within riparian buffers and instead allow grasses and other vegetation to grow. Although the public perception of many of these wild landscapes is that they are "ugly" and unkempt and promote establishment of invasive species, in actuality these natural habitats if maintained are beneficial for reducing soil erosion and providing wildlife habitat.

Bioretention Area around Roanoke
(Photograph courtesy of VADEQ)

The Roanoke River Conservation Overlay District (RRCO) is used by Roanoke County to regulate the use of property within 500 feet of both the Roanoke River and the North Fork of the Roanoke River in an effort to protect it as a critical resource of the Roanoke Valley. Countywide, approximately 1,555 acres on portions of 452 individual parcels falls within the RRCO.

Although the majority of the existing BMPs drain developed land, some BMPs also drain other land uses especially forest and pasture land. Reductions in bacteria and sediment loads from these land uses due to the existing BMPs were calculated and taken into account during quantification of new proposed BMPs (Table 5-9). The majority of stormwater BMPs did not have a date of installation, so the separation of BMPs between those installed prior to TMDL development and those installed post-TMDL development were accounted for in an alternative manner. In order to account for some benefit from existing stormwater BMPs, VADEQ and stakeholders agreed that reductions from these existing BMPs should be accounted for in the IP by reducing their pollutant reduction efficiencies by 50%.

Proposed Detention Basin Retrofits

Retrofits of existing BMPs such as detention ponds and infiltration basins are more economically viable because the infrastructure is already in place. Existing detention basins were initially constructed for water quantity control but can be upgraded to also reduce or remove pollutants and improve water quality. Retrofitting can include a combination of the following actions: conversion to a wet pond, structure enlargement, and the addition of outlet control structures, sediment forebay, wetland, and bioretention and infiltration capabilities. The first step in quantification of retrofits was to determine the percentage of each type of soil (well-draining, poorly draining, and blank/urban land) in each subwatershed as well as the presence of karst topography. Existing BMPs overlying well-draining soil are appropriate for infiltration basin retrofits because the nature of the treatment technique requires that runoff has the ability to percolate through the soil. Existing BMPs overlying poorly draining soil are more suited to constructed wetland retrofits that retain the runoff in a specific area allowing the vegetation and soil to uptake pollutants in the storm water. The presence of karst topography underneath certain BMPs could result in damage to or the failure of the BMP as well as possible water quality and safety concerns. Therefore, six existing detention ponds were excluded from the retrofits due to karst topography. It is critical to note that site specific analysis needs to be performed before these BMP retrofits can be sited, designed and implemented. Table 5-10 details the proposed detention pond retrofits for each watershed, including the number of BMPs and the associated drainage areas. These associated drainage areas primarily consist of developed and forested land, but also treat a minimal amount of other land uses (as defined by the NLCD 2006 dataset).

Table 5-8: Existing Stormwater BMP Summary																				
Stormwater BMP	**Back Creek**		**Carvin Creek**		**Glade Creek**		**Lick Run**		**Mason Creek**		**Mud Lick, Murray Run, and Ore Branch**		**Peters Creek**		**Roanoke River 1**		**Roanoke River 2**		**Tinker Creek**	
	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated
Bioretention	-	-	-	-	2	3.4	1	0.3	-	-	6	57.2	-	-	3	55	4	1.1	1	52
Detention	54	1705	69	1080	53	998	49	343	27	412	105	2815	28	465	78	1,894	50	867	59	641
Extended Detention	3	29	7	62	2	5	1	7	1	4	2	16	1	15	1	15	5	58	2	13
Infiltration	2	6	5	3	8	4	5	3	1	1	16	27	13	17	-	-	11	4	8	4
Manufactured BMP	1	2	21	28	16	14	2	2	-	-	9	14	-	-	2	3	2	4	5	4
Porous Pavement	-	-	-	-	-	-	-	-	1	16	1	16	-	-	1	16	-	-	1	0
Sand filter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
Underground Detention	10	13	15	20	7	5	11	12	1	11	53	53	4	12	3	13	18	19	9	9
Underground Infiltration	-	-	-	-	1	0	-	-	-	-	-	-	-	-	-	-	1	0	3	2
Water Quality Grass Swale	-	-	-	-	1	1	1	4	-	-	-	-	-	-	-	-	1	3	1	52
Constructed Wetland	-	-	-	-	-	-	-	-	-	-	1	29	-	-	-	-	-	-	-	-
Wet Pond	5	223	2	106	-	-	-	-	-	-	5	277	-	-	4	973	1	6	2	160
Total	**75**	**1,978**	**119**	**1,300**	**90**	**1,031**	**70**	**371**	**31**	**445**	**198**	**3,303**	**46**	**507**	**92**	**2,969**	**94**	**963**	**91**	**938**
Bacteria Reduction From Existing BMPs (cfu/year)	1.11E+12		5.98E+13		5.20E+13		1.46E+13		3.02E+11		2.60E+12		3.89E+11		8.71E+11		2.57E+11		3.03E+13	
Sediment Reduction From Existing BMPs (ton/year)	35.07		27.55		24.81		10.04		11.49		65.56		11.45		64.64		22.38		24.85	

Table 5-9: Proposed Detention Pond Retrofits																				
	Back Creek		**Carvin Creek**		**Glade Creek**		**Lick Run**		**Mason Creek**		**Mud Lick, Murray Run, and Ore Branch**		**Peters Creek**		**Roanoke River 1**		**Roanoke River 2**		**Tinker Creek**	
BMP	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated	Number	Acres Treated
Infiltration Basin	37	1,160	35	538	22	421	10	72	17	264	25	661	9	154	53	1,298	29	501	32	348
Constructed Wetland	17	545	34	538	31	577	33	228	10	149	80	2,154	19	309	25	596	21	366	27	293

Proposed Stormwater BMPs

Permeable/Porous Pavers
(Photograph courtesy of VADEQ)

Proposed stormwater BMPs include bioretention basins, rain gardens, infiltration basin/trenches, manufactured BMPs[1], constructed wetlands, detention ponds, permeable pavers, rain barrels, vegetated swales, and riparian buffers (forested or grass/shrub) (Table 5-10). Similar to BMP retrofits, some stormwater BMPs function better when placed on particular soil types. Infiltration basins or trenches are better on well-draining soil, whereas bioretention basins, manufactured BMPs, and constructed wetlands work better on poorly draining soil. Because of area and size constraints, BMPs on dense urban landscapes typically include bioretention and manufactured BMPs.

A variety of methods were applied for the quantification of stormwater BMPs. Based on an average drainage area for each stormwater BMP (as reported by stakeholders), the quantification process used the available developed land within the drainage area of the proposed BMPs, while not exceeding the amount of developed land available for stormwater BMP implementation. By multiplying the BMP drainage area by the proposed units (i.e., number) of the BMP, a total area of acres treated was determined. Stakeholders agreed that proposing 1% of houses in each subwatershed (except in the Back Creek subwatershed) purchase rain barrels (with an average of two barrels per house) would be a reasonable goal for this type of BMP. Back Creek was excluded because rain barrels are ineffective at treating bacteria runoff, and Back Creek is downstream of the benthic impairment (where sediment is the primary stressor). A total drainage area of five acres for permeable pavement and 150 acres for vegetated swales were proposed for each subwatershed (except for Back Creek, as these practices are only effective at reducing sediment). A total drainage area of 196 acres for detention ponds were proposed for each subwatershed. Table 5-11 presents the proposed drainage area for each stormwater BMP by

[1] Manufactured BMPs or manufactured treatment devices (also referred to as *proprietary treatment devices*) means commercial products fabricated in manufacturing facilities that provide stormwater pollution treatment. Some examples include hydrodynamic separators and filters. (Source: VA Stormwater BMP Clearinghouse).

watershed. While the stormwater BMPs were calculated using average drainage area, it is recognized that each stormwater BMP will have a variable drainage area, so only the area treated is being reported.

Courtyard Raingarden
(*Picture courtesy of VADEQ*)

Quantification of the appropriate length of urban riparian buffer required spatial analysis of aerial imagery, land use and stream layers using GIS. Stream layers located within urban land uses were evaluated and the lengths of perennial and intermittent streams that were lacking adequate riparian buffer were noted. In addition, the analysis noted whether the riparian buffer was need on one or both sides of the stream. An average urban riparian buffer of 100 feet was used to calculate the total acreage of proposed buffer. This average buffer was used in lieu of site specific riparian buffer widths. Site-specific analysis is required prior to the siting, design, and implementation of this BMP in order to determine the appropriate width and type for each location. After summing the total length of stream and multiplying it by 100 feet (either on one side or both) the total acreage was determined and then split evenly between the forested and grass/shrub buffer types. Streams that appeared to be associated with a stormwater detention pond or retention area were not included nor were streams that flowed through residential or other developed areas where the addition of riparian buffer would not be feasible. Figure 6-X in Chapter 6 shows the proposed riparian buffer widths in each subwatershed and model segment.

Urban land use conversion consists of tree plantings on areas that currently do not have trees. This area could be pervious non-tree vegetation or impervious areas that do not contain buildings, roads, or water. Based on data collected by the Virginia Department of Forestry (VDOF, 2010), and the detailed analysis performed by RVARC (RVARC, 2010) the amount of available land that could theoretically be planted with trees in the study area was determined to be 39,867 acres. This plan proposes the conversion of urban land on 1% of this potential conversion within each subwatershed. The final row in Table 5-11 details the proposed area for each subwatershed.

Table 5-10: Proposed Stormwater BMPs (Acre-Treated)										
	Back Creek	**Carvin Creek**	**Glade Creek**	**Lick Run**	**Mason Creek**	**Mud Lick Creek, Murray Run, and Ore Branch**	**Peters Creek**	**Roanoke River 1**	**Roanoke River 2**	**Tinker Creek**
Bioretention	1,520	590	885	1,950	590	1,500	800	1,375	1,250	1,240
Raingarden	304	118	177	390	118	300	160	275	250	248
Infiltration Trench	303	117	176	388	117	299	159	274	249	247
Manufactured BMP	367	142	214	471	142	362	193	332	302	299
Constructed Wetland	2,580	1,577	4,013	2,150	1,921	4,472	1,634	4,787	5,733	5,504
Detention Pond	196	196	196	196	196	196	196	196	196	196
Permeable Paver	-	5	5	5	5	5	5	5	5	5
Vegetated Swale	-	150	150	150	150	150	150	150	150	150
Rain Barrel*	-	147	245	246	86	345	180	370	430	358
Riparian Buffer (Forested)**	38	16	15	23	2	15	11	30	28	26
Riparian Buffer (Grass/Shrub)**	38	16	15	23	2	15	11	30	28	26
Urban Land Use Conversion**	81	28	30	31	16	48	20	70	50	24

*Units
**Acre-Installed

5.2.3.2 Street Sweeping

Street Sweeper
(Photograph courtesy of VA Stormwater Handbook)

Street sweeping frequency and equipment vary locality in the Roanoke River watershed. Street sweeping is one of the most economical BMPs utilized with respect to reductions of sediment. The quantification of the street sweeping BMP is based on municipalities and therefore is not separated by subwatershed. The IP is proposing to create a street sweeping program for Roanoke County and to expand the existing street sweeping programs in the Cities of Roanoke and Salem.

From 2008 to 2013, the City of Roanoke program swept an average 10,763 road miles annually resulting in an annual removal of 9,226 tons of sediment. An average sediment removal of 0.86 tons per mile per year was used to estimate greater increases in sediment removal from the program's expansion. The proposed expansion of the existing City of Roanoke program includes an increase in the sweeping frequency from an average of 3.2 cycles per year to 4 cycles per year on residential streets, and from an average of 12 cycles per year to 18 cycles per year for arterial streets. It was assumed that these expansions would amount to an annual net increase of 2,165 tons of sediment and 4.77E+12 cfu of bacteria removed from city streets.

The City of Salem reported removing 533 tons of sediment in 2013 from street sweeping. The proposed expansion of the existing City of Salem program included an increase in the sweeping frequency from an average of 12 cycles per year to 18 cycles per year. As the number of miles swept was unreported, a conversion factor of 1.5 was used to extrapolate the potential sediment removal from the increase in street sweeping frequency. It's projected that the expansion to Salem's street sweeping program would amount to an annual net increase of approximately 270 tons of sediment and 5.82E+11 cfu of bacteria.

The pollutant reductions associated with the creation of a street sweeping program in Roanoke County used the following assumptions. The new program would sweep half of the approximately 850 miles of roads present in Roanoke County on a frequency of one time per month. The average annual sediment reduction per curb mile from the City of Salem and City of Roanoke's program (0.55 tons) was used to extrapolate the projected sediment reduction of approximately 2,800 tons and 2.80E+12 cfu of bacteria per year.

Table 5-11 depicts the existing and expanded street sweeping programs for the Cities of Roanoke and Salem, the new program for the County of Roanoke, and the total annual sediment reductions expected from the overall programs.

Table 5-11: Street Sweeping Programs - Existing and Proposed

Municipality	Existing Program		Proposed Program		Total Annual Sediment Reduction
	Miles Swept Annually	Annual Sediment Reduction (tons)	Additional Miles Swept Annually	Annual Additional Sediment Reduction (tons)	
City of Roanoke	10,763	9,226	2,526	2,165	11,391
City of Salem	2,115*	533	1,058*	267	800
County of Roanoke	-	-	5,092	2,824	2,824

*estimated using ArcGIS

The Town of Vinton currently has a street sweeping program but does not plan on expanding it. Therefore, this program was not included in the quantification of pollutant reductions from street sweeping in this IP. The town reported that under their current program, primary streets are swept weekly and other streets are swept biweekly to every three weeks. There is no proposed street sweeping for Botetourt County as there was no defined interest in creating a program.

5.2.4 Stream Restoration (Existing/Proposed)

Stream restoration projects are those that use instream engineering methods and/or natural stream design techniques to protect and restore the stream and associated hydrology, stabilize streambanks, and enhance riparian plant communities, which will reduce erosion and sediment transport. Several restoration projects that have already been funded are currently being implemented or have recently been completed. Two projects include the planting of 360 and 350 trees in riparian buffers within the Tinker Creek and Glade Creek subwatersheds, respectively. Citizen volunteers maintain the Tinker Creek project. URRR restoration projects include 1,460 feet of stream restoration on Murray Run in Mud Lick Creek, Murray Run, and Ore Branch subwatershed; planting of vegetation for a riparian buffer on Carvins Cove; and 1,000 feet of native riparian buffer plantings along the Roanoke River in the Roanoke River 2 subwatershed. Several other stream and riparian restoration projects completed in the past ten years include restoration of Glade Creek at Vinyard Park, Mudlick Creek at Garst Park, and restoration and revegetation of Tinker Creek along the greenway and in East Gate Park.

Stream restoration throughout the watershed aims to reduce the sediment loading from instream erosion (Table 3-24). Using the sediment reduction efficiency of a stream restoration project as reported in Table 5-1, the total amount of stream length necessary to achieve the sediment loading reductions was calculated as 83,624 linear feet. The total restoration length was distributed among the subwatersheds by using the percentage of stream length within each subwatershed compared to the total stream miles of all the subwatersheds within this study area. Finally, the lengths of all stream restoration projects completed post-TMDL development, and of any planned projects (with funds allocated), were calculated and subtracted from the required stream restoration length to determine the proposed stream restoration lengths for each subwatershed (Table 5-12). Back Creek is excluded from this list as Back Creek's outlet is located below the most downstream benthic impaired segment, and stream restoration does not reduce bacteria loading to the stream networks.

Table 5-12: Planned and Proposed Stream Restoration Lengths

Subwatershed	Total Estimated Stream Length for Restoration (feet)	Planned, Ongoing, Completed Projects (feet)	Additional Proposed Stream Restoration (feet)
Carvin Creek	12,433	0	12,433
Glade Creek	11,818	4,720	7,098
Lick Run	1,203	0	1,203
Mason Creek	10,264	0	10,264
Mud Lick Creek, Murray Run, and Ore Branch	5,482	4,360	1,122
Peters Creek	2,245	0	2,245
Roanoke River 1	22,506	0	22,506
Roanoke River 2	2,674	1,000	1,674
Tinker Creek	14,999	4,665	10,334

5.3 Innovative Pollution Control Strategies and Outreach Opportunities

Working group meetings included some lively discussions about innovative strategies that ultimately could not be tied directly to pollutant reductions. These measures and techniques to control pollution could not be quantified for a variety of reasons. For some, the quantification procedure was unknown or prohibitively difficult, or the extent of installation could not be determined, whereas for others the scientific data to support pollutant removal efficiencies was unavailable. These measures are described below but were not quantified or costed to account towards attaining TMDL pollutant reductions.

- **Pet Waste Composters**: Pet waste composters are most appropriate for pet owners that have small lots and live in an urban area with limited outdoor space for pets. Stakeholders were in agreement that this BMP would not be popular and would be difficult to quantify bacteria reductions. The difficulty in quantifying bacteria reductions from this BMP include how many pets would be serviced by the device, associated bacteria reduction, and the number of residents per watershed that would utilize this practice.
- **Enhanced Erosion and Sediment Control:** Erosion and sediment control practices are used during construction projects throughout the watershed. However, sometimes these practices are not installed properly or are not maintained and therefore do not prevent as much erosion and sediment transport to surrounding waterways as designed. A suggestion by the stakeholders was to increase inspections of required erosion and sediment control practices and to recommend installation of erosion and sediment control practices that go above and beyond what is required. There was not enough information provided to quantify additional sediment reductions by enhancing the erosion and sediment control practices. More information about Virginia's Erosion and Sediment Control requirements can be found here: *http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications/ESCHandbook.aspx*

- **Educational Programs**
  - *Sanitary Sewer Educational Program:* Related to grease issues causing sanitary sewer overflows.
  - *Residential LID Educational Program:* Stakeholders suggested a program to educate citizens and business owners on what they can do on their own properties to improve water quality, and educate them in general about the issues with stormwater runoff and LID techniques.

- **Tracking Program for Septic Haulers**: Citizens have noted that septic haulers do not have a tracking program to monitor how much sewage is pumped from septic systems, and whether that sewage is properly delivered and disposed of at the sewage treatment plants. They suggested a program to track septic haulers because of reports that some haulers are illegally disposing the pumped waste.

- **Adopt-an-Inlet Program:** Stakeholders suggested an environmental stewardship program for regularly cleaning out and maintaining storm drain inlets.

- **Recognition for Installation of Residential Water Quality Improvements:** Stakeholders suggested a community recognition program for those citizens and households who install measures to improve water quality such as rain gardens, no-mow zones or enhancement of riparian zones on their own properties.

- **Residential Environmental Stewardship Program:** This program would incentivize homeowners to implement small-scale BMPs such as roof drain disconnection, rain barrels, rain gardens, riparian vegetation establishment/enhancement, and/or pet waste composters on their property. For each practice a homeowner established, they would be awarded points. With enough points, a homeowner would be awarded a garden flag to display in their yard. The idea came from the Lynnhaven watershed's "Pearl Homes" initiative (*http://www.lynnhavenrivernow.org/Pearl-Homes.aspx*). Stakeholders discussed having this program linked to a reduction in their stormwater utility fee. Ideas for names were "Logperch Homes" or "Roanoke River Star Homes."

- **Outreach Opportunities:** Within the Roanoke River watershed, opportunities to educate the public on the importance of regional water quality and the goals of this IP include:
  - Clean Valley Day (Spring)
  - Clean Valley Council Recycled Regatta and Watershed Awareness Day (Spring)
  - Earth Day Celebrations (Spring)
  - Earth Summit (Roanoke Valley High School and Middle School students) (Fall)
  - Roanoke Green Living and Energy Expo (Fall)
  - Fall Waterways Clean-up (Fall)
  - Farmer's markets (Year-round)
  - Newspapers (Year-round)
  - New River Valley Eco Expo (Spring/Summer)
  - Radio (Year-round)
  - The Great Roanoke River Duck Race
  - Roanoke Regional Home Show
  - Vinton Dogwood Festival (Spring)
  - Vinton Fall Festival (Fall)

5.4 Technical Assistance

Technical assistance will be necessary beyond what local programs and services provide to help the stakeholders implement agricultural, residential, and stormwater BMPs proposed in this plan. Technical assistance includes (1) performing administrative and organizational tasks, (2) providing outreach and education about BMPs and available funding, and (3) assisting with the design and installation of BMPs. Quantification of technical assistance is in Full Time Equivalents (FTEs). Technical assistance for agricultural BMPs would be provided through the Blue Ridge Soil and Water Conservation District (SWCD) and Mountain Castles SWCD. Technical assistance for residential BMPs could possibly be provided through SWCDs, Health Department, regional planning commission or county governments, dependent upon available grant funding. In addition, there will be a need for technical assistance for stormwater BMP implementation, which could be handled through a regional planning commission or county governments. Below are lists of potential activities associated with technical assistance by program type.

- **Potential technical assistance and educational outreach tasks associated with agricultural programs**

  1. Make contacts with landowners in the watershed to make them aware of implementation goals and cost-share assistance programs.
  2. Provide technical assistance for agricultural programs (e.g., survey, design, layout, and approval of BMP installation).
  3. Administer cost-share assistance and track BMP implementation.
  4. Develop educational materials and programs, based on local needs.
  5. Organize educational programs (e.g., pasture walks, presentations at field days or grazing-club events, etc.).
  6. Distribute educational materials (e.g., informational articles in Farm Service Agency (FSA) or Farm Bureau newsletters, local media, etc.).
  7. Assess progress towards BMP implementation goals.
  8. Follow-up contact with landowners who have installed BMPs.
  9. Coordinate use of existing agricultural programs and suggest modifications where necessary.

- **Potential technical assistance and educational outreach tasks associated with residential programs**

  1. Make contacts with landowners in targeted areas where there are documented problems with on-site sewage systems based on age of homes, poor soils, and high number of repairs and replacements of systems needed based on IP data.
  2. Track septic system repairs/ replacements / installations.
  3. Administer cost-share assistance and track BMP implementation.
  4. Develop educational materials and programs.
  5. Organize educational programs (e.g., demonstration on septic pump-outs).
  6. Distribute educational materials (e.g., informational pamphlets on TMDLs, and on-site sewage disposal systems).
  7. Assess progress toward BMP implementation goals.
  8. Follow-up contact with landowners who have participated in the program(s).

- **Potential technical assistance and educational outreach tasks associated with stormwater BMP implementation**

  1. Make contacts with landowners in the local watersheds to make them aware of implementation goals.
  2. Assist in the identification of grant opportunities and development of grant writing to fund BMP implementation.

3. Provide assistance for stormwater BMPs (e.g., survey, design, layout, and approval of installation).
4. Develop educational materials and local workshops on rain barrels, rain gardens, vegetated buffers, turf to trees, etc.
5. Organize educational programs.
6. Distribute educational materials.
7. Assess and track progress toward BMP implementation goals.
8. Follow-up contact with landowners who have installed BMPs.

As stated previously, the BMPs proposed in this plan would be implemented over the course of a 15 or 20 year timeline (depending on the subwatershed). BMP numbers by watershed vary and are staggered across the timeline; this approach includes implementation of the more cost-effective BMPs in the earlier stages, and the more costly or challenging BMPs in the later stages. The technical assistance proposed in this plan reflects the differences in BMP implementation goals across the staged timeline and experiences from TMDL watershed implementation projects statewide. Chapter 6, Section 1 will describe the staging of the BMPs in greater detail for each subwatershed.

A total of 1.5 FTEs for agricultural BMPs are proposed per year (one FTE for Mountain Castles SWCD and 0.5 FTE for Blue Ridge SWCD) for the first stage, one FTE per year for the second stage, and 0.5 FTE per year for the third stage. Two FTEs would be necessary for implementation of residential waste treatment BMPs for the first and second stages, and one for the final stage. FTEs for non-MS4 stormwater BMPs would apply to Botetourt and Roanoke Counties because there are urban areas in those counties that are outside of MS4 boundaries. When the NLCD 2006 land use layer is overlaid with the 2010 Urban Census layer (which MS4s are based on), there is very little development outside of the boundaries. The development outside the boundaries primarily consists of streets and roads, many of which would fall under VDOT's MS4. As a result, it is proposed that one half of an FTE per county per year for the first two stages and then one quarter FTE per county per year for the final stage would be sufficient to assist in the implementation of stormwater BMPs (Table 5-13).

Table 5-13: Full Time Equivalent Positions by IP Stage & BMP Category			
	Stage 1 (Year 1-8)	**Stage 2 (Year 9-16)**	**Stage 3 (Year 17-20)**
Agricultural	1.5	1	0.5
Residential	2	2	1
Non-MS4 Urban	1	1	0.5

5.5 Costs of Control Measures

The costs for the control measures were derived from multiple sources. Table 5-14 shows the cost of each BMP per system/unit/program, per acre installed, or acre treated, as well as the cost sources. Costs in Table 5-14 (and subsequent tables) are based on BMP installation and do not include maintenance, unless otherwise noted.

Tables 5-15 through 5-24 present the total costs of all IP actions for all three implementation stages by subwatershed, grouped by BMP category and type. Tables 5-25 and 5-26 depict the costs associated with street sweeping and technical assistance, respectively, which transcend watershed boundaries. Included in the cost for street sweeping is the purchase for a street sweeper for Roanoke County. Table 5-27 summarizes the cost for all subwatersheds to attain the bacteria and sediment TMDL allocations set in the TMDL development and found in Chapter 3. Table 5-28 summarizes the costs necessary to de-list the bacteria impaired segments. The cost to delist for bacteria excluded the costs associated with stream restoration, permeable pavers, vegetated swales, and rain barrels, as these activities are not effective at reducing bacteria.

Table 5-14: Best Management Practice Cost			
Agricultural			
BMP Type	**BMP**	**Cost (per system)**	**Reference**
Livestock Exclusion/ Manure Storage	CREP Livestock Exclusion (CRSL-6)	$27,000	1
	Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T)	$21,000	1
	Small Acreage Grazing System (SL-6AT)	$9,000	2
	Livestock Exclusion with Reduced Setback (LE-2T)	$17,000	2
	Stream Protection/Fencing (WP-2T)	$21,000	1
	Manure Storage (WP-4) - Dairy	$100,000	1
	Manure Storage (WP-4) - Beef	$58,000	1
Pasture	Vegetative Cover on Critical Areas (SL-11)	$1,200	1
	Reforestation of Erodible Pasture (FR-1)	$560	1
	Pasture Management (EQIP 528, SL-10T)	$75	2
	Wet Detention Ponds for Pastureland	$150	3
Cropland	Continuous No-Till (SL-15)	$100	10
	Small Grain Cover Crop (SL-8)	$30	10
	Permanent Vegetative Cover on Cropland (SL-1)	$175	1
	Sod Waterway (WP-3)	$1,600	1
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	1
Residential			
BMP Type	**BMP**	**Cost (per system)**	**Reference**
Waste Treatment	Septic System Pump-Out (RB-1)	$300	1
	Sewer Connection (Targeted Areas and RB-2)	$9,500	4
	Repaired Septic System (RB-3)	$3,600	1
	Septic System Installation/Replacement (RB-4)	$6,000	1
	Alternative Waste Treatment System Installation (RB-5)	$16,000	1
Pet Waste	Pet Waste Education Campaign	$5,000	5
	Pet Waste Station[1]	$4,070	6
Urban			
BMP Type	**BMP**	**Cost (per acre-treated)**	**Reference**
Stormwater	Rain Barrel	$150	7
	Permeable Pavement	$240,000	8
	Infiltration Trench	$6,000	7
	Bioretention	$10,000	9
	Rain Gardens	$5,000	9
	Vegetated Swale	$18,150	10
	Constructed Wetland	$2,900	10
	Manufactured BMP	$20,000	11
	Wet Pond	$8,350	10
	Detention Pond	$3,800	10
	Riparian Buffer: Forest	$3,500	12
	Riparian Buffer: Grass/Shrub	$360	9
Other	Street Sweeping	$520 per curb mile	13
	Urban Land Use Conversion	$3,500 per acre installed	11
	Stream Restoration	$300 per linear foot	Stakeholder Input

[1]Cost includes initial unit and five years' worth of bag and trash can liner refills.

References (right column in table):

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11. VADCR. 2013. Spout Run Water Quality Improvement Plan.
12. Rivanna River Basin Commission. 2012. Moores Creek Bacteria Implementation Plan 2012 Update.
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Table 5-15: Back Creek TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Livestock Exclusion/ Manure Storage	CREP Livestock Exclusion (CRSL-6)	$27,000	0	$0
	Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T)	$21,000	35	$735,000
	Livestock Exclusion w/ Reduced Setback (LE-2T)	$17,000	4	$68,000
	Small Acreage Grazing System (SL-6AT)	$9,000	2	$18,000
	Stream Protection/Fencing (WP-2T)	$21,000	1	$21,000
BMP Type	**BMP**	**Cost (per acre)**	**Acre-Installed**	**Total Cost**
Pasture	Vegetative Cover on Critical Areas (SL-11)	$1,200	269	$322,800
	Reforestation of Erodible Pasture (FR-1)	$560	142	$79,520
	Pasture Management (EQIP 528, SL-10T)	$75	2,694	$202,050
	Wet Detention Ponds for Pastureland	$150	1,450	$217,500
Cropland	Continuous No-Till (SL-15)	$100	63	$6,300
	Small Grain Cover Crop (SL-8)	$30	63	$1,890
Residential				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$300	432	$129,600
	Sewer Connection (Targeted Areas and RB-2)	$9,500	94	$893,000
	Repaired Septic System (RB-3)	$3,600	328	$1,180,800
	Septic System Installation/Replacement (RB-4)	$6,000	352	$2,112,000
	Altern. Waste Treatment System Installation (RB-5)	$16,000	34	$544,000
Pet Waste	Pet Waste Education Campaign	$5,000	3	$15,000
	Pet Waste Station	$4,180	5	$20,900
Urban				
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban Retrofit	Infiltration Basin	$6,000	1,160	$6,960,000
	Constructed Wetland	$2,900	545	$1,580,500
Urban	Bioretention	$10,000	1,520	$15,200,000
	Rain Gardens	$5,000	304	$1,520,000
	Infiltration Trench	$6,000	303	$1,818,000
	Manufactured BMP	$20,000	367	$7,340,000
	Constructed Wetland	$2,900	2,580	$7,482,000
	Detention Pond	$3,800	196	$744,800
	Riparian Buffer: Forest (acre-installed)	$3,500	38	$133,000
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	38	$13,680
	Urban Land Use Conversion (acre-installed)	$3,500	81	$283,500
			Total Subwatershed IP Cost	**$49,642,840**

Table 5-16: Carvin Creek TMDL IP Costs

BMP Type	BMP	Cost (per system)	Systems	Total Cost
Agricultural				
Livestock Exclusion/ Manure Storage	CREP Livestock Exclusion (CRSL-6)	$27,000	1	$27,000
	Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T)	$21,000	7	$147,000
	Livestock Exclusion w/ Reduced Setback (LE-2T)	$17,000	1	$17,000
Pasture	Vegetative Cover on Critical Areas (SL-11)	$1,200	97	$116,400
	Reforestation of Erodible Pasture (FR-1)	$560	54	$30,240
	Pasture Management (EQIP 528, SL-10T)	$75	487	$36,525
Residential				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$300	22	$6,600
	Sewer Connection (Targeted Areas and RB-2)	$9,500	181	$1,719,500
	Repaired Septic System (RB-3)	$3,600	16	$57,600
	Septic System Installation/Replacement (RB-4)	$6,000	18	$108,000
	Altern. Waste Treatment System Installation (RB-5)	$16,000	2	$32,000
Pet Waste	Pet Waste Education Campaign	$5,000	3	$15,000
	Pet Waste Station	$4,180	7	$29,260
Urban				
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban Retrofit	Infiltration Basin	$6,000	538	$3,228,000
	Constructed Wetland	$2,900	538	$1,560,200
Urban	Bioretention	$10,000	590	$5,900,000
	Rain Gardens	$5,000	118	$590,000
	Infiltration Trench	$6,000	117	$702,000
	Manufactured BMP	$20,000	142	$2,840,000
	Constructed Wetland	$2,900	1,577	$4,573,300
	Detention Pond	$3,800	196	$744,800
	Permeable Pavement	$240,000	5	$1,200,000
	Vegetated Swale	$18,150	150	$2,722,500
	Rain Barrel (number of barrels)	$150	147	$22,050
	Riparian Buffer: Forest (acre-installed)	$3,500	16	$56,000
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	16	$5,760
	Urban Land Use Conversion (acre-installed)	$3,500	28	$98,000
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	12,433	$3,729,900
			Total Subwatershed IP Cost	**$30,314,635**

Table 5-17: Glade Creek TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Livestock Exclusion/ Manure Storage	CREP Livestock Exclusion (CRSL-6)	$27,000	4	$108,000
	Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T)	$21,000	55	$1,155,000
	Livestock Exclusion with Reduced Setback (LE-2T)	$17,000	6	$102,000
	Small Acreage Grazing System (SL-6AT)	$9,000	3	$27,000
	Stream Protection/Fencing (WP-2T)	$21,000	2	$42,000
	Manure Storage (WP-4) - Beef	$58,000	2	$116,000
BMP Type	**BMP**	**Cost (per acre)**	**Acre-Installed**	**Total Cost**
Pasture	Vegetative Cover on Critical Areas (SL-11)	$1,200	724	$868,800
	Reforestation of Erodible Pasture (FR-1)	$560	402	$225,120
	Pasture Management (EQIP 528, SL-10T)	$75	3,618	$271,350
Cropland	Continuous No-Till (SL-15)	$100	50	$5,000
	Small Grain Cover Crop (SL-8)	$30	45	$1,350
	Permanent Vegetative Cover on Cropland (SL-1)	$175	3	$525
	Sod Waterway (WP-3)	$1,600	7	$11,200
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	3	$3,000
Residential				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$300	597	$179,100
	Sewer Connection (Targeted Areas and RB-2)	$9,500	265	$2,517,500
	Repaired Septic System (RB-3)	$3,600	511	$1,839,600
	Septic System Installation/Replacement (RB-4)	$6,000	429	$2,574,000
	Altern. Waste Treatment System Installation (RB-5)	$16,000	45	$720,000
Pet Waste	Pet Waste Education Campaign	$5,000	3	$15,000
	Pet Waste Station	$4,180	6	$25,080
Urban				
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban Retrofit	Infiltration Basin	$6,000	421	$2,526,000
	Constructed Wetland	$2,900	577	$1,673,300
Urban	Bioretention	$10,000	885	$8,850,000
	Rain Gardens	$5,000	177	$885,000
	Infiltration Trench	$6,000	176	$1,056,000
	Manufactured BMP	$20,000	214	$4,280,000
	Constructed Wetland	$2,900	4,013	$11,637,700
	Detention Pond	$3,800	196	$744,800
	Permeable Pavement	$240,000	5	$1,200,000
	Vegetated Swale	$18,150	150	$2,722,500
	Rain Barrel (number of barrels)	$150	245	$36,750
	Riparian Buffer: Forest (acre-installed)	$3,500	16	$56,000
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	16	$5,760
	Urban Land Use Conversion (acre-installed)	$3,500	30	$105,000
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	7,098	$2,129,400
			Total Subwatershed IP Cost	**$48,714,835**

Table 5-18: Lick Run TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per acre)**	**Acre-Installed**	**Total Cost**
Pasture	Vegetative Cover on Critical Areas (SL-11)	$1,200	11	$13,200
	Reforestation of Erodible Pasture (FR-1)	$560	6	$3,360
	Pasture Management (EQIP 528, SL-10T)	$75	53	$3,975
	Wet Detention Ponds	$150	15	$2,250
Residential				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$300	2	$600
	Sewer Connection (Targeted Areas and RB-2)	$9,500	112	$1,064,000
	Repaired Septic System (RB-3)	$3,600	1	$3,600
	Septic System Installation/Replacement (RB-4)	$6,000	5	$30,000
Pet Waste	Pet Waste Education Campaign	$5,000	3	$15,000
	Pet Waste Station	$4,180	19	$79,420
Urban				
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban Retrofit	Infiltration Basin	$6,000	72	$432,000
	Constructed Wetland	$2,900	228	$661,200
Urban	Bioretention	$10,000	1,950	$19,500,000
	Rain Gardens	$5,000	390	$1,950,000
	Infiltration Trench	$6,000	388	$2,328,000
	Manufactured BMP	$20,000	471	$9,420,000
	Constructed Wetland	$2,900	2,150	$6,235,000
	Detention Pond	$3,800	196	$744,800
	Permeable Pavement	$240,000	5	$1,200,000
	Vegetated Swale	$18,150	150	$2,722,500
	Rain Barrel (number of barrels)	$150	246	$36,900
	Riparian Buffer: Forest (acre-installed)	$3,500	23	$80,500
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	23	$8,280
	Urban Land Use Conversion (acre-installed)	$3,500	31	$108,500
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	1,203	$360,900
			Total Subwatershed IP Cost	**$47,003,985**

