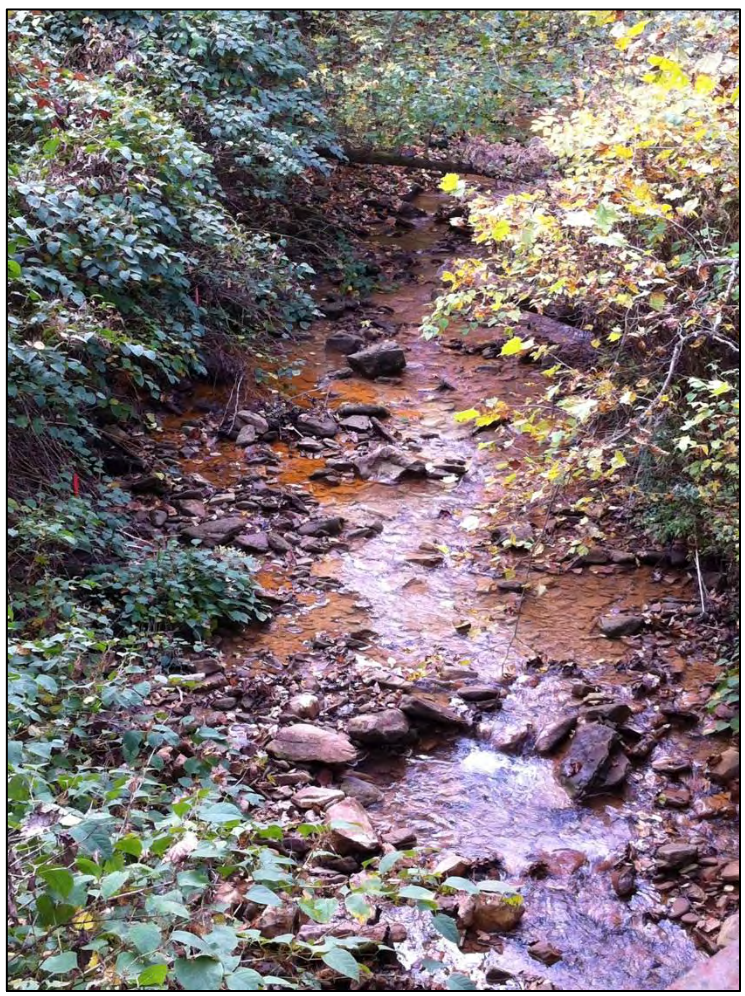
Watershed Based Plan for Morris Creek, Implementation of the Upper Kanawha TMDL 2013

December 2013



Prepared by

DEPs Nonpoint Source Program and the Morris Creek Project Team

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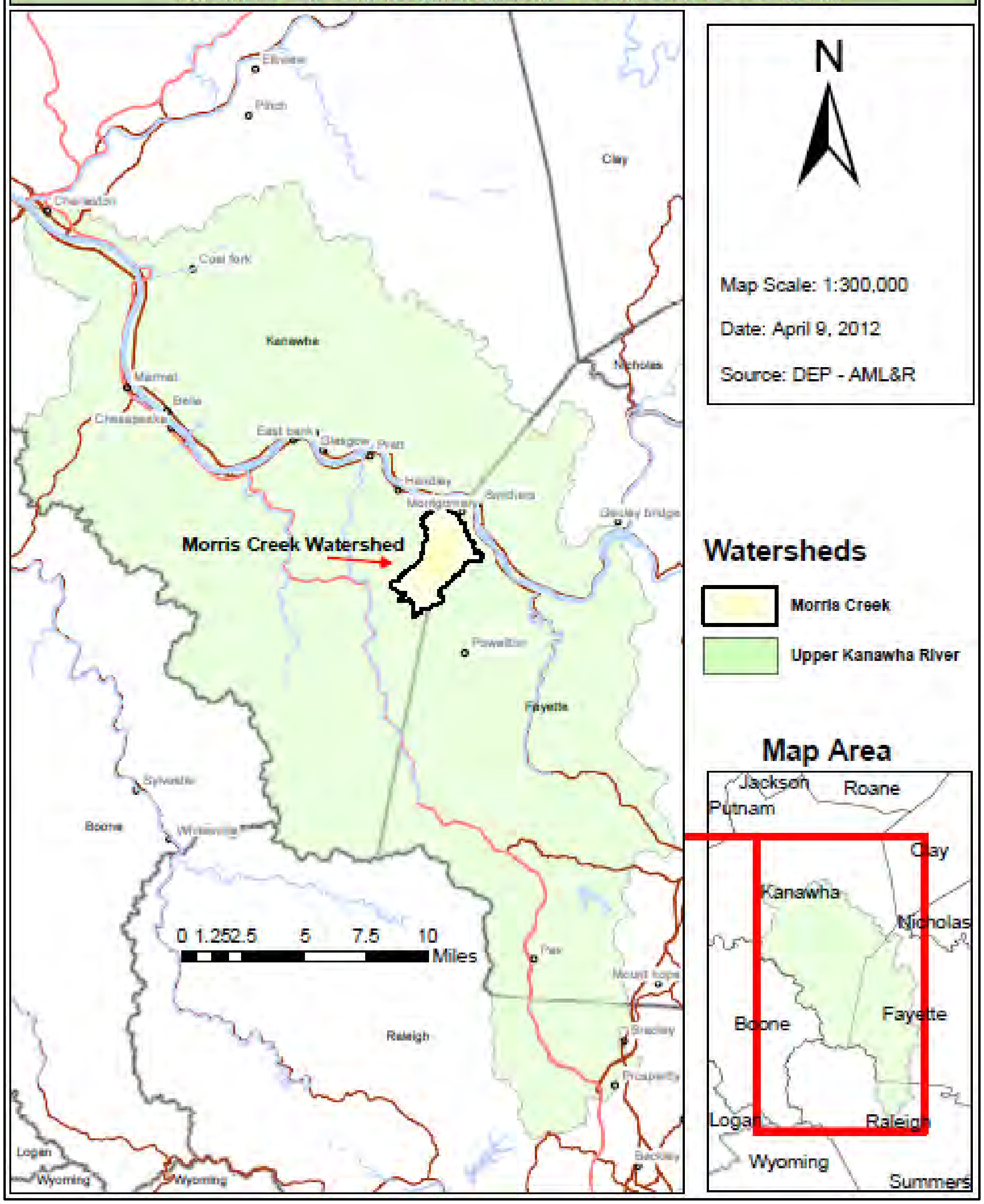
Morris Creek Watershed ID-Codes

<u>Hydrologic Unit Codes</u>	
HUC 8	05050006 (Lower Kanawha)
HUC 12	050500060306 (Hughes Creek – Kanawha River)
<u>TMDL SWS #</u>	
Morris Creek	7001, 7003, 7004
Shuyler Fork	7004
<u>Stream AN Codes</u>	
Morris Creek	WVK-70
Shuyler Fork	WVK-70-A

Introduction

The Morris Creek watershed is located approximately 25 miles southeast of Charleston, West Virginia, near the town of Montgomery. Morris Creek is a tributary of the upper Kanawha River. The watershed spans a little over 5 miles, north to south, and covers approximately seven and a half square miles. The elevation at the source of the drainage is approximately 1800 feet above mean sea level and drops to about 640 feet above sea level at the mouth

Figure 1
Morris Creek Watershed - General Location



where it joins the Kanawha River. The average drop is 228 feet per linear mile across the watershed.

Acid Mine Drainage (AMD) is negatively affecting the health and well-being of the watershed. Where erosion and sedimentation has attributed to the collapse of the benthic macro-invertebrate community, iron, aluminum, and low-pH has greatly impaired Morris Creek. Stretches of the stream were devoid of aquatic life, but improvements have been made through efforts of the Morris Creek Watershed Association (MCWA). Sections of the stream display red stained rocks and streambanks from iron deposition or streaked white rocks from aluminum precipitation. These conditions, resulting from improper reclamation practices from past mining activities, have somewhat impeded future economic growth potential along the Morris Creek watershed. Stained streambeds and eroding streambanks have contributed to a decline in property value. MCWA has been counteracting this decline by seeking community assistance to treat, vegetate, and stabilize sections of the streambed within the watershed. To date, the MCWA has removed 172 tons of solid waste, remediated four AMD sites, completed 75% of their original streambank projects, planted over 2,000 trees including 200 blight-resistant American chestnuts, introduced three species of trout to the stream, and constructed five in-stream structures designed to improve stream pattern and profile, and provide habitat for the trout. With MCWA's encouragement, the Morris Creek community is motivated to restore the creek's aquatic livelihood.

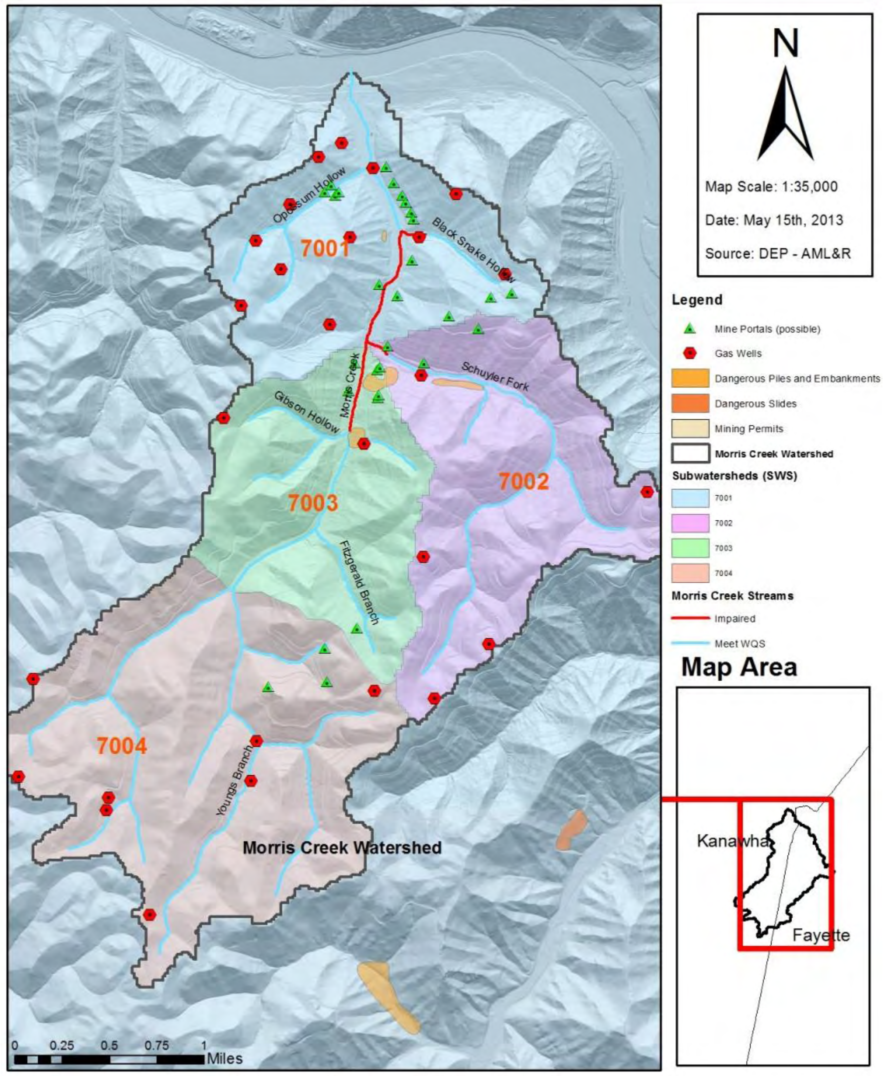
Morris Creek is part of the Upper Kanawha River Watershed, which is categorized in Group A of the WV Watershed Management Framework (WMF) system. Group A was scheduled for prioritization by 2004. In October of 2003, the WMF Committee selected Morris Creek as one of the priority watersheds to focus the resources of various state and federal agencies to restore water quality standards. Morris Creek was selected at this time, due to the nature of the contamination, the activities already being planned and implemented, the interest and involvement of MCWA, and the availability of resources and potential partners. In March of 2004, a WMF project team was formed to coordinate the development of this *Morris Creek Watershed Based Plan* and the projects that will derive from this plan.

In 2005, Morris Creek was listed on West Virginia's 303(d) list of impaired streams for biological, iron, manganese, and pH. A TMDL was developed in 2005 with the primary stressors listed as iron toxicity and acidity (pH). In 2012, Morris Creek was placed on Supplemental Table B of the West Virginia Draft 2012 Section 303(d) List. Table B implies that a TMDL was developed, but water quality improvements are not yet complete and/or documented.

