Tuscarora Creek Watershed Based Plan
West Virginia Stream Code: WVP-4-C

In the Potomac River Watershed
Berkeley County, WV

March 2013

Prepared By

Alana Hartman, West Virginia Dept. of Environmental Protection
Kristin Mielcarek, Canaan Valley Institute
And the Opequon Creek Project Team

Cover photo: Tuscarora Creek near the confluence with Opequon Creek, by A. Hartman 2010

EPA Criteria for Evaluating WBPs

A. Identification of Causes & Sources of Impairment	Page reference
Sources of impairment are identified and described.	8 - 17
Specific sources of impairment are geographically identified (i.e. mapped)	8 - 17, Figure 5
Data sources are accurate and verfiable, assumptions can be reasonably justified	
B. Expected Load Reductions	
Load reductions achieve environmental goal (e.g. TMDL allocation)	21, Table 9 24, Table 10
Desired load reductions are quantified for each source of impairment identified in Element A	21, Table 9 24, Table 10
Expected load reductions are estimated for each management measure identified in Element C and overall watershed.	21, Table 9 24, Table 10
Data sources and/or modeling process are accurate and verifiable, assumptions can be reasonably justified	
C. Proposed Management Measures	
Specific management measures are identified and rationalized	17 - 24
Proposed management measures are strategic and feasible for the watershed	17 - 24
Critical/Priority implementation areas have been identified	17 - 24
The extent of expected implementation is quantified (e.g. x miles of streambank fenced, etc.)	17 - 24, Tables 9, and 10
D. Technical and Financial Assistance Needs	
Cost estimates reflect all planning and implementation costs	26 - 27, Table 11
Cost estimates are provided for each management measure	27, Table 11
All potential Federal, State, Local, and Private funding sources are identified	25
Funding is strategically allocated - activities are funded with appropriate sources (e.g. NRCS funds for BMP cost share)	25
E. Information, Education, and Public Participation Component	
A stakeholder outreach strategy has been developed and documented.	28 - 30
All relevant stakeholders are identified and procedures for involving them are defined.	28 - 30
Educational/Outreach materials and dissemination methods are identified.	28 - 30

F/G. Schedule and Milestones	
Implementation schedule includes specific dates and expected accomplishments	30 - 31
Implementation schedule follows a logical sequence	30 - 31
Implementation schedule covers a reasonable time frame	30 - 31
Measurable milestones with expected completion dates are identified to evaluate progress	30 - 31
A phased approach with interim milestones is used to ensure continuous implementation	30 - 31
H. Load Reduction Evaluation Criteria	
Proposed criteria effectively measure progress toward load reduction goal	30 - 31
Criteria include both: quantitative measures of implementation progress and pollution reduction; and qualitative measures of overall program success (including public involvement and buy-in)	30 - 31
Interim WQ indicator milestones are clearly identified; The indicator parameters can be different from the WQ standard violation	30 - 31
An Adaptive Management approach is in place, with threshold criteria identified to trigger modifications	30 - 31
I. Monitoring Component	
Monitoring plan includes an appropriate number of monitoring stations	25 - 32
Monitoring plan has an adequate samplying frequency	25 - 32
Monitoring plan will effectively measure evaluation criteria identified in Element 8	25 - 32

Introduction

Tuscarora Creek, a tributary of Opequon Creek, is located in Berkeley County in the Potomac Direct Drains Watershed of West Virginia. It drains approximately 26 square miles, and is approximately 11.7 miles long. Its major tributary, Dry Run, is 5 miles long. It is part of the Ridge and Valley physiographic province. It is characterized by karst terrain, so springs, sinkholes, and discontinuous drainage patterns are common. Kilmer Spring, occurring very close to the Tuscarora Creek mainstem, is a significant source of drinking water for the City of Martinsburg.

The Opequon Creek watershed is a priority area for West Virginia's efforts to reduce nutrients and sediment delivered to the Chesapeake Bay. It is the first priority watershed (HUC 0207000409) out of 24 identified in West Virginia Potomac Tributary Strategy's Implementation Plan. Part of the reason it ranked so high in priority was that it had high likelihood of landowner participation in agricultural BMP programs, and high activity level of local watershed groups. An additional, more local motivation for addressing nutrient levels is "nutrients are so abundant in the Opequon Creek sub-watershed that stream health is threatened," according to an Ecological Assessment published by WVDEP (West Virginia Division of Water and Waste Management, 2005).

Finally, Tuscarora Creek and its major tributary, Dry Run, were listed on the 303(d) list as impaired for biological criteria and fecal coliform bacteria. The Total Maximum Daily Load (TMDL) for Selected Streams in the Potomac Direct Drains Watershed, West Virginia (January 2008) addressed these impairments for Tuscarora Creek and Dry Run (Tables 1 and 2). It linked the biological impairment to organic enrichment and sedimentation, and it listed the prescribed fecal coliform and sediment load reductions from various sources in each of the 18 subwatersheds. The TMDL was modeled based on source tracking, analysis of a Geographic Information System (GIS: maps and accompanying information), and monthly water quality monitoring of seven sites in the watershed. Two sites were below, and two were above the confluence of Tuscarora Creek and Dry Run, on Tuscarora Creek. Three sites were on Dry Run.

Figure 1. Tuscarora Creek watershed area

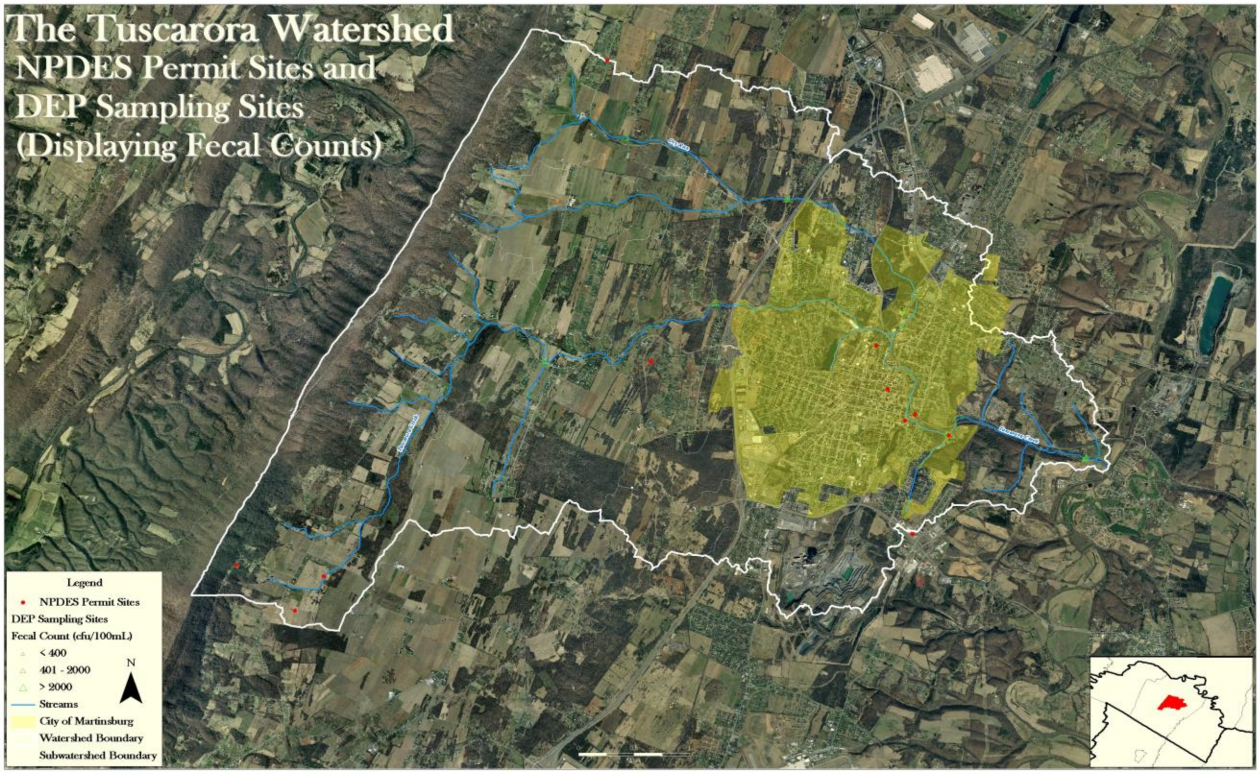


Table 1: From Table A-1-2 of the TMDL, Significant stressors of biologically impaired streams in the Tuscarora Creek watershed

Stream	Biological Stressors	TMDLs required
Tuscarora Creek	Organic enrichment; Sedimentation	Fecal coliform; Sediment
Dry Run	Organic enrichment; Sedimentation	Fecal coliform; Sediment

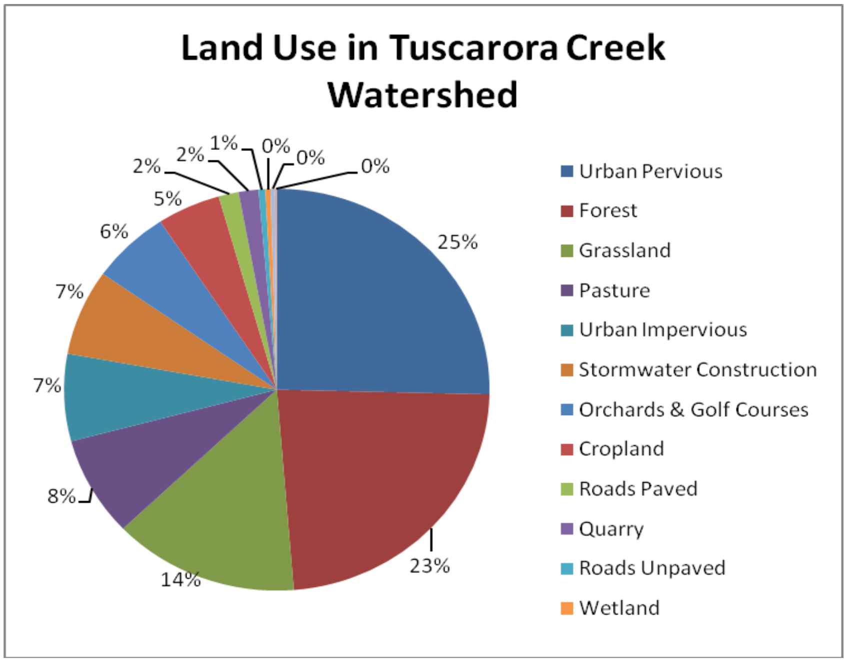
Table 2: From Tables A-1-3 and A-1-4 of the TMDL, Fecal coliform and Biological TMDLs for the Tuscarora Creek watersheds

Major watershed	Stream/Stream code	Parameter	Load Allocation	Wasteload Allocation	Margin of Safety	TMDL	Units
Opequon Creek	Tuscarora Creek/WVP-4-C	Fecal coliform	$1.92x10^{10}$	$1.03x10^{11}$	$6.42x10^{09}$	$1.28X10^{11}$	counts/day
Opequon Creek	Tuscarora Creek/WVP-4-C	Sediment	16.39	99.14	6.08	121.62	tons/day
Opequon Creek	Dry Run/WVP-4-C-1	Fecal coliform	$1.14x10^{10}$	$2.64x10^{10}$	$1.99x10^{09}$	$3.98x10^{10}$	counts/day
Opequon Creek	Dry Run/WVP-4-C-1	Sediment	4.06	21.54	1.35	26.95	tons/day

"Scientific notation" is a method of writing or displaying numbers in terms of a decimal number between 1 and 10 multiplied by a power of 10. The scientific notation of 10,492, for example, is 1.0492×10^4.

