Watershed Based Plan for Mill Creek

A Tributary of Opequon Creek, in the Potomac Direct Drains Watershed

Berkeley County, WV

Prepared 2008
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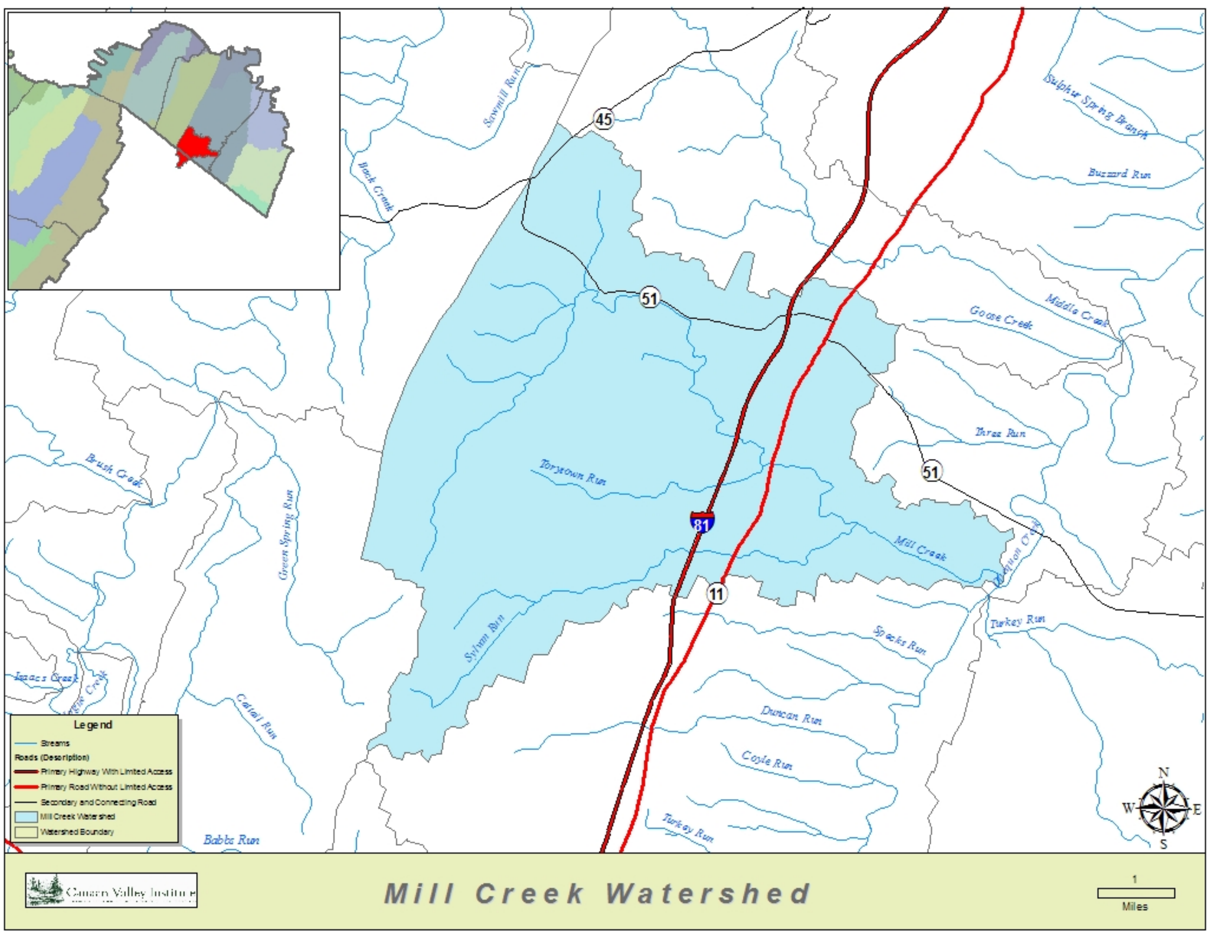
Cover photo of Mill Creek by Sandra Bernardi and Mary Palmer, September 2007.

Table of Contents

Introduction and Description of Mill Creek Watershed

The purpose of this document is to provide a Watershed Based Plan for the U.S. Environmental Protection Agency and the stakeholders of the Mill Creek watershed, which can guide future nonpoint source project proposals for funding through the Clean Water Act Section 319 and other sources. Mill Creek is a spring-fed stream that begins in Virginia, just south of the Berkeley County, West Virginia border (Figure 1). It is 14.5 miles long (one mile of which is in Virginia), and its watershed covers 29.75 square miles. It flows north to Gerrardstown, WV, then bends toward the east and flows through orchards, new developments, older residential areas, the town of Bunker Hill, and on to Opequon Creek. South of the mainstem are situated two major tributaries, Torytown Run (3.5 miles) and Sylvan Run (7.7 miles, 2.7 of which are in Virginia).

Figure 1. Location of the Mill Creek watershed, Berkeley Co., West Virginia. In the inset, the red area is the Mill Creek watershed, and the gray area surrounding and including it is the Opequon Creek watershed.



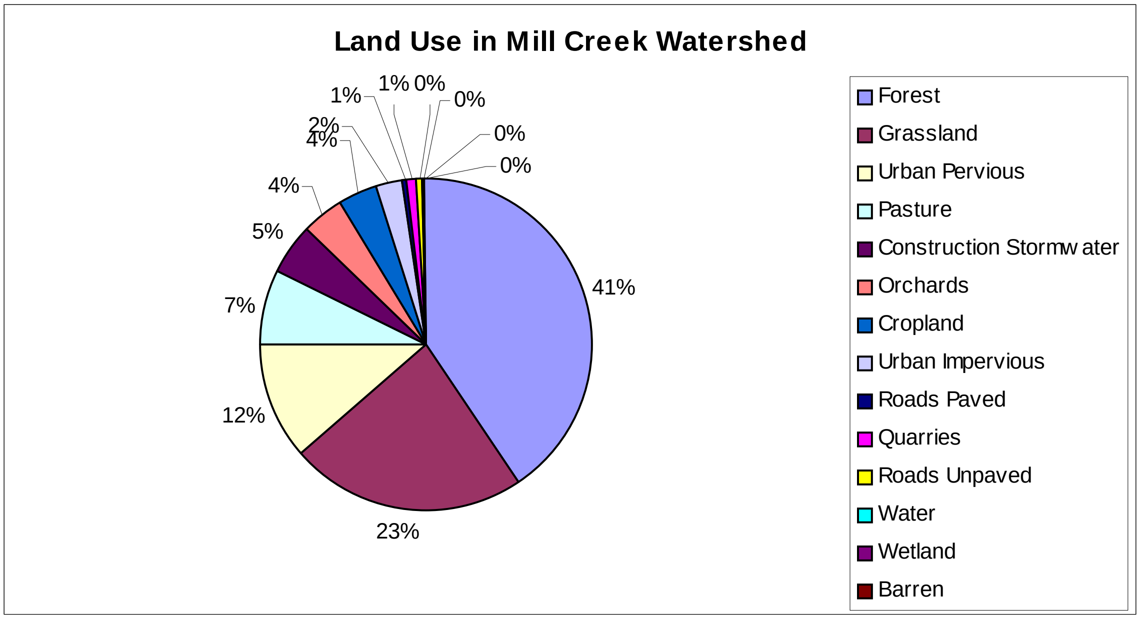
Mill Creek is located in the southeastern part of Berkeley County in the Shenandoah Valley, also called the Great Valley. The area is characterized by gently rolling topography with elevations ranging from approximately 310 ft to 800 ft above sea level. A dendritic drainage pattern has developed on streams in the Shenandoah Valley. Hence, Mill Creek has several tributaries that feed it (Shultz et al., 1995). The bedrock geology that Mill Creek flows through is mainly composed of limestones and shale. Much of the watershed has prime farmland soils (Berkeley County Planning Commission, 2006). In a stream flow study by the U.S. Geological Survey, Mill Creek and Torytown Run experienced both channel gains from, and channel losses to groundwater, while Sylvan Run experienced channel gains only (Evaldi and Paybins, 2006 [see map]).

The Mill Creek watershed is notable for its role in the history of West Virginia's settlement. As the first settlers were coming into the northern Shenandoah Valley of (then) Virginia in the second quarter of the 18th century, they found that this creek amply suited their needs for water power for mills. Thus, it became known as Mill Creek. The abundance of mill seats, or topographical areas where it was easy to dam and convey water through mill races to mill wheels, resulted in at least 13 mills present on the creek at one time. Only two mills remain from that time, but several of the dams and mill races still exist (Miller, 1977). These structures affect the hydrology of the creek. Another historic feature in the watershed is Morgan Cabin, c. 1734, home of the first white settler in West Virginia, located at Cool Spring, at the headwaters of Torytown Run. In addition to historical significance, the springs in this watershed continue to provide water for human use today. For example, LeFevre Spring in Bunker Hill, near the confluence of Torytown Run and Mill Creek, is a significant source of drinking water for Berkeley County (Fig. 2). The Berkeley County Public Service Water District also has a wellfield at Springdale Farm, near the headwaters of an unnamed tributary of Mill Creek.

Figure 2. Berkeley County Public Service Water District's facility at LeFevre Spring, with a development construction project in the background.

Today, the Mill Creek watershed includes diverse land uses, with forest, grassland, urban pervious, and pasture comprising over 80% of the total area (Fig. 3). Orchards (4%) and quarries are also present (1%). A transportation corridor consisting of Interstate-81, a railroad, and Route 11 runs in a north-south direction through the eastern 1/3 of the watershed. The most urban portion is around the Inwood exit of the Interstate, at the northern edge of the watershed. Coexisting here are lodging, convenience stores, a grocery store, a farmers market, and an apple processing plant.