Identification of Impairment

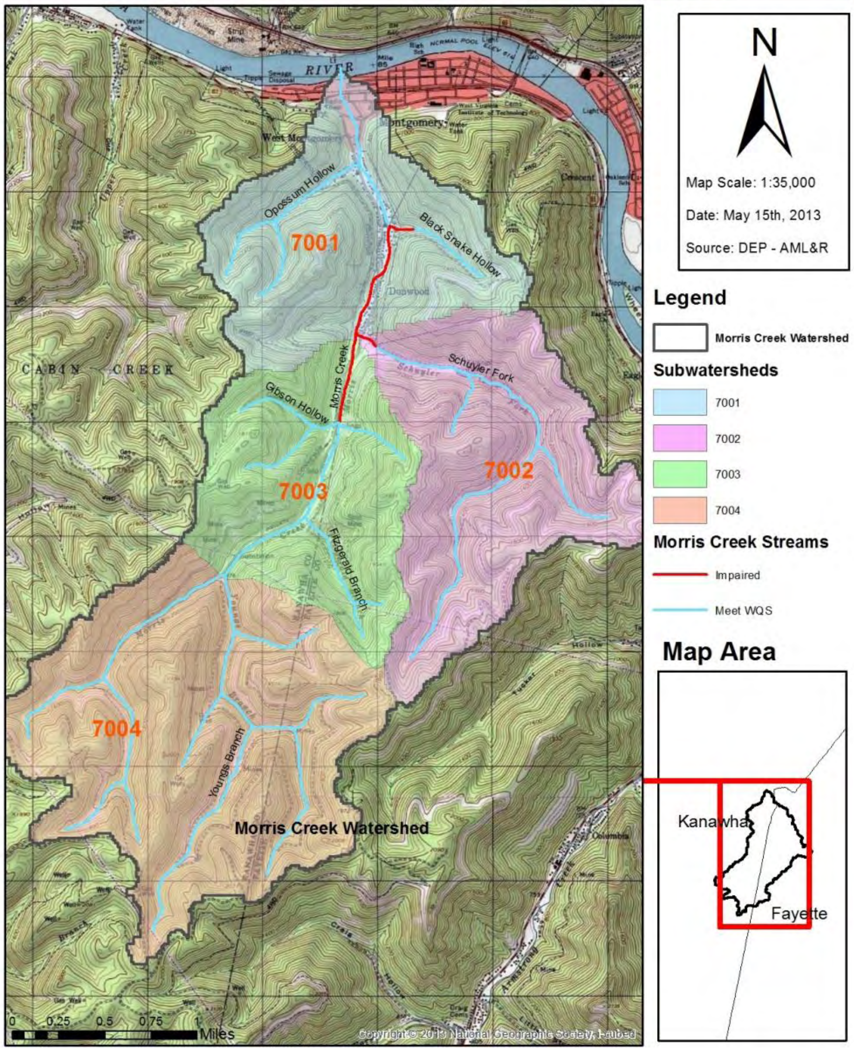
AMD Morris Creek has several water quality problems that affects its overall health; however, the primary one is acid mine drainage (AMD) produced by abandoned coal mine sources. There are two categories of AMD sources in Morris Creek. The first and most prevalent occurs from mine sites abandoned prior to the enactment of the Surface Mine Control and Reclamation Act (SMCRA). These sites originally had no reclamation and in the 2005 TMDL were responsible for an estimated 9,138lbs/yr of iron, 6301lbs/yr of aluminum and 5077lbs/yr of manganese in Morris Creek and thus eventually the Upper Kanawha. MCWA installed four projects in 2006 to help reduce the amounts of metals entering the creek. To date, metal loads have been lowered enough to allow for some benthic macroinvertebrate life, but it is not sustainable.

Figure 2
Morris Creek 2005 TMDL Assessment



The second category is the mine sites that were mined after SMCRA. These sites have undergone some reclamation. Monitoring and modeling of the watershed during the development of the TMDL show no apparent loading of AMD coming from these sites. There are currently no active mines on Morris Creek; however, there is a bonded area at Mountain View with renewed permits.

Figure 3
Portion of Morris Creek Outside Quality Standards



The major source of AMD pollution and metal contaminations in Morris Creek comes from pre-SMCRA sites. Several coal seams have been extensively prospected throughout the 19th and 20th centuries included the Eagle, #2 Gas, Powellton, Cedar Grove, #5 Block, and Coalburg. The 22 different mining operations, including punch mines, left dozens of deep mine portals and passages scattered throughout the watershed at different elevations. When the mainstem water mixes with the metal-laden seeps, biological diversity dramatically decreases.

In Morris Creek, these sources are seen in seeps coming from the vast array of underground mine tunnels. Six major seeps had been identified and designated in the 2005 TMDL as K-70-1 through 4, K-70-A1 and A2. WVDEP's Abandoned Mine Lands (AML) Program had selected four sites for reclamation with portals, refuse or seeps of AMD. The four sites were titled: Opossum Hollow, Black Snake Hollow, Lower Mainstem, and Upper Mainstem. Smaller AMD seeps can be found throughout the watershed. A small temporary tributary, Schuyler Fork, contributes AMD pollutants too from seeps found along its waterway (see Figure 3). The overall drainage is complex in this area due to extensive mining of several seams combined with the northwest plunge of the bedrock geology. The metals allocated from these seeps impacts each sub-watershed as shown in Figure 3 and Table 1.

TABLE 1

NPS Metals 2005 TMDL Allocations and % Reductions

Metal	SWS	Abandoned Mines			Forest Harvest			Roads			Barren Land			Other NPS		
		Baseline Load (lbs/yr)	Allocated Load (lbs/yr)	% Reduction	Baseline Load (lbs/yr)	Allocated Load (lbs/yr)	% Reduction	Baseline Load (lbs/yr)	Allocated Load (lbs/yr)	% Reduction	Baseline Load (lbs/yr)	Allocated Load (lbs/yr)	% Reduction	Baseline Load (lbs/yr)	Allocated Load (lbs/yr)	% Reduction
Aluminum	7001	461	388	16	1,774	1,774	0	239	239	0	81	81	0	666	666	0
Aluminum	7002	770	267	65	0	0	0	314	314	0	403	403	0	1,009	1,009	0
Aluminum	7003	7,267	1,944	73	0	0	0	529	529	0	72	72	0	842	842	0
Aluminum	7004	33	33	0	0	0	0	924	924	0	0	0	0	2,472	2,472	0
Iron	7001	357	357	0	2,589	2,589	0	344	344	0	118	118	0	566	566	0
Iron	7002	696	696	0	0	0	0	454	454	0	582	582	0	828	828	0
Iron	7003	10,115	2,107	79	0	0	0	765	765	0	104	104	0	686	686	0
Iron	7004	13	13	0	0	0	0	1,336	1,336	0	0	0	0	1,940	1,940	0
Manganese	7001	265	258	3	548	548	0	59	59	0	20	20	0	98	98	0
Manganese	7002	659	222	66	0	0	0	77	77	0	99	99	0	144	144	0
Manganese	7003	5,489	1,489	73	0	0	0	130	130	0	18	18	0	120	120	0
Manganese	7004	135	135	0	0	0	0	228	228	0	0	0	0	656	656	0

Sediment Erosion is a natural part of the dynamic landscape. Many factors play a role in impacting the severity of erosional forces including topography, soil type, rain intensity, and vegetative cover. Development in the form of roads and roofs for settlement or natural resource extraction alter the natural ebb and flow of water across the land. It is this alteration that leads to an increase in sedimentation within a watershed. Consequently, sediment supplied to the stream is usually increased. The increased volume of sediment leads to loss of aquatic habitat, increased risk of flooding and increased water temperatures.

Sampling for sediment has not been conducted to determine load rates. During sampling for the TMDL, monitoring sites were selected for AMD and were in high gradient areas. Reductions for sediment were not called for in the Morris Creek watershed TMDL; however, evidence of excess sediment can be found in the lower reaches of the watershed. Buried culverts, extensive stream bank erosion and a large sediment and debris field in the Kanawha River below Morris Creek are evidence of major sediment problems. There are three major sources of sediment in Morris Creek: multiple mass wasting sites, dirt roads, and failing streambanks.

Mass Wasting Sites

Figure 4 - Jones Hollow Slip

A mass wasting event occurs when earth materials are transported down a slope by the force of gravity; commonly referred to as landslides, the process can be very slow or very rapid. This type of incident can be triggered when surface drainage is altered. This is the case for two sites within Morris Creek documented by the MCWA and partnering agencies. The first is referred to as the Jones Hollow Slip.

The Jones Hollow Slip is actually a huge gully approximately 400 feet long, over 50 feet wide and 30 feet deep at its deepest point. This site was created during reclamation on a mine site when the drainage was changed from its original course and forced into a new direction. In 1999, the new drainage was responsible for an estimated 9,000 tons of sediment into Morris Creek and the Kanawha River. A second site located above the confluence of Schuyler Fork and Morris Creek is contributing an estimated 63 tons of sediment annually. A poorly placed culvert is responsible for compromising the toe of the opposing hillside of the outfall area. The affected area measures approximately 30’ x 60’ and is denuded of all vegetation. Erosion calculations were derived using RUSLE calculations. In addition to the documented isolated sources of sediment, more chronic diffused sources exist within the watershed; dirt roads and failing streambanks.

Figure 5 - Opossum Hollow

Dirt Roads

Abandoned roads in the watershed contribute significantly to Morris Creek's sediment problem. A randomized assessment of the roads was conducted as part of the planning process in 2004. The assessment estimated that the percentage of roads that have been naturally reclaimed is about 80%. The 20% that are still exposed and producing sediment account for 155 miles of discernible roads. The amount of sediment entering Morris Creek from all of these roads is estimated to be about 3873.8 tons/year. Although the actual mileage is much greater than the 155 miles of discernible roads indicated by West Virginia Conservation Agency (WVCA) technical staff, this figure appears to be indicative of the amount of roadways in regular and sporadic use within the watershed. The total loss of 2,563,488 pounds (1281.7 tons) of road material divided by the 9,000 feet of roads measured indicates an approximate loss of 0.142 ton (or 284lbs) per foot of road. The soil loss from the 155 miles of discernible roads over three decades of use is estimated (155 X 5,280 X 0.142) at 116,213 tons.

Table 2

Survey of Dirt Roads in Morris Creek Watershed

Station #	Date	Latitude	Longitude	Gradient	Cu Yds.	Pounds
1	7/14/04	38 08.398	81 21.258	Moderate	128	331,776
2	7/15/04	38 07.174	81 21.005	Steep/Level	74	191,808
3	7/14/04	38 07.620	81 21.457	Low/Level	60	155,520
4	07/06/04	38 08.735	81 20.487	Moderate	111	287,712
5	07/06/04	38 08.343	81 20.780	Moderate	79	204,768
6	07/09/04	38 08.601	81 20.982	Low	96	248,832
7	07/09/04	38 09.043	81 20.952	Slightly Steep	114	295,488
8	07/15/04	38 10.227	81 20.511	Moderate	81	209,952
9	07/15/04	38 07.141	81 20.514	Steep	119	308,448
10	07/06/04	38 07.189	81 20.959	Moderate	127	329,184
Total					**989**	**2,563,488**

Blacksnake Hollow Project Area is an AMD site that also faces sediment issues from a gravel road. The road leads to a cell tower located uphill of Morris Creek. Since the installation of the road, sediment has been interrupting remedial measures on Blacksnake Hollow. In 2006, limestone channels and a culvert were installed to treat and direct the AMD water. Presently, limestone rocks are embeddded and no longer interact with the AMD water and the culvert is plugged with sediment.

Failing Streambanks

In situations where excessive sediment is delivered to the channel, areas of ***aggradation*** and or ***degradation*** are created within the stream. *Aggradation* involves the raising of the streambed elevation, an increase in width/depth ratio and a corresponding decrease in channel capacity. Often, aggradation is the result of an increase in upstream sediment load and or sediment size that exceeds the transport commpetence of the channel (Rosgen and Silvey, 2006).

Degradation is the lowering of the local base of streams through the process of excess bed scour and channel incision. The lowering of the streambed abandons floodplains, lowers the water table and increases bank height, which adds to bank erosion and often leads to long term instability. The causes of degradation are complex and may be related to many sources. Urban storm drains, excess shear stress due to changes in flow, straightening of the channel alignment that alters slope, excess shear through contraction and bed scour from bridges and culverts can all contribute to channel degradation (Rosgen and Silvey, 2006). In essence, the stream is "knocked out of balance."

During the spring and summer of 2012, WVCA technical staff assessed potential sediment loading to the stream by completeing Bank Erosion Hazard Index (BEHI) surveys at multiple sites along the stream. Sites were identified by MCWA members and documented by WVCA staff. It should be noted that a number of the sites reviewed by WVCA staff were previously included in the document completed by Canaan Valley Insitute in 2005, the table summarzing the results can be found in Table 4.

Load Reductions

Aluminum, Iron, and Manganese In 2005 the Watershed Assessment Branch (WAB) of WVDEP issued the 'TMDLs for Selected Streams in the Upper Kanawha Watershed, West Virginia.' Table 3 shows the baseline and TMDL loadings of the abandoned mine land discharges that were identified and characterized by WVDEP DWWM during source tracking efforts in 2005 and what the AMD Project Loads are projected to reduce the metal loads to meet the TMDL criteria.

