Anthony Creek Watershed Based Plan

ANTHONY CREEK HUC12 BASINS

050500030502	North Fork Anthony Creek
050500030503	Upper Anthony Creek
050500030504	Middle Anthony Creek
050500030505	Lower Anthony Creek

<u>Partners</u>

1. WV Conservation Agency
2. WV Department of Environmental Protection
3. WV Division of Natural Resources
4. US Fish and Wildlife Service
5. US Forest Service
6. Natural Resources Conservation Agency
7. Ducks Unlimited
8. Trout Unlimited
9. WV University
10. Local landowners
11. Greenbrier Valley Conservation District
12. Greenbrier Watershed Association

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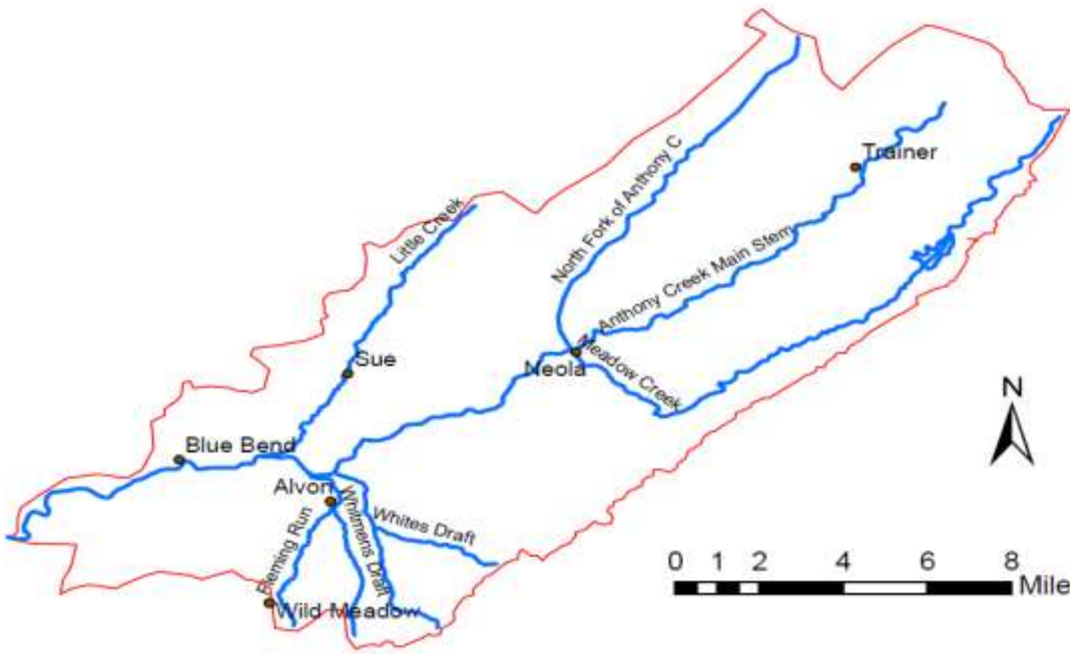
Introduction

The Anthony Creek Watershed is 146 square mile drainage located in the north east corner of Greenbrier County and South east corner of Pocahontas county. The primary thoroughfare of the watershed is U.S. Route 92 that extends from the Wild Meadow and Alvon area in the southern portion of the watershed to the Neola and Trainer area in the northern portion of the watershed. The eastern boundary of the watershed is the West Virginia/Virginia state line. The watershed extent to the west is the top of Hopkins Mountain overlooking the Greenbrier River. Other notable locations within the watershed are Sue, Lake Sherwood, and Blue Bend.

Figure 1. Anthony Creek Watershed showing its main stem and major tributaries.



A significant portion of this watershed is located within the Monongahela National Forest. The stream supports stocked trout from fall through spring with suspicions of sustaining the occasional hold over and is a well-known recreation area throughout the spring and summer for campers. A species of concern in the watershed is the endangered Shale barren rock cress (Arabis serotine). This plant is found in shale barren areas that are frequently eroding slopes undercut by a stream. Portions of Anthony Creek are also known to be freshwater mussel habitat. To accompany the presence of the shale barren rock cress and mussels, some headwater tributaries in the Anthony creek watershed are suspected to inhabit the Candy Darter (Etheostoma osburni), which is soon to be classified as a threatened and endangered species. The entire watershed is a known fishery for stocked Rainbow Trout (Oncorhynchus mykiss) and Brown Trout (Salmo trutta) with the head waters sustaining Native Brook Trout (Salvelinus fontinalis).

While it will appear that this protection plan is very large in scope based to total land mass of the watershed, it should be noted that over 90% of the watershed is National Forest, private forest land, or land area that will not be addressed by practices covered by this plan. It is estimated that only 4%-7% of this watershed will need to be impacted by this plan.

Potential causes and sources

While the Total Maximum Daily Load for the Greenbrier River Watershed indicates that failing septic systems are the source of bacteria impairment throughout most of the watershed and agriculture is impacting the Little Creek sub-watersheds with bacteria, source tracking provides evidence that other impairments such as sediment and nutrients may also be negatively affecting the watershed. These additional impairments are posing a threat to the overall habitat for wildlife and fisheries, recreation, and the health and safety of the residence of the watershed as well as its recreational users. To address this, a holistic watershed management approach must be taken.

Fecal Coliform

A fecal Coliform bacterium is an impairment caused by the introduction of defecation by either humans or other warm-blooded mammals into the water source. Though the TMDL (Total Maximum Daily Load) directly correlates the bacteria load in the watershed with human influence, it must be taken into consideration that there is also the possibility of other influence. In this case, the leading source of bacteria is believed to be failing, or occasionally failing septic systems which results in the discharge of untreated sewage. There is a possibility that there could be an agricultural influence on the bacteria load exposed to the watershed by farms.

Sedimentation

Sedimentation occurs when soil is moved from the land or streambanks into the water, which is then later deposited on the stream bed, or suspended in the water as solids. Given that this stream is notorious for frequent high water flows it can be assumed that flooding is a major cause of sedimentation due to streambank erosion. Due to the proximity of the stream to the road, along with the highly populated areas that the stream flows through, there is little to no riparian buffer or supportive root structure, leaving the bank susceptible to erosion. To accompany the stream bank erosion, agricultural practices can be a frequent cause of erosion and sedimentation.

Given the abundance of livestock farms near or around the watershed, there is a high possibility that livestock access to the stream bank can cause such erosion. When livestock have access to the streambanks the constant hoof traffic kills the riparian vegetation and weakens the bank structure. The implementation and management of a good riparian buffer is key to bank stabilization. However, some residents and farmers find that a clean exposed bank is more aesthetically pleasing, therefore they clear the bank, leaving it exposed to the elements. For this reason, sheet erosion is also a possible source of erosion and sedimentation in the watershed.

Table 1. Excess sediment being added to the Anthony Creek Watershed because of streambank erosion.

Sub Watershed	Excess Sediment Load Due to streambank Erosion (tons/year)
2801	
2802	34.46
2803	*15.65*
2804	
2805	
2806	12.04
2807	*9.41*
2808	*20.17*
2809	6.75
2810	*12.15*
2811	*18.62*
2812	*14.73*
2813	63.15
2814	*18.76*
2815	
2816	*13.87*
2817	
2818	*12.65*
2819	*4.31*
2823	47.74
2824	
Total Excess Sediment Load Due to Streambank Erosion	304.46

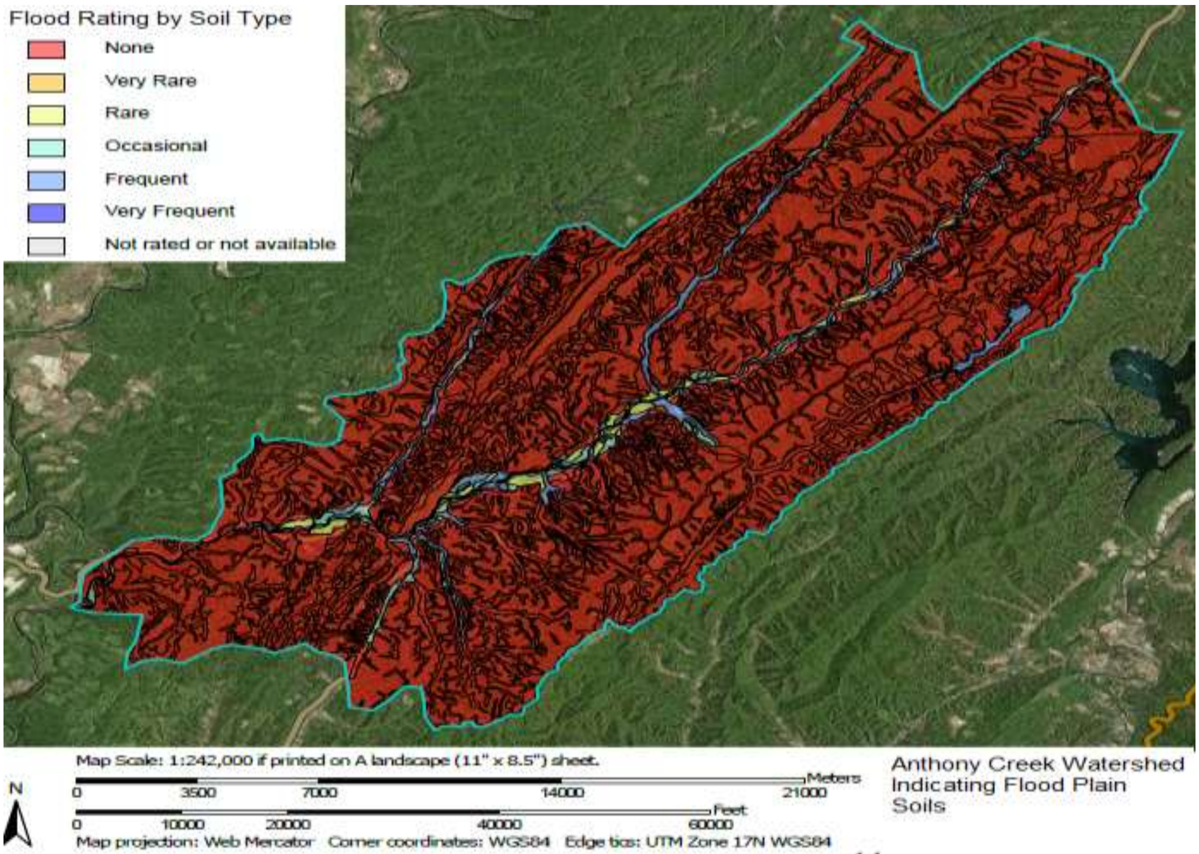
Landowners and residences within this watershed feel very strongly that a significant cause of problems is a result of frequent flooding. In fact, most of the residences in the higher populated areas such as Neola, are built within the flood plain. Flood plain soils that are frequently flooded in this watershed consist of Atkins-Philo-Potomac Complex 2,653 acres, Holly Silt Loam 86 acres, Potomac Very Gravelly Fine Sandy Loam 256 acres, Potomac Very Gravelly Loam 35 acres, and Potomac Loam 35 acres. Occasionally flooded flood plain soils within the watershed include: Philo silt Loam 65 acres, Lobdell silt loam 45 acres, Tioga-Potomac Complex 182acres, Poe fine Sandy Loam 362 acres, and Philo Silt Loam 431 acres. Of the 93,502 acres within the watershed, 3,065 acres are frequently flooded and 1,085 are occasionally flooded. These 4,150 acres are where most of the development, residential areas, and farmland is located within the watershed providing a high potential for non-point source contaminants to be introduced into Anthony Creek.