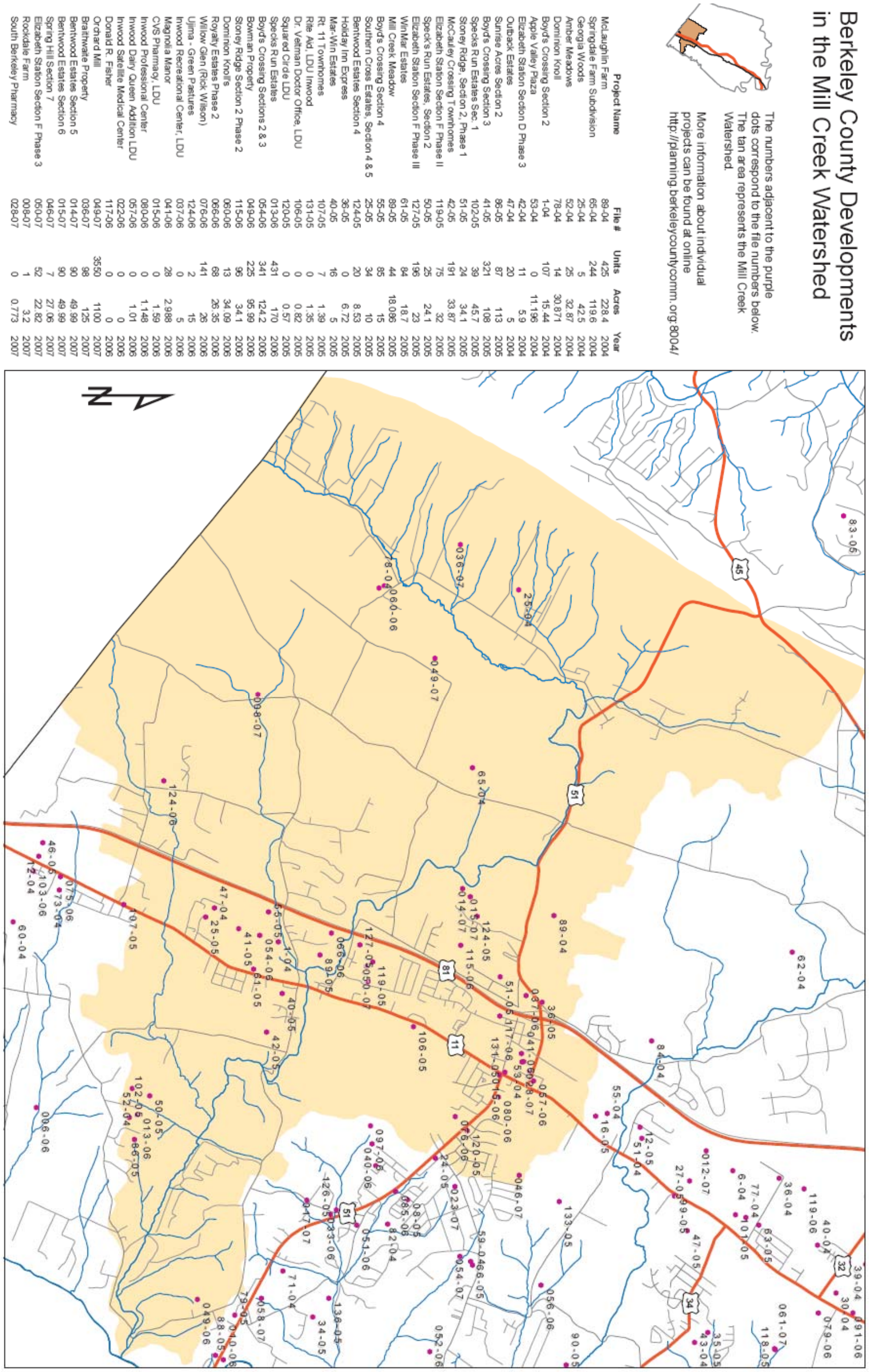
Figure 3. Land Use in Mill Creek Watershed. These estimates from the TMDL Appendix C "Modeled Landuses" include the Virginia area.



The watershed has seen a rapid increase in residential use since the TMDL development effort in 2003-2004 (Fig. 4). In addition, a large portion of the orchard acreage in the watershed has recently been sold and could be converted to residential use. Yet another significant land use change could result from the recent purchase of forest acreage by a local brick company on the east side of North Mountain, which is the western edge of watershed, if the company begins to conduct shale mining there.

Several schools, including a high school, are located in the Mill Creek watershed. School students, teachers and programs are potential targets and partners for outreach opportunities proceeding from this TMDL implementation effort. School grounds could also be appropriate places for BMP (Best Management Practice) demonstration projects.

Figure 4. Development projects proposed in the Mill Creek watershed since 2004. Map courtesy of Berkeley County staff. Total acres represented by these projects = 2908.



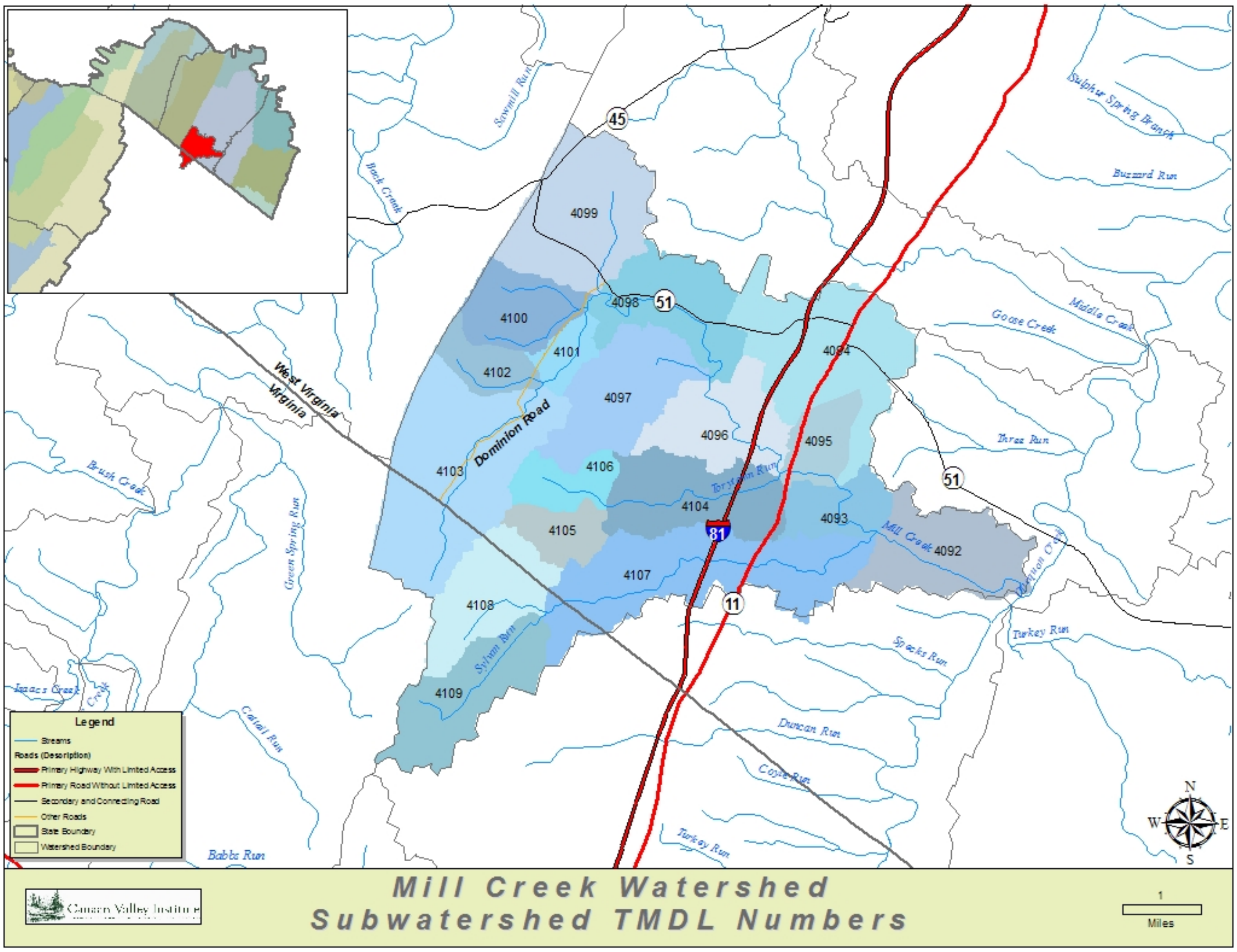
Mill Creek and Torytown Run are on the 303(d) list for biological impairment, with organic enrichment and sedimentation determined to be the biological stressors. These two streams are listed for fecal coliform impairment as well. Therefore, Mill Creek and Torytown Run received Total Maximum Daily Loads (TMDLs) for sediment and fecal coliform. Sylvan Run is listed for biological impairment only, and the biological stressor is sedimentation. Therefore, Sylvan Run received a sediment TMDL (Table 1).

Table 1. Biological and fecal coliform TMDLs for Mill Creek watershed. Numbers are taken from TMDL tables A-1-3: Fecal coliform bacteria TMDLs for the Opequon Creek watershed, and A-1-4: Biological TMDLs for the Opequon Creek watershed. The fecal coliform numbers are duplicated on both tables, but only listed once here.

Stream Code	Stream Name	Biological Stressor	Parameter	Load Allocation	Wasteload Allocation	Margin of Safety	TMDL
WVP-4-M	Mill Creek	Organic enrichment	Fecal coliform	2.33E+10 counts/day	5.69E+10 counts/day	4.23E+09 counts/day	8.45E+10 counts/day
		Sedimentation	Sediment	18.54 tons/day	54.15 tons/day	3.83 tons/day	76.51 tons/day
WVP-4-M-2	Torytown Run	Organic enrichment	Fecal coliform	2.02E+09 counts/day	7.55E+09 counts/day	5.04E+08 counts/day	1.01E+10 counts/day
		Sedimentation	Sediment	1.95 tons/day	3.00 tons/day	0.26 tons/day	5.21 tons/day
WVP-4-M-1	Sylvan Run	Sedimentation	Sediment	5.78 tons/day	1.79 tons/day	0.40 tons/day	7.97 tons/day

These TMDLs are part of the TMDL for Selected Streams in the Potomac Direct Drains Watershed, approved by EPA in January 2008. The TMDL subwatersheds that comprise the Mill Creek watershed are #4092-4109, with all of 4109 and portions of others being entirely in Virginia (Figure 5). Both the TMDL Load Allocations and this Watershed Based Plan only address the Mill Creek watershed in West Virginia.

Figure 5. The TMDL subwatersheds of the Mill Creek watershed.



Section A

Sources of fecal coliform impairment in the Mill 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 Mill Creek watershed include sewage treatment facilities (3 permitted outlets in Mill Creek watershed), discharges from Municipal Separate Storm Sewer Systems (MS4s), failing or nonexistent on-site sewage disposal systems (also called "septic systems" in this plan), and stormwater runoff from pasture and cropland. The sewage treatment facilities are regulated as point sources. The entirety of the Mill Creek watershed is within Berkeley County, which is 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 2 summarizes the fecal coliform load reductions estimated to be needed from nonpoint sources, with some other sources included for reference. These sources are discussed below in order of the magnitude of fecal coliform reduction needed. Prioritization schemas are included.

Table 2. Estimated annual load allocations and reductions needed from nonpoint sources to achieve **fecal coliform** TMDL. 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/yr)	Allocated load (counts/yr)	Reduction needed (counts/yr)	Percent Reduction needed
Background & other nonpoint sources[a]	12,879.4 acres	n/a	1.02E+13	1.02E+13	0	0
Residential/ urban[a]	2998.1 acres	not estimated	3.26E+13	1.03E+13	2.2E+13[b]	68.4[b]
Cropland	725 acres	not estimated	2.34E+12	1.19E+12	1.15E+12	49.1
Pasture	1277 acres	645 acres[d]	3.12E+13	4.28E+12	2.70E+13	86.3
Onsite sewer systems	1638 systems[c]	471 systems[c]	2.76E+15	0	2.76E+15	100
Virginia	n/a	n/a	3.16E+14	3.05E+12	3.13E+14[b]	99.0[b]
Total of WV Cropland, Pasture, and Onsite sewer systems	**n/a**	**n/a**	**2.79E+15**	**5.47E+12**	**2.79E+15**	**99.8**

[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] This number is a slight overestimate, since it includes the Virginia portions of subwatersheds #4103, 4107, and 4108.