<table>
<tr><th colspan="5">Table 5-19: Mason Creek TMDL IP Costs</th></tr>
<tr><th colspan="5">Agricultural</th></tr>
<tr><th>BMP Type</th><th>BMP</th><th>Cost (per system)</th><th>Systems</th><th>Total Cost</th></tr>
<tr><td rowspan="3">Livestock Exclusion/ Manure Storage</td><td>CREP Livestock Exclusion (CRSL-6)</td><td>$27,000</td><td>1</td><td>$27,000</td></tr>
<tr><td>Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T)</td><td>$21,000</td><td>7</td><td>$147,000</td></tr>
<tr><td>Livestock Exclusion with Reduced Setback (LE-2T)</td><td>$17,000</td><td>1</td><td>$17,000</td></tr>
<tr><th>BMP Type</th><th>BMP</th><th>Cost (per acre)</th><th>Acre-Installed</th><th>Total Cost</th></tr>
<tr><td rowspan="3">Pasture</td><td>Vegetative Cover on Critical Areas (SL-11)</td><td>$1,200</td><td>94</td><td>$112,800</td></tr>
<tr><td>Reforestation of Erodible Pasture (FR-1)</td><td>$560</td><td>52</td><td>$29,120</td></tr>
<tr><td>Pasture Management (EQIP 528, SL-10T)</td><td>$75</td><td>470</td><td>$35,250</td></tr>
<tr><td rowspan="2">Cropland</td><td>Continuous No-Till (SL-15)</td><td>$100</td><td>9</td><td>$900</td></tr>
<tr><td>Small Grain Cover Crop (SL-8)</td><td>$30</td><td>9</td><td>$270</td></tr>
<tr><th colspan="5">Residential</th></tr>
<tr><th>BMP Type</th><th>BMP</th><th>Cost (per system)</th><th>Systems</th><th>Total Cost</th></tr>
<tr><td rowspan="5">Waste Treatment</td><td>Septic System Pump-Out (RB-1)</td><td>$300</td><td>129</td><td>$38,700</td></tr>
<tr><td>Sewer Connection (Targeted Areas and RB-2)</td><td>$9,500</td><td>563</td><td>$5,348,500</td></tr>
<tr><td>Repaired Septic System (RB-3)</td><td>$3,600</td><td>85</td><td>$306,000</td></tr>
<tr><td>Septic System Installation/Replacement (RB-4)</td><td>$6,000</td><td>133</td><td>$798,000</td></tr>
<tr><td>Altern. Waste Treatment System Installation (RB-5)</td><td>$16,000</td><td>11</td><td>$176,000</td></tr>
<tr><td rowspan="2">Pet Waste</td><td>Pet Waste Education Campaign</td><td>$5,000</td><td>3</td><td>$15,000</td></tr>
<tr><td>Pet Waste Station</td><td>$4,180</td><td>6</td><td>$25,080</td></tr>
<tr><th colspan="5">Urban</th></tr>
<tr><th>BMP Type</th><th>BMP</th><th>Cost (per acre-treated)</th><th>Acre-Treated</th><th>Total Cost</th></tr>
<tr><td rowspan="2">Urban Retrofit</td><td>Infiltration Basin</td><td>$6,000</td><td>264</td><td>$1,584,000</td></tr>
<tr><td>Constructed Wetland</td><td>$2,900</td><td>149</td><td>$432,100</td></tr>
<tr><td rowspan="12">Urban</td><td>Bioretention</td><td>$10,000</td><td>590</td><td>$5,900,000</td></tr>
<tr><td>Rain Gardens</td><td>$5,000</td><td>118</td><td>$590,000</td></tr>
<tr><td>Infiltration Trench</td><td>$6,000</td><td>117</td><td>$702,000</td></tr>
<tr><td>Manufactured BMP</td><td>$20,000</td><td>142</td><td>$2,840,000</td></tr>
<tr><td>Constructed Wetland</td><td>$2,900</td><td>1,921</td><td>$5,570,900</td></tr>
<tr><td>Detention Pond</td><td>$3,800</td><td>196</td><td>$744,800</td></tr>
<tr><td>Permeable Pavement</td><td>$240,000</td><td>5</td><td>$1,200,000</td></tr>
<tr><td>Vegetated Swale</td><td>$18,150</td><td>150</td><td>$2,722,500</td></tr>
<tr><td>Rain Barrel (number of barrels)</td><td>$150</td><td>86</td><td>$12,900</td></tr>
<tr><td>Riparian Buffer: Forest (acre-installed)</td><td>$3,500</td><td>2</td><td>$7,000</td></tr>
<tr><td>Riparian Buffer: Grass/Shrub (acre-installed)</td><td>$360</td><td>2</td><td>$720</td></tr>
<tr><td>Urban Land Use Conversion (acre-installed)</td><td>$3,500</td><td>16</td><td>$56,000</td></tr>
<tr><th colspan="5">Stream Restoration</th></tr>
<tr><td colspan="2" rowspan="2">Stream Restoration</td><th>Cost (per linear foot)</th><th>Linear Feet</th><th>Total Cost</th></tr>
<tr><td>$300</td><td>10,264</td><td>$3,079,200</td></tr>
<tr><td colspan="4">Total Subwatershed IP Cost</td><td>$32,518,740</td></tr>
</table>

Table 5-20: Mud Lick Creek, Murray Run, and Ore Branch TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Livestock Exclusion	Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T)	$21,000	1	$21,000
BMP Type	**BMP**	**Cost (per acre)**	**Acre-Installed**	**Total Cost**
Pasture	Vegetative Cover on Critical Areas (SL-11)	$1,200	9	$10,800
	Reforestation of Erodible Pasture (FR-1)	$560	9	$5,040
	Pasture Management (EQIP 528, SL-10T)	$75	10	$750
Cropland	Continuous No-Till (SL-15)	$100	3	$300
Residential				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$300	23	$6,900
	Repaired Septic System (RB-3)	$3,600	20	$72,000
	Septic System Installation/Replacement (RB-4)	$6,000	6	$36,000
	Altern. Waste Treatment System Installation (RB-5)	$16,000	1	$16,000
Pet Waste	Pet Waste Education Campaign	$5,000	3	$15,000
	Pet Waste Station	$4,180	14	$58,520
Urban				
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban Retrofit	Infiltration Basin	$6,000	661	$3,966,000
	Constructed Wetland	$2,900	2,154	$6,246,600
Urban	Bioretention	$10,000	1,500	$15,000,000
	Rain Gardens	$5,000	300	$1,500,000
	Infiltration Trench	$6,000	299	$1,794,000
	Manufactured BMP	$20,000	362	$7,240,000
	Constructed Wetland	$2,900	4,472	$12,968,800
	Detention Pond	$3,800	196	$744,800
	Permeable Pavement	$240,000	5	$1,200,000
	Vegetated Swale	$18,150	150	$2,722,500
	Rain Barrel (number of barrels)	$150	345	$51,750
	Riparian Buffer: Forest (acre-installed)	$3,500	15	$52,500
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	15	$5,400
	Urban Land Use Conversion (acre-installed)	$3,500	48	$168,000
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	1,122	$336,600
			Total Subwatershed IP Cost	**$54,239,260**

Table 5-21: Peters Creek TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Livestock Exclusion/ Manure Storage	Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T)	$21,000	1	$21,000
BMP Type	**BMP**	**Cost (per acre)**	**Acre-Installed**	**Total Cost**
Pasture	Vegetative Cover on Critical Areas (SL-11)	$1,200	9	$10,800
	Reforestation of Erodible Pasture (FR-1)	$560	18	$10,080
	Pasture Management (EQIP 528, SL-10T)	$75	162	$12,150
Residential				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$300	12	$3,600
	Sewer Connection (Targeted Areas and RB-2)	$9,500	94	$893,000
	Repaired Septic System (RB-3)	$3,600	8	$28,800
	Septic System Installation/Replacement (RB-4)	$6,000	16	$96,000
	Altern. Waste Treatment System Installation (RB-5)	$16,000	1	$16,000
Pet Waste	Pet Waste Education Campaign	$5,000	3	$15,000
	Pet Waste Station	$4,180	1	$4,180
Urban				
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban Retrofit	Infiltration Basin	$6,000	154	$924,000
	Constructed Wetland	$2,900	309	$896,100
Urban	Bioretention	$10,000	800	$8,000,000
	Rain Gardens	$5,000	160	$800,000
	Infiltration Trench	$6,000	159	$954,000
	Manufactured BMP	$20,000	193	$3,860,000
	Constructed Wetland	$2,900	1,634	$4,738,600
	Detention Pond	$3,800	196	$744,800
	Permeable Pavement	$240,000	5	$1,200,000
	Vegetated Swale	$18,150	150	$2,722,500
	Rain Barrel (number of barrels)	$150	180	$27,000
	Riparian Buffer: Forest (acre-installed)	$3,500	11	$38,500
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	11	$3,960
	Urban Land Use Conversion (acre-installed)	$3,500	20	$70,000
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	2,245	$673,500
			Total Subwatershed IP Cost	**$26,763,570**

Table 5-22: Roanoke River 1 TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Livestock Exclusion/ Manure Storage	CREP Livestock Exclusion (CRSL-6)	$27,000	2	$54,000
	Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T)	$21,000	14	$294,000
	Livestock Exclusion with Reduced Setback (LE-2T)	$17,000	2	$34,000
	Small Acreage Grazing System (SL-6AT)	$9,000	1	$9,000
BMP Type	**BMP**	**Cost (per acre)**	**Acre-Installed**	**Total Cost**
Pasture	Vegetative Cover on Critical Areas (SL-11)	$1,200	286	$343,200
	Reforestation of Erodible Pasture (FR-1)	$560	159	$89,040
	Pasture Management (EQIP 528, SL-10T)	$75	1,430	$107,250
	Wet Detention Ponds for Pastureland	$150	0	$0
Cropland	Continuous No-Till (SL-15)	$100	25	$2,500
	Small Grain Cover Crop (SL-8)	$30	5	$150
	Permanent Vegetative Cover on Cropland (SL-1)	$175	2	$350
	Sod Waterway (WP-3)	$1,600	4	$6,400
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	2	$2,000
Residential				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$300	197	$59,100
	Sewer Connection (Targeted Areas and RB-2)	$9,500	835	$7,932,500
	Repaired Septic System (RB-3)	$3,600	134	$482,400
	Septic System Installation/Replacement (RB-4)	$6,000	180	$1,080,000
	Altern. Waste Treatment System Installation (RB-5)	$16,000	15	$240,000
Pet Waste	Pet Waste Education Campaign	$5,000	3	$15,000
	Pet Waste Station	$4,180	11	$45,980
Urban				
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban Retrofit	Infiltration Basin	$6,000	1,298	$7,788,000
	Constructed Wetland	$2,900	596	$1,728,400
Urban	Bioretention	$10,000	1,375	$13,750,000
	Rain Gardens	$5,000	275	$1,375,000
	Infiltration Trench	$6,000	274	$1,644,000
	Manufactured BMP	$20,000	332	$6,640,000
	Constructed Wetland	$2,900	4,787	$13,882,300
	Detention Pond	$3,800	196	$744,800
	Permeable Pavement	$240,000	5	$1,200,000
	Vegetated Swale	$18,150	150	$2,722,500
	Rain Barrel (number of barrels)	$150	370	$55,500
	Riparian Buffer: Forest (acre-installed)	$3,500	30	$105,000
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	30	$10,800
	Urban Land Use Conversion (acre-installed)	$3,500	70	$245,000
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	22,506	$6,751,800
			Total Subwatershed IP Cost	**$69,439,970**

Table 5-23: Roanoke River 2 TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Livestock Exclusion/ Manure Storage	CREP Livestock Exclusion (CRSL-6)	$27,000	1	$27,000
	Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T)	$21,000	8	$168,000
	Livestock Exclusion with Reduced Setback (LE-2T)	$17,000	1	$17,000
	Small Acreage Grazing System (SL-6AT)	$9,000	1	$9,000
BMP Type	**BMP**	**Cost (per acre)**	**Acre-Installed**	**Total Cost**
Pasture	Vegetative Cover on Critical Areas (SL-11)	$1,200	263	$315,600
	Reforestation of Erodible Pasture (FR-1)	$560	146	$81,760
	Pasture Management (EQIP 528, SL-10T)	$75	1,316	$98,700
Cropland	Continuous No-Till (SL-15)	$100	1	$100
Residential				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$300	153	$45,900
	Sewer Connection (Targeted Areas and RB-2)	$9,500	39	$370,500
	Repaired Septic System (RB-3)	$3,600	86	$309,600
	Septic System Installation/Replacement (RB-4)	$6,000	86	$516,000
	Altern. Waste Treatment System Installation (RB-5)	$16,000	8	$128,000
Pet Waste	Pet Waste Education Campaign	$5,000	3	$15,000
	Pet Waste Station	$4,180	22	$91,960
Urban				
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban Retrofit	Infiltration Basin	$6,000	501	$3,006,000
	Constructed Wetland	$2,900	366	$1,061,400
Urban	Bioretention	$10,000	1,250	$12,500,000
	Rain Gardens	$5,000	250	$1,250,000
	Infiltration Trench	$6,000	249	$1,494,000
	Manufactured BMP	$20,000	302	$6,040,000
	Constructed Wetland	$2,900	5,733	$16,625,700
	Detention Pond	$3,800	196	$744,800
	Permeable Pavement	$240,000	5	$1,200,000
	Vegetated Swale	$18,150	150	$2,722,500
	Rain Barrel (number of barrels)	$150	430	$64,500
	Riparian Buffer: Forest (acre-installed)	$3,500	28	$98,000
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	28	$10,080
	Urban Land Use Conversion (acre-installed)	$3,500	50	$175,000
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	1,674	$502,200
			Total Subwatershed IP Cost	**$49,688,300**

Table 5-24: Tinkers Creek TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Livestock Exclusion/ Manure Storage	CREP Livestock Exclusion (CRSL-6)	$27,000	4	$108,000
	Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6T/LE-1T)	$21,000	55	$1,155,000
	Livestock Exclusion with Reduced Setback (LE-2T)	$17,000	6	$102,000
	Small Acreage Grazing System (SL-6AT)	$9,000	3	$27,000
	Stream Protection/Fencing (WP-2T)	$21,000	2	$42,000
	Manure Storage (WP-4) - Beef	$58,000	2	$116,000
BMP Type	**BMP**	**Cost (per acre)**	**Acre-Installed**	**Total Cost**
Pasture	Vegetative Cover on Critical Areas (SL-11)	$1,200	1,299	$1,558,800
	Reforestation of Erodible Pasture (FR-1)	$560	722	$404,320
	Pasture Management (EQIP 528, SL-10T)	$75	6,497	$487,275
Residential				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$300	688	$206,400
	Sewer Connection (Targeted Areas and RB-2)	$9,500	244	$2,318,000
	Repaired Septic System (RB-3)	$3,600	459	$1,652,400
	Septic System Installation/Replacement (RB-4)	$6,000	558	$3,348,000
	Altern. Waste Treatment System Installation (RB-5)	$16,000	49	$784,000
Pet Waste	Pet Waste Education Campaign	$5,000	3	$15,000
	Pet Waste Station	$4,180	7	$29,260
Urban				
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban Retrofit	Infiltration Basin	$6,000	348	$2,088,000
	Constructed Wetland	$2,900	293	$849,700
Urban	Bioretention	$10,000	1,240	$12,400,000
	Rain Gardens	$5,000	248	$1,240,000
	Infiltration Trench	$6,000	247	$1,482,000
	Manufactured BMP	$20,000	299	$5,980,000
	Constructed Wetland	$2,900	5,504	$15,961,600
	Detention Pond	$3,800	196	$744,800
	Permeable Pavement	$240,000	5	$1,200,000
	Vegetated Swale	$18,150	150	$2,722,500
	Rain Barrel (number of barrels)	$150	358	$53,700
	Riparian Buffer: Forest (acre-installed)	$3,500	26	$91,000
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	26	$9,360
	Urban Land Use Conversion (acre-installed)	$3,500	24	$84,000
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	10,334	$3,100,200
			Total Subwatershed IP Cost	**$60,360,315**

Table 5-25: Cost of Additional Street Sweeping				
Municipality	**Additional Lane Miles to be Swept per year**	**Cost Per mile swept**	**Street Sweeper Equipment Cost***	**Total Cost (per year)**
City of Roanoke	2,526	$520	NA	$1,313,520
City of Salem	1,058		NA	$550,160
County of Roanoke	5,092		$175,000	$2,647,840
			Total per year	$4,686,520
			Total Cost**	$82,140,230

*One time cost

**Total reflects the varied timelines of the subwatershed (15 and 20 years)

Table 5-26: Technical Assistance for Roanoke River IP Part I				
BMP Category	**Stage 1 (Year 1-8)**	**Stage 2 (Year 9-16)**	**Stage 3 (Year 17-20)**	**Total**
Agricultural	$720,000	$480,000	$120,000	$1,320,000
Residential	$960,000	$960,000	$240,000	$2,160,000
Urban/Stormwater	$600,000	$600,000	$150,000	$1,350,000
Total Cost	**$2,280,000**	**$2,040,000**	**$510,000**	**$4,830,000**

Table 5-27: Summary of Cost of Roanoke River IP (Part I) by Subwatershed					
BMP Category	**Agricultural**	**Residential**	**Urban**	**Stream Restoration**	**Total**
Back Creek	$1,672,060	$4,895,300	$43,075,480	-	$49,642,840
Carvin Creek	$374,165	$1,967,960	$24,242,610	$3,729,900	$30,314,635
Glade Creek	$2,936,345	$7,870,280	$35,778,810	$2,129,400	$48,714,835
Lick Run	$22,785	$1,192,620	$45,427,680	$360,900	$47,003,985
Mason Creek	$369,340	$6,707,280	$22,362,920	$3,079,200	$32,518,740
Mud Lick, Murray Run, and Ore Branch	$37,890	$204,420	$53,660,350	$336,600	$54,239,260
Peters Creek	$54,030	$1,056,580	$24,979,460	$673,500	$26,763,570
Roanoke River 1	$941,890	$9,854,980	$51,891,300	$6,751,800	$69,439,970
Roanoke River 2	$717,160	$1,476,960	$46,991,980	$502,200	$49,688,300
Tinker Creek	$4,000,395	$8,353,060	$44,906,660	$3,100,200	$60,360,315
Subtotals	***$11,126,060***	***$43,579,440***	***$393,317,250***	***$20,663,700***	$468,686,450
Additional Street Sweeping*					$82,140,230
Technical Assistance					$4,830,000
Total Cost					**$555,656,680**

*Total reflects the varied timelines of the subwatershed (15 and 20 years)

Table 5-28: Summary of Bacteria Delisting Cost of Roanoke River TMDL IP (Part I) by Subwatershed	
BMP Category	**Approximate Cost to Delist the Subwatershed for Bacteria Impairment***
Back Creek	$54,932,010
Carvin Creek	$24,610,975
Glade Creek	$46,008,485
Lick Run	$17,994,500
Mason Creek	$30,714,890
Mud Lick, Murray Run, and Ore Branch	$62,832,980
Peters Creek	$25,588,650
Roanoke River 1	$76,457,950
Roanoke River 2	$20,999,690
Tinker Creek	$57,779,245
Technical Assistance	$4,830,000
Total Bacteria Delisting Cost	**$422,749,375**

*Costs do not include cost associated with Permeable Pavers, Vegetated Swales, Rain Barrels, and Stream Restoration as they do not reduce bacteria.

5.6 Benefits of Control Measures

The ultimate goal of this Roanoke River IP is to meet water quality standards that support human recreational use and aquatic life. Successful pollutant reductions through BMPs and educational programs would allow the impaired segments to be delisted and eventually achieve the bacteria and sediment allocations in the TMDLs. The main benefit of implementation of the various control measures is the improvement of the water quality of the Roanoke River and its tributaries. Benefits are derived not only from the resulting clean water but also directly from the actual control measures themselves. Enhanced natural resources also provide for enriched recreational opportunities. Reducing bacteria and sediment loads in the Roanoke River watershed will protect human health and safety, promote healthy aquatic communities, improve agricultural production, and add to the economic vitality of communities.

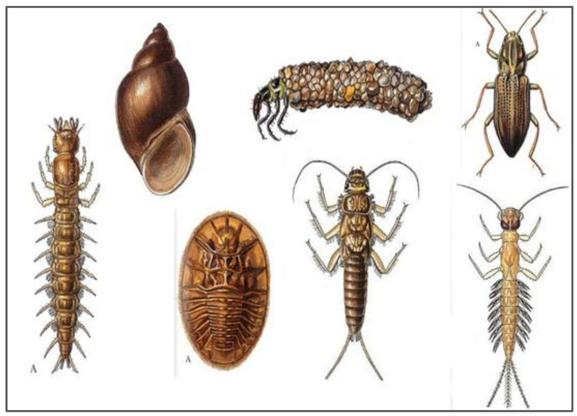
<u>Human Health and Safety</u>

Human, livestock, and wildlife waste can carry viruses and bacteria that are harmful to human health. Although the full range of effects from reduced bacteria loadings on public health is uncertain, the improved water quality should, at the very least, reduce the incidence of infection derived from contact with surface waters (VADCR, 2003). Throughout the United States, the

Centers for Disease Control (CDC) estimates that at least 73,000 cases of illnesses and 61 deaths per year are caused by *E. coli* 0157:H7 bacteria (CDC, 2001). Other fecal pathogens (e.g., *E. coli* 0111) are responsible for similar illnesses. Reducing the presence of bacteria in the watershed should considerably reduce the chances of infection from *E. coli* sources through contact with surface waters in tributary streams and the Roanoke River. In addition to preventing infection and disease, strategies in this plan addressing stormwater could help mitigate and prevent future flooding.

Healthy Aquatic Communities

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



Examples of intolerant benthic macroinvertebrates

Reducing sediment in the Roanoke River watershed will help restore the health of aquatic communities for the benefit of the flora, fauna and human residents. Improved water quality would provide better instream habitats for aquatic wildlife as well as terrestrial wildlife that use the surrounding waters. Implementation of many of the BMPs would protect and enhance existing natural resources and habitats such as riparian areas, forests, wetlands, and vegetated areas used by wildlife typically found in urban areas. For example, streamside buffers of trees and shrubs help reduce erosion and provide shading of the stream. This helps keep water temperatures lower during the summer and allows for a greater amount of dissolved oxygen in the stream that benefits macroinvertebrates and fish. Fisheries which will in turn provide more stock for local anglers. In 2011 alone, approximately $3.5 billion was spent on wildlife recreation in Virginia (USDOI et al, 2011). Buffers can also improve habitat for wildlife and migratory songbirds that also benefit from having access to a healthy, thriving aquatic community.

Agricultural Production

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

Restricting cattle access to streams and providing them with a clean water source can improve weight gain (Surber et al., 2005; Landefeld and Krueger, 2002). Increasing weight associated with drinking from off stream waterers can translate into economic gains for producers as shown in Table 5-29. Additionally, keeping cattle in clean, dry areas has been shown to reduce the occurrence of *mastitis* and foot rot. The Virginia Cooperative Extension estimates *mastitis* costs producers $150 per cow in reduced milk production quantity and quality (Jones and Balley, 2009).

Table 5-29. Production gains associated with provision of clean water for cattle*

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

*Surber et al., 2005

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

Improvements to Residential Properties

Individual homeowners and residents could also see financial benefits from these efforts. Implementation activities in the plan will help give homeowners the knowledge and tools needed for properly maintaining and extending the life of their septic systems. The overall cost of ownership could also be reduced by advocating regular pump outs which cost about $300 compared to the $3,000-$25,000 cost of a repair or replacement system. The additional services provided by new stormwater BMPs could raise the market value of nearby homes by 0-5% (Braden and Johnston, 2004). Another study in the Chesapeake Bay area found that lower fecal coliform concentrations correlates with increased property values (Leggett and Bockstael, 2000).

Economic Benefits of Stormwater BMPs

Stormwater BMPs can be incorporated into a landscape design as an amenity both on private and public properties. Many BMPs like vegetated swales, buffer strips, and infiltration trenches are inexpensive and easy to implement given limited space and other constraints. Installation of stormwater BMPs provide educational opportunities to increase awareness of water quality strategies (i.e., watershed plans) and green initiatives.

Potential economic benefits of stormwater BMPs (Wise, 2007):

- Incremental implementation and funding can result in less debt service
- Stormwater BMPs are less capital intensive and may have overall lower costs
- Can extent existing capacity of current infrastructure
- Captures the asset values of clean water, soil capacity and open space amenities: values ecosystem services
- Reduce wastewater and water treatment costs
- Increased property values to the benefits of the private sector and public revenue collection

Stormwater infrastructure that reduces stormwater runoff onsite can reduce losses from flood damage by $6,700-$9,700 per acre (Medina et al., 2011.) Urban stormwater BMPs can also help increase stormwater retention and lower peak discharges, thereby reducing the pressure on and need for stormwater infrastructure. This will in turn lower engineering, land acquisition, and material costs for municipalities and private enterprises.

Community Economic Vitality

Not only will clean water and improved habitats benefit a landowner that earns their livelihood through their land but it will also benefit the overall regional economy by encouraging outdoor pursuits that stimulate the local economy and employment such as fishing, canoeing, kayaking, hiking, and other recreational tourism. The Roanoke River Valley is a very active outdoor recreational area with the Roanoke Valley River Greenways established in 1997 by the City of Roanoke, Roanoke County, City of Salem and Town Of Vinton. An intergovernmental agreement is in placed supporting regional cooperation and the implementation of 35 planned routes through the Roanoke Valley. A number of greenway trails are already built or are planned in subwatersheds included in the IP.

Healthy watersheds provide many ecosystem services necessary for a community's well-being. These services include, but are not limited to, water filtration and storage, air filtration, carbon storage, energy, nutrient cycling, removal of pollutants, soil formation, recreation, food and timber. Many of these services are hard to quantify in terms of dollars and are often under-valued (Bockstael et al., 2000). However, it is understood that many of these services are difficult to replace and often expensive to artificially engineer. Efforts to restore the Roanoke River watershed to a healthier state may reduce the financial burden on residents, businesses, and municipalities who currently bear the cost of damages caused by a degraded aquatic system such as flooding. Lastly, the combined economic and natural resource benefits provide for a better quality of life for local and regional residents now and in the future.

Once the IP is complete, organizations in the watershed will be eligible to apply for competitive funding to help cover some of the costs associated with installing the BMPs. These potential funds along with matching funds from other sources will benefit many local contractors involved in the repair and installation of septic systems, building of livestock exclusion systems, and installation and retrofits of stormwater BMPs. In a 2009 study, researchers estimated that every $1 million invested in environmental efforts such as reforestation, land and watershed restoration, and sustainable forest management, would create approximately 39 jobs (Heintz et al., 2009). Economic benefits to the region and individual stakeholders are an indirect result of the IP. Improvement of water quality provides greater economic opportunities throughout the area.

5.6.1 Cost/Benefit Analysis

Tables 5-30 and 5-31 present the cost-effectiveness of each proposed BMP which has quantifiable bacteria and sediment reductions in the Roanoke River IP. The practices are ranked from the most to least cost-effective practices for each BMP category. The cost-effectiveness is based on the amount of bacteria (in cfu; Table 5-29) and sediment (in pounds; Table 5-30) reduced per $1,000 spent. Table 5-30 also includes the cost of the practice per 1000 pounds of sediment reduction. For bacteria, the effectiveness values are based on the bacteria loading from the Tinker Creek subwatershed. Because the bacteria loading within each subwatershed varies, the bacteria loads reduced per $1,000 spent would be slightly different for the other subwatersheds.

Table 5-30: BMP Cost-Effectiveness for Bacteria Reduction in the Roanoke River Watershed

BMP	Bacteria Reduction per $1,000 (in cfu)
Stormwater BMPs	
Riparian Buffer: Grass/Shrub	2.27E+11
Constructed Wetland	4.52E+10
Riparian Buffer: Forest	2.67E+10
Infiltration Trench	2.46E+10
Urban Land Use Conversion	2.33E+10
Rain Gardens	2.29E+10
Bioretention	1.47E+10
Street Sweeping	1.38E+10
Detention Pond	1.29E+10
Manufactured BMPs	6.55E+09
Vegetated Swale	N/A
Permeable Paver	N/A
Rain Barrel	N/A
Residential BMPs	
Repaired Septic System (RB-3)	2.18E+10
Septic System Pump-Out (RB-1)	1.31E+10

Table 5-30: BMP Cost-Effectiveness for Bacteria Reduction in the Roanoke River Watershed	
BMP	**Bacteria Reduction per $1,000 (in cfu)**
Septic System Installation/Replacement (RB-4)	1.31E+10
Sewer Connection (RB-2)	8.27E+09
Pet Waste Management Education Program	8.19E+09
Altern. Waste Treatment System Installation (RB-5)	4.91E+09
Cropland BMPs	
Continuous No-Till (SL-15)	1.25E+14
Small Grain Cover Crop (SL-8)	1.19E+14
Permanent vegetative cover on cropland (SL-1)	7.66E+13
Cropland Buffer/Field Borders (CP-33 and WQ-1)	1.49E+13
Sod Waterway (WP-3)	5.58E+12
Pasture BMPs	
Pasture Management (EQIP 528, SL-10T, SL-9)	1.21E+12
Wet Detention Pond	8.46E+11
Reforestation of Erodible Pasture (FR-1)	2.82E+11
Vegetative Cover on Critical Areas (SL-11)	1.13E+11
Livestock Exclusion BMPs	
Small Acreage Grazing System (SL-6AT)	4.15E+11
Livestock Exclusion with Reduced Setback (LE-2T)	2.19E+11
Livestock Exclusion (SL-6T/LE1-T)	1.78E+11
Stream Protection/Fencing (WP-2T)	1.49E+11
Livestock Exclusion (CRSL-6)	1.38E+11

Table 5-31: BMP Cost-Effectiveness for Sediment Reduction in the Roanoke River Watershed		
BMP	**Sediment Reduction per $1000 (in lbs)**	**Sediment Reduction per 1,000 lbs (in $)**
Stormwater BMPs		
Street Sweeping*	2,133.2	$469
Riparian Buffer: Grass/Shrub	332.1	$3,011
Rain Barrel	159.4	$6,274
Urban Land Use Conversion	65.5	$15,257
Riparian Buffer: Forest	47.8	$20,913
Constructed Wetland	41.2	$24,259
Rain Gardens	33.5	$29,875
Detention Pond	31.5	$31,788
Infiltration Trench	29.9	$33,461
Bioretention	16.7	$59,751
Manufactured BMPs	9.6	$104,564
Vegetated Swale	8.6	$116,790
Permeable Paver	0.8	$1,254,770
Cropland BMPs		
Continuous No-Till (SL-15)	8,690.4	$115
Small Grain Cover Crop (SL-8)	8,276.5	$121
Permanent vegetative cover on cropland (SL-1)	5,320.6	$188
Cropland Buffer/Field Borders (CP-33 and WQ-1)	1,034.6	$967
Sod Waterway (WP-3)	388.0	$2,578
Pasture BMPs		
Pasture Management (EQIP 528, SL-10T)	301.0	$3,323
Wet Detention Pond	250.8	$3,987
Reforestation of Erodible Pasture (FR-1)	117.1	$8,541
Vegetative Cover on Critical Areas (SL-11)	47.0	$21,265
Livestock Exclusion BMPs		
Small Acreage Grazing System (SL-6AT)	4.7	$213,598
Livestock Exclusion with Reduced Setback (LE-2T)	2.5	$403,463
Livestock Exclusion (SL-6T/LE1-T)	2.0	$498,396
Stream Protection/Fencing (WP-2T)	1.7	$593,328
Livestock Exclusion (CRSL-6)	1.6	$640,794
Stream Restoration		
Stream Restoration**	1,033.3	$968

*Per curb mile per year (rate of one cycle per month)

**Per foot per year

6.0 Measurable Goals and Milestones for Attaining Water Quality Standards

The primary goals of the Roanoke River TMDL IP are to restore water quality in the impaired waterbodies and subsequently de-list the impaired segments from the Virginia 303(d) List of Impaired Waters for bacteria and aquatic life impairments. This section will outline specific implementation milestones, water quality milestones, the link between implementation and water quality improvement, provide a timeline for implementation, and describe additional tracking and monitoring to measure implementation of achievements.

6.1 Milestone Identification

Expected progress in implementation is established with two types of milestones: **implementation milestones** and **water quality milestones**. Implementation milestones establish the amount of control measures installed within prescribed timeframes, while water quality milestones establish the corresponding improvements in water quality that can be expected as the implementation milestones are met. The implementation of control measures proposed in the Roanoke River IP will take place over three stages in a 15 or 20 year timeline. The period of implementation varies by the size and urban coverage of the subwatershed:

- Implementation actions for smaller and/or more rural subwatersheds will occur over a 15-year timeline. The first two stages will be implemented over 6 years each; the final stage will be implemented over 3 years. We are proposing this approach for the following subwatersheds: *Carvin Creek, Peters Creek, Mason Creek, and Back Creek* (Figure 1-1).
- Implementation actions for larger and/or more urbanized subwatersheds will occur over a 20-year timeline. The first two stages will be implemented over 8 years each; the final stage will be implemented over 4 years. We are proposing this approach for the following subwatersheds: *Glade Creek, Tinker Creek, Lick Run, Mud Lick/Murray/Ore Branch, Roanoke River 1 and Roanoke River 2* (Figure 1-1).

Of the three implementation stages, the first stage focuses on implementing the more cost-effective and commonly implemented actions such as livestock exclusion practices, crop and pasture BMPs, and septic system repairs. The second stage focuses on implementing the majority of the remaining BMPs to reach the goal of delisting the bacteria impaired segments.

The delisting goal is achieved for *Carvin Creek*, *Back Creek*, *Lick Run,* and *Roanoke River 2* watersheds in stage 2. The third stage goal, while implementing the remainder of the more expensive BMPs, is to reach the goal of delisting the bacteria impaired segments for *Glade Creek; Mud Lick Creek, Murray Run and Ore Branch; Mason Creek; Peters Creek; Roanoke River 1, and Tinker Creek* and not violate the bacteria geometric mean criterion required by the TMDLs. All 10 watersheds at the end of stage 3 while at a bacteria violation rate of less than 10.5% for the single sample maximum do not meet the single sample maximum criterion (0% violation rate) required by the TMDLs because of bacteria loadings attributed to wildlife sources. The IP addresses implementation actions to reduce the man-induced sources of bacteria and does not address wildlife reductions both direct and indirect in the TMDLs. Implementations milestones in Stages I and II also address the required sediment reductions from the TMDLs.

Tables 6-2 to 6-11 present the three stages for each subwatershed with specific control measures distributed in each stage. Actions listed in each stage are cumulative in nature, and there are place-markers for the later stages to mark when the extent of proposed BMP implementation has been accomplished in a previous stage.

Implementation milestones establish the amount of control measures installed within prescribed timeframes, while water quality milestones establish the corresponding improvements in water quality that can be expected as the implementation milestones are met.

One of the goals of the Roanoke River TMDL IP is to link the implementation of control measures to corresponding improvements in water quality. These improvements in water quality of the impaired segments can be determined through bacteria modeling and adding total sediment reductions. The HSPF model was used to determine the percent exceedance of the geometric and single sample maximum water quality criterion for each stage (or milestone) for each subwatershed. In addition, the instream average annual bacteria loading (cfu/year) at each milestone was determined (Tables 6-2 to 6-10). Table 6-1 depicts the sediment reductions (tons/year) obtained from implementing BMPs at each stage. The total sediment reduction required to meet the benthic TMDL is 19,649 tons per year (Section 3.3.3). From the implementation of the BMPs necessary to meet the bacteria TMDL reductions, the benthic

TMDL is estimated to be attained in the 13th year of the 20 year TMDL IP timeline. Sediment is not displayed in each subwatershed, as each subwatershed is not impaired for sediment for this IP.