The TMDL documentation includes acreage of various land uses in the watershed (Fig. 2). Approximately 25% of the watershed is "urban pervious," which is urban or suburban areas that are not covered with rooftops, roads, or other surfaces that make the land impervious to water. Forest comprises 23% of the watershed, and grassland (may include hay fields, some residential yards, and other grassed areas) is 14%. According to the TMDL, other agricultural land uses only make up 8% (pasture) and 5% (cropland).

Figure 2. TMDL Land use estimated percentages for Tuscarora Creek watershed



Some of these percentages differ greatly from the condition in the Potomac Direct Drains watershed at large, according to Table 3-1 of the TMDL. For example, urban pervious comprises only about 7.9% of the Potomac Direct Drains watershed, and urban impervious only about 1.4%, but forest makes up approximately 50%. Many residential subdivisions occur in the western half of Tuscarora Creek watershed, and the City of Martinsburg takes up most of the eastern half. A transportation corridor consisting of Interstate-81, a railroad, and Route 11 also runs in a north-south direction through the eastern half of the watershed.

A. Impairments/sources of pollution

Fecal coliform impairment in Tuscarora Creek watershed

The TMDL for Selected Streams in the Potomac Direct Drains Watershed lists the sources of fecal coliform impairment in the Opequon Creek watershed. Those that are present in Tuscarora Creek watershed include one significant municipal sewage treatment facility, discharges from Municipal Separate Storm Sewer Systems (MS4s), failing or nonexistent on-site sewage disposal systems (septic systems), and stormwater runoff from residential areas, pasture and cropland. Background sources are considered to include contributions from wildlife in forested areas, which are not significant in the Potomac Direct Drains watershed (TMDL p. 15). The sewage treatment facility is regulated as a point source. The entirety of Tuscarora Creek watershed is within Berkeley County, City of Martinsburg, and/or Department of Highways areas, which are all (three separate entities) covered under the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer Systems (MS4) General permit. Therefore, all fecal coliform bacteria loading associated with precipitation and runoff from residential and urbanized areas is considered regulated as a point source. Table 3 summarizes the fecal coliform load reductions estimated to be needed from nonpoint sources, with other sources included for reference. These sources are discussed below. Since the best management practices (BMPs) to reduce fecal coliform from cropland and pasture are the same, these two loads have been combined in Table 4.

Table 3. Estimated annual load allocations and reductions needed from nonpoint sources to achieve **fecal coliform** TMDL in Tuscarora Creek watershed. This Watershed Based Plan is chiefly concerned with the shaded cells

Source	Total amount of this source	Amount contributing to the load that must be reduced	Baseline load (counts/ year)	Allocated load (counts/ year)	Reduction needed (counts/ year)	Percent reduction needed
Background & other nonpoint sources [A]	9597 [AC]	n/a	$1.11x10^{13}$	$1.11x10^{13}$	0	0%
Residential/urban [A]	6258 [AC]	not estimated	$7.57x10^{13}$	$1.81x10^{13}$	$5.76x10^{13}$ [B]	76.0[B%]
Cropland	876 [AC]	not estimated	$3.11x10^{12}$	$1.13x10^{12}$	$1.98x10^{12}$	63.8%
Pasture	1458 [AC]	880[c]	$5.30x10^{13}$	$5.88x10^{12}$	$4.71x10^{13}$	88.9%
Onsite sewer systems	2694[D]	713[D]	$4.47x10^{15}$	0	$4.47x10^{15}$	100.0%

[A] Considered part of wasteload allocation (WLA), and reported in WLA or MS4 section of TMDL spreadsheets. [B] Not required to be reduced as part of this Watershed Based Plan. [C] Estimated by adding acreage of pastures recorded by WV DEP during source tracking, with high and moderate erosion potential rating. [D] As estimated during the TMDL process for modeling purposes. [AC] acres

Table 4. Combined annual load allocations and reductions needed from cropland and pasture to achieve **fecal coliform** TMDL in Tuscarora Creek watershed.

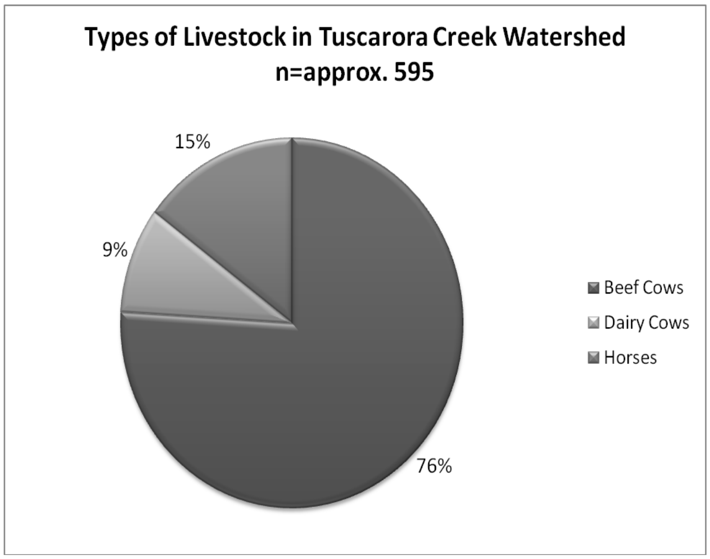
Source	Total amount of this source (acres)	Amount contributing to the load that must be reduced	Baseline load (counts/ year)	Allocated load (counts/ year)	Reduction needed (counts/ year)	Percent Reduction Needed
Cropland	876	not estimated	$3.11x10^{12}$	$1.13x10^{12}$	$1.98x10^{12}$	
Pasture	1458	616	$5.30x10^{13}$	$5.88x10^{12}$	$4.71x10^{13}$	
CROP+ PASTURE	2334		$5.61x10^{13}$		$4.91x10^{13}$	88%

Residential/urban: Runoff from residential and urbanized areas during storm events can be significant fecal coliform sources, delivering bacteria from the waste of pets and wildlife to the water body. In the Tuscarora Creek watershed, these areas are all within the City of Martinsburg, the Division of Highways, or Berkeley County, and therefore subject to these three MS4 permits. The magnitude of the load reduction prescribed by the TMDL for this source is $5.76X10^{13}$ cfu/year. It will be beneficial to implement residential/urban BMPs that reduce bacteria deposition or the volume of stormwater runoff into streams. These may include proper pet waste disposal, forest and grass buffers along streams, bioretention (rain gardens), wetlands, downspout disconnections, dry swales, and impervious surface reduction.

Pasture and cropland: Grazing livestock and land application of manure results in the deposition and accumulation of bacteria on land surfaces. These bacteria are then available for wash-off and transport during rain events. In addition, livestock with access to streams can deposit feces directly into the water (TMDL p. 15). Source tracking performed by WVDEP during TMDL development estimated approximately

1506 acres of active pasture in Tuscarora Creek watershed. Forty-one livestock operations were identified, supporting 595 livestock, 337 of which have stream access. These operations consisted of one dairy, one feedlot, and the remainder pastures. The proportions of beef cows, horses and dairy cows are depicted in Figure 3.

Figure 3. Proportions of different kinds of livestock in Tuscarora Creek watershed, as estimated during TMDL source tracking, 2003-2004



Nine livestock operations were identified as having high "runoff potential," an index used as an input for the TMDL modeling, and nine had moderate runoff potential. This index is based on the land slope, presence of buffer zones, and whether the animals appeared to have access to surface drainages (Fig. 4).

The total area of the nine livestock operations with a high runoff potential rating is estimated to be 658 acres, and there are approximately 222 acres of pasture with moderate runoff potential. This analysis can serve as a starting point for identifying pastures where nonpoint management measures can be implemented to achieve fecal coliform reductions. That is, owners of pastures with high or moderate runoff potential ratings can be interviewed to determine their awareness of federal or local agricultural cost-share programs and their willingness to participate in them. Several factors can be used to prioritize projects, including proximity to headwaters, proximity to a perennial stream, and landowner willingness.

Estimates of the baseline loads and allocated loads of fecal coliform from pasture and cropland are given in Table 3. Cropland was prescribed a 63.8% reduction, although the magnitude is less than 1/10th that of pasture, and less than 1/100th that of septic systems.

The TMDL's modeled Load Allocation of fecal coliform may be the best starting point for identifying opportunities for nonpoint management measures on cropland (Table 5). The prescribed load reduction was greater than 50% in half of the subwatersheds. Implementation should begin in these subwatersheds, and then move to the remaining three that have a prescribed load reduction. Within these subwatersheds, several factors can be used to prioritize projects, including proximity to headwaters, proximity to a perennial stream, and landowner willingness.

Onsite sewer systems: Human sources of fecal coliform bacteria in these areas include sewage discharges from failing septic systems, and possible direct discharges of sewage from residences (straight pipes). An analysis of 911 emergency response addressable structure data combined with WVDEP source-tracking information yielded an estimate of 2694 unsewered homes in the Tuscarora Creek watershed. A septic system failure rate derived from geology and soil type was applied to the number of unsewered homes to calculate nonpoint source fecal coliform loading from failing septic systems (TMDL p. A1-7). The colored polygons in Figure 5 depict the estimated cumulative untreated flow from failing septic systems within modeled subwatersheds. For a more detailed description of failing septic system fecal coliform modeling, please refer to the Potomac Direct Drains watershed TMDL Technical Report.

Table 5. TMDL fecal coliform bacteria load allocations for cropland in Tuscarora Creek subwatersheds.