Table 2. Overall Composition of Sediment Entering Anthony Creek (missing sub-watersheds from this chart did not indicate any excess streambank erosion contributing to the sedimentation levels)

Sub Watershed	Fecal Coliform counts/gram	Nitrate Nitrogen NO_3 PPM	Phosphorus Lbs Per Acre	Iron Lbs Per Acre	Zinc Lbs Per Acre
2801	15	1.36	14	271	5.9
2802	45	2.44	7	535	6.2
2803	15	7.68	25	228	8.1
2806	15	8.23	13	188	22.8
2809	100	11.92	100	562	12.4
2810	15	6	9	326	6.4
2813	500	4.98	8	395	6.3
2814	300	.46	5	478	6.7
2815	15	1.49	9	301	10.9
2816	15	.58	3	512	19.1
2818	105	1.09	13	453	6.9

2819	15	.82	9	336	4.4
2820	15	1.40	8	191	2.2
2821	15	1.02	6	331	7.6
2822	15	.21	15	461	3.2
2823	195	14.90	48	478	13.8
2824	30	12.68	13	241	12.7

Figure 2. Flood plain areas located within the Anthony Creek Watershed. These areas are prone to mass soil erosion along the stream banks and overland flushing of bacteria and nutrients into the stream.



Eroding stream banks are often a result of poor riparian management by landowners combined with high water flows. For years it has been the mentality of landowners to clear brush from the riparian to make more useable and aesthetically pleasing. The result of this practice has resulted in unstable soils due to the lack of a healthy root zone reinforcing the materials. As high-water flows from flooding or seasonal fluctuation saturates these unstable soils, they release materials that deposit downstream as mid-channel or point bars. These in stream structures then can cause more bank stress as the flow of the channel is rerouted, thereby having a result in further erosion to the streambank and higher sediment load in the stream. Once these point bars form and cause excess stress to the bank, the erosion is then done even faster due to the minimal riparian areas along the developed areas of the creek. To accompany the lack of the riparian areas, residents go down to the stream bank to clear out the wood and debris that has complied along their banks. This is something that also exposes the bank even more. When the bank is cleared of everything sheltering it from the bash of the current there is nothing to take the beating other than the soil, which will then slump off into the water as sedimentation. Removing the woody debris from a bank after a high-water event is possibly one of the worst things that can be done in these areas.

Figure 3. This point bar has developed over time and narrowed down the stream channel. It has restricted flow and created a large pool.

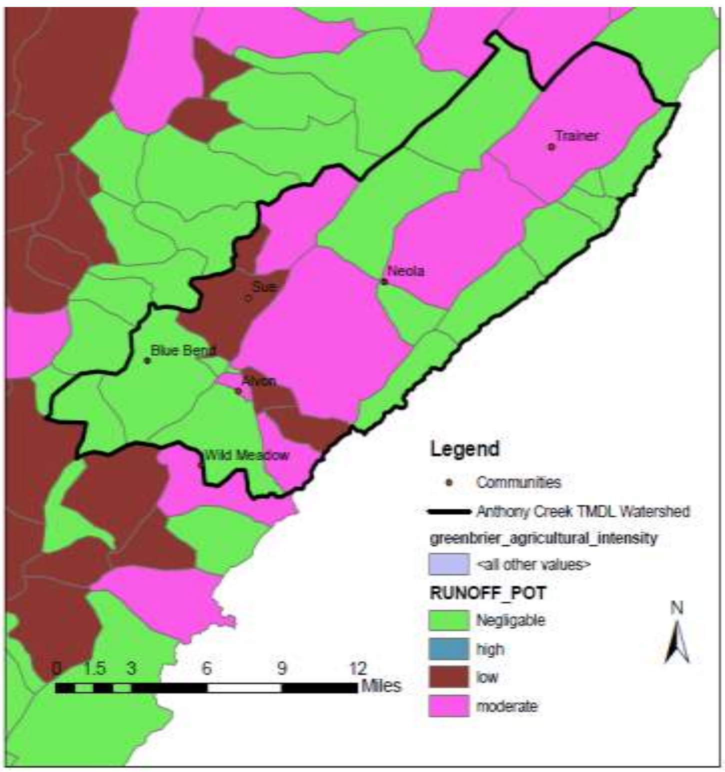
Improper stream crossings typically in the form of a low water culverted crossing or a bridge that restricts high water flow may have varying results on a stream. To begin, culverts typically erode at the downstream end. This creates an aquatic organism passage barrier for any organism attempting to move above or below the crossing. These structures also disrupt the natural flow of bedload through the stream, creating large sediment bars usually below the structure. Low water crossings like these can also clog up creating a pool on the upstream end of the structure, saturating unstable streambank soils and leading to additional erosion.

When an improper stream crossing is in the form of a bridge, these structures often restrict water flow access to the floodplain. This re-routes flood water to areas of unstable soils causing excess erosion and can cause stream blockages by catching debris and forcing sediment to fall out in inappropriate locations.

Figure 4. Left: fish passage barrier created by culvert low water crossing, Center: pool created by culvert low water crossing, Right: sediment build up created by culvert low water crossing.

Poorly managed storm water controls are often a cause of erosion and other water quality issues in rural residential areas. It is so much of an afterthought, that it is rarely seen as a cause of flooding. This leads landowners to want to dredge streams and do another un-necessary flood mitigation that will ultimately fail. Storm water issues can range from lack of ditch and culvert management along roads, un-managed roof runoff from homes and other structures. Additionally, runoff in these areas is usually disposed of into unstable areas along the streams leading to mass soil erosion. Storm water runoff can also cause sheet erosion when crossing dirt parking lots, crop fields, and other barren areas. This leads to very fine, often suspended sediment found in stream and is more likely to carry nutrients. Along with the excess nutrients that are being run into the stream along with the high sedimentation rates, the sediment is detrimental to the benthic macroinvertebrates in the water source that act as a major food source for the fish which the water contains.

Figure 5. Potential for agricultural runoff by individual sub watershed.



To accurately determine how much soil is being lost due to stream bank erosion annually, a bank erosion height index (BEHI) has been conducted on the entire watershed. The BEHI method was developed by Dave Rosgen of Wildland Hydrology, designed to assess streambank erosion conditions. The BEHI assigns point values to sections of the bank based on their specific properties and aspects. Once these points have been calculated and measured, the readings will then give the banks potential to erode soon.

Failing onsite sewage treatments are a problem anywhere there is a lack of a public sewage treatment system. Particularly in the floodplain soils found along Anthony Creek. Since this area is highly recreational, most of the homes are seasonal camps. Camps like these are notoriously constructed without proper permitting, appropriate onsite treatment facilities, and often without any onsite treatment.

Figure 6. Septic zones and potential of failure based on overall soil type.

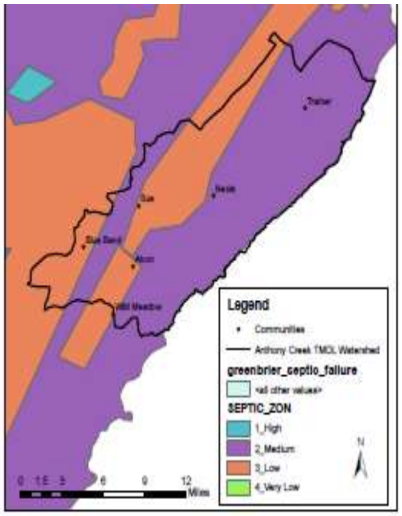


Figure 7. Areas where septic systems are prone to periodic failure based on overall soil type.

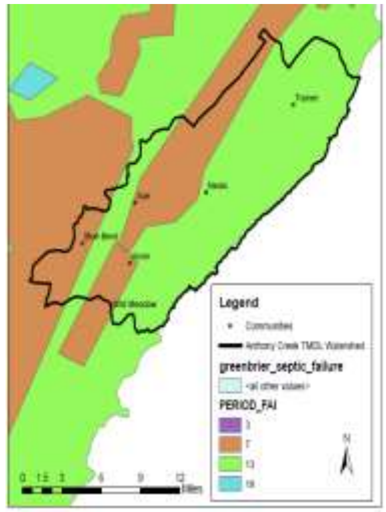
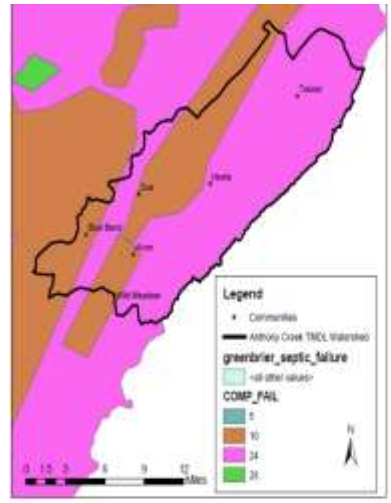


Figure 8. Areas where septic systems are prone to complete failure based on overall soil type.



The TMDL assumes that a failing system provides 10,000 counts per 100 ml of waste water, and that a failing system will discharge 50 gallons per day. 189270 (ml/50 gal) /100 x 10,000 counts = 1.89E+7 counts per day x 365 = 6.90E+9 counts per year discharge from a single completely failing septic system. The TMDL assumes that a partial failing septic system produces half of this at a rate of 3.45E+9.

Table 3. Total number of failing septic systems that need repair by sub-watershed.