[d] estimated by adding acreage of pastures with high and moderate erosion potential rating

On-site sewage disposal systems (septic systems)
Failing septic systems were determined by the TMDL to be the most significant contributor to the nonpoint source fecal coliform load in the Mill Creek watershed. The TMDL estimates the most northwestern three subwatersheds of Mill Creek as having the highest septic failure rates (0.18-0.23 gallons per day per acre) of the Mill Creek watershed. The remaining 15 subwatersheds had septic failure rates of less than 0.14 gallons per day per acre. In the TMDL, an analysis of 911 emergency response addressable structure data combined with West Virginia Department of Environmental Protection (WVDEP) source tracking information yielded an estimate of 1638 homes in the West Virginia portion of the watershed that are not served by centralized sewage collection and treatment systems. Approximately 290 of those are estimated to have complete septic failure and 181 to have seasonal septic failure (Table 3). Thus, approx. 471 septic systems require some type of correction. Complete failure was represented as 50 gallons per house per day of untreated sewage escaping a septic system, and seasonal failure as 25 gallons per house per day. During the TMDL model calibration process, adjustments were made to best represent the pollutant load reaching receiving waters as driven by seasonal hydrologic conditions.

Mill Creek watershed, oriented from west to east, contains three approximate tiers of septic priorities, as identified through public meetings that included Berkeley County Health Department staff and Canaan Valley Institute's wastewater engineer. Canaan Valley Institute's "Watershed Wastewater Protection Plan" for Mill Creek concludes there is a significant source of fecal contamination from failing onsite systems, and that the most at-risk area is the western tier of the watershed. Some of these failures are due to age and neglect, others to poor soils or biological and hydraulic overloading (Appendix F). The three tiers of septic priorities are approximately divided by Dominion Road (County 51/2), and Interstate 81 (Fig. 5). The western tier of Mill Creek watershed, which is all west of Dominion Road, is the highest priority for septic upgrades, because its shale soils make poor drainfields and it is not slated for public sewer line expansion in the near future. Shale soils make poor drainfields because the shale fractures and effluent seeps through quickly and without treatment, or because it doesn't fracture and is impermeable. In addition, when sorted by the number of failing septic systems, three of the top four subwatersheds are in this western tier (Appendix F). It includes the headwaters of Mill Creek at the southern edge of Berkeley County, where there is a subdivision of approximately 50 lots of 2-15 acres. It also includes the historic village of Gerrardstown, where Mill Creek and two unnamed tributaries flow through small lots with septic systems. Combining all the homes with failures in the western tier from Table 3 yields 212 septic systems needing to be upgraded. This number may include several in Virginia because subwatershed #4103 is in this group. Within each subwatershed, septic maintenance or upgrade projects can be prioritized based on several factors including the cost of the new system divided by number of failing systems it will correct, proximity to headwaters, proximity to a perennial stream, and landowner willingness.

The eastern tier is the middle priority for septic upgrades because it is almost all on public sewer, but septic systems that do exist are likely to have problems because of the shale soils. Unsewered areas would likely require a pumping station to convey the wastewater to the Inwood Wastewater Treatment Plant, if they are ever to be connected to public sewer. Combining all the homes with failures in the middle tier from Table 3 (assuming 25, or half the total number of failing systems, from #4107) yields 106 septic systems needing to be upgraded.

The middle tier is the lowest priority because of the potential for sewer coverage and the better suitability of the soils for on-site systems. It is oriented between Dominion Road and I-81. Expansion of public sewer lines from the eastern part of the watershed has progressed westward to I-81. West of I-81, privately funded sewer extensions to new developments are the norm in this middle tier. When public funding is secured for the next expansion phase of the Berkeley County Public Service Sewer District, even more of this area will be covered. Here the soils are better suited for onsite systems, thus it is assumed the majority of onsite systems function well if there is adequate surface soil, when properly maintained. It should be noted, however, that because of the karst geology, effluent could be failing (barely treated) to the groundwater. Comprehensive soil evaluations and pretreatment (Class II or alternative systems) could still be needed in this area. Combining all the homes with failures in the eastern tier from Table 3 (assuming 25, or half the total number of failing systems, from #4107) yields 152 septics needing to be upgraded. This number may include a few in Virginia because subwatersheds #4107 and 4108 are in this group.

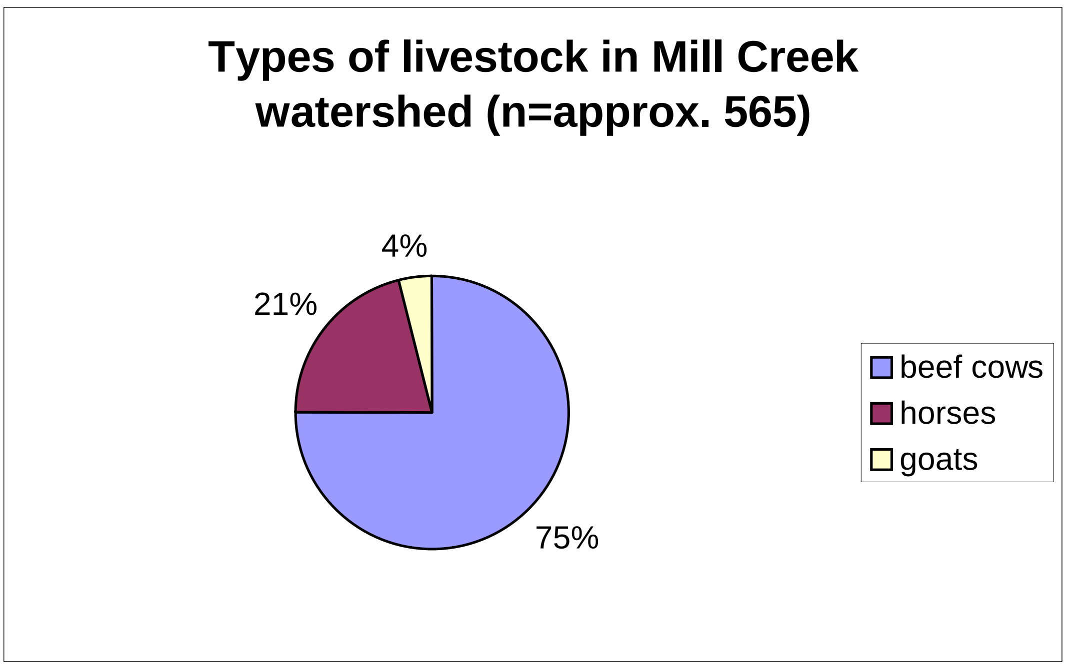
Table 3. Septic systems population in the subwatersheds of Mill Creek, as used in the modeling for the TMDL, with corresponding "Tier" added.

TMDL Subwatershed number	Corresponding "Tier" of watershed	Estimated Total Homes	Estimated homes with complete septic failure	Estimated homes with seasonal septic failure
4092	Eastern	81	19	11
4093	Eastern	31	9	6
4094	Eastern	225	17	11
4095	Eastern	98	5	3
4096	Middle	204	23	13
4097	Middle	33	8	4
4098	Middle	65	16	10
4099	Western	196	50	34
4100	Western	101	27	18
4101	Western	37	10	7
4102	Western	7	2	1
4103	Western/VA	149	38	25
4104	Middle	142	20	11
4105	Middle	12	3	2
4106	Middle	17	4	2
4107	Middle/Eastern/VA	205	31	18
4108	Middle/VA	35	7	4
WV Mill Creek Total*		**1638**	**290**	**181**
4109	Virginia	60	11	7

* some of the unsewered homes (and corresponding septic failures) in subwatersheds 4103, 4107 and 4108 are in Virginia, so the total numbers in this row should be slightly lower.

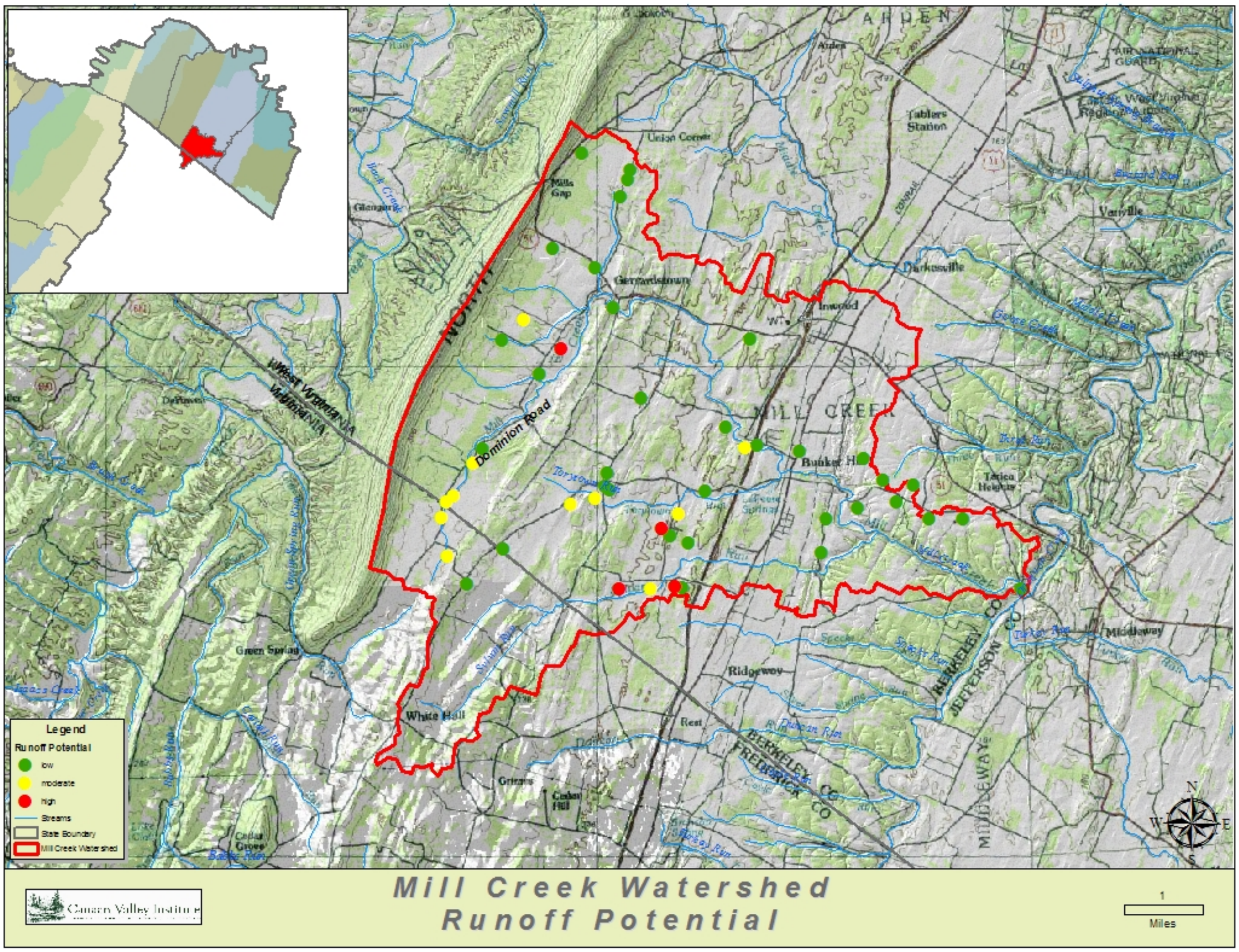
Pasture and cropland
Grazing livestock and land application of manure (cattle and poultry) result in the deposition and accumulation of bacteria on land surfaces in the Mill Creek watershed. Those bacteria are then available for wash-off and transport during rain events. In addition, livestock with unrestricted access can deposit feces directly into streams (West Virginia Division of Water and Waste Management 2007). Pasture is the second most significant contributor to the nonpoint source fecal coliform load in this watershed. Source tracking performed by WVDEP during TMDL development estimated approximately 1300 acres of active pasture in Mill Creek watershed in West Virginia, supporting 565 livestock, 186 of which have stream access. The proportions of beef cows, horses and goats in these estimates are shown in Figure 6.

