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Annual Monitoring Report 2008

Remining No. 2 Surface Mine
Lick Fork/Grapevine Creek Stream Restoration

1.0 Applicant Information

Central Appalachia Mining, LLC (CAM) located at P.O. Box 1169, 265 Hambley Blvd., Pikeville, Kentucky 41509 is the entity responsible for this project. CAM contracted Heritage Technical Associates (HTA) of Chapmanville, WV to conduct annual monitoring for mitigation actions associated with the Remining No. 2 Surface Mine located near Edgarton in Mingo County, West Virginia (Attachment 1). If any questions should arise concerning this project please contact Heritage Technical Associates (HTA) of Chapmanville, WV.

2.0 Introduction

Mitigation actions for Lick Fork and for the lower reach of Grapevine Creek have been completed. These actions included long-term physical structure and stability of the channel, establishment of native species within the riparian zone where appropriate and practicable, and enhancement to the aquatic habitat by the installation of Cross Vanes. Annual monitoring of the mitigation actions is required per the Compensatory Mitigation Plan (CMP). Field assessments of these actions have indicated that the stream channel has been contained by the placement of Cross Vanes, the riparian zone has a vegetative cover, and pools have been created that improve aquatic habitat.

3.0 Purpose

This is the fourth Annual Monitoring Report (AMR) that has been conducted for Lick Fork. The As-Built Report was submitted in 2004. The first Annual Monitoring Report was submitted in 2005. This is the fifth year for the Lick Fork restoration. This report assesses mitigation efforts implemented to compensate for impacts of the Remining No. 2 Surface Mine. Section I, Monitoring and Long-Term Management, of the CMP requires annual monitoring in order to determine the success of the restoration plan based on the CMP performance standards. The CMP stipulates completion of in-stream structures and seeding of the stream restoration area in Lick Fork, a tributary of Grapevine Creek, and in the lowest 1540 feet of Grapevine Creek, a tributary of the Tug Fork River. This is the third AMR for the lower section of Grapevine Creek. The As-Built Report was submitted in February 2006 (for the 2005 year). This is the fourth year for the lower Grapevine Creek restoration.

This AMR now includes both restored stream sections. The scope of the restoration efforts for both streams includes: long-term physical structure and stability of the channel, establishment of native species within the riparian zone, and enhancement to the aquatic habitat by the installation of Cross Vanes.

Lick Fork restoration was completed during Phases I and II of the mitigation plan. To achieve long-term channel stability, one step-pool complex structure and 37 rock Cross Vanes were constructed in Lick Fork. Stream restoration began at the upper weir (0+00), and terminated at the access road to Pond 2 (31+88), compiling a total length of 3,188 linear feet. The step-pool complex structure (0+00 to 0+50) dissipates energy and maintains erosion control in the steeply graded area below the weir. Cross Vanes were placed at approximately 84 foot intervals, approximately six bankfull widths, throughout the remaining length of stream. Attachment 2 illustrates the as-built locations of the Cross Vane and step-pool structures in comparison to the proposed locations.

Grapevine Creek restoration was completed during ~~p~~ Phase III of the mitigation plan. Thirteen rock Cross Vanes were constructed within the lower portion of Grapevine Creek. Stream restoration began approximately 1540 linear feet from the confluence of Grapevine Creek and the Tug Fork River (0+00) and ended just before a bridge just upstream from the confluence with the Tug Fork (13+00), compiling a total length of 1300 linear feet. The CMP proposed the restoration of 1540 feet of lower Grapevine Creek, however, due to the construction of a new bridge restoration activities could not be implemented in the lower 240 feet. Cross Vanes were placed at approximately 84 foot intervals, approximately 6 bankfull widths[1], throughout the remaining length of stream. Attachment 3 illustrates the Grapevine Creek as-built location of the in-stream structures in comparison to the proposed locations.

To quantify success of the in-stream structures, conditions of the structures were examined and compared to the initial as-built configuration. Additional monitoring conducted included analyses of benthic macroinvertebrate surveys, water chemistry, habitat survey, stream channel stability and documentation of vegetative cover. Vantage points, areas with long continual vistas of riparian disturbances, were selected along the stream to assist in annual evaluation and documentation. Annual photographs, taken from the same locations, were used to monitor and compare the progression and naturalization of the mitigation sites. A detailed description of management actions implemented throughout the year and photographic confirmation of the mitigation efforts are also incorporated.