Sub Watershed	Fecal Coliform Baseline Load	Fecal Coliform Load Reduction	Systems Needing Rehabilitation
2801	1.26E+09	1.26E+09	0
2802	2.07E+11	2.07E+11	30
2803	1.55E+11	1.55E+11	22
2804	5.41E+10	5.41E+10	8
2805	8.37E+10	8.37E+10	12
2806	4.61E+10	4.61E+10	7
2807	8.90E+10	8.90E+10	13
2808	1.46E+11	1.46E+11	21
2809	3.92E+10	3.92E+10	6
2810	1.91E+11	1.91E+11	28
2811	6.26E+10	6.26E+10	9
2812	1.34E+11	1.34E+11	19
2813	1.53E+12	1.53E+12	222
2814	1.11E+11	1.11E+11	16
2815	4.11E+10	4.11E+10	6
2816	4.58E+11	4.58E+11	66

2817	1.14E+10	1.14E+10	2
2818	1.00E+00	1.00E+00	0
2819	2.85E+09	2.85E+09	0
2820	0.00E+00	0.00E+00	0
2821	0.00E+00	0.00E+00	0
2822	0.00E+00	0.00E+00	0
2823	8.00E+11	8.00E+11	116
2824	6.77E+11	6.77E+11	98

Livestock grazing near the streams is a common practice where the stream is the only source of water available. Farmers are often reluctant to restrict livestock from accessing a waterway because of the shade and dependability of the water source. This leads to a direct deposit of nutrients and fecal coliform bacteria. Additionally, livestock loafing on the streambanks destroys vegetation and prevents the growth of a good riparian area. With destroyed vegetation there becomes no root structure, the root systems of the vegetation acts as an anchor for the streambank holding the materials to the bank, without a root system the bank is susceptible to extreme erosion. To accompany the increased erosion, when livestock have close access to streambanks there is an increased chance for their defecation to find its way into the water source. Although the TMDL says that most of the Bacteria load comes from human influence there is a chance that some may be due to livestock for this reason. Most of the human microbial DNA load will come from failing or no septic systems in residences along the streams. To test this, multiple human microbial DNA samples were taken throughout the watershed to test fecal coliform bacteria partials against human and Ruminant animals. The results are found below, these tests were taken in the same locations as the samples that were used to form the TMDL.

Table 4. Microbial DNA results that indicate the presence of Agricultural vs. Human contributed Bacteria in the impaired streams.

Sub Watershed	2801	2803	2807	2810	2813	2816	2814	2824	2819
Ruminant Bacteroidetes Rum2Bac	<4.80E+00	2.26E+03	3.10E+03	<4.80E+00	<5.20E+00	<5.00E+00	<4.80E+00	<4.90E+00	<4.80E+00
Ruminant Bacteroidetes BacR	<4.80E+00	1.92E+01	9.00E-01	4.00E-01	<5.20E+00	<5.00E+00	<4.80E+00	<4.90E+00	<4.80E+00
Human Bacteroidetes	<4.80E+00	1.47E+02	1.79E+01	2.05E+01	<5.20E+00	<5.00E+00	<4.80E+00	<4.90E+00	<4.80E+00

Figure 9. Indicates the overall Agricultural Intensity by individual SWS.

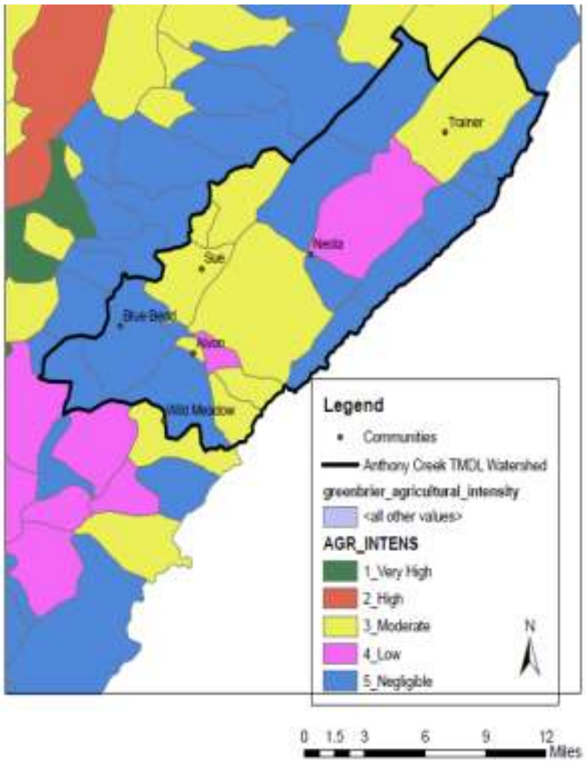


Figure 10. Indicates the overall Agricultural Intensity in Animal Numbers by individual SWS.

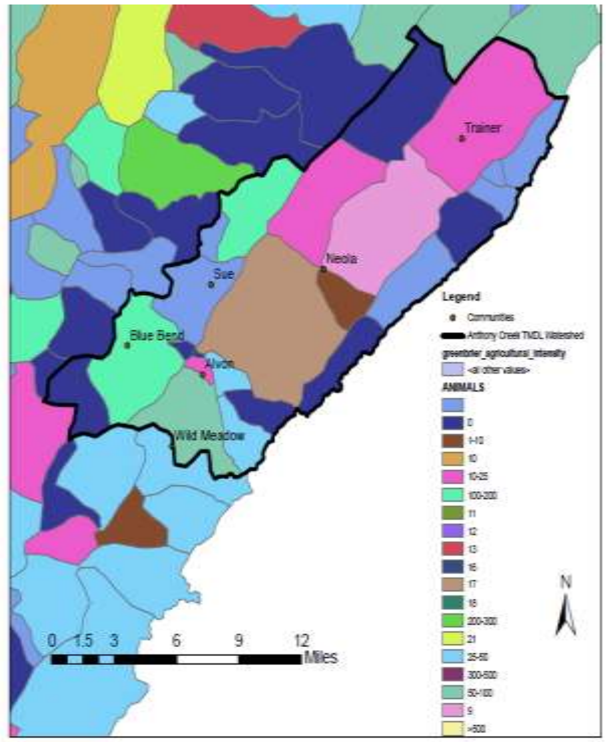


Figure 11. Left: Bank erosion causing excess sediment to build up and bars along the stream. Right: Low water Bridge preventing fish passage and causing excess sediment to build up.

Load reductions

Estimate of the loads reductions expected for the management measures described below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item above. This step will be difficult since there is no TMDL; however, baseline conditions need to be established.

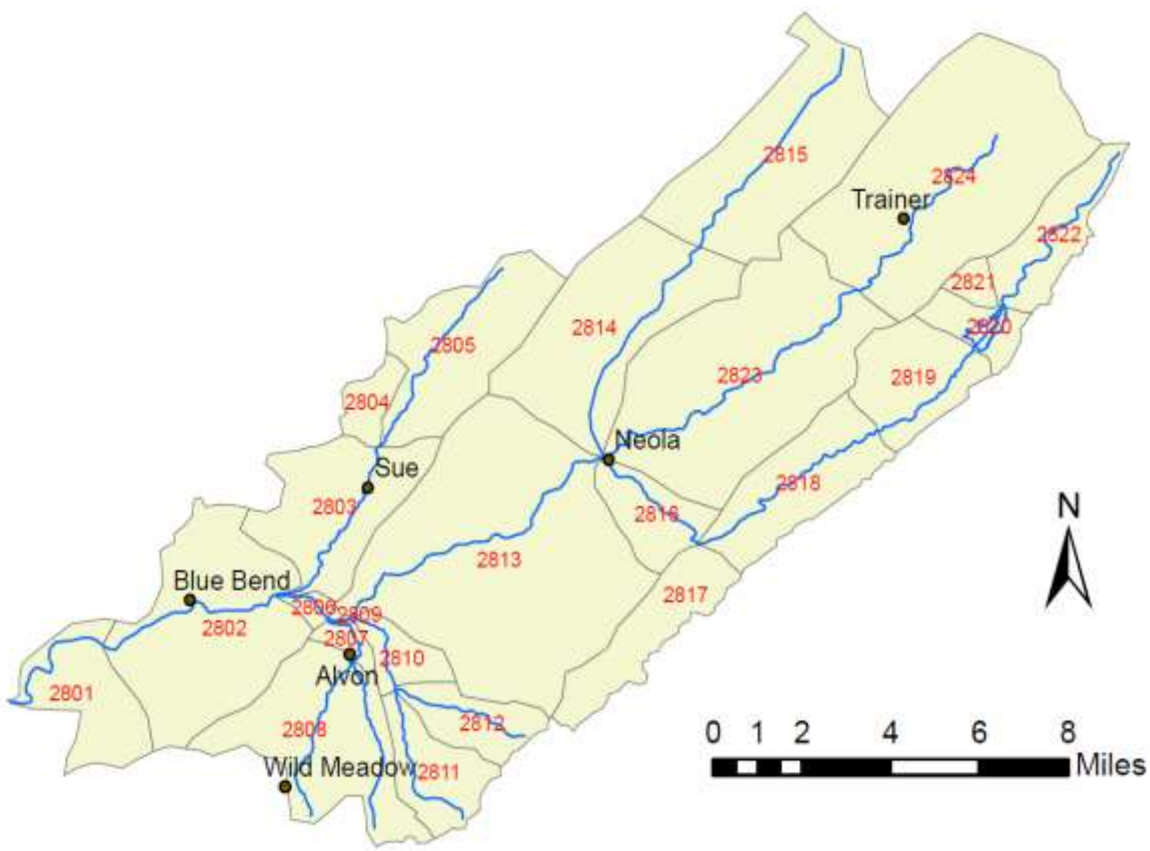
Table 5. Expected load reductions for by pollutant in the Anthony Creek sub-watersheds.