Subwatershed	Cropland Area (Acres)	Cropland Baseline Load (counts/yr)	Cropland Allocated Load (counts/yr)	Cropland Percent Reduction
4021	36.2	8.46E+10	3.02E+10	64.3%
4022	1.6	3.54E+09	3.54E+09	0%
4023	0.0	0.00E+00	0.00E+00	0%
4024	57.2	1.83E+11	6.53E+10	64.3%
4025	6.2	1.84E+10	1.84E+10	0%
4026	16.6	3.98E+10	3.98E+10	0%
4027	23.8	5.44E+10	3.11E+10	42.9%
4028	75.5	3.64E+11	1.35E+11	63.1%
4029	244.3	1.15E+12	3.21E+11	72.1%
4030	9.7	4.43E+10	1.44E+10	67.6%
4031	1.1	2.81E+09	2.81E+09	0%
4032	99.0	2.26E+11	8.06E+10	64.3%
4033	128.7	2.94E+11	1.05E+11	64.3%
4034	6.1	1.40E+10	1.40E+10	0%
4035	70.8	1.62E+11	5.07E+10	68.6%
4036	29.9	1.54E+11	4.29E+10	72.1%
4037	9.0	4.08E+10	2.24E+10	45.1%
4038	59.6	2.71E+11	1.49E+11	45.1%

The number of systems needing improvement was estimated during the TMDL modeling process to be 713. Four septic failure zones were delineated during the WVDEP source tracking process using geology, and defined by rates of septic system failure (TMDL, p. 14). The estimates were made using a seasonal failure rate of 3% and a complete failure rate of 5% in Zone 1, 7% and 10%, respectively, in Zone 2, 13% and 24%, respectively, in Zone 3, and 19% and 28% in Zone 4. No systems have been taken offline due to sewer line extensions since the TMDL was developed, and there are no plans in the near future to do so in Tuscarora Creek watershed.

Canaan Valley Institute (CVI) has formed a multi-disciplinary project team with a professional focus on decentralized wastewater treatment and community service. This team has secured grant funding to develop the Eastern West Virginia Wastewater Plan (EWVWP). This approach will use outreach, GIS, engineering, and planning expertise, to provide the Region 9 Planning and Development Council with a plan for improving water quality in the Opequon watershed using viable wastewater treatment solutions. As part of this effort CVI will meet with local leaders including the Berkeley County Health Department Sanitarians and Berkeley County Public Service District (PSD) to collaborate on:

- The collection of information on current wastewater treatment measures;
- The identification and prioritization of rural areas needing wastewater treatment improvements in the watershed;
- The development of appropriate strategies for improving treatment; and
- The development of a final plan with wastewater treatment recommendations.

Since some stakeholders expressed skepticism that the number of failing systems could be so high; these efforts will be used to refine the number of failures estimated in each subwatershed as the implementation of this Watershed Based Plan progresses.

Figure 4. Fecal coliform sources in Tuscarora Creek watershed

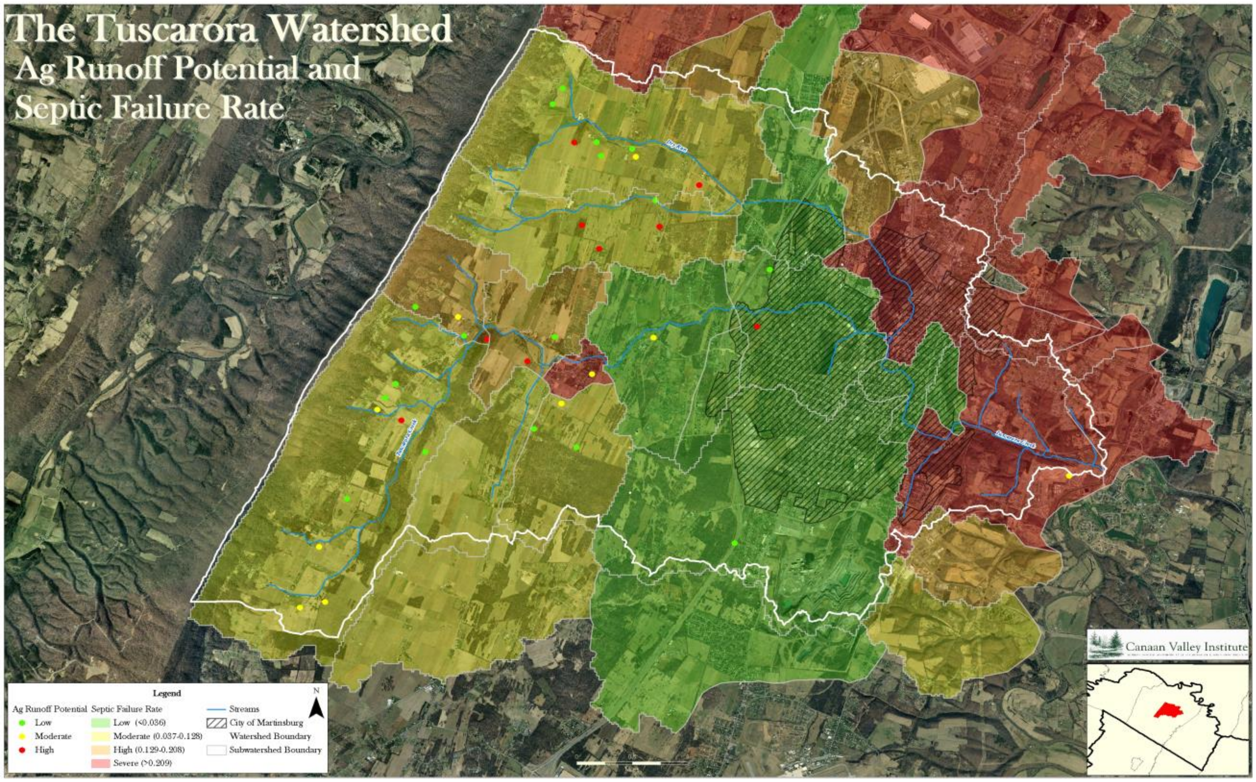


Table 6. Estimates of failing septic systems in Tuscarora Creek watershed by subwatershed

Sub-watershed	Total # Septic Systems in Sub-watershed	Total # Failing Septic Systems in Sub-watershed
4021	699	**265**
4022	2	**0**
4023	0	**0**
4024	54	**4**
4025	529	**109**
4026	468	**37**
4027	45	**4**
4028	107	**34**
4029	185	**59**
4030	15	**1**
4031	25	**2**
4032	83	**8**
4033	49	**16**
4034	40	**14**
4035	53	**20**

4036	80	**30**
4037	42	**19**
4038	218	**90**
Total	2694	**713**

Biological impairment in Tuscarora Creek watershed

Organic enrichment: Where organic enrichment was identified as a biological stressor, fecal coliform levels in the TMDL serve as a surrogate. See the previous section for a discussion of the sources of fecal coliform bacteria.

Sediment: Excess sediment is also a significant biological stressor of the benthic communities in Tuscarora Creek. The TMDL identifies sources of sediment in Opequon Creek watershed. Those that are present in Tuscarora Creek watershed include NPDES permit outlets with effluent limitations for Total Suspended Solids (TSS); streambank erosion; and upland sources such as residential/urban/roads areas, cropland, pasture, barren areas, and stormwater construction general permit sites. Residential and urban land uses can also be indirect sources of sedimentation, because increased impervious area associated with those land uses can increase the volume and velocity of stormwater runoff and accelerate streambank erosion. Table 6 summarizes the sediment load reductions estimated to be needed from various sources. Since the best management practices (BMPs) to reduce sediment from cropland and pasture are the same, these two loads have been combined in Table 8.

Streambank erosion: According to the TMDL, "the base and allocated loads associated with bank erosion are generally included in the MS4 wasteload allocations in subwatersheds where MS4 entities have responsibility. In a limited number of MS4 subwatersheds, where WVDEP source tracking determined moderate and high water quality impact from agricultural land uses, the bank erosion components are prescribed as nonpoint source load allocations." As shown in Table7, this splitting of the streambank erosion load is the case in some of the Tuscarora Creek subwatersheds.

Table 7**.** Estimated annual load allocations and reductions needed from nonpoint sources to achieve **sediment** TMDL.

Source	Area of this source in the Tuscarora Watershed (acres)	Baseline Load (tons/yr)	Allocated Load (tons/year)	Reduction Needed (tons/year)	Percent Reduction Needed
Background & other nonpoint sources [A]	8039.1	3353.3	3353.3	0	0
Urban/residential/road impervious areas [A]	6257.5	4018.6	3985.1	33.5	0.8%
Cropland	875.5	1976.7	1492.6	484.1	24.5%
Pasture	1458.4	1627.6	1389.1	238.5	16.3%
Streambank erosion	Area or length not directly estimated in	3674.5	3101.7	572.8	15.5%

	TMDL				
MS4 Streambank erosion [A]	Area or length not directly estimated in TMDL	31,892.0	27,683.6	4208.4[b]	13%[b]

[A] Considered part of the wasteload allocation (WLA), and reported in WLA or MS4 section of TMDL spreadsheets. [B] Not required to be reduced as part of this Watershed Based Plan.

Table 8. Combined annual load allocations and reductions needed from cropland and pasture to achieve **sediment** TMDL in Tuscarora Creek watershed.

Source	Area of this source in the Tuscarora Watershed (acres)	Baseline Load (tons/yr)	Allocated Load (tons/yr)	Reduction Needed (tons/ yr)	Percent Reduction Needed
Cropland	876	1976.7	1492.6	484.1	
Pasture	1458	1627.6	1389.1	238.5	
CROP+ PASTURE	2334	3604.3		722.6	20.0%

Spanning the length of Tuscarora Creek and Dry Run are a variety of different soil types that contribute to the properties of the stream banks. There are approximately 38 different soil types in a buffered area of roughly 70 feet on either side of the streams. Around 30% of the soils are Dunning silt loams, 23% are Lindside silt loams, and 8% are Poorhouse silt loams. Thirty nine percent of the area is composed of small units of 35 other soil types. Dunning silt loams are poorly drained hydric soils, Lindside silt loams are moderately well drained, and Poorhouse silt loams are somewhat poorly drained. All three of these soils have a K factor of .37 for the whole soil. K factors are erosion factors that indicate the susceptibility of the soil to sheet and rill erosion by water. A value of .37 indicates moderate susceptibility to sheet and rill erosion. Based on slope and K values, Dunning silt loams and Lindside silt loams are unlikely to undergo significant erosion after disturbance activities under normal climatic conditions. Poorhouse silt loams are unlikely/somewhat likely to undergo erosion under the same conditions, depending on slope (0-3% slope in some areas, 3-8% in others).

Detailed descriptions of all soils in the watershed can be found at: http://websoilsurvey.nrcs.usda.gov.