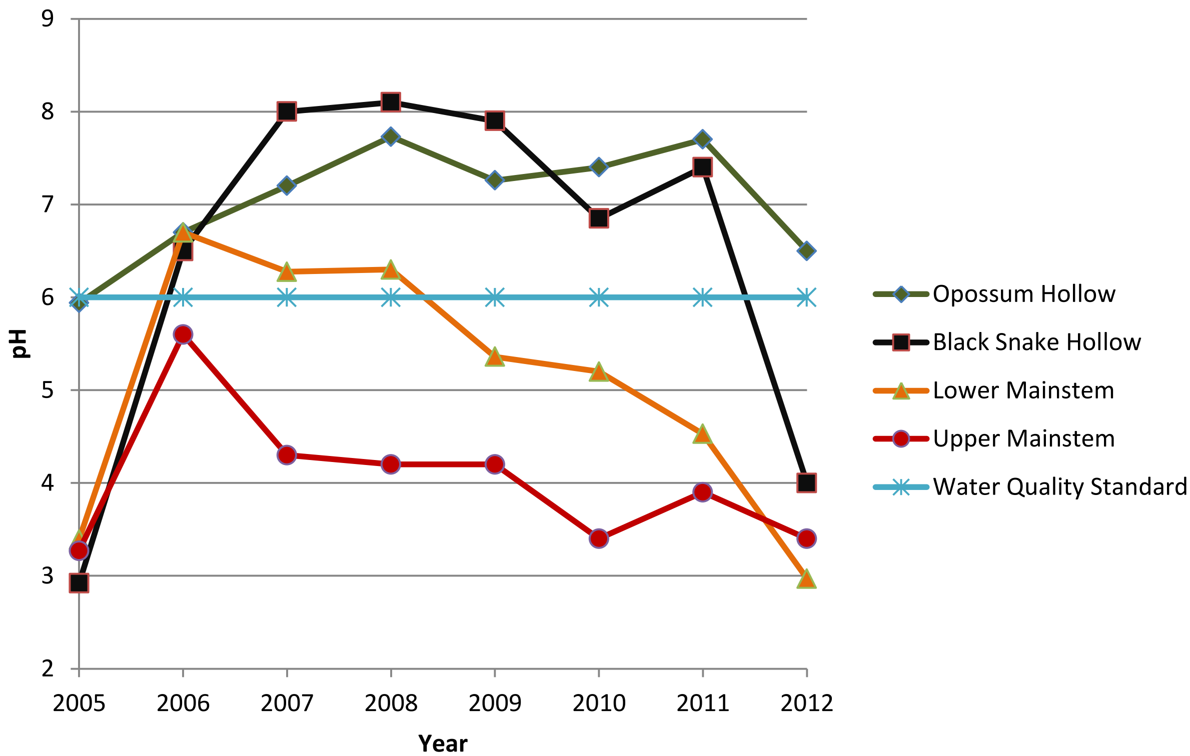
TABLE 3 - Morris Creek and Schuyler Fork TMDL Loads				
			TMDL Loads	AMD Treatment by AML Loads
Metal	SWS	Stream Name	Summed Total Reduction (lbs/yr)	Summed Total Reduction (lbs/yr)
Aluminum	7001	Morris Creek	5,900	6,680
	7002	Schuyler Fork		
	7002	Schuyler Fork		
	7003	Morris Creek		
	7003	Morris Creek		
	7004	Morris Creek		
Iron	7001	Morris Creek	8,007	43,983
	7002	Schuyler Fork		
	7002	Schuyler Fork		
	7003	Morris Creek		
	7003	Morris Creek		
	7004	Morris Creek		
Manganese	7001	Morris Creek	4,444	1,132
	7002	Schuyler Fork		
	7002	Schuyler Fork		
	7003	Morris Creek		
	7003	Morris Creek		
	7004	Morris Creek		

The TMDL (including both Morris Creek and it's tributary, Schuyler Fork) called for load reductions in aluminum, iron and manganese from abandoned mine sources; 5900 lbs/yr of aluminum, 8007 lbs/yr of iron, and 4444 lbs/yr of manganese. Regarding manganese, the mouth of Morris Creek is within five miles of a public water intake in Pratt; however, this plan will not address manganese reductions since the water intake is being taken over by West Virginia American Water and will be decommissioned (Crum, 2013).

A total of four sites (Black Snake Hollow, Opossum Hollow, Upper Mainstem, and Lower Mainstem) were selected for AMD treatment by AML. Passive treatment systems were designed for each of the four sites in 2005 to reduce the metal loads. The treatment systems were sized to accomodate the limited space available due to the narrow valley which Morris Creek flows through.

In addition to passive treatment, limestone fines have been placed in Morris Creek by the MCWA since 2008. The limestones fines have raised the pH so that iron and aluminum will fall out and allow the pH of the stream to support trout. A timeline of pH readings can be found in Figure 6.

Figure 6 - Mean pH Values for Sites Identified for Reclamation of Portal, Refuse, or Seeps of AMD within the Morris Creek Watershed



Several factors have proven to be a challenge for treating AMD in Morris Creek especially for the purpose of removing a sufficient amount of manganese to achieve the TMDL load reductions. There is no dedicated funding source for operation and maintenance of active systems, this requires the construction of passive systems; space is limited in this narrow valley and beside the technical difficulty, raising the pH high enough to cause manganese to precipate (9-9.5) could cause more serious water quality problems downstream.

Sediment

Control of sediment-producing sources may be necessary to meet water quality criteria for dissolved aluminum and total iron during critical high flow conditions. A stream sedimentation study conducted by the CVI in 2005 concluded that there were a total of 17 sites in need of stream bank stabilization. Of the 17, six were selected from the upper reach of Morris Creek for remedial planning. One of those sites was the mass wasting site of Jones Hollow Slip.

The Jones Hollow slip described in section (A) was the greatest contributor of sediment into the Morris Creek Watershed for many years. In 2007, it was determined that any effort to construct sediment control would be dangerous and potentially destabilize the slip. The slip was primarily caused by the excess drainage from the road above. A plan was implemented and completed in 2008 to stabilize the road and the installation of cross drains allowed for water to drain in its orginial pattern. The estimated load reduction from this project is 213 tons/yr based on the assessment model used in the WBP. Presently, it is still a contributor of sediment; however, remedial actions and time has removed it as the main source of sediment pollution.

Figure 7 -Streambank Erosion

Sedimentation issues are still present within Morris Creek from unstable and erroding streambanks, see Figure 7. In 2011, MCWA members identified sites and WVCA staff documented current sediment load potential. Some of these sites were determined during the CVI study of 2005. WVCA and WVDEP were able to address four (4) of these identified sites.

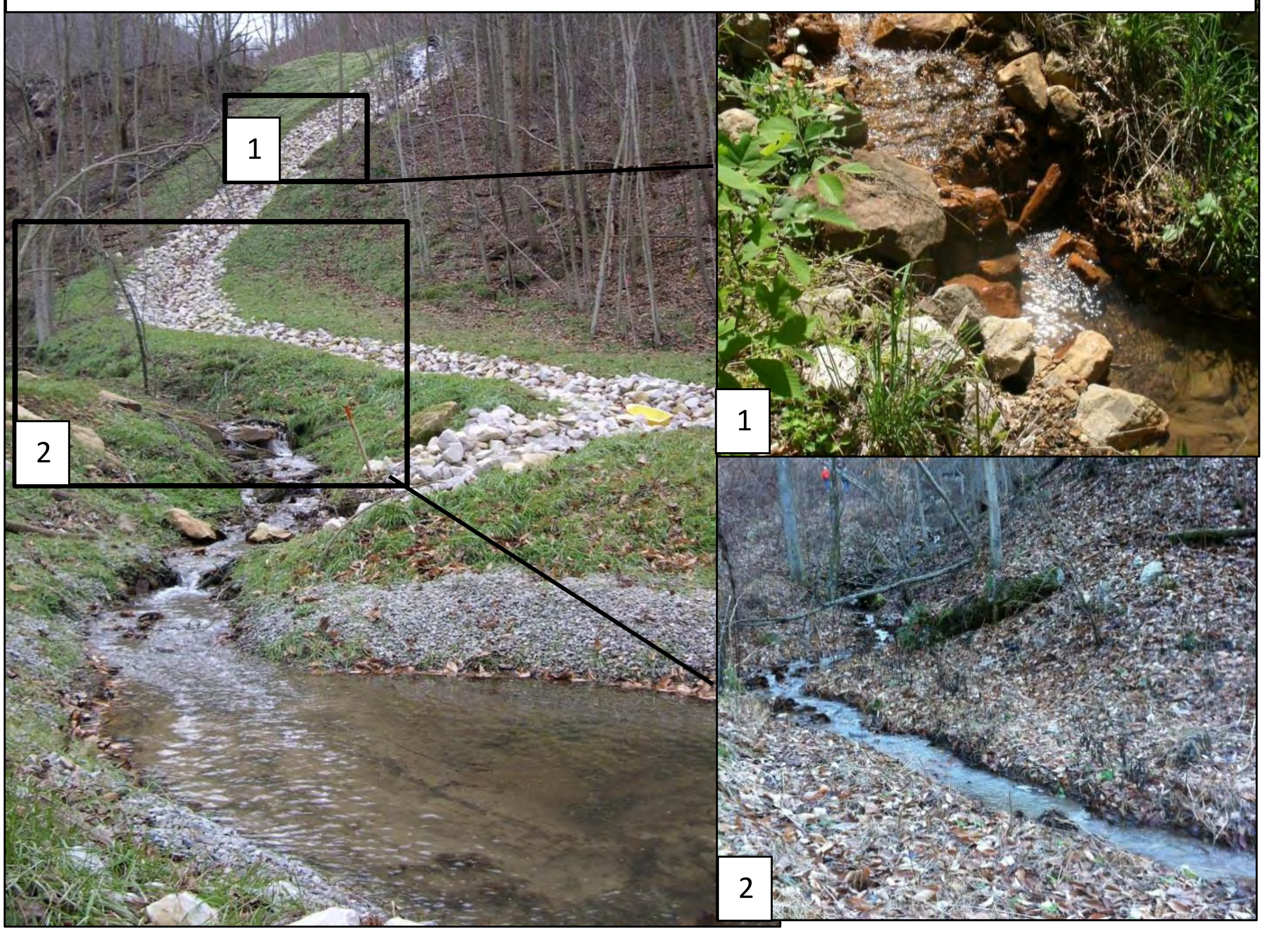
TABLE 4 - Potential Sediment Loads from Streambank Erosion for Six Sites of Morris Creek				
Site Name	**Sub-Site**	**Length of Erosion (ft)**	**Erosion Rate (ft/yr)**	**Potential Sediment Load (tons/yr)**
1. Schulyer Fork	1	25	1.5	21.7
	2	48	0.5	13.9
2. Jackson Property	1	45	1.5	36.83
	2	38	1.5	40.25
	3	75	1.5	86.67
	4	10	0.15	1.45
	5	50	0.15	5.48
3. Watershed Building	1	53	0.03	2.2
	2	57	0.6	36.52
4. Below Possum Hollow	1	75	0.06	9.06
	2	67	0.15	9.62
5. Murry Site	12	20	0.08	5.92
	14	20	0.15	10.37
	17	30	0.08	2.37
6. Below Black Snake Hollow	1	160	0.5	53
Total Length of Erosion		**772.50 ft**		
Total Potentiol Sediment Load		**335.34 tons/yr**		

In addition to eroding streambanks, abandoned dirt roads contribute to Morris Creek's sediment problem. The total loss of 2,563,488 pounds (1281.7 tons) of road material divided by the 9,000 feet of roads measured indicates an approximate sediment loss of 0.142 ton/ft of road (284lbs/ft of road). The soil loss from the 155 miles of discernible roads over three decades of use is estimated (155 X 5,280 X 0.142) at 116,213 tons. Because the TMDL does not address sediment and monitoring for sediment has not occurred in the watershed, there is no estimate of the amount of needed load reduction and no documented environmental impact from sediment; however, metals in the soil do enter the stream through erosion. MCWA has asked to be trained in sediment monitoring by the West Virginia Save our Streams (WVSOS) program to document the environmental impact of sediment. Future proposals will give specific estimates on sediment load reductions.

Proposed Management Measures

<u>AMD</u> The largest source of metal contamination in Morris Creek comes from AMD discharges; MCWA has dedicated 10 years of volunteer service to remediate the pollution in their watershed. In January of 2006, four projects designed by Triad Engineering and coordinated by AML and MCWA were installed on Morris Creek: Upper Mainstem Site, Lower Mainstem Site, Blacksnake Hollow Sub-Area, and Opossum Hollow Project Area (Figure 9). The stream waters around each output of the four treatment cells had been monitored every month by MCWA. After their initial installment (see Figure 8), the water quality in the stream had improved—wildlife was returning and the heavy metal contamination had decreased dramatically.