Table 6-1: Water Quality Milestones - Cumulative Sediment Reductions by IP Stage (tons/year) and Percentage Attainment of TMDL Goal

Subwatershed	Stage I	Stage II	Stage III
Carvin Creek	1,392	2,494	2,514
Glade Creek	2,310	2,616	2,655
Lick Run	988	1,255	1,298
Mason Creek	1,189	2,136	2,159
Mud Lick, Murray Run, and Ore Branch	1,862	2,196	2,247
Peters Creek	746	896	920
Roanoke River 1	2,726	4,813	4,864
Roanoke River 2	1,428	1,787	1,842
Tinker Creek	1,781	3,371	3,425
Total	**14,422**	**21,564**	**21,924**
Percent of TMDL Reductions Attained	**73%**	**100%**	**100%**

Table 6-2: Back Creek Implementation Staging				
Best Management Practice	Unit	Stage I (Y1-Y6)*	Stage II (Y7-Y12)*	Stage III (Y13-Y15)*
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	216	432	-
Sewer Connection (RB-2)	System	47	94	-
Repaired Septic System (RB-3)	System	164	328	-
Septic System Installation/Replacement (RB-4)	System	176	352	-
Alternative Waste Treatment System Installation (RB-5)	System	17	34	-
Pet Waste Management Education Program	Program	Program	Program	Program
Pet Waste Station	Unit	4	5	-
	Total Cost	$2,450,375	$2,439,925	$5,000
Existing BMPs and Detention Pond Retrofits				
Infiltration Trench	System	28	37	-
Constructed Wetlands	System	13	17	-
Street Sweeping (additional miles to be swept annually)**	Miles Swept	1,434	1,434	1,434
	Total Cost	$10,880,625	$6,610,375	$2,237,620
Stormwater BMPs				
Bioretention	Acre Treated	380.0	1,368.0	1,520.0
Rain Gardens	Acre Treated	152.0	273.6	304.0
Infiltration Trench	Acre Treated	75.8	272.7	303.0
Manufactured BMPs	Acre Treated	183.5	330.3	367.0
Constructed Wetland	Acre Treated	645.0	2,322.0	2,580.0
Detention Pond	Acre Treated	49.0	176.4	196.0
Riparian Buffer: Forest	Acre Installed	19.0	38.0	-
Riparian Buffer: Grass/Shrub	Acre Installed	19.0	38.0	-
Urban Tree Canopy/Land use Conversion	Acre Converted	20.3	72.9	81.0
	Total Cost	$10,885,415	$20,210,735	$3,438,830
Cropland BMPs				
Continuous No-Till (SL-15)	Acre Installed	63.0	-	-
Small Grain Cover Crop (SL-8)	Acre Installed	63.0	-	-
	Total Cost	$8,190	-	-
Livestock Exclusion Systems and Manure Management				
Livestock Exclusion (SL-6T/LE1-T)	System	26	35	-
Livestock Exclusion with Reduced Setback (LE-2T)	System	4	-	-
Small Acreage Grazing System (SL-6AT)	System	2	-	-
Stream Protection/Fencing (WP-2T)	System	1	-	-
	Total Cost	$658,250	$183,750	-
Pasture BMPs				
Reforestation of Erodible Pasture (FR-1)	Acre Installed	106.5	142.0	-
Pasture Management (EQIP 528, SL-10T, SL-9)	Acre Installed	1,347.0	2,694.0	-
Vegetative Cover on Critical Areas (SL-11)	Acre Installed	134.5	269.0	-
Wet Detention Pond	Acre Treated	0.0	0.0	1,450.0
	Total Cost	$322,065	$282,305	$217,500
	Total Cost Per Stage	**$25,204,920**	**$29,727,090**	**$5,898,950**
	Percent Exceedance Geometric Mean (126 cfu/100 mL)	**7.3%**	**2.1%**	**0.0%**
	Percent Exceedance Single Sample Maximum (235 cfu/100mL)	**21.9%**	**10.9%**	**9.6%**
	Bacteria Load Per Stage (cfu/year)	**3.32E+13**	**1.89E+13**	**1.11E+13**

*Numbers represent cumulative total of BMPs implemented
**Not cumulative, represented annually

Table 6-3: Carvin Creek Implementation Staging				
Best Management Practice	Unit	Stage I (Y1-Y6)*	Stage II (Y7-Y12)*	Stage III (Y13-Y15)*
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	22	-	-
Sewer Connection (RB-2)	System	181	-	-
Repaired Septic System (RB-3)	System	16	-	-
Septic System Installation/Replacement (RB-4)	System	18	-	-
Alternative Waste Treatment System Installation (RB-5)	System	2	-	-
Pet Waste Management Education Program	Program	Program	Program	Program
Pet Waste Station	Unit	5	7	-
	Total Cost	$1,950,645	$12,315	$5,000
Existing BMPs and Detention Pond Retrofits				
Infiltration Trench	System	26	35	-
Constructed Wetlands	System	26	34	-
Street Sweeping (additional miles to be swept annually)**	Miles Swept	564	564	564
	Total Cost	$5,351,450	$2,957,350	$880,150
Stormwater BMPs				
Bioretention	Acre Treated	147.5	531.0	590.0
Rain Gardens	Acre Treated	59.0	106.2	118.0
Infiltration Trench	Acre Treated	29.3	105.3	117.0
Manufactured BMPs	Acre Treated	71.0	127.8	142.0
Constructed Wetland	Acre Treated	394.3	1419.3	1577.0
Detention Pond	Acre Treated	49.0	176.4	196.0
Permeable Paver	Acre Treated	1.3	3.8	5.0
Vegetated Swale	Acre Treated	37.5	135.0	150.0
Rain Barrel	System	74	147	-
Riparian Buffer: Forest	Acre Installed	12	16	-
Riparian Buffer: Grass/Shrub	Acre Installed	12	16	-
Urban Tree Canopy/Land use Conversion	Acre Converted	7	25	28
	Total Cost	$5,757,495	$11,579,855	$2,117,060
Livestock Exclusion Systems and Manure Management				
Livestock Exclusion (CRSL-6)	System	1	-	-
Livestock Exclusion (SL-6T/LE1-T)	System	7	-	-
Livestock Exclusion with Reduced Setback (LE-2T)	System	1	-	-
	Total Cost	$191,000	$0	$0
Pasture BMPs				
Reforestation of Erodible Pasture (FR-1)	Acre Installed	27.0	54.0	-
Pasture Management (EQIP 528, SL-10T, SL-9)	Acre Installed	487.0	-	-
Vegetative Cover on Critical Areas (SL-11)	Acre Installed	48.5	97.0	-
	Total Cost	$109,845	$73,320	$0
Stream Restoration				
Stream Restoration	Feet	6,217	12,433	-
	Total Cost	$1,864,950	$1,864,950	$0
Total Cost Per Stage		**$15,225,385**	**$16,487,790**	**$3,002,210**
Percent Exceedance Geometric Mean (126 cfu/100 mL)		**0.0%**	**0.0%**	**0.0%**
Percent Exceedance Single Sample Maximum (235 cfu/100mL)		**17.8%**	**15.1%**	**10.3%**
Bacteria Load Per Stage (cfu/year)		**2.67E+13**	**1.45E+13**	**8.05E+12**

*Numbers represent cumulative total of BMPs implemented
**Not cumulative, represented annually

Table 6-4: Glade Creek Implementation Staging				
Best Management Practice	Unit	Stage I (Y1-Y8)*	Stage II (Y9-Y16)*	Stage III (Y17-Y20)*
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	448	597	-
Sewer Connection (RB-2)	System	133	265	-
Repaired Septic System (RB-3)	System	383	511	-
Septic System Installation/Replacement (RB-4)	System	322	429	-
Alternative Waste Treatment System Installation (RB-5)	System	34	45	-
Pet Waste Management Education Program	Program	Program	Program	Program
Pet Waste Station	Unit	5	6	-
	Total Cost	$5,267,085	$2,598,195	$5,000
Existing BMPs and Detention Pond Retrofits				
Infiltration Trench	System	17	22	-
Constructed Wetlands	System	23	31	-
Street Sweeping (additional miles to be swept annually)**	Miles Swept	325	325	325
	Total Cost	$4,502,395	$2,402,745	$676,460
Stormwater BMPs				
Bioretention	Acre Treated	221.3	796.5	885.0
Rain Gardens	Acre Treated	88.5	159.3	177.0
Infiltration Trench	Acre Treated	44.0	158.4	176.0
Manufactured BMPs	Acre Treated	107.0	192.6	214.0
Constructed Wetland	Acre Treated	1,003.3	3,611.7	4,013.0
Detention Pond	Acre Treated	49.0	176.4	196.0
Permeable Paver	Acre Treated	1.3	3.8	5.0
Vegetated Swale	Acre Treated	37.5	135.0	150.0
Rain Barrel	System	123	245	-
Riparian Buffer: Forest	Acre Installed	12.0	16.0	-
Riparian Buffer: Grass/Shrub	Acre Installed	12.0	16.0	-
Urban Tree Canopy/Land use Conversion	Acre Converted	7.5	27.0	30.0
	Total Cost	$9,226,195	$19,025,215	$3,328,100
Cropland BMPs				
Continuous No-Till (SL-15)	Acre Installed	50.0	-	-
Small Grain Cover Crop (SL-8)	Acre Installed	45.0	-	-
Permanent vegetative cover on cropland (SL-1)	Acre Installed	3.0	-	-
Sod Waterway (WP-3)	Acre Installed	7.0	-	-
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre Installed	3.0	-	-
	Total Cost	$21,075	$0	$0
Livestock Exclusion Systems and Manure Management				
Livestock Exclusion (CRSL-6)	System	3	4	-
Livestock Exclusion (SL-6T/LE1-T)	System	41	55	-
Livestock Exclusion with Reduced Setback (LE-2T)	System	3	6	-
Small Acreage Grazing System (SL-6AT)	System	3	-	-
Stream Protection/Fencing (WP-2T)	System	2	-	-
Manure Storage (WP-4)	System	2	-	-
	Total Cost	$1,183,250	$366,750	$0
Pasture BMPs				
Reforestation of Erodible Pasture (FR-1)	Acre Installed	201.0	402.0	-
Pasture Management (EQIP 528, SL-10T, SL-9)	Acre Installed	1809.0	3618.0	-
Vegetative Cover on Critical Areas (SL-11)	Acre Installed	362.0	724.0	-
	Total Cost	$682,635	$682,635	$0
Stream Restoration				
Stream Restoration	Feet	7,098	-	-
	Total Cost	$2,129,400	$0	$0
	Total Cost Per Stage	**$23,012,035**	**$25,075,540**	**$4,009,560**
	Percent Exceedance Geometric Mean (126 cfu/100 mL)	**51.0%**	**17.7%**	**0.0%**
	Percent Exceedance Single Sample Maximum (235 cfu/100mL)	**40.3%**	**28.3%**	**9.7%**
	Bacteria Load Per Stage (cfu/year)	**3.06E+13**	**1.11E+13**	**3.11E+12**

*Numbers represent cumulative total of BMPs implemented
**Not cumulative, represented annually

Table 6-5: Lick Run Implementation Staging				
Best Management Practice	Unit	Stage I (Y1-Y8)*	Stage II (Y9-Y16)*	Stage III (Y17-Y20)*
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	2	-	-
Sewer Connection (RB-2)	System	84	112	-
Repaired Septic System (RB-3)	System	1	-	-
Septic System Installation/Replacement (RB-4)	System	5	-	-
Alternative Waste Treatment System Installation (RB-5)	System	-	-	-
Pet Waste Management Education Program	Program	Program	Program	Program
Pet Waste Station	Unit	14	19	-
	Total Cost	$896,765	$290,855	$5,000
Existing BMPs and Detention Pond Retrofits				
Infiltration Trench	System	8	10	-
Constructed Wetlands	System	25	33	-
Street Sweeping (additional miles to be swept annually)**	Miles Swept	788	788	788
	Total Cost	$4,096,540	$3,549,940	$1,638,320
Stormwater BMPs				
Bioretention	Acre Treated	487.5	1755.0	1950.0
Rain Gardens	Acre Treated	195.0	351.0	390.0
Infiltration Trench	Acre Treated	97.0	349.2	388.0
Manufactured BMPs	Acre Treated	235.5	423.9	471.0
Constructed Wetland	Acre Treated	537.5	1935.0	2150.0
Detention Pond	Acre Treated	49.0	176.4	196.0
Permeable Paver	Acre Treated	1.3	3.8	5.0
Vegetated Swale	Acre Treated	37.5	135.0	150.0
Rain Barrel	System	123	246	-
Riparian Buffer: Forest	Acre Installed	17.3	23.0	-
Riparian Buffer: Grass/Shrub	Acre Installed	17.3	23.0	-
Urban Tree Canopy/Land use Conversion	Acre Converted	7.8	27.9	31.0
	Total Cost	$13,979,735	$25,753,865	$4,600,880
Pasture BMPs				
Reforestation of Erodible Pasture (FR-1)	Acre Installed	6.0	-	-
Pasture Management (EQIP 528, SL-10T, SL-9)	Acre Installed	53.0	-	-
Vegetative Cover on Critical Areas (SL-11)	Acre Installed	11.0	-	-
Wet Detention Pond	Acre Treated	-	-	15.0
	Total Cost	$20,535	$0	$2,250
Stream Restoration				
Stream Restoration	Feet	1,203	-	-
	Total Cost	$360,900	$0	$0
	Total Cost Per Stage	**$19,354,475**	**$29,594,660**	**$6,246,450**
	Percent Exceedance Geometric Mean (126 cfu/100 mL)	**0.0%**	**0.0%**	**0.0%**
	Percent Exceedance Single Sample Maximum (235 cfu/100mL)	**15.8%**	**13.9%**	**10.0%**
	Bacteria Load Per Stage (cfu/year)	**2.77E+13**	**1.24E+13**	**5.76E+12**
*Numbers represent cumulative total of BMPs implemented **Not cumulative, represented annually				

Table 6-6: Mud Lick Creek, Murray Run, and Ore Branch Implementation Staging				
Best Management Practice	Unit	Stage I (Y1-Y8)*	Stage II (Y9-Y16)*	Stage III (Y17-Y20)*
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	23	-	-
Repaired Septic System (RB-3)	System	20	-	-
Septic System Installation/Replacement (RB-4)	System	6	-	-
Alternative Waste Treatment System Installation (RB-5)	System	1	-	-
Pet Waste Management Education Program	Program	Program	Program	Program
Pet Waste Station	Unit	11	14	-
	Total Cost	$179,790	$19,630	$5,000
Existing BMPs and Detention Pond Retrofits				
Infiltration Trench	System	19	25	-
Constructed Wetlands	System	60	80	-
Street Sweeping (additional miles to be swept annually)**	Miles Swept	1,241	1,241	1,241
	Total Cost	$12,821,280	$7,714,980	$2,580,910
Stormwater BMPs				
Bioretention	Acre Treated	375.0	1,350.0	1,500.0
Rain Gardens	Acre Treated	150.0	270.0	300.0
Infiltration Trench	Acre Treated	74.8	269.1	299.0
Manufactured BMPs	Acre Treated	181.0	325.8	362.0
Constructed Wetland	Acre Treated	1,118.0	4,024.8	4,472.0
Detention Pond	Acre Treated	49.0	176.4	196.0
Permeable Paver	Acre Treated	1.3	3.8	5.0
Vegetated Swale	Acre Treated	37.5	135.0	150.0
Rain Barrel	System	173	345	-
Riparian Buffer: Forest	Acre Installed	11.3	15.0	-
Riparian Buffer: Grass/Shrub	Acre Installed	11.3	15.0	-
Urban Tree Canopy/Land use Conversion	Acre Converted	12.0	43.2	48.0
	Total Cost	$13,088,825	$25,845,115	$4,513,810
Cropland BMPs				
Continuous No-Till (SL-15)	Acre Installed	3.0	-	-
	Total Cost	$300	-	-
Livestock Exclusion Systems and Manure Management				
Livestock Exclusion (SL-6T/LE1-T)	System	1	-	-
	Total Cost	$21,000	-	-
Pasture BMPs				
Reforestation of Erodible Pasture (FR-1)	Acre Installed	9.0	-	-
Pasture Management (EQIP 528, SL-10T, SL-9)	Acre Installed	10.0	-	-
Vegetative Cover on Critical Areas (SL-11)	Acre Installed	9.0	-	-
	Total Cost	$16,590	-	-
Stream Restoration				
Stream Restoration	Feet	1,122	-	-
	Total Cost	$336,600	-	-
	Total Cost Per Stage	**$26,464,385**	**$33,579,725**	**$7,099,720**
	Percent Exceedance Geometric Mean (126 cfu/100 mL)	**1.0%**	**1.0%**	**1.0%**
	Percent Exceedance Single Sample Maximum (235 cfu/100mL)	**20.0%**	**19.2%**	**19.0%**
	Bacteria Load Per Stage (cfu/year)	**4.96E+13**	**2.61E+13**	**2.00E+13**

*Numbers represent cumulative total of BMPs implemented
**Not cumulative, represented annually

Table 6-7: Mason Creek Implementation Staging

Best Management Practice	Unit	Stage I (Y1-Y6)*	Stage II (Y7-Y12)*	Stage III (Y13-Y15)*
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	129	-	-
Sewer Connection (RB-2)	System	140.75	422.25	563.00
Repaired Septic System (RB-3)	System	85	-	-
Septic System Installation/Replacement (RB-4)	System	133	-	-
Alternative Waste Treatment System Installation (RB-5)	System	11	-	-
Pet Waste Management Education Program	Program	Program	Program	Program
Pet Waste Station	Unit	5	6	-
	Total Cost	$2,679,635	$2,685,520	$1,342,125
Existing BMPs and Detention Pond Retrofits				
Infiltration Trench	System	13	17	-
Constructed Wetlands	System	8	10	-
Street Sweeping (additional miles to be swept annually)**	Program	668	668	668
	Total Cost	$3,596,375	$2,588,325	$1,042,150
Stormwater BMPs				
Bioretention	Acre Treated	147.5	531.0	590.0
Rain Gardens	Acre Treated	59.0	106.2	118.0
Infiltration Trench	Acre Treated	29.3	105.3	117.0
Manufactured BMPs	Acre Treated	71.0	127.8	142.0
Constructed Wetland	Acre Treated	480.3	1728.9	1921.0
Detention Pond	Acre Treated	49.0	176.4	196.0
Permeable Paver	Acre Treated	1.3	3.8	5.0
Vegetated Swale	Acre Treated	37.5	135.0	150.0
Rain Barrel	System	86	-	-
Riparian Buffer: Forest	Acre Installed	2.0	-	-
Riparian Buffer: Grass/Shrub	Acre Installed	2.0	-	-
Urban Tree Canopy/Land use Conversion	Acre Converted	4	14	16
	Total Cost	$5,959,670	$12,174,530	$2,212,620
Cropland BMPs				
Continuous No-Till (SL-15)	Acre Installed	9.0	-	-
Small Grain Cover Crop (SL-8)	Acre Installed	9.0	-	-
	Total Cost	$1,170		
Livestock Exclusion Systems and Manure Management				
Livestock Exclusion (CRSL-6)	System	1	-	-
Livestock Exclusion (SL-6T/LE1-T)	System	7	-	-
Livestock Exclusion with Reduced Setback (LE-2T)	System	1	-	-
	Total Cost	$191,000		
Pasture BMPs				
Reforestation of Erodible Pasture (FR-1)	Acre Installed	52.0	-	-
Pasture Management (EQIP 528, SL-10T, SL-9)	Acre Installed	470.0	-	-
Vegetative Cover on Critical Areas (SL-11)	Acre Installed	94.0	-	-
	Total Cost	$177,170	$0	$0
Stream Restoration				
Stream Restoration	Feet	5,132	10,264	-
	Total Cost	$1,539,600	$1,539,600	$0
	Total Cost Per Stage	**$14,144,620**	**$18,987,975**	**$4,596,895**
	Percent Exceedance Geometric Mean (126 cfu/100 mL)	**5.2%**	**4.2%**	**1.0%**
	Percent Exceedance Single Sample Maximum (235 cfu/100mL)	**22.7%**	**20.8%**	**10.4%**
	Bacteria Load Per Stage (cfu/year)	**1.19E+13**	**6.31E+12**	**1.93E+12**

*Numbers represent cumulative total of BMPs implemented

**Not cumulative, represented annually

Table 6-8: Peters Creek Implementation Staging				
Best Management Practice	Unit	Stage I (Y1-Y6)*	Stage II (Y7-Y12)*	Stage III (Y13-Y15)*
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	12	-	-
Sewer Connection (RB-2)	System	94	-	-
Repaired Septic System (RB-3)	System	8	-	-
Septic System Installation/Replacement (RB-4)	System	16	-	-
Alternative Waste Treatment System Installation (RB-5)	System	1	-	-
Pet Waste Management Education Program	Program	Program	Program	Program
Pet Waste Station	Unit	1	-	-
	Total Cost	$1,046,580	$5,000	$5,000
Existing BMPs and Detention Pond Retrofits				
Infiltration Trench	System	7	9	-
Constructed Wetlands	System	14	19	-
Street Sweeping (additional miles to be swept annually)**	Miles Swept	442	442	442
	Total Cost	$2,744,305	$1,834,255	$689,620
Stormwater BMPs				
Bioretention	Acre Treated	200.0	720.0	800.0
Rain Gardens	Acre Treated	80.0	144.0	160.0
Infiltration Trench	Acre Treated	39.8	143.1	159.0
Manufactured BMPs	Acre Treated	96.5	173.7	193.0
Constructed Wetland	Acre Treated	408.5	1470.6	1634.0
Detention Pond	Acre Treated	49.0	176.4	196.0
Permeable Paver	Acre Treated	1.3	3.8	5.0
Vegetated Swale	Acre Treated	37.5	135.0	150.0
Rain Barrel	System	135	180	-
Riparian Buffer: Forest	Acre Installed	8.3	11.0	-
Riparian Buffer: Grass/Shrub	Acre Installed	8.3	11.0	-
Urban Tree Canopy/Land use Conversion	Acre Converted	5	18	20
	Total Cost	$6,989,570	$13,680,800	$2,488,990
Livestock Exclusion Systems and Manure Management				
Livestock Exclusion (SL-6T/LE1-T)	System	1	-	-
	Total Cost	$21,000	-	-
Pasture BMPs				
Reforestation of Erodible Pasture (FR-1)	Acre Installed	18.0	-	-
Pasture Management (EQIP 528, SL-10T, SL-9)	Acre Installed	162.0	-	-
Vegetative Cover on Critical Areas (SL-11)	Acre Installed	9.0	-	-
	Total Cost	$33,030	-	-
Stream Restoration				
Stream Restoration	Feet	2,245	-	-
	Total Cost	$673,500	-	-
	Total Cost Per Stage	**$11,507,985**	**$15,520,055**	**$3,183,610**
	Percent Exceedance Geometric Mean (126 cfu/100 mL)	**0.0%**	**0.0%**	**0.0%**
	Percent Exceedance Single Sample Maximum (235 cfu/100mL)	**22.7%**	**20.6%**	**10.3%**
	Bacteria Load Per Stage (cfu/year)	**1.67E+13**	**6.90E+12**	**2.78E+12**

*Numbers represent cumulative total of BMPs implemented
**Not cumulative, represented annually

Table 6-9: Roanoke River 1 Implementation Staging				
Best Management Practice	Unit	Stage I (Y1-Y8)*	Stage II (Y9-Y16)*	Stage III (Y17-Y20)*
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	148	197	-
Sewer Connection (RB-2)	System	209	418	835
Repaired Septic System (RB-3)	System	101	134	-
Septic System Installation/Replacement (RB-4)	System	135	180	-
Alternative Waste Treatment System Installation (RB-5)	System	11	15	-
Pet Waste Management Education Program	Program	Program	Program	Program
Pet Waste Station	Unit	8	11	-
	Total Cost	$3,418,735	$2,464,995	$3,971,250
Existing BMPs and Detention Pond Retrofits				
Infiltration Trench	System	40	53	-
Constructed Wetlands	System	19	25	-
Street Sweeping (additional miles to be swept annually)**	Miles Swept	1,707	1,707	1,707
	Total Cost	$14,236,410	$9,478,210	$3,549,560
Stormwater BMPs				
Bioretention	Acre Treated	343.8	1237.5	1375.0
Rain Gardens	Acre Treated	137.5	247.5	275.0
Infiltration Trench	Acre Treated	68.5	246.6	274.0
Manufactured BMPs	Acre Treated	166.0	298.8	332.0
Constructed Wetland	Acre Treated	1196.8	4308.3	4787.0
Detention Pond	Acre Treated	49.0	176.4	196.0
Permeable Paver	Acre Treated	1.3	3.8	5.0
Vegetated Swale	Acre Treated	37.5	135.0	150.0
Rain Barrel	System	278	370	-
Riparian Buffer: Forest	Acre Installed	15.0	30.0	-
Riparian Buffer: Grass/Shrub	Acre Installed	15.0	30.0	-
Urban Tree Canopy/Land use Conversion	Acre Converted	17.5	63.0	70.0
	Total Cost	$12,654,175	$25,320,365	$4,400,360
Cropland BMPs				
Continuous No-Till (SL-15)	Acre Installed	25.0	-	-
Small Grain Cover Crop (SL-8)	Acre Installed	5.0	-	-
Permanent vegetative cover on cropland (SL-1)	Acre Installed	2.0	-	-
Sod Waterway (WP-3)	Acre Installed	4.0	-	-
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre Installed	2.0	-	-
	Total Cost	$11,400	-	-
Livestock Exclusion Systems and Manure Management				
Livestock Exclusion (CRSL-6)	System	2	-	-
Livestock Exclusion (SL-6T/LE1-T)	System	14	-	-
Livestock Exclusion with Reduced Setback (LE-2T)	System	2	-	-
Small Acreage Grazing System (SL-6AT)	System	1	-	-
	Total Cost	$391,000	-	-
Pasture BMPs				
Reforestation of Erodible Pasture (FR-1)	Acre Installed	79.5	159.0	-
Pasture Management (EQIP 528, SL-10T, SL-9)	Acre Installed	1430.0	-	-
Vegetative Cover on Critical Areas (SL-11)	Acre Installed	143.0	286.0	-
	Total Cost	$323,370	$216,120	-
Stream Restoration				
Stream Restoration	Feet	11,253	22,506	-
	Total Cost	$3,375,900	$3,375,900	-
	Total Cost Per Stage	**$34,410,990**	**$40,855,590**	**$11,921,170**
	Percent Exceedance Geometric Mean (126 cfu/100 mL)	**1.0%**	**1.0%**	**1.0%**
	Percent Exceedance Single Sample Maximum (235 cfu/100mL)	**18.4%**	**17.9%**	**10.5%**
	Bacteria Load Per Stage (cfu/year)	**6.14E+13**	**4.31E+13**	**3.35E+12**
*Numbers represent cumulative total of BMPs implemented				
**Not cumulative, represented annually				

Table 6-10: Roanoke River 2 Implementation Staging				
Best Management Practice	Unit	Stage I (Y1-Y8)*	Stage II (Y9-Y16)*	Stage III (Y17-Y20)*
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	153	-	-
Sewer Connection (RB-2)	System	29	39	-
Repaired Septic System (RB-3)	System	86	-	-
Septic System Installation/Replacement (RB-4)	System	86	-	-
Alternative Waste Treatment System Installation (RB-5)	System	8	-	-
Pet Waste Management Education Program	Program	Program	Program	Program
Pet Waste Station	Unit	17	22	-
	Total Cost	$1,351,345	$120,615	$5,000
Existing BMPs and Detention Pond Retrofits				
Infiltration Trench	System	22	29	-
Constructed Wetlands	System	16	21	-
Street Sweeping (additional miles to be swept annually)**	Miles Swept	1,074	1,074	1,074
	Total Cost	$7,518,930	$5,485,230	$2,234,190
Stormwater BMPs				
Bioretention	Acre Treated	312.5	1125.0	1250.0
Rain Gardens	Acre Treated	125.0	225.0	250.0
Infiltration Trench	Acre Treated	62.3	224.1	249.0
Manufactured BMPs	Acre Treated	151.0	271.8	302.0
Constructed Wetland	Acre Treated	1433.3	5159.7	5733.0
Detention Pond	Acre Treated	49.0	176.4	196.0
Permeable Paver	Acre Treated	1.3	3.8	5.0
Vegetated Swale	Acre Treated	37.5	135.0	150.0
Rain Barrel	System	215	430	-
Riparian Buffer: Forest	Acre Installed	21.0	28.0	-
Riparian Buffer: Grass/Shrub	Acre Installed	21.0	28.0	-
Urban Tree Canopy/Land use Conversion	Acre Converted	12.5	45.0	50.0
	Total Cost	$12,623,810	$25,845,570	$4,455,200
Cropland BMPs				
Continuous No-Till (SL-15)	Acre Installed	1.0	-	-
	Total Cost	$100	-	-
Livestock Exclusion Systems and Manure Management				
Livestock Exclusion (CRSL-6)	System	1	-	-
Livestock Exclusion (SL-6T/LE1-T)	System	8	-	-
Livestock Exclusion with Reduced Setback (LE-2T)	System	1	-	-
Small Acreage Grazing System (SL-6AT)	System	1	-	-
	Total Cost	$221,000	-	-
Pasture BMPs				
Reforestation of Erodible Pasture (FR-1)	Acre Installed	73.0	146.0	-
Pasture Management (EQIP 528, SL-10T, SL-9)	Acre Installed	1316.0	-	-
Vegetative Cover on Critical Areas (SL-11)	Acre Installed	131.5	263.0	-
	Total Cost	$297,380	$198,680	-
Stream Restoration				
Stream Restoration	Feet	1,674	-	-
	Total Cost	$502,200	-	-
	Total Cost Per Stage	**$22,514,765**	**$31,650,095**	**$6,694,390**
	Percent Exceedance Geometric Mean (126 cfu/100 mL)	**0.0%**	**0.0%**	**0.0%**
	Percent Exceedance Single Sample Maximum (235 cfu/100mL)	**14.4%**	**11.4%**	**9.9%**
	Bacteria Load Per Stage (cfu/year)	**5.79E+13**	**2.98E+13**	**1.87E+13**
*Numbers represent cumulative total of BMPs implemented				
**Not cumulative, represented annually				

Table 6-11: Tinker Creek Implementation Staging				
Best Management Practice	Unit	Stage I (Y1-Y8)*	Stage II (Y9-Y16)*	Stage III (Y17-Y20)*
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	516	688	-
Sewer Connection (RB-2)	System	183	244	-
Repaired Septic System (RB-3)	System	344	459	-
Septic System Installation/Replacement (RB-4)	System	419	558	-
Alternative Waste Treatment System Installation (RB-5)	System	37	49	-
Pet Waste Management Education Program	Program	Program	Program	Program
Pet Waste Station	Unit	5	7	-
	Total Cost	$6,258,545	$2,089,515	$5,000
Existing BMPs and Detention Pond Retrofits				
Infiltration Trench	System	24	32	-
Constructed Wetlands	System	20	27	-
Street Sweeping (additional miles to be swept annually)**	Miles Swept	432	432	432
	Total Cost	$4,001,405	$2,532,555	$899,070
Stormwater BMPs				
Bioretention	Acre Treated	310.0	1116.0	1240.0
Rain Gardens	Acre Treated	124.0	223.2	248.0
Infiltration Trench	Acre Treated	61.8	222.3	247.0
Manufactured BMPs	Acre Treated	149.5	269.1	299.0
Constructed Wetland	Acre Treated	1376.0	4953.6	5504.0
Detention Pond	Acre Treated	49.0	176.4	196.0
Permeable Paver	Acre Treated	1.3	3.8	5.0
Vegetated Swale	Acre Treated	37.5	135.0	150.0
Rain Barrel	System	179	358	-
Riparian Buffer: Forest	Acre Installed	19.5	26.0	-
Riparian Buffer: Grass/Shrub	Acre Installed	19.5	26.0	-
Urban Tree Canopy/Land use Conversion	Acre Converted	6.0	21.6	24.0
	Total Cost	$12,360,845	$25,246,625	$4,361,490
Livestock Exclusion Systems and Manure Management				
Livestock Exclusion (CRSL-6)	System	4	-	-
Livestock Exclusion (SL-6T/LE1-T)	System	41	55	-
Livestock Exclusion with Reduced Setback (LE-2T)	System	6	-	-
Small Acreage Grazing System (SL-6AT)	System	3	-	-
Stream Protection/Fencing (WP-2T)	System	2	-	-
Manure Storage (WP-4)	System	2	-	-
	Total Cost	$1,261,250	$288,750	-
Pasture BMPs				
Reforestation of Erodible Pasture (FR-1)	Acre Installed	361.0	722.0	-
Pasture Management (EQIP 528, SL-10T, SL-9)	Acre Installed	3248.5	6497.0	-
Vegetative Cover on Critical Areas (SL-11)	Acre Installed	649.5	1299.0	-
	Total Cost	$1,225,198	$1,225,198	
Stream Restoration				
Stream Restoration	Feet	7,499	14,999	-
	Total Cost	$1,550,100	$1,550,100	-
	Total Cost Per Stage	**$26,657,343**	**$32,932,743**	**$5,265,560**
	Percent Exceedance Geometric Mean (126 cfu/100 mL)	**22.9%**	**16.7%**	**0.0%**
	Percent Exceedance Single Sample Maximum (235 cfu/100mL)	**33.6%**	**25.3%**	**9.7%**
	Bacteria Load Per Stage (cfu/year)	**5.43E+13**	**2.57E+13**	**7.20E+12**
*Numbers represent cumulative total of BMPs implemented				
**Not cumulative, represented annually				

6.2 Targeting

Targeting more specific locations for BMP implementation is part of staged implementation. In order to use sometimes limited resources in the most effective manner, targeting smaller areas for BMP implementation, other than on the subwatershed level, can prove useful. To do this, the model segments used in the original TMDL development (Figure 6-1) (VADEQ, 2006a) were ranked based on different criteria for stakeholders to use as a guide in the implementation process.

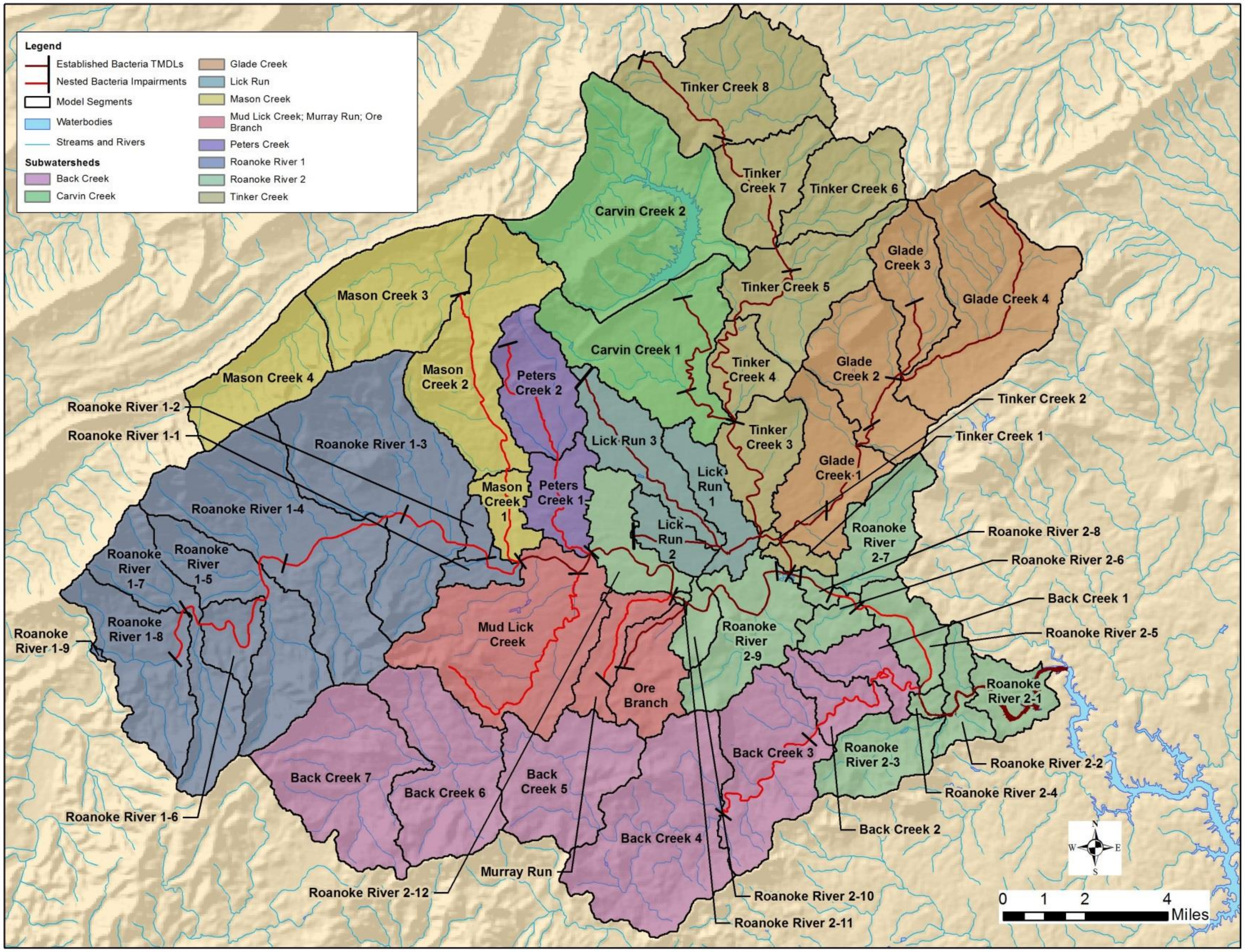


Figure 6-1: HSPF Modeling Segments for the Roanoke River Implementation Plan Part I

The first ranking of the subwatersheds was on residential on-site sewage disposal. The ranks were derived from the number of failing septic systems to be corrected in each model segment and the potential sewer connections from targeted areas (see 5.2.2.1) (Table 6-12).

Table 6-12: Targeting of Priority Subwatersheds for Residential On-Site Sewage Disposal BMPs

Model Segment	Rank	Model Segment	Rank
Glade Creek 1	1	Roanoke River 2-12	28
Roanoke River 1-3	2	Lick Run 3	29
Mason Creek 2	3	Peters Creek 2	30
Glade Creek 2	4	Roanoke River 1-2	31
Tinker Creek 3	5	Roanoke River 2-7	32
Back Creek 5	6	Roanoke River 1-7	33
Tinker Creek 5	7	Lick Run 1	34
Mason Creek 1	8	Back Creek 2	35
Roanoke River 1-4	9	Roanoke River 1-6	36
Glade Creek 4	10	Back Creek 1	37
Carvin Creek 1	11	Lick Run 2	38
Tinker Creek 4	12	Mud Lick Creek	39
Back Creek 4	13	Tinker Creek 2	40
Tinker Creek 8	14	Roanoke River 2-10	41
Glade Creek 3	15	Roanoke River 1-9	42
Mason Creek 3	16	Roanoke River 2-5	43
Tinker Creek 7	17	Murray Run	44
Tinker Creek 6	18	Roanoke River 2-8	45
Back Creek 3	19	Roanoke River 2-1	46
Back Creek 7	20	Roanoke River 2-6	47
Tinker Creek 1	21	Ore Branch	48
Roanoke River 1-1	22	Mason Creek 4	49
Roanoke River 1-5	23	Roanoke River 2-2	50
Roanoke River 1-8	24	Roanoke River 2-3	51
Back Creek 6	25	Roanoke River 2-11	52
Roanoke River 2-9	26	Carvin Creek 2	53
Peters Creek 1	27	Roanoke River 2-4	54

Another targeting analysis was based on the estimated length of riparian buffer creation in urban areas. While there are a total of 54 segments in the first part of the Roanoke River Implementation Plan, not all segments had streams running through urban areas which warranted a riparian buffer creation; hence only 41 segments were ranked. The segments are ranked by the total length of urban riparian zone creation proposed in each segment (Table 6-13). Figure 6-2 illustrates the potential urban riparian zone creation opportunities in all subwatersheds.

Table 6-13: Spatial Targeting of Urban Riparian Buffer Creation

Model Segment	Rank	Model Segment	Rank
Lick Run 3	1	Glade Creek 2	22
Carvin Creek 1	2	Glade Creek 1	23
Roanoke River 1-4	3	Roanoke River 2-10	24
Roanoke River 2-9	4	Mason Creek 1	25
Mud Lick Creek	5	Tinker Creek 7	26
Back Creek 4	6	Roanoke River 1-5	27
Back Creek 6	7	Roanoke River 2-1	28
Tinker Creek 5	8	Tinker Creek 4	29
Glade Creek 4	9	Roanoke River 1-6	30
Peters Creek 2	10	Back Creek 2	31
Tinker Creek 8	11	Roanoke River 2-7	32
Roanoke River 1-3	12	Roanoke River 2-3	33
Roanoke River 2-12	13	Lick Run 1	34
Back Creek 7	14	Roanoke River 1-1	35
Back Creek 5	15	Tinker Creek 3	36
Tinker Creek 6	16	Glade Creek 3	37
Peters Creek 1	17	Murray Run	38
Back Creek 3	18	Roanoke River 2-6	39
Roanoke River 1-7	19	Mason Creek 2	40
Roanoke River 1-8	20	Back Creek 1	41
Ore Branch	21		

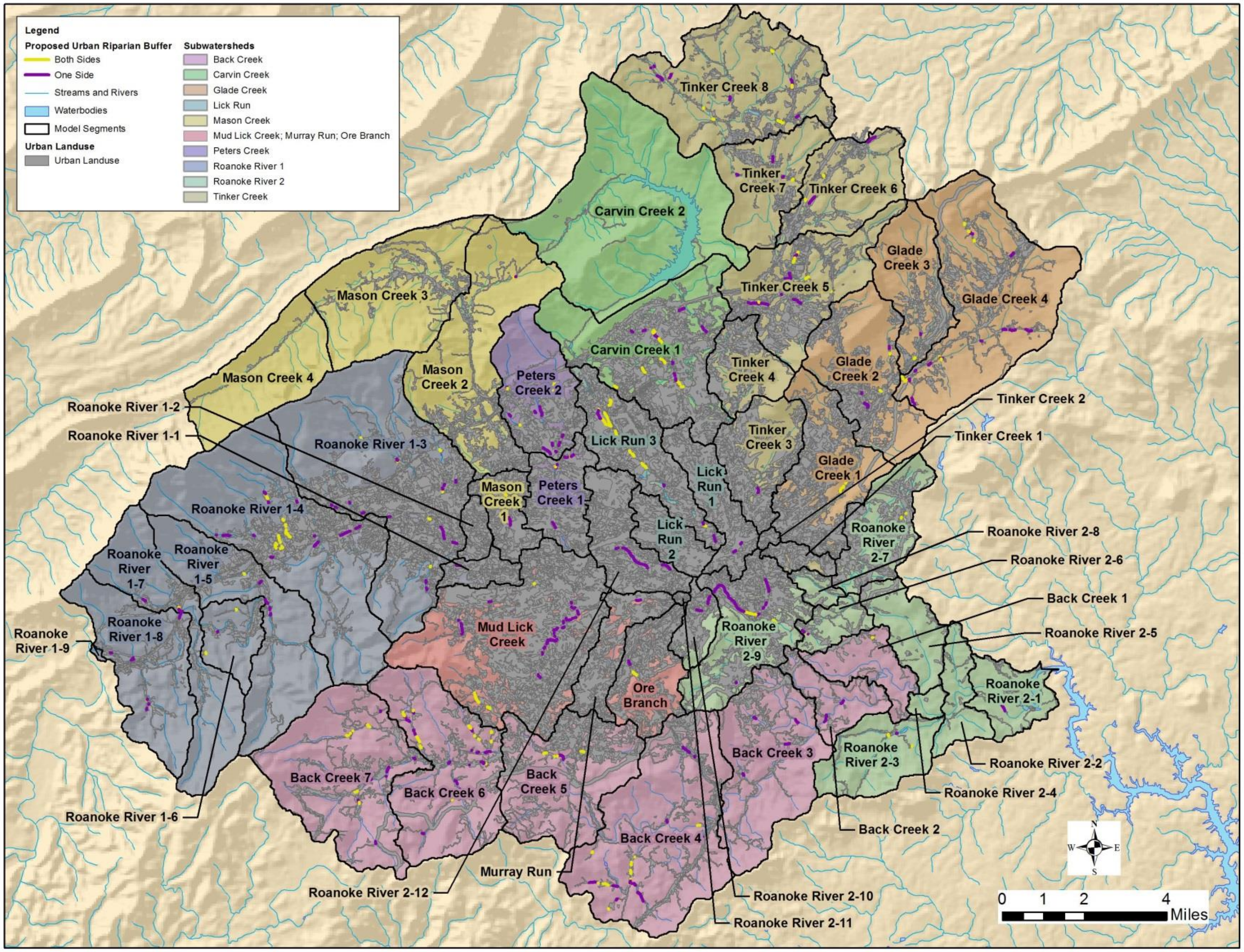


Figure 6-2: Proposed Urban Riparian Zone Creation by Segment for the Roanoke River Implementation Plan Part I

Stakeholders expressed the desire that the IP would help them identify areas which contribute high bacteria and sediment loads so stormwater controls could be implemented to maximize reductions. Table 6-14 ranks the model segments by the density of urban land, or in other words, those model segments which would require the highest coverage of stormwater BMPs. Several segments were 100% urbanized, so in this case, the model segments were ranked based on total urban area. Figure 6-3 presents the spatial distribution of the urban land use in all subwatersheds.