Sub Watershed	Fecal Coliform Reduction Failing Septic Systems	Fecal Coliform Reduction Erosion Control	Fecal Coliform Reduction Agriculture Management	Fecal Coliform Load Reduction	Excess Sediment Reduction (Tons/Year)	Zinc Reduction (lbs/Year)	Phosphorus Reduction (lbs/Year	Iron Reduction (lbs/Year	Nitrogen Reduction (lbs/year)
2801	1.26E+09	0	0.00E+00	1.26E+09	0	0	0	0	0
2802	2.07E+11	1.407E+09	0.00E+00	2.08E+11	34.46	21.37	24.12	1843.61	3.78
2803	1.55E+11	212961618	1.61E+13	1.63E+13	*15.65*	*12.68*	*39.13*	*356.82*	*5.41*
2804	5.41E+10	0	9.88E+11	1.04E+12	0	0	0	0	0
2805	8.37E+10	0	8.02E+12	8.10E+12	0	0	0	0	0
2806	4.61E+10	163837564	0.00E+00	4.63E+10	12.04	14.93	120.4	676.6	6.46
2807	8.90E+10	0	1.88E+12	1.97E+12	*9.41*	0	0	0	0
2808	1.46E+11	0	0.00E+00	1.46E+11	*20.17*	0	0	0	0
2809	3.92E+10	612349700	0.00E+00	3.98E+10	6.75	8.37	67.5	379.35	3.62
2810	1.91E+11	165334419	5.50E+11	7.41E+11	*12.15*	*7.78*	*10.94*	*396.09*	*3.28*
2811	6.26E+10	8.446E+09	7.89E+11	8.60E+11	*18.62*	*0*	*0*	*0*	*0*
2812	1.34E+11	4.009E+09	9.24E+11	1.06E+12	*14.73*	*0*	*0*	*0*	*0*
2813	1.53E+12	859330745	2.51E+13	2.66E+13	63.15	39.78	50.52	2494.43	14.15
2814	1.11E+11	255281786	0.00E+00	1.11E+11	*18.76*	*12.57*	*9.38*	*896.73*	*0.39*
2815	4.11E+10	0	0.00E+00	4.11E+10	0	0	0	0	0
2816	4.58E+11	188739785	0.00E+00	4.58E+11	*13.87*	*26.49*	*4.16*	*710.14*	*0.36*
2817	1.14E+10	0	0.00E+00	1.14E+10	0	0	0	0	0
2818	1.00E+00	172138304	0.00E+00	1.72E+08	*12.65*	*8.73*	*16.45*	*573.05*	*0.62*
2819	2.85E+09	58649493	0.00E+00	2.91E+09	*4.31*	*1.9*	*3.88*	*144.82*	*0.16*
2823	8.00E+11	8.445E+09	0.00E+00	8.08E+11	47.74	65.74	228.67	2277.19	31.94
2824	6.77E+11	0	0.00E+00	6.77E+11					
Total Reductions	4.84E+12	2.50E+10	5.43E+13	5.92E+13	304.46	220.34	575.15	10748.83	70.17

In Table 5, sub watersheds that receive an "*" are ones that are suspected to create minimal baseline loads and are of least concern, this does not mean there is no load, it means more data needs to be collected to acquire accurate readings in these areas. Most of these areas are uninhabited and are dense forested areas receiving minimal erosion. The sub watersheds that have their data italicized are sediment baseline loads that were estimated by using a sub watershed that has similar traits and attributes. Other remaining sub watershed data was collected by using a BEHI.

An extensive evaluation of the watershed has been conducted to determine the baseline loads of various impairments. Fecal coliform loads and reductions have been determined by the TMDL for the Greenbrier River Watershed. Additionally, the bank erosion hazard index (BEHI) was used to determine the overall sediment baseline load entering Anthony Creek. This BEHI study coincided with soils analysis of the eroding sites to determine the nitrogen and phosphorus loads in the stream. It is assumed that the significant nutrient loads are entering the stream attached to sediment through erosion. Several studies were also conducted utilizing the Revised Universal Soil Loss Equation (RUSLE) to help consider sheet erosion from agricultural lands. The objective of this watershed protection plan is to reduce overall erosion (streambank and sheet erosion) by 80 percent, thus reducing nutrient loads to the stream by the same 80 percent. The fecal coliform load reduction goals have already been prescribed by the TMDL. However, given the date of the TMDL it must be taken into consideration that since then the USDA Natural Resource Conservation Service (NRCS) has done several projects on Little Creek of Anthony Creek (SWS 2803, 2804, 2805) that could drastically change the fecal coliform bacteria load in the watershed. NRCS Has implemented 5 exclusion fences to prevent cattle access to the stream, along with alternative watering sources. These farmers are most of the farms in the area and therefore this should be taken into consideration when looking at the load reduction requirements for fecal on Little Creek. Since so much investment has already been made in Little Creek and it is expected that all the landowners who would be willing to install BMP’s have, the watershed is not a priority for additional restoration. It will be monitored to determine an appropriate amount of BMP’s have been installed to achieve the required load reduction. These load reductions will be accounted for as NRCS begins their focus conservation approach. While NRCS will be the primary agency responsible for implementing agricultural practices, the WVCA will track their progress and account for the load reductions associated with agricultural practices.

Figure 12. Sub-watershed map.



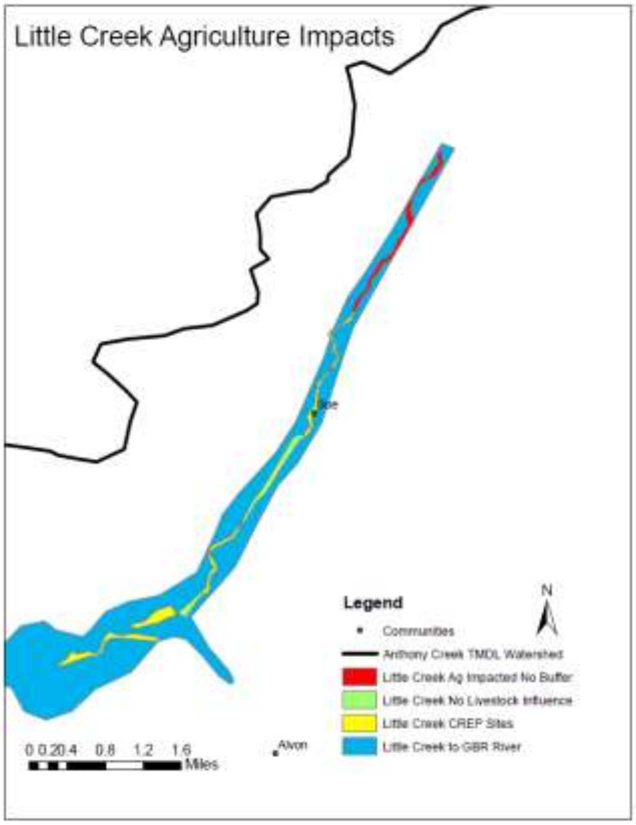


Figure 13. (Left) While the TMDL indicated that a load reduction is required for the Little Creek sub watersheds (SWS 2803, 2804, and 2805), it must be noted that this TMDL was published in 2008. Beginning in 2012, the USDA Natural Resources Conservation Service began working with several landowners within this watershed to implement the Conservation Reserve Enhancement Program (CREP) to exclude livestock from the riparian areas along Little Creek. This effort combined with riparian areas not impacted by livestock account for more than 60% of the riparian along Little Creek excluded from livestock. It is expected that this should account for the required agricultural load reduction. In this plan, USDA NRCS is responsible for instituting agricultural practices and achieving those load reductions through their Environmental Quality Incentive Program, Focus Conservation Approach.

Table 6. TMDL Required load reductions from agriculture.

Subwatershed	Pasture/Cropland Baseline Load (counts/yr)	Pasture/Cropland Allocated Load (counts/yr)	Pasture/Cropland Percent Reduction Required
2801	0.00E+00	0.00E+00	0.0
2802	0.00E+00	0.00E+00	0.0
2803	2.15E+13	1.61E+13	25.1
2804	1.10E+12	9.88E+11	10.2
2805	8.91E+12	8.02E+12	10.0
2806	0.00E+00	0.00E+00	0.0
2807	1.88E+12	1.88E+12	0.0
2808	0.00E+00	0.00E+00	0.0
2809	0.00E+00	0.00E+00	0.0
2810	5.50E+11	5.50E+11	0.0
2811	7.89E+11	7.89E+11	0.0
2812	9.24E+11	9.24E+11	0.0
2813	2.51E+13	2.51E+13	0.0
2814	0.00E+00	0.00E+00	0.0
2815	0.00E+00	0.00E+00	0.0
2816	0.00E+00	0.00E+00	0.0
2817	0.00E+00	0.00E+00	0.0

2818	0.00E+00	0.00E+00	0.0
2819	0.00E+00	0.00E+00	0.0
2820	0.00E+00	0.00E+00	0.0
2821	0.00E+00	0.00E+00	0.0
2822	0.00E+00	0.00E+00	0.0
2823	3.69E+12	3.69E+12	0.0
2824	8.34E+12	8.34E+12	0.0

Table 7. Expected load reductions from BMP implementation.

Sub Watershed	Fecal Coliform Reduction From Addressing Failing Septic Systems	Failing Septic Systems Needing Rehabilitation	Fecal Coliform Reduction From Erosion Control	Feet of Stream Restoration	Fecal Coliform Reduction From Agriculture Management	Animal Units Requiring Impact to Reduce Bacteria Load	Fecal Coliform Load Reduction	Excess Sediment Reduction (Tons/Year)	Nutrient Management Plans	Exclusion Fence	Stream Crossings	Water Pumping Facilities	Water Troughs	Wells	Tree Planting (acres)	Grazing Plans
2801	1.26E+09	0	0		0.00E+00	0	1.26E+09	0								
2802	2.07E+11	30	1.41E+09	600	0.00E+00	0	2.08E+11	34.46								
2803	1.55E+11	22	2.13E+08	600	1.61E+13	1193	1.63E+13	15.65	3	2139	1	1	10	3	20	3
2804	5.41E+10	8	0		9.88E+11	73	1.04E+12	0	2	1426	1	1	15	1	15	2
2805	8.37E+10	12	0		8.02E+12	594	8.10E+12	0	4	2852	1	1	20	1	20	4
2806	4.61E+10	7	1.64E+08	600	0.00E+00	0	4.63E+10	12.04		0						
2807	8.90E+10	13	0		1.88E+12	139	1.97E+12	9.41	2	1426			15		20	2
2808	1.46E+11	21	0		0.00E+00	0	1.46E+11	20.17		0						
2809	3.92E+10	6	6.12E+08	600	0.00E+00	0	3.98E+10	6.75		0						
2810	1.91E+11	28	1.65E+08	600	5.50E+11	41	7.41E+11	12.15	1	713		1	6	1	10	1
2811	6.26E+10	9	8.45E+09	200	7.89E+11	58	8.60E+11	18.62	1	713		1	6	1	10	1
2812	1.34E+11	19	4.01E+09	200	9.24E+11	68	1.06E+12	14.73	1	713			8		10	1
2813	1.53E+12	222	8.59E+08	1200	2.51E+13	1859	2.66E+13	63.15	6	4278			40	3	20	6
2814	1.11E+11	16	2.55E+08	300	0.00E+00	0	1.11E+11	18.76								
2815	4.11E+10	6	0		0.00E+00	0	4.11E+10	0								
2816	4.58E+11	66	1.89E+08	300	0.00E+00	0	4.58E+11	13.87								
2817	1.14E+10	2	0	300	0.00E+00	0	1.14E+10	0								
2818	1.00E+00	0	1.72E+08	300	0.00E+00	0	1.72E+08	12.65								
2819	2.85E+09	0	5.86E+07	200	0.00E+00	0	2.91E+09	4.31								
2823	8.00E+11	116	8.45E+09	2400	0.00E+00	0	8.08E+11	47.74								
2824	6.77E+11	98	0	600	0.00E+00	0	6.77E+11									
Total Reductions Per Watershed Based Plan	4.84E+12	701	2.50E+10	9000	5.43E+13	4026	6.E+13	304	20	14260	3	5	120	10	125	20

Management measures

Description of the management measures that will need to be implemented to achieve the watershed goals identified in this protection plan, and an identification (using a map or description) of the critical areas in which those measures will be needed to implement this plan. Discuss how the proposed management measures, when implemented, will protect and perhaps improve water quality goals should also be included here.