The field analyses performed in preparation of this Watershed Based Plan was of two types: a general assessment of Tuscarora Creek mainstem by Opequon Creek Project Team (OCPT) volunteers, and site visits by West Virginia's Potomac Basin Coordinator and Canaan Valley Institute's Circuit Rider spring 2010 to estimate Bank Erodibility Hazard Index (BEHI) values. The OCPT is a watershed organization that consists of Berkeley County residents and local, state, and federal agency personnel who are dedicated to improving the quality of water in Opequon Creek watershed. In fall 2009, OCPT volunteers walked the mainstem of Tuscarora Creek and noted areas of erosion and sedimentation (Appendix A). Along the Tuscarora Creek mainstem, 45 sites were characterized as having erosion or sedimentation, seven of which were identified as having unrestricted cattle access. Three sites were chosen as representative of the characteristics observed at the noted erosion sites throughout Tuscarora Creek and BEHI values were calculated at each.

The BEHI estimates made in spring 2010 from Tuscarora Creek streambanks provided estimates of sediment loads associated with these lengths. Three sites were chosen to represent "Low" and "Moderate" and "High" amounts of erosion (Poor House Farm, Roach, and the mouth of Tuscarora Creek, respectively). With this method, the erosion potential for streambanks at a site can be rated Very Low, Low, Moderate, High, Very High, and Extreme. The Poor House Farm site was dominated by streambanks with Low BEHI scores. The measurements and subsequent calculations yielded an estimate of 3.5 tons/year entering Tuscarora Creek over this 300-foot section, or 0.01 tons/year per foot. The Roach site was dominated by streambanks with Moderate BEHI scores, yielding an estimate of 8.3 tons/year entering Tuscarora Creek over this 448-foot section, or 0.02 tons/year per foot. Measurements taken at the mouth of Tuscarora Creek show erosion sites dominated by Low and Moderate BEHI scores, however the significant amount of Extreme erosion brought the overall score for this site to High. Calculations estimate 50 tons/year or 0.12 tons/year per foot enter the creek from this site.

Future volunteer assessments will provide estimates of the lengths and severity of each erosion site. Sites will be categorized as "Low," "Moderate," or "High" (terms loosely defined by us for the purpose of this analysis) based on the height of exposed bank. Sites with eroding banks less than 2 feet high will be given a "Low" score, eroding banks 2 to 4 feet high will be given a "Moderate" score and those with banks higher than 4 feet will receive a "High" score. The lengths of each type of erosion site will be multiplied by the erosion rates estimated from the representative BEHI sites to determine how many Natural Stream Design projects will be necessary to achieve the prescribed load reduction from nonpoint source eroding streambanks. Among the many sites where High and Moderate erosion is occurring, several factors can be used to prioritize projects including proximity to headwaters, landowner willingness, whether management practices can be installed to assure bank stability (e.g. livestock exclusion fencing, riparian buffer plantings, etc.) and the project cost per unit of sediment proposed to be reduced. The overall cost of implementation could be significantly lessened by including the maximum number of stream feet in each project, to take advantage of economies of scale in materials, equipment mobilization, and project design.

Pasture and Cropland*:* Agricultural runoff can contribute excess sediment loads when farming practices allow soils to be washed into the stream. The erosion potential of cropland and overgrazed pasture is particularly high because of the lack of year round vegetative cover. Livestock traffic, especially along streambanks, disturbs the riparian buffer and reduces vegetative cover, causing an increase in erosion from these areas (West Virginia Division of Water and Waste Management, 2007). Neither pasture nor cropland was prescribed a load reduction in the Tuscarora Creek watershed. However, sediment loads from these sources were acknowledged, and implementing sediment BMPs on these lands will contribute to load reductions overall. Therefore the dual benefit of some pasture BMPs should be emphasized, since practices like restricting livestock access to streams and providing alternative water sources can reduce both fecal coliform loads (discussed above) and sediment loads.

Urban/residential/road impervious area*:* Stormwater runoff from residential and urbanized areas that are not subject to MS4 permitting requirements can be a significant source of sediment (West Virginia Division of Water and Waste Management, 2007). There is only a small (0.8%) reduction prescribed for this source, but, as with pasture and cropland, implementing sediment BMPs on these lands will contribute to load reductions overall. These should include BMPs that reduce the volume of stormwater runoff into streams, such as bioretention (rain gardens), wetlands, downspout disconnections, and impervious surface reduction.

Sediment loads from roads are considered part of the MS4. Runoff from paved and unpaved roadways can contribute significant sediment loads to nearby streams. Heightened stormwater runoff from paved roads (impervious surface) can increase erosion potential. Unpaved roads can contribute sediment through precipitation-driven runoff. Roads that traverse stream paths elevate the potential for direct-deposition of sediment. Road construction and repair can further increase sediment loads if BMPs are not properly employed (West Virginia Division of Water and Waste Management, 2007). Therefore, sediment reduction BMPs for roads not included in the three MS4 permittee's' Stormwater Management Plans should also be eligible for Section 319 funding.

Chesapeake Bay priority

As part of West Virginia's Chesapeake Bay drainage, Tuscarora Creek watershed represents an opportunity to reduce sources of nitrogen, phosphorus, and sediment. Berkeley County has a high nitrogen delivery factor, which means that practices done there will have more of a positive effect on the Bay compared to practices done in the more upstream area of WV's Bay drainage.

Sediment is addressed in this Watershed Based Plan. Measures to reduce nitrogen and phosphorus are outlined in West Virginia's Chesapeake Bay TMDL Phase II Watershed Implementation Plan (WIP, March 2012). Nutrient loads from the developed lands sector, including septic systems and stormwater runoff from commercial and residential development, are prescribed by the WIP to stay the same, i.e. to not increase, even if new development occurs. In order to achieve this goal, however, stormwater retrofits, reforestation, denitrifying septic systems, and other practices may be needed in some places to offset any increased nutrients and sediment in other places. If voluntary efforts are not sufficient to maintain current levels, more regulation of runoff from developed lands may be required in the future.

According to the WIP, the agriculture sector is the only nonpoint source of nutrients and sediment prescribed to reduce its loading to the Chesapeake Bay. Numeric goals and 2-year milestones were set over broad geographic areas (e.g. county level) for several practices including installing livestock exclusion fencing and forest buffers along streams, cover crops, and nutrient management planning. This strategy emphasizes voluntary practices and programs available to assist landowners with the cost and technical expertise needed to implement them. Since the WIP did not allocate reductions to individual subwatersheds, the baseline analysis in Section 11 can be understood as an estimate of the level of effort likely required to reduce loads adequately from agriculture sources. This analysis revealed the need to reduce approximately 21% nitrogen and 29% phosphorus loads from agriculture sources, as portrayed in the Chesapeake Bay watershed model's "2010 No-Action Scenario."

Tuscarora Creek, itself, will benefit from nutrient reduction activities; the pre-TMDL monitoring data revealed an average total nitrogen level of 6.4, 5.7, and 4.7 mg/L at each of three sampling sites on Tuscarora Creek and 7.1 and 6.6 mg/L at each of two sites on Dry Run, with two instances over 10 mg/L. Average total phosphorus levels were 0.43, 0.04, and 0.03 mg/L at Tuscarora Creek sites, and 0.24 and 0.11 mg/L at the Dry Run sites.

Other information about pollutants and their sources in the Tuscarora Creek watershed

Information about this watershed was gained through mailing a survey to landowners along the Tuscarora Creek mainstem in spring 2009. It was developed by faculty in Agricultural and Resource Economics at West Virginia University with input from the Opequon Creek Project Team. The objectives of this survey were to (1) elicit interest in potential stream restoration projects; (2) determine landowner perceptions of problems in Tuscarora Creek watershed; and (3) raise awareness of efforts to improve water quality in

Berkeley County. There were 32 responses out of 54 surveys mailed. To the question “What are your concerns about this stream or creek? (please check all that apply)” the responses were: trash in the stream (82%), stream pollution (71%), streambank erosion (61%), flooding (43%), septic systems not working properly (21%), other (21%), stream course changes (18%), wildlife (10%), and recreational users [fishing, kayaking, canoeing, etc.] (7%). The “other” category included concerns about runoff from fields into the creek, sewer and storm drains from the city, livestock access, a dam changing the course of flow, pollution from hundreds of Canada geese, and people withdrawing water from the creek for ponds. Another section for comments at the end of the survey yielded notes about runoff from so much impervious surface in residential developments; trees cut from the riparian area; city, goose, and farm pollution; and flooding of property resulting from problems in the stream pattern and profile.

Local residents also voiced concerns about the health of local streams during two public workshops held in preparation for the writing of this Watershed Based Plan on July 1, 2009, and another on June 17, 2010. Many of the nonpoint source pollution sources listed in the previous paragraphs were repeated at these meetings. Other new concerns included impacts from loss of forested areas and concern about the large number of septic upgrades prescribed by the TMDL.

A special note is warranted about the need to conserve forested area in this watershed. Berkeley County is one of the least forested counties in the state of West Virginia. As noted previously, forestland cover in the Tuscarora Creek Watershed according to the TMDL land use data set is 23%, which equates to 4,248 acres. Due to recent clear cutting for development, this number is now less than 4,018, or 22% (Herb Peddicord, WVDOF, pers. comm.) Most of the forested acreage is on the east slope of North Mountain. These forests are historically oak-dominated with a mix of red maple, yellow poplar, and white ash. Today these forests are in poor condition due to overharvesting and the presence of invasive plants and wild grape. Only 360 acres, or less than 9%, are currently being managed. There are no forestland conservation easements in the watershed. The remaining fragments of forestland in the watershed are scattered and discontinuous. These forests are on abandoned farms or poor building sites. Many of the native trees have been taken over by locust, elm, *Ailanthus* and honeysuckle. The lack of forest conservation and stewardship in this watershed should be considered a concern equal to the sources of pollutants outlined in this Plan, and BMPs to improve forest cover and the preservation of such should be pursued at the same time as BMPs to reduce the TMDL pollutants.

B/C. Nonpoint Source Management Measures proposed to achieve load reductions, and magnitude of load reductions expected

To achieve fecal coliform reductions

A suite of Best Management Practices (BMPs) will be used to achieve the fecal coliform load reductions called for in the TMDL. Below are the descriptions of these practices and their associated load reductions are listed in Table 9.