Figure 6. Types of livestock in Mill Creek watershed in West Virginia. These are estimates from source tracking activities during TMDL development.



Source tracking also collected GPS points for active pastures and rated the runoff potential of each pasture as low, medium, or high; runoff potential ratings were based on land slope, presence of buffer zones, and stream access (Fig. 7). The total area of the four pastures with a “high” erosion potential rating, all supporting beef cattle, is estimated to be 381 acres. The total area of the 11 pastures with a “moderate” erosion potential rating is estimated to be 265 acres. These include feedlots and pastures supporting beef cattle, horses and goats. 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 agricultural cost-share programs and their willingness to participate in them. Within these two groups, several factors can be used to prioritize projects, including proximity to headwaters, proximity to a perennial stream, and landowner willingness.

Figure 7. Estimated runoff potential in Mill Creek watershed pastures.



Finally, cropland was prescribed a 49.1% load reduction in the TMDL, although the magnitude of the load reduction is less than 1/10th that of pasture, and less than 1/1000th that of septic systems. The following insights regarding cropland sources were gained through conversations with local Natural Resources Conservation Service staff. Corn is the main crop grown on cropland in Mill Creek (orchards and hay were modeled separately in the TMDL and were not assigned a Load Allocation). In some cases it is grown for 2-5 years between orchard tree crops. In others, it is used as the first step in refreshing a hay field, followed by small grain as a cover crop, then followed by hay again indefinitely. Cattle and poultry manure application occurs on cropland in the Mill Creek watershed, but over-application is not known to be a problem. On farms where both livestock and crop fields exist, the typical situation in Mill Creek is a shortage of manure compared to what the fields could handle, in terms of nutrients. A cost-share program for transporting poultry litter from West Virginia’s Potomac Valley region to Berkeley County has been in place for several years, but is no longer accepting new applications; participation from this watershed has been minimal. However, crop growers may be importing poultry litter at personal expense.

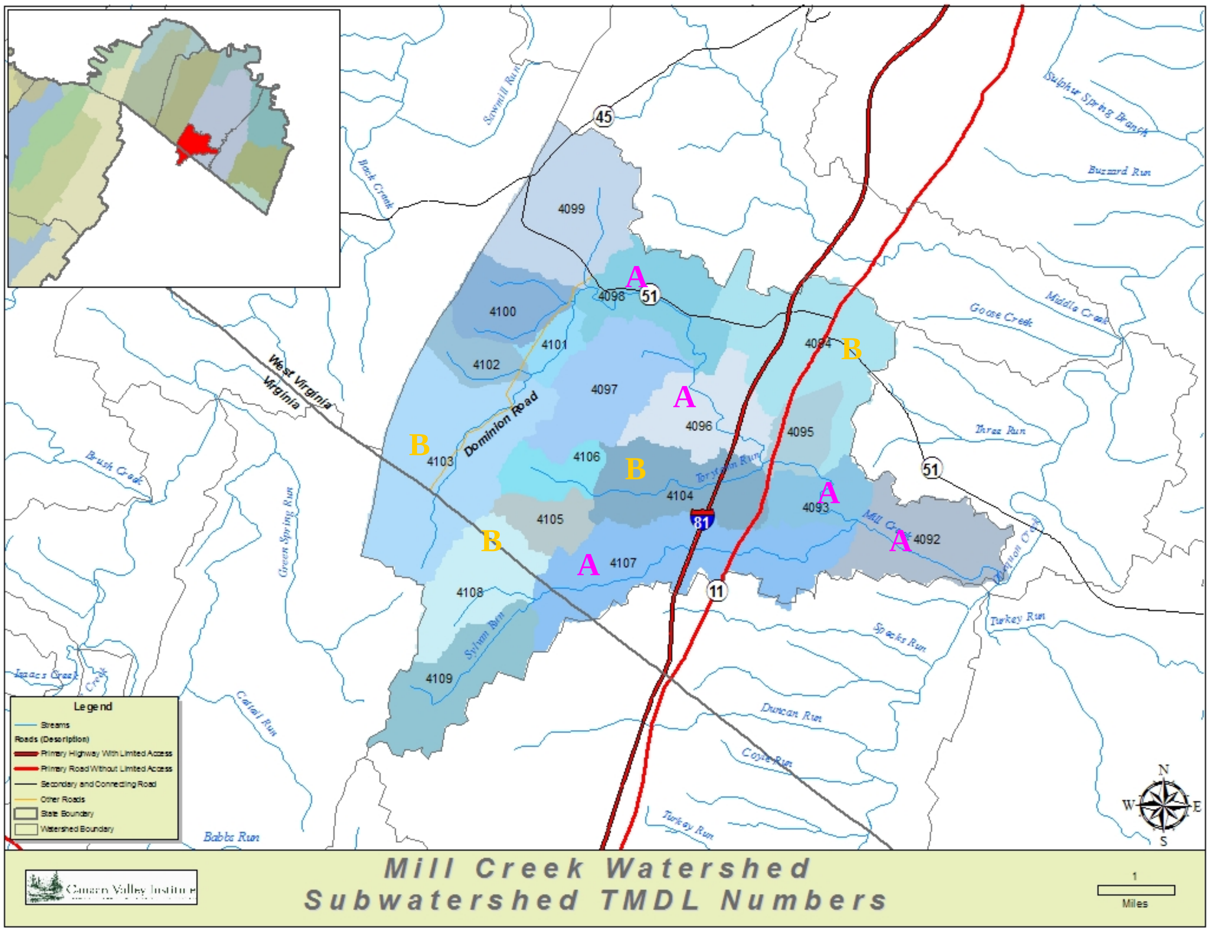
The TMDL's modeled Load Allocation of fecal coliform may be the best starting point for identifying opportunities for nonpoint management measures on cropland (Table 4). The prescribed load reduction was greater than 50% in five subwatersheds (Group A). Implementation should begin in these watersheds, then move to the remaining four subwatersheds (Group B) that were prescribed a load reduction. Within these two groups, several factors can be used to prioritize projects including proximity to headwaters, proximity to a perennial stream, and landowner willingness .

Table 4. TMDL Load Allocation for Cropland in Mill Creek subwatersheds.

Subwater-shed	Jurisdiction	Cropland Area (acres)	Cropland Baseline Load (counts/yr)	Cropland Allocated Load (counts/yr)	Cropland Percent Reduction	
4096	Berkeley Co.	97.4	4.75E+11	8.99E+10	81.1	
4098	Berkeley Co.	94.6	2.16E+11	4.93E+10	77.2	
4092	Berkeley Co.	98.5	2.25E+11	8.02E+10	64.3	Group A
4093	Berkeley Co.	16.8	4.80E+10	1.72E+10	64.3	
4107	Berkeley Co.	49.2	2.24E+11	8.27E+10	63.1	
4104	Berkeley Co.	24.2	1.31E+11	7.22E+10	45.1	
4094	Berkeley Co.	151.2	4.35E+11	2.48E+11	42.9	Group B
4103	Berkeley Co.	31.1	1.41E+11	1.09E+11	22.5	
4108	Berkeley Co.	7.9	1.79E+10	1.64E+10	8.6	
4097	Berkeley Co.	63.9	1.60E+11	1.60E+11	0.0	
4095	Berkeley Co.	38.4	8.75E+10	8.75E+10	0.0	
4106	Berkeley Co.	24.3	1.10E+11	1.10E+11	0.0	
4099	Berkeley Co.	13.8	3.15E+10	3.15E+10	0.0	
4100	Berkeley Co.	5.8	1.32E+10	1.32E+10	0.0	
4102	Berkeley Co.	4.2	9.64E+09	9.64E+09	0.0	
4105	Berkeley Co.	2.0	4.57E+09	4.57E+09	0.0	
4101	Berkeley Co.	1.9	8.52E+09	8.52E+09	0.0	
4103	Virginia					
4107	Virginia					
4108	Virginia					
4109	Virginia					
Total		**725.0**	**2.34E+12**	**1.19E+12**	**49.1**	

These subwatershed groups are illustrated in Figure 8.

Figure 8. Subwatershed groups for BMP implementation in cropland. Group A is first priority, Group B is second priority.



Residential/urban land

Runoff from residential and urbanized areas during storm events can be a significant fecal coliform source, delivering bacteria from the waste of pets and wildlife to the waterbody. In the Mill Creek watershed, these areas are all within Berkeley County, and therefore subject to that entity's MS4 permit. The magnitude of the load reduction prescribed by the TMDL for this source is similar to that of pasture. 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, and impervious surface reduction. These BMPs are not specifically included in Berkeley County's Stormwater Management Plan (Appendix B). Therefore, these residential/urban BMPs are included in this Watershed Based Plan, and should be eligible for federal Section 319 funding.

Sources of biological impairment in the Mill 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 Mill Creek, Torytown Run, and Sylvan Run. The TMDL identifies sources of sediment in Opequon Creek watershed. Those that are present in Mill 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 landuses can also be indirect sources of sedimentation, because increased impervious area associated with those landuses can increase the volume and velocity of stormwater runoff and accelerate streambank erosion. Table 5 summarizes the sediment load reductions estimated to be needed from various sources.

Table 5. Estimated annual load allocations and reductions needed from nonpoint sources to achieve **sediment** TMDL. This watershed based plan is chiefly concerned with the shaded cells.