Table 6-14: Spatial Targeting of Urbanized Model Segments for Implementation of Stormwater BMPs

Model Segment	Rank	Model Segment	Rank
Roanoke River 2-12	1	Roanoke River 2-8	28
Lick Run 1	2	Roanoke River 2-6	29
Lick Run 2	3	Glade Creek 3	30
Tinker Creek 2	4	Roanoke River 1-4	31
Roanoke River 2-11	5	Tinker Creek 6	32
Mason Creek 1	6	Tinker Creek 7	33
Roanoke River 1-2	7	Mason Creek 2	34
Lick Run 3	8	Back Creek 2	35
Peters Creek 1	9	Glade Creek 4	36
Tinker Creek 1	10	Back Creek 6	37
Murray Run	11	Tinker Creek 8	38
Roanoke River 1-1	12	Back Creek 3	39
Roanoke River 1-9	13	Back Creek 4	40
Mud Lick Creek	14	Back Creek 7	41
Roanoke River 2-10	15	Roanoke River 1-6	42
Ore Branch	16	Back Creek 1	43
Tinker Creek 3	17	Roanoke River 2-1	44
Glade Creek 1	18	Roanoke River 1-8	45
Carvin Creek 1	19	Roanoke River 2-5	46
Roanoke River 2-9	20	Roanoke River 1-5	47
Roanoke River 2-7	21	Mason Creek 3	48
Tinker Creek 4	22	Roanoke River 1-7	49
Peters Creek 2	23	Roanoke River 2-2	50
Tinker Creek 5	24	Roanoke River 2-4	51
Roanoke River 1-3	25	Roanoke River 2-3	52
Glade Creek 2	26	Mason Creek 4	53
Back Creek 5	27	Carvin Creek 2	54

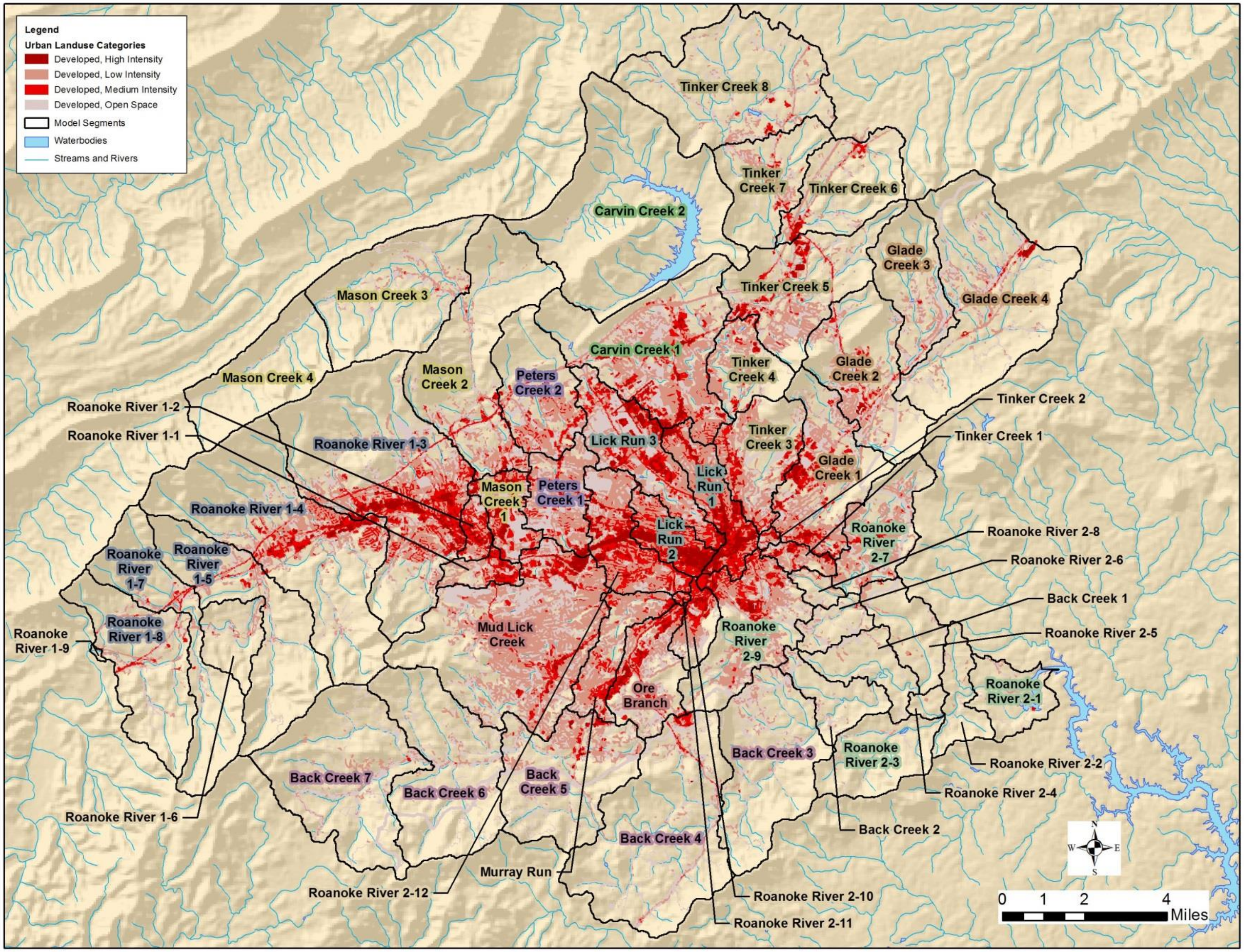


Figure 6-3: Urban Area Density by Segment for the Roanoke River Implementation Plan Part I

Livestock exclusion practices are another spatially calculated BMP which lends itself to targeting, and is highly effective at removing bacteria from streams. As is the case with the urban riparian buffer analysis, not all segments had livestock exclusion practices proposed, thereby only 35 model segments are shown. Table 6-15 ranks each model segment by the total length of livestock stream fencing proposed for these model segments; Figure 6-4 shows the potential stream segments which would need installation of livestock stream fencing.

Table 6-15: Spatial Targeting of Livestock Stream Fencing

Model Segment	Rank	Model Segment	Rank
Glade Creek 4	1	Tinker Creek 4	19
Tinker Creek 8	2	Back Creek 2	20
Glade Creek 2	3	Mason Creek 2	21
Tinker Creek 6	4	Roanoke River 1-3	22
Tinker Creek 7	5	Tinker Creek 3	23
Back Creek 3	6	Roanoke River 2-2	24
Carvin Creek 1	7	Back Creek 5	25
Back Creek 4	8	Roanoke River 1-7	26
Back Creek 6	9	Roanoke River 2-7	27
Back Creek 7	10	Murray Run	28
Glade Creek 1	11	Roanoke River 2-4	29
Mason Creek 3	12	Roanoke River 1-6	30
Tinker Creek 5	13	Roanoke River 2-1	31
Roanoke River 1-4	14	Roanoke River 1-9	32
Roanoke River 2-3	15	Peters Creek 2	33
Glade Creek 3	16	Carvin Creek 2	34
Roanoke River 1-5	17	Back Creek 1	35
Roanoke River 1-8	18		

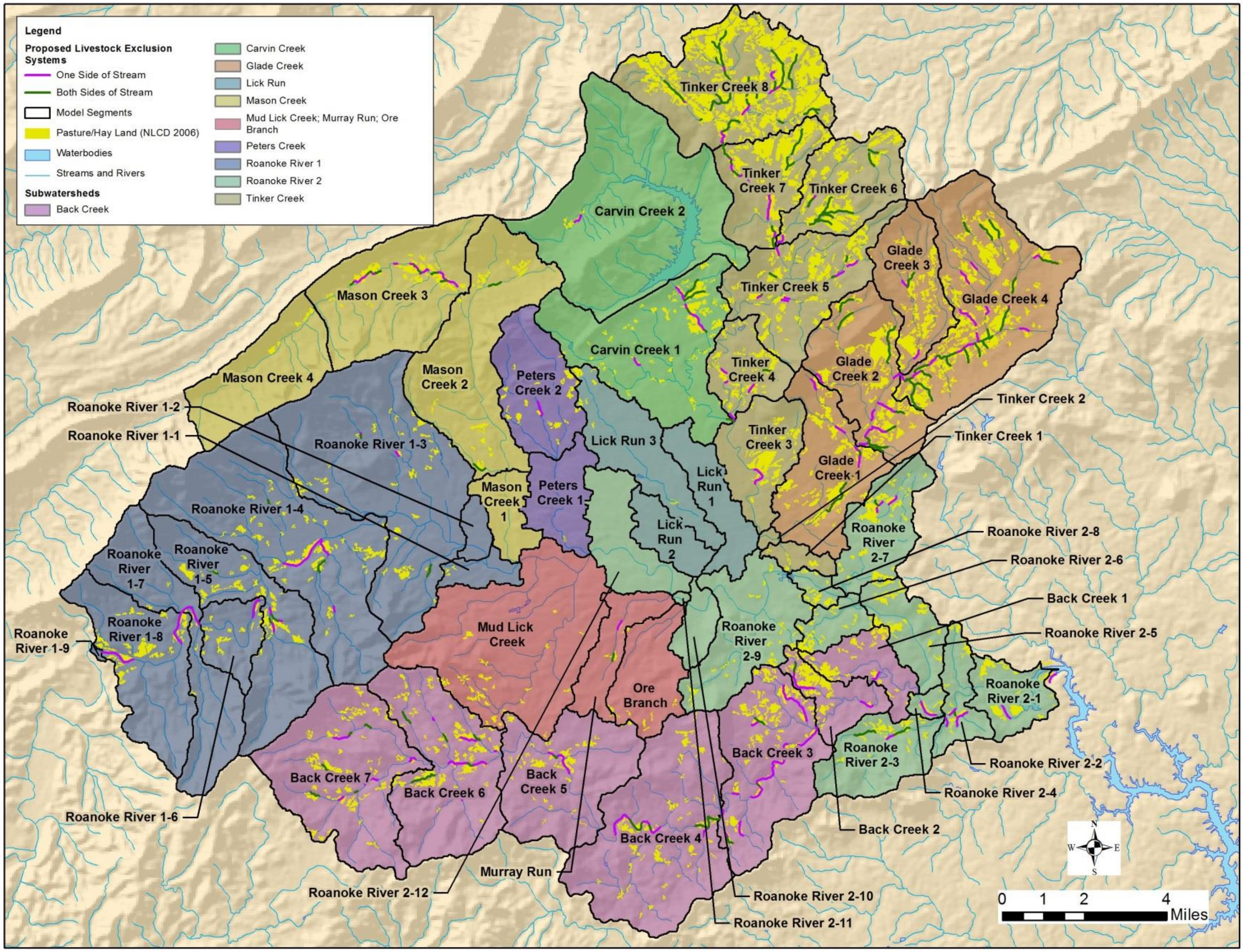


Figure 6-4: Proposed Livestock Exclusion by Segment for the Roanoke River Implementation Plan Part I

6.3 Reasonable Assurance

A big portion of the IP process is to solicit information and vet proposed BMPs, educational programs, and the experiences of the stakeholders. Many of the actions are voluntary, so buy-in from the public is crucial to the success of the watershed IP. During the entire IP process, the major stakeholders and a variety of local conservation agency personnel participated in public meetings, working groups and steering committees. They provided feedback in-person and through emails, and information specific to their fields in regards to BMPs proposed. The high level of participation, diverse group of stakeholders and the presence of many MS4 permit holders provide reasonable assurance that the public contributed to and influenced the selection of implementation practices proposed in this IP.

6.4 Implementation Tracking

Implementation actions should be tracked to ensure that BMPs are adequately installed and maintained. Implementation tracking involves inventorying the locations of and the numbers of BMPs put into place within the watershed and will be used to evaluate changes in the watershed. BMP tracking will include the quantification of the various BMPs identified in the IP and reporting the applicable units that are installed in each subwatershed. Management measures, such as types of outreach education activities (e.g., workshops, mailings, field days) and number of participants, should also be tracked. The agricultural practices that are cost-shared will be tracked through the local Soil and Water Conservation Districts and be part of the Virginia Agricultural Cost-share Database, administered by VADCR. Tracking of stormwater BMPs will occur on a municipality level, as the municipalities in the area must track and report progress towards meeting their wasteload allocations for local watershed TMDLs to VADEQ as required by their MS4 permits. A subset of the IP steering committee may want to reconvene and collaborate on implementation tracking at key points throughout the implementation timeline.

6.5 Monitoring Plan

In order to evaluate progress toward meeting water quality milestones, monitoring the water quality of the impaired watersheds will occur throughout the timeline of the IP. Monitoring will also show the progress made from implementing the BMPs proposed in this plan. Since the primary goal of the IP is to de-list the impaired segments for both bacteria and aquatic life, VADEQ will focus its monitoring efforts on the original listing stations for both the bacteria and benthic impairments (Tables 6-16 and 6-17, Figure 6-5). VADEQ supported monitoring will occur at these and/or additional stations in the IP area after a period of at least 2 years of implementation project installation in a particular subwatershed (to allow for the effectiveness of BMPs to be in place). Key stakeholders may convene with VADEQ to discuss monitoring start times and implementation activities. Monitoring at bacteria and water chemistry stations will occur on a bi-monthly cycle and twice annually for biomonitoring stations, typically in the spring and fall. If VADEQ is unable to de-list the impaired segments in this plan for bacteria and/or sediment using these timeframes, additional monitoring may be scheduled.

Table 6-16: Bacteria Monitoring Stations in the Roanoke River Watershed Part 1

Watershed Code	Station ID	Station Description	Stream Name
VAW-L03R	4AROA212.17	Route 11 Bridge Below Eaton, Inc.	Roanoke River
VAW-L03R	4AROA220.94	Rt. 639 Bridge South of Wabun	Roanoke River
VAW-L03R	4AROA224.54	Route 639 Bridge Near Dixie Caverns – Ro	Roanoke River
VAW-L04R	4AMDL000.34	Downstream of Brambleton Ave. behind She	Mud Lick Creek
VAW-L04R	4AMSN000.67	Roanoke Boulevard Bridge	Mason Creek
VAW-L04R	4AMUR001.63	Fishburn Park off Route 221	Murray Run
VAW-L04R	4AORE000.19	Wiley Drive (Greenway) - City of Roanoke	Ore Branch
VAW-L04R	4APEE001.04	Shenandoah Avenue Bridge	Peters Creek
VAW-L04R	4AROA199.20	Blue Ridge Parkway Bridge below Roanoke	Roanoke River
VAW-L04R	4AROA202.20	13th. St. Bridge above Roanoke STP	Roanoke River
VAW-L04R	4AROA205.73	Franklin Road Bridge, Roanoke	Roanoke River
VAW-L05R	4ACRV000.28	Plantation Rd (Rt. 115)	Carvin Creek
VAW-L05R	4ACRV001.88	Brookside Park Off Rt. 623 Hollins	Carvin Creek
VAW-L05R	4AGLA000.20	Walnut Avenue Bridge	Glade Creek
VAW-L05R	4AGLA004.39	Layman Rd. (Rt. 606)	Glade Creek
VAW-L05R	4AGLA008.10	Rt. 723	Glade Creek
VAW-L05R	4ALCK000.38	N & W Parking Lot Bridge	Lick Run
VAW-L05R	4ALCK002.17	Orange Ave. Bridge	Lick Run
VAW-L05R	4ATKR009.30	Rt. 11 Bridge at Hollins	Tinker Creek
VAW-L05R	4ATKR015.88	Off Rt. 779 Intersect Rt. 675 at Gaging	Tinker Creek
VAW-L06R	4ABAA000.03	End Rt. 618 Confluence with Roanoke River	Back Creek
VAW-L06R	4ABAA002.61	Gage Near Dundee, Rt. 660 Bridge	Back Creek
VAW-L12L	4AROA196.05	Smith Mtn. Lake, Mcveigh Ford	Roanoke River

Table 6-17:Benthic Monitoring Stations in the Roanoke River Watershed Part 1			
Water Shed Code	**Station ID**	**Station Description**	**Stream Name**
VAW-L03R	4AROA215.13	Mill Lane Bridge, Salem	Roanoke River
VAW-L04R	4ABHT001.90	Behind Track At Hidden Valley MS	Barnhardt Creek
VAW-L04R	4AGSH001.28*	Off Rt. 311 Dnstr of I-81	Gish Branch
VAW-L04R	4AMDL002.93	Garst Mill Park Near Picnic Shelter	Mud Lick Creek
VAW-L04R	4AMSN000.53	At Arnold Burton Technical School	Mason Creek
VAW-L04R	4AMSN003.05*	Off Kesler Mill Road	Mason Creek
VAW-L04R	4AMUR001.82	Fishburn Park, Roanoke	Murray Run
VAW-L04R	4AORE000.01	Upstream of Wiley Drive	Ore Branch
VAW-L04R	4AROA202.20	13th. St. Bridge Above Roanoke STP	Roanoke River
VAW-L04R	4AROA206.27	Wasena Park	Roanoke River

*Note that exact sampling location is subject to change based on site accessibility

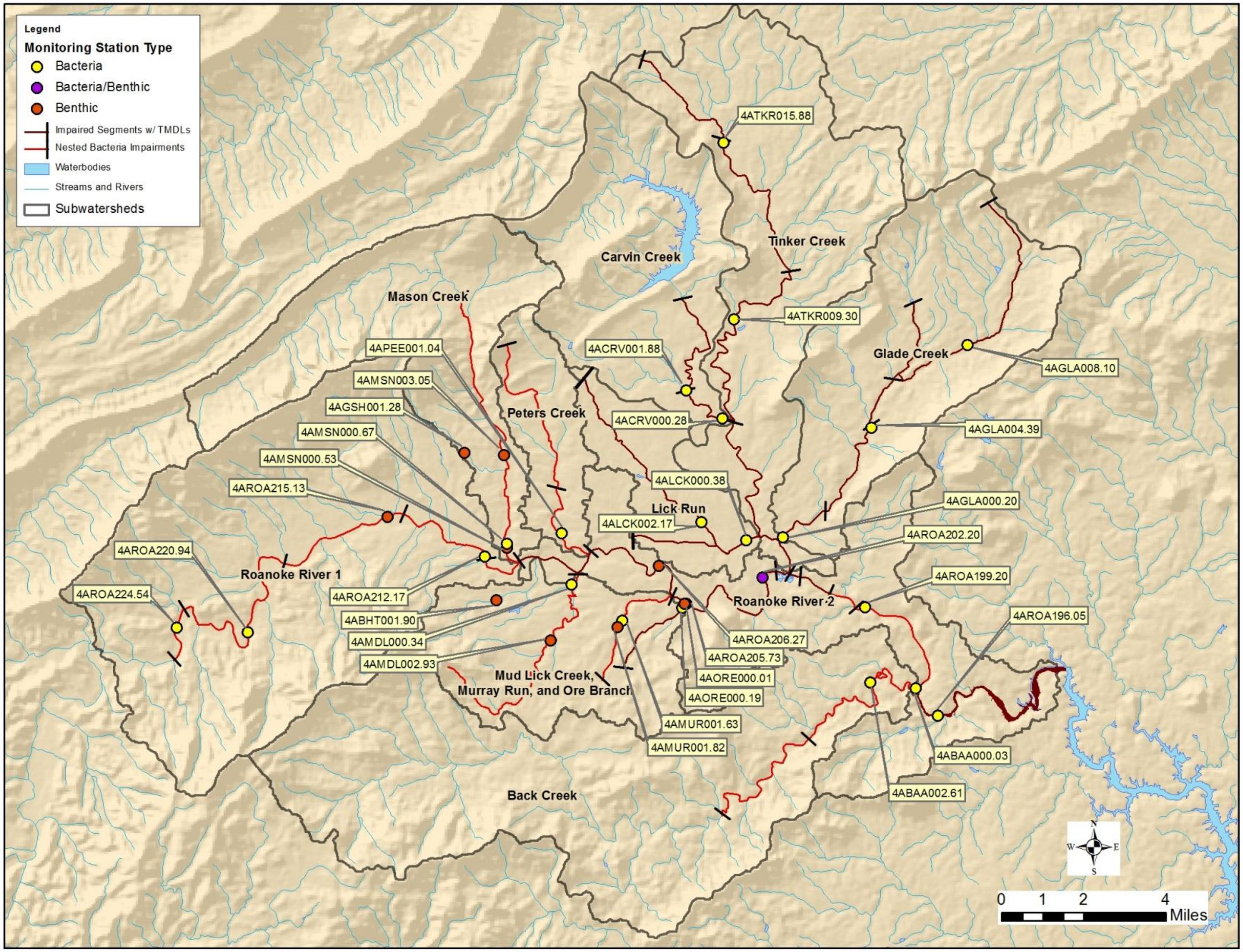


Figure 6-5: Monitoring Station Map for the Roanoke River Implementation Plan Part I

7.0 Stakeholders' Roles and Responsibilities

Stakeholders are individuals or groups who live or have land management responsibilities in the watershed, including federal, state and local government agencies, businesses, special interest groups, and citizens. Stakeholder participation and support is essential for improving water quality and removing streams from the impaired waters list. The purpose of this chapter is to acknowledge the roles of the stakeholders who worked together to develop the Roanoke River IP and to identify and define the roles and responsibilities many of these stakeholders will also play in the implementation of the control measures described in the IP.

7.1 Federal Government

U.S. Environmental Protection Agency (EPA): **EPA** has the responsibility of overseeing the various programs necessary for the success of the CWA. However, administration and enforcement of such programs falls largely to the states. Section 303(d) of the CWA and current EPA regulations do not require the development of TMDL implementation plans. EPA has outlined nine minimum elements of an approvable IP for States to receive Section 319 funding for IP development and implementation.

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

7.2 State Government

In the Commonwealth of Virginia, water quality problems are dealt with through legislation, incentive programs, education, and legal actions. Currently, there are six state agencies that have a major role for regulating and/or overseeing statewide activities that impact water quality in Virginia. These agencies include: Virginia Department of Environmental Quality (VADEQ), Virginia Department of Conservation and Recreation (VADCR), Virginia Department of

Agriculture and Consumer Services (VDACS), Virginia Department of Health (VDH), Virginia Department of Forestry (VDOF), and Virginia Cooperative Extension (VCE). VADEQ, VADCR, and VDH, have participated in the Roanoke River IP development process through meeting attendance, comments and suggestions on various aspects of the plan, and/or through provision of watershed and water quality data.

Virginia Department of Environmental Quality (VADEQ): **VADEQ** is the lead agency in the TMDL process. The Code of Virginia (62.1-44.19:5) directs VADEQ to develop a list of impaired waters, develop TMDLs for these waters, and develop IPs for the TMDLs. VADEQ administers the TMDL process, including the public participation component, and formally submits the TMDLs and IPs to EPA and the State Water Control Board for approval. VADEQ also provides available grant funding and technical support for TMDL implementation. VADEQ has a role in working with local agency partners to track implementation progress for control measures identified in the IP. In addition, DEQ regional staff will work with interested partners on grant proposals to generate funds for implementation. VADEQ is also responsible for assessing water quality to determine compliance with water quality standards. VADEQ will continue monitoring water quality in the Roanoke River and tributaries in order to assess water quality and determine when water quality standards are attained and the streams can be removed from Virginia's impaired water list. More information on VADEQ is available at *http://www.deq.virginia.gov/*.

Virginia Department of Conservation and Recreation (VADCR): **VADCR** administers the Virginia Agricultural Cost Share Program, working closely with Soil and Water Conservation Districts to provide cost share and operating grants needed to deliver this program at the local level and track BMP implementation. In addition, VADCR administers the state's Nutrient Management Program, which provides technical assistance to producers in appropriate manure storage and applications of manure and commercial fertilizer. More information on VADCR water quality programs is available at *http://www.dcr.virginia.gov/soil_and_water/index.shtml*.

Virginia Department of Agriculture and Consumer Services (VDACS): **VDACS** administers the Agricultural Stewardship Act and with the local soil and water district investigates and reviews claims that an agricultural producer is causing a water quality problem. Examples include sediment erosion and runoff containing nutrients and pesticides. If deemed a problem, the Commissioner can order the producer to submit an agricultural stewardship plan to the local soil and water conservation district. If a producer fails to implement the plan, corrective action can be taken, which may include civil penalties. The Commissioner of Agriculture can issue an emergency corrective action if runoff is likely to endanger public health, animals, fish and aquatic life, public water supply, etc. An emergency order can shut down all or part of an agricultural activity and require specific stewardship measures. Although complaint-driven, the Agricultural Stewardship Act is considered a regulatory tool that can support the implementation of conservation practices to address pollutant sources in TMDL impaired watersheds. More information on VDACS is available at *http://www.vdacs.virginia.gov/stewardship/index.shtml*.

Virginia Department of Health (VDH): **VDH** is responsible for adopting and implementing regulations for onsite wastewater treatment and disposal. VDH has the responsibility of enforcing actions to correct failed septic systems and/or eliminate straight pipes (Sewage Handling and Disposal Regulations, 12 VAC 5-610-10 *et seq*.). Homeowners are required to secure permits for handling and disposal of sewage (e.g., repairing a failing septic system or installing a new treatment system). VDH staff provide technical assistance to homeowners with septic system maintenance, design and installation, and respond to complaints regarding failing septic systems and straight pipes. All of the localities included in this IP are served by the Alleghany Health District office located in Fincastle, Virginia. More information on VDH programs is available at *http://www.vdh.state.va.us/EnvironmentalHealth/Onsite/index.htm*.

Virginia Department of Forestry (VDOF): **VDOF** water quality inspectors assist loggers and landowners with timber harvest planning and execution and encourage the use of specific voluntary best management practices to keep streams free of silvicultural sediments. If loggers fail to apply necessary BMPs on harvest sites, sediment deposition may occur, and that can lead to civil penalties under the Virginia Silvicultural Water Quality Law (10.1-1181.2). The VDOF has prepared a manual to inform and educate forest landowners and the professional forest community on proper BMPs and technical specifications for installation of these practices in forested areas *(http://www.dof.virginia.gov/water/index-BMP-Guide.htm)*. VDOF also has a major role in protecting watersheds through riparian forest buffers. Forest buffers provide nutrient uptake and soil stabilization, which can benefit water quality by reducing the amount of nutrients and sediments that enter local streams. VDOF administers several cost-share programs including the Reforestation of Timberlands (RT) Program which provides financial assistance to private landowners and the forest industry for pine reforestation. More information on VDOF programs is available at *http://www.dof.virginia.gov/water/index.htm*.

Virginia Cooperative Extension (VCE): **VCE** is an educational outreach program of Virginia's land grant universities (Virginia Tech and Virginia State University), and a part of the national Cooperative State Research, Education, and Extension Service, an agency of the U.S. Department of Agriculture. VCE is a product of cooperation among local, state, and federal governments in partnership with citizens. VCE offers educational programs and technical resources for topics such as crops, grains, livestock, poultry, dairy, natural resources, and environmental management. VCE has published several publications that deal specifically with TMDLs. More information on these publications and the location of county extension offices is available at *http://www.ext.vt.edu*.

Virginia Department of Transportation (VDOT): **VDOT** has prepared a manual to provide guidance in the design of BMPs for water quality control and stormwater management related to VDOT projects and facilities. In addition, VDOT participates in educating the public on the protection of state waters, stormwater pollution prevention, and their MS4 program. VDOT participated in the Roanoke River IP development process through meeting attendance, comments and suggestions on various aspects of the plan, and/or provision of watershed data. More information and resources on VDOT stormwater programs is available at *http://www.virginiadot.org/programs/stormwater_management.asp*. The VDOT BMP Design Manual is available at *http://www.virginiadot.org/business/resources/LocDes/BMP_Design-Manual/BMP_Design_Manual_Cover.pdf*.

7.3 Local Government

Local government groups work closely with state and federal agencies throughout the TMDL process; these groups possess insights about their community that may help to ensure the success of TMDL implementation. These stakeholders have knowledge about a community's priorities, how decisions are made locally, and how the watershed's residents interact. Some local government groups and their roles in the TMDL process are listed below.

Soil and Water Conservation Districts (SWCDs): SWCDs are local units of government responsible for the soil and water conservation work within their boundaries. The districts' role is to increase voluntary conservation practices among farmers, ranchers and other land users. District staff work closely with watershed residents and have valuable knowledge of local watershed practices. The **Mountain Castles** (covering Botetourt County portion of the IP) and **Blue Ridge** (covering Roanoke County portion of the IP) **SWCDs** participated in the Roanoke River IP development process through meeting attendance, comments and suggestions on agricultural practices included in the plan, and/or provision of watershed data.

Planning District Commissions (PDCs): PDCs were organized to promote the efficient development of the physical, social, and economic resources of the regional district including the environment by assisting and encouraging local governmental agencies to plan for the future. PDCs focus much of their efforts on water quality planning, which is complementary to the TMDL process. TMDL development and implementation projects are often contracted through PDCs. More information on the PDCs located in Virginia is available at *http://www.institute.virginia.edu/vapdc/*. The **Roanoke Valley-Alleghany Regional Commission** (RVARC) contracted the Roanoke River TMDLs IP project and participated in the IP development process through meeting attendance, comments and suggestions on various aspects of the plan, and through the provision of watershed and water quality data.

County/City Government Departments: City and county government staff work closely with PDCs and state agencies to develop and implement TMDLs. They may also help to promote education and outreach to citizens, businesses and developers to introduce the importance of the TMDL process. Local governments have the ability to enact ordinances that aid in the reduction of water pollutants and support BMP implementation such as requirements for pet waste pickup and septic system maintenance and pump out. They operate the locality Virginia Stormwater Management Program in the capacity as a Virginia Stormwater Management Program Authority in accordance to the Stormwater Management Act (62.1-44.15:24). Representatives from **Botetourt and Roanoke Counties, the Cities of Roanoke and Salem, and the Towns of Blacksburg, Christiansburg, and Vinton** participated in the IP development process through meeting attendance, comments and suggestions on various aspects of the plan, and/or provision of watershed, BMP, and water quality data.

7.4 Businesses, Community Groups, and Citizens

While successful implementation depends on stakeholders taking responsibility for their role in the process, the primary role falls on the local groups that are most affected; that is, businesses, community watershed groups, and citizens.

Community Watershed and Conservation Groups: Local watershed and conservation groups offer a meeting place and events for river and land conservation groups to share ideas and coordinate preservation efforts and are also a showcase site for citizen action. These groups also have a valuable knowledge of the local watershed and river habitat that is important to the implementation process. The following organizations have participated in the IP development process through meeting attendance, comments, and suggestions on various aspects of the plan.

Blue Ridge Land Conservancy (BRLC) promotes the conservation of western Virginia's natural resources—farms, forests, waterways and rural landscapes. They educate landowners and professionals about land conservation options, hold and steward conservation easements, encourage land planning and development which minimizes environmental impacts, and promote best management practices for forestry and agriculture. Their priority places include rivers and streams as well as family farms and greenways/trails. They serve the Counties of Bedford, Botetourt, Craig, Floyd, Franklin, Montgomery, and Roanoke and the Cities of Roanoke and Salem. Additional information is available at *http://www.blueridgelandconservancy.org.*

Glade Creek Restoration Committee is a conservation organization with the goals of protecting and restoring Glade Creek and its associated watershed for humans and wildlife. The group provides education to local citizens concerning anthropogenic impacts on the creek, participates in restoration projects, and promotes citizen involvement in restoration of the creek and watershed.

Roanoke Valley Greenways is a program created by citizens within Roanoke County, the City of Roanoke, Salem, and the Town of Vinton in order to enhance recreation, education, health, and transportation in the region. The main focus of the group is to promote and create a network of greenways and trails along local waterways to connect local communities and provide better accessibility to natural resources, green space for recreation, and educational opportunities.

Trout Unlimited (TU) is a national conservation organization devoted to the protection and restoration of coldwater fisheries and associated watersheds on national, state, and local levels. TU uses education, funding, and cooperation with other conservation partners to initiate studies, sampling, restoration projects, and funding of grassroots projects. The local chapter is based in the Roanoke Valley.

Upper Roanoke River Roundtable (URRR) serves as an advisory group in the upper basin, making recommendations about appropriate management solutions to those whose decisions impact the upper basin of the Roanoke River. They also work to identify and address issues of water quality and quantity through initiatives such as the regional watershed conference, purchasing pet waste stations for use in public areas, stream restoration projects, and outreach and education activities. Details are available at *http://www.upperroanokeriver.net/*.

Friends of the Rivers of Virginia (FORVA) provides communication and coordination for conservation groups in Virginia. They are involved with research and development of river-related legislation and regulations. FORVA provides members with information on specific river issues as well as expertise in organizing new river protection groups. More information is available at *http://www.forva.org/index.html.*

Impact+Amplify promotes integrated whole systems thought and proaction at both ecosystemic and cultural scale. In the Roanoke River, New River, and Upper James River Valleys, Impact+Amplify gathers folks to share thoughts and to work proactively for the safety, health and well-being of our communities and bioregion. Their focus is to work as a catalyst with and within existing institutions to encourage integrated, cost-effective low impact development. Additional information may be viewed at *http://www.livingwithinnature.org/*.

<u>Citizens and Businesses</u>: The primary role of citizens and businesses within the TMDL and implementation process is involvement and input. This may include participating in public meetings, assisting with public outreach and education, providing input about the local watershed history, and/or implementing best management practices on their property to help restore water quality. Local residents and farmers as well as the following organizations and businesses have participated in the IP development process through meeting attendance, comments, and suggestions on various aspects of the plan.

Orvis is an international outdoor outfitter and fly-fishing business with a presence in the Roanoke River watershed. In addition to selling outdoor products, Orvis promotes and provides funding for conservation projects to protect and restore natural resources and local communities.

The *Roanoke Region Chamber of Commerce* is a membership-based organization focused on supporting businesses within the greater Roanoke Valley. The goals of the Chamber are to serve businesses through programs and services concentrating on advocacy, networking, information, and business assistance.

Southeast Rural Community Assistance Project, Inc. (SERCAP) is a nonprofit organization founded and based in Roanoke that focuses on improving the quality of life within rural communities. Through training programs, technical assistance, and community action as well as partnerships with federal, state, regional and local agencies and businesses SERCAP primarily addresses water and wastewater needs in rural communities but also assists with community and economic development, housing, and health care.

Williamson Road Area Business Association, Inc. is a nonprofit membership-based organization with goals to represent local businesses, provide a forum for business concerns, promote local businesses to the public, and facilitate new development and investment.

The *Western Virginia Water Authority* is an independent, public authority that provides water and wastewater services to the City of Roanoke and the Counties of Franklin and Roanoke. The Authority also promotes education and outreach on water conservation.

<u>Community Civic Groups</u>: Community civic groups take on a wide range of community service including environmental projects. Such groups include Ruritan, Farm Clubs, Homeowner Associations and youth organizations such as 4-H and Future Farmers of America. These groups offer a resource to assist in the public participation process, educational outreach, and assisting with implementation activities in local watersheds. The following groups have participated in the IP development process through meeting attendance, comments, and suggestions on various aspects of the plan.

Clean Valley Council (CVC) is a non-profit organization that has served the Roanoke Valley for more than 35 years. CVC provides educational programming and citizen participation events to spread the word about litter prevention, recycling, waste stream reduction, stormwater pollution prevention, and protecting our natural resources. CVC provides educational resources and programming for the school systems, the public and the municipalities in the Cities of Roanoke and Salem, the Counties of Botetourt and Roanoke, and the Town of Vinton. CVC hosts and sponsors several valley-wide litter cleanup events and e-waste collections each year.

The Town of Vinton, Roanoke County, and City of Roanoke entered into a contract agreement with CVC in August 2006 to implement a public education program to distribute and make available educational materials to the community and conduct equivalent outreach activities about the impacts of stormwater discharges on water bodies and the steps that the public can take to reduce pollutants in stormwater runoff. The town, county, and CVC have created a stormwater programs database. The database documents educational programs, brochures, pamphlets, videos, maps, and training opportunities related to stormwater quality, stormwater management, and pollution prevention. The database is accessible through the town's website and includes instructions on accessing the variety of educational materials located on the site. Additional information is available at *http://www.cleanvalley.org.*

The *Mill Mountain Garden Club* of Roanoke, Virginia, was organized in 1927 with the vow to "stimulate and encourage the knowledge and love of gardening among amateurs, to aid in the protection of native plants and birds, and to promote civic planting and allied subjects." Today the membership is active in environmental and conservation issues, both locally and nationally, and recently participated in the completion of the Greenways project along the Roanoke River.

Smith Mountain Lake Association (SMLA) is a membership-based organization focusing on the Smith Mountain Lake and its watershed. SMLA educates and informs citizens on actions and issues that could affect the Smith Mountain Lake area and cooperates with local, state, and federal governments on these actions and issues. It also participates in and assists with projects to protect local water quality, and lake and shoreline management.

Animal Clubs/Associations: Clubs and associations for various animal groups (e.g., beef, equine, poultry, swine, and canine) provide a resource to assist and promote conservation practices among farmers and other land owners, not only in rural areas, but in urban areas as well, where pet waste has been identified as a source of bacteria in water bodies.

Virginia's approach to correcting nonpoint source pollution problems continues to be encouragement of participation through education and financial incentives; that is, outside of the regulatory framework. If, however, voluntary approaches prove to be ineffective, it is likely that implementation will become less voluntary and more regulatory.

The benefits of involving the public in the implementation process can be very rewarding, but the process of doing so in an effective manner is often challenging. It is, therefore, the primary responsibility of these stakeholder groups to work with the various state agencies to encourage public participation and assure broad representation and objectivity throughout the IP development process.