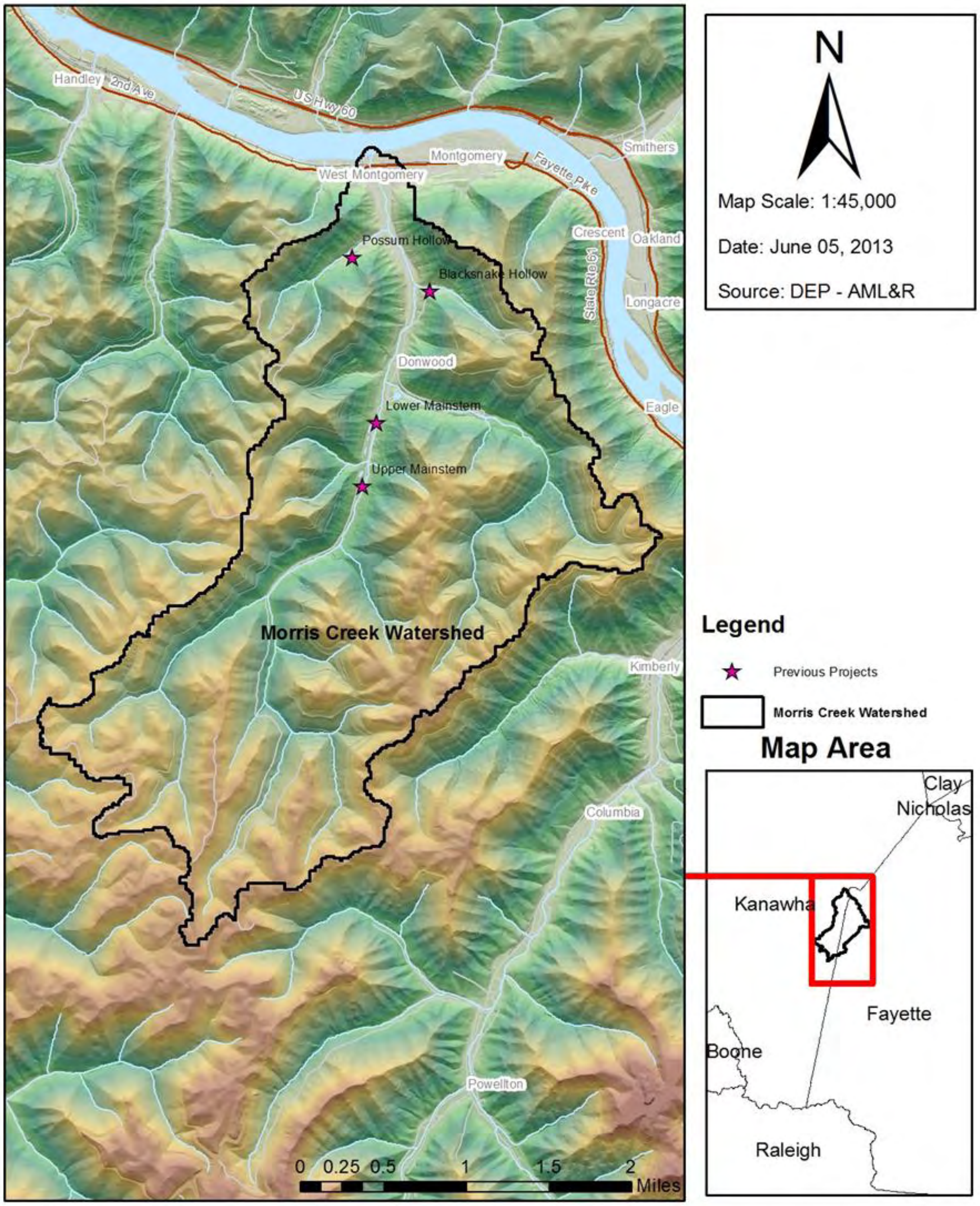
Figure 8 - Open limestone channel (OLC) installed on Black Snake Hollow in 2006 (left); present condition of the limestone channel (right) indicates degradation of the limestone and an incised and embedded channel from land disturbances.



Presently, the success of three of the four projects has degraded due to exceedances of the original estimates and capabilities of the passive treatment systems. Opossum Hollow Project

Area is the only system still effectively providing treatment. The series of successive alkalinity-producing systems (SAPS) at Blacksnake Hollow are embedded. The limestone can no longer boost the pH before it enters Morris Creek. Both the Upper Mainstem and Lower Mainstem projects have unplanned seeps discharging near the final stages of the treatment system.

FIGURE 9 - MORRIS CREEK WATERSHED – PREVIOUS PROJECTS

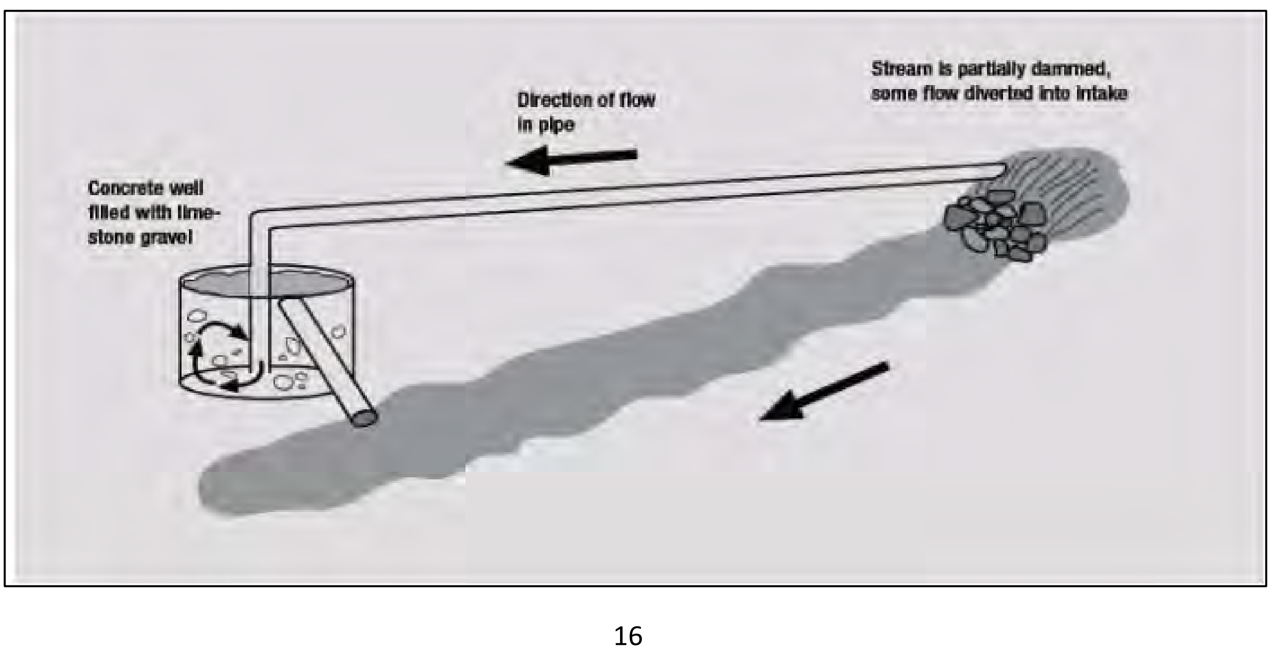


Additionally, limestone installed within the treatment cells to boost the pH levels did not meet the recommended calcium carbonate content as the plan originally prescribed. Both mainstem projects are suffering severe armoring from the overload of metals and tangent from the prescribed design. Essentially pollution is slipping through the passive treatment cells into the main stream; therefore, systems resulting in metal reduction and a neutral pH still need to be refurbished in these areas. The series of passive AMD treatment systems need to be refurbished and enhanced to treat the impaired water.

Project 1

Upper Mainstem Site discharge comes from the extensive Eureka Mine in the #2 Gas coal seam. The site consists of several seeps discharging through what appears to be refuse near the floodplain of Morris Creek. In 2006, based on flows and chemistry, a design for passive treatment utilizing a vertical flow pond and two polishing ponds was constructed. On April 15, 2007, a stopped up road culvert caused a flood to purge the passive treatment system—washing out limestone and leaving behind sediment. Much of the limestone that was washed out was replaced by local contractors with stone that was easily accessible—sandstone. A seep from the hillside also enters the treatment system midway through the polishing pond series, thus missing half the treatment. In an effort to address the overcome system, MCWA has installed a limestone diversion well (see Figure 10) at the start of the series of polishing ponds to reroute and boost the alkalinity the hillside seep.

To enable the treatment of these passive systems, they will need to be refurbished and enhanced. Existing AMD sludge will need removed, then limestone with a high calcium carbonate content (>90%), will need to be installed within the existing system. Culverts may also need upgraded.



Project 2

Figure 11 - Original Lower Mainstem Passive Treatment System

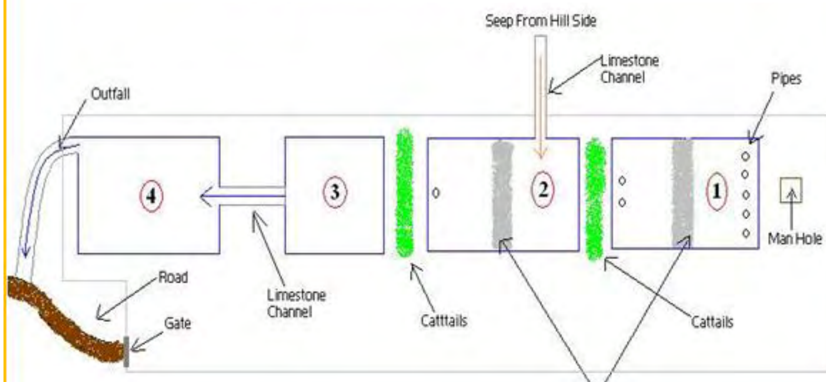


Figure 10 - Cross-sectional diagram of limestone diversion

Lower Mainstem Site discharge is located close to the Upper Mainstem site. It comes from the Eureka #2 Mine in the #2 Gas coal seam. The discharge emanates from a pipe that may be draining to a portal of the Eureka Mine. In 2006, based on chemistry and flow, a passive treatment system with an anaerobic wetland and a series of polishing ponds were constructed. A seep from the hillside bypassed the first polishing pond in the series. Presently, the piping to allow the first cell to be anaerobic is no longer functioning; thus, retention time in this system is lacking.

In an effort to enable the system, MCWA has rerouted the hillside seep to the start of the system. The water is piped into a limestone diversion well and through a hydro-generator to collect the energy of and boost the alkalinity of the hillside seep (See Figure 10 and Figure 12).

Figure 12 - Present state of Lower Mainstem treatment system; hillside seep has been rerouted to head of the treatment. It is piped through a hydro-generator and limestone diversion well before entering the system.

This whole Lower Mainstem system also needs refurbished and enhanced. The piping of the seep to the start of the system needs to be permanently installed. Within the series of polishing ponds, baffles need installed in ponds one and two, limestone check dams need refurbished throughout the series, and floating wetlands need installed in the fourth final polishing pond to aid in metal uptake and retention of the water. The construction of a fifth polishing pond to the treatment system would also aid in retention time and allow for metals to fall out in the system rather than to discharge into the creek.

Project 3

Blacksnake Hollow Site is located downstream of the mainstem sites and consists of a total of 9 portals with one discharging AMD. Several seeps drain into one path to make up the total discharge. Flow is small (10.5gpm), but acidity values are high (246 mg/l). In 2006, based on the chemistry and flow, the design (limited by a nearby gas line) called for a passive treatment system using gravity fed vertical flow OLC. The OLC was installed in 2006, but sediment from a neighboring cell tower road slip and construction has caused sediment to fill in and embed the OLC. The construction of the cell tower road also released an additional seep to flow down blacksnake hollow. Currently, MCWA is treating the flow with limestone fines. Remediation at this site may require a new location and a new OLC made of high calcium carbonate content (>90%) Additional remediation measure will be needed on the road and hillside to reduce any future land disturbances to the treatment site.

Project 4.

Schuyler Fork is a tributary to Morris Creek, but flow is intermediate, with water not flowing at above surface levels during dry spells. It flows into Morris Creek below the two mainstem projects. Schuyler Fork is a major source of aluminum to the Morris Creek watershed. Currently this tributary is being treated with high calcium carbonate content (>90%) limestone sand. The limestone fines help the viability of Morris Creek by neutralizing the water before it mixes with the mainstem. A project utilizing SAPS may be proposed in the future.

All mentioned passive treatment systems will be designed to be sustainable and achieve the maximum amount of reductions possible at each seep location. Pre-construction and historic data will be used when remodeling the systems to achieve complete neutralization of the acid and metal loading entering Morris Creek. Until then, limestone fines were purchased via an AEP grant and have been placed within the Morris Creek watershed at three different locations by MCWA, John Rebinski of WVDNR and Ernie Nester of TU. These locations include Schuyler Fork, Lower and Upper Mainstem. This has been a short term solution to the inadequate and overburdened AMD systems originally installed.