Failing septic systems

Failing septic systems may be addressed in two different ways. Either by repairing or replacing an existing system in the case of a complete failure or pumping in the case of a periodic failure. Another option for the more highly populated areas could be a package system with underground discharge. A system of this kind could serve multiple residences with a central treatment system. By fixing failing septic systems the amount of human influenced bacteria that reaches the water will be mostly cut out. In the instance that the bacteria load is coming from an agricultural stand point then some best management practices (BMP's) can be done to reduce that load. To begin, exclusion fencing should be used in instances where livestock have direct stream access, fencing out the stream and giving adequate room for a buffer zone, and supplying and alternate watering source for the livestock. The implementation of an undisturbed riparian buffer is a good way to prevent excess nutrients and bacteria from entering the water source. Much like a sponge the buffer vegetation will soak up and filter the run-off before it reaches the stream. These buffers should include hydric vegetation planting and tree planting to create a good deep root system, by doing so you are also stabilizing the bank and, in the future, reducing the erosion rate.

Better agricultural practices

In agricultural areas, some BMP's can be used to reduce the amount of stress put on the stream. Though there is not a clear majority of farm land along this watershed, poor practices in these areas could drastically affect the sediment and bacteria load of the stream. By using some of these practices, in the correct way fecal coliform bacteria and sediment load along with erosion rates can be reduced. Livestock fencing is crucial for the stream bank; fences should be a reasonable distance away from the streambank to ensure there is enough buffer space available for vegetation and tree growth. By allowing access to close to the stream and not allowing adequate growth of the riparian, excess nutrients and erosion become more common to the stream in that area. In the instance that livestock need to be moved through a riparian area to get to another location then the implementation of an armored stream crossing is necessary. By creating these crossing the damage to the riparian through the movement of the livestock is minimal and the buffer is still able to perform the way it is needed. In the instance that livestock have direct stream access, then exclusion fencing is necessary along with the implementation of an alternate watering source like a well or a spring. To add to any of these practices nutrient management plans along with rotational grazing or crop rotations should be used to maximize utilization of the land as well as conserve soils. To accompany all management practice, we recommend the implementation of a well-managed riparian buffer zone to stabilize the stream bank, allow adequate vegetation growth and filter run-off before it is discharged in the stream.

Alternative watering sources, with fencing

To reduce occurrences of livestock coming into direct contact with a stream or other waterway, a narrow strip of land along the stream bank can be fenced off. Alternative watering sources, such as spring development and wells with pipelines and troughs, must then be provided for the livestock. This will prevent livestock form defecating in or close to the stream and reduce stream bank erosion. This includes dry hydrants for any systems that have enough water to support them. Dry hydrants are needed in case of drought conditions. They aid in grass fire suppression and alternative water for livestock during a drought. This reduces erosion common after fires and eliminates the need to allow livestock into the riparian buffer zones for water. NRCS conservation practices that can accomplish this are: 378 Pond, 382 Fence, 516 Pipeline, 533 Pumping Plant for Water Control, 574 Spring Development, 587 Structure for Water Control, 614 Watering Facility, 636Water Harvesting Catchment, 642 Well, 472 Access Control. These practices correspond to BMP efficiencies in Table 10 for: off-site watering systems and fencing. In most situations, alternative watering sources are installed prior to any exclusion or pasture division fencing. This allows for appropriate infrastructure to be in place when the management system is initiated. It has been observed in other recent 319 project watersheds that as soon as an alternative watering system is put in place, that livestock prefer to drink from the water troughs as opposed to streams and ponds. This observation is consistent with the Chesapeake Bay model allowing for a 50% load reduction by installing a watering system without exclusion fence.

Heavy Use Area Protection

Practices that restore or put into proper use, areas that are or have been used by large numbers of areas for feeding, walking, loafing. NRCS conservation practices that can accomplish this are: 313 Waste Storage Facility, 342 Critical Area Planting, 484 Mulching, 512 Pasture & Hayland Planting, 528 Prescribed Grazing, 560 Access Road, 561 Heavy Use Area Protection, 575 Animal Trails and Walkways, 561 Heavy Use Area Protection., as well as various erosion and sediment control measures according to the WV Erosion and Sediment Control Handbook. These practices correspond to BMP efficiencies in Table 10 for: Sediment Pond/Swale in combination with filter strip and fencing.

Addressing load reductions associated with heavy use area protection is directly related to soil loss. Calculating this load reduction should be done utilizing the Revised Universal Soil Loss Equation, A=RK(LS)CP. A = Tons of soil lost per year, R = rainfall factor, K = soil erodibility factor, LS = length of slope factor, C = ground cover factor, P = practice factor. The difference of A between pre- and post-practice instillation would be the total sediment load reduction measured in tons per year. This figure can be converted to a bacteria load reduction by understanding the typical fecal coliform bacteria concentration of the soils. For example, in nearby watersheds it has been determined that the typical concentration of soil FC Bacteria is 50 counts per gram which calculates to 4.5E+7 counts per ton (907,185 grams/ton of soil X 50 counts per gram of soil = 4.5E+7 counts per ton). Thus, if a practice is reducing 100 tons of soil from eroding per year then the practice is also reducing 4.5E+9 counts of bacteria per year as well (100 X 4.5E+7 = 4.5E+9). See appendix E for soil loss calculation charts.

Streambank erosion/streambank stabilization

Sedimentation is the process from which the stream bank or other area of exposed sediment erode and are then discharged into the water source. High sediment loads then cover the bottom of the stream bed, creating a layer along the bed. This sediment layer on the bed is detrimental to benthic fish and aquatic invertebrate's habitat which, feed the fish, birds, and other organisms in the area. With Anthony Creek having the possibility of inhabiting the soon to be endangered Candy Darter (Etheostoma osburni) and inhabiting the very sensitive Native Brook Trout (Salvelinus fontinalis) it is very important to reduce the sediment load as much as possible. With the benthic macroinvertebrates that inhabit the stream being the primary food source for both species it exposes the importance on minimizing the sedimentation and erosion of the stream.

There are several ways of reducing the amount of erosion and damage that is done to a stream in high waters. One method that has worked in the past is the implementation and anchoring of large wood into and along the stream bank. By doing so the wood can take some of the stress away from the bank directly while the water is high. Giving the bank some relief during the high water and keeping the integrity of the bank intact through the high flow, thereby lowering the substrate discharged into the waterway. For this type of structure to work and hold a few things must be measured and used to proportions. Without the proper design and proper implementation, the wood structure would be subject to failure in high water situations and could be pushed downstream. When choosing the trees and wood to be used in the bank for these sites it must be taken into consideration the strength of the flow and other dimensions of the water, the bank it is intended to protect, and the size of the material being used to anchor it into place, along with the size of the wood being used for the structure. Without taking these factors into considerations the structure will not remain intact or in place

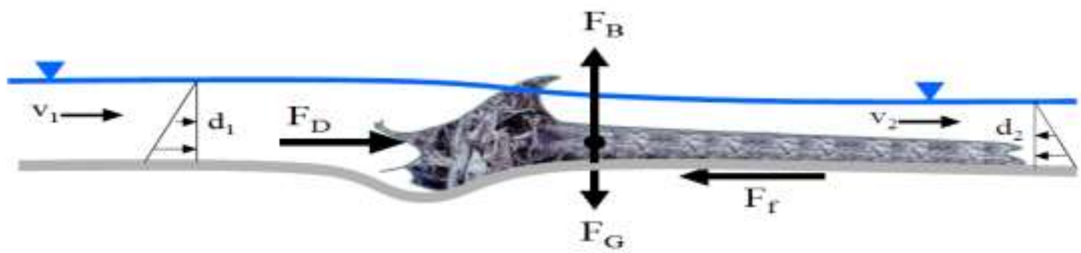


Figure 14. Example of a wood structure used for erosion protection and wildlife habitat

To explain the figure 14 above, a slight understanding of physics must be brought to the table as the implementation of these structures is a never-ending science considering the vast amounts of abuse they will take from the stream. The figure above has a one log structure in the water and labels all the forces that could potentially act upon it. The Importance of the calculations become crucial when high water occurs, because these forces will increase with the water levels. The Fb is the buoyant force of the log, or its tendency to float, where the Fg is the weight of the log. Fd is the dynamic fluid force, and acts as the force acted upon the structure by the flow of the stream. Not only will the factor of the weight if the wood come into play as downward force, but the water displaced by the structure can also act as a factor of downward pressure. This is important because without the downward forces amounting to more than the buoyant force, the log structure will float. Ff acts as the friction created by the structure on the bottom of the channel with the substrate that already exists there. This is the force that acts to help keep the structure in place. The stronger the Fg force (downward weight on the log) the stronger the friction force. V is the mean flow velocity, obviously according to the incident that you are accounting it more. Example, higher flows will have different velocity than a light smaller flow. D is accounting for the size of the wood debris that is in the flow and the effect or displacement it will have on the channel flow. All these factors come into play when deciding the type of wood, the size and the implementation method. Without creating and reading this correctly the structure will not last and will not remain intact or in place.

To go into further detail of the wood anchoring for structures there are a few different methods that can be used to create certain conditions to accomplish different goals. Considering the bank of a stream is never going to be synonymous, there will need to be different anchor points or objects to secure to at each site. Each of the methods below is designed to be used at specific sights considering the presence or absence of anchors available. First is ballast anchoring which is used when you simply want to add weight to wood below. Considering that this method really doesn't have any cobble that is anchored into place it would not be feasible to use this method of stabilization on Anthony Creek considering the frequent high flows. When the design is to trap wood pieces behind vertical driven poles into the bank then they are classified as pilings. Cabling or chaining is when you secure large wood using large existing trees on the sight to themselves or other vegetation on the site. Considering the area around Anthony Creek and the sites that will possibly be future anchor areas, this cable method will most likely be the method used on this watershed often. Other existing methods that could possibly be used are pinning, which is the process of trapping large wood on vegetation or another tree and holding together with rebar pins or bolts. Other methods could be used where bedrock or even large boulders that are in place could be used to anchor down tree or wood structures. However, considering areas that have bedrock exposed or have large boulders on the bank is most likely going to be areas of least concern in the aspect of erosion and sedimentation it is unlikely we would work on those areas. As statement previously, the most common method considering the watershed we are working in will be anchor and stabilization via cabling and/or chaining. When the process of cabling or anchoring is to be conducted the dark around the tree should be removed to prevent the cable from loosening when the bark decays or falls off. To further prevent the occurrence of the cable loosening notches can be cut into the wood around the area where the cable will be tightened. To further assure the holding of the cable around the wood a hole can be drilled through the log and the cable ran through it and tightened around.