4.0 Project Overview

The primary objective for this restoration plan was to construct a stream channel capable of supporting an ecosystem comparable to the pre-mitigation ecosystem, while minimizing impacts from past mining practices. The jurisdictional waters proposed for impact have a heterotrophic[2] food web[3]. In this type of system, coarse particulate organic matter (CPOM), such as leaves, sticks or wood, provides the primary source of energy to aquatic organisms. The organisms that feed on CPOM may be transported downstream, providing food for larger organisms and fish. The constructed stream channels are anticipated to maintain a similar heterotrophic ecosystem, while reducing channel instabilities.

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[1] Bankfull width is a typical top width of a stream at the occurrence of a bankfull storm event

[2]Heterotrophic is defined as "obtaining nourishment from organic substances,..." (The American Heritage Dictionary, Second College Edition, 1982.)

[3]A heterotrophic food web derives its energy source from the contribution of organic matter from other sources such as leaves, sticks and wood as compared to an autotrophic system which produces energy from photosynthesis.

The stream restoration techniques implemented more than compensate for the anticipated impacts to jurisdictional waters. The completion of mitigation efforts and water quality improvements that are expected after the remining of this project will provide a habitat with the potential for an increase in the number and diversity of taxa within the streams.

4.1 Project Goals and Objectives

Mitigation actions were implemented in order to produce a more stable stream channel with an equivalent or improved ecosystem in the areas of temporary impacts and below the valley fills.

Stream restoration structures have been constructed in Lick Fork to create a diverse habitat, dissipate energy within the channel, and control the anticipated erosion stresses. The stream restoration structures installed are capable of accommodating "bankfull" flow events and enhancing channel morphology.

The jurisdictional waters impacted by the foot print of Valley Fill 3, Pond 1 and Ponds 3 & 3A were offset by the stream restoration in Lick Fork and in the lower portion of Grapevine Creek. Valley Fills 1, 2, and Pond 2 were not constructed due to geologic conditions encountered, which lessened the amount of disturbance to jurisdictional waters.

Lick Fork and Grapevine Creek stream restoration efforts also included the planting of native species within the riparian zone. These remedial actions included seeding all disturbed areas in the riparian zones with native grasses and the planting of native shrubs and trees. These stream restoration measures are intended to increase soil stability, reduce erosion potential and enhance the aquatic habitat by providing shade and CPOM to the ecosystem. Re-vegetation of the riparian zone assures that ecological functions, present prior to mitigation, return to the restored streams.

During construction, precautions were taken to minimize disturbance of the existing riparian zone and reduce or prevent erosion and sedimentation from occurring as presented in prior reports. Precautions included leaving larger trees intact and placing hay bails downstream to impede sediment movement related to Cross Vane construction.

Thus far, the restoration plan has proven successful by accomplishing the primary restoration objective: to establish a stable channel capable of supporting an ecosystem comparable to the pre-mitigation ecosystem, while minimizing impacts from past mining practices.

4.2 Performance Standards

The performance or success standards for this mitigation plan have established qualitative and quantitative gauges of success. Performance standards, set forth in the CMP previously accepted by the USACE, are described in detail below:

4.2.1 Riparian Zone Vegetation

The project will be considered successful if native species are established on at least 80 percent of the mitigation sites. Species proposed for planting are considered native species. It is anticipated that natural succession will occur and that adjacent tree species will migrate into the mitigation sites. The project will not be considered successful if non-native species prevent the establishment of at least 80 percent of the native species. Success will be determined by visual analyses and inventory of the site.

4.2.2 Stream Stability

Stream morphology will be visually examined to determine if erosion is controlled. The project will be considered successful if the stream and structures installed are stable, both laterally and vertically.

4.2.3 Stream Geometry

The mitigation plan will be deemed successful if the structures are constructed in the approximate location proposed in the pre-plans. The structures should have vertical tolerances of +/- 1 foot. Stream channel geometry will be surveyed as needed.