Sediment Based on scientific knowledge of sediment/metal interactions and knowledge of West Virginia's soils, it is reasonable to conclude that sediments contain high levels of aluminum and iron, and to a lesser extent, manganese (TMDL, 2005). Control of sediment-producing sources may be necessary to meet water quality criteria for dissolved aluminum, total iron, and total manganese during critical high flow conditions. Sediment issues in Morris Creek are a result of eroding stream banks, dirt roads, and poorly placed culverts.

Project 1

A main source of past sediment loading was the Jones Hollow slip. By 2006, the slip was cut down to bedrock and remediated to correct normal rain events; however, during heavy rain events erosion is seen on the sides of the gulley. A plan was implemented and completed in 2008 to stabilize the road and the installation of cross drains allowed for water to drain in its orginial pattern. Stabilizing the slip itself has been and will be difficult due to the steep and the unstable nature of the slip. Once it is fully stabilized, the area will need to be vegetated with native plant species and have larger culverts in place to properly drain the area.

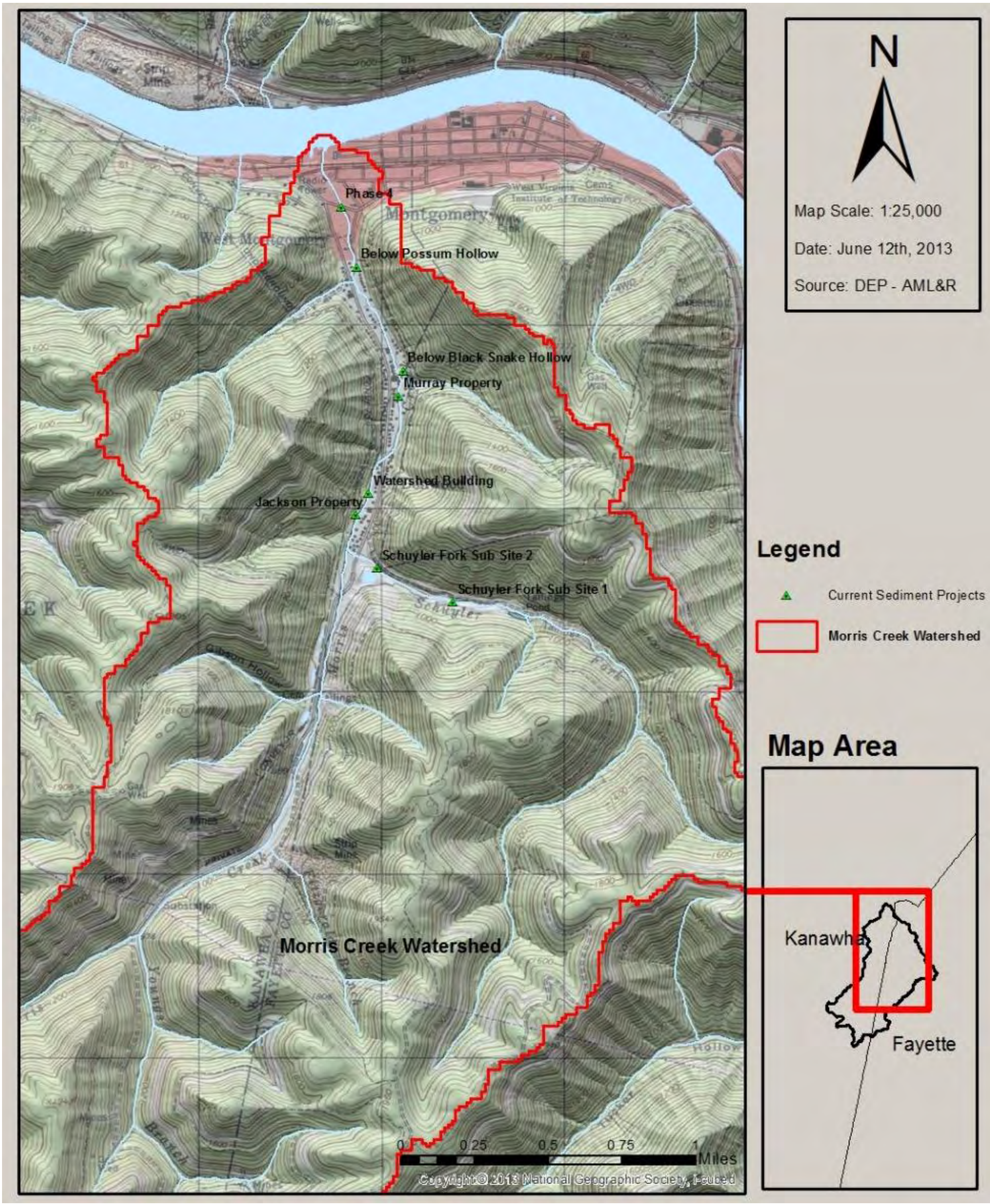
Project 2

Stream bank restoration projects will utilize natural stream channel design principles whenever possible. These projects rely on techniques that direct the force of the stream away from the banks, but enable the stream to adequately carry its normal sediment load. In some cases natural stream channel designs may not be possible, especially around bridges and culverts. The urbanized nature of the lower reaches of the watershed have,

Figure 13 - Photo (above/right) show area before restoration project, (below) from left to right show during and after the riprap armor project.

thus excluded any true natural stream channel design project. Since 2005, a few

FIGURE 14 - PROPOSED STREAMBANK PROJECTS ALONG MORRIS CREEK



sediment reduction projects (see Table 4 and Figure 14) such as riprap armor, re-vegetation of the streambank, and gabion walls have been installed along sections of Morris Creek, but long stretches of the stream still show significant erosion (see Figure 13). Currently, there is an estimated 1.25 miles of streambank within Morris Creek that is unstable and eroding; the highest priority will be the 772.50 ft of severely eroding banks.

Project 3

Road Restoration is needed on the dirt roads, which are the final contributor to the sediment loads found in Morris Creek. There is an estimated 155 miles of discernible dirt roads that contribute sediment to Morris Creek watershed. The cost to manage these roadways is dependent on the topography, condition of the road, and which management plan to implement. It is anticipated that the cost may be as much as $40,000 per mile for restoring roads retired from the system. Conducting a thorough assessment of the road system will be the first step. After this, roads can be categorized into either "roads in use" or "retired with BMPs." Techniques that can be employed on any eligible road include: surface hardening or protection, drainage swales, water bars, ditches and sediment catch basins. The techniques used on these roads must be sufficient to require little or no maintenance for at least ten years. In the Blacksnake Hollow project area, the culvert was properly installed, but became plugged with sediment over the years due to unstable gravel roads (cell tower road, Figure 15). A culvert needs attention; it is currently plugged with sediment.

Figure 15 - Two sediment contributors to Morris Creek are dirt roads (left) and eroding streambanks (right).

Technical and Financial Assistance Needed

In order for successful implementation of the Watershed Based Plan, several partners including federal and state agencies, the MCWA, consultants, nonprofit assistance providers, academic institutions (WVU and WV Tech), and the citizens of Montgomery will collaborate in order to provide the technical and financial resources (see Table 5).

Table 5 Morris Creek Project Team

Name	Acronym	Contribution
American Electric Power	AEP	Donates limestone fines.
Bridgemont Community & Technical College	BCTC	Provide meeting spaces; assist with educational outreach, and volunteers.
Chesapeake Energy	CE	Donated money for TU and VISTA positions.
City of Montgomery	CM	Received four properties into possession and gave city right of entry.
Marshall University	MU	Conducted mussel surveys, stream assessment, benthic and fish counts at the mouth of Morris Creek.
Morris Creek Watershed Association	MCWA	Contributed 45 volunteers, 18 board members, full-time VISTA; mows AMD sites; conducts educational tours; doses limestone; monitors stream; provides tools and equipment.
Pardee Resources	PR	Allow land easement; provide access to their property (over 5,000 acres surrounding the watershed).
Trout Unlimited	TU	Provides professional resources for trout stocking, water monitoring, limestone, provide/borrow tanks for trout in the classroom, and donates $750-1000 annually for liming.
WV Conservation Agency	WVCA	In-stream design and construction, hired an outside engineer.
WV Department of Energy	WVDE	Processed grant for Hydro Generator ($7,000)
WV Department of Environmental Protection	WVDEP	Provides technical assistance and surveys; strengthens partnerships.
Abandoned Mine Lands	AML	Operates and maintenances AMD sites (4) and since 2009 donates limestone sands; conducts monitoring on creek
Nonpoint Source Program	NPS	Funding via Stream Partner's grant, Project Assistance, Save our Streams, and Project WET training.
Office of Oil & Gas	OOG	Road Maintenance
Rehabilitation Environmental Action Plan	REAP	Provides materials and transportation for annual stream clean-up.
WV Division of Forestry	WVDOF	Donated 2,000 trees for streambank stabilization.

WV Division of Natural Resources	WVDNR	Donates limestone; stream assessment, survey, and permits.
WVU Institute of Technology	WVUIT	Assists with water monitoring, bird counts, and general counsel on biology issues.
US Army Corps of Engineers	USACE	Assists with permits.
US Department of Agriculture	USDA	Provided funding to pay for community garden and equipment; grant assistance for in-stream structures and wildlife habitat improvement projects.
US Office of Surface Mining	OSM	Assisted with funding source, permitting, and VISTA program.

AMD Collaboration among several groups including the WVDEP (AML & NPS), WVCA, MCWA, Office of Surface Mining (OSM), Trout Unlimited (TU) and Plateau Action Network (PAN) will be providing aid with technical assistance, construction review, and funding of the AMD passive treatment projects. The WBP will be shared with each partner since it includes background information that explains why the projects are needed and what resources are needed to implement the plan.

Initial funding that covers planning, construction, and implementation of the remedial projects can be provided by several of the AMD partners listed above, including CWA 319 Funding, WVDEP Nonpoint Source Program, OSM Watershed Cooperative Agreement Program (WCAP) funding, AML, and the MCWA (via a Department of Energy grant). The funding will also be used for sampling, monitoring, and administration of the AMD projects.

In order to meet the TMDL, additional AMD projects may be needed to keep the passive systems sustainable, but this need will be assessed after Lower Mainstem, Upper Mainstem, and Blacksnake Hollow projects are completed and monitored. One area of concern is Schuyler Fork (Figure 3); no passive treatment system has been installed, but twice a year 25 tons of limestone fines are dumped into Schuyler Fork. If the TMDL is not met, an additional passive treatment system on Schuyler Fork could be needed.

Sediment Based on scientific knowledge of sediment/metal interactions and knowledge of West Virginia's soils, it is reasonable to conclude that sediments contain high levels of aluminum and iron, and to a lesser extent, manganese (TMDL, 2005). Control of sediment-producing sources may be necessary to meet water quality criteria for dissolved aluminum, total iron, and total manganese during critical high flow conditions.

The WVCA provides the technical assistance on erosion and stream bank restoration. WVCA will also provide coordination with the CCD on the disbursement of funds for erosion projects. Mark Buchanan, of WVCA, is the regional Conservation Specialist.

Pardee Minerals, LLC is the main landowner of the Morris Creek watershed. They have been actively involved in the project team. Pardee has assessed their property and will be involved in planning future use of the dirt road system and any other aspects affecting their property. Jeff Allen is the Pardee representative.

Budget Breakdown

The following project budget breakdown assumes a 60% CWA 319 funding and 40% matching funds from other sources classified as non-federal funds.