<u>From residential/urban sources</u>*:* No fecal coliform load allocation is given to residential sources in the TMDL, because Berkeley County, Martinsburg, and parts of DOH property are regulated under MS4 permits, therefore so are the loadings from precipitation and runoff in the residential sector. However, we see many opportunities to reduce fecal coliform from residential sources that are not covered in the Stormwater Management Plans. Therefore we propose these additional choices of measures as part of this Watershed Based Plan:

- Grass buffer*:* an area of grasses that is at least 35 feet wide on one side of a stream that is adjacent to a body of water. The riparian area is managed to maintain the integrity of stream channels and shorelines, to reduce the impacts of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and other chemicals.

- Riparian forest buffer*:* an area of trees at least 35 feet wide on one side of a stream, usually accompanied by trees, shrubs and other vegetation that is adjacent to a body of water. The riparian area is managed to maintain the integrity of stream channels and shorelines, to reduce the impacts of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and other chemicals. A 2003 study performed in Virginia found that buffers can reduce bacteria by 43 to 57% (Boyer 2006).

- Urban Wet Ponds*:* depressions or basins created by excavation or berm construction that receive sufficient water via runoff, precipitation, and groundwater to contain standing water year-round at depths too deep to support rooted emergent or floating-leaved vegetation (in contrast with dry ponds, which dry out between precipitation events). Nutrients and suspended particles are removed via settling. Nitrogen is further removed primarily via plant and microbial uptake and nitrification-denitrification reactions, while phosphorus is further removed by soil sorption. Wet ponds can reduce bacteria concentrations by 50% (EPA, 2012).

- Urban Wetlands*:* Wetlands have soils that are saturated with water or flooded with shallow water that support rooted floating or emergent aquatic vegetation (e.g. cattails). Nutrients and suspended particles are removed via settling. Nitrogen is further removed primarily via plant and microbial uptake and nitrification-denitrification reactions, while phosphorus is further removed by soil sorption. Wetlands are reported to reduce bacteria concentrations by 78 to 90% (Boyer 2006).

Biofiltration

- Filtering practices: the filtration BMPs are designed for reduction of urban runoff impacts, water quality control, stream channel protection, and peak discharge control for both small and large storms. They capture and temporarily store the water quality volume and pass it through a filter of sand, organic matter and vegetation, promoting pollutant treatment and recharge.

  - Filters*:* Filters capture and treat runoff by filtering through an organic media.
  - *Vegetated Open Channels:* Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed, includes bioswales. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils.

- *Infiltration practices:* the infiltration BMPs are designed for reduction of urban runoff impacts, groundwater recharge, water quality control, stream channel protection, and peak discharge control for both small and large storms. Performance information for all of these practices was derived from their use in urbanized/high impervious land use areas.
  - *Bioretention: An excava*ted pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants.

- Permeable Pavement and Pavers: Pavement or pavers that reduce runoff volume and treat water quality through both infiltration and filtration mechanisms. Water filters through open voids in the pavement surface to a washed gravel subsurface storage reservoir, where it is then slowly infiltrated into the underlying soils or exits via an under drain.
- Infiltration Trenches and Basins: A depression to form an infiltration basin where sediment is trapped and water infiltrates the soil. No under drains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. (Simpson and Weammert 2009, pp. 342-344). Biofiltration practices are reported to reduce bacteria by more than 50% (EPA 2012).

- Impervious surface reduction: Practices that reduce the total area of impervious cover and practices that capture storm water and divert it to pervious areas, subsequently encouraging storm water infiltration; e.g. natural area conservation, disconnection of rooftop runoff, and rain barrels.

- Pet Waste Runoff Reduction Campaign, possibly including:
  - maintaining vegetative buffer areas between streams and areas where pets or wildlife defecate
  - distributing and promoting pet waste digesters
  - installing pet waste bag stations in common areas of subdivisions
  - conducting outreach about pet waste disposal, especially showcasing the above practices

From pasture sources: To reduce 88.9 % of this fecal coliform load, a suite of BMPs must be implemented to achieve 100% reductions on 1297 acres of pasture land. Pasture BMPs will be pursued mainly through federal cost-share programs (Conservation Reserve Enhancement Program [CREP], Environmental Quality Incentives

- Grass buffer: (see description above)
- Riparian forest buffer: (see description above)

Program [EQIP], and Wildlife Habitat Incentives Program [WHIP]) and the state's cost-share program (Agriculture Enhancement Program), including the following:

- Livestock fencing: This BMP excludes animals from streams. It incorporates both alternative watering and installation of fencing that eliminates livestock access to narrow strips of land along stream. The implementation of stream fencing should substantially limit livestock access to streams, eliminating direct manure deposition to streambeds and banks and reducing erosion and nutrient deposition to riparian areas. Effectiveness estimates: 40% for TSS, 25% for TN and 30% for TP (Simpson and Weammert 2009, p. 414). In Appendix A of the Mill Creek (South Branch Potomac) Watershed Based Plan, 70% efficiency for reducing fecal coliform was used for fencing an unknown number of livestock (West Virginia Conservation Agency et al., 2007). There may be a need in Tuscarora Creek watershed for cost share funding for fencing close to, or at the top of, streambanks. Although this is not ideal, it provides an opportunity to reduce nonpoint pollution on lands whose owners have been resistant to existing cost-share programs. This opportunity would be especially helpful on headwaters areas where streams are narrow and may require less protection than 35 feet on both sides.

- Alternative water sources (can include trough, pipeline, and well): This BMP requires the use of alternative drinking water sources away from streams to reduce the time livestock spends near and in streams and streambanks, reducing direct manure deposition to streambeds and banks and also reducing erosion and nutrient deposition to riparian areas. When alternative watering practices are used in conjunction with fencing, see the discussion of pollutant removal efficiencies for Livestock Fencing, above. Without fencing, the Effectiveness Estimates are: 30% for TSS, 15% for TN and 22% for TP (Simpson and Weammert 2009, p. 414). Reduction efficiency for fecal coliform similar to that for TP might be defensible, because of both pollutants' tendency to move with soil particles.

- Armored stream crossing*:* A stream crossing will be constructed to improve water quality by reducing sediment, nutrient, organic, and inorganic loading of the stream and reduce stream bank and streambed erosion. The stream crossing will be constructed according to an engineering design based on NRCS standard and installed as indicated on the Conservation Plan Map. NRCS will be contacted prior to construction. Stream crossing will be maintained according to the Operation and Maintenance Plan in the design (description provided by FSA staff). This practice is not given its own pollutant reduction efficiencies, but is used in conjunction with Livestock Fencing and Alternative Watering.

- Wetland Restoration*:* Returning natural/historic functions to a *former* wetland. This results in a gain in wetland acres. Nutrients and suspended particles are removed via settling. Nitrogen is further removed primarily via plant and microbial uptake and nitrification-denitrification reactions, while phosphorus is further removed by soil sorption (Simpson and Weammert 2009, p. 599).

- Wetland Creation*:* Developing a wetland that did not previously exists on an upland or deepwater site. Results in a gain in wetland acres. Nutrients and suspended particles are removed via settling. Nitrogen is further removed primarily via plant and microbial uptake and nitrification-denitrification reactions, while phosphorus is further removed by soil sorption. Wetlands are reported to reduce bacteria concentrations by 78 to 90% (Boyer 2006).

- Manure Storage *St*ructures
- Manure Transport Cost Share

From cropland sources*:* A 63.8% reduction in bacteria from cropland was also prescribed, although the magnitude of that reduction is less than 1/10th that of pasture, and less than 1/1000th that of septic systems. To achieve this reduction, the goal is to implement nutrient management plans on at least 558 *a*cres of cropland, in combination with other BMPs where appropriate. The allocations by subwatershed, (Table 4) indicate the reductions should occur in 12 of the 18 subwatersheds. Cropland BMPs will be pursued mainly through federal cost-share programs (Conservation Reserve Enhancement Program [CREP], Environmental Quality Incentives Program [EQIP], and Wildlife Habitat Incentives Program [WHIP]) and the state's cost-share program (Agriculture Enhancement Program), including the following:

- Nutrient management plan*:* Farm operators develop a comprehensive plan that describes the optimum use of nutrients (sometimes consisting of animal manures containing fecal coliform bacteria) to minimize nutrient loss while maintaining yield.
    - *Manure composting to reduce live bacteria:* see Composting Facility NRCS Practice Code 317
    - *Increased soil testing* – this will enable better precision in the application of nutrients, thus decreasing the cost of commercial fertilizer needed on a field.
    - *Manure storage structure* – as more nutrient management planning is accomplished in Tuscarora Creek watershed, the need may arise for covered structures in which to store animal waste that cannot be immediately applied to fields. Even agricultural producers who clearly document the need

for these structures, along with their rotation schedule and manure analysis may have a difficult time applying for federal cost-share funds if they do not actually raise poultry or livestock on their operation.
  - *Transport of manure to fields outside the watershed or further from streams*

- Grass buffer*:* (see description above)
- Riparian forest buffer*:* (see description above)
- Wetland restoration and creation (see descriptions above)

From onsite sewer systems*:* The TMDL prescribes 100% reductions from failing septic systems. Failing systems will need to be identified and inspected to determine adequate solutions:

- Pumping
- Repair: the upgrade might include drainfield rehabilitation, a new tank or drainfield, or the addition of treatment before the drainfield
- Replacement with an appropriate system
- Sewer line extensions

As part of the Eastern West Virginia Wastewater Plan (EWVWP) CVI will help to refine what is known about the extent of the septic system failures in the Tuscarora Creek Watershed. This project will include a comprehensive study of the current treatment available in the project area and will provide recommendations for the most cost efficient treatment in high priority areas. The recommendations will include encouraging the use of onsite systems in appropriate areas and suggested areas to consider alternative onsite systems. The plan will also include recommendations for appropriate treatment in communities where onsite systems are not appropriate. These recommendations may include cluster systems with subsurface disposal to keep the per-household cost at a minimum.

Most of the septic upgrade projects will likely occur in the western half of Tuscarora Creek watershed, due to sewer system coverage in the eastern half. One exception is an older (pre-1990s) subdivision of approx. 45 homes just north of Martinsburg city limits, which was noted during the plan-writing process as likely requiring extensive septic system upgrades. Limestone pinnacles throughout this area indicate rocky conditions - probably the reason that sewer was not extended to this area- and karst topography. To add to the challenge, alternate drainfield areas were likely not reserved when these homes were built, so Class II (e.g. sand mound) systems might be needed. Residents' concerns, along with costs of alternative solutions should be examined during Phase I of implementing this plan.

Table 9. Best Management Practices (BMPs) for reduction of fecal coliform bacteria and their associated reductions proposed for Tuscarora Creek. Reported efficiencies are based on the optimal efficiency rating reported by Boyer (2006).