Source	Area of this source in Mill Creek watershed	Baseline load (tons/yr)	Allocated load (tons/yr)	Reduction needed (tons/yr)	Percent Reduction needed
Background & other nonpoint sources[a]	11,684 acres	4234.1	4234.1	0	0
Urban/residential/road impervious areas[a]	2998.1 acres	2045.7	2045.7	0	0
Cropland	725 acres	1637	1637	0	0
Pasture	1277 acres	1425.5	1425.5	0	0
Streambank erosion	Area or length not directly estimated in TMDL	2771.4	2003.4	768.1	27.7
MS4 Streambank erosion[a]	Area or length not directly estimated in TMDL	13033.6	12630.1	403.5[b]	3.1[b]
Virginia	n/a	1731.6	1701.0	n/a	n/a
Total of WV Cropland, Pasture, and Streambank erosion	**n/a**	**5833.9**	**5065.8**	**768.1**	**13.2**

[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

Streambank Erosion

Streambank erosion is the only sediment source for which a nonpoint source load reduction is prescribed in the Mill Creek watershed. According to the TMDL, "[t]he 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 landuses, the bank erosion components are prescribed as nonpoint source load allocations." As shown in Table 5, this splitting of the streambank erosion load is the case in some of the Mill Creek subwatersheds. However, the field analyses of streambank erosion did not distinguish between land uses adjacent to the eroding streambanks.

The field analyses performed in preparation of this Watershed Based Plan were of two types: a general assessment of Mill 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 and geologist in winter 2008 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 summer and fall 2007, OCPT volunteers walked the mainstem of Mill Creek and noted areas of erosion and sedimentation (Appendix E). Along the Mill Creek mainstem, 83 sites were characterized as having erosion or sedimentation. Fifteen of those were marked because of sedimentation features, only. Of the remaining 68 sites, the volunteers estimated the average bank erosion height and length at 45 sites. The average eroding bank height of this subset is six feet, and the average eroding area length of this subset is 90 feet (with a total eroding length of 3695 feet estimated).

The volunteer assessment provided estimates of the lengths of "Large" and "Medium" (terms loosely defined by us for the purpose of this analysis) amounts of erosion that are present in the Mill Creek watershed. Of the 68 erosion sites for which the volunteers estimated and recorded length and height dimensions, 26 sites (with a total bank length of 1595 feet) were considered to have a "Medium" amount of erosion with eroding bank heights of two to four feet. Nineteen sites (with a total bank length of 2100 feet) were considered to have a "Large" amount of erosion with eroding bank heights of five feet or greater. These lengths represent 2.24% and 2.95% of the 13.5 miles of Mill Creek in West Virginia. Applying these percentages to the 3.5 miles of Torytown Run and the 5 miles of Sylvan Run in West Virginia, we estimate that the total stream length of areas with a Medium amount of erosion (in these three named streams) is 2600' (1595' + 414' + 591'). The total stream length of areas with a Large amount of erosion is 3422' (2100' + 544' + 778'). These values are summarized in Table 6.

Table 6. Estimated lengths of eroding streambank on Mill Creek, Torytown Run, and Sylvan Run. *Medium* = sites with 2-4' high eroding banks. *Large* = sites with $\geq$ 5' high eroding banks.

Stream	Total length of streambanks with *Medium* amounts of erosion (ft)	Total length of streambanks with *Large* amounts of erosion (ft)
Mill Creek mainstem	1595	2100
Torytown Run	414	544
Sylvan Run	591	778
Total	**2600**	**3422**

The Bank Erodibility Hazard Index (BEHI) estimates made in winter 2008 from Mill Creek streambanks provided estimates of sediment loads associated with these lengths. Two sites were chosen to represent "Medium" and "Large" amounts of erosion (Webber and lower Conley, respectively, as described in Appendix A "Hydrologic Description of Mill Creek of the Opequon"). With this method, the erosion potential for streambanks at a site can be rated Very Low, Low, Moderate, High, Very High, and Extreme. The Webber site was dominated by streambanks with Moderate and High BEHI scores. The measurements and subsequent calculations yielded an estimate of 88.7 tons/year entering Mill Creek over this 1217-foot section (Appendix C, BEHI estimates and calculations), or 0.07 tons/year per foot. The lower Conley site was dominated by streambanks with High and Very High BEHI scores, yielding an estimate of 210.1 tons/year entering Mill Creek over this 1225-foot section, or 0.17 tons/year per foot. Multiplying these loads by the estimated lengths in Table 6, we estimate a total of 764 tons/year (182 + 582) entering Mill Creek, Torytown Run and Sylvan Run from Large and Medium eroding streambanks. See Section B for further analyses of these numbers, showing that Natural Stream Design (NSD) projects can achieve the prescribed load reduction from nonpoint source eroding streambanks. Among the many sites where Large and Medium 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 Mill 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 areas

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 are no reductions prescribed for this source, but there is a baseline load documented (Table 5). Therefore, 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. To the extent that these BMPs are not specifically included in Berkeley County's Stormwater Management Plan (Appendix B), they should be eligible for federal Section 319 funding.

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 Berkeley County's Stormwater Management Plan (Appendix B) should also be eligible for Section 319 funding.

Chesapeake Bay priority

The Opequon Creek watershed is the number one priority in West Virginia's Chesapeake Bay cleanup effort. Therefore, nitrogen, phosphorus, and sediment loads in Opequon Creek and its tributaries need to be reduced. Sediment is covered by this TMDL. Reducing excess nitrogen and phosphorus should have the added benefit of decreasing the organic enrichment of these streams, thereby promoting abundance and diversity of the benthic community. 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 before the beginning of TMDL development (West Virginia Division of Water and Waste Management, 2005).

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

In addition to noting eroding streambanks and sedimentation during their assessment of Mill Creek, OCPT also noted areas with inadequate vegetative buffers, pipe outfalls, and other potential threats to water quality (Appendix E). They created an extensive digital photo record corresponding to each data point. Through a grant from the West Virginia Stream Partners Program, they hired an intern from Shepherd University to begin organizing these data in a GIS for easier analysis. This photographic and descriptive database will be a valuable tool as nonpoint source project implementation proceeds. It also helped OCPT to begin making positive personal contacts in the Mill Creek watershed, and understanding the concerns of landowners along the creek.

Additional information about this watershed was gained through mailing a survey to landowners along the Mill Creek mainstem in April 2007. It was developed by the 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 improvement projects; (2) determine landowner perceptions of problems in Mill Creek; and (3) raise awareness of efforts to improve water quality in Berkeley County. There were 31 responses from residents along Mill Creek, out of 85 surveys mailed. To the question “What are your concerns about this stream or creek? (check all that apply)” the responses were: Stream pollution (61%), trash in the stream (59%), streambank erosion (45%), flooding (24%), wildlife (24%), other (21%), stream course changes (17%), and recreational users [fishing, kayaking, canoeing, etc.] (10%). The explanations written in for “other” included a nearby odor of failing septic systems, a desire to improve the stream to attract fish, and a concern that county government is planning to extract water from the creek for residential use. Another section for comments at the end of the survey yielded notes about failing septic systems, eroding streambanks, an abandoned streamside house, mysterious daily appearances of soap suds in the creek, and woody debris that impedes flow. Therefore, the results of this survey in general support the findings of the TMDL regarding sources of pollution in Mill Creek, in addition to raising issues for possible follow-up.

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. Many of the concerns in the previous paragraph were repeated at these meetings. A notable new concern raised repeatedly at these meetings was that of water quantity and quality in groundwater, drinking water, and wells. Residents were generally knowledgeable about potential impacts that land use changes could have on their properties’ water supplies, and are concerned about these. Other new concerns included impacts from roads, and streambed and streambank damage following sewer and water line installations. Outreach insights and ideas resulting from these workshops are discussed in Section E.

<u>Section B/C: BMPs or "Nonpoint Source Measures" proposed to achieve load reductions, and magnitude of load reductions expected from these</u>

To achieve fecal coliform reductions

<u>From on-site sewer system sources:</u>

In the western tier of Mill Creek watershed, failing septic systems need to be identified and inspected to determine adequate solutions: pumping, repair, or replacement with an appropriate system. The upgrade might include a new drainfield or the addition of treatment before the drainfield. Communities like mobile home parks or dense neighborhoods (e.g. Gerrardstown) might be best served by cluster systems (see Appendix F). In the eastern tier of the watershed, sewer line extensions, including pumping stations in many cases (because homes that can be served by the Inwood plant through gravity flow are already connected), will be an option that will have to be weighed against septic system upgrade options. In the middle tier of the watershed, some sewer lines have already been extended to take septic systems off-line since the time that the sewer information was gathered for the TMDL (c. 2004). Other septic systems in this middle tier are scheduled to be replaced by sewer extensions when funding is secured by Berkeley County for this purpose.

The TMDL prescribes 100% reductions from failing septic systems. Therefore, when all the failing onsite systems in a given subwatershed are working properly, it is assumed the fecal coliform load in Mill Creek will be reduced by the same amount as the baseline for that subwatershed, as given in the TMDL (Table 7). Using the subtotals in Table 7, we estimate that upgrading the failing septic systems in the western tier will result in 43.9% of the total reduction required from onsite systems (2.76E+15 counts/year, from Table 3), the eastern tier will achieve 23.7%, and the middle tier will achieve 32.4%.

Table 7. Reductions expected from pumping or upgrading all failing septic systems in each subwatershed.

TMDL Subwatershed number	Estimated total failing septic systems	Baseline load from TMDL = reductions expected from this subwatershed (counts/year)	
4099	84	5.22E+14	
4100	45	2.82E+14	Western Tier = 1st priority
4101	17	1.08E+14	
4102	3	1.70E+13	
4103	63[b]	2.81E+14	
Subtotal	212	1.21E+15	
4092	30	1.91E+14	Eastern Tier = 2nd priority
4093	15	9.01E+13	
4094	28	1.76E+14	
4095	8	5.41E+14	
4107 (in part)[a]	25[b]	1.44E+14	
Subtotal	106	6.55E+14	
4096	36	2.29E+14	Middle Tier = 3rd priority
4097	12	7.81E+13	
4098	26	1.64E+14	
4104	31	1.97E+14	
4105	5	2.80E+13	
4106	6	4.01E+13	
4107 (in part)[a]	25[b]	1.44E+14	
4108	11[b]	1.38E+13	
Subtotal	152	8.94E+14	

[a] The number of failing septic systems and the load are assumed to be divided evenly between the middle and eastern tiers.

[b] These are slight overestimates because some of these failing septic systems are in Virginia.