TABLE 6 - MORRIS CREEK BUDGET BREAKDOWN

Project Type	Project Number/Name	CWA- 319 Funds	Match	Total
AMD Projects	1. Upper Mainstem (20 year)	$22,440	$14,960	$37,400
	2. Lower Mainstem (20 year)	$96,960	$64,640	$161,600
	3. Black Snake Hollow	$12,204	$8,136	$20,340
Sediment Projects	1. Jones Hollow Slip	$6,000	$4,000	$10,000
	2. Bank Stabilization (6 sites)	$125,145	$83,430	$208,575
	3. Road Restoration (60 miles)	$2,347,488	$1,564,992	$3,912,480
	TOTALS	**$2,610 ,237**	**$1,740,158**	**$4,350,395**

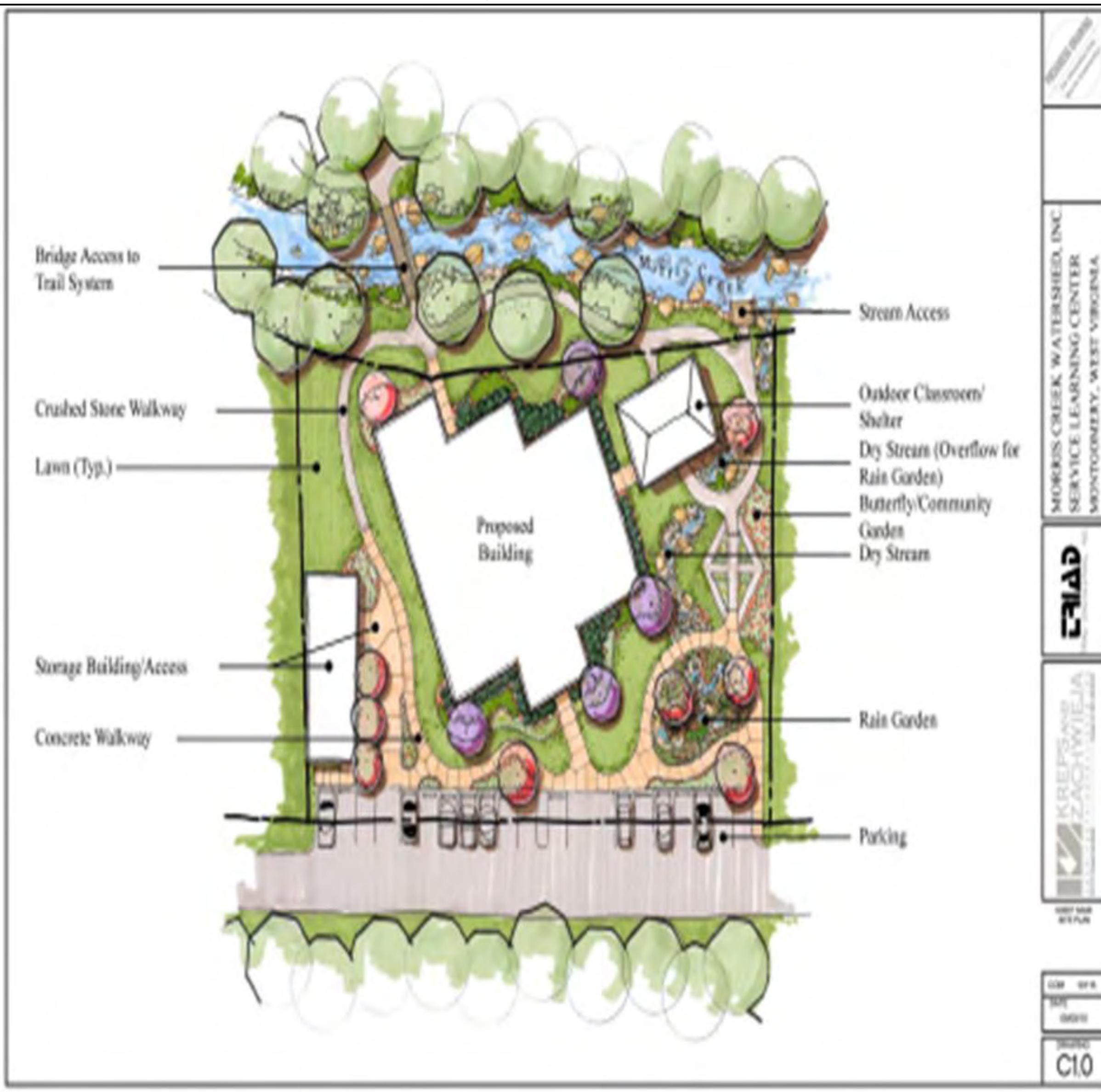
Information, Education and Public Participation

Morris Creek Watershed Association (MCWA) is a non-profit 501.c.3 organization founded in 2001 and incorporated in 2003. MCWA has three missions:

1. To improve the safety of the Morris Creek watershed, restore its natural beauty, and return the watershed to a safe environment for all residents.
2. To restore the water quality to a condition capable of supporting aquatic life and local recreational activities.
3. To address other key concerns such as flood prevention, streambank stabilization, acid mine drainage remediation, maintenance and water quality testing.

Since their inception, MCWA has worked diligently to meet their goals and provide educational opportunities to both residents and visitors to the watershed; MCWA is always looking for new ways to enhance and expand educational experiences. Through support from the U.S.

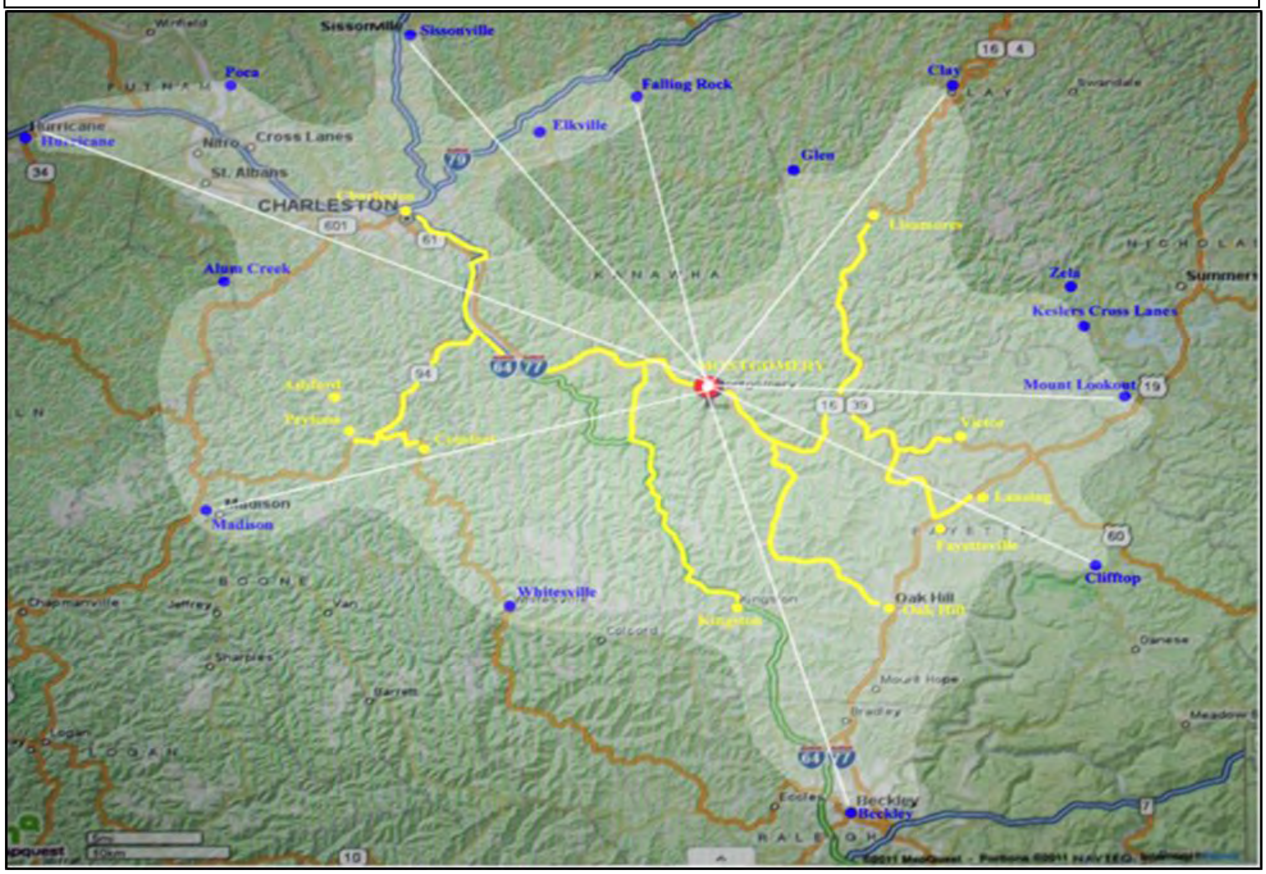
FIGURE 16 - MORRIS CREEK WATERSHED, SERVICE LEARNING CENTER



Environmental Protection Agency (EPA), Office of Brownfields and Land Revitalization (OBLR), EPA Region 3 selected MCWA to receive technical assistance related to the development of an Environmental Education Center. This unique environmental education and research facility will showcase watershed management and illustrate creative alternatives for post-mining land uses. A variety of conceptual designs and architectural plan proposals have been developed to create a vision of the facility that can serve as a gateway and catalyst for education, recreation, and economic assets for the community and region (Figure 16). Educational tours at this center would include workshops and displays to showcase BMPs for a wide range of land uses activities such as logging, oil and gas extraction, and off road vehicle use. Although this is something MCWA strives for, they have not been discouraged from exhibiting Morris Creek as a learning tool for various students, professors, and interested parties. Since their formation, MCWA has sponsored a range of programs in environmental education and remediation activities that attracted nearly 2,600 participants and visitors from the region, country, and overseas.

As shown in Figure 17, the city of Montgomery is an ideal location for educational outreach, within a 45-minute drive of sections of Boone, Raleigh, Fayette, Nicholas, Clay, and Kanawha

Figure17 - Intermediary community one-hour drive time shown by light shaded area.



counties. Located at the mouth of Morris Creek and just over the ridge from Paint Creek, the proposed location of the center will be in close proximity to two successful watershed restoration efforts driven by MCWA and Paint Creek Watershed Association. West Virginia University Institute of Technology, located in the city of Montgomery, could incorporate various Morris creek projects into the curriculum for environmental engineering and provide a hands-on learning laboratory. The following events have occurred, and will continue to take place on Morris Creek; they are excellent examples of MCWA passion for environmental education:

- May 30th of 2013 MCWA hosted a water festival for 70 8th graders from Valley Middle School. The children learned how AMD is formed, how it is treated, and how it affects freshwater mussels, benthic macroinvertebrates, trout, the watershed, and communities (See Figure 18). The 2014 water festival is expected to include 250+ children.

Figure 18 - Morris Creek Watershed Association hosted a water festival for Valley Middle School.

- Students from Concord University and Marshall University are planning to conduct freshwater mussel surveys at the mouth of Morris Creek in 2013 -2014.
- MCWA applied for and received a grant from AEP to purchase and install and Hydro-Generator on their Lower Mainstem passive treatment system. Chris Mitchell, an electrical engineer of WV Tech's graduate program has been using the Hydro-Generator for his research study.
- MCWA applied for and received an AGO grant from WVDEP to pipe the hillside seeps to the beginning of the passive treatment systems. These seeps are directed into a limestone diversion well. Deborah Beutler, a member of the MCWA and a professor at WVU Tech, has students from her ecology class monitoring any changes that the limestone diversion wells are having on the creek. Students are also performing maintenance on the Hydro-Generator and the limestone diversion well. The data they collect will be compiled for their senior projects. Deborah and her students have been collecting data since 2009 on Morris Creek.

- The “Embrace a Stream” grant offered by TU was awarded to MCWA to have in-stream structures installed on Morris Creek. Three civil engineering students

Figure 19 - 2013 Energy Tour group at the London Hydro site.

from WV Tech and Bridgemont Community and Technical College plan to write their senior projects on sediment transfer on Morris Creek.
- An Energy Tour, running from March 17 to 21, 2013, was sponsored by the Sustainability Institute at Bridgemont and MCWA. The tour consisted of visiting energy production facilities in Fayette, Nicholas, Kanawha, and Tyler counties, and was designed to educate participants on a variety of energy sources including coal, natural gas, hydropower, and wind. Students from Dartmouth University visited West Virginia as part of an Alternative Spring Break program to participate in the tour (see Figure 19).
- Dartmouth University, a private Ivy League research university located in Hanover, New Hampshire has been bringing their “Big Green Bus” to Morris Creek annually since 2009. Students from varying studies stay at the MCWA’s

Figure 20 - Dartmouth University students helping plant a riparian area.

building for a week to become educated on the watershed and to volunteer their time working on physical activities such as distributing limestone fines, planting trees, or stream clean ups (see Figure 20). In the spring of 2013 they participated in an Energy Tour which was co-hosted by MCWA.

- MCWA hosts an annual Trout in a Classroom release and picnic from Poca, Pinch, Pratt, Chesapeake, and Capitol High Schools. Trout is a Classroom is sponsored by TU and AML; materials are distributed to the schools by MCWA (see Figure 21).

Figure 21 - During the 2013 trout release (right), WVSOS's coordinator, Glenn Nelson showed the students benthic macroinvertebrates found in Morris Creek (left).

In addition to MCWA efforts, WV SOS has been conducting an annual workshop on Morris Creek since 2007. This program trains volunteers on how to monitor their local wadeable stream. WVDEP's NPS has also developed a short video on dirt roads, their impacts and BMPs used to alleviate those impacts. This will be included in an effort to promote good dirt road construction and maintenance from land users such as loggers and natural gas producers. Workshops conducted by DOF, OOG, and WVCA will focus on reducing sedimentation from dirt roads and will be presented in the area in coordination with MCWA.

Schedule

AMD

Four main AMD treatment systems are scheduled to address the greatest impacts and flow into Morris Creek in a progressive order: Upper mainstem, Lower mainstem, Blacksnake Hollow, and Schuyler Fork. AMD pollution will be consecutively lowered as each project is completed.