4.2.4 Benthic Populations

Benthic macroinvertebrate populations will be monitored until the project is determined successful by the USACE. Benthic analysis will help assess the overall health of the restored stream. However, benthic populations, including the presence of certain species, will not be used as a gauge of success.

4.3 Project Success

The overall project will be deemed a success once the following has occurred: 1) Construction of restored stream channels, 2) Vigorous vegetation has been established in appropriate areas, 3) Native species have been established in over 80 percent of the mitigation site, 4) The reclamation bond for the operation is released by the WVDEP. Since the reclamation bond can only be released after a minimum of five years, the five year project success time frame will be obtained.

Presently, the mitigation plan is progressing as planned and it is anticipated that the project will achieve the proposed performance standards. CAM is responsible for all phases of construction and compliance proposed within the original CMP. CAM is obligated to maintain compliance with criteria set forth in the CMP and make adequate repairs to the site when necessary. The site must meet requirements set forth by the State of West Virginia, including the requirements for water quality improvements stipulated by the WVDEP[4].

CAM has provided the financial assurances needed to achieve project success. Financial assurance guarantees implementation of the proposed mitigation actions and maintenance of the mitigation sites until final acceptance by the USACE. Thus, it is assured that CAM will adequately comply with the requirements within the original CMP.

CAM will not be responsible for damages to the site caused by violations of the proposed restrictive covenants or any damage caused by parties other than Central Appalachian Mining, LLC.

Thus far, with the exception of the establishment of at least 80 percent native riparian vegetation, the majority of the mitigation efforts are progressing accordingly. There are no indications that the actions proposed within the CMP will not be successful. However, if mitigation cannot be implemented

[4] The variance from water quality was granted by the West Virginia Environmental Quality Board (EQB). The authority to grant water quality variances was transferred by the legislature to the WVDEP effective July 1, 2005.

successfully in the proposed locations, adjacent jurisdictional waters that have also been impacted by mining may be included in a future, revised CMP.

4.4 Monitoring and Management

For at least five years following completion of the mitigation site construction, mitigated areas will be monitored annually to determine project success based on the pre-determined performance standards. Annual monitoring will occur once each calendar year after completion of the project, until final WVDEP reclamation bond release and USACE approval. Areas to be inspected and monitored include the stability of the stream channel and success of the vegetation. Maintenance will be performed on an as-needed basis to assure that CMP objectives are accomplished.

Cross-sections established on as-built maps provide a baseline reference for the restored stream channels. Cross-sections were prepared for critical areas, such as restored channels through the reclaimed sediment pond areas. Cross-sections were also established in other reaches of the restored stream channels in intervals not exceeding 500 feet. These cross-sections will help identify any adverse changes to dimensions of the restored channels. Permanent survey markers were used to monument the cross-sections. Limits of the mitigation reaches were delineated by the establishment of a monument in the form of a marker or sign.

Mitigation sites were not fenced, since the restored streams provide water resources for the wildlife indigenous to the area.

Six representative sections, vantage points, with long continual vistas of riparian disturbances were selected along the stream to assist in annual evaluation and documentation. Photographs will be taken from the same locations annually to monitor and compare the progression and naturalization of the mitigation sites.

5.0 Site Integrity

The integrity of the site is guaranteed by CAM through the implementation of the restrictive covenants set forth in the agreement with the landowner. The current landowners are Logan Coal and Timber Corp., 37 North Road, Building 2, Paoli, PA 19301 and Heartwood Forestland Fund II, P. O. Box 916, Chapel Hill, NC 27515[5].

Restrictive covenant areas are depicted on maps enclosed in the CMP (Attachments 26 to 29) previously accepted by the USACE.

6.0 Mitigation Actions

In the Annual Monitoring Report submitted in December of 2005, CAM proposed to revise the phases within the mitigation plan to reflect the actual impacts of the project and the mitigation implemented to offset the actual impacts. Fewer impacts occurred since 2 valley fills and 1 pond was not constructed, altering the mitigation requirements for the project. As documented below, the mitigation actions installed to date surpass the mitigation required to offset the impacts to jurisdictional waters (Tables 1 and 2).