There are suspicions that the proper implementations of these structures have in the past helped reduce the damages of high water flows in watersheds by slightly slowing the water and reducing the load it is carrying downstream; however, there is no guarantee considering the primary reason for the implementation of this structure is for bank stabilization. By reducing the roughness of the water that goes down stream of it, there is reason to suspect that the structures may make high water flows less detrimental to the flood plain, but in no way will it completely protect or stop the area from flooding. These structures could potentially work in the aspect of flood resiliency.

While the anchoring of the structure into the stream bank will reduce the sediment load and erosion rates during high flows the wood structures are prime examples and will be largely intended to double as adequate fish habitat for the numerous species of fishes that inhabit Anthony Creek. If the structures hold and provide enough protection and enhancement of the creek there is reason to believe that these structures have the possibility to not only increase but strengthen the fish population, especially that of the Native Brook and other trout species throughout the watershed. By giving them adequate shelter and food sources, you should thereby increase the spawning productivity resulting in a strengthened population of species in the watershed.

Figure 15. Shows the town of Neola, the red line is Anthony Creek, notice the lack of riparian buffer.

To accompany the implementation of these structures to create habitat and stabilize the bank, there will need to be other efforts to help stabilize and reduce the stress on these structures. In the areas that are most susceptible to high water flow damages there is little to no riparian buffer in existence. Most of these areas are due to landowner riparian disturbances, where the creek is literally exposed to all forms of traffic, with the road being several feet away from the stream with nothing standing between them but the occasional tree. In these instances where the flooding occurs, and the riparian is poor, the number of homes and residences that are exposed to flooding are in fact located within the flood plain. With, recommendations of implementing a strong undisturbed riparian area are strongly encouraged. Public outreach is a factor that is vital at this stage considering many landowners clear their stream banks to make it more aesthetically pleasing. When in fact all they are doing is making themselves along with their neighbors more susceptible to high flow damages and erosion of the stream bank. The area where this is problem is noticeably at play is in the Neola area along with short a distance downstream where the area is highly populated. With, recommendations to the public should be made stressing the importance of planting and nurturing a good riparian zone and stressing the importance of leaving the woody debris after high water flooding within the channel rather than removing it.

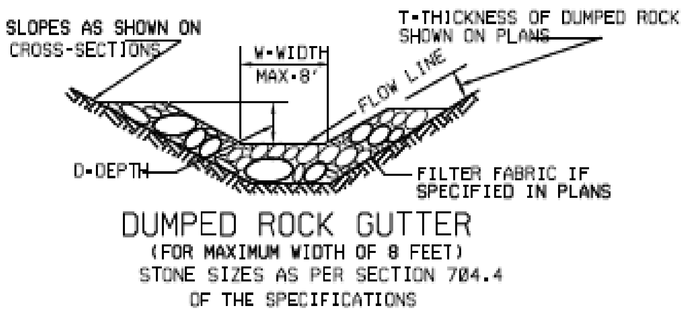
Figure 16. Before and after example of using toe wood structures to address streambank erosion along agricultural land in the Anthony Creek Watershed.

To show some examples of how wood anchoring can increase bank stabilization, and decrease erosion rates, the above images are some before and after pictures of a site that was done by the West Virginia Conservation Agency on Anthony Creek, just above Blue Bend. Before construction began on the site there was about a 6-foot-high vertical bank, which was eroding quickly and causing the land owner to lose his fence as well as is his land. To stabilize the bank, the bank height was reduced, and large root systems of trees were placed and anchored into the bank to allow relief. After the site was completed it was planted and will eventually grow a very strong riparian buffer to add some extra strength to the bank.

Stormwater management

These practices may include ditch management, culvert management, retention practices, wetland development, and subsurface drainage. Even some small practices such as the implementation of a rain catch, and barrel could help reduce the amount of damage caused by storm water.

Figure 17. Example of a stormwater management structure that may need to be used to address flooding issues.



Fish passage barriers

In the Anthony Creek watershed there are three low water culverted bridges that have the potential to act as fish passage barriers. In most instances the initial thought would be to immediately remove these structures and replace them with something functional to the watershed. These low water culvert bridges not only restrict the up and downstream movement of fishes, but they also have the capability of creating a blockage usually pooling upstream of the bridge and seeing a pile up of discharge downstream. This can increase the sediment load in the watershed. However, with this watershed it will not be that simple. Given the suspected presence of the Candy Darter (Etheostoma osburni) in the Anthony Creek watershed the idea of leaving these bridges in place may be considered depending on the presence of the species. Since the leading cause of this fishes decrease in population is due to hybridization with the closely related Variegate Darter (Etheostoma variatum) leaving the bridges in place could be beneficial for the soon to be endangered candy darter. To determine the actions that should be done regarding these low water bridges the presence of the fishes must be confirmed or denied. In the instance of the presence of the Candy Darter, their population location must be pinpointed, and then these culverts will have to be proven to be actual barriers to the fish. In the instance that they are certainly allowing no fish passage and there is available habitat and the presence of Candy Darters in the watershed, the possibility of reintroduction into the population could be a potential option.

Another potential option to be explored is to leave the low water bridges in place to separate the stocked trout population and the Native Brook trout (Salvelinus fontinalis) populations. In June of 2018, there were significant findings of Native Brook trout on the Meadow Creek of Anthony, and in the past according to US Forest Service records, there is a confirmed presence of Native Brook Trout on the North Fork of Anthony also. On Meadow Creek not only were full grown adult Brook trout found but also small fry, which is an indicator of a self-sustaining population. Keep in mind, above these culvert bridges the WVDNR currently stocks Rainbow (Oncorhynchus mykiss) and Brown trout (Salmo trutta) on top of the existing Native Brook trout. In the area where the large amounts of Native Brook Trout were found, there was no stocking of other non-native trout species and zero chance of them making their way to this area. The Native Brook trout will soon be rooted out of the Anthony Creek watershed completely if the stocking of non-native trout continue in these areas. The Rainbow trout and the Brown trout will out-compete the Brook trout completely, given their increased aggression and greater size. This will eventually lead the Native Brook trout to its extirpation from the watershed. Taking this into consideration, the idea of leaving these low water culvert bridges in place should be considered, to accompany leaving the bridges in place ceasing the non-native trout stocking above these bridges should also be considered. Stopping the stocking of these species above the low water bridges still allows for 12 or more miles of downstream water to still be stocked, including the major Recreation hotspot of the watershed, Blue Bend.

Figure 18. Native Brook Trout found on Meadow Creek of Anthony, June 2018.

If the stocking of non-native trout species above these bridges will come to an end, there have been local interests through the US Fish and Wildlife in doing some stream side egg extraction of the native brook trout in this watershed and using some of the Native males of the watershed to fertilize the eggs. Then later after the fry hatch and can sustain themselves they will be restock some of these Native Brook right back into the area's in which they came from. In this instance, you would be stocking Native Brook Trout and enhancing the population. With the low water culvert bridges in place, the stocked non-native species would remain below the barriers and the revived Native trout populations can flourish above the barriers, without being rooted out by non-native species. In the instance that these low water bridges would be left in place, they would need to be cleaned and maintained to prevent the sediment build up below and above them as well as the cleanup of the blockages in which they may cause.

To accurately determine the presence of Native Brook Trout throughout the North Fork of Anthony as well as to assess the habitat capabilities for other species, temperature loggers will be strategically placed throughout the tailwaters of this stream to be able to make reasonable determinations as to the presence of these species throughout the year. The U.S. Forest Service as well as the West Virginia Conservation Agency will work together to monitor water quality (including temperature) throughout this area.

Aquatic habitat

Throughput the entire watershed there are strong sustaining fish populations. The water quality is fair, and the habitat is decent, however in some parts of the stream it is poor. In the middle section of the watershed, mainly between Neola and Alvon, almost all the stream bed is down to bedrock. This is not adequate fish habitat. Therefore, throughout the watershed, some structure will be implemented to create prime fish habitat and enhance the populations of multiple different species of fishes throughout the watershed. These structures will include anchored tree snags as well as large woody debris that will also be anchored into place to prevent them from washing away in the annual high flows. By attracting and allowing proper shelter and protection to these fish you are simultaneously causing them to have a higher reproductive fitness. Also, has the sedimentation rates drop due to bank stabilization and other BMP's the fish habitat will also continue to get better, as other sources of food and shelter will become more readily available to them.

Riparian Buffer implementation and management

The implementation of a riparian buffer should accompany almost any management practice that is near or around the creek. A buffer zone should allow adequate growth and should remain undisturbed in grounds of the buffer. These buffers are key to filtration, and bank stabilization. Trees should be planted, and other vegetation should be planted in the process of creating one, in other instances simply fencing out and area near the stream and giving it freedom to grow itself is a good way to create a strong riparian buffer zone.

Technical and financial assistance

Estimate of the amounts of technical and financial assistance needed; associated cost, and/or the sources and authorities that will be relied upon to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, USDA's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds that may be available to assist in implementing this plan.

Technical assistance will come from all partners involved in this plan. The West Virginia Conservation Agency provide most of the monitoring and date collection on the watershed, this included but is not limited to, Fecal coliform water samples, soil samples, microbial DNA samples, BEHI data, and other monitoring practices. The WVCA will also seek section 319 grant funding to repair and replace failing onsite sewage treatment systems at a cost share with landowners. Below is a graph showing estimated cost of septic repair and implementation cost on the watershed.

Table 8. Cost associated with fixing septic system issues associated with the Anthony Creek bacteria fecal coliform impairments.

Service	# of jobs	Cost estimate	Total cost
Complete system repair	351	$7,000	$2,457,000
Pumping	349	$500	$174,500
Total	700		$2,631,500

The USDA Natural Resource Conservation Service is planning to use this protection plan in their Fiscal Year 2020 for their focused conservation approach. The focused conservation approach is part of the environmental quality incentive program (EQIP), which is a program dedicated to providing some financial assistance to farmers to help them implement some conservation BMP's on their operation.

Additionally, NRCS will also be utilizing the Appalachian Ecosystem Restoration Initiative. This program is a multi-year partnership between the US Forest Service and the NRCS to improve the health ad resiliency in forest ecosystems where public and private land meet.

Table 9. Budget estimates of implementation of BMP's for agriculture.