8.0 Integration with Other Watershed Plans

Like most watersheds in Virginia, water quality in the Roanoke River watershed is a component of many different organizations, programs and activities. Such efforts include, voluntary and regulatory actions, through watershed implementation plans, TMDLs, Roundtables, Water Quality Management, Erosion and Sediment Control Regulations, Stormwater Management Programs, Source Water Assessment Programs, local comprehensive and strategic plans, and local environmentally-focused organizations. These efforts should be evaluated to determine how they may compliment the implementation goals outlined in this plan and how local efforts can be more effective. Often these efforts are related or collaborative, but this is not always the case. Coordination of local programs can increase participation and prevent redundancy. Initiatives coinciding with the Roanoke River TMDL IP efforts in this watershed include, but are not limited to, those described below.

8.1 Projects and Programs

There are various existing programs, projects, and plans that focus on aspects of the Roanoke River watershed including natural resources, water quality and quantity, stormwater, and public education. Although this is not a comprehensive list, brief descriptions of some of these are provided below.

8.1.1 Watershed-wide Plans

Livable Roanoke Valley: In 2011 the Roanoke Valley Alleghany Regional Council (RVARC) and the Council of Community Services (CCS) created the Partnership for a Livable Roanoke Valley (Livable Roanoke Valley) to address regional challenges such as the economy, employment, population growth, retention of the workforce, health care, and poverty and to plan for a better future. With a goal to promote economic opportunity and a greater quality of life for all residents, they developed the first integrated regional plan for the Roanoke Valley. One of the plan's goals is to work collaboratively to preserve the historic, cultural, and natural assets of the region which includes the strategy of improving air and water quality. In a survey, 85% of respondents indicated clean air and water as a top priority for the valley. Actions to support this strategy include the development of stormwater banking systems and the restoration and maintenance of stream buffers along critical waterways. More information on this plan is available at *http://livableroanoke.org/*.

Upper Roanoke River Roundtable (URRR): As described in Section 7.4, the URRR supports numerous projects including education and outreach activities, riparian plantings, clean-up activities, citizen stream monitoring, and pet waste stations. These efforts intend to identify, prevent, and resolve water resources issues in the watershed. The URRR partners with other stakeholders for restoration projects. Specific projects include stream and riparian area restoration on Murray Run, Roanoke River (Bennington Street), and Carvins Cove. Partnered with localities, the URRR continues to work on pet waste issues including ongoing education, the installation of three new pet waste collection stations on greenways and trails within the Roanoke River watershed, and the provision of supplies for the stations. These programs and activities are intended to reduce nonpoint source pollution and improve the health of streams within the region.

Roanoke Valley Greenways: The Roanoke Valley, Virginia greenway program arose in 1995 as a citizen initiative to improve quality of life in the region. The City of Roanoke, Roanoke County, Salem and the Town of Vinton established the Roanoke Valley Greenway Commission in 1997 with the signing of an Intergovernmental Agreement. At the same time, greenway founders set up Pathfinders for Greenways, Inc. to be a non-profit organization that could involve volunteers in greenway development. To date, 26 miles of greenways with bicycle/pedestrian trails have been built in the Roanoke Valley, with additional hubs of natural surface trails at Mill Mountain, Carvins Cove, and Read Mountain. The update to the Roanoke Valley Greenway Plan in 2007 provides for 35 routes that would provide linkages throughout the Roanoke Valley.

Roanoke River Blueway: The Roanoke River Blueway is a 45-mile water trail running from the South Fork Roanoke River in Montgomery County to Smith Mountain Lake in Bedford County. The Blueway includes portions of the Roanoke River, Tinker Creek, and Back Creek within Bedford, Franklin, Montgomery, and Roanoke Counties; the Cities of Roanoke and Salem; and the Town of Vinton. River access through the Blueway facilitates recreational pursuits such as canoeing, kayaking, fishing, and wildlife viewing. In addition to recreational opportunities, the

Blueway holds a goal of educating the public about the importance of watersheds and water resources.

Western Virginia Water Authority: The Western Virginia Water Authority is committed to helping students learn about protecting and preserving our natural resources. The Authority offers free outreach classroom presentations and tours of our facilities to our customers and school, civic, neighborhood and community groups. Free, Virginia Standards of Learning-correlated classroom presentations on a wide range of topics, including water supply, watersheds, water conservation and properties of water are available for grades Kindergarten through 12 in any school in the City of Roanoke, Roanoke County, and Franklin County. In the past, the Authority has also offered free water conservation kits for its water and sewer customers. The kits help customers save on the water bills, but they also raise the profile of water resource issues in the community.

The Cities of Roanoke and Salem, the Town of Vinton, and Roanoke County all support urban tree canopy projects. Planting of trees in these localities is encouraged. The addition of trees to a landscape benefits both residents and the environment by providing improved water quality; reducing temperatures, air pollution, stormwater runoff, and carbon dioxide; saving energy; and providing habitat for wildlife and educational opportunities.

Trout Unlimited (TU): The Roanoke Valley Chapter of TU focuses on locally implementing projects which support the TU mission to “conserve, protect and restore North America’s trout and salmon fisheries and their watersheds.” Some projects that the Roanoke Valley Chapter has been involved in are Trout in the Classroom, Help Glade Creek, and Project Healing Waters. See *https://sites.google.com/site/roanokevalleytu/home* for more information.

8.1.2 Local Comprehensive Plans

Botetourt County: The Botetourt County Comprehensive Plan includes a section dedicated to Cultural & Environmental Resources, including the objective of enhancing and protecting Botetourt County’s environment from adverse environmental impacts of land development through implementation and enforcement of local, state, and federal environmental regulatory requirements (Botetourt County 2011). Relevant policies include: continue implementation of the County’s floodplain management regulations; encourage new development to be connected to public water and sewer whenever feasible; continue to enforce the county-wide erosion and sedimentation control laws; cooperate with VDOF in the monitoring of timbering operations to ensure compliance with environmental requirements; continue to support VADEQ in its efforts to investigate pollution and maintain and improve water quality standards; discourage land uses which would have a detrimental effect on the environment; enforce standards for site development, and construction and maintenance to minimize adverse impacts to the environment. In addition to these policies, the plan recommends the county explore creative ways to encourage the management of stormwater quality including the development of mandatory and/or voluntary low-impact development design standards.

Roanoke County: The Roanoke County 2005 Community Plan objectives include protecting soils, aquatic life and water quality by reducing runoff and soil erosion and reducing flooding and flood damage by protecting floodplains and wetlands (Roanoke County 2005). The County has adopted the Roanoke River Overlay District as part of the zoning ordinance which provides a moderate level of environmental protection to this significant water resource. Given the large land base of the county and the amount of construction activity occurring, the county requires additional monitoring and enforcement resources directed towards the control and prevention of soil erosion. The county has developed a regional stormwater management plan but this plan does not emphasize the use of open space or greenways as a cost effective, non-engineering tool.

Future strategies listed in the plan that would help meet water quality objectives in the Roanoke River watershed include: adopting a protective tree ordinance; developing a county-wide "conservation and development" resource map including such features as wetlands and floodplains; adopt a Natural Resources Overlay District which encompasses lands that include wetlands and floodplains; incorporate the design and development of the greenway system into the regional stormwater management plan; revise parking lot standards to reduce impervious surfaces; adopt stormwater management techniques, such as grassy swales, that are both effective on-site control measures and aesthetically pleasing; encourage the use of best management practices in the watersheds of Spring Hollow and Carvins Cove Reservoirs; and enhance existing regulations and enforcement procedures to reduce soil runoff and erosion and provide for the protection of soils, aquatic life and water quality.

City of Roanoke: Water quality actions in the City of Roanoke's Comprehensive Plan, *Vision 2001-2020*, include: limiting the amount of impervious surfaces to reduce runoff; planting natural vegetation, preferably indigenous plant species, on land adjacent to the Roanoke River; ensuring integrity of the storm and wastewater systems; protecting and stabilizing creek banks by controlling stormwater flow and preventing discharge through vegetative buffers, bioengineering, and other related methods; protecting shorelines of the Roanoke River to enhance their scenic quality and protect water quality through a river conservation overlay and other appropriate tools (City of Roanoke 2001). According to a 2011 update, the City of Roanoke has made progress on most of these actions (City of Roanoke 2011). A zoning ordinance requires pervious paving systems where maximum parking limit is exceeded (e.g. Wasena Park trailhead) and it established a tree canopy requirement for parking lots. A River and Creek Corridor overlay requires a 50-foot riparian buffer along the Roanoke River and its tributaries, effectively limiting the creation of impervious surfaces along stream banks. A stormwater management ordinance requires runoff reductions for redevelopment projects which decreases impervious surfaces. The Roanoke River Flood Reduction Project used native grasses and other indigenous plants along the streambank. A dry weather survey of Tinker Creek storm drain systems and Peters Creek and Ore Branch was performed to identify illicit discharges and/or connections. A new web-hosted database was implemented for tracking and recording activities under the City's Virginia Pollutant Discharge Elimination System (VPDES) Plan and new Illicit Discharge Detection and Notice of Violation protocols.

City of Salem: The Comprehensive Plan for the City of Salem contains several objectives that relate to water quality with the Roanoke River watershed (City of Salem 2012). One of these objectives is to preserve existing riparian areas along the Roanoke River where appropriate. Strategies to achieve this include installation of native plantings where appropriate and the reconsideration of land management practices such as mowing and other activities. A second related objective is to continue to implement and administer a stormwater management program for the city. This objective includes the strategies of ensuring that all structures and land uses comply with the city's flood plain and stormwater management regulations as part of the development plan review process and working with neighboring jurisdictions on regional stormwater detention and flood reduction facilities and programs. A third objective is to strive for lowering the environmental impact of construction through the exploration of ways to encourage city projects and developers to use environmentally friendly (green) construction techniques.

8.2 MS4 TMDL Action Plans

There are eight MS4 permits within the Roanoke River watershed. These are Botetourt County, Roanoke County, City of Roanoke, Town of Vinton, City of Salem, VDOT Roanoke Urban Area, Virginia Western Community College, and Veterans Administration Medical Center. MS4 permittees are required to limit and prevent, to the extent possible, pollutants from entering the stormwater system in order to protect the water quality of surrounding surface waters. To achieve the required TMDL wasteload allocations, MS4 operators must develop and implement an TMDL action plan that includes the minimum elements of public education and outreach on stormwater impacts, public involvement and participation, illicit discharge detection and elimination, construction site stormwater runoff control, post-construction stormwater management in new development and redevelopment, and pollution prevention/good housekeeping for municipal operations. These include measures such as BMPs, stormwater management strategies, maintenance of stormwater infrastructure and discharge data, public involvement, education, and outreach. Most of the MS4 permittees have an illicit discharge detection and elimination system in place. In preparing local TMDL action plans, MS4 permittees can use the Roanoke River IP as a resource for action plan development. However, the IP does not provide prescriptive actions for the localities to employ in order to meet their MS4 requirements.

The *Town of Vinton* has established a program to meet the requirements of their MS4 permit. Their program is designed to reduce the discharge of pollutants from the MS4 and address impaired waters into which the MS4 discharges. The Town, in conjunction with CVC, coordinates a storm drain stenciling program with local schools, neighborhoods, businesses, and other organizations, to stencil messages on storm drains that educate people about the consequences of dumping waste into the storm drain system. The Town also holds an annual Special Spring Cleanup Week, where citizens are allowed to dispose of bulk items on the curb on their regular refuse collection day at no extra charge.

As a Phase II MS4 permit holder, *Virginia Western Community College* must implement a stormwater management program. Their program includes posting informational pieces on the Virginia Western Television system throughout campus, providing assistance for local household hazardous waste disposal days and stream clean-ups, a quarterly street sweeping program, landscaping to reduce runoff, and more as described in their 2010 annual report. Virginia Western Community College is also committed to operating in a way that responsibly utilizes their natural resources, and they encourage faculty, staff, and students to engage in behaviors that support conservation and sustainability. See *http://www.virginiawestern.edu/fpd/swm/index.php* for additional information.

8.3 Legal Authority

In accordance with the Virginia Stormwater Management Law and Virginia Erosion, Sediment Control Law, and HB1065, ordinances regulating stormwater management and erosion and sediment control are mandatory within the Roanoke River TMDL implementation study area. These regulations address land disturbing activities to prevent an increase in stormwater quality and quantity issues such as erosion, sedimentation, flooding, and polluted stormwater runoff and surface waters. Although every local program varies, each contains a stormwater pollution prevention plan (SWPPP) that must include a stormwater management plan, erosion and sediment control plan, and pollution prevention plan outlining techniques and best management practices to prevent and reduce stormwater related issues. Available BMPs are those described in the Virginia Stormwater BMP Clearinghouse. This clearinghouse is a source of the BMPs included in this IP as well. BMPs and other information concerning the Clearinghouse are available at *http://www.vwrrc.vt.edu/swc/.*

Roanoke City Council adopted a Stormwater Utility Ordinance at their meeting on November 18, 2013. All developed properties, including city-owned properties and properties owned by tax-exempt organizations are subject to the fee (City of Roanoke Stormwater Utility Fee) unless such properties are expressly exempt from the fee under State Code or under the Stormwater Utility Ordinance. The fee went into effect in July 2014 and will be billed using the city's real estate tax billing system. The City Council acknowledged when establishing the Stormwater Utility that certain on-site stormwater management activities can reduce the impact on the public system by treating or reducing the stormwater runoff from a developed property. In order to recognize the positive impact these on-site activities can have, properties that install and maintain stormwater BMPs that reduce the stormwater flow rate, flow volume, or pollutant load of runoff from their property can qualify to receive a reduction in their stormwater fee. A BMP is an activity, measure or facility that prevents or reduces the transport of pollutants, controls stormwater volume or rate or otherwise limits the impacts to the storm drainage system. These measures can include on-site practices such as bioretention, vegetated swales, constructed wetlands, rain gardens and detention ponds that manage stormwater at its source. Additional information is available at *http://www.roanokeva.gov/*.

Ordinance creation is an avenue for compliance with proposed IP actions; however, the IP is not prescribing any ordinance creation. Currently, no localities have mentioned pursuing a septic ordinance as an option. No localities within the Roanoke River watershed that this IP addresses currently have comprehensive pet waste removal or septic system maintenance regulations; any actions related to these measures are voluntary. Some localities have provided education and outreach focused on pet waste issues and the importance of picking up waste but no enforceable rules are in place. Stakeholders within the watershed suggested during the IP development process localities should pass ordinances to require owners to pick up pet waste and to periodically pump out septic systems. Maintenance of septic systems could prevent septic system failure and the removal of pet waste on public and/or private property would reduce the amount of bacteria from this source entering local waters.

8.4 Citizen Monitoring

VADEQ supports a program for the voluntary monitoring of state waters by citizen groups. This monitoring can assist in the listing or delisting of impaired waters, TMDL development through source identification, tracking progress of waters with approved TMDLs or TMDL implementation plans, and identifying waters for potential future VADEQ monitoring. Citizen monitoring also helps to educate the public about water quality in the region and the effect of anthropogenic land uses and activities on water quality. A quality assurance project plan is required before citizens can receive funding for water quality monitoring. State funding allows for development and support of monitoring programs, purchase of equipment, and educational materials.

9.0 Potential Funding Sources

Potential funding sources available for the implementation of the proposed control measures and practices (Chapter 5.0) were identified during development of this implementation plan. Funding options vary in applicability to specific watershed conditions, including pollutant sources and land uses, as well as the potential project sponsor(s). A brief description of the programs and their requirements include, but are not limited to, those described below.

9.1 Federal

Federal Clean Water Act Section 319 Incremental Funds – Through Section 319 of the Federal Clean Water Act, Virginia is awarded grant funds to implement TMDLs. Stakeholder organizations can apply, on a competitive basis through a Request for Proposals process administered by VADEQ, for 319 grants to implement BMPs and educational components included in a TMDL IP.

United States Department of Agriculture (USDA) – Farm Service Agency (FSA)

Conservation Reserve Program (CRP) – Through this program, cost-share assistance is available to establish cover of trees or herbaceous vegetation on cropland. Offers for the program are ranked, accepted and processed during fixed signup periods that are announced by FSA. If accepted, contracts are developed for a minimum of 10 years and not more than 15 years. Land must have been owned or operated by the applicant for at least 12 months prior to the close of the signup period. The payment to the participant is up to 50% of the cost for establishing ground cover. Incentive payments for wetlands hydrology restoration equal 25% of the cost of restoration. Information is available at:
http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp.

Conservation Reserve Enhancement Program (CREP) – This program is an "enhancement" of the existing USDA CRP Continuous Sign-up. It has been "enhanced" by increasing the cost-share rates from 50% to 75% and 100%, increasing the rental rates, and offering a flat rate incentive payment to place a permanent "riparian easement" on the enrolled area. Pasture and cropland (as defined by USDA) adjacent to streams, intermittent streams, seeps, springs, ponds

and sinkholes are eligible to be enrolled. Buffers consisting of native, warm-season grasses on cropland, to mixed hardwood trees on pasture, must be established in widths ranging from the minimum of 30% of the floodplain or 35 feet, whichever is greater, to a maximum average of 300 feet. Cost-sharing (75% to 100%) is available to help pay for fencing to exclude livestock from the riparian buffer, watering facilities, hardwood tree planting, filter strip establishment, and wetland restoration. In addition, a 40% incentive payment upon completion is offered and an average rental rate of $70/acre on stream buffer area for 10 to 15 years. The Commonwealth of Virginia will make an additional incentive payment to place a perpetual conservation easement on the enrolled area. Program details are available at:
http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=cep and
http://www.dcr.virginia.gov/soil_and_water/crep.shtml.

USDA – Natural Resources Conservation Service (NRCS)

Conservation Stewardship Program (CSP) – The CSP is a voluntary program that encourages agricultural and forestry producers to address resource concerns by (1) undertaking additional conservation activities, and (2) improving and maintaining existing conservation systems. CSP provides financial and technical assistance to help land stewards conserve and enhance soil, water, air, and related natural resources on their land. CSP is available to all producers, regardless of operation size or crops produced. Eligible lands include cropland, grassland, prairie land, improved pastureland, rangeland, nonindustrial private forest land, and agricultural land under the jurisdiction of an Indian tribe.

Environmental Quality Incentives Program (EQIP) – This program was established in the 1996 Farm Bill to provide a single voluntary conservation program for farmers and landowners to address significant natural resource needs and objectives. Approximately 65% of the EQIP funding for the state of Virginia is directed toward "Priority Areas." These areas are selected from proposals submitted by a locally led conservation work group. Proposals describe serious and critical environmental needs and concerns of an area or watershed, and the corrective actions they desire to take to address these needs and concerns. The remaining 35% of the funds are directed toward statewide priority concerns of environmental needs. EQIP offers 5-year 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. Additional information is available at: *http://www.nrcs.usda.gov/wps/portal/nrcs/detail/va/programs/financial/eqip/?cid=nrcs142p2_018820.*

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

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

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9.2 State

Virginia Agricultural Best Management Practices (BMPs) Cost-Share Program – The cost-share program is funded with state and federal monies through local Soil and Water Conservation Districts (SWCDs). SWCDs administer the local programs with state oversight through VADCR to encourage farmers and landowners to use BMPs on their land to better control transport of pollutants into 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. Details concerning this program are available at: *http://www.dcr.virginia.gov/soil_and_water/costshar.shtml#tools*, and *http://dswcapps.dcr.virginia.gov/htdocs/agbmpman/csmanual.pdf.*

Virginia Agricultural Best Management Practices Loan Program – The purpose of this program is to provide a long term source of low interest financing which will encourage the use of specific BMPs which reduce or eliminate the impact of Agricultural Non-Point Source (NPS) pollution to Virginia waters. This "Low-Interest Loan Program", as it is sometimes referred, is administered by VADEQ. Additional benefits of the program include the protection of open space or natural values of the properties and/or the assurance of the availability of the land for agricultural, forest, recreation, or open space use. Although these other benefits are of value, the principal focus and utilization of the Fund is to improve water quality in the Commonwealth. Details concerning this program and eligible BMPs are available at:
http://dswcapps.dcr.virginia.gov/htdocs/agbmpman/csmanual.pdf.

Virginia Agricultural Best Management Practices Tax Credit Program – For all taxable years, any individual or corporation engaged in agricultural production for market, who has in place a soil conservation plan approved by the local SWCD, is allowed a credit against the tax imposed by Section 58.1-320 of an amount equaling 25%. of the first $70,000 expended for agricultural best management practices by the individual. Any practice approved by the local SWCD Board must be completed within the taxable year in which the credit is claimed. The credit is only allowed for expenditures made by the taxpayer from funds of his/her own sources. The amount of the credit cannot exceed $17,500 or the total amount of the tax imposed by this program (whichever is less) in the year the project was completed. If the amount of the credit exceeds the taxpayer's liability for such taxable year, the excess may be carried over for credit against income taxes in the next five taxable years until the total amount of the tax credit has been taken. It is also approved for use in supplementing the cost of repairs to streamside fencing. Details concerning eligible BMPs and other program details are available at:
http://www.dcr.virginia.gov/soil_and_water/costshar.shtml#tools and
http://dswcapps.dcr.virginia.gov/htdocs/agbmpman/csmanual.pdf.

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

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

Virginia Department of Forestry

Urban and Community Forestry Assistance Program (U&CF) – Funds for U&CF Program are provided by the USDA Forest Service and are administered by the Virginia Department of Forestry. The U&CF Program is designed to encourage projects that promote tree planting, the care of trees, the protection and enhancement of urban and community forest ecosystems, and education on tree issues in cities, towns and communities across the nation. Grants may be awarded to state agencies, local and regional units of government, approved non-profit organizations, neighborhood associations, civic groups, public educational institutions (college level) or community tree volunteer groups for proposals which meet some, or all, of the specific program objectives. Non-governmental organizations must be designated a 501-c-3 non-profit organization or submit their application through such an organization or a government entity. The typical proposal is in the $5,000 to $10,000 range.

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

Private nonindustrial forest lands that are managed under existing Federal, State, or private sector financial and technical assistance programs are eligible for assistance under the Forest Stewardship Program. Forest resource management activities on such forest lands must meet, or be expanded or enhanced to meet the requirements of the Forest Stewardship Program. Participation in the Forest Stewardship Program is voluntary. To enter the program, landowners agree to manage their property according to an approved Forest Stewardship Management Plan. Landowners also understand that they may be asked to participate in future management outcome monitoring activities. Additional information is available at:
http://www.dof.virginia.gov/manage/stewardship/index.htm, and
http://www.fs.fed.us/cooperativeforestry/programs/loa/fsp.shtml.

Virginia Outdoors Foundation (VOF) – VOF was created by the General Assembly in 1966 to promote the preservation of open-space lands and to encourage private gifts of money, securities, land or other property to preserve the natural, scenic, historic, scientific, open-space and recreational areas of the Commonwealth. The primary way VOF protects land is by holding conservation easements, which are voluntary agreements with landowners that restrict certain types of development on land in perpetuity. VOF also accepts donations of land, which it either protects with an easement and transfers to another landowner, or owns and manages for public benefit.

VOF also administers the Open Space Lands Preservation Trust Fund, which assists landowners with the costs of conveying open-space easements and purchases all or part of the value of easements. Priority for funding is given to applications on family farms and for those with demonstrated financial need. For more information, visit the Preservation Trust Fund page. A gift of a permanent open-space easement may qualify as a charitable gift and be eligible for certain state and federal tax benefits. In addition, there may be local property tax reductions and federal estate tax exemptions. An independent certified appraiser must establish the value of the easement that is primarily based on the value of the development rights forgone. Once that value is established, it becomes the basis for calculating tax benefits. Visit the Tax Benefits section for more information. (Note: VOF does not give tax advice.) Additional information is available at: *http://www.virginiaoutdoorsfoundation.org/.*

Virginia Small Business Environmental Compliance Assistance Loan Fund – The Fund, administered through VADEQ, is used to make loans or to guarantee loans to small businesses for the purchase and installation of environmental pollution control equipment, equipment to implement voluntary pollution prevention measures, or equipment and structures to implement agricultural BMPs. The equipment must be needed by the small business to comply with the federal Clean Air Act, or it will allow the small business to implement voluntary pollution prevention measures. The loans are available in amounts up to $100,000 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. Information is available at:
http://www.deq.virginia.gov/portals/0/deq/air/smallbusinessassistance/autobody/appendix13.pdf.

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

Virginia Water Quality Improvement Fund – This is a permanent, non-reverting fund established by the Commonwealth of Virginia in order to assist local stakeholders in reducing point and nonpoint nutrient loads to surface waters. Eligible recipients include local governments, SWCDs, and individuals. Grants for point sources and nonpoint sources are administered through VADEQ. Most WQIF grants provide matching funds on a 50/50 cost-share basis. Additional information is available at: *http://www.deq.virginia.gov/Programs/Water/CleanWaterFinancingAssistance/WaterQualityImprovementFund.aspx.*

9.3 Regional and Private

Community Development Block Grant (CDBG) – The CDBG program is a flexible program that provides communities with resources to address a wide range of unique community development needs. Beginning in 1974, the CDBG program is one of the longest continuously run programs at the United States Department of Housing and Urban Development. The CDBG program provides annual grants on a formula basis to 1209 general units of local government and States.

Over a 1, 2, or 3-year period, as selected by the grantee, not less than 70% of CDBG funds must be used for activities that benefit low- and moderate-income persons. In addition, each activity must meet one of the following national objectives for the program: benefit low- and moderate-income persons, prevention or elimination of slums or blight, or address community development needs having a particular urgency because existing conditions pose a serious and immediate threat to the health or welfare of the community for which other funding is not available. Information on the program, participation, and eligible activities is available at: *http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs.*

Foundation for Roanoke Valley – The Foundation for Roanoke Valley supports qualified nonprofit organizations primarily in the Cities of Roanoke and Salem and the Counties of Roanoke, Alleghany, Botetourt, Craig and Franklin. Consideration may be given to organizations through our geographic affiliates in other areas or when specified by the donor. The Foundation looks for projects and programs where a moderate amount of grant money can produce a significant result. They look for innovative but practical approaches to solving community problems. Grantees should show a well-planned approach to important public issues; a base of other support (financial, participatory and voluntary); efficient use of community resources;

involvement of underserved constituencies; and coordination, cooperation and sharing among nonprofit organizations and elimination of project duplication.

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

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

Funding priorities for this program include:

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

Southeast Rural Community Assistance Project (SERCAP) – The mission of this project is to promote, cultivate, and encourage the development of water and wastewater facilities to serve low-income residents at affordable costs and to support other development activities that will improve the quality of life in rural areas. Staff members of other community organizations complement the SERCAP 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, or installation of a septic system, and $2,000 toward repair, replacement, or installation of an alternative waste treatment system. Funding is only available for families making less than 125% of the federal poverty level. Details about specific loans and funding opportunities are available at: *http://www.sercap.org/*.

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

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

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Wise 2007

Appendix A – Impaired Waters Tables

Table A-1: Bacteria Impairment Summary*							
Cause Group ID	**Assessment Unit**	**Stream Name**	**Length (mi)**	**Boundaries**	**Listing Station ID**	**Impair-ment**	**Established or Nested?**
L05R-02-BAC	VAW-L05R_CRV01A00	Carvin Creek	1.79	Carvin Creek mainstem from its confluence with Tinker Creek upstream to the mouth of Deer Branch.	4ACRV000.28	*Escherichia coli*	Established
L05R-02-BAC	VAW-L05R_CRV02A00	Carvin Creek	3.59	Carvin Creek mainstem from the mouth of Deer Branch upstream to an unnamed tributary upstream of I-81.	4ACRV000.28	*Escherichia coli*	Established
L05R-03-BAC	VAW-L05R_GLA01A00	Glade Creek	1.55	Glade Creek mainstem from the Glade Creek mouth on Tinker Creek upstream to the Berkley Rd. crossing.	4AGLA000.20	*Escherichia coli*	Established
L05R-03-BAC	VAW-L05R_GLA02A00	Glade Creek	2.84	Glade Creek mainstem from the Berkley Rd. crossing on upstream to the confluence of Cook Creek.	4AGLA000.20	*Escherichia coli*	Established
L05R-03-BAC	VAW-L05R_GLA03A00	Glade Creek	1.33	Glade Creek mainstem from the Cook Creek mouth upstream to the confluence of Coyner Spring Branch.	4AGLA004.39	*Escherichia coli*	Established
L05R-03-BAC	VAW-L05R_GLA04A00	Glade Creek	6.85	Glade Creek mainstem from the mouth of Coyner Spring Branch upstream to its headwaters.	4AGLA008.10	*Escherichia coli*	Established
L05R-05-BAC	VAW-L05R_LAY01A00	Layman-town Creek	2.07	Laymantown Creek mainstem from an outlet of a small pond downstream to the Laymantown Creek mouth on Glade Creek.	4ALAY000.37	*Escherichia coli*	Established
L05R-04-BAC	VAW-L05R_LCK01A00	Lick Run	9.37	Lick Run mainstem from near Shaffer's Crossing downstream to the mouth of Lick Run on Tinker Creek.	4ALCK000.38	*Escherichia coli*	Established
L05R-01-BAC	VAW-L05R_TKR01A00	Tinker Creek	5.33	Tinker Creek mainstem from its confluence with the Roanoke River upstream to the mouth of Carvin Creek.	4ATKR000.69	*Escherichia coli*	Established
L05R-01-BAC	VAW-L05R_TKR01B06	Tinker Creek	6.54	Tinker Creek mainstem from the Carvin Creek mouth upstream to the confluence of Buffalo Creek.	4ATKR009.30	*Escherichia coli*	Established
L05R-01-BAC	VAW-L05R_TKR02A00	Tinker Creek	4.34	Tinker Creek mainstem from the mouth of Buffalo Creek upstream to the Roanoke City diversion tunnel located just upstream of the USGS stream gaging station.	4ATKR015.88	*Escherichia coli*	Established
L05R-01-BAC	VAW-L05R_TKR03A00	Tinker Creek	3.12	Tinker Creek mainstem from the Roanoke City diversion tunnel to Carvin Cove on upstream to its headwaters.	4ATKR015.88	*Escherichia coli*	Established
L06R-01-BAC	VAW-L06R_BAA01A00	Back Creek	5.65	Back Creek mainstem from the WQS designated end of the public water supply (PWS) section, about 0.83 miles upstream of the Rt. 116 crossing downstream to the Back Creek mouth; as determined from the 795 ft. Smith Mountain Lake pool elevation.	4ABAA000.03	*Escherichia coli*	Nested

Table A-1: Bacteria Impairment Summary*							
Cause Group ID	**Assessment Unit**	**Stream Name**	**Length (mi)**	**Boundaries**	**Listing Station ID**	**Impair-ment**	**Established or Nested?**
L06R-01-BAC	VAW-L06R_BAA02A00	Back Creek	4.22	Back Creek mainstem waters from just below the Rt. 220 crossing (about 0.5 miles), Red Hill at the mouth of an unnamed tributary to Back Creek on downstream to the WQS designated end of the PWS section, about 0.83 miles upstream of the Rt. 116 crossing.	4ABAA000.03	*Escherichia coli*	Nested
L04R-05-BAC	VAW-L04R_MSN01A00	Mason Creek	7.56	Mason Creek mainstem from its confluence with the Roanoke River upstream to near the Mason Cove Community.	4AMSN000.67	*Escherichia coli*	Nested
L04R-02-BAC	VAW-L04R_MDL01A06	Mud Lick Creek	7.27	Mud Lick Creek from its confluence on the Roanoke River upstream to its headwaters.	4AMDL000.34	*Escherichia coli*	Nested
L04R-07-BAC	VAW-L04R_MUR01A00	Murray Run	3.22	Murray Run mainstem from its headwaters to its mouth on the Roanoke River.	4AMUR001.63	*Fecal coliform*	Nested
L04R-04-BAC	VAW-L04R_ORE01A00	Ore Branch	2.42	Ore Branch mainstem headwaters near Hunting Hills downstream to its confluence with the Roanoke River.	4AORE000.19	*Escherichia coli*	Established
L04R-06-BAC	VAW-L04R_PEE01A02	Peters Creek	2.52	Peters Creek mainstem from its confluence with the Roanoke River upstream to the Melrose Avenue bridge (Rt. 11/460).	4APEE001.04	*Escherichia coli*	Nested
L04R-06-BAC	VAW-L04R_PEE02A02	Peters Creek	4.62	Peters Creek mainstem from the Melrose Avenue bridge (Rt. 11/460) upstream to its headwaters.	4APEE001.04	*Escherichia coli*	Nested
L04-01-BAC	VAW-L03R_ROA01A00	Roanoke River	1.20	Roanoke River mainstem from the Mason Creek mouth upstream to the Rt. 419 bridge.	4AROA212.17	*Escherichia coli*	Nested
L04-01-BAC	VAW-L03R_ROA02A00	Roanoke River	2.67	Roanoke River mainstem from the Rt. 419 bridge upstream to the City of Salem downtown intake on the Roanoke River.	4AROA212.17	*Escherichia coli*	Nested
L04-01-BAC	VAW-L03R_ROA03A00	Roanoke River	3.41	Roanoke River mainstem from the Salem City wastewater treatment plant (WTP) downtown intake upstream to the Big Bear Branch mouth on the Roanoke River.	4AROA212.17	*Escherichia coli*	Nested
L04-01-BAC	VAW-L03R_ROA04A00	Roanoke River	5.60	Roanoke River mainstem from the Big Bear Rock Branch mouth upstream to end of the Water Quality Standard designated public water supply (PWS) section just downstream of an unnamed tributary at Dixie Caverns.	4AROA220.94	*Escherichia coli*	Nested
L04-01-BAC	VAW-L03R_ROA05A00	Roanoke River	1.40	Roanoke River mainstem from the end of the WQS designated public water supply (PWS) section just downstream of an unnamed tributary at Dixie Caverns upstream to the Roanoke County Spring Hollow Reservoir intake.	4AROA224.54	*Escherichia coli*	Nested

Table A-1: Bacteria Impairment Summary*							
Cause Group ID	**Assessment Unit**	**Stream Name**	**Length (mi)**	**Boundaries**	**Listing Station ID**	**Impair-ment**	**Established or Nested?**
L04-01-BAC	VAW-L07L_ROA04A10	Smith Mtn. Lake (Roanoke River)	350 (acres)	Roanoke River from the Back Creek confluence downstream to the mouth of Falling Creek.	4AROA192.94	*Escherichia coli*	Established
L04-01-BAC	VAW-L04R_ROA01A00	Roanoke River	3.14	Roanoke River mainstem waters from Niagara Dam downstream to the mouth of Back Creek (PWS section 6i).	4AROA199.20	*Escherichia coli*	Nested
L04-01-BAC	VAW-L04R_ROA02A00	Roanoke River Niagara	0.78	These are the Roanoke River mainstem impounded waters of the Niagara Dam (PWS section 6i).	4AROA199.20	*Escherichia coli*	Nested
L04-01-BAC	VAW-L04R_ROA03A00	Roanoke River Niagara	0.86	Roanoke River mainstem from near the backwaters of the Niagara Impoundment upstream to the end of the WQS designated public water supply (PWS section 6i) segment. The upstream ending of the PWS segment from SML 795 ft. pool elevation.	4AROA199.20	*Escherichia coli*	Established
L04-01-BAC	VAW-L04R_ROA04A00	Roanoke River	0.25	Roanoke R. mainstem from near the backwaters of Niagara Impoundment upstream to the Tinker Creek confluence on the Roanoke River (section 6). The upstream ending of the WQS designated public water supply (PWS) segment from Smith Mountain Lake 795 ft. pool elevation.	4AROA199.20	*Escherichia coli*	Established
L04-01-BAC	VAW-L04R_ROA05A00	Roanoke River	0.35	Roanoke River mainstem from the Western Virginia Water Authority Roanoke Regional Water Pollution Control Plant downstream to the Tinker Creek confluence (WQS section 6).	4AROA202.20	*Escherichia coli*	Established
L04-01-BAC	VAW-L04R_ROA06A00	Roanoke River	4.33	Roanoke River mainstem from the Murray Run mouth downstream to the Western Virginia Water Authority Roanoke Regional Water Pollution Control Plant.	4AROA202.20	*Escherichia coli*	Established
L04-01-BAC	VAW-L04R_ROA07A00	Roanoke River	3.31	Roanoke River mainstem from the Peters Creek mouth downstream to the Murray Run confluence on the Roanoke River.	4AROA202.20	*Escherichia coli*	Established
L04-01-BAC	VAW-L04R_ROA08A02	Roanoke River	2.21	Roanoke River mainstem from the Mason Creek mouth downstream to the confluence of Peters Creek on the Roanoke River.	4AROA206.27	*Escherichia coli*	Established

*Based on Virginia's 2010 305(b)/303(d) Water Quality Integrated Assessment

**2004 Fecal coliform exceedance rate reported in the Virginia 2010 305(b)/303(d) Water Quality Integrated Assessment

Table A-2: Benthic Impairment Summary*						
Cause Group ID	**Assessment Unit**	**Stream Name**	**Length (mi)**	**Boundaries**	**Listing Station ID**	**Impairment**
L04R-01-BEN	VAW-L04R_ROA03A00	Roanoke River Niagara	0.86	Roanoke River mainstem from near the backwaters of the Niagara Impoundment upstream to the end of the WQS designated public water supply (PWS section 6i) segment. The upstream ending of the PWS segment from SML 795 ft. pool elevation.	4AROA202.20	Benthic
L04R-01-BEN	VAW-L04R_ROA04A00	Roanoke River	0.25	Roanoke R. mainstem from near the backwaters of Niagara Impoundment upstream to the Tinker Creek confluence on the Roanoke River (section 6). The upstream ending of the WQS designated public water supply (PWS) segment from SML 795 ft. pool elevation.	4AROA202.20	Benthic
L04R-01-BEN	VAW-L04R_ROA05A00	Roanoke River	0.35	Roanoke River mainstem from the Western Virginia Water Authority Roanoke Regional Water Pollution Control Plant downstream to the Tinker Creek confluence (WQS section 6).	4AROA202.20	Benthic
L04R-01-BEN	VAW-L04R_ROA06A00	Roanoke River	4.33	Roanoke River mainstem from the Murray Run mouth downstream to the Western Virginia Water Authority Roanoke Regional Water Pollution Control Plant.	4AROA202.20	Benthic
L04R-01-BEN	VAW-L04R_ROA07A00	Roanoke River	3.31	Roanoke River mainstem from the Peters Creek mouth downstream to the Murray Run confluence on the Roanoke River.	4AROA202.20	Benthic
L04R-01-BEN	VAW-L04R_ROA08A02	Roanoke River	2.21	Roanoke River mainstem from the Mason Creek mouth downstream to the confluence of Peters Creek on the Roanoke River.		Benthic

*Based on Virginia's 2010 305(b)/303(d) Water Quality Integrated Assessment

Appendix B – Steering Committee and Working Group Meeting Minutes and Summaries

Table B-1: Meetings during Development of the Roanoke River TMDL Implementation Plan		
Date	**Meeting Type**	**Notes?**
04/10/2013	Steering Committee #1	Y
06/11/2013	Public Meeting #1	N
06/20/2013	Business Working Group #1	Y
06/20/2013	Agricultural and Residential Working Groups #1	Y
08/27/2013	Government Working Group #1	Y
11/21/2013	Steering Committee #2	Y
2/27/2014	Business Working Group #2	Y
2/27/2014	Agricultural and Residential Working Groups #2	Y
2/28/2014	Government Working Group #2	Y
8/20/2014	Steering Committee #3	Y
8/20/2014	Business Working Group Report	Y
8/20/2014	Agricultural and Residential Working Group Report	Y
8/20/2014	Government Working Group Report	Y
4/21/2015	Steering Committee #4	
4/30/2015	Public Meeting #2	

Upper Roanoke River Total Maximum Daily Load Implementation Plan (TMDL) Steering Committee Meeting

10 April 2013, 1:30 p.m., DEQ Roanoke Office

-Meeting Notes-

Welcome and Introductions

- Attendees: Mary Dail, Paula Nash and Kip Foster (DEQ), Carol Linkenhoker (Botetourt Co.), Christopher Blakeman (Roanoke City), Ashley Parks (EEE Consulting), Chris Burns (Balzer & Assoc.), Bill Tanger (Friends of the Roanoke River), Erica Moore and Staci Merkt (Mountain Castles SWCD), John Burke (Gay and Neel, Inc.), Mike Rigney (TU/Orvis), Nick Tatalovich, Djamel Benelmouffok and Erin Hagan (Louis Berger Group, Inc.), Gary Woodson and Anita McMillan (Town of Vinton), Shane Sawyer and Ed Wells (RVARC), Kafi Howard (Town of Blacksburg), Megan Daily and David Henderson (Roanoke Co.), Sarah Baumgardner and Mike McEvoy (WVWA), Heather Vereb Longo (DCR), David Burris (VDH), Tom Dale (Lumsden Assoc.)
- Steering Committee (SC) members introduced themselves and their hopes/expectations for the meeting. Hopes and expectations expressed by SC:
    - Increased collaboration (MS4 permits and beyond)
    - Project timeline
    - Efficiency
    - Discussion of project costs
    - Knowledge of the process
    - Opportunities for education/outreach
    - Clean water
- Meeting Guidelines: There were no additions to the Meeting Guidelines.