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[5] Restrictive covenants have been obtained from Logan Coal and Timber Corp. Because the amount of impacts have been lessened, as will be explained in more detail later in this AMR, restrictive covenants from Heartwood Forestland Fund II will not be necessary since restoration measures were not constructed on Heartwood property.

The revised proposed mitigation plan consists of four phases. The first three phases of the proposed plan have been completed. Phase IV will be completed at the end of the project. This will see final mitigation actions for Ponds 1, 3, and 3a which will allow for final bond release. Mitigation actions taken to date are described below and illustrated in the phase map (Attachment 4).

6.1 Mitigation Phases

The remining operation (Remining No. 1 Mine) conducted on adjacent lands has significantly improved the water quality. Thus, the primary restoration objective of this project was to enhance the physical structure of the same stream channel where the water quality improvements occurred. The installation of Cross Vanes (CMP Attachment 19) and step-pool channel features (CMP Attachment 20) have accomplished the following: 1) added channel structure, 2) provided vertical stability to the stream, inhibiting further entrenchment, 3) provided lateral stability, preventing the stream from cutting into the natural hillsides and haul road fill banks, and 4) established the formation of channel features such as, pools, glides, riffles, and runs, improving the habitat and the occurrence of natural stream processes. Phase maps can be found in Attachment 4.

Phase I

Completed measures of Phase I of the original accepted mitigation plan included the restoration[6] of Lick Fork from 0+00 to 18+40 (CMP Attachments 14 to 16). Restoration work began at the most upstream location and progressed downstream. Channel structure and features were established with the construction of a step-pool complex and Cross Vanes in a stream that was previously impacted by the physical and chemical effects of mining. Disturbed riparian zones were seeded and planted with the appropriate seed mixture and tree species. Large trees, growing in the riparian zone, were not disturbed. These trees provide bank stability, contribute leaf litter and debris to the stream, and contribute seeds to the riparian area.

Restoration work began with installation of the step-pool channel. The step-pool complex (0+00 to 0+50) provides a form of energy dissipation and maintains erosion control within the steeply graded channel below Pond 3 of the adjacent Remining No. 1 Mine (Permit No. S-4006-00). Cross Vanes were located at approximately 84 foot intervals, approximately 6 bankfull widths, throughout the remaining length of the restored stream segment (0+50 to 18+40). This interval was determined with hydraulic and geomorphologic analysis of similar, stable streams and general accepted information (Leopold) regarding stream size.

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[6] Due to the incised characteristics of the streams to be restored with this CMP which include narrow, confined floodplains and deep entrenchment ratios, it was determined that a “Priority 4” restoration would be most practical. “Priority 1” restoration cannot be accomplished because there is no historical floodplain for which to reconnect the streams to be restored. “Priority 2” restoration cannot be accomplished because a new floodplain and stream pattern cannot be created within the narrow confines of the streams to be restored. “Priority 3” restoration cannot be accomplished because there is no room to widen the floodplain due to the narrow confines of the streams to be restored. “Priority 4” restoration can be accomplished and will stabilize the stream banks in their current location.

As per the CMP, construction of channel features began in Phase I, work then commenced in Valley Fill 1 and on the access road. However, geologic conditions prevented the remining of the Alma Seam within the confines of Valley Fill 1. Due to this, Valley Fill 1 was not constructed. Pond 1, which would have provided drainage control for Valley Fill 1, was installed in anticipation of construction of the valley fill. The area designated for Valley Fill 1 was cleared, but no material was placed in the valley fill. The construction of Pond 1 will temporarily impact jurisdictional waters.

Phase II

Phase II stream restoration involved the completion of restoration within Lick Fork from approximately 19+60 to 31+88 (CMP Attachments 16 to 18). Cross Vane installation in the channels was based on criteria discussed above.

Originally, Phase II operations proposed the installation of two stream crossings, one for Haulroad A and one for the access road. However, since Haulroad A was never constructed and the access road was not used, no culverts were installed.

Phase III

Phase III stream restoration involved the completion of stream restoration structures in Grapevine Creek from 0+00 to 13+00 (CMP Attachment 33). The CMP proposed that the Grapevine Creek restoration extend to the confluence of Grapevine Creek and the Tug Fork River, approximately 1540 feet. Restoration plans had to be altered, due to the construction of a bridge by the West Virginia Department of Highways (Attachment 6). The bridge altered the channel morphology, adding a retaining wall that flanks the left side of the stream. The proposed stable construction of step-pools in this area could not be achieved with the new retaining wall in place. Constructed Cross Vanes were located at approximately 84 foot intervals, approximately 6 bankfull widths, throughout the length of the restored stream segment.