Best Management Practice	Planned units	Cost per unit	Total
Nutrient Management Plans	20	$5,953.50	$119,070
Stream Crossing	3	$1,500	$4,500
Water Pumping Facility	5	$10,000	$50,000
Water Troughs	120	$1,000	$120,000
Well	10	$10,000	$100,000
Natural Stream Restoration	15	$118 per foot	$1,062,000
Tree Planting	30	$111 per acre	$13,875
Stream Exclusion Fence	20	$3.50 per foot	$49,910
Grazing Plans	20	$1580	$31,600
Educational Component			$5,000
Monitoring			$20,000
Septic Work			$2,631,500
			$4,207,455

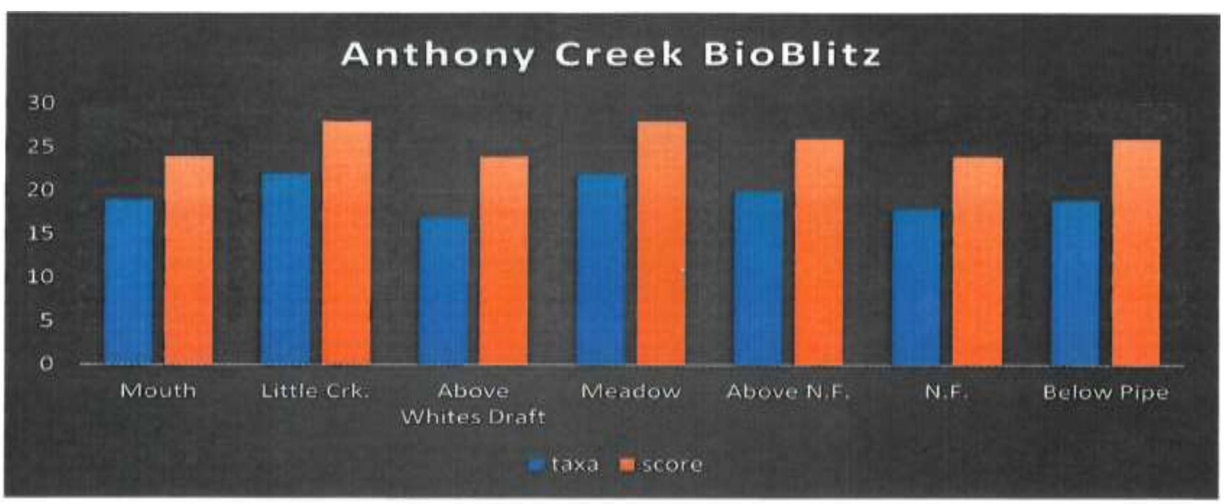
Table 10. Cost associated with implementing BMP's in individual sub-watersheds.

SWS	Cost of Septic Rehabilitation	Cost of Stream Restoration	Cost of Nutrient Management Plans	Cost of Exclusion Fence	Cost of Stream Crossings	Cost of Water Pumping Facilities	Cost of Water Troughs	Cost of Wells	Cost of Tree Planting	Cost of Grazing Plans	Cost Per SWS
2801	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2802	$112,618	$70,800	$0	$0	$0	$0	$0	$0	$0	$0	$183,418
2803	$82,586	$70,800	$17,861	$7,487	$1,500	$10,000	$10,000	$30,000	$2,220	$4,740	$237,193
2804	$30,031	$0	$11,907	$4,991	$1,500	$10,000	$15,000	$10,000	$1,665	$3,160	$88,254
2805	$45,047	$0	$23,814	$9,982	$1,500	$10,000	$20,000	$10,000	$2,220	$6,320	$128,883
2806	$26,277	$70,800	$0	$0	$0	$0	$0	$0	$0	$0	$97,077
2807	$48,801	$0	$11,907	$4,991	$0	$0	$15,000	$0	$2,220	$3,160	$86,079
2808	$78,832	$0	$0	$0	$0	$0	$0	$0	$0	$0	$78,832
2809	$22,524	$70,800	$0	$0	$0	$0	$0	$0	$0	$0	$93,324
2810	$105,110	$70,800	$5,954	$2,496	$0	$10,000	$6,000	$10,000	$1,110	$1,580	$213,049
2811	$33,785	$23,600	$5,954	$2,496	$0	$10,000	$6,000	$10,000	$1,110	$1,580	$94,524
2812	$71,324	$23,600	$5,954	$2,496	$0	$0	$8,000	$0	$1,110	$1,580	$114,063
2813	$833,370	$141,600	$35,721	$14,973	$0	$0	$40,000	$30,000	$2,220	$9,480	$1,107,364
2814	$60,063	$35,400	$0	$0	$0	$0	$0	$0	$0	$0	$95,463
2815	$22,524	$0	$0	$0	$0	$0	$0	$0	$0	$0	$22,524
2816	$247,759	$35,400	$0	$0	$0	$0	$0	$0	$0	$0	$283,159
2817	$7,508	$35,400	$0	$0	$0	$0	$0	$0	$0	$0	$42,908
2818	$0	$35,400	$0	$0	$0	$0	$0	$0	$0	$0	$35,400
2819	$0	$23,600	$0	$0	$0	$0	$0	$0	$0	$0	$23,600
2823	$435,455	$283,200	$0	$0	$0	$0	$0	$0	$0	$0	$718,655
2824	$367,884	$70,800	$0	$0	$0	$0	$0	$0	$0	$0	$438,684
	$2,631,498	$1,062,000	$119,070	$49,910	$4,500	$50,000	$120,000	$100,000	$13,875	$31,600	
Total Cost to Impliment Practices Associated With This Watershed Based Restoration Plan										$4,182,453	

According to Table 10 the watersheds requiring the least investment to restore are in the North Fork (2815) and Meadow Creek (2819) sub-watersheds. These would be primarily failing septic system issues associated with seasonal camp sites as these streams are located almost entirely on US Forest Service property. The most investment in the watershed would come from the main stem section of Anthony Creek, north of Neola (SWS 2823 and 2824) due to a significant amount of stream restoration and septic systems that would need to be addressed.

The U.S. Fish and Wildlife Service has helped with some fish shocking in the search of the Candy Darter and the Native Brook trout, as well as helped with the process of preforming environmental DNA samples on the watershed in search of the same species. The USFWS has also agreed to perform the raising and stocking of native brook trout back into the headwaters of the watershed. In the future, depending on the presence of the Candy Darter and Brook trout, there could be a vast increase of agency and department interests in the watershed, as well as increased interests by those we have already established partnerships on this project. Trout Unlimited will create fish habitat structures throughout the watershed that will not only help increase the population of the fish in the watershed, but it may also act as a flood resiliency measure. To accompany the flood resiliency this a measure that could also help reduce the erosion rates in the watershed by a large amount. The WV Division of Environmental Protection will help in the process of preforming some benthic macroinvertebrate surveys, which will be performed both before management of the watershed and after. Together we performed a "bio blitz" which is where several groups of people all preform these surveys at numerous sites on the watershed, this way there is no skew based on the collection times of the samples. Throughout the watershed we had seven different sample locations, all of which turned out to be pretty good coming in at optimal or suboptimal. Something interesting that we found is that, some of the areas which came in right on the line at suboptimal are the areas that are considered pristine water and are the areas where the Brook Trout are found in the watershed. However, it should be noted that in these areas like the North Fork of Anthony, the number of taxa was very low.

Figure 19. Findings throughout the watershed showing the site, stream score and taxa. The majority were in the suboptimal – optimal range.



The Greenbrier River Watershed Association has the intention to dedicate themselves to public outreach, possibly making some signs and other ways to communicate with the public. There are also some local elected leadership (delegates, senators, county commissioners, district supervisors, etc.) that have encouraged and driven this project along and have committed to continued leadership in public awareness about the watershed as well as the capabilities and limitations of what the partnering agencies or departments. Ducks Unlimited has agreed to donate wood duck boxes to put up along the watershed, as well as offered their hand in locating the proper places to implement them and how to put them in properly. Below is a chart showing the cost of time of state, federal, or other agencies involved while working on this plan.

Table 11. The value of state, federal, and local partners' labor that will be associated with this plan.

State Agency	$30 hourly	40,000 hours	$1,200,000
Federal Agency	$30 hourly	40,000 hours	$1,200,000
Other Agency	$30 hourly	600 hours	$18,000

Financial assistance will be sought out from various grant sources that may include but not be limited to:

1. Section 319 Clean Water Act Grants
2. USDA NRCS Focused Conservation Approach
3. USDA Farm Bill Programs
4. USDA FSA Conservation Reserve Program
5. U.S. Fish and Wildlife Service Funding
6. Private Non-Governmental Organization Funds
7. County Commission Funding
8. In-Kind contributions from landowners

Outreach and education

An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint management measures that will be implemented.

In this watershed outreach and education will be crucial given the size of the watershed. Anthony Creek is a very popular recreational area for campers, hikers, and fisherman throughout the summer, therefore some signs and even some flyers or pamphlets could come in use in areas such as the Blue Bend, which is a very popular swimming hole. Some public meetings can be planned for the residents in the area to discuss their concerns with the watershed as well as the plans we have in the future for the watershed. We have already had some public interactions with some residents of the Neola are who have expressed their resource concerns with the watershed. To reach out to public even more, signs could be placed at some popular pull offs for fisherman as well as public water access which could contain explanations of some good BMPs. For example, the importance of maintaining the proper riparian buffer and the importance of leaving woody debris on and around the banks could be placed on these signs. Other information such as educational information could be placed on these signs, with telephone numbers for outreach purposes. The Greenbrier Valley Conservation District is very active with its community outreach and communications. Using these district supervisors could be a great way to communicate with the public and educate them on how to prevent some types of erosion that are primarily associated with human disturbance. Therefore, these educational emphases can be directed on many of the BMP's that are directly related to agriculture and other human influences. The Greenbrier Valley Conservation District will sponsor a field day on the watershed, which will consist of education and demonstration of proper agriculture BMP's as well as other practices that can help influence proper stream habitat and flood resiliency.

Nearing the end of the summer of 2018, a public meeting was given in the Neola area of Anthony creek to address the concerns that the public may have for the watershed. The meeting turned out to be a very popular topic in the areas and we were able to bring out over 90 individuals from the area to collaborate with us about the future of the watershed. After our presentation and listening to the concerns of the land owners the most popular interest on their part was by far how we can help via excess erosion and flood resiliency practices. Bank stabilization sites would be needed in some of these areas as some are in greater need that others. Days prior to the meeting we received phone calls from many farmers in the area who had an adequate interest in some programs, some of these land owners cover a clear majority of the streamside farmland throughout sections of the watershed, meaning large sections of streamside will be affected with implementation of BMP's in these areas and on these farms. As time goes on collaboration with individuals throughout the watershed continues to grow as we get more interest as we continue to work.

Schedule

A schedule for implementing the nonpoint management measures identified in this plan that is reasonably expeditious. (ask partners about their funding cycle before completion.)