From pasture sources:

To reduce 86.3% of this source's load, a suite of practices must be implemented to achieve 100% reductions on 1102 acres of pasture. Pasture BMPs will be pursued mainly through Conservation Reserve Enhancement Program (CREP), Environmental Quality Incentives Program (EQIP), and Wildlife Habitat Incentives Program (WHIP) enrollments, including:

-*Grass buffer:* A linear strip of grass or other non-woody vegetation maintained along stream banks helps filter bacteria, nutrients, sediment and other pollution from runoff. During high water and flooding events, vegetation holds soil in place and can trap some excess nutrients from upstream waters flowing over it. A 35-foot minimum width is necessary to achieve significant benefit from this measure (West Virginia Tributary Strategy Stakeholders Working Group, 2005 [Appendix 6]). According to the "Agricultural BMP Effectiveness Estimates" posted on the Chesapeake Bay Program website, efficiencies are listed by geomorphic region. For Valley and Ridge Marble Limestone, grass buffer efficiencies are listed as 40% for Total Suspended

Sediment (TSS), 24% for Total Nitrogen (TN) and 30% for Total Phosphorus (TP) (Simpson and Weammert, 2008). A reduction efficiency for fecal coliform similar to that for TP might be defensible, because of both pollutants' tendency to move with soil particles. However, this may be a low estimate. For example, in Appendix A of the Mill Creek (South Branch Potomac) Watershed Based Plan, a 70% efficiency for reducing fecal coliform was used for vegetated filter strips, as the lower end of the values typically reported (West Virginia Conservation Agency et al., 2007).

-*Riparian forest buffer:* A tree and shrub buffer of at least 35 feet will be established and maintained along the stream corridor and/or water body to reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow. The location, layout, width, and density of the riparian forest buffer will be selected to accomplish the intended purpose and function (description provided by Farm Service Agency [FSA] staff). According to the "Agricultural BMP Effectiveness Estimates" posted on the Chesapeake Bay Program website, efficiencies are listed by geomorphic region. For Valley and Ridge Marble Limestone, forest buffer efficiencies are listed as 40% for TSS, 34% for TN and 30% for TP (Simpson and Weammert, 2008). See Grass Buffers above for an estimate of the fecal coliform removal efficiency of vegetated filter strips.

-*Livestock fencing:* A fence will be constructed on the stream bank to keep livestock from stream. This practice may be applied on any area where management of animal or people movement is needed. The fence will be constructed to the specifications of the Natural Resources Conservation Service (NRCS) job sheet for fence, which identifies the type of fence, materials and construction requirements (description provided by FSA staff). According to the "Agricultural BMP Effectiveness Estimates" posted on the Chesapeake Bay Program website, "off-stream watering with fencing" efficiencies are listed as 40% for TSS, 25% for TN and 30% for TP (Chesapeake Bay Program, 2007). In Appendix A of the Mill Creek (South Branch Potomac) Watershed Based Plan, a 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 Mill Creek 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):
A trough will be constructed to provide watering facilities for livestock and/or wildlife at selected locations in order to: protect and enhance vegetative cover through proper distribution of grazing; provide erosion control through better grassland management; or protect streams, ponds and water supplies from contamination by providing alternative access to water. The trough will be constructed according to an engineering design based on NRCS standard and installed where indicated on the Conservation Plan Map. NRCS will be contacted prior to construction. The trough will be maintained according to the Operation and Maintenance Plan in the design. A pipeline will be installed to supply water to livestock watering troughs (descriptions provided by FSA staff).

A well will be drilled to facilitate proper use of vegetation on pastures, and wildlife areas; to supply the water requirements of livestock and wildlife; to provide an adequate supply of water for conservation irrigation; and to provide for human use at recreation sites.
The well will be drilled according to an engineering design based on NRCS standard. NRCS will be contacted prior to construction. Well will be maintained according to the Operation and Maintenance Plan in the design (description provided by FSA staff).

When alternative watering practices are used in conjunction with fencing, see the discussion of pollutant removal efficiencies for Livestock Fencing, above. Without fencing, according to the "Agricultural BMP Effectiveness Estimates" posted on the Chesapeake Bay Program website, "off-stream watering without fencing" efficiencies are listed as 30% for TSS, 15% for TN and 22% for TP (Dillaha et al., 2008).

-*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.

<u>From cropland sources:</u>
To achieve the 49.1% reduction of this source's load, the goal is to implement nutrient management plans on at least 356 acres of cropland, in combination with a vegetative buffer where these fields are adjacent to streams. Cropland BMPs will be pursued mainly through CREP, EQIP, and WHIP program enrollments, including:

-*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.

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

<u>From residential/urban sources:</u>
No fecal coliform load allocation is given to residential sources in the TMDL, because Berkeley County is an MS4 and loadings from precipitation and runoff in the residential sector are all considered regulated under the MS4 permit. However, we see many opportunities to reduce fecal coliform from residential sources that are not covered in Berkeley County's approved Stormwater Management Plan (Appendix B). Therefore we propose these additional measures as part of this Watershed Based Plan:

-*Filtering practices:* 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; e.g. surface sand filter, swale, bioretention areas (rain gardens) (source: Chesapeake Bay Program, Best Management Practices Basics).

-*Wet ponds and wetland:* Wetponds and wetland practices collect and increase the settling of pollutants and protect downstream channels from frequent storm events. Wetponds retain a permanent pool of water; e.g. Wetpond, wet extended detention pond, retention pond and constructed wetlands (source: Chesapeake Bay Program, Best Management Practices Basics).

-*Impervious surface reduction:* includes 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 (source: Chesapeake Bay Program, Best Management Practices Basics).

-*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

To achieve sediment reductions

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 streambanks at sites representing “Medium” and “Large” amounts of erosion (Webber and lower Conley, respectively, Appendix A), an analysis that was introduced in the previous section. The Webber site was dominated by streambanks with Moderate and High BEHI scores. The measurements and subsequent calculations yielded an estimate of 85.2 tons/year reduction possible over this 1217 foot section of Mill Creek (Appendix C, BEHI estimates and calculations). Therefore, we estimate that sediment at Medium erosion sites could be reduced by 0.070 tons per year per foot, if NSD were to bring all the banks down to a “Low” BEHI rating. The lower Conley site was dominated by streambanks with High and Very High BEHI scores, and yielded an estimate of 205.3 tons per year of sediment that it is possible to reduce (over 1225 feet of Mill Creek) at this example of a Large erosion site. Therefore, we estimate that sediment at Large erosion sites could be reduced by 0.168 tons per year per foot.

We then multiplied these reductions by the lengths previously estimated (Table 6). Multiplying the length of Medium erosion site lengths times the rate in the above paragraph (0.070 tons/yr/foot), we estimate a possible reduction of 182.0 tons/year. Similarly, applying NSD to the Large erosion sites is estimated to result in a reduction of 0.168 tons/yr/foot, or 574.9 tons/year.

Therefore, 756.9 tons/year (98.5% of the 768.1 tons/year reduction prescribed for nonpoint sources by the TMDL) could be reduced through NSD alone on the stream feet that are included in this tally. These lengths are likely underestimates since erosion on many tributaries is not accounted for. Also, on the Mill Creek mainstem there were 23 sites noted as erosion whose dimensions were not included in the Assessment, and therefore were not included in the lengths calculation. Finally, the volunteers might not have marked all of the sites where erosion was present but minimal or intermittent. These un-accounted-for lengths could represent the sources of remaining sediment load that the TMDL allocated to the MS4.

Of the sources assigned a sediment Load Allocation (Cropland, Pasture, and Streambank Erosion), only Streambank Erosion was assigned a reduction, which is 768.1 tons, or 27.7%. However, 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 the Mill Creek mainstem performed by Opequon Creek Project Team, twelve of the 68 sites marked for erosion also had livestock access. 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. One such example is the Upper Conley site, as described in Appendix A "Hydrologic Description of Mill Creek of the Opequon". Also, on both Cropland and Pasture landuses along streams where streambank erosion is occurring, planting a forest buffer might be more cost-effective in some cases than NSD.

-*Armored streambank stabilization:* 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.

<u>From pasture sources:</u>
See above pasture BMPs for achieving fecal coliform reductions

<u>From cropland sources:</u>
-*Conservation till:* planting and growing crops with minimal disturbance of the surface soil. Conservation tillage requires two components, (a) a minimum 30% residue coverage at the time of planting and (b) a non-inversion tillage method (source: Chesapeake Bay Program, Best Management Practices Basics). According to the "Agricultural BMP Effectiveness Estimates" posted on the Chesapeake Bay Program website, efficiencies are listed as 30% for TSS, 8% for TN and 22% for TP (Simpson and Weammert, 2008).

-*Cover crops:* reduce erosion and the leaching of nutrients to groundwater by maintaining a vegetative cover on cropland and holding nutrients within the root zone. This practice involves the planting and growing of crops with minimal disturbance of the surface soil. The crop is seeded directly into vegetative cover or crop residue with little disturbance of the surface soil. These crops capture or "trap" nitrogen in their tissues as they grow. By timing the cover crop burn or plow-down in spring, the trapped nitrogen can be released and used by the following crop (source: Chesapeake Bay Program, Best Management Practices Basics).

See also above cropland BMPs for achieving fecal coliform reductions.

From urban/residential/road impervious areas:
Although no sediment load allocation or wasteload 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.

From man-made dams or road crossings:
Finally, as mentioned in Appendix A, the dams and some road crossings "…cause several sites of instability including: unnatural storage of the sand and gravel bedload [and] improper sediment and nutrient fluxes…" Therefore, we would like to further investigate the possibilities that proper removal of one or more dams and enlarging or re-designing culverts on driveways or roads that cross the streams may reduce the amount of sediment ultimately transported to Opequon Creek.

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. Additional desirable BMPs include:

-*De-nitrifying septic system:* Septic denitrification represents the replacement of traditional septic systems with more advanced systems that have additional nitrogen removal capabilities method (source: Chesapeake Bay Program, Best Management Practices Basics). The West Virginia Potomac Tributary Strategy prescribes 100 denitrifying septic systems to be implemented in the 8-county region of West Virginia's Chesapeake Bay drainage (West Virginia Tributary Strategy Stakeholders Working Group, 2005). Therefore, five is a reasonable number for this priority watershed to attempt in a ten-year period.

-*Rehabilitating right-of-ways:* Widening existing buffers on Mill Creek mainstem, especially where water and sewer lines were installed in recent years, leaving a linear swath of no trees or shrubs that is much too wide. The Public Service Sewer District agreed that the mowed right-of-way should be narrower. This would essentially constitute a large-scale, efficient riparian forest buffer planting project, spanning many types of adjacent land uses.

Section D: Technical and Financial Assistance Needed

Upgrade/fix failing septic systems
Canaan Valley Institute's "Watershed Wastewater Protection Plan" addresses the cost of the septic system implementation, "There are estimated to be 471 failures in the Mill Creek watershed alone. Estimating $5,000 of project money to fix each failure would yield a project budget of roughly $2.5 Million (Appendix F, p. 4)." This estimate assumes the homeowner makes up the rest of the cost not provided through Section 319 project funds. In a similar report for the Sleepy Creek watershed (Winant, 2007), the estimated average total cost of upgrading each septic system is $7500, for a total cost of about $3.5 million. This is likely an overestimate of what will actually be incorporated into Section 319 project proposals, because by the time the central tier is addressed in a project proposal, sewer service is expected to replace several existing septic systems in that area.