Why are we here?

- Dail presented background information about the importance of healthy watersheds, water quality programs at DEQ, and Total Maximum Daily Load studies in the Upper Roanoke River watershed.
    - Suggestion was made to be more specific as to what happens to the "TMDL Pie" (slide #5) between existing pollutant loads and the reduced, or TMDL, loads.
    - Question regarding the inclusion of PCB TMDL into the Upper Roanoke watershed IP project was answered with an explanation of current activities related to the PCB TMDL. Implementation of the Roanoke River watershed PCB TMDL will be accomplished through the VPDES permitting process. VPDES permittees (with specific sector identification codes) are collecting and submitting low-level PCB data from their outfall(s) per TMDL Guidance Memo No. 09-2001. Data will be evaluated with respect to facility Wasteload Allocations (WLAs) and facilities that don't meet WLAs will develop a Pollutant Minimization Plan to address PCB problems.

- Dail and Benelmouffok presented information about the Implementation Plan (IP), specifically requirements and components of an IP, existing Best Management Practices (BMPs), potential new BMPs, stakeholder participation and timeline.
    - **Project Area:** North Fork and South Fork subwatersheds are not included in "phase 1" of the IP project. Those subwatersheds will be captured in a separate IP project next year.
    - Landuse adjustments that account for landuse changes from the time of TMDL development to the time of the IP (i.e. "updating" the landuse layers for the watershed) will not affect WLAs, but reductions by source category may change. Subwatershed factsheets were shared with the SC.
    - **BMP Discussion:**
        - Question about existing BMPs inventory (slide #17, "Existing BMPs – Stormwater) totals due to the fact that in some cases only inspected BMPs are reported. Final numbers will be available in October.
        - Louis Berger Group requested shapefiles for existing BMPs (where possible) and will send out a formal request following the meeting. Instructions for file transfer will be provided with the request.
        - Some BMPs do not qualify for cost-share and the question arose about a BMP list for use during IP project development.
        - The comment was made that BMPs need to be included in the IP in order to be eligible for funding. Cautionary tip about ensuring that BMPs are appropriate for the watershed (i.e. soils) and timeless so that they are still reasonable several years down the road.
    - **MS4 Discussion:** Question was asked about MS4 area and whether or not it encompasses the whole county or just the urbanized area. MS4 area is just the urbanized area (example: Roanoke County MS4 represents 2010 census urbanized area).
    - **Fact sheet Discussion:**
        - Concern was expressed that bacteria reductions are too stringent (example: >99% reductions called for in Tinker Creek). IP will have to address several levels of reductions, i.e. milestones, all the way to 0% violations of the water quality standards. Stakeholders can influence the timeline/milestones.
        - Allocations need to be expressed without the use of scientific notation for the public.
    - **Working Groups discussion:**
        - Additional working group suggested encompassing non-profit, commercial stakeholders. It needs to include all of the appropriate Chambers of Commerce, small businesses, churches, business associations, urban forestry, etc. DEQ requested input on what organizations to reach out to.

Next Steps and Feedback

- **Obstacles to Implementation?**
    - Funding is a challenge. Cost-share is attainable for agricultural BMPs but not for urban/stormwater BMPs. Grant opportunities must be identified.

  - Public's knowledge of water quality problems/solutions is a challenge.
- **Public participation discussion:**
  - SC recommends a slide depicting the sample jar (100 ml) used to collect bacteria samples and a Petri dish showing bacteria colony growth. The water quality standards/levels of pollution need to be user-friendly.
  - SC suggested presenting success stories, specifically any streams that have been delisted due to IP activities. The public needs to see the benefits of implementation.
  - Emphasize benefits of existing BMPs like cattle fencing, properly installed silt fencing, Low Impact Development. The intent is to have the property/BMP owner speak to the benefits of their project.
- **Outreach/Advertising Public Meeting(s)**
  - SC suggested making a recording of the meeting, posting on YouTube and re-running on local TV channel (RVTV)
  - Newspapers (Roanoke Times, Star Sentinel, Main Street)
  - Press Release
  - Newsletters, listservs for businesses, civic organizations
  - Facebook
  - Fliers
  - DEQ website will house project documents information: http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/TMDL/TMDLImplementation/TMDLImplementationProgress.aspx
- **Public Meeting**
  - Possible locations: Hollins College, Greenfield Center, Roanoke Civic Center (Roanoke City to help coordinate)
  - Meeting style discussion:
    - Café style with short, formal program in the early afternoon and repeat in the evening. Cafe style utilizes an open space with information booths. Participants can listen to the formal program and then visit the specific booths for detailed information.
    - Traditional public meeting (presentation, Q&A)
    - Open House style where several people staff informational booths throughout the day and people can come and go all day long (no formal program)
- **Next Steps**
  - **Arrange public meeting details (including date, time, location)**
  - **DEQ/Louis Berger will send out formal request for BMP information**
  - **DEQ will share meeting minutes and project updates**

Upper Roanoke River (Roanoke and Botetourt Counties, Cities of Roanoke and Salem, Town of Vinton)
TMDL Implementation (Cleanup) Plan Development

Residential and Agricultural Working Group – Meeting 1

Thursday June 20, 2013, 7 P.M.
Virginia Department of Environmental Quality, 3019 Peters Creek Rd., Roanoke, VA

Attendance:

- Angela Nielan - Virginia Department of Environmental Quality (DEQ)
- Paula Nash - Virginia Department of Environmental Quality (DEQ)
- Mary Dail - Virginia Department of Environmental Quality (DEQ)
- Heather Longo - Virginia Department of Conservation and Recreation (DCR)
- Stacy Horton - Virginia Department of Conservation and Recreation (DCR)
- Mike McEvoy - Western Virginia Water Authority
- Margie Lucas - Mill Mountain Garden Club
- Marlin Old - Mountain Castle Soil and Water Conservation District (SWCD)
- Staci Merkt - Mountain Castle Soil and Water Conservation District (SWCD)
- Jeff Henderson - Botetourt County Farmer
- Michael Beahm - Botetourt County Farmer
- Doug Phillips- Southeast Rural Community Assistance Project (SERCAP)
- Dave Burris - Virginia Department of Health (VDH)
- Dave Henderson - Roanoke County
- Bruce Peters - Roanoke County

TMDL Implementation Plan Discussion

Mary Dail provided some project background and explained the Cleanup Plan process

Residential/Urban Working Group (RUWG)

Sewer Overflows

- Stakeholders did not suggest any areas of the watershed that may smell of sewage or show other evidence of a sewer leak/overflow. Any information on this topic would be beneficial in assisting with the targeting of pollution control practices in the watershed.
- 98% of Roanoke City is connected to sanitary sewer.
- Less than half of Roanoke County is unsewered.

Onsite Residential Waste Systems

- The number of straight pipes in the watersheds will be estimated based on the age of homes and proximity to streams and rivers.

- It can be difficult to identify straight pipes. Mountain Castles SWCD mentioned that people are more likely to come forward if they know funding assistance is available. Neighbors may also complain about the straight pipes.

- Glade Creek and Laymantown are areas likely to have failing septic systems.

- None of the localities in the Cleanup Plan have ordinances that require septic system maintenance. Roanoke County does require houses within a certain distance of sewer lines to hook-up to the system. Botetourt County does not require this. There are some houses within Roanoke City that are not hooked up to the sewer because connection is impractical. Western VA Water Authority has GIS data that will show the difference between sewer coverage and service. Areas that are eligible for sewer line extension need to be specifically identified in the cleanup plan in order to be eligible for sewer line connection cost share funds.

- There are alternative waste treatment systems in areas covered by the cleanup plan.

- In Roanoke County, less than 50% of homes are on sewer.

- Once the Cleanup Plan is complete, stakeholders in the watersheds will be able to apply for competitive funding, including cost-share on septic system repairs and replacements. Southeast Rural Community Assistance Project (SERCAP) has some grants and loans for septic improvements and installations. Eligibility is based on income.

- Stakeholders agreed that there is a need for education on septic systems and straight pipes in areas addressed by the Plan.

- Stakeholders agreed that newsletters (homeowners' associations, agricultural groups, etc.), mailings, and door hangers would be effective forms of outreach. It was also recommended the septic pumpers carry literature for distribution.

- Most jurisdictions have GIS and they could identify houses with onsite systems that are close to the streams to target outreach.

- VDH maintains a database of permits for installations and repairs; this could be used to target areas with houses likely needing new systems.

- Home age may also indicate overwhelmed systems, handling a volume of water exceeding that for which they were designed.

- Stakeholders raised concerns about septage haulers improperly disposing of waste. A tracking system was suggested to ensure that pumped waste goes to the wastewater treatment plant.

Pet Waste

- It was recommended that educational literature be distributed via pet stores or vets.

- Roanoke County sent out fliers to vets to educate pet-owners on picking up waste.

- Animal control officers may be able to assist in identifying homes/areas in need of information on the importance of properly disposing of pet wastes.

Stormwater Best Management Practices (BMPs)

- Concerns were raised about the effectiveness of Erosion and Sediment (E&S) controls in the watersheds. Some stakeholders felt that E&S practices are not installed properly and some are not maintained properly. This problem may be exacerbated by limited numbers of inspectors and inspections, as well as the prevalence of highly erodible land available for new construction.

- Areas were identified erosion problems exist; include the Glebe Development and Sports Complex that put dirt on Etzler.

- There is a slope ordinance in Roanoke County, but it is lenient.

Outreach

- It was recommended that a recognition program, like the Lynhaven Pearl Home project (http://www.lynnhavenrivernow.org/Pearl-Homes.aspx), be instituted in the watershed. This program would encourage households to do a certain number of things that benefit the watershed to earn some time of recognition, such as a flag in their yard.

- It was recommended that education and outreach programs could be run through the Cooperative Extension

- It was suggested that a QR code could be registered and placed on literature to improve the impact of outreach materials.

Financial and Technical Assistance

- A list of potential funding sources will be included in the Cleanup Plan. Input on any additional sources is welcome.

- There is some question if MS4 areas would be eligible for state implementation funding. This funding has historically focused on residential septic and agricultural funding but is increasingly being used to fund stormwater projects. It is recommended that stakeholders in MS4 areas discuss potential projects with funding entity contacts when Requests for Proposals are released.

Agricultural Working Group (AWG)

Local Agriculture

- Agriculture as a living is getting harder to do. Hobby farmers are present and likely becoming more common in the watersheds.

- Louis Berger has records of all agricultural practices in the watershed that were partially funded with cost-share money. Additional information on voluntary BMPs would be helpful. The tracking program currently used by SWCD's has the ability to track the voluntary practices. These working group meetings are intended to gather more "on the ground" information about BMPs in the watersheds.

- Stakeholders asked who would be responsible for implementation and tracking of BMPs in this Plan. The road map is still being developed, but ideally the Steering Committee will stay in place and guide implementation. SWCDs will continue to handle funding and tracking of agricultural BMPs, however other organizations may lead other sectors of implementation (residential septic, pet, stormwater BMPs, etc.). In the last two years, implementation grant funding has been offered through a competitive process, and the collaboration of multiple organizations to handle different parts of implementation has been strongly encouraged. Now that the funding will come from DEQ, this process may change, but no decisions have been made.

- Stakeholders asked for a clarification of how agricultural loads are modeled. Louis Berger uses land use runoff based on precipitation, bacterial density for different animals' excrement, and the number of animals (based on the Ag census). They model for a long period time and at different points on the stream and correlate the data points with the seasonal variations. They try to use all the data available and all the variations as possible to get a representative model.

- There are livestock markets present in the watershed. One is in the Tinker Creek watershed.

Agricultural BMP Cost-Share

- Mountain Castles SWCD representatives felt that increased cost-share match would increase participation in the program. It was noted that TMDL cost share funding (awarded competitively in areas with Cleanup Plans) increases the cost share on the most popular fencing practice to 85%. 100% cost-share on the fencing practice in all areas is proposed for the new fiscal year, starting July 1.

- It was clarified that cost-share funding is available for fencing practices that require a 35 foot setback or a 10 foot setback, though the latter has a lower percentage of cost-share offered.

- Farmers fear that the government will have more control over their farm if they accept cost-share.
- Farmers are more wary of working with DEQ or EPA than working with DCR. SWCDs try to tell farmers that the money is still there, it's just coming from a different state entity.

- Word of mouth is a good tool to show farmers that the government is not going to take your farm and that BMPs can actually make the farming process easier and more profitable.

- There are some stipulations on famers and specifications that practices must meet to be eligible for cost share. Farmers must have the money to pay for the practices up-front, as cost-share funding is on a reimbursement basis.

What's Next?

- The Government Working Group will meet in July
- The Steering Committee will convene to review information discussed in all four working groups; if you would like to represent a working group on the Steering Committee, please notify Mary Dail (contact information below)
- The next Agricultural and Residential Working Group meetings will take place in September

For More Information

- Contact Mary Dail, DEQ (540) 562-6715, mary.dail@deq.virginia.gov.
- The TMDL studies for this cleanup plan can be viewed at
  http://www.deq.virginia.gov/portals/0/DEQ/Water/TMDL/apptmdls/roankrvr/tinkerfc.pdf
  http://www.deq.virginia.gov/portals/0/DEQ/Water/TMDL/apptmdls/roankrvr/uroanec.pdf
  http://www.deq.virginia.gov/portals/0/DEQ/Water/TMDL/apptmdls/roankrvr/uroanbc.pdf

Questions for Government Working Group Meeting – 8/27/13, 10:00 a.m.

Roanoke DEQ Office

Sewage Handling and Disposal

Ask VDH to give an overview of their activities/programs to correct straight pipes and failing septic systems locally.

The TMDL assumed a septic system failure rate of 3% (Upper Roanoke River TMDL) of the total septic systems in the watershed. In order to appropriately quantify numbers of BMPs that address septic system failures, do we need to adjust the estimated failure rate?

Is it appropriate to assume that new development that has occurred since approval of the TMDLs (2004 and 2006) has been connected to the sanitary sewer system?

Are there certain communities, subdivisions, etc. that could be referenced in the IP that generally have a higher number of septic system failures?

- *RWG suggested that Glade Creek and Laymantown areas are more likely to have failing septic systems.*

RWG reported that there are no septic system maintenance ordinances. Roanoke Co. requires that houses within a certain distance to the sewer system hook up. Do other localities enforce a similar ordinance? In Roanoke Co., what is the distance to the sewer system that the ordinance addresses?

RWG: Stakeholders raised concerns about septage haulers improperly disposing of waste. A tracking system was suggested to ensure that pumped waste goes to the wastewater treatment plant. Are there options from a locality-standpoint to address these problems?

BWG discussed grease and the associated Building Codes. The highest amounts of sewer overflows are related to grease. Are there ways to address this problem?

If grant funds are made available to address straight pipes and failing septic systems which local agency/organization would possibly be interested and best suited for this role?

Working Group/Project Team suggested:

- Southeast Rural Community Assistance Project (SERCAP)
- VDH
- SWCDs
    - Do all of these have experience in managing grant funds?

Agricultural Programs and Implementation Locally

Ask NRCS/SWCD to give an overview of the federal agricultural programs that local landowners are utilizing (e.g., CREP CRP, WHIP and EQIP).

- What is the level of participation in these programs?
- Is there adequate funding for these programs?

Ask the SWCDs to give an overview of the state cost-share program in their areas.

- What is the level of participation in these programs?
- What is the estimate of farmers not participating in federal and or state cost-share programs locally?
- How much cost-share funding does each District generally receive annually? Is there adequate funding for this program?

Are the Districts involved in tracking voluntary BMPs? Should voluntary BMPs be included in the IP (means we would list certain BMPs and targeted numbers that could be implemented at landowner cost (e.g., stream fencing) with or without an incentive such as CCI-SE-1).

Note: Patrick County Stream Exclusion Initiative funding (ask Tony to discuss progress); also, up to 100% cost-share on exclusion practices (Virginia Enhanced Conservation Initiative). To be eligible farmers must first have an approved program year 2013 contract under VACS or TMDL funds.

From Agricultural Working Group Meeting:

- *Farmers fear that the government will have more control over their farm if they accept cost share.*
- *Word of mouth is a good tool to show farmers that the government is not going to take your farm and that BMPs can actually make the farming process easier and more profitable.*

Are these accurate? How is participation in practices that would reduce loading through runoff?

Stormwater Programs (Urban Runoff)

Are there any efforts underway through local stormwater programs that are addressing bacteria sources that should be referenced in the IP?

Are there any existing illicit discharges along sewer lines in the urban areas (even if they are been addressed through corrective actions)?

From RWG/AWG:

- *Concerns were raised about the effectiveness of Erosion and Sediment (E&S) controls in the watersheds. Some stakeholders felt that E&S practices are not installed properly and some are not maintained properly. This problem may be exacerbated by limited numbers of inspectors and inspections, as well as the prevalence of highly erodible land available for new construction.*

- *Areas were identified erosion problems exist; include the Glebe Development and Sports Complex that put dirt on Etzler.*

From BWG:

- *The word, "Stormwater" is associated with a fee. Businesses are fearful of stormwater utility fees being implemented at the same time over multiple localities.*
- *Local gov't are doing a better job monitoring E&SCs*
- *Williamson Road area needs more inlets*

Existing BMPs

<u>Pet Waste</u>

What is going on locally to educate about and or control pet waste?

- *From RWG: Roanoke Co. sent out fliers to veterinarians offering information to educate pet owners on picking up waste. Are there similar efforts/opportunities in other localities?*
- *BWG suggested localities pass ordinances requiring pet owners to pick up after their pets.*

How receptive would residents in concentrated residential areas be to such a campaign?

Who can help identify where there are existing pet waste disposal stations in the impaired watersheds?

Are there some other dog walking areas where disposal stations and educational kiosks should be installed? (Parks, walking trails, etc.)

Are there hunt clubs, kennels, other boarding facilities where dogs are confined locally long-term or either seasonally? Should these be considered as a potential source issue to address in the IP?

- *The RWG suggested enlisting Animal Control officers in the identification of homes/areas in need of information on the importance of proper pet waste disposal.* Is this approach feasible? Are there others?

Which agency and or organization would be good to help with education to address this bacteria source? (VCE, Parks and Rec, others?)

<u>Other Bacteria Sources</u>

Are there other potential sources of bacteria that have not been mentioned that should be discussed?

Integration with Other Activities and Planning in the Area

Are there existing or planned activities, studies, planning efforts that should be referenced in the IP since these could possibly help with meeting IP goals?

- Eden Watershed Assessment (DRBA)
- DCR – Mayo River State Park (Mussels)

Regulatory Controls

We are required to identify in the IP regulatory controls in place that could be used to promote implementation. These include the state's Agricultural Stewardship Act and VDH's Sewage Handling and Disposal Regulations.

Currently no septic tank pump-out ordinances – any in the works?

Any sewer extensions anticipated?

Any programs in place to control wildlife? Any anticipated?

Are there other relevant regulations and ordinances?

Upper Roanoke River (Roanoke and Botetourt Counties, Cities of Roanoke and Salem, Town of Vinton) TMDL Implementation (Cleanup) Plan Development

Steering Committee Meeting DRAFT Notes

November 21, 2013, 1:00 – 4:00 p.m.

Virginia Department of Environmental Quality, 3019 Peters Creek Rd., Roanoke, VA

Attendance:

- ☐ Paula Nash, Mary Dail, Diana Hackenburg, Charlie Lunsford, Jay Roberts, Kip Foster - Virginia Department of Environmental Quality (DEQ)
- ☐ Scott Shirley - Western Virginia Water Authority
- ☐ Dave Burris - Virginia Department of Health (VDH)
- ☐ Tarek Monier - Roanoke County
- ☐ Nick Tatalovich, Erin Hagan – Louis Berger Group
- ☐ Chuck VanAllman, Josh Pratt – Salem
- ☐ Carol Linkenhoker – Botetourt Co.
- ☐ John Burke – Gay and Neel, Inc.
- ☐ Roy Nester – Town of Christiansburg
- ☐ Tom Cain – Lick Run Watershed Association
- ☐ Ed Wells, Shane Sawyer – Roanoke Valley Alleghany Regional Commission
- ☐ Anita McMillan, Ryan Spitzer – Town of Vinton
- ☐ Christopher Blakeman – City of Roanoke
- ☐ Ashley Parks – EEE on behalf of VDOT
- ☐ Jack Ward – TU
- ☐ Tom Dale – Lumsden Associates
- ☐ Wendy Jones – Williamson Road Area Business Association
- ☐ Larry Iceman – Smith Mountain Lake Association
- ☐ Cristina Siegel – Clean Valley Council
- ☐ David Perry, Meagan Cupke – Blue Ridge Land Conservancy
- ☐ Liz Belcher – Roanoke Valley Greenways
- ☐ Bill Tanger – Upper Roanoke River Roundtable

Welcome and Introductions

Attendees introduced themselves. Mary Dail went over the agenda and provided a recap of prior meetings including the June 2013 Open House, Residential and Agricultural Working Groups, Business Working Group and Government Working Group. Mary explained that the purpose of this meeting is to address any concerns that arose during the working group meetings, discuss Best Management Practices (BMPs), BMP costs, and BMP efficiencies.

Working Group Summaries

- David Burris presented highlights from the Residential Working Group meeting
- Wendy Jones presented highlights from the Business Working Group meeting
- Mary Dail provided highlights from the Agricultural Working Group and Government Working Group meetings

BMP Discussion

Nick Tatalovich explained the two BMP handouts: *BMP Efficiency and Costs,* and *Summary of Agricultural and Stormwater BMPs.* It was mentioned that the BMP list in the Clean-up Plan should be all-inclusive so as not to exclude a potential BMP from grant funding.

Stormwater BMPs Discussion:

- The primary source for stormwater BMP information originated from the DEQ handbook
- Efficiencies and Costs can be refined, if necessary.
- Need to add stream restoration to the list and the group discussed how to estimate cost. DEQ stated that the costs that are included in the plan are estimates. A price range per linear foot would be an appropriate representation of cost.
- Any projects that are currently underway or planned for the near future should be included in the Plan.
- The group discussed BMPs for upgrading stormwater ponds
- Based on the land uses we know what the reductions are needed, but we don't know exactly where the BMPs are needed.
- There is an established stream restoration project at Garst Mill Park that may provide an example of costs.
- The question was asked about obtaining information from homeowners about rain gardens. Homeowners are going to get credits for BMPs, so therefore there may eventually be a place to obtain this information. Roanoke City citizens can lower their stormwater fee costs by up to 50% by installing BMPs.
- A comment was made that there is a GIS layer for Glade creek.
- According to the Blue Ridge Land Conservancy, 500 trees have been planted on Blue Ridge Parkway. Conservation easements may have restrictions; however, these may not be available in any databases. There are currently 90,000 acres in easements.
- Salem commented on Erosion and Sediment Control. When there is a 10,000 sq ft-5,000 sq ft conversion, this would be a way to see how much sediment has been captured. You can use an increase in efficiency to account for this difference (Universal Soil loss). We would need this information by the specific watersheds.
- How does the plan address forested area roads that are eroding? VA Dept. of Forestry has their own forestland BMPs.
- How does the plan address VDOT projects? These large-scale road projects are not in the BMP list. For example, water bar BMP to reduce erosion on dirt roads is not on the list. The comment was made that runoff goes from the road into the forest. There is a VDOT manual that contains a complete list of all the BMPs that VDOT uses. VDOT essentially develops their own Action

Plans as part of their permitting process. It was suggested that the clean-up plan should build onto the VDOT action plan. VDOT is limited to the amount of BMPs that they can implement.

- A group member asked how one report VDOT E&S complaints does. Answer is to call 511 and report any observed issues.
- A group member expressed frustration that everyone is not working together and that integration of all of the entities in the room will improve water Quality.
- A comment was made that there is a chapter in the Clean-up Plan that summarizes other watershed initiatives.
- Another challenge mentioned is that people don't know who has MS4 permits.
- The focus of the Clean-up Plan is on the land uses within the watershed and what reductions are called for in the TMDLs.
- Could a table be composed to show the MS4? The wasteload allocations assigned to the MS4s is in the TMDL and could be put in the clean-up plan.
- The group was asked if there are additional BMPs that should be included.
- It was suggested that Impervious Area reduction, for example BMP retrofits, be included as BMPs. Is there a way to itemize landuse conversion in the plan so that they may potentially get funding? LBG is not sure of efficiencies, but will to check into this question.
- Industrial Commercial Wash Run-off becomes an illegal discharge for the City of Roanoke; are there BMPs to address this?
- Drain and Inlet maintenance, like cleaning them out, is important for water quality. What about an "Adopt-an-Inlet" program?
- Could velocity or flow rate dispersion (weirs or traps) be considered a filtration BMP?
- It was suggested that a category of Waste management BMPs, or pollution prevention BMPs, to address bacteria reductions be included.
- A suggestion was made that a "pilot BMP" line item be included so there is always a way to be able to receive Grant funding for innovative BMPs.
- The City of Salem brought up the following potential inequity: If in one locality you are required to comply with certain stormwater ordinances, but then in another locality you are going to get a credit for installing a BMP; is this fair? There is a need to give the ordinance-requiring locality recognition of their effort.
    - For example, 97% of land disturbance in urbanized areas is less than 1 acre, but no one gets any "credit" for BMPs on parcels less than 1 acre. There was some discussion regarding crediting and how it relates to MS4 TMDL Action Plans. Localities need incentive to push for their Boards of Supervisors to pay attention to land disturbance less than one acre.
- It was suggested that we need a Stormwater Authority to address stormwater concerns regionally.

- BREAK -

Residential BMP Discussion

- Septic system pump outs were discussed. The document lists 5% bacteria removal efficiency. A comment was made that this practice shouldn't be removed from the plan. The removal efficiency data comes from real data collected by Maptech both before and after pump outs.
- Charlie L. has seen IPs that eartag millions of dollars for pump outs. His suggestion is to put a percentage of total houses (like 10%) to be pumped out in the plan.
- Franklin County imposes the pump out on the septic System of houses that are within 500 ft of Smith Mountain Lake.
- Suggested to put the ordinance in the Plan to require pump outs; however, an ordinance cannot be a BMP. Ordinance required areas are NOT eligible for grant funds.
- There is a place in the IP to list all of the ordinances in the area to meet the BMPs that are in the watershed.
- Charlie L. stated that LBG will have to work on prioritization of where the money is most beneficial to improving water quality.
- A question was asked about getting people off of Septic Systems onto sewered areas. Connecting these septic systems is a BMP and the costs are in the plan. It would help if the plan listed potential target areas for sewer connection. There were comments about educating homeowners about septic pump outs and the group thought this would be worthwhile.
- A question was asked about the VPDES permit for single family homes. These are required to have annual maintenance, however there is no enforcement. Another suggestion was that these should be included in this plan. Since they are regulated through a VPDES permit, though, they would not be eligible for grant funding.
- Bioretention areas and Rain gardens are sometimes lumped together. These should be broken out.
- A discussion about BMP tracking came up and it was stated that BMPs must be tracked.
- WVWA is going to quantify the amount of people on septic systems in the City of Roanoke and provide this information to WRABA.
- The $7500 cost for Sewer Connection in the handout is a connection fee and does not include any additional lines that are needed to connect people that aren't close to connection (per WVWA).
- Pet waste BMPs were discussed and the group determined that pet waste needs to be addressed at the source: either pick up the feces or treat it.
- Pet Waste Education is creditable.
- Have there been any counts of feral animals in rural areas? Not to anyone's knowledge.
- Where in the developed community is the bacteria coming from? LBG mentioned that controlled sources pose challenges. You can't control the wildlife in your yard, but you could control the run-off leaving your property. SSO, pets, failing septic systems are targeted ways to address sources.
- Salem is going to send LBG data from Street Sweeping.
- A question was asked about bacteria reductions in the forest? Wildlife? Allocation scenario in Carvins shows an 85% reduction from forest land use. LBG explained that reductions are included to meet the TMDL required by state and federal regulation, but this plan will be to the

extent most practical. DEQ stated that the TMDLs that were done in 2004 and 2006 are what they are and that the Clean-up Plan needs to address the reductions in a reasonable manner.

- The group discussed that VA has moved away from bacterial source tracking. The anti-biotic resistance method was explained to the group and the project team was certain that all four main sources of bacteria exist in the watershed.
- Wildlife, Livestock, Pets and human are the most common sources as shown by the bacterial tracking. The method however was more just a presence/absence test and it doesn't give real %s. You can't get actual reliable %s until you do DNA sampling which is expensive.
    - Based on acres of forest and available, modelers generate estimates for wildlife species numbers and this gets plugged into the model.
    - Water quality standards are protective and TMDLs have to show a scenario with zero violations of the standard. With respect to the bacteria standard, most streams are not monitored enough [>1 time within a calendar month] to have the geometric mean standard of 126 cfu/100 mL applied. Sampling varies but, in general, DEQ samples bimonthly at many stations.
    - The Clean-up Plan emphasizes on what it will take to get the stream off of the impaired waters list.
- Ashley P. asked if the bacteria standard is up for discussion in RAP standards.
- Charlie – state has tried for years to not have all streams listed for designated use of primary contact recreation
    - Secondary contact standard is on the books; but we can't apply it until we try to clean up a stream.
- Concern of public perception of validity of doing this; looking at Glade/Laymantown where a small percentage is septic and the majority of pollution is other land use.
- The group was reminded that the watershed models are tools to help describe the watershed and how water quality responds to the application of BMPs.
- WVWA suggested that municipalities would want to fund more monitoring.
- Diana H. stated that the Clean-up Plan is part of a process and that we continue to evaluate how the plan and practices are working with monitoring and re-evaluation.
- Cristina S. mentioned that the CVC provides citizen monitoring opportunities.
- URRR trains monitors; however, if URRR had seen the TMDL maps, they may have redirected volunteers
    - There should be more monitoring and it should be more directed
    - Monitoring is expensive; it costs to train and for kits
    - We don't get enough monitors because of lack of education
    - Jay R. suggested that MS4s might want to make monitoring part of their action plans to help their efforts and this area.
- Mary D. said that eventually we'll look at stations and where we may want to monitor in the future for the Follow-up Monitoring section of the Plan.
- New VPS regulations will address monitoring in TMDLs not for bacteria but for other pollutants

Agricultural BMPs Discussion:

- Not a lot of Ag BMPs or cropland
- Ag BMPS are from DCR database. Voluntary BMPs may or may not have been reported.
- Chuck – what is the relationship with the agricultural industry? Ag E&S monitored by departments other than the localities
- It's incentive-based on the agricultural side of BMPs
    - VDACS deals with compliant-based problems to help producers deal with issues
- How many states have state laws to prohibit cows from going in the stream?
    - State is right now paying for 100% cost-share
    - Can't regulate everything. How many regulations on the books are not enforced?
    - Maybe an overlay district
    - We need the messengers that will convince the farmers that these BMPs are good for them
    - How to represent this without mentioning DEQ – districts have the relationships with their constituents
- Two levels of bioretention with different removal efficiencies and rain gardens are a third very specific type of bioretention

Upper Roanoke River (Roanoke and Botetourt Counties, Cities of Roanoke and Salem, Town of Vinton) TMDL Implementation (Clean-up) Plan Development

Second Business Working Group Meeting Notes

February 27, 2014, 2:00 – 4:00 p.m.

Virginia Department of Environmental Quality, 3019 Peters Creek Rd., Roanoke, VA

Attendees:

- Wendy Jones - Williamson Road Area Business Association
- Bill Tanger - FORVA
- Mary Dail, Diana Hackenburg, Charlie Lunsford, Paula Nash, Emma Jones – Virginia Department of Environmental Quality (DEQ)
- Scott Shirley - Western VA Water Authority
- Nick Tatalovich & Erin Hagan - Louis Berger Group
- Cindy Linkenhoker – Roanoke County
- Shane Sawyer – Roanoke Valley Alleghany Regional Commission
- Allen Austin

Introductions were made and meeting guidelines were established.

Background: The Roanoke River is impaired for both bacteria and sediment. This clean-up plan will describe the strategies needed for reducing bacteria and sediment in the Roanoke River watershed to meet applicable water quality standards. This plan covers the Roanoke River watershed from Smith Mountain Lake to the confluence of Mason Creek and the Roanoke River, which includes 10 subwatersheds. The TMDL identified the loads of bacteria and sediment that the different subwatersheds could receive and still meet water quality standards. From these loads, reductions were estimated by source or land use such as developed, cropland, pasture/hay, etc. Clean-up plan actions to meet these reductions can include indirect measures like outreach, educational programs and signage and direct measures which are more commonly known as Best Management Practices (BMPs). The Business Working Group (BWG) will assist in determining the types and extent of BMPs needed in the subwatersheds that will result in reductions in bacteria and sediment loads from commercial areas. In addition, BWG members will help identify potential partnerships and funding sources for implementing clean up measures included in the plan. The total cost estimates presented are those identified for the clean up measures needed to meet water quality standards.

Handouts: Business Working Groups Meeting #2 Handout, Best Management Practices Efficiency and Cost (updated Draft), Best Management Practice Estimates by Subwatershed

Presentation: The Louis Berger Group (LBG) presented project background and BMP estimation approaches as well as examples from a few subwatersheds. The Project Team reiterated the hope that participants will comment today and take the meeting handouts home and submit comments at a later date. The information presented represents a “first-cut” at estimates of BMPs needed by subwatershed.

General Discussion

- Question about BMPs: do they reduce both sediment and bacteria? Answer was in most cases, yes, they address both pollutants.
- Q: After all the targeted BMPs are installed, will pollutant levels be below the TMDL? Not all the reductions are falling on the urban landuses. All of the landuses will have reductions associated with them. The BMPs that are suggested are estimated to meet the bacteria and sediment load reductions called for in the TMDL studies.
- Q: Was this modeling to instantaneous or geomean bacteria Water Quality Standard? A: Geomean bacteria standard.
- Question asked about how extreme watershed conditions were accounted for. The Bacteria TMDL has an implicit Margin of Safety (MOS) and the Sediment MOS was explicit.
- Stakeholder asked if each one of the subwatersheds included in the plan will have reductions associated with them. A: yes.
- By reducing the sediment loads in the tributaries, the cumulative loads in the mainstream Roanoke River will be reduced. Instream erosion is accounted for in the TMDLs. When there is more impervious surface (pavement/asphalt), the water shoots into the stream and causes stream erosion. Prioritization of BMP installation is a big part of this plan. Measureable goals and milestones will be included. The Plan will set a percentage of BMPs targeted for installation and the schedule (i.e. number of years it is expected to take to install said BMPs). Project Team will model to assess changes in instream bacteria and sediment loadings and predict water quality outcomes. Water quality – through monitoring – will ultimately occur after the BMPs are installed and have had a chance to be effective.
- We may detect water quality improvement (in the monitoring data) before Water Quality Standards are met.
- Q: What is the time frame? A: The time frame for implementation of the clean-up plan will be discussed in the Steering Committee meeting. It is a requirement of the plan that implementation is staged and that an estimated amount of time is attributed to each stage.
- Stakeholder suggested that the BMP map needs to be in the presentation.
- Q: What is adopt-an-inlet? A: The adopter/adopting organization is responsible for cleaning out the inlet.

Stormwater BMP Discussion

- Detention pond Q: Nick explained that the detention ponds are already in place, retrofit BMP calls for upgrading them for more efficient pollutant reduction.
- It was requested that a graphic depicting what's in place be produced and that the approach to retrofitting be explained in the Plan.
- There are costs associated with each pond and then a cost attributed to the retrofit. All of these costs need to be represented in the Clean-up Plan along with the efficiencies.
- With respect to maintenance, sediment BMPs will eventually fill up if not properly maintained; therefore the BMP efficiencies are only going to provide the expected efficiency if they are maintained properly.
- The comment was made that there will be BMP tracking. Roanoke County conducts enforcement inspections. A stakeholder spoke about how a pond that he manages is inspected
- A stakeholder observed that it appears that most of the BMPs focus on ponds that need to be retrofitted. The ponds are on private property; how do you propose that to happen? DEQ

explained the IP process and that these retrofits could be eligible for certain grant monies once the plan is in place.