Practice				
Urban/Residential	Planned units (acres)	Baseline load per acre	Percent efficiency for fecal	Fecal- anticipated load reduction
Stream buffers	1000	1.21×10^{10}	57%	6.90E+12
Sand filters	50	1.21×10^{10}	83%	5.02E+11

Urban wet ponds	50	1.21×10^{10}	50%	3.02E+11
Wetland construction	50	1.21×10^{10}	90%	5.44E+11
Biofiltration	50	1.21×10^{10}	50%	3.02E+11
Total				**8.55E+12**
Cropland/Pasture	Planned units (acres)	Baseline load per acre	Percent efficiency for fecal	Fecal- anticipated load reduction
Grass buffer establishment	25	2.40×10^{10}	57%	3.43×10^{11}
Forest buffer establishment	25	2.40×10^{10}	57%	3.43×10^{11}
Fencing	20	2.40×10^{10}	70%	3.37×10^{11}
Alternative water system	20	2.40×10^{10}	22%	1.06×10^{11}
Manure storage structures	9	2.40×10^{10}	90	1.95×10^{13}
Manure transport cost share	12	2.40×10^{10}	100	2.88×10^{13}
Total				**4.94×10^{13}**
Septic Systems	Planned units (acres)	Baseline load per acre	Percent efficiency for fecal	Fecal- anticipated load reduction
Upgrade/fix failing systems	713 systems	6.27×10^{12}	100%	4.47×10^{15}
Total reduction from all practices				**4.53×10^{15}**

To achieve sediment reductions

A suite of Best Management Practices (BMPs) will be used to achieve the sediment load reductions called for in the TMDL. Below are the descriptions of these practices and their associated load reductions are listed in Table 10.

From eroding streambank sources*:*

Natural stream design*:* To understand the amount of Natural Stream Design (NSD) work that would be needed to achieve desired load reductions, we began by estimating the Bank Erodibility Hazard Index (BEHI) of 3 streambanks with characteristics representative of the erosion sites identified by OCPT volunteers, an analysis that was introduced in the previous section.

The Poor House farm site was dominated by areas of erosion with Low BEHI scores. Although it has high (>6 ft), steep banks it is very densely vegetated with a narrow buffer. BEHI calculations yielded an estimate of 3.5 tons of sediment reduction possible per year or 0.01 tons per foot per year. Sites with similar characteristics will be of lowest priority for NSD projects.

The Roach site had BEHI scores ranging from Very Low to Very High with the majority being Moderate. The banks were low ($\leq$4 ft), with very little vegetation. Calculations estimated a possible sediment reduction of

8.3 tons per year for this 448 foot reach, or 0.02 tons per year per foot. Stream buffer establishment will be considered the recommended practice for reducing sediment from sites with similar characteristics.

The mouth of Tuscarora Creek was dominated by streambanks with Low, Moderate and Extreme BEHI scores. The measurements and subsequent calculations yielded an estimate of 50 tons/year reduction possible over this 415 foot section of Tuscarora Creek. Therefore, we estimate that sediment at similar erosion sites could be reduced by 0.12 tons per year per foot, if NSD were to bring all the banks down to a "Low" BEHI rating. High priority for NSD projects will be given to sites with similar characteristics.

To achieve the 572.8 tons/year reduction prescribed for streambank erosion, the 38 erosion sites identified by OCPT volunteers will be evaluated based on their similarities to the three BEHI sites. Sites will be mapped and the longest reaches with characteristics similar to the mouth of Tuscarora Creek will be evaluated by estimating BEHI to identify roughly 4773 feet of streambank suitable for Natural Stream Design projects.

Since a significant amount of sediment reduction was prescribed for cropland (484.1 tons/year or 24.5%) and since NSD, the BMP normally used to correct streambank erosion, is so expensive, we propose to also address loads coming from Cropland and Pasture. According to the assessment on Tuscarora Creek performed by Opequon Creek Project Team, seven of the 45 sites marked for erosion also had livestock access directly to the stream. This indicates opportunities for addressing pasture loads by restricting livestock access to the creek may have the added benefit of reducing loads from streambanks without the need for NSD. That is, allowing more vegetation to grow and develop root systems along the creek is likely to bring streambanks with Moderate and Low BEHI ratings down to Low and Very Low ratings.

- <u>Armored streambank stabilization</u>: in some cases where streambank erosion is a problem but NSD is not possible due to site constraints (e.g. a road or building very close to streambank, making a bankfull bench out of the question), rip-rap or other methods of streambank armoring may be necessary. Innovative options which allow for greater vegetative growth may also be used, such as articulated concrete block.

From pasture sources*:*

To reduce 16.3% of this sediment load, a suite of BMPs must be implemented to achieve 100% reductions on 238 acres of pasture land. See above pasture BMPs for achieving fecal coliform reductions.

From cropland sources*:*

To reduce 24.5% of this sediment load, a suite of BMPs must be implemented to achieve 100% reductions on 214 acres of crop land. Cropland BMPs will be pursued mainly through federal cost-share programs (Conservation Reserve Enhancement Program [CREP], Environmental Quality Incentives Program [EQIP], and Wildlife Habitat Incentives Program [WHIP]) and the state's cost-share program (Agriculture Enhancement Program), including the following:

- <u>Conservation till</u>*:* involves the planting, growing and harvesting of crops with minimal disturbance to the soil surface through the use of minimum tillage, mulch tillage, ridge tillage, or no-till. Effectiveness estimates: 30% for TSS, 0-18% for TN and 22% for TP (Simpson and Weammert 2009, p. 69).

- Cereal cover crops*:* Non-harvested winter cereal cover crops, including wheat, rye and barley, designed for nutrient removal. This BMP also provides some benefit for sediment erosion control, particularly when established after low residue crops. The BMP is less effective in reducing phosphorus than sediment losses since some phosphorous is transported in water soluble forms in addition to particulate forms. Effectiveness estimates vary according to crop type and planting date (Simpson and Weammert 2009, p. 99, 101). *Commodity cover crops:* Commodity cereal cover crops differ from cereal cover crops in that they may be harvested for grain, hay or silage and may receive nutrient applications, but only on or after March 1 of the spring following their establishment. The intent of the practice is to modify normal small grain production practices by eliminating fall and winter fertilization so that the crops scavenge available soil nitrogen similarly to cover crops for part of their production cycle.

See also above cropland BMPs for achieving fecal coliform reductions.

From urban/residential/road impervious areas:

Although only a very small sediment wasteload allocation (and no [nonpoint] load allocation) is given to residential sources in the TMDL, we see many opportunities to reduce sediment from residential sources. The BMPs used for this purpose are already included in those listed for fecal coliform reductions, above.

To address Chesapeake Bay pollutants

Many of the BMPs appropriate for reducing nutrients and sediment have already been discussed above, with reduction efficiencies listed in some cases. An additional desirable BMPs is:

- De-nitrifying septic system*:* Septic denitrification represents the replacement of traditional septic systems with more advanced systems that have additional nitrogen removal capabilities. There is currently no incentive program or local emphasis on conversion to these types of septic systems, but a plan to install two would be reasonable.

To address the lack of forest cover

- Afforestation*:* Tuscarora Creek Watershed soils are rated excellent for trees. Planting open areas or abandoned fields with high-quality hardwoods or evergreens will help to capture rainfall, reduce runoff, filter nutrients and sediment and stabilize soils. More forest land will ultimately increase watershed health. This results in a gain in forest acres.

- Land Conservation*:* Permanently protect watershed forests from conversion, targeting those on the east slope of North Mountain. Work with local governments, land trusts, or other local stakeholders to create or dedicate sources of funding to conserve forests. This will help to balance nutrient loads that come from open or developed lands.

Table 10. Best Management Practices (BMPs) for reduction of sediment and their associated reductions proposed for Tuscarora Creek. Reported efficiencies are based on reduction efficiencies listed in Simpson and Weammert 2009, pp. 342-362 and efficiencies currently used in scenario builder.

Streambank erosion	Planned units	Baseline load per acre (tons/year)	Percent efficiency for sediment	Sediment- anticipated Load Reduction
	Feet			
NSCD implementation	4773	3674.5*	100%	572.76
MS4 Streambank erosion	Feet			
Armored streambank stabilization	3500	0.64	0.12	420.00
Cropland/Pasture	Acres			
Residue management (no-till, strip-till etc.)	122	20.05	70%	1712.12
Cover crops	120	20.05	20%	481.16
Grass buffer establishment	175	20.05	40%	801.93
Forest buffer establishment	25	20.05	40%	801.93
Fencing	50	20.05	40%	400.97
Alternative water system	50	20.05	30%	300.72
Total				**4498.83**
Urban/Residential	Acres			
Stream Buffers	35	0.64	40%	8.99
Wetland construction	45	0.64	60%	17.34
Raingarden demonstration	15	0.64	90%	8.67
Residential rain gardens	25	0.64	90%	14.45
Total				**49.45**
Total Reduction from all practices				**5541.04**

***Baseline load (tons/year)**

D. Technical & financial assistance

Lead agency and contacts:

Canaan Valley Institute (CVI) will be coordinating the implementation of BMPs, reporting, and the management of the 319-Incremental Grant. CVI will administer funding for this Watershed Based Plan, and sequential 319-Incremental Grants. Its role in outreach and education is outlined below. It is currently conducting a 319 Incremental project in Mill Creek of the Opequon watershed, addressing the same suite of pollutant and nonpoint source categories.

The West Virginia Department of Environmental Protection (DEP) will oversee the reporting for this project. The Potomac Basin Coordinator will provide support in the form of outreach, contacts, and familiarity with the TMDL.

The Berkeley County Health Department will inform citizens of septic pumping, repair or replacement programs when citizens are in eligible areas. Health Department staff will also inform citizens of West Virginia's Onsite Loan Program to help them pay for the cost of these activities. Staff will also provide technical support to residents with septic system problems and will facilitate the use of additional technical support from outside service providers.

The USDA-Natural Resource Conservation Service will provide technical assistance to interested landowners, suggesting and designing the agricultural BMPs. Its staff will make agricultural operators aware of federal, state, and 319 programs that provide cost-share on BMPs appropriate for their operations.

The Eastern Panhandle Conservation District recognizes Opequon Creek watershed as one of its local priorities in its annual plan of work, and is committed to remaining informed about this implementation effort through its Watershed Committee. The outreach specialist of the EPCD is also available to educate students and homeowners in the Mill Creek watershed using a groundwater model and other tools. The EPCD, in conjunction with the other resource professionals at the USDA Service Center in Martinsburg, will be instrumental in assisting landowners applying for low interest loans through the State Revolving Fund to help them make up their portion of the cost-share on agricultural BMPs.