Additional treatment for de-nitrifying
Canaan Valley Institute's "Watershed Wastewater Protection Plan" states: "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 drainfields may be required in addition to advanced treatment," (Appendix F, p. 4).

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 in Berkeley County.

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

Natural Stream Design costs
Costs per foot from Appendix A were multiplied by the appropriate length estimates, which are described in Section A. The Lower Conley estimates were used for Large erosion sites, and the Webber estimates were used for Medium erosion sites.

Education/outreach costs
Canaan Valley Institute provided estimates of workshop costs. The professional workshop estimate was based on a 2-day model. Cost estimate of rain barrel workshop was based on recent experience in Berkeley County.

Monitoring costs
Current cost of monitoring one site in Mill Creek twice monthly for *E. coli* and a suite of chemicals that includes nutrients is $1000/year. Nine sites for 15 years would cost $135,000. Project-specific monitoring is assumed to cost another $50,000. This is one line item in Table 8 where the in-kind contribution (of volunteers taking and transporting samples) is <u>not</u> included in the cost.

Table 8. Estimated cost of implementing nonpoint source TMDLs in the Mill Creek watershed.

Practice	Planned units	Cost/unit	Total
Upgrade/fix failing septic systems	471 systems	$6,500[a]	$3,061,500
Additional treatment for de-nitrifying	5 systems	$12,000	$60,000
Additional treatment for poor soils	50 systems	$12,000	$600,000
Grass buffer establishment (agricultural)	4.8 acres	$230/ac	$1104
Forest buffer establishment	21.5 acres	$3,055/ac	$65,683
Fence	16,262 ft	$2.50/ft	$40,656
Alternative watering system	13	$17,000/system	$221,000
Stream crossing	10	$3,400	$34,000
Nutrient management plans:			
Two "WAE" temporary staff	240 days	$96/day	$23,040
Rain garden demonstrations	3	$20,000	$60,000
Rain gardens at residences	10	$500	$5000
Wetland Construction	1	$20,000	$20,000
Pet Waste Runoff Reduction Campaign	1	$25,000	$25,000
Road BMPs and culvert improvements	10	$10,000	$100,000
NSD projects design, oversight, monitoring, and construction	6022 feet[b]	$130/foot	$783,000
Armored streambank stabilization	5 sites	$1000	$5000
Rain barrel workshops (15 barrels ea.)	5	$1200	$6,000
Public workshops re: septic systems	4	$5686	$22,744
Professional workshop re:septic systems	1	$7259	$7259
Monitoring 9 twice-monthly sites plus project-specific monitoring			$185,000
Total			$5,325,986

[a]Assuming approximately half of the 471 systems will require standard septic upgrades at $5000 each, and half will require Class II systems at $8000 each (estimate from Berkeley County Health Dept., pers. comm.), the average of both figures, $6500, is used.

[b] As explained in Section B/C, there are additional lengths available to be addressed by NSD, and some of those might represent the sources of loads allocated to the MS4 permit held by Berkeley County. Therefore, the total cost of NSD to address the streambank erosion load (Load Allocation and Wasteload Allocation) is well above this figure.

The WVDEP Potomac Basin Coordinator will continue to be actively involved in implementing the TMDL in Mill Creek, and will coordinate the writing of at least the first project proposal. Canaan Valley Institute (CVI) will support implementation through its local circuit rider, and through its staff who specialize in GIS, wastewater, and hydrology, as those functions are needed and funding is available to support their time and travel.

The Eastern Panhandle Conservation District (EPCD) 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. Developing those contracts in the first place will be the responsibility of the Natural Resources Conservation Service and the Farm Service Agency. An increase in applications by producers in the Mill Creek watershed might create a need for increased staff and federal funding, especially for labor-intensive programs such as Nutrient Management Planning.

The U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program will be a likely partner for agricultural fencing projects, and possibly for buffer projects as well. This program integrates well with NRCS and FSA cost share programs by providing a crew to erect fencing, and by leveraging other funding and partnerships, including the Chesapeake Bay Foundation and Trout Unlimited.

Both CVI and the EPCD have demonstrated support for this plan, and one of these two entities will likely submit at least the first project proposal to the U.S. EPA for Section 319 funding. The entity that submits the proposal will administer the funding and track matching funds, and will obtain any needed permits for projects that require in-stream work or land disturbance. The West Virginia Conservation Agency may be depended upon to support this project administratively and/or to involve its stream restoration team for project design or construction oversight as the need arises and as they are available.

As failing septic systems are identified, technical assistance from the Berkeley County Health Department and the Berkeley County PSSD will be needed to identify the best solution in each situation. A study was recently completed for the Berkeley County Commission and the Eastern Panhandle Conservation District by TetraTech, Inc. to design a septic system inspection program for existing septic systems. Such a program is an essential part of the management program recommended in Canaan Valley Institute's "Watershed Wastewater Protection Plan":

> Any plan for reducing contamination from onsite wastewater sources must include a management component. This component, of course, can then address other needs like inspection and repair. There are many methods and styles of managing onsite systems, from voluntary participation and minimum oversight to treating onsite systems as a utility with full service and monthly bills. It would be the province of the Opequon Creek Project Team to suggest a likely management program and the local residents, or the County Commission, to adopt it legally.
>
> What should be done to provide a carrot and encourage participation in the management program is create a fund from grant monies to assist homeowners with systems repairs and replacements. As an example, the Project Team could secure $100,000 and make $5,000 grants available to any homeowner willing to upgrade or replace a failing or substandard system. Low-interest loans, funded from WV DEPs revolving loan program, could be used to make up the rest of the system repair or replacement costs. A large

> advantage to this approach is that homeowners are encouraged to self-identify problems and report them. As a part of this program, technical assistance, from an organization like Canaan Valley Institute could be offered for inspecting the selected sites and assisting with determining the proper upgrade or replacement technology (Appendix F, p. 4)

The report identifies additional elements and partners of a successful program:

> Education, management, word-of-mouth and public support are the keys to building a program of healthy onsite wastewater systems. The most probable management style for this watershed is voluntary, with reminders to perform maintenance, financial assistance and education. Thus, it will be a many-avenued system of approach relying on the participation and activity of the local homeowners and support from the Project Team …Finally, it would be a good idea to require inspections of onsite systems during property transfer by certified onsite wastewater inspectors. These requirements would have to be adopted by the County Commission, but the Opequon Creek Project Team could push for their adoption (Appendix pp 5-6).

Meanwhile, West Virginia's State Revolving Loan Fund and Low-Interest loan programs can provide significant match funds for septic system upgrades or connections to public sewer.

The Berkeley County Commission has been, and will continue to be, a vital partner in this watershed restoration effort. Three considerable areas of potential partnership with the Commission are evident at this time. The septic system inspection program for existing septic systems in the Mill Creek watershed, mentioned above, will serve as a pilot project to inform the County Commission about the true costs, obstacles, and best strategies, of such an ambitious effort. As mentioned on the previous page, they recently co-commissioned a study to determine the cost and steps for carrying out a county-wide septic inspection and maintenance program. Another project of the County Commission that might occur in the near future is the development of a Stormwater Management Utility, to collect and handle appropriate fees for the operation and maintenance of stormwater management structures. It would be beneficial to the implementation of this Watershed Based Plan if some of those funds would be made available as local match, when federal Section 319 funds are sought for stormwater BMPs in Mill Creek. It should be noted that because of its participation in the MS4 program, Berkeley County has, in recent years, expended considerable resources to establish new ordinances, permitting, inspection and enforcement capacity related to stormwater management. Thus the County Commission has demonstrated its commitment to partner with the community to reduce stormwater pollution. Finally, through the writing of this Watershed Based Plan, a third possible area of partnership has arisen. If the County Commission were to decide that eroding streambanks are a priority issue facing its natural resources, it could provide local matching funds when federal Section 319 funds are sought for Natural Stream Design projects. The rationale for this in Mill Creek is that the TMDL allocated some of the load from eroding streambanks to the MS4 entity, but also some of the load to nonpoint sources.

The success of any nonpoint source pollution reduction efforts in Mill Creek depends upon the acceptance and participation of local residents and landowners. They will need assurance that the point sources of pollution in the watershed are doing their part to achieve their load allocations, as well. Especially regarding stormwater runoff and sediment pollution, it will be essential that both the County and the State continue to enforce stormwater and subdivision regulations and permit limits. This point was made repeatedly by participants in the public workshops leading to this Plan.

The Virginia Tech Biological Systems Engineering Department and its local partners received a Targeted Watershed Grant from the EPA in 2006. The grant which is administered by the National Fish & Wildlife Foundation is entitled "Effective Strategies for Reducing Nutrient Loads in the Opequon Creek watershed." The 3-year, $998,000 grant is now in its second year. In year one a comprehensive monitoring program was developed for the Virginia portion of the watershed. Currently 38 sites are being monitored bi-weekly for both nutrients and bacteria. In addition the project has installed two floodplain wetlands and will monitor them for their ability to remove pollutants from the stream during storm events. This broad-based partnership includes West Virginia University, the Frederick-Winchester Service Authority, the City of Winchester, the West Virginia DEP and Opequon Creek Project Team. The overall objective of the project is to develop an implementation plan for the entire watershed that identifies a cost-effective strategy for meeting the nutrient reduction goals of the Chesapeake Bay Agreement and the requirements of the Clean Water Act. In year two a monitoring program for West Virginia will be developed along with the installation of additional innovative stormwater and agricultural BMPs. Three monitoring sites have been added in the Mill Creek watershed and a total of $6000 in Targeted Watershed project funds have been allocated by Virginia Tech and West Virginia University for 2008 monitoring.

The Opequon Targeted Watershed Project will provide critical water quality data along with technical assistance and additional funding to enhance the proposed Mill Creek Watershed Based Plan and other basin wide efforts. To date the project's Opequon Watershed Coordinator, based in Winchester has been an active participant in field trips, project identification, water quality monitoring, and public workshops during the writing of this Watershed Based Plan. This partnership is expected to continue through the duration of the Targeted Watershed Project. Specific Targeted Watershed Project objectives include:

- Develop a comprehensive water quality monitoring program, and compile all related data in a structure capable of analyzing current conditions, identifying target areas for restoration and quantifying improvement from implementation of innovative BMPs.
- Evaluate the nutrient-reduction performances and cost-effectiveness of specific innovative BMPs.
- Develop, implement, and evaluate strategies to overcome barriers to adoption of selected BMPs.
- Develop a comprehensive cost-effective nutrient reduction strategy for the entire Opequon Creek watershed

In accordance with the Virginia Opequon TMDL Implementation Plan the Virginia Department of Conservation and Recreation (VA DCR) has allocated over $300,000 to the Lord Fairfax Soil and Water Conservation District for agricultural BMPs in the watershed. Currently the Virginia portion of Mill Creek and Sylvan Run watersheds are not included. Citing the prioritization of Mill Creek in West Virginia and the cross-state collaboration fostered by the Opequon Targeted

Watershed Project, the District and NRCS are petitioning VA DCR to expand the target area to include these watersheds.