- Stakeholder commented that businesses will not likely take advantage of monies to help retrofit the ponds.
- DEQ mentioned that the only BMPs that are being presented today are Urban BMPs. The other working groups will discuss BMPs related to their specific interest area (Ag, Residential, Government).
- Q: Should the locations of the ponds in the watershed be presented in this plan? If so, how would we capture this? A: Due to the focus of the plan on landuse categories, specific locations of ponds within a subwatershed is not within the scope. Keeping the plan non-prescriptive allows for flexibility when choosing specific sites for BMP installation.
- The group was asked if they thought a campaign to go to businesses and discuss retrofits would help. A: This would help with some businesses, but it won't interest others.
- Q: Are most of the ponds in the City or the County? A: They are spread out all over the city and the county and are identified in the plan by subwatershed. The following discussion ensued:
  - Most of the ponds are dry ponds.
  - County of Roanoke has the drainage areas mapped. Roanoke City isn't quite there.
  - Most of the ponds are not associated with individual business; outreach needs to target the managing entity for the ponds. The localities that provided the existing pond locations should have information about who manages these ponds.
  - The recommendation is to find ways to reduce pollutants in each of the subwatershed and not specify individual localities.
- Stakeholder suggested that it would be good to get people that want to promote wildlife on board with this retrofitting idea.
- Q: VDOT has many detention ponds; are their ponds located on this map? A: VDOT has not provided BMP information, but DEQ will specifically request VDOT's existing BMP data.
  - Stakeholder comment: VDOT is generating a large amount of sediment from roads. VDOT should have to reduce their loads.
  - MS4 permits have pollutant allocations in the TMDLs. VDOT has its own load assigned to its MS4 area, as does each MS4.
- According to CL, the loads are small for VDOT construction projects based on the 2006 TMDL study.
  - Stakeholder commented that it's not just the construction projects; it's also the runoff from the roads. They do not have ponds [associated with their roads].
- Q: By looking at the BMP location map, it appears that the ponds are mostly dry ponds; this could get very tricky to retrofit dry ponds that were installed for the purpose of flood control.
- Q: How do you retrofit wet ponds? Does this have an implication on dam safety? A: The ponds that are being suggested for retrofitting are not wet ponds; they are dry ponds.
  - Stakeholder suggested that wet ponds do not reduce bacteria loads; they attract wildlife and are therefore a source of bacteria. NT commented that there is some die-off and bacteria reduction from wet ponds.

<u>Educational Program BMPs</u>

- The group was supportive of a Low Impact Development (LID) symposium and specific outreach related to existing pond retrofits.

- Q: Grease disposal is a problem and can lead to back-ups. There is an opportunity to educate folks about grease disposal by targeting the general public at festivals.

Low Impact Development Discussion

- The group was asked about businesses with LID practices and/or BMPs in place
  - The Dollar Store on Williamson Road has permeable pavers.
  - Enterprise Zones are in Roanoke City and are the highest concentration of impervious area; there are grant monies available for improving these areas.
- Q for the group: Are there any planned BMPs out there?
  - Meridian has a green roof as does the City of Roanoke building.
  - The Hanging Rock park-and-ride would be a good place to install permeable pavers.
- Suggestion was made to include curb-cutting as a BMP practice: a curb retrofit.
- Q: Will people be more likely to install green roofs if they get a reduction in their stormwater fees? A: The fee offset is not that significant.

Discussion of Other BMPs

- Urban tree canopy by RVARC included identifying potential areas for tree planting. This study may be a tool that can be used to locate existing impervious cover.
- A good example of re-planting is in cloverleaves on I-581.

Closing Comments

- The group was asked to review the handouts and send comments to Mary Dail.
- A stakeholder commented that the people at the "bottom of the bowl" need to see that work is being done at the "top of the bowl."
- Q: Is there a speaker that would come out and speak to different groups about the Plan? A: DEQ is available to present information about the Plan.
- Q. Is there an interest in reconvening the Steering Committee following completion of the Plan in order to keep up with implementation progress? There is interest and it was suggested that Steering Committee meet annually.
- Livability Initiative Plan (RVARC) means that there are additional grant funds for the Roanoke Valley.
- RVARC has established a Regional Stormwater Committee and meetings will be an opportunity for outreach and collaboration.
- Q: Are there any public events coming up in the Roanoke area? A: Kite Festival, Marathon, Clean Valley Day (April 5th), Earth Day were mentioned. Bob Clements can get DEQ in touch with different groups. Williamson Road Association has an event scheduled in October.

Upper Roanoke River (Roanoke and Botetourt Counties, Cities of Roanoke and Salem, Town of Vinton) TMDL Implementation (Cleanup) Plan Development
Second Residential and Agricultural Working Group Meeting Notes
February 27, 2014, 6:00 – 8:00 p.m.
Virginia Department of Environmental Quality, 3019 Peters Creek Rd., Roanoke, VA

Attendees:

- Michael Beahm - Mountain Castles SWCD
- Meagan Cupka - Blue Ridge Land Conservancy
- Mary Dail, Diana Hackenburg, Charlie Lunsford, Jim Scott – Virginia Department of Environmental Quality (DEQ)
- Stacy Horton - DCR
- Margie Lucas - Mill Mountain Garden Club
- Michael McEvoy - Western VA Water Authority
- Staci Merkt - Mountain Castles SWCD
- Marlon Old - Mountain Castles SWCD
- Nick Tatalovich & Erin Hagan - Louis Berger Group
- Cindy Linkenhoker - Roanoke County

Introductions were made and meeting guidelines were set.

Background: The Roanoke River is impaired for both bacteria and sediment. This clean-up plan will describe the strategies needed for reducing bacteria and sediment in the Roanoke River watershed to meet applicable water quality standards. This plan covers the Roanoke River watershed from Smith Mountain Lake to the confluence of Mason Creek and the Roanoke River, which includes 10 subwatersheds. The TMDL identified the loads of bacteria and sediment that the different subwatersheds could receive and still meet water quality standards. From these loads, reductions were estimated by source or land use such as developed, cropland, pasture/hay, etc. Clean-up plan actions to meet these reductions can include indirect measures like outreach, educational programs and signage and direct measures which are more commonly known as Best Management Practices (BMPs). The Agricultural and Residential working groups will assist in determining the types and extent of BMPs needed in the subwatersheds as well as the partnerships and funding sources needed to implement the identified clean-up strategies. Different clean-up plan strategies were presented to address residential pollutant sources (sewage disposal, pet waste, stormwater) and agricultural sources (livestock exclusion and manure management, pasture, cropland). The total cost estimates presented are those identified strategies needed to meet water quality standards.

Handouts: Agricultural & Residential Working Groups Meeting #2 Handout, Best Management Practices Efficiency and Cost (updated Draft), Best Management Practice Estimates by Subwatershed

Presentation: The Louis Berger Group (LBG) presented project background and BMP estimation approaches as well as examples from a few subwatersheds. The Project Team reiterated the hope that participants will comment tonight and take the meeting handouts home and submit comments at a later date. The information presented represents a “first-cut” at estimates of BMPs needed by subwatershed.

<u>Residential BMPs Discussion</u>

- The Clean-up plan does not directly target nutrients, but it is recognized that some of the BMPs could reduce nutrient loading in the watershed.

- Pet waste station estimates were calculated by taking the number of residential roads and including a station for every 2 miles. In other Clean-up Plans, this is determined by looking at places in communities were the stations would best serve public dog walking areas. On the Roanoke Greenways, there are 8 pet waste stations. Maintenance is a problem with the stations because people steal the bags. Servicing the stations would be a problem if they were located every 2 miles. Should amend analysis to include or target parks and hotels. May also look at trail coverage map and suggest stations on trails.
- Mill Mountain Garden Club's "Scoop the Poop" educational campaign is starting. They are working with the City and Clean Valley Council and applying for money to purchase interpretative signage. They are also seeking pledges from members and community members to commit to picking up their pet's waste. Eventually, they would like to give participants a symbol of their commitment such as a magnet.
- Pet waste composters are a new concept to most people. Group would like more information about the systems and vendors. These are being used in other Implementation Plan projects. Charlie cited the Doggie Dooley sold by Drs. Foster and Smith which scales to different numbers of dogs serviced. Most useful for people with small yards. Cost-share has been used to purchase units or they can be given out to promote interest in the water quality issue.
- "Pearl Homes" could be the next step in bringing people's attention to water quality issues. The Pearl Homes initiative was started in the Lynnhaven watershed and includes a checklist of a wide array of environmentally responsible practices that homeowners can implement. Homeowners apply to become a "Pearl Home" based on the number/quality of practices they implement in their home and on their property. They receive a garden flag to display in their yard. Could something similar be used in conjunction with stormwater utility fee offsets for homeowners? Some ideas for names are "Logperch Homes" or "Roanoke River Star Homes". However, efforts might be more successful if they start small such as the "Scoop the Poop" initiative.
- "No Mow Zone" program is an initiative of Trout Unlimited's Glade Creek Restoration Committee to encourage landowners to keep grassy riparian buffers. There is a public perception problem with wild landscapes being seen as "ugly" and unkempt rather than as habitat, natural, etc.
- On Back Creek, many homes are old, but because of their location, most of their drainfields are just flowing off so they'll never fail. There is a tendency among developers to find the "sand" to fit in a bigger home. Other states require septic systems be built into clay so the water doesn't drain out. Alternative Waste Treatment system cost may be low. Other IPs use $25,000 as an average.

Agricultural BMPs Discussion

- Mountain Castles SWCD suggested that it is hard for farmers here to qualify for continuous no-till SL-15 here in the mountains. The practice is more common in the eastern part of the state.
- Manure storage dairy and beef in the subwatersheds are not needed. There are no dairies in the Back Creek subwatershed and only one in Tinker Creek which already has a storage area. There are probably a limited number of beef farms that would need manure storage. However, manure storage may include winter feeding lots for calf/cow operations. Those BMPs should be moved around to exclude manure storage to get a more accurate cost estimate.
- Mountain Castles primary BMPs are SL-6, stream exclusions and cover crops. Would suggest referring to the current year's Best Management Practices manual for the full suite of agricultural practices available to the District and farmers for cost-share. Mountain Castles does not do many FR-1 practices, but may be able to get that information.
- Small Acreage Grazing Systems (SL-6AT) are generally for equine and alternative livestock which statewide is booming. DEQ gets a lot of complaints about equine operations which are chronically

overgrazed. Those complaints are sent to VDACS. Those landowners can be hard to reach because they are not plugged into the traditional agricultural community. Botetourt Extension Agent is working now to reach these landowners as it takes a "different approach" to education. Mountain Castles has does very few of those practices with non-traditional farm animals. That is potentially an area for education efforts.

- There is a need to reach out to and educate equine owners
- WP-2A, Streambank Stabilization, can be stand alone, but usually is only done with other practices such as WP-2 (Stream Protection). Would be good to include. Urban riparian buffer analysis should catch some of the opportunity for residential properties that back onto stream areas.

<u>General Discussion</u>

- The strategies needed to meet the sediment TMDL were greater than the strategy needs to meet the bacteria TMDL.
- Erosion & Sediment controls are a concern and will be discussed further in the Government Working Group, including ways to enhance those measures.
- DCR would definitely have options for landowners. They've had a lot of interest from residential landowners in recent years needing help with water issues on their properties. Smith Mountain Lake Association runs a landscape buffer program to help with lake erosion problems. New River RC&D has a live-stake planter for trees to help landowners. A bank erosion problem is known by WVWA in Fairway Forest Estates and the estimate for fixing the problem is $40,000 or more.
- 319(h) funds are out there, but now they are more competitive. It's also a relatively small pool compared to the restoration cost per watershed.
- For administration, these grants can be a hassle. Partnerships help with getting funding. Community organizations, schools, Districts - anyone can be involved.
- A Residential & Agricultural Working Group representative is needed for the Steering Committee.
- Please provide feedback on these BMP and cost estimates as well as any thoughts on prioritizing clean-up efforts throughout the watershed.
- The Government Working Group will meet on February 28. After gathering feedback from the working group meetings, the Steering Committee will meet to review the working group comments. DEQ and Louis Berger will then finalize the draft clean-up plan and present it to the community in a public meeting. Public comment on the draft plan will be accepted and then the plan will be finalized.

Upper Roanoke River (Roanoke and Botetourt Counties, Cities of Roanoke and Salem, Town of Vinton) TMDL Implementation (Clean-up) Plan Development

Second Government Working Group Meeting Notes

February 28, 2014, 9:30 – 11:30 a.m.

Virginia Department of Environmental Quality, 3019 Peters Creek Rd., Roanoke, VA

Attendees:

- Josh Pratt – City of Salem
- Mary Dail, Diana Hackenburg, Charlie Lunsford, Paula Nash, Emma Jones, Jay Roberts, Derick Winn, Jeff Selengut, Jaime Bauer, Greg Anderson – Virginia Department of Environmental Quality (DEQ)
- Scott Shirley - Western VA Water Authority
- Nick Tatalovich & Erin Hagan - Louis Berger Group
- David Henderson, Cindy Linkenhoker – Roanoke County
- Christopher Blakeman, Ian Shaw, Patrick Hogan, Danielle Bishop – City of Roanoke
- Anita McMillan, Ryan Spitzer – Town of Vinton
- Shane Sawyer – Roanoke Valley Alleghany Regional Commission
- Ashley Hall – EEE on behalf of VDOT
- Bill Tanger – Upper Roanoke River Roundtable, FORVA, FFV, FORR
- John Burke - Christiansburg

Introductions were made and meeting guidelines were established.

Background: The Roanoke River is impaired for both bacteria and sediment. This clean-up plan will describe the strategies needed for reducing bacteria and sediment in the Roanoke River watershed to meet applicable water quality standards. This plan covers the Roanoke River watershed from Smith Mountain Lake to the confluence of Mason Creek and the Roanoke River, which includes 10 subwatersheds. The TMDL identified the loads of bacteria and sediment that the different subwatersheds could receive and still meet water quality standards. From these loads, reductions were estimated by source or land use such as developed, cropland, pasture/hay, etc. Clean-up plan actions to meet these reductions can include indirect measures like outreach, educational programs and signage and direct measures which are more commonly known as Best Management Practices (BMPs). The Government Working Group (GWG) will assist in determining the types and extent of BMPs needed in the subwatersheds that will result in reductions in bacteria and sediment loads. In addition, GWG members will help identify potential partnerships and funding sources for implementing clean up measures included in the plan. The total cost estimates presented are those identified through modeling needed to meet water quality standards.

Handouts & Materials: Government Working Group Meeting #2 Handout, Best Management Practices Efficiency and Cost (updated Draft), Best Management Practice Estimates by Subwatershed, Map of Existing BMPs, Map of Livestock Exclusion BMPs Needed

Presentation: The Louis Berger Group (LBG) presented project background and BMP estimation approaches as well as examples from a few subwatersheds. The Project Team reiterated the hope that participants will comment today and review meeting handouts over the next several days and submit comments at a later date. The information presented represents a "first-cut" at estimates of BMPs needed by subwatershed.

Residential Waste Treatment and Pet Waste BMPs Discussion

- Question about Septic pump-outs [BMP Estimates Handout, presentation]: Is unit number representative of 100% or 10% [failure rate]? Answer: 10%
- Q: Is there a place that has the explanation of how the failing septic systems were estimated? A: Not in the hand-out, but it can be added into the presentation so it can be reviewed. Also in the original TMDL documents.
- Q: Are septic systems within 1000 ft from stream on both sides, or 500 ft on each side? A: 1000 ft on both sides.
- Q: Any thoughts on where pet waste stations could be placed? A: Housing complexes, Homeowners Associations' properties
- Q: How would the government implement any of the residential BMPs? These are homeowners' responsibilities. A: The plan and presentation includes all of the recommended BMPs. Local Governments may not be able to regulate, however, there may be a role the government can play in educating the public. DEQ explained that once these residential BMPs are in the plan, grant money may be available. The government may be a partner in getting this information out to the public. The BMPs included in the plan bring the opportunity for some money but not enough for the entire watershed.
- Stakeholder commented that there may be a way to require pump-outs when houses are sold.
- Q: Why do pet waste stations have no removal efficiency? A: Input from the group is welcome. Project Team hopes to come up with a way to quantify pet waste. Same is true for composters.
- Stakeholder commented that an educational program is being implemented for pet waste, then you should also do pump-outs with it; this may help low income families.

Detention Pond Retrofit and General Stormwater BMPs Discussion

- Stakeholder comment to BMP Handout: There is a varying degree of efficiency and the total number of that BMP needed. The efficiencies of each category need to be included in the columns.
- LBG discussed how the BMP reductions were halved in the cases where dates of installations were not available. If practices were installed after TMDL development (2003), then they should be available for 100% reductions. If localities can provide

this information about BMPs installed after 2003, even if it is an estimated percentage of the BMPs, the plan can account for these BMPs more accurately.

- Q: Why are you looking at pre-2003 or post-2003 for accounting for BMPs? A: The model is calibrated through 2003, BMPs in place pre-2003 would have been included in the development and incorporated in the actual pollutant loads; post 2003 installed BMPs should be accounted for as having an impact on reducing pollutant loads.
- Comments from the group regarding material presented today should be received within the next 30 days.
- Discussion regarding retrofitting detention ponds to increase their efficiencies: stormwater is already feeding these detention ponds, to increase the efficiencies would be more beneficial and practical then establishing new BMPs.
- Q: How was infiltration of the soil in these areas considered? One locality lost two detention basins due to sink holes. Karst needs to be looked at prior to developing detention ponds. Were karst maps studied when BMPs were identified? A: Each site will have to be looked at on an individual basis. The plan is not prescribing specific locations for BMPs; BMPs are recommended on a sub-watershed level based on landuse within each subwatershed .
- Stakeholder commented that we may find that the soil infiltrates too well, which causes another set of issues.
- Stakeholder commented that Karst Maps need to be reviewed; there are areas in the area that would NOT be a good idea for infiltration.
- The plan aims to select BMPs that will reduce both pollutants [bacteria and sediment].
- Q: With respect to manufactured BMPs, how are those efficiencies determined? A: LBG looked at other Clean up Plans and applied those efficiencies in this plan. These are BMPs that have been approved by DCR. Need to cross-reference with DCR's Stormwater BMP Clearinghouse.
- Stakeholder commented that the state is designing the removal rates for these BMPs. Maybe the BMPs will not actually meet these reduction efficiencies.
- Q: Some of the older basins were not designed for water quality; would closing these basins be better than retrofitting them?
- Roanoke City wants to encourage planting trees near impervious areas to increase canopy cover. City of Roanoke wants this to be incorporated as a BMP. This could be added as a land conversion BMP.
- Urban Tree Canopy study GIS layers has different datasets that may be useful like non-building and non-road.

- The efficiencies are based on Type 1 practices. There are also Type 2 practices that are in the 2013 Clearing house practices.
- Is there a way to include inspectors for the BMP practices? A: Yes, this can be included in Technical Assistance costs.
- Stakeholder commented that some of these BMPs will have an annual cost for maintenance. How can we include a cost for this? Can we use an average? Pet waste bags are expensive and there needs to be a mechanism for maintaining the trash cans. Roanoke Roundtable is putting stations in place that have the bags, but not the receptacles to throw the waste in. Could be treated kind of like don't leave a trace, take your waste with you or utilize already maintained trash cans (greenway).

Agricultural BMP Discussion

- Q: Explain the unit for Exclusion of Livestock? A: LBG explained that EPA tracks the BMPs by unit not stream length. The number that is used is an average of the stream length in the DCR BMP database.
- Stakeholder comment: Again, the explanation should be readily available in the document so people understand how the BMP representations were decided.
- Stakeholder commented that for tracking purposes, the [Agricultural BMP] unit needs to be in whole numbers. For accounting this needs to be in whole numbers, due to the same reason as a unit is 1 not 1.2. This is also helpful when you have to show improvement depending on how many BMPs are installed.
- Stakeholder commented that DCR tracks "systems" and also tracks the acres treated.
- Q: Can we find the 269 acres that need vegetative cover? A: Not specifically. LBG evaluated at the entire landuse type and established a 10% reduction to come up with the "269 acres". BMPs are not prescriptive to a certain location/address. They are specific to the landuse type within a subwatershed.
- Stakeholder commented that it sounds like there is not enough information to have a viable plan. A: Project Team is using the available information to develop the best plan possible. Existing published IPs and BMP information is utilized to try to estimate what is needed in order to meet water quality. The plan must include BMPs in a way that established TMDL pollutant reduction goals are met.
- As measures are implemented on agricultural land, who keeps track? Local Soil and Water Conservation Districts (SWCDs) track agricultural BMP installation.
- Q: How do localities ensure that the practices that they put into place are going to be tracked and accounted for in this plan? A: Coordination of all of these entities is

what this entire discussion is about. This is another thought as to why steering committee may want to stay involved once the IP is completed.

- Comment was made that the stakeholders are the trackers. Agricultural and residential tracking systems are already in place. MS4 tracking may be required by MS4 permit; this is a question for MS4 staff.
- Since the efficiencies for the BMPs are based on water quality analyses, how can the localities put BMPs into place that are going to reduce the loads?
- Is this [the Clean-up Plan] going to be more prescriptive or are the localities going to have to come up with their own plans? The Plan is being developed to reduce bacteria and sediment loads on different landuse types by subwatershed and is not intended to be any more prescriptive than that.
- Stakeholder commented that as a locality that is downstream of a large agricultural community, there is interest in [the locality] knowing what is going on with BMPs in the agricultural community and is there a mechanism for this? A: The working groups have been separated due to the category of the information, however putting all the stakeholders in the same room would be beneficial. SWCD personnel were unable to attend this meeting, but normally, they would be in the room with the localities (and the SWCDs have a handle on agricultural BMPs). There are opportunities for partnerships due to the "downstream of a large agricultural area" situation.
- The Plan is being developed by stream, is there a way to define the jurisdiction [boundary]? A: Approach has been watershed specific and is not intended to be prescriptive beyond recommending what is needed to meet TMDL reductions for sediment and bacteria.
- Stakeholder suggested that units should be number of BMPs. Units depends on type of BMP.

<u>Stream Restoration BMP Discussion</u>

- Q: With respect to "Total Estimated Stream Length for Restoration" [Planned or Proposed Stream Restoration BMP Table], is this the total length of stream in the watershed? A: No, it is the stream length (feet) that are being considered for stream restoration. It is related to achievement of sediment load reductions.
- Stakeholder requested that total length of streams within the watershed be added to BMP handout.
- City of Roanoke did work in Tinker Creek about 5 years ago and will provide this sending this information to LBG.

- Q: Is Stream Restoration defined? A: Stream restoration was quantified by taking the efficiency and applying it then to the stream length where sediment reductions were needed. Intent was to not limit stream restoration activities by prescribing different stream restoration techniques; thus, stream restoration BMP represents a variety of stream restoration options.
- Stakeholder comment: There needs to be some language in the plan that reflects that the numbers are average units, not actually what may be needed. Some will be higher, some will be lower. There is a significant range in these different real numbers.
- Stakeholder comment: Stormwater handbook has benefits of different stream restoration techniques and referencing this document [Stormwater Handbook] in this plan may be a helpful tool.
- Stakeholder comment: This Plan is a planning document and each BMP will be dealt with on a case-by-case site specific basis.

Discussion of Other BMPs

- Question about Vegetated Swales: Are these reasonable for this Plan? The group affirmed that vegetated swales are appropriate.
- Q: Are there any regulatory restrictions to converting drainage areas to vegetated swales? A: localities couldn't think of any. They don't think there it is prohibited, but it could be hard to overcome some hurdles.
- Stakeholder commented that street sweeping is a challenge for Roanoke County: VDOT owns roads and therefore Roanoke County cannot do this. VDOT does this [street sweeping] very rarely.
- Stakeholder commented that street sweeping is not a 'one size fits all' due to different kinds of sweepers with different efficiencies. Sweepers are expensive to maintain.
- Stakeholder commented that VDOT will be completing an action plan for Roanoke County and there will be more street sweeping in this plan. In the past, VDOT used inmates to physically sweep the streets with brooms and put the sediment into buckets.
- Stakeholder requested that government BMPs should be included in the plan since there are BMPs that they can do on their own property.
- Mary mentioned that Industrial Stormwater General permits were carved out of the MS4 loads. This was based on information provided when their permits were issued/reissued. Industrial Stormwater General Permits received their own WLAs.

- Roanoke County questioned their urbanized area and if their allocation is based on only the regulated area or the entire county? This question will be discussed at the 11:30 MS4 session. Roanoke County's written comments were recognized.
- Stakeholder suggested that the Plan document references in the Stormwater BMP Clearinghouse for more BMPs. Jay Roberts explained that the Clearinghouse BMPs do NOT address sediment but that this would come from 2013 handbook.

Closing Comments

DEQ MS4 staff will be on hand to participate in an MS4 discussion immediately after the GWG meeting. GWG Resources will be posted on the website. Mary will send out draft notes. Group was asked to please provide comments and then the notes will be finalized and posted on the website.

Upper Roanoke River (Roanoke and Botetourt Counties, Cities of Roanoke and Salem, Town of Vinton) TMDL Implementation (Clean-up) Plan Development
Steering Committee Meeting Notes
Virginia Department of Environmental Quality, 3019 Peters Creek Rd., Roanoke, VA
August 20, 2014 1:30 pm

- **ATTENDEES**

  - Sarah Baumgardner, Mike McEvoy (Western Virginia Water Authority)
  - Bill Modica (Upper Roanoke River Roundtable)
  - Bill Tanger
  - Margie Lucas (Mill Mountain Garden Club)
  - Wendy Jones (Williamson Road Area Business Association)
  - Liz Belcher (Roanoke Valley Greenways)
  - Tom Dale (Lumsden Associates)
  - Staci Merkt (Mountain Castles SWCD)
  - Dave Henderson, Tarek Moneir (Roanoke County)
  - Christopher Blakeman, Megan Scott (City of Roanoke)
  - Anita McMillan (Town of Vinton)
  - Ashley Hall (EEE on behalf of VDOT)
  - Jay Roberts, Mary Dail, Diana Hac[illegible]burg, Kip Foster, Cha[illegible] Lunsford (DEQ)
  - Larry Iceman (Smith Mountain Lake Association)
  - Paul Bender, Marcus Aguilar (Virginia Tech)
  - Kafi Howard (Town of Blacksburg)
  - Ed Wells (Roanoke Valley Alleghany Regional Commission)
  - Nick Tatalovich, Erin Hag[illegible] (Louis Berger Group/DEQ Contractor)
  - Josh Pratt (Salem City)
  - Tom Cain (Lick Run Watershed)

- **Welcome, Introductions and Meeting Guidelines**

Handouts: *Updated Best Management Practices (BMPs) by Subwatershed, Updated BMP Efficiencies and Costs*

- **Overview of TMDL and Clean-up Plan Process (presentation)**

Working Group Reports

- Reports will be circulated and placed on

website Business Working Group (Wendy Jones)

- Key Topics & Recommendations
  - Map of existing BMPs to be included in the discussions
  - Confusion of the implementation of the plan being mandatory vs. MS4
  - Businesses concerned about bearing burden of costs
  - Businesses not interested in retrofits

- Most stormwater ponds are dry ponds and not associated with individual businesses
  - ponds mapped in County, not City
- maintenance costs for BMPS should be explained in the plan because BMPs will only provide removal if properly retained
- should be technical assistance to help businesses
- low-impact development resources for businesses

Residential & Agricultural Working Group (Margie Lucas & Mary Dail)

- Key Topics & Recommendations
  - Mill Mountain Garden Club – Scoop the Poop campaign (signage, grants, pledges, etc.)
  - Concern about septage haulers
    - Recommendation to talk about how to deal with inappropriate management by septage haulers
  - Pet waste
    - Plan should account for current pet waste stations and continued station maintenance
  - Pet waste composters should be built into the plan
  - Increase E&S inspections/inspectors should be increased
  - Ag programs should be inclusive of nontraditional producers
  - Make BMP specifications very clear
  - Ed/Outreach - Programs to encourage homeowner participation (i.e. Pearl Homes) – Logperch Homes?
  - Septic maintenance/straight pipe education and outreach needed in the plan
  - Outreach/educational literature specific to septic haulers may also be needed

Government Working Group (Mary Dail)

- Key Topics & Recommendations
  - Needs for septic systems, straight pipe maintenance
  - Considering ordinances for septic maintenance, pet waste
  - Adding additional funding sources (VA revolving loan fund)
  - Talked about areas to target for septic system work
  - Appropriate BMPs for specific watersheds
- MS4 work session - Spin-off of Government WG

o **BMPs and UPDATES (presentation and discussion)**

- Street Sweeping Discussion
  - Proposing that Roanoke County start street sweeping? VDOT controls roads.
    - Included because cooperation between the County and VDOT could occur to create a program
    - It is a cost-effective and efficient BMP for reducing sediment
    - Would Roanoke County or VDOT get the MS4 credit?
      - Good question to ask the MS4 program
  - Should Vinton’s program be included even if it will not be expanded?
    - It will be mentioned in the plan as a recommendation

- Was information procured from VDOT regarding their existing stormwater BMPs?
  - Data request with some detail given – 3 detention ponds reported in the watershed
    - Information came from their MS4 annual report
    - Spatial information included, but tabular specifics not included
    - VDOT will meet their WLA as required by the permit
    - Stakeholder suggested that VDOT's BMP location information is important to know
- Riparian Buffers
  - Question about whether there is a threshold to be included as a BMP?
  - Stakeholder noted that there were projects done on Glade Creek and Tinker Creek that need to be accounted for
- General Discussion about BMPs
  - How would the localities get credit for private septic system maintenance and repairs?
    - Information of system would be reported to VDH; VDH would need to cooperate with localities to share the information
    - Failing septic systems are treated as a separate load in TMDL development
    - BMPs are quantified by land use and not by jurisdiction
  - Stakeholder asked if BMPs could be split out by individual MS4 areas.
    - The TMDL Implementation/Clean-up Plan goal is to meet the pollutant reductions called for in the TMDLs and **not** to prescribe BMPs for inclusion in MS4 TMDL Action Plans. Permittees are responsible for developing TMDL Action Plans as defined by MS4 permits.
    - Stakeholder commented that breakdown by subwatershed does not help
    - TMDLs are developed on a watershed basis
    - Stakeholder commented that TMDL Action Plans must be consistent with the TMDL Implementation Plan and it is hard when the BMPs are not broken up by MS4 areas. Response that TMDL Implementation Plans
    - During the WG meeting discussion, a stakeholder mentioned creating a regional group to develop coordinated TMDL Action Plans

Clarification regarding MS4 TMDL Action Plans and TMDL Implementation Plans:

With respect to general and individual MS4 permits, implementation of and compliance with local TMDL wasteload allocation(s) will be achieved through permit reissuances and the required MS4 Program Plan updates. More specifically, permittees will be required to update their MS4 Program Plans to include TMDL Action Plans to address local TMDL wasteload allocations as permits are reissued. TMDL Action Plans will identify BMPs and other management strategies to be implemented by the MS4 owner to achieve compliance with the TMDL wasteload allocation.

TMDL Action Plans can be implemented in multiple phases over multiple permit cycles using an adaptive iterative approach (i.e. the action plans can and most likely will be revised) provided that permittees demonstrate adequate progress in achieving the WLA(s). Implementation of the TMDL Action Plans is tracked via annual reports prepared by the MS4 owner.

TMDL Implementation plans (IPs) are designed to meet TMDL pollutant reduction targets within a watershed based on landuse as defined by TMDL studies. IPs may be utilized by localities for pollutant reduction strategies; however they are not considered a requirement for permit compliance. Further, IPs do not prescribe specific BMPs for localities to implement to meet their MS4 permit requirements.

- Stakeholder commented that, ideally, as a region, we want to hit the yellow highlighted targets.
    - How does the MS4 do the work that is needed for septic problems and get credit for that work in their plan if failing septics is a separate load?
    - The Clean-up Plan defines the BMPs needed to meet pollutant reduction goals called for by the TMDLs. Failing septic system estimated loads are being addressed by BMPs per subwatershed.
- Stakeholder asked how we control for changes in land use that will continue to happen in the watershed.
    - Original TMDLs were developed using 1996 land use
    - The Clean-up plan updated that to 2006 land use
    - Future land use changes would require revisions to the TMDLs
    - National Land Cover Dataset for 2011 now available, but too late in this process to use
    - The Clean-up Plan is a starting point; water quality monitoring data will ultimately be the way Clean-up Plan progress is demonstrated
- A discussion about Virginia's water quality standards and the fact that they are extremely protective
- Stakeholder requested that GIS shapefiles should be provided to the municipalities instead of them having to do a FOIA request
    - GIS layers that are not considered "draft" can be made available
    - Clean-up Plan specific layers will be available once the Plan is finalized
- Some stakeholders expressed concern over the lack of connection between this project and the localities
- Section 319 Grant Money can only be spent in parts of the subwatersheds that are not covered by a permit (such as an MS4 permit or Industrial Stormwater General Permit)
- Stakeholder mentioned that this should be a Phase I/starting point? Where clean-up efforts/BMPs go from here can be up to the Steering Committee
    - Phase II should connect the localities better with the plan – jurisdictional responsibility
    - Efforts to improve water quality can go beyond the Clean-up Plan
    - This plan is different than other plans because of the scale and time that has elapsed since the TMDLs were completed
- Stakeholder expressed interest in the TMDL Allocation scenarios:

- Watershed Allocation scenario reflects bacteria loads and reductions from the original TMDL
  - Septic system estimates were reviewed by VDH
- Stakeholder commented that Street Sweeping is in the plan to meet the LA, but the City of Roanoke will be counting it for their WLA reductions
- Could street sweeping and land use conversion be included in the BMP tables?
- Comment was made that we need to make sure the load reductions and efficiency calculations are included in the plan for each BMP
- Stakeholder commented that BMP costs look low; Stakeholders are encouraged to comment on specific BMP costs
  - $20,000 acre/manufactured acre > more like $20,000 per ¼ acre-treated
  - $5,000 acre/rain garden looks low
  - DEQ should include these cost estimates for plans throughout the state
  - Retrofits which are likely in this situation will shoot the cost way up
- City of Roanoke has challenges in meeting resurfacing goals and this will continue into the foreseeable future. As roads degrade they create more sediment; they may choose to increase those efforts over purchasing a new sweeper
- Stakeholder commented that the Plan needs to take into consideration Erosion and Sediment Control requirements and increasing restrictions
- Roanoke County asked if DEQ is saying they can meet their WLA with just street sweeping. DEQ suggested that the County discuss its WLA compliance with DEQ MS4 Staff. Roanoke County wanted the name of someone in the MS4 program to contact.

Jaime Bauer is the MS4 Program Manager and would be a good person to start with.

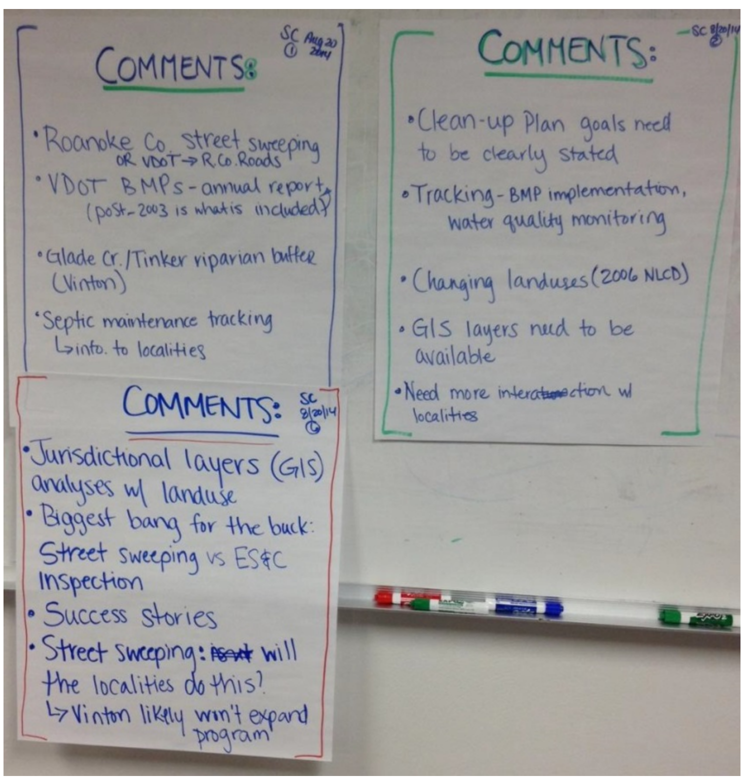
- Roanoke County does not street sweep and there would be resistance to starting efforts
- Street Sweeping more cost-effective; more cost-effective BMPs will be prioritized
  - Vinton is expanding their program
- The group revisited the discussion from previous meetings regarding infiltration basins vs. soils. Soil surveys would need to be completed prior to BMP installation. This note will be included in the Clean-up Plan
- Stakeholder asked about forestry BMPs
  - There is not a large sediment load from forestry
  - Reductions may be required from forests for bacteria based on wildlife. This approach is taken for watersheds where all other source reductions have occurred. Wildlife loads are generally not addressed unless there is a nuisance wildlife population in a specific subwatershed [and then the Virginia Dept. of Game and Inland Fisheries will be consulted].
  - Watersheds of concern for timber harvesting
    - Back Creek, Tinker Creek, Masons Creek, Roanoke River (all except Lick Run and Peters Creek)
    - A stakeholder noted that these harvests are regulated by the state; localities have no power over timber harvests
- Land Use Conversion discussion
  - What types of land uses are being converted? All land uses that could be converted into areas with trees (example: I-581 medians, parking lot islands)
  - Why was 1% used in the BMP tables? Starting point for implementation; 1% equals about 500 acres for the whole plan (Source – Regional Commission Urban Tree Canopy study)

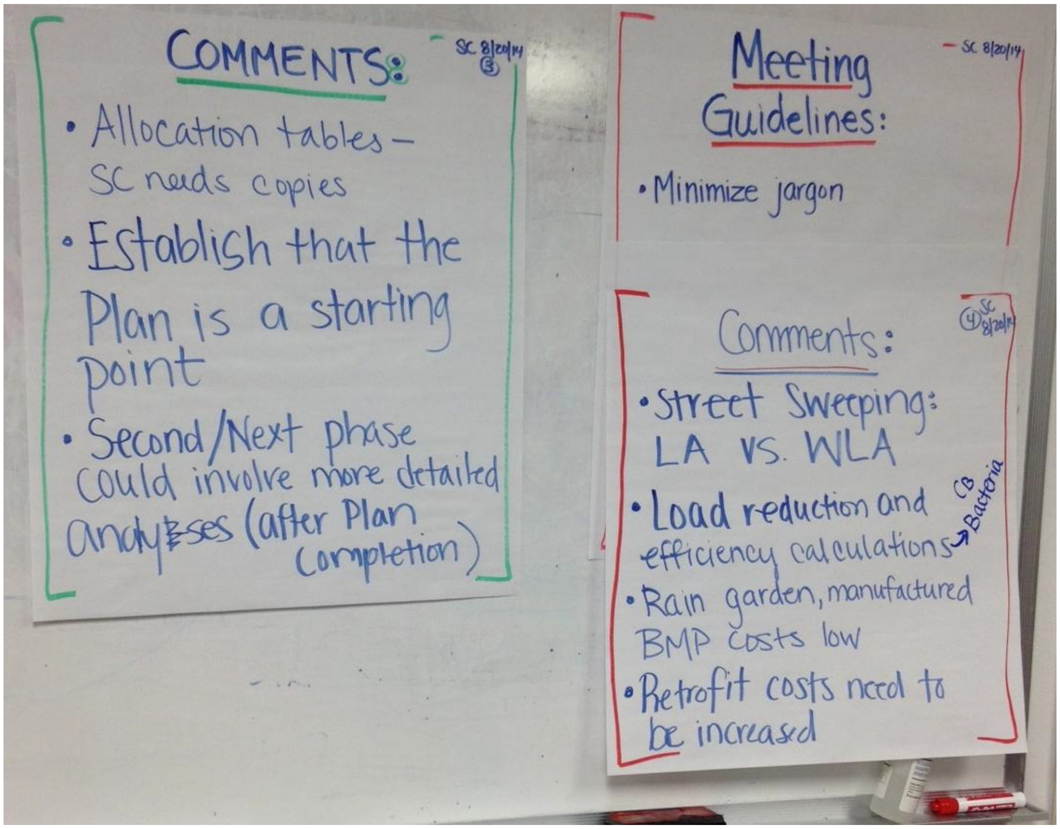
- Are these TMDLs "nested"? Tinker Creek TMDL assumes that the feeding tributary TMDLs will be met
- Not doubling loads of what needs to be reduced

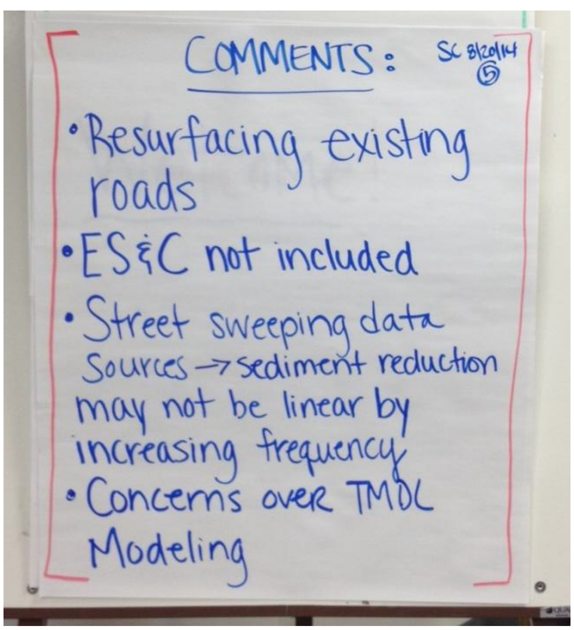
- **Final Discussion**

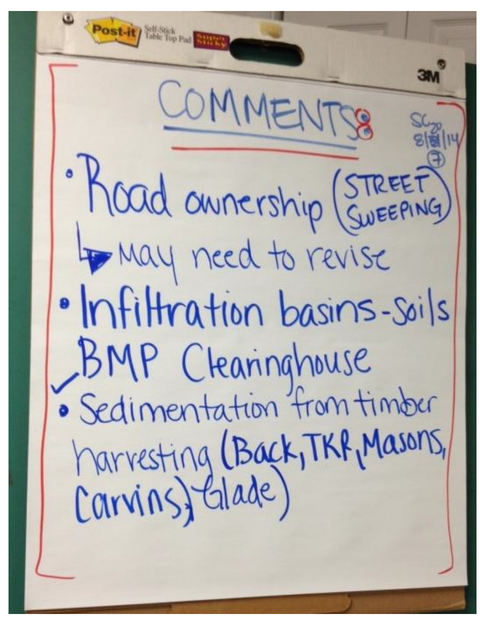
  - **Staging and Milestones, Funding Sources, Monitoring Plan and Technical Assistance discussion will be saved for the next Steering Committee Meeting**
  - Stakeholder asked what was meant by "Technical Assistance" (TA)
    - Clean-up plan will build in some TA
      - Example – Agricultural side includes costs Full Time Employee for the local SWCD
      - The Steering Committee needs to discuss how to allocate Technical Assistance for to support the pollutant reduction strategies for the stormwater component
      - Question was asked about how you break it out by County vs. MS4? Technical assistance will need to include the assistance needed for BMP support in areas outside of MS4s
      - The goal is to quantify cost for Technical Assistance that covers the whole plan area (i.e. TA won't be assigned to specific subwatersheds)
  - The group was asked to please **submit any additional comments to Mary Dail (mary.dail@deq.virginia.gov or 540.562.6715) by Wednesday, September 10th**, unless there were objections. There were no objections.