Table 7 Timeline and Schedule for 4 AMD Treatment Systems

2014				2015				2016				2017			
Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Apply for Funds				Pre-Construction Monitoring				Construction/Remediation of Existing System				Pre-Construction Monitoring			
Project Proposal				Sampling of AMD seep and discharge into Morris Creek from the passive treatment system (PTS)				Remediation construction begins as designed and permitted, project is implemented and fuctional				Sampling of AMD seep and discharge into Morris Creek from the PTS			
			Permitting		Surveying/Engineering					Post-Construction Monitoring				Surveying/Engineering	
			Apply for Army Corps of Engineers and DNR permits		Redesign and engineering for the project; bidding for construction					Sampling of AMD outfall and discharge into Morris Creek from the refurbished passive treatment system				Redesign and engineering for the project	
								Apply for Funds				Permitting			
								Project Proposal				Apply for Army Corps of Engineers and DNR permits			

2018				2019				2020				2021			
Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Construction/Remediation of the Existing System			Post-Construction Monitoring				Construction		Post-Construction Monitoring				Construction		Post-Construction Monitoring
Remediation construction begins as designed and permitted; project is implemented and functional			Samplng of AMD outfall and discharge into Morris Creek from the refurbished PTS				Remediation of project, new OLC installed.		Samplng of AMD outfall and discharge into Morris Creek from the refurbished PTS				Remediation construction begins as designed and permitted, project is implemented and fuctional		Sampling at mouth of the tributary into Morris Creek for 4 seasons
Apply for Funds				Pre-Construction Monitoring				Apply for Funds				Surveying/Engineering			
Project Proposal				Sampling of AMD seep and discharge into Morris Creek from the PTS; confirm road tower road's stability				Project Proposal				Redesign and engineering for the project; bidding for construction			
			Permitting		Surveying/Engineering			Pre-Construction Monitoring							
			Apply for Army Corps of Engineers and DNR permits		Redesign and engineering for the project; bidding for construction			Sampling at mouth of tributary into Morris Creek							
										Permitting					
										Apply for Army Corps of Engineers and DNR permits					

LEGEND	
(pink)	Upper Mainstem
(orange)	Lower Mainstem
(olive)	Blacksnake Hollow
(light green)	Schuyler Fork

Sediment

Three sediment issues are scheduled for Morris Creek: Jones Hollow Slip, bank stabilization, and road restoration. Each issue will be individually addressed due to its nature, property ownership, and weather conditions.

Table 8 Timeline and Schedule for Three Sediment Issues

<table>
<tr><th colspan="4">2014</th><th colspan="4">2015</th><th colspan="4">2016</th><th colspan="4">2017</th><th colspan="4">2018</th></tr>
<tr><th>Spring</th><th>Summer</th><th>Fall</th><th>Winter</th><th>Spring</th><th>Summer</th><th>Fall</th><th>Winter</th><th>Spring</th><th>Summer</th><th>Fall</th><th>Winter</th><th>Spring</th><th>Summer</th><th>Fall</th><th>Winter</th><th>Spring</th><th>Summer</th><th>Fall</th><th>Winter</th></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">Apply for Funds
Project Proposal</td><td></td><td></td><td colspan="3">Surveying and Engineering
Survey the area during a heavy rainfall to determine how to properly channel runoff; ensure stability of slip</td><td></td><td></td><td></td><td colspan="4">Post-Construction Monitoring
Monitor slip, especially during heavy rain events to ensure stability and proper channeling</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Pre-Construction Monitoring
Monitor slip to see when runoff is the highest</td><td></td><td></td><td colspan="4">Construction
Begin remediation of project</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="4">Apply for Funds
Project Proposal</td><td colspan="5">Surveying and Engineering
WVCA will perform the required surveys and consult engineers to develop a plan to stabilize the banks</td><td></td><td></td><td></td><td colspan="4">Post-Construction Monitoring
MCWA will conduct sediment monitoring following the implementation of the project</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">Pre-Construction Monitoring
MCWA will conduct sediment monitoring prior to any sreambank construction</td><td></td><td></td><td colspan="4">Implementation of Projects
Initation of bank stabilization projects (see Table 4)</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Apply for Funds
Project Proposal</td><td colspan="4">Pre-Construction Monitoring
Monitor to determine which roads are contribution the great load to the</td><td colspan="4">Implementation of Techniques
Initiate road restoration techniques and plans</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="4">Conduct Assessment of Road System
Determine which roads are still in use</td><td></td><td colspan="3">Landowner Agreement
Contact landowners and sign appropriate documents</td><td></td><td></td><td colspan="4">Post-Constrction Monitoring
MCWA will monitor the conditions of the roads and contributed sediment loads after rain events; will host a workshop on proper BMPs</td><td></td><td></td><td></td><td></td></tr>
</table>

LEGEND	
(green)	Jones Hollow Slip
(yellow)	Bank Stabilization
(purple)	Road Restoration

Milestones

The project team will coordinate and monitor the success of implementation. The WVDEP Basin Coordinator and the NPS Coordinator will also monitor the implementation schedule. The milestone schedule in Section (F) will serve as measureable milestones.

1. Aluminum load by 73% or 5323lbs/year;
2. Iron by 79% or 8008lbs/year;
3. Manganese by 73% or 4,444lbs/year.

If any milestone appears to be falling behind schedule the project team and coordinators will assess the reason and recommend actions to correct any problems.

Goals and Objectives

AMD

Upper and Lower Mainstem

The ultimate goal for both Upper and Lower mainstem treatment projects is to reduce loads into Morris Creek. Load reduction numbers may be adjusted based on current monitoring results. The Upper mainstem project will be initiated in 2014 (see Table 7). Once post-construction monitoring begins on Upper mainstem, the Lower mainstem project proposal will be drafted. The Upper and Lower mainstem projects share a similar schedule and objectives as listed below:

1. A year will be allowed to draft a project proposal; apply for and receive funds.
2. While waiting on funds, appropriate Army Corps of Engineering and DNR permits will be applied to.
3. Once funds are approved, pre-construction monitoring will occur and will last for approximately one year. The monitoring will involve taking samples from seeps and the discharge from the passive treatment system into Morris Creek.
4. Surveying and engineering will then take place and the bidding for construction will begin.
5. Once a plan is approved, remediation construction (removal of AMD sludge) will begin and the project can be refurbished and enhanced as the design calls, if necessary.
6. Once construction is complete and the project is fully implemented, post-construction sampling of the AMD seep and discharge into Morris Creek from the passive treatment system will be monitored for approximately one year.

Blacksnake Hollow

The ultimate goal for the blacksnake hollow project area is to treat the AMD pollution before it enters Morris Creek, by reducing aluminum by 65 or 73lbs/year and magnesium by 3% or 7lbs/year. This will not be possible if the cell tower road is unstable and contributing sediment to the treatment area. The following objectives will need to be realized for the Blacksnake Hollow goal to be met:

1. Road stabilization projects will be fully implemented by 2018, including the stabilization of the cell tower road which is a priority for the overall success of this project.
2. A year will be allowed to apply for and receive funds through a project proposal.
3. While waiting on funds, appropriate Army Corps of Engineering and DNR permits will be applied to.
4. Once funds are approved, pre-construction monitoring will occur this will last for approximately one year. The monitoring will involve taking samples from seeps and the discharge from the passive treatment system into Morris Creek.
5. Surveying and engineering will then take place and the bidding for construction will begin.
6. Once a plan is approved, a new OLC can be installed or the project can be refurbished and enhanced as the design calls for.
7. Once construction is complete and the project is fully implemented, post-construction sampling of the AMD seep and discharge into Morris Creek from the passive treatment system will be monitored for approximately one year.

Schuyler Fork

The ultimate goal for Schuyler Fork is to reduce its aluminum load by 65% or 503lbs/year and magnesium by 66% or 437lbs/year into Morris Creek. Schuyler Fork is the primary aluminum contributor to the watershed. There is one main objective that must be met for Schuyler Fork to be treated properly; aluminum seeps will need to be identified along Schuyler Fork. Additionally, the same objectives listed above (2-7) for Blacksnake Hollow will be followed for Schuyler Fork.

Limestone sand fines will continue to be distributed where needed until AMD systems are enhanced to properly treat the polluted waters. MCWA will continue to use limestone diversion wells at both the upper and lower mainstem sites in an effort to boost alkalinity of the hillside seeps.

SEDIMENT

Of the three sediment issues identified, road restoration will be given first priority since it directly affects Blacksnake Hollow's project area.

Road Restoration

The ultimate goal of the road restoration projects is reduce the amount of sediment entering Morris Creek from surrounding roads, by 116,213 tons. There are several objectives that must be met as outlined in the schedule (Table 8). One of the main objectives is to determine which roads are contributing the greatest sediment load.

Bank Stabilization

The ultimate goal for the bank stabilization projects is to stabilize the banks along Morris Creek and reduce their load of sediment (and therefore, iron by 335,34tons/year) into the waters. There are several objectives that must be met as outlined in the schedule (Table 8). The main objective is to address the six bank stabilization projects listed in Table 4. These sites have been identified to contribute over 335.34 tons of sediment per year to Morris Creek.

Jones Hollow Slip

The ultimate goal for the Jones Hollow slip is to stabilize the slip and reduce sediment to Morris Creek, by 8787 tons/year. There are several objectives that must be met as outlined in the schedule (Table 8). The main objective that must be met for the Jones Hollow slip is to survey the area during a heavy rainfall to determine how to properly channel the runoff. Once this is determined, the slip can be stabilized.

All three sediment issues will need to be in cooperation with the landowners. Since MCWA is very rooted in their community, most landowners are willing to give permission for sediment reduction projects to be conducted.

Load Reductions Criteria

AMD treatment projects that were installed in 2006 reduced iron, aluminum, and acid loads into Morris Creek through 2008 (see Figures 22 and 23). After 2008, monitoring data gathered by AML on the mainstem of Morris Creek shows an increase in iron and aluminum. Acidity has not shown an increase, this is due to MCWA's distribution of limestone fines into the creek since 2008 (see Figure 24).

Figure 22 - Iron Load Below AMD Treatment Projects on Mainstem of Morris Creek

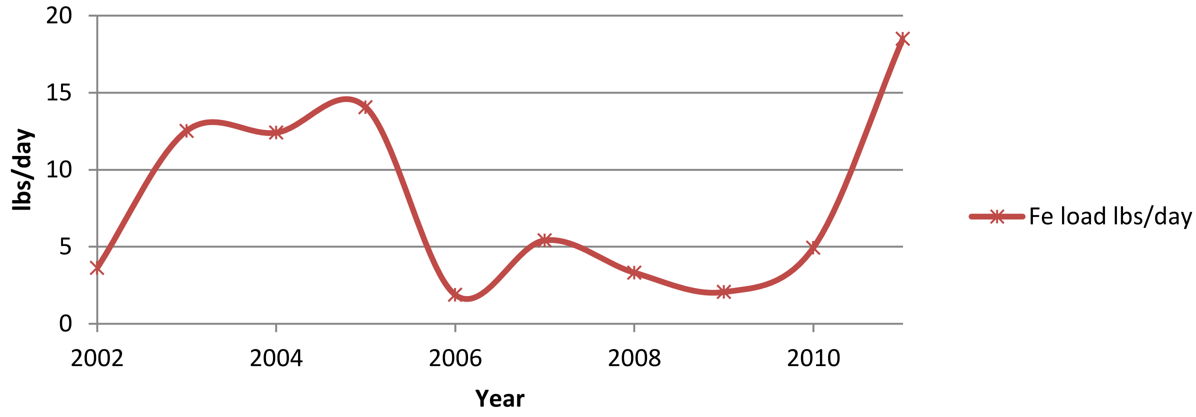


Figure 23 - Aluminum Load Below AMD Treatment Projects on the Mainstem of Morris Creek

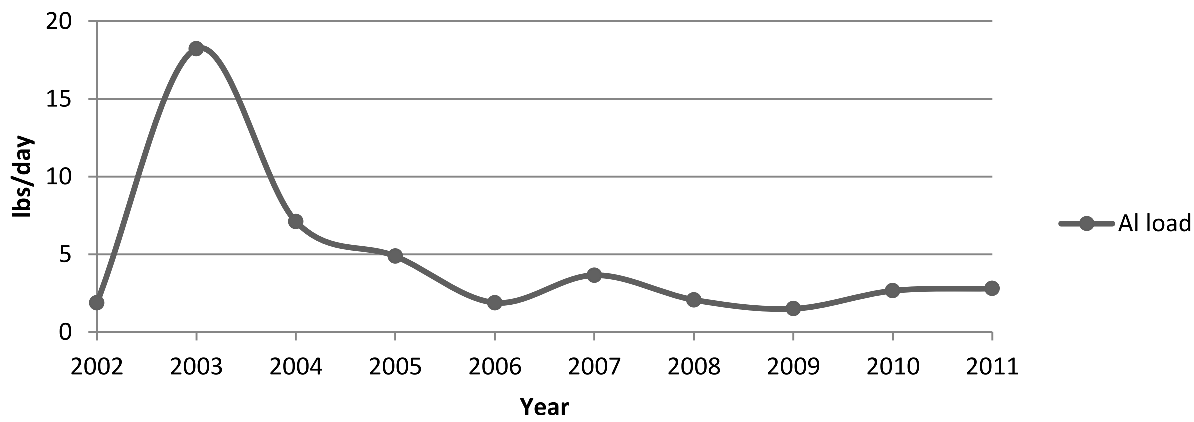


Figure 24 - Acid Load Below AMD Treatment Projects on the Mainstem of Morris Creek