West Virginia University Extension maintains contact with farmers in the Tuscarora Creek watershed, and occasionally offers workshops on topics that could include nonpoint source pollution-reducing BMPs. Extension currently has a Conservation Innovation Grant that promotes the transfer of manure outside a farmstead, the soil sampling needed to prepare for the split application of nitrogen on crop fields, and the actual split-application of nitrogen on such fields in Jefferson, Berkeley and Morgan counties. Its staff along with other agencies will continue to make agricultural operators aware of federal, state, and 319 programs that provide cost-share on BMPs appropriate for their operations.

The WVDA employs nutrient management specialists who are available to write nutrient management plans for producers. The WVDA also provides free manure analysis.

The Martinsburg-Berkeley County Parks and Recreation Department manages four public parks along Tuscarora Creek: Oak Street Park, Oatesdale Park, Poor House Farm Park and War Memorial Park. Its headquarters are located within the watershed as well, in the Berkeley 2000 Recreation Center in Lambert Park on Woodbury Avenue in Martinsburg. It recently acquired a fifth site along Tuscarora Creek near E. Burke St. in Martinsburg. Its Executive Director and Board have, in recent years, worked with some of the partners listed above on nonpoint source reduction projects. A natural stream restoration project was carried out at War Memorial Park in 2006 to keep the streambed from shifting toward a parking lot and pavilion, thereby preventing future erosion. Its staff worked with Potomac Headwaters RC&D and the WVDEP to plant several shrub and tree seedlings along the streambanks in that area, but the activities of wildlife and visitors prevented many of them from surviving. Options for future stabilization and re-vegetation projects will likely be pursued at these properties as part of this TMDL implementation project. The Berkeley 2000 Recreation Center was the site of a recent workshop for area watershed organizations, and could serve as a central training facility for other topics to help reduce nonpoint source pollution, as well.

Cost estimates:

Upgrade/fix failing septic systems: Homeowners should be expected to provide matching funds for a portion of the estimated $7000 average cost, plus any additional cost. State Revolving Loan funds are available through the Onsite System Loan Program to assist homeowners with their portion of the cost.

As mentioned above, the Eastern West Virginia Wastewater Plan (EWVWP) will provide recommendations for the most cost efficient treatment in high priority areas. The recommendations will include encouraging the use of onsite systems in appropriate areas and suggested areas to consider alternative onsite systems. The plan will also include recommendations for appropriate treatment in communities where onsite systems are not appropriate. These recommendations may include cluster systems with subsurface disposal to keep the per-household cost at a minimum.

Additional treatment for de-nitrifying: The cost of additional treatment, especially if that treatment provides for nutrient (mostly nitrogen) removal is approximately $12,000 per system. On the positive side, this additional treatment can renovate certain types of drainfield failure, so two fixes can be provided with one intervention, but some new drain fields may be required in addition to advanced treatment. (Winant 2008)

Pasture and cropland BMPs costs: Unit cost estimates for pasture and cropland BMPs were primarily provided by the Farm Service Agency and Natural Resources Conservation Service staff.

Urban/Residential BMPs costs: Cost estimates for urban and residential BMPs were based on recent experience with similar projects in Berkeley County and nearby.

Natural Stream Design costs: The cost per foot from the Watershed Based Plan for Mill Creek (Opequon 2008) was used, plus approx. 10% for increases in construction and supplies since 2008. Any streambank stabilization project should include replanting with cuttings, shrubs, and/or trees. E.g. a 500 ft. stabilization project would require approximately 180 plants, at a cost of $1500-1800, unless just cuttings or bare root stock are used.

Education/outreach costs: Canaan Valley Institute provided estimates of workshop costs for the Mill Creek Watershed Based Plan (2008). The professional workshop estimate was based on a 2-day model. Cost estimate of rain barrel workshop was based on recent experience in the Eastern Panhandle.

Monitoring costs: Funding will be requested to develop a QAPP and more detailed monitoring plan. This is an area in which volunteers in the Eastern Panhandle of West Virginia have sought professional expertise. In Tuscarora Creek watershed, several entities' monitoring data must be synthesized effectively. Benthic macroinvertebrate samples will likely be collected at volunteer-driven events, and these will need to be analyzed by professionals. Estimates are given for these activities.

Table 11. Estimated cost of implementing nonpoint source TMDLs in the Tuscarora Creek watershed

Practices				
Residential and Urban	Units	Planned units	Cost/unit	Total
Stream Buffers	Acres	1000	$1,920	$1,920,000
Sand Filters	Filters	2	$1,600,000	$3,200,000
Urban Wet Ponds	Acres	50	$1,000	$50,000

Wetland Construction	Acres	50	$1,000	$50,000
Biofiltration	Acres	2	$1,600,000	$0
Raingarden Demonstration	Acres	15	$4,000	$60,000
Residential Rain Gardens	Acres	25	$500	$12,500
Pet waste campaign		1	$5,000	$5,000
Agricultural	Units	Planned units	Cost/unit	Total
Residue management (no-till, strip-till etc.)	Acres	122	$4.30	$524.60
Cover crops	Acres	120	$66.60	$7,992.00
Grass buffer establishment	Acres	175	$243	$42,525.00
Forest buffer establishment	Acres	25	$3,600	$90,000.00
Fencing	Acres	50	$3,756	$187,800
Alternative water system	Acres	50	$7,000/350 ft	$2,450,000
Nutrient management plans	Plan	25	$7,200/plan	$180,000
Manure storage lagoons	Acres	9	$40,000/1,500 ft^2	$10,454,400
Manure transport cost share	Pounds	500	$10.00/mile	$5000
Eroding streambank projects	Units	Planned units	Cost/unit	Total
NSCD implementation	Feet	8,000	$130	$1,040,000
500 ft of vegetation (to stabilize projects)		16	$1,650	$26,400
Armored streambank stabilization		5	$5,000	$25,000
Septic systems	Units	Planned units	Cost/unit	Total
Pumping	Systems	30	$266	$7,980
Upgrade/fix failing systems	Systems	713	$7,000	$4,991,000
Additional de-nitrifying treatments	Systems	2	$12,000	$24,000
Education and outreach	Units	Planned units	Cost/unit	Total
Impervious surface reduction campaign		2	$5,000	$10,000
Rain barrel workshops (15 barrels)		2	$1,200	$2,400
Septic system workshops		2	$2,500	$5,000
Monitoring	Units	Planned units	Cost/unit	Total
QAPP and monitoring plan development			$2,000	$2,000
Benthic macroinvertebrate samples		10	$70	$700
Total				**$17,415,822**

E. Outreach and education

Opequon Creek Project Team (OCPT), the local nonprofit watershed group that identified Tuscarora Creek as its priority watershed, is committed to participating in implementing this plan. The OCPT is actively engaged in projects that will lead to a reduction in pollutants such as nutrients, sediment, fecal coliform bacteria, and trash entering Opequon Creek and its tributaries. Through these projects they have gained visibility in the community for the issue of water quality in its streams and creeks. They communicate both through conversation and direct mailings with residential and agricultural landowners to learn about their concerns regarding the Opequon Creek watershed and in turn to share information about the need for BMPs such as proper septic system maintenance, stormwater runoff, riparian forest buffers and livestock fencing.

To showcase BMPs the Team has planted over 1,000 trees at 6 stream buffers, installed 4 rain gardens, and conducted 5 rain barrel workshops. These projects are often in partnership with state and local agencies as well as local home owners. OCPT through its activities and community network is well positioned to implement the education and information component of this plan.

Monitoring -The Team concluded a 3-year monitoring program that sampled for E. Coli in the main stem, the Tuscarora and other tributaries in the Opequon watershed. The information gained from this monitoring program has been shared with the public at several monthly Team meetings, with the Public Service Sewer District, and was the impetus for a front page article in the Martinsburg Journal.

Survey - A landowner survey, mentioned in section A, was mailed to residents in the Tuscarora watershed. Based on the response received from that survey OCPT is committed to maintaining personal contacts and to ensure that project proposals resulting from this plan reflect the priorities and capabilities of the community.

Assessment - Using the WVDEP “Conducting a Watershed Survey Using The Easy Assessment Method” procedure, the Team completed a physical assessment (mentioned in section A) that included walking and photographing the length of the Tuscarora to build an information database to underpin the Tuscarora Creek Plan. While conducting this survey, volunteers knocked on every door of creek side residents who did not respond to the survey. This personal contact is the most effective way of getting the OCPT message to the public and to get feedback from property owners as to their concerns about water quality.

Public Presentations - The Team has a program of presentations and has begun to deliver these presentations to local schools, homeowner associations and other venues. These presentations describe project methods designed to protect nature; for example, the benefits of trees along the creek’s edge; proper disposal of oil; cleaning up after our pets; proper septic maintenance, rain gardens, rain barrels and lawn care for homeowners. By conducting these public seminars, OCPT is hoping to make residents of the watershed aware of the effect certain actions have on the water quality in the Tuscarora and eventually the Chesapeake Bay.

Social Networking and Website - The Project Team will use the social network FaceBook in addition to its website to inform current members and interested people of the progress of the Tuscarora project. The Team maintains a website which, among other things, defines the mission statement (what the Team seeks to achieve), describes the history of OCPT, provides links to educational material about the Team’s activities, is consistently updated and explains activities of volunteers with project descriptions, dates and pictures. The website will also include links to information on methods to help improve water quality.

Public Meetings - The Project Team’s monthly meetings are open to the public and the Team will discuss the Tuscarora project at those meetings. Guest speakers are asked to present topics focused on water quality and quantity issues, and development of possible solutions for improvement.

Publicity - The Project Team will publicize this project in the local newspaper, the Martinsburg Journal. In addition to newspaper publicity, the Team will re-draft and print for the Tuscarora Creek audience, several brochures already written by various groups in WV. Subjects of these brochures include septic system maintenance and environmentally sound lawn care. The Project Team periodically circulates a newsletter via its extensive contact list and will include updates on the Tuscarora project in each newsletter.

Seminars/Workshops - The Team promotes and sponsors public educational and outreach seminars and workshops for participants interested in learning about the watershed, water quality and quantity issues, and develop possible solutions for improvement. A program of presentations is being created addressing residential BMPs, etc. to be delivered by Team members to local schools, government agencies, homeowner associations and other venues. Brochures and booklets on these subjects, already written by various groups in WV will be printed or re-drafted for the Tuscarora Creek audience specifically. Subjects to be covered include, but are not limited to, the following: lawn care, riparian buffers, storm water (rain barrels and rain gardens), low impact development, litter, septic systems, wells, pet waste, and pharmaceuticals.