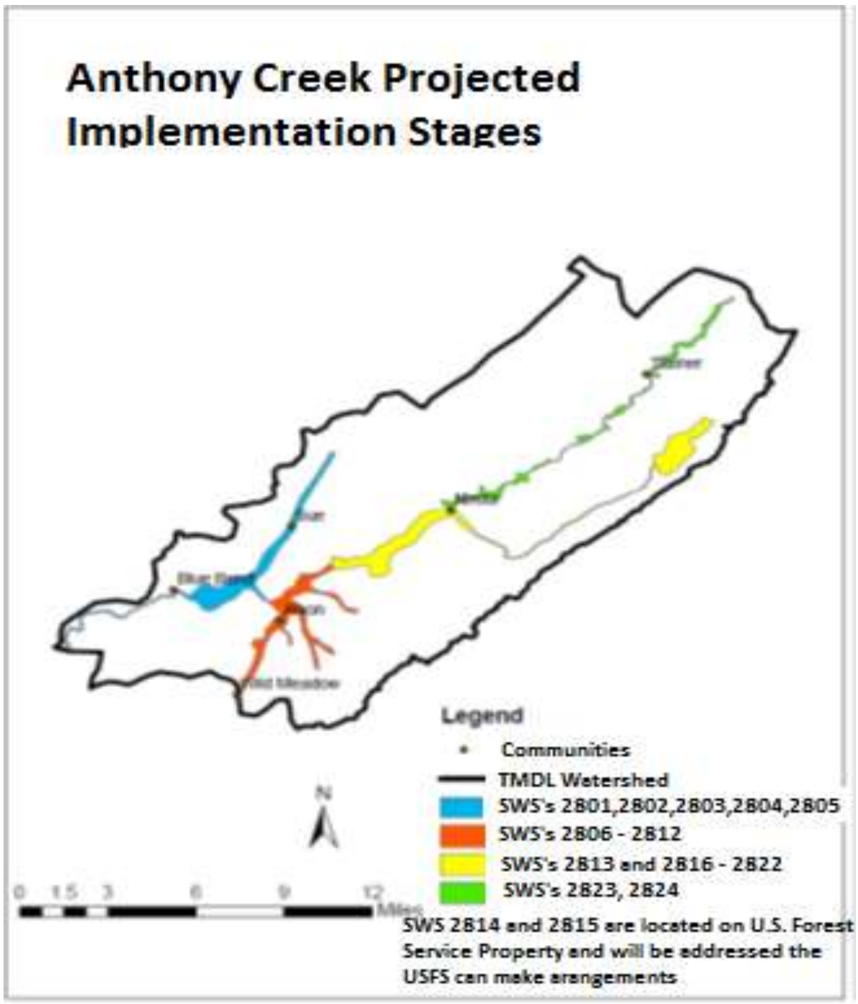
1. August 2018 – Complete final draft of the protection plan and submit for EPA approval
2. December 2018 – Watershed plan approval
3. April 2019 – Submit grant for 319 funding to address Bacteria Fecal Coliform issue
4. May 2019 – Submit grant for habitat development and flood resiliency practices
5. August 2019 – State implementing 319 funding to address Bacteria Fecal Coliform Issues
6. April 2020 – Begin implementing first pilot projects for habitat development and flood resiliency practices
7. September 2020 – Begin Focused Conservation Approach for agriculture
8. January 2021 – Evaluate water quality monitoring data and achieve 20% of required fecal coliform load reeducations.
9. April 2021 – Submit second grant to address on site fecal coliform bacteria issues.
10. August 2021 – Achieve 50% habitat development
11. October 2021- Submit semi-annual reports for 319 related projects.
12. January 2022- Evaluate water quality monitoring data and achieve 40% of require fecal Coliform load reductions
13. March 2022 – Achieved 50% habitat development goal
14. May 2022- Submit semi-annual reports for 319 related projects.
15. October 2022- Submit semi-annual reports for 319 projects
16. January 2023 – Evaluate water quality monitoring data and achieve 60% of require fecal Coliform load reductions achieve
17. August 2023 – Submit second application for Focused Conservation Approach
18. January 2024- Evaluate water quality monitoring data and achieve 80% of require fecal Coliform load reductions
19. January 2025 –Achieved 100% fecal coliform bacteria load reduction goal.
20. July 2025- Submit final reports for 319 related projects
21. October 2025 – Achieved 100% of habitat development goal.

Milestones: Description of interim, measurable milestones for determining whether nonpoint management measures or other control actions are being implemented.

This plan will be implemented over a 10-year time frame and be carried out in four stages.

1. Pocahontas/Greenbrier County line to Neola (including North Fork Anthony Creek)
2. Neola to Alvon (Including Meadow Creek)
3. Alvon to the Watershed Southern Boundary
4. Little Creek/Blue Bend to the Greenbrier River

Figure 20. Areas of the watershed that will be addressed simultaneously.



Adaptive management: Set of criteria that can be used to determine whether watershed goals are being achieved over time and substantial progress is being made towards protecting water quality standards and, if not, the criteria for determining whether this plan needs to be revised.

The goals that are being set fourth for the Anthony Creek Watershed are ones that should take time to reach. Some of the parameters for seeing some forward movement would be impossible to tell without adequate research and data collection; however, others should not be all that difficult to see. To begin, the first thing that should become noticeable throughout the watershed is the development of strong and mostly undisturbed riparian buffer. Throughout the watershed there are zones which have good flourishing riparian zones with little to know influence of outside sources, but in the more residential areas, there is little to no buffer zone at all. Therefore, simply going along the bank and gaging the vegetation or tree growth would be a good method. Next could be a noticed decrease in bank loss or erosion. Many landowners keep close tabs on their streambanks and often call in to express their concerns with their land being eroded away with high water. In the instance that our goals are being reached, the erosion rates should decline meaning that number of concerned land owners in the area should also decline with it. To indicate forward progress towards meeting the goal if decreases sedimentation, there should be noticeable decline in the amount of sediment that is being deposited along the bed of the stream. Also, streamside walking and laying eyes on stream banks that are notorious for large amounts of erosion are another good way to gauge success of bank erosion rates. Throughout the watershed there are a total of three low water culverted bridges. In the instance that we are making substantial progress towards the goals of this plan the large pile ups of sediment being discharged below these bridges should be reduced due to annual cleanings. If the sediment is not being removed annually then it should be noticeable by frequent visitations or even landowner help to keep eyes in the stream in that instance. If the bridges stay and place and get cleaned then the goals have been met, In the instance that these low water bridges get removed then we should see nearly a complete decline in sediment build up at these areas, as well as a decline in blockages above and below these areas. When these goals are being met for fish habitat structures, these structures should remain in place with minimal movement, as well as a noticeable increase in fish population in the area. All of these variables can be seen simply by paying attention to the surrounding parts of the watershed and can be gauged by frequent visitation as well as logs, to record conditions. The WVCA will more than likely be responsible for the frequent visitations to the creek and will take on the responsibility for assuring that the goals for this WBP are being met.

Monitoring

A monitoring plan to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established above.

To monitor all the parameters that have been established to the watershed, it will require annual sampling and annual visitation to many of the sites. The responsibility of monitoring on the Anthony Creek Watershed will be taken over by the WVCA. The parameters to be monitored will have to fulfill the requirements of this plan and the reporting requirements of Section 319 grants reports. The parameters that will be included could be temperature, dissolved oxygen, pH, flow, turbidity etc. There will be a monitoring station that will be located within each sub watershed, and if other stations need to be implemented then they will be strategically place according to their desired purpose. The timing of the monitoring will be up to the project managers but should be done monthly within a year during varying flow regimes to establish a baseline.

Fecal coliform water samples will be collected by the WVCA, who has their own laboratory equipment on hand, and has the capability of completing and reading these samples on their own. In other instances, these samples will be sent off for testing. The project sites that are being monitored every watershed for all other parameters will also be the location for the fecal coliform sampling. According to the TMDL the fecal coliform load that is in Anthony creek is primarily human influenced. Taking that into consideration a microbial DNA sample will be taken and sent off for professional testing to pinpoint the source of the fecal coliform bacteria load after the completion of the sewage treatment system rehabilitations throughout the watershed.

To address the erosion rates and sedimentation rates throughout the watershed. Adequate time must be given to the watershed to grow a quality riparian buffer. To accompany the time for the buffer, all large wood structures for fish habitat should be implemented, as these structures are believed to possibly reduce the roughness of the water. After completions of all projects on the watershed there should be a Bank Erosion Hazard Index, completed throughout the entire watershed, which should then be compared to the BEHI preformed prior to the management practices being implemented. Considering the scoring of the BEHI evaluation it must be taken into consideration that a BEHI rating of the same points after the management practices as before, should be a success. As this would indicate that little to no erosion has been done since the last evaluation of that bank. The only way that the BEHI rating would increase and become better is if there was complete stream and bank reconstruction at the site.

To further assure that the water quality has improved or remained the same, a second benthic macroinvertebrate survey will be performed after adequate time is given to the watershed to recuperate after completion of all management practices. It should be noted where as well as time of year (Date) the surveys were performed prior to any work on the watershed. The new survey should be done at the same time of year and in the same locations that they were before. To accompany the benthic macroinvertebrate survey, a habitat quality assessment should be done to assure that the large wood structures being implemented to the banks are in fact serving their intended purpose as fish habitat improvement.

Additionally, further monitoring throughout the entire watershed will be doing to assess the species composition of fish as well as habitat inventory and monitoring to assure the presence of the fish will be maintained in these areas. Once the data is collected and results are formed by each sub-watershed a fish assemblage based off presence or absence in each area. Then using water quality, sediment erosion estimates, and other data collected throughout this plan, estimations can be made as to why certain species of fish are found or not found in these specific areas. West Virginia University will be offering their assistance in analyzing the data of species composition against location, as well as limiting factors for presence/absence. U.S. Forest Service will also be conducting a similar project of their own on sections of the watershed, where our data can overlap and be used together to further understand the fish community in the watershed.

To assure the data being collected is of good quality and usable for determining progress, a Quality Assurance Project Plan (QAPP) will be developed for this effort. The QAPP will be submitted to the DEP Nonpoint Source Program Coordinator for review and approval. The Coordinator will then be responsible for submitting the QAPP to EPA for review, comment and approval. The QAPP will be submitted for review at least 60 days in advance of monitoring. No monitoring for this plan will begin until the QAPP receives final approval. To maintain consistency in the monitoring process and assuring the data collected for use on this plan, the same water quality monitoring sites that were used by the WVDEP to develop their TMDL will be used, along with others, for monitoring purposes for this plan.

Upon completion of this plan, the WVDEP Watershed Assessment Branch will conduct follow up monitoring to determine if any of the watershed may be removed from the list of impaired streams. Data collected during the plan timeframe by the WVCA and its partners will be utilized internally as an indicator of how the plan is progressing and to determine whether adjustments are needed with the plan.