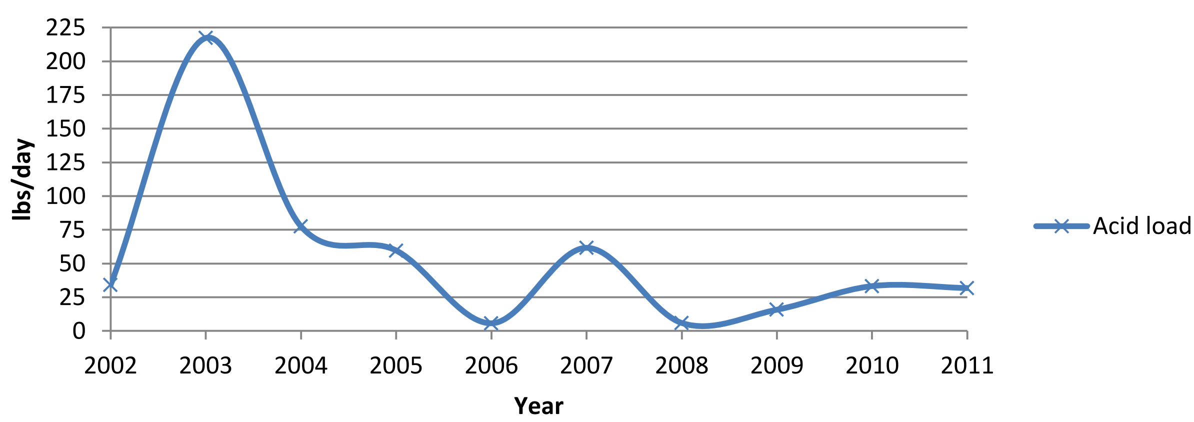
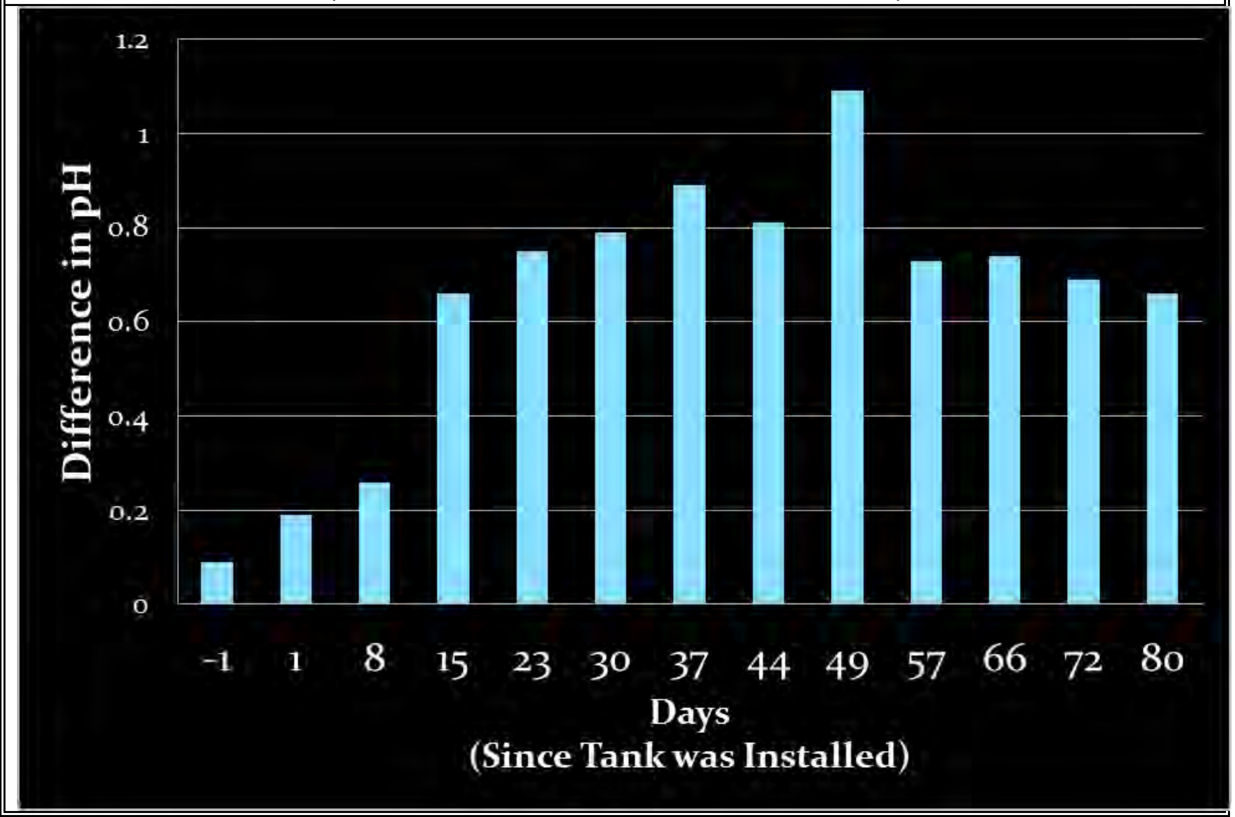


FIGURE 25 - DIFFERENCE IN PH OF POND OUTFLOW AND MOUNTAIN OUTFLOW AT THE UPPER MAINSTEM SITE (LIMESTONE DIVERSION WELL EXPERIMENT)



Monitoring the projects, as described in Section (I), will be conducted to determine if the projects are achieving the improvements in water quality needed to both comply with the TMDL and to enhance aquatic life to Morris Creek. In the interim, qualitative aspects will be observed such as less staining on the streambed and streambanks and benthic life observations by the multiple groups of students, educations, and other interested parties that are touring the creek (see Section E) via MCWA's outreach program.

The first post-project monitoring should occur in 2016. By 2017, it should be known if AMD load reductions are sufficient to comply with the TMDL load reductions. If projects are not sufficient, they will be modified or upgraded.

Monitoring

The Watershed Assessment Branch (WAB) in WVDEP conducts monitoring on a five year cycle to determine TMDL progress. The Upper Kanawha Basin is scheduled for monitoring in 2016. This will be the official determination of whether or not load reductions in Morris Creek have been sufficient; however, other monitoring efforts will be conducted as the projects are in progress (see Section F and Table 9).

AMD

The Stream Restoration Group (SRG) of AML has done extensive baseline monitoring (see Figure 6) in the watershed. The SRG will continue to monitor during and after the enhancement of the AML projects.

Table 9 - Monitoring on Morris Creek Watershed

Monitoring Partner	Initiation/Frequency	Where
AML	2002, Monthly	AML sampling points (Figure 25)
MCWA (WV Tech)	Since 2008, Monthly	At and below AMD project sites
WAB	1996, Varying degrees of frequency	Whole watershed
WVSOS	Since 2011; Annually	Whole watershed, reference reaches

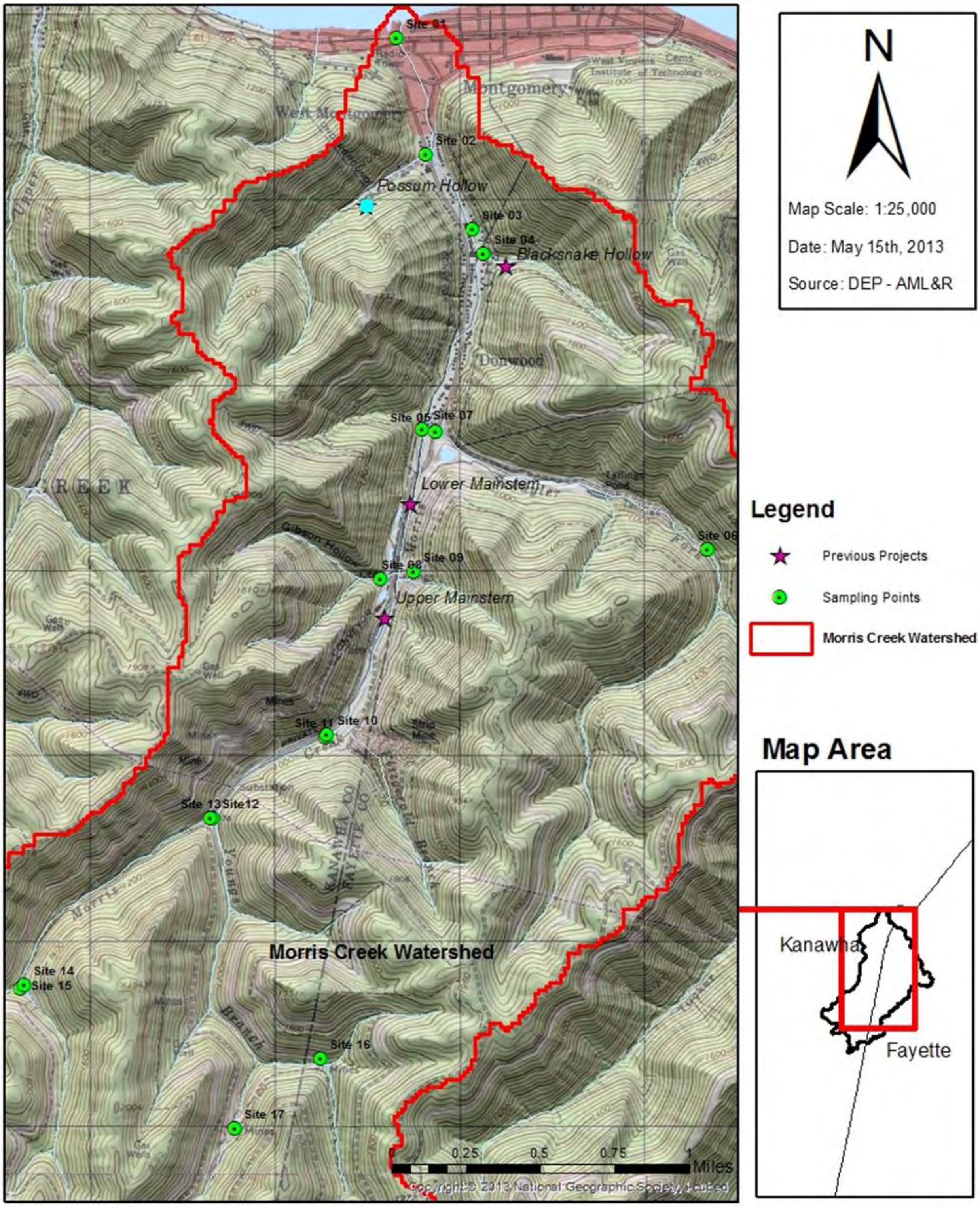
Deborah Beutler, a member of the MCWA and a professor at WVU Tech, began taking her ecology class out on Morris Creek to monitor in 2009 (see Figure 27). Benthic macroinvertebrate kicks and physical data such as temperature, pH, velocity, dissolved oxygen, depth, and conductivity have been collected monthly since 2011. WVU Tech has been monitoring sections of Morris Creek as the watershed association has been adding limestone fines, installing a hydro generator and two limestone diversion wells. The data compiled has helped MCWA determine how their efforts can be best utilized.

Sediment

The NPS will conduct supplemental monitoring to fill any data gaps that may exist. This will be done on a continuing basis and coordinated by the NPS Coordinator. The NPS Volunteer Monitoring Coordinator will train the MCWA to advanced levels of biological and habitat monitoring. A proposed sediment monitoring program coordinated through the WVCA and WV SOS program will measure the success of sediment related projects. The MCWA monitoring will be the assessment needed to determine the degree of sediment reduction and any environmental impact. To reduce metals in Morris Creek, sediment entering Morris Creek will also need to be reduced.

Figure 26 - Deborah Butler's WVU Tech students monitoring sections of Morris Creek

FIGURE 27 - AML SAMPLING POINTS ON MORRIS CREEK



Monitoring will at a minimum:

1. Monitor for acidity, pH, flow, Al, Fe, and Mn
2. Monitor at project seeps and outfalls to measure project load reductions
3. Monitoring will be conducted before and after each project completion, as well as several times a year to represent varying flow conditions

The QA/QC procedures are applied to an environmental data operation to assure that the results obtained are the type and quality needed and expected. A Quality Assurance Project Plan (QAPP) will be created to document planning results for environmental data operations and to provide a project-specific "blueprint" for obtaining the type of quality of environmental data needed for a specific decision or use. The QAPP is submitted to EPA for approval prior to commencing any project monitoring. Once the plan is approved and members of the MCWA are QA/QC certified, monitoring for both sediment and biological health can begin. By coordinating with the WVSOS and NPS programs the MCWA will be able to document the environmental results of this effort. When data demonstrates that Morris Creek has reached the prescribed TMDL, it will be presented to WAB to determine if Morris Creek can be removed from the 303.d list.

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