- **FLIP CHARTS**:




COMMENTS:
SC 8/20/14 ③
• Allocation tables – SC needs copies
• Establish that the Plan is a starting point
• Second/Next phase could involve more detailed analyses (after Plan completion)
Meeting Guidelines:
SC 8/20/14
• Minimize jargon
Comments:
④ SC 8/20/14
• Street Sweeping: LA vs. WLA
• Load reduction and efficiency calculations → Bacteria
CB
• Rain garden, manufactured BMP costs low
• Retrofit costs need to be increased


COMMENTS:
SC 8/20/14 ⑤
• Resurfacing existing roads
• ES&C not included
• Street sweeping data sources → sediment reduction may not be linear by increasing frequency
• Concerns over TMDL Modeling


Post-it
3M
COMMENTS:
⑦
• Road ownership (STREET SWEEPING)
↳ May need to revise
• Infiltration basins - Soils
BMP Clearinghouse
• Sedimentation from timber harvesting (Back, TKR, Masons, Carvins, Glade)

Upper Roanoke River (Roanoke and Botetourt Counties, Cities of Roanoke and Salem, Town of Vinton) TMDL Implementation (Cleanup) Plan Development

Business Working Group Report to Steering Committee

Presented: August 20, 2014, 1:30 p.m.

Virginia Department of Environmental Quality, 3019 Peters Creek Rd., Roanoke, VA

Working Group Participants:

- **Wendy Jones - Williamson Road Area Business Association (representative to the Steering Committee)**
- Bill Tanger - FORVA
- Mary Dail, Diana Hackenburg, Charlie Lunsford, Paula Nash, Emma Jones, Angela Neilan, Kip Foster – Virginia Department of Environmental Quality (DEQ)
- Heather Longo – Virginia Department of Conservation and Recreation
- Scott Shirley - Western VA Water Authority
- Nick Tatalovich, Chris Flannagan, Erin Hagan - Louis Berger Group
- Cindy Linkenhoker – Roanoke County
- Shane Sawyer – Roanoke Valley Alleghany Regional Commission
- Allen Austin – Small Business Owner, Resident
- Tori Williams – Roanoke Region Chamber of Commerce
- Doug Phillips – Southeast Rural Community Assistance Project (SERCAP)
- Liz Belcher – Roanoke Valley Greenways
- Megan Daily – Roanoke County

Purpose of Working Groups: The Business Working Group concentrated on the following identified problems contributing to excessive sediment and bacteria from commercial areas: lack of streamside vegetation, failing septic systems from businesses, stream channel modifications, litter, illicit connections/discharges , pollutant buildup on impervious surfaces, managing peak flows from stormwater runoff, and enforcement of erosion and sediment control regulations.

Meeting Dates: The Business Working Group met on June 20, 2013 2:00 p.m. and February 27, 2014 2:00 p.m. Both meetings were held at the DEQ Roanoke office (3019 Peters Creek Road, Roanoke).

Key Topics and Recommendations

Stormwater

- The group recommended that a map showing existing BMPs needs to be included in the discussion.
- Business-owner concerns:
    - Stormwater is associated with fees and the fees concern the business community,
    - BMPs will be installed and water quality improvement achievements will occur on the backs of businesses.
- There are costs associated with each stormwater pond and then a cost for the retrofit. All of these costs need to be represented in the Clean-up Plan along with the efficiencies.
- Stakeholder commented that businesses will not likely take advantage of monies to help retrofit stormwater ponds.

- Stormwater ponds
  - Most of the ponds are dry ponds
  - Roanoke County has the drainage areas mapped but Roanoke City doesn't have theirs mapped yet.
  - Stormwater ponds may be managed by an entity other than the locality or entity who originally constructed the pond.
  - The recommendation is to find ways to reduce pollutants on the entire watershed, not individual localities/businesses.

Bacteria Loads

- Roanoke Wastewater Treatment Plant Update: Dry Flow 28-29MGD, phosphorus is the lowest in the state, high flows currently are 137 MGD; the plant is still able to meet their limit: 170-180 MGD should be their maximum capacity. It would cost $150 million to upgrade the system; relief Sewer in Tinker Creek.
- Pet waste: need to reach out to the Association of Vets, animal control personnel, Mill Mountain Zoo, and SPCA

Other Related Topics

- Urban tree canopy by RVARC included identifying potential areas for tree planting. This may be a tool that can be used to locate impervious cover.
- Livability Initiative may include additional funds applicable to BMP installation

Recommendations to Steering Committee

- The Business Working Group is concerned about BMP maintenance. Maintenance costs for Stormwater BMPs need to be explained and included in the Clean-up Plan:
  - With respect to maintenance, sediment BMPs will eventually fill up if not properly maintained. Therefore the BMP efficiencies are only going to provide the expected efficiency if they are maintained properly.
  - Stormwater BMP inspection is important and inspection programs exist in at least one locality. Technical Assistance should consider BMP inspections.
- Low impact development (permeable pavers, green roofs) exists in the watershed. Those responsible for maintaining these features would be good resources for local businesses.

<u>Outreach</u>

- Educational materials (like Low Impact Development training) related to stormwater retrofits for businesses are needed.
- Need to get the folks who want to promote wildlife on board with retrofitting
- Proper disposal of oil and grease education is needed.
- There are several public events throughout the year (Kite Festival, Blue Ridge Marathon, etc.) that provide a platform for outreach.
- Vets, pet stores, Mill Mountain Zoo, SPCA should be targeted for pet waste outreach
  - Suggested that Vets and Pet Stores could print "Please use this bag for picking up pet waste" (or similar) on the shopping bags about picking up poop

- Need to make sure that people are educated about the correlation among money, TMDLs and the Clean-up Plan
- Promote and expand programs that recognize businesses for excellence in environmental management practices: Cool Green BIZ (Roanoke County) and Clean and Green (Roanoke City)
- Recreational interests could be used to provide support for the Clean-up Plan because healthy waters are economic stimuli (via recreation). Roanoke Outside (Pete Eschelman) should be contacted for support. Roanoke Outside has data on the economic advantage of putting in BMPs and having healthy natural resources.

Upper Roanoke River (Roanoke and Botetourt Counties, Cities of Roanoke and Salem, Town of Vinton) TMDL Implementation (Clean-up) Plan Development
Residential and Agricultural Working Group Report to Steering Committee
Presented: August 20, 2014, 1:30 p.m.
Virginia Department of Environmental Quality, 3019 Peters Creek Rd., Roanoke, VA

Working Group Participants:

- Michael Beahm - Mountain Castles SWCD & Botetourt County Farmer
- Meagan Cupka - Blue Ridge Land Conservancy
- Margie Lucas - Mill Mountain Garden Club
- Michael McEvoy - Western VA Water Authority
- Nick Tatalovich, Erin Hagan - Louis Berger Group
- Cindy Linkenhoker, Dave Henderson, Bruce Peters – Roanoke County
- Heather Longo, Stacy Horton - Virginia Department of Conservation and Recreation (DCR)
- Marlon Old, Staci Merkt - Mountain Castle Soil and Water Conservation District (SWCD)
- Jeff Henderson - Botetourt County Farmer
- Doug Phillips- Southeast Rural Community Assistance Project (SERCAP)
- Dave Burris - Virginia Department of Health (VDH)
- Mary Dail, Diana Hackenburg, Charlie Lunsford, Jim Scott, Angela Neilan – Virginia Department of Environmental Quality (DEQ)

Purpose of Working Groups: The Agricultural Working Group concentrated on the following identified problems contributing to excessive sediment and bacteria from agricultural areas: lack of streamside vegetation, agricultural runoff, livestock access to streams, and livestock waste management. The Residential Working Group considered the following identified problems contributing to excessive sediment and bacteria from urban, residential, and commercial areas: failing septic systems and straight pipes, lack of streamside vegetation, pet wastes, stream channel modifications, litter, illicit connections/discharges, pollutant buildup on impervious surfaces, increasing development and peak flows from storm water runoff, and enforcement of erosion and sediment control regulations with residential construction. Due to low numbers of stakeholders in each working group, it was determined at the first meeting to combine them into one working group.

Meeting Dates: The Residential and Agricultural Working Group met on June 20, 2013 7:00 p.m. and February 27, 2014 6:00 p.m. Both meetings were held at the DEQ Roanoke office (3019 Peters Creek Road, Roanoke).

Key Topics and Recommendations

The following is a summary of the issues discussed at the Residential and Agricultural Working Group meetings and their recommendations to the Steering Committee:

On-site sewage disposal systems:

- Background Information includes:
    - It can be difficult to identify straight pipes. Residents with straight pipes are more likely to come forward if they know funding assistance is available.
    - None of the localities in the Clean-up Plan have ordinances that require septic system maintenance. Roanoke County does require houses within a certain distance of sewer

lines to hook-up to the system. There are some houses within Roanoke City that are not hooked up to the sewer because connection is impractical.
    - In Roanoke County, less than 50% of homes are on sewer.
    - 95% of Roanoke City is connected to sanitary sewer.
    - Most jurisdictions have GIS and they could identify houses with onsite systems that are close to the streams to target outreach.
- Problem areas within the watershed include:
    - Glade Creek and Laymantown are areas likely to have failing septic systems.
    - Septage haulers improperly disposing of waste may be a watershed-wide problem.
    - Roanoke County areas with no sewer: Ardmore, Summerdean, Cherokee Hills, Andrew Lewis Place, Loch Haven Road, Glenvar Heights, Bennett Springs, Miller Highlands, Mason Cove, Wildwood Road, Indian Grave Road/Clearbrook, West Ruritan, West River/ Poor Mtn. Rd.
    - Roanoke City areas with no sewer: Richards Avenue, Oak Road, VA Hospital area, Cove Road (Fairhope), Hershberger Road area.
    - Back Creek area has many older homes and may also be a problem area.

- Alternative systems:
    - There are opportunities to install alternative waste treatment systems in areas covered by the Clean-up Plan.

Pet Waste:

- Maintenance is a problem with pet waste stations (replacing bags, proper disposal of used bags, etc.).
- Mill Mountain Garden Club has partnered with Clean Valley Council and Roanoke City to establish a “Scoop the Poop” educational campaign. They are seeking pledges from garden club members and community members to commit to picking up their pet’s waste.
- Pet waste composters are a new concept to most people. Most useful for people with small yards. Cost-share has been used in other plan areas to purchase units or they can be given out to promote interest in water quality issues.

Stormwater:

- There are areas in the watershed where Erosion and Sediment Control (E&S) practices are not installed or maintained properly.

- There are too few E&S inspectors and inspections. There is also a prevalence of highly erodible land available for new construction.

Agriculture:

- Additional information on voluntary (i.e. non cost-share funded) BMPs is needed; specifically there needs to be a way to account for practices that are installed but not tracked through Soil and Water Conservation Districts.
- There are livestock markets present in the watershed and can be a bacteria non-point source. One livestock market is in the Tinker Creek watershed.
- BMP Considerations

- Mountain Castles SWCD representatives felt that increased cost-share match would increase participation in the program.
- It was noted that TMDL cost-share funding (awarded competitively in areas with Clean-up Plans) increases the cost-share on the most popular fencing practice to 85%.
- 100% cost-share for cattle exclusion fencing practices will be available in all areas as proposed for the 2014 and fiscal years (starting July 1).
- It was clarified that cost-share funding available for fencing practices requires a 35 foot setback or a 10 foot setback; though the latter has a lower percentage of cost-share offered.
- There are some stipulations on farmers and specifications that practices must meet to be eligible for cost-share. Farmers must have the money to pay for the practices up-front, as cost-share funding is conducted on a reimbursement basis.
- Some farmers fear that the government will have more control over their farm if they accept cost-share monies.

Recommendations to Steering Committee:

- Onsite sewage disposal:
  - Suggest establishing a tracking system for septage haulers to ensure that pumped waste goes to the wastewater treatment plant.
  - Target areas for sewer line extension need to be specifically identified in the Clean-up plan in order to be eligible for sewer line connection cost-share funds.

- Pet Waste
  - The Plan needs to consider existing pet waste stations and build in cost for maintenance of new pet waste stations.
  - Include residential pet waste composters and educational materials in the Plan (since most pet-owners are not familiar with these systems).

- Stormwater
  - Recommend increased E&S inspectors and inspections in the Plan.

- Agriculture
  - Hobby farmers are becoming more common; thus, programs need to be inclusive of both non-traditional and traditional agricultural constituents.
  - Provide clarity regarding cost-share money availability and requirements (i.e. financial commitments, 35' buffer, etc.).

- Education and Outreach
  - Consider establishing a program such as the Lynnhaven "Pearl Homes" to bring attention to water quality issues. [The Pearl Homes initiative consists of a checklist including a wide array of environmentally responsible practices that homeowners can implement. Homeowners apply to become a "Pearl Home" based on the number/quality of practices they implement in their home and on their property. They receive a garden flag to display in their yard.] Some ideas for names are "Logperch Homes" or "Roanoke River Star Homes".
  - Include septic system maintenance and straight pipe education in the Clean-up Plan:

    - Newsletters (distributed to homeowners' associations, agricultural groups, etc.), mailings, and door hangers would be effective forms of outreach.
    - Septic system pumping companies should also carry educational literature for distribution.
- Pet waste educational materials should be available at pet stores, veterinarian offices, dog parks, and pet waste bag kiosks.

Upper Roanoke River (Roanoke and Botetourt Counties, Cities of Roanoke and Salem, Town of Vinton)
TMDL Implementation (Clean-up) Plan Development
Government Working Group Report to Steering Committee
Presented: August 20, 2014, 1:30 p.m.
Virginia Department of Environmental Quality, 3019 Peters Creek Rd., Roanoke, VA

Working Group Participants:

- Chuck Van Allman, Josh Pratt – City of Salem
- Roy Nester, John Burke – Town of Christiansburg
- Carol Linkenhoker – Botetourt Co.
- John Burke – Gay and Neel, Inc.
- Kafi Howard – Town of Blacksburg
- Ed Wells, Shane Sawyer – Roanoke Valley Alleghany Regional Commission
- Anita McMillan, Ryan Spitzer – Town of Vinton
- Christopher Blakeman, Danielle Bishop, Ian Shaw, Patrick Hogan – Roanoke City
- Michael McEvoy, Scott Shirley - Western VA Water Authority
- Nick Tatalovich, Erin Hagan, Chris Flannagan - Louis Berger Group
- Cindy Linkenhoker, Dave Henderson, Bruce Peters – Roanoke County
- Heather Longo, Stacy Horton - Virginia Department of Conservation and Recreation (DCR)
- Doug Phillips- Southeast Rural Community Assistance Project (SERCAP)
- Dave Burris - Virginia Department of Health (VDH)
- Ashley Hall – EEE on behalf of VDOT
- Bill Tanger – Upper Roanoke River Roundtable, FORVA, FFV, FORR
- Mary Dail, Diana Hackenburg, Paula Nash, Charlie Lunsford, Emma Jones, Jay Roberts, Derick Winn, Jeff Selengut, Jaime Bauer, Greg Anderson – Virginia Department of Environmental Quality (DEQ)

Purpose of Working Groups: The Government Working Group (GWG) assisted in determining the types and extent of Best Management Practices (BMPs) needed in the subwatersheds that will result in reductions in bacteria and sediment loads. GWG members helped identify potential partnerships and funding sources for implementing clean up measures included in the plan. In addition, the GWG aided in identifying additional programs and technical resources, lead agencies for agricultural, residential and business water quality improvement efforts, and regulatory controls currently in place that may compel water quality improvement in the impaired watersheds.

Meeting Dates: The Government Working Group met on August 27, 2013 10:00 a.m. and February 28, 2014 9:30 a.m. Both meetings were held at the DEQ Roanoke office (3019 Peters Creek Road, Roanoke).

Key Topics and Recommendations

The following is a summary of the issues discussed at the Government Working Group meetings and their recommendations to the Steering Committee:

On-site sewage disposal systems:

- Background Information includes:

    - The TMDL assumed a septic system failure rate of 3% (Upper Roanoke River Watershed Bacteria TMDL) of the total septic systems in the watershed. The "failure" rate in the TMDL studies is based on VDH's definition (i.e. sewage on the ground).
    - Straight pipe estimates during TMDL development were 162 (Upper Roanoke River Bacteria TMDL) and 75 (Tinker, Glade areas) (0.04% estimated in the Cities of Roanoke and Salem). These estimates are based on a self-reported number from a question on the 1990 census. On the 1990 U.S. Census, people were asked what time of sewage disposal system that was associated with their home: sanitary sewer connection, septic system or "other". During TMDL development, the census data is interpreted the "other" to mean straight pipes. Pit privies are considered straight pipes during TMDL development (and with respect to negative effects on water quality). The number of estimated straight pipes is conservative. It's very hard to find all the straight pipes that may be estimated in the TMDL. Clean Up plans are usually repair-focused.
    - VDH summarized their programs during the first GWG meeting:
        - Straight pipes and failing systems are addressed on a complaint basis. Repair is done by homeowners and VDH does not require pumpouts. There is a local ordinance that requires septic system pumpouts in areas of Franklin County within close proximity to Smith Mountain Lake. In addition, VDH does have a pump out program for boats on Smith Mountain Lake.
        - VDH does not have an inspection program and there is no database that contains information about septic system applications. Annual inspections are required for alternative systems.
- Cost-share for septic system pump-outs was discussed.
- The group discussed the possibility of having specific failure rates by locality/subwatershed.
- Grey water from straight pipes was discussed and the group agreed that grey water is a source of bacteria. VDH records don't specifically identify where straight pipes are removed.
- The group discussed ordinances related to sewer line connection:
    - Roanoke Co. requires that houses within 300 feet of the sewer system connect.
    - Vinton: They have their own ordinances, they do not fall under Roanoke County, but they are concerned about the cost to connect to the sanitary sewer system.
    - Salem: They require people to hook up, but there are some exceptions. Within 1000 ft. of the sewer line, the connection fee is $1900. They take the hook up to the property line. Straight pipes are unlikely in Salem.
    - Botetourt: There are ordinances on water, but not sure about sewer.
    - Roanoke City requires connection to the sewer system regardless of distance.
- WVWA evaluates about 10-12 sewer line requests per year. There is usually a good reason that they have not been connected.

Sewer Overflows related to Oil and Grease

- The localities discussed their various programs and most have had success with their outreach efforts.

Pet Waste:

- The group discussed the need for a pet waste BMP removal efficiency. Project Team hopes to come up with a way to quantify pet waste and welcomed input from the GWG, same is true for pet waste composters.

- There was concern over maintenance of pet waste station garbage cans and it was suggested that a cost be included for maintenance of these BMPs.
- Most localities have dealt with pet waste by distributing literature and/or reaching out to residents.
- Upper Roanoke Roundtable will provide the bags if localities/organizations request them.

Stream Restoration:

- The GWG participants informed the project team of planned and ongoing stream restoration projects in the watersheds.
- There was confusion expressed over the units and lack of specifics with respect to stream restoration BMPs presented. There was concern over the fact that the BMP numbers could be over or under estimating what exactly is needed out there in terms of stream restoration.

Stormwater:

- Background information includes:
    - Industrial Stormwater General Permitted facility areas were carved out of MS4 boundaries and given their own WLA where information was available at the time of TMDL development.
    - Localities expressed concern over their MS4 WLAs being assigned based on now outdated census information.
- Discussion regarding retrofitting detention ponds to increase their efficiencies mentioned stormwater is already feeding these detention ponds, to increase the efficiencies would be more beneficial and practical then establishing new BMPs.
- The group discussed the importance of soil infiltration and karst topography. It was noted that each site will have to be looked at on an individual basis. The plan is not prescribing specific locations for BMPs; types and numbers of BMPs are recommended on a sub-watershed level based on landuse within each subwatershed.
- DCR's stormwater BMP clearinghouse was mentioned multiple times and the project team needs to cross-reference it and ensure that consistency exists as appropriate.
- The group discussed street sweeping extensively and mentioned that it is not a 'one size fits all' approach due to different kinds of sweepers with different efficiencies. Sweepers are expensive to maintain. Roanoke Co. has the challenge of not owning their roads; thus street sweeping is not under their control.
- The GWG discussed the City of Roanoke's Stormwater utility fee that is based on the percent of impervious cover. There is a crediting system in place for existing BMPs and is based on the VA Stormwater BMP Clearinghouse.

Agriculture:

- Livestock exclusion BMP discussion included the need for additional explanation of how BMPs are expressed. State reporting to EPA tracks the BMPs by unit not stream length. The number that is used is awatershed average of the stream length in the DCR BMP database.
- Agricultural BMP unit needs to be in whole numbers. For accounting this needs to be in whole numbers, due to the same reason as a unit is 1 not 1.2. This is also helpful when you have to show improvement depending on how many BMPs are installed. DCR tracks "systems" and also tracks the acres treated.

- GWG participants discussed the BMPs and why they couldn't be pinpointed to an exact location in the watersheds. BMPs are not prescriptive to a certain location/address. They are specific to the landuse type within a subwatershed.
- There was concern that the lack of prescriptive BMPs meant that there is not enough information to have a viable plan. Existing published IPs and BMP information is utilized to try to estimate what is needed in order to meet water quality. The plan must include BMPs and demonstrate that established TMDL pollutant reduction goals are met.
- Locality representatives expressed concern about BMP tracking and crediting. The group thought that this issue provides support for the/a steering committee to continue to be involved once the IP is complete. Agricultural and residential tracking systems are already in place. MS4 tracking may be required by MS4 permit; this is a question for MS4 staff.
- There was a discussion about localities downstream of large agricultural communities. In light of their proximity, there is interest in knowing what is going on with BMPs in the agricultural community. The group recognized that putting all the stakeholders in the same room would be beneficial in order to foster relationships across the working groups. SWCD personnel were unable to attend the GWG meetings, but normally, they would be in the room with the localities (and the SWCDs have a handle on agricultural BMPs). There are opportunities for partnerships due to the "downstream of a large agricultural area" situation.

Recommendations to Steering Committee:

- General
  - The GWG participants request that BMP types, units and efficiencies be explained in the plan across all BMP types (agricultural, stormwater, and residential).
  - Include vegetated swales in the plan. There are subwatersheds where these are feasible.
  - "Garbage juice" as a potential bacteria source was discussed during one of the GWG meetings and it was suggested that the failure rate of septics be expanded to include this leakage from dumpsters.

- Onsite sewage disposal:
  - Local Governments may not be able to regulate, however, there may be a role the government can play in educating the public. Specifically, local governments may be a partner in getting educational and grant information out to the public. There may also be a way for local governments to require septic system pump-outs with property transfers.
  - The methods used to estimate failing septic systems and straight pipes in the watersheds needs to be explained in the clean-up plan.

- Pet Waste
  - Pet waste BMPs will have an annual cost for maintenance. The plan needs to include costs for maintainence of BMPs such as trash can placement and maintenance near pet waste stations.

- Stream Restoration
  - Need to clearly define how the stream restoration BMP was defined and include the total number of stream miles (not just those that are targeted for stream restoration activities).
  - The plan should explain that the recommended BMPs may be greater or fewer.

  - The Stormwater Handbook contains useful information about stream restoration techniques and should be referenced in the plan.

- Stormwater
  - Include land conversion BMPs such that increases in tree canopy cover are recommended in the plan. The Urban Tree Canopy Study layers may be useful for the project team.
  - BMP inspectors need to be included in the Technical Assistance costs.
  - Localities need a clear understanding of MS4 TMDL Action Plan requirements.
  - The Plan needs to contain explicit language stating that the purpose is to identify actions that correlate to bacteria and sediment load reductions on different landuse types by subwatershed. The plan is not intended to prescribe BMPs for inclusion in MS4 TMDL Action Plans.
  - MS4 localities are interested in any information specific to their jurisdiction.
  - Street sweeping varies by locality, equipment, frequency and efficiency. Localities may be willing to provide information to make the street sweeping BMPs realistic.

- Agriculture
  - Livestock exclusion BMP units need to be explained in the plan.
  - BMP tracking by Soil and Water Conservation Districts needs to be mentioned in the plan and available to stakeholders.
  - There is interest among the local governments to interact and potentially partner with SWCDs in order to be involved in agricultural-related water quality improvement projects.

- Education and Outreach
  - There is a need for an educational program to inform the public about how to maintain septic systems.
  - Localities may be able to assist in the effort to educate residents about proper septic system maintenance and pet waste effects on water quality.
  - If grant funds are obtained to cost-share on addressing straight pipes and failing septic systems which local agency/organization would possibly be interested and best suited for this role?
    - Southeast Rural Community Assistance Project (SERCAP)
    - VDH
    - Soil and Water Conservation Districts
    - Roanoke Valley Alleghany Regional Commission
    - TAP (Total Action against Poverty)
  - Western VA Water Authority noted that in the past they have not been able to receive grant money directly; they have worked with partners. The arrangement would depend on the grant.
  - Recommended organizations to help with pet waste education:
    - Parks and recreation departments
    - Clean Valley Council
    - Upper Roanoke River Roundtable
    - Veterinarian offices, kennels, SPCA, Angels of Assissi (Vinton distributes information at Angels of Assissi events)
    - Police Department/Animal Control officers

- Homeowners Associations – City representatives have good report with neighborhood associations.
- Roanoke County regularly has meetings with homeowners' associations, but not all HOAs participate
- PetSmart, Petco, Nature's Emporium

Appendix C – Benthic Nesting Rationale

Roanoke River Benthic TMDL Nesting Rationale

Counties of Botetourt, Floyd, Montgomery, Roanoke, Roanoke City, & Salem City, *Virginia*

Completed TMDL Name: Benthic TMDL Development for the Roanoke River
Stream Name: Roanoke River and tributaries Barnhardt Creek, Mason Creek, Mudlick Creek, Murray Run, Ore Branch, Unnamed tributary to Smith Creek (XMV) and Gish Branch.
TMDL Completion Date: 5/10/2006

Table 1
Segments Included in the TMDL

ID305B	TMDL ID	WATER NAME	RIVER (Miles)	LOCATION
General Standard Benthic - Sediment				
VAW-L03R_ROA01A00	L04R-01-BEN	Roanoke River	1.20	Roanoke River mainstem from the Mason Creek mouth upstream to the Rt. 419 Bridge.
VAW-L03R_ROA02A00	L04R-01-BEN	Roanoke River	2.67	Roanoke River mainstem from the Rt. 419 Bridge upstream to the City of Salem downtown intake on the Roanoke River.
VAW-L04R_ROA03A00	L04R-01-BEN	Roanoke River Niagara	0.86	Roanoke River mainstem from near the backwaters of the Niagara Impoundment upstream to the end of the WQS designated public water supply (PWS section 6i) segment. The upstream ending of the PWS segment from SML 795 ft. pool elevation.
VAW-L04R_ROA04A00	L04R-01-BEN	Roanoke River	0.25	Roanoke R. mainstem from near the backwaters of Niagara Impoundment upstream to the Tinker Creek confluence on the Roanoke River (section 6). The upstream ending of the WQS designated public water supply (PWS) segment from SML 795 ft. pool elevation.
VAW-L04R_ROA05A00	L04R-01-BEN	Roanoke River	0.35	Roanoke River mainstem from the Western Virginia Water Authority Roanoke Regional Water Pollution Control Plant downstream to the Tinker Creek confluence (WQS section 6).
VAW-L04R_ROA06A00	L04R-01-BEN	Roanoke River	4.33	Roanoke River mainstem from the Murray Run mouth downstream to the Western Virginia Water Authority Roanoke Regional Water Pollution Control Plant.
VAW-L04R_ROA07A00*	L04R-01-BEN	Roanoke River	3.31	Roanoke River mainstem from the Peters Creek mouth downstream to the Murray Run confluence on the Roanoke River.
VAW-L04R_ROA08A02*	L04R-01-BEN	Roanoke River	2.21	Roanoke River mainstem from the Mason Creek mouth downstream to the confluence of Peters Creek on the Roanoke River.

* Segment proposed for 2014 delist

Table 2 Segments for Nesting in the Year 2014 Report				
ID305B	TMDL ID	WATER NAME	RIVER	LOCATION
General Standard Benthic - Sediment				
VAW-L01R_XMV01A10	L01R-01-BEN	Smith Creek, UT (XMV)	1.61	Smith Creek, UT (XMV) from its mouth on Smith Creek upstream to its headwaters.
VAW-L04R_BHT01A10	L04R-06-BEN	Barnhardt Creek	5.31	Barnhardt Creek from its confluence on the Roanoke River upstream to its headwaters.
VAW-L04R_MDL01A06	L04R-02-BEN	Mudlick Creek	7.61	Mud Lick Creek from its confluence on the Roanoke River upstream to its headwaters.
VAW-L04R_MSN01A00	L04R-05-BEN	Mason Creek	7.72	Mason Creek mainstem from its confluence with the Roanoke River upstream to near the Mason Cove Community.
VAW-L04R_MUR01A00	L04R-07-BEN	Murray Run	3.57	Murray Run mainstem from its headwaters to its mouth on the Roanoke River.
VAW-L04R_GSH01A14	L04R-08-BEN	Gish Branch	2.40	Gish Branch mainstem from its mouth on Mason Creek upstream to its headwaters.
VAW-L04R_ORE01A00	L04R-04-BEN	Ore Branch	2.55	Ore Branch mainstem headwaters near Hunting Hills downstream to its confluence with the Roanoke River.

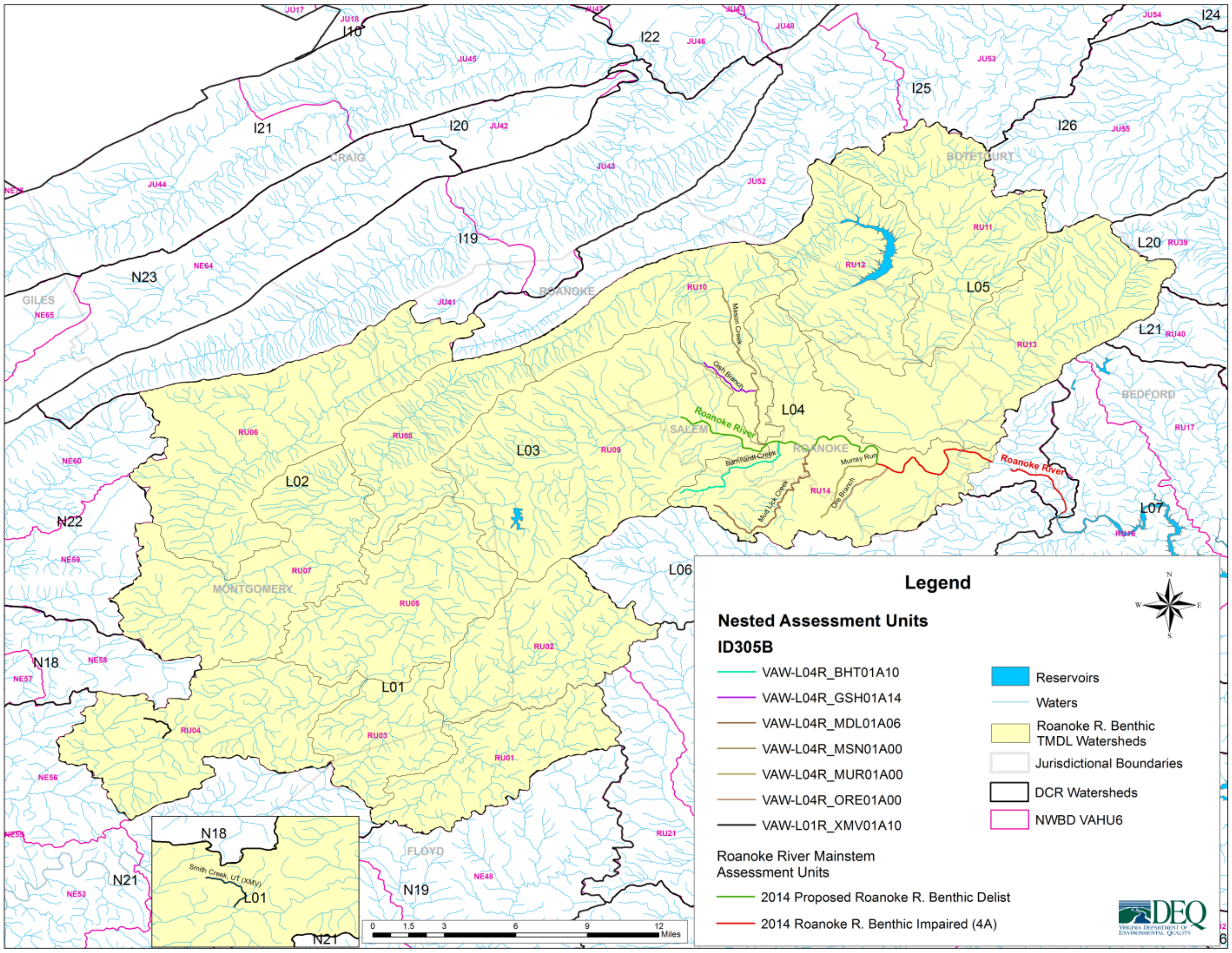


Figure 1. Map of TMDL Boundary, approved TMDL segment, and proposed nested segments.

Justification for Nesting:

The approved Benthic TMDL for the Roanoke River, Virginia (TMDL) addressed sediment contributions as being the most probable stressor to the benthic macroinvertebrate communities in the Roanoke River. The TMDL took into account all point sources and non-point sources in the watershed. In addition, a TMDL Implementation Plan (IP) is currently under development to meet the pollutant reduction goals called for in the TMDL. Since the TMDL and TMDL IP addressed all areas contributing to instream sedimentation, it is our recommendation that the seven above mentioned assessment units (Table 2) in the Roanoke River watershed be placed in Category 4A for the Aquatic Life Use.

The proposed nested segments are contained within the approved Benthic TMDL for the Roanoke River, Virginia developed by the Louis Berger Group, Inc. for the Virginia DEQ and EPA approved on 5/10/2006. The Virginia Stream Condition Index (VSCI) average scores from collections during the assessment period are as follows: Murray Run: 19.5; Mudlick Creek: 24.3 and 28.7 (2 stations); Mason Creek: 55.3 and 37.6 (2 stations); Gish Branch: 47.9; Barnhardt Creek: 36.8; Smith Creek, UT: 54.6; and Ore Branch: 23.3. Acceptable (meeting) scores are 60 and above. Land use surrounding the proposed nested segments is similar to the landuse that comprises the Benthic TMDL for the Roanoke River, Virginia area. There are no individual VPDES permitted outfalls within the proposed nested drainages. Industrial Stormwater General Permits (ISWGPs) within the proposed nested watersheds will be assigned sediment waste load allocations if they were not included in the Benthic TMDL for the Roanoke River, Virginia. Implementation of best management practices in the Upper Roanoke River watershed is anticipated to reduce sedimentation. Sedimentation from the proposed nested portions is believed minimal in comparison to the overall approved TMDL watershed.