Section E: Information/Education Campaign

The roles of Opequon Creek Project Team and its partners

Opequon Creek Project Team (OCPT), the local nonprofit watershed group that identified Mill 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 done stream buffer plantings and put in rain gardens. These are often in partnership with state and local agencies. The Team has a monitoring program that is sampling for *E.coli* in Mill Creek as well as other tributaries in the Opequon watershed. In addition to the water monitoring the Team has walked and photographed the length of Mill Creek to build an information database to underpin the Mill Creek Plan (Appendix E). To further education and information dissemination, OCPT:

- circulates a quarterly newsletter via its extensive contact list
- actively maintains its website, www.opequoncreek.org with project updates, opportunities and meeting announcements
- has its activities regularly covered in the Martinsburg Journal, the local newspaper with wide circulation in Berkeley and Jefferson Counties.
- is featured on West Virginia Public Radio when it is in the community showcasing BMPs
- participates in local events such as the annual Home Show, Youth Fair, Audubon education events, etc.
- conducts rain barrel workshops three or four times a year to help the community learn about storm water runoff and its role in water quality
- hosts town hall meetings in tributary watersheds
- sponsors with DEP and Health Dept. meetings and presentations to homeowners associations and community groups to promote the low-interest loan program, residential BMPs, etc.
- works with local youth to implement watershed projects, thereby instilling water quality principles in a future generation of potential leaders

Partnerships are an important component of OCPT education and information activities by providing expertise to augment that of OCPT. For example, the Canaan Valley Institute provides technical expertise, the West Virginia University Extension Service provides botanical knowledge and experience, local landowners provide access and labor, and local agencies often provide heavy equipment for projects. OCPT through its activities and community network is well positioned to implement the education and information component of this plan.

The OCPT and other partners can build on the knowledge gained from the Mill Creek landowner survey described in Section A and Appendix D. Several questions not summarized above yielded data on stream improvement projects that streamside landowners would consider doing, and those for which they required more information or financial assistance. Finally, OCPT is committed to maintaining personal contacts in the Mill Creek watershed to ensure that project proposals resulting from this plan reflect the priorities and capabilities of the community.

Outreach about wastewater

Canaan Valley Institute's "Watershed Wastewater Protection Plan" specifically recommends the following, "The [onsite wastewater] management system should also incorporate an educational component. Again this could be approached in several different ways, from making informational brochures and handouts available, to hosting homeowner workshops or providing technical assistance for inspection and repair work (Appendix F, p.4)." The Berkeley County Public Service Sewer District has recently developed a flyer and brochure to educate its customers about disposal of household wastes. The purpose is to reduce the amount of grease and other harmful chemicals that the sewage treatment process has to cope with. The same message is appropriate for septic system owners, so there is a possible opportunity to combine efforts in publicizing this specific message.

Another avenue for education will be through a more technical approach. Working with consultants and technical providers, Canaan Valley Institute will provide education and technical assistance for the public and the administrators in Berkeley County. CVI focuses on improvements to wastewater treatment systems to reduce pollution to the region's rivers and streams caused by inadequate wastewater treatment and has 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. 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
- Available financial assistance programs

In addition CVI provides consultation and training for public service and wastewater management personnel to enhance septic system reliability and performance.

The following education and outreach activities will be conducted in association with this project.

- Two public workshops on the effects of wastewater pollution on a watershed
- Two public workshops on the proper maintenance and care of an onsite wastewater (septic) system. This will include alternative options to traditional wastewater systems and available financial assistance programs
- Consultation and training for public service and wastewater management personnel to enhance Individual Sewer System reliability and performance.

During two public workshops held in preparation for the writing of this Plan, stakeholders began brainstorming about public education regarding septic systems. Mill Creek watershed is home to a high school, a middle school, two intermediate schools and two elementary schools, so there is great potential for outreach to and through the education system in this community. One outreach idea at the top of the list was a student contest for the best short video regarding septic system maintenance or reducing fecal coliform pollution. Attendees of the meetings agreed that this video project could be attempted by high school or middle school students, who already share video content via cell phones, and video websites. Humorous or catchy videos would be distributed effortlessly by the students themselves, within but also potentially beyond the Mill Creek watershed. Stakeholders also identified several brochures and booklets on septic system maintenance already written by various groups in West Virginia, which could be printed or re-drafted for the Mill Creek audience specifically. One promising method for distributing this material is through personal presentations at Homeowners Association's annual meetings in subdivisions that have septic systems. The stakeholders stressed that financing information, especially the low interest loan program, would be key in any of these communications. They also recommended this information be posted on the Berkeley Co. Health Department website.

Stakeholders at the public meetings also raised questions about the best methods of disposing of pet waste and unused medicines. There might be interest in the community in investigating these issues and conducting local outreach campaigns based upon them.

Outreach about agricultural practices and programs

The Potomac Basin Coordinator and OCPT will coordinate outreach to livestock operations denoted in Figure 6, beginning with those estimated to have moderate to high runoff potential. The purpose will be to increase awareness of the financial and environmental benefits of agricultural BMPs, and to attempt to overcome any barriers, if any, to participating in federal cost share programs and state revolving loan funds that pay for these practices. Small horse operations, which are abundant in the watershed, may also be a good focus area, because these landowners might not be informed about the availability of federal cost share program for stream protection practices. These outreach efforts will include face-to-face meetings and field days to showcase successful local projects.

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

2008, first half:

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

2008, second half – 2009, first half:

- Begin communicating with septic system owners in the western tier of the watershed:
    - public meeting in Gerrardstown, targeting Gerrardstown residents, regarding low-interest loan program and proper septic maintenance
    - public meeting in one development, e.g. Pleasant Ridge, regarding low-interest loan program and proper septic maintenance
    - outreach and meetings with owners and residents of the mobile home parks in the western tier of Mill Creek watershed, regarding low-interest loan program and to identify any problems with septic systems and consider upgrade options
- Develop Mill Creek watershed monitoring plan, identify partners for each component, and develop Quality Assurance Project Plan

PHASE I: 2009, second half - 2014, first half

- Receive first Section 319 Incremental Grant
- Continue assessing septic project priorities on a finer scale (within western tier of watershed)
- Professional workshop with septic installers, pumpers, etc. to provide technical support
- Public meeting in Gerrardstown (II), targeting Gerrardstown residents, regarding low-interest loan program and proper septic maintenance
- Public meeting in Bunker Hill, targeting Bunker Hill residents, regarding low-interest loan program and proper septic maintenance
- Outreach and meetings with owners and residents of the mobile home parks in the western tier of Mill Creek watershed, regarding low-interest loan program and to identify problems with septic systems and consider upgrade options
- Upgrade, pump, or account for 212 failing septic systems in the western tier of the watershed
- Outreach (including one field demonstration day) to cropland farmers in the priority “Group A” subwatersheds, regarding nutrient management and other BMPs
- Outreach to 7 of the 13 medium & high erosion potential pastures, regarding fecal coliform and sediment BMPs
- **Reduce fecal coliform by 1.22E+15 cfus** (1.21E+15 cfus from the western tier of septic upgrades, 1.35E+13 from pasture [1/2 the needed load reduction] and 8.68E+11 from cropland Group A subwatersheds)
- 2 - 3 Rain Barrel workshops (~15 barrels each)
- 2 Natural Stream Design projects totaling 2400 feet
- **Reduce sediment by 290 tons**
- Ongoing monitoring
- (by 2013, first half) submit 2nd Section 319 Incremental Project Proposal

PHASE II: 2014, second half – 2019, first half

- RE-EVALUATE THE WATERSHED BASED PLAN BASED ON PROJECT IMPLEMENTATION TO DATE AND MONITORING RESULTS
- Re-evaluate monitoring plan
- Receive 2nd Section 319 Incremental Project Proposal
- More of what is in phase I, but in the next priority area of:
    - septic systems (**eastern tier**),
    - pasture,
    - cropland ("Group B" subwatersheds),
    - and eroding streambanks
- Upgrade, pump, or account for 106 failing septic systems in the eastern tier of the watershed
- Outreach to 6 of the 13 medium & high erosion potential pastures, regarding fecal coliform and sediment BMPs
- (by 2018, first half) submit 3rd Section 319 Incremental Project Proposal

PHASE III: 2019, second half –2024, 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:
    - septic systems (**middle tier**),
    - remaining pastures,
    - any remaining cropland,
    - and eroding streambanks
- Upgrade, pump, or account for 152 failing septic systems in the middle tier of the watershed

Section H (cont'd): Evaluating achievement of pollutant load reductions

1) Berkeley County is currently seeking funds to implement a major stormwater infrastructure project in Inwood. Its successful completion would result in Inwood's runoff being directed out of the Mill Creek watershed to Three Run, a different tributary of Opequon Creek.

2) As mentioned above, land use in the Mill Creek watershed has changed somewhat since the GAP 2000 landuse dataset was compiled. For example, many farms and orchards have converted to residential areas. Therefore, it might be challenging to identify sufficient opportunities to reduce agricultural loads of fecal coliform and sediment, for example. More emphasis might need to be placed on outreach and demonstration projects within residential areas.

3) “…[S]pring-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.

Section I: Monitoring program

The WV DEP will conduct its regular 5-year-cycle sampling in the Potomac Direct Drains watershed in 2008. Any sites repeated in Mill Creek from the pre-TMDL sampling in 2003-2004 will provide new baseline data before Section 319 implementation begins. Parameters will include fecal coliform, nutrients, TSS, and in some cases benthic invertebrates.

Opequon Creek Project Team and WV DEP’s Potomac Basin Coordinator will oversee volunteer water sampling of regular sites within Mill Creek watershed. Some sites will be chosen based on their potential to show downstream differences before and after groupings of project implementation (e.g. downstream of a community where several septic systems are scheduled to be upgraded, and again after upgrades). Volunteer travel and time may be in-kind, but funding will be necessary for fecal coliform testing at a local certified laboratory, and chemical testing, to include nutrients, at the Friends of Shenandoah River’s laboratory at Shenandoah University.

Some volunteer sampling of benthic macro-invertebrates will also occur, using West Virginia’s Save Our Streams protocol.

A Quality Assurance Project Plan will be submitted to EPA for their approval. The monitoring plan will be designed to evaluate progress from groups of projects and overall.

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Appendix A, Hydrologic Description of Mill Creek of the Opequon, Canaan Valley Institute

Appendix B, Berkeley County's Stormwater Management Plan (2005)

Appendix C, BEHI Estimates and Calculations

Appendix D, Mill Creek Survey Results

Appendix E, Mill Creek Assessment, by Opequon Creek Project Team, Summer/Fall 2007

Appendix F, Watershed Wastewater Protection Plan, Canaan Valley Institute