Local Events – The Team participates in local events such as the annual Home Show, Apple Harvest Festival, Earth Day Festival, Audubon education events, etc.; conducts rain barrel workshops several times a year to help the community learn about storm water runoff and its role in water quality, hosts guest speakers at its monthly meetings and works with local youth to implement watershed projects, thereby instilling water quality principles in a future generation of potential leaders.

Local schools include: Winchester Avenue Sch., Martinsburg High, St. Joseph Parish Sch. (Queen St. and Stephen St.), Martinsburg South Middle, Burke St. Elementary, International Beauty Sch., Rosemont Elementary, Blue Ridge Technical College, Berkeley Heights Elementary School, Mountain State University, WVU Eastern Division School of Health Sciences, Opequon Elementary, Tuscarora Elementary, Rocky Knoll Adventist Sch., Martinsburg North Middle, Pikeside Sch., Valley College of Technology, Eagle Intermediate, Valley View Elementary, and Warm Spring Middle, and Orchard View Intermediate. A teacher at Orchard View Intermediate School recently raised funds for and implemented, with students' help, a series of check-dams and plantings to remediate and eroding stormwater ditch on school grounds.

Oct. 1, 2008 Orchard View Intermediate School's stormwater ditch remediation.

Wastewater outreach

Canaan Valley Institute focuses on improvements to wastewater treatment systems to reduce pollution to the region's rivers and streams caused by inadequate wastewater treatment and have considerable experience in the development of regional comprehensive wastewater plans. These plans typically focus on four components: community engagement; assessment; identifying options; and assisting and coordinating design and implementation.

CVI also has extensive experience in hosting public workshops on wastewater issues, and will be developing an outreach campaign as part of the Eastern West Virginia Wastewater Planning project. This project will develop small and rural community focused outreach and education materials for decentralized treatment technologies. It will review existing materials and develop packets that are most appropriate for the areas of interest and types of treatment proposed.

CVI will work with sanitarians and PSD to develop mailing list and NESC will develop an electronic listserv for these materials.

Other forums will also be used to reach out to homeowners. CVI has extensive experience in hosting public workshops on wastewater issues. Such workshops are developed to inform local citizens on: the effects of wastewater pollution on a watershed, proper maintenance and care of an onsite wastewater (septic) system, alternative options to traditional wastewater systems, and available financial assistance programs. The project team will also meet with reporters to develop articles for local newspapers about onsite maintenance.

CVI will also continue the well established relationship between CVI and OCPT for disseminating project goals to the public by developing displays and information booths at local fairs and festivals across the project area.

CVI has already developed courses on alternative onsite and subsurface disposal systems. These training courses will be made available to installers and sanitarians in the project area. Another critical component of improving wastewater treatment in the project areas will be working to educate developers about alternative treatment systems. Information packets will be designed specifically for this group and we will work with sanitarians and other local leaders to identify key stakeholders.

Trout Unlimited's Potomac Headwaters Youth Education Initiative is also active in West Virginia and could provide leadership and continuity to teachers and students interested in monitoring local water quality and implementing related on-the-ground projects.

The Berkeley County Council is aware of the ongoing Mill Creek 319 project in Opequon Creek watershed, and welcomes updates about Tuscarora Creek project plans. When project partners brief the Council, representatives of the local press are often present and articles may result.

Section F, G, H: Schedule for Implementing NPS management measures, Description of Milestones, and Measurable Goals

2013:

- Submit Tuscarora Creek Watershed Based Plan to U.S. Environmental Protection Agency
- Develop and submit first Tuscarora Creek Project Proposal

2013, second half – 2014, first half:

- Begin communicating with septic system owners in the western tier of the watershed:
    - regarding low-interest loan program
    - and to identify any problems with septic systems and consider upgrade options
- Develop Tuscarora Creek watershed monitoring plan, identify partners for each component, and develop Quality Assurance Project Plan

PHASE I: 2014, second half - 2019, first half

- Receive first and second Section 319 Incremental Grant
- Continue assessing septic project priorities on a finer scale
- Professional workshop with septic installers, pumpers, etc. to provide technical support
- Public meeting in Shenandoah Junction or a high-priority subdivision regarding septic system loan program and proper septic maintenance
- repair 238 underperforming septic systems

- Outreach (including one field demonstration day) to cropland farmers in the priority Subwatersheds, regarding nutrient management and other BMPs
- Outreach to medium & high erosion potential pastures, regarding fecal coliform and sediment BMPs
- **Reduce fecal coliform by 1.5E+15**
- 1 Rain Barrel workshop (~15 barrels each)
- 2 Natural Stream Design projects
- **Reduce sediment by 431.8 tons**
- Ongoing monitoring
- (by 2018, first half) submit 3rd Section 319 Incremental Project Proposal

PHASE II: 2019, second half – 2024, first half

- RE-EVALUATE THE WATERSHED BASED PLAN BASED ON PROJECT IMPLEMENTATION TO DATE AND MONITORING RESULTS
- Re-evaluate monitoring plan
- Receive 3rd Section 319 Incremental Project Proposal
- More of what is in phase I, but in the next priority area of:
- pasture,
- cropland 2nd priority subwatersheds),
- and eroding streambanks
- Repair, pump, or account for 235 underperforming septic systems
- Outreach to medium & high erosion potential pastures, regarding fecal Coliform and sediment BMPs
- **Reduce fecal coliform by 1.5E+15**
- **Reduce sediment by 431.8 tons**
- (by 2022, first half) submit 3rd Section 319 Incremental Project Proposal

PHASE III: 2024, second half –2029, first half

- RE-EVALUATE THE WATERSHED BASED PLAN BASED ON IMPLEMENTATION TO DATE AND MONITORING RESULTS
- Re-evaluate monitoring plan
- More of what is in Phase I&II, but in the next priority area of:
- remaining pastures,
- any remaining cropland,
- and eroding streambanks
- Repair, pump, or account for 235 underperforming septic systems
- **Reduce fecal coliform by 1.5E+15**
- **Reduce sediment by 431.8 tons**

Evaluating achievement of pollutant load reductions

1) Spring-fed waters in such faulted karst are usually nutrient rich and relatively heavily laden with bacteria, metals, and other pollutants," (Ecological Assessment, p. 46). If long-term implementation is not resulting in sufficient reductions, the groundwater influence might have to be addressed.

2) The extent of septic system failures in the watershed has been questioned by some stakeholders during the writing of this Plan. We will continue to evaluate this at the subwatershed level as we proceed with implementation, based on our experiences with septic system owners and neighborhoods in the watershed.

I. Monitoring

The WV DEP will conduct its regular 5-year cycle sampling in the Potomac Direct Drains watershed in 2013. At that time, the seven sites from the 2003-04 pre-TMDL sampling in Tuscarora Creek watershed will likely be re-tested. Parameters will include fecal coliform, nutrients, TSS, and possibly benthic macroinvertebrates. Occasionally, sites within the watershed may also be monitored as part of WV DEP's random sampling program. Some volunteer sampling of benthic macroinvertebrates will also occur, using West Virginia's Save Our Streams protocol. Monitoring will be conducted in accordance with an EPA accepted QAPP.

References

Boyer, Allison. 2006. Reducing Bacteria with Best Management Practices. p.2. http://www.wr.udel.edu/ChristinaTribTeam/Fact%20Sheets/ReducingBacteria_wBMPs.pdf

Chesapeake Bay Program, 2007, Agricultural BMP Effectiveness Estimates, 10 pp. Accessed at http://www.chesapeakebay.net/tribtools.htm#resources, April 2, 2008.

Chesapeake Bay Program, Best Management Practices Basics, 41 pp. http://www.chesapeakebay.net/tribtools.htm#resources

Chesapeake Stormwater Network, 2010. Bayside Design Specifications. (Dry swales) http://www.chesapeakestormwater.net/all-things-stormwater/dry-swale-design-specification.html (Grass channels) http://www.chesapeakestormwater.net/all-things-stormwater/grass-channel-design-specification.html

Environmental Protection Agency, 2012. National Menu of Stormwater Best Management Practices. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=75&minmeasure=5

Gaujot, Ryan. 2008. Hydrologic Description of Mill Creek of the Opequon, Inwood, West Virginia. Canaan Valley Institute. 4 pp. [Appendix A of Mill Creek Watershed Based Plan] http://www.opequoncreek.org/Watershed%20Based%20Plan/Appendix_A_%20Mill_Cr_Hydrology_Report.pdf

Watershed Based Plan for Mill Creek, A Tributary of Opequon Creek, in the Potomac Direct Drains Watershed, 2008. 42 pp. http://www.opequoncreek.org/Watershed%20Based%20Plan/Watershed%20Based%20Plan%20for%20Mill%20CreekMAY_1_08.pdf

West Virginia's Chesapeake Bay TMDL Watershed Implementation Plan, March 2012, www.wvca.us/bay/documents.cfm

West Virginia Conservation Agency, 2007, Mill Creek of the South Branch of the Potomac Watershed Based Plan, in cooperation with the West Virginia Department of Agriculture and

Cacapon Institute, Appendix A, pp. 23-24.

West Virginia Division of Water and Waste Management, 2005, An Ecological Assessment of the Potomac River Direct Drains Watershed, Report No. 02070004, p. 48.

West Virginia Division of Water and Waste Management, 2008. Total Maximum Daily Loads for Selected Streams in the Potomac Direct Drains Watershed, West Virginia, Prepared by Water Resources and TMDL Center, Tetra Tech, Inc. 59 pp. & Appendices.

Winant, Edward H. 2008. Watershed wastewater protection plan, Opequon Creek Watershed, Mill Creek Subwatershed: Canaan Valley Institute. 6 pp. [Appendix F of Mill Creek Watershed Based Plan] http://www.opequoncreek.org/Watershed%20Based%20Plan/Appendix_F_%20Mill_Cr_WS_%20Wastewater_Report.pdf

Acknowledgments

Many entities within the community provided support to write this plan. Citizens of the Opequon Creek watershed attended two public meetings and continue to alert partnering agencies to potential project opportunities. The Opequon Creek Project Team allowed time on several meetings' agendas for coordinating this and related planning efforts. The Berkeley County Health Department and Berkeley County Public Service Sewer District all provided valuable information about septic systems and plans to extend sewer service in the county. Berkeley County offices of WVU Extension Service and Natural Resources Conservation Service and the Berkeley County Farm Service Agency provided insight into practices on local farm operations and costs of installing BMPs. A Section 319 grant supported Canaan Valley Institute's work gathering information to complete this plan. The West Virginia Division of Forestry contributed forestry and land use insights. The Eastern Panhandle Conservation District and West Virginia Conservation Agency have maintained an interest in this watershed. Volunteers Lou Scavnicky and Bill Zinner of Opequon Creek Project Team conducted a streambank assessment of Tuscarora Creek.