The original accepted CMP stated that Phases II and III could occur simultaneously. After construction of channel features began in Phase I, work commenced in Valley Fill 3. The construction of Ponds 3 & 3A, which serve as drainage control for the Valley Fill 3, were also completed. Ponds 3 & 3A temporarily impact jurisdictional waters, while Valley Fill 3 will permanently impact jurisdictional waters.

Phase IV

Phase IV will be the final phase of the project. Adjustments were made to phases proposed within the original accepted CMP, due to changes in the remining process dictated by geologic conditions. Fewer disturbances will occur since Valley Fill 2 and Pond 2 are no longer planned for construction.

Phase IV will involve the restoration of streams temporarily impacted by Ponds 1, 3 and 3A. This stream restoration is not complete at this time but will occur as the structures are removed during the WVDEP permit release process. Channel restoration through the footprints of Ponds 1, 3, and 3A will be accomplished and allow for final bond release. After restoration has been completed, a stream length of 4728 lf (Lick Fork and Grapevine Creek mitigation) will be restored to compensate for permanent disturbances and a stream length of 765 lf (pond area mitigation) will be restored to offset temporary disturbances.

6.2 Mitigation Summary

A total stream length of 5493 lf will be restored through mitigation efforts (Table 2). The actual permanent stream disturbance length is 1392 lf (Table 1). After considering the temporal effects of 5% for every five year phase [1392+ (1392x5%) + (1392x5%)], the total length of mitigation required is 1531.2 lf. The completed restoration total is 4488 lf (Table 2). Mitigation efforts will restore a greater length (2957 lf) of channel than is required to offset disturbances[7]. The mitigation efforts above what is required (2957 lf) may be used by CAM to offset future impacts to jurisdictional waters.

Table 1. Proposed Impacts versus Actual Impacts to Jurisdictional Waters

Proposed Impact Features	Proposed Permanent Stream Disturbance (lf)	Proposed Temporary Stream Disturbance (lf)	Actual Permanent Stream Disturbance (lf)	Actual Temporary Stream Disturbance (lf)
Valley Fill 1	1309 lf of intermittent 219 lf of ephemeral	0 lf	0 lf	0 lf
Valley Fill 2	1437 lf of intermittent	0 lf	0 lf	0 lf
Valley Fill 3	1180 lf of intermittent 212 lf of ephemeral	0 lf	1180 lf of intermittent 212 lf of ephemeral	0 lf
Pond 1	0 lf	225 lf of intermittent	0 lf	225 lf of intermittent
Pond 2	0 lf	254 lf of intermittent	0 lf	0 lf
Pond 3 and 3A	0 lf	540 lf of intermittent	0 lf	540 lf of intermittent
Total Disturbance	**4357 lf total stream**	**1019 lf total stream**	**1392 total stream**	**765 lf total stream**

[7] [Completed stream restoration (4488lf)] minus [Adjusted actual stream disturbance (1531)] = [2957 lf of restored stream above what is required]

Table 2. Proposed and Completed Stream Restoration Actions

Stream	Proposed Restoration	Completed Restoration	Phases Addressed
Lick Fork	3188 lf of perennial	3188 lf of perennial	I and II
Grapevine Creek	1540 lf of perennial	1300 lf of perennial	III
Channels through Pond 1	225 lf of intermittent	0 lf of intermittent	IV
Channels through Ponds 3 and 3A	540 lf of intermittent	0 lf of intermittent	IV
Total Restoration	**5493 lf total stream**	**4488 lf total stream**	

7.0 Monitoring and Sampling Methods

Environmental biologists for Heritage Technical Associates, Inc. of Chapmanville, West Virginia conducted the annual monitoring for Lick Fork and the lower portion of Grapevine Creek on November 3 and 11, 2008. Benthic and water sampling occurred on November 11, 2008 for Lick Fork and for the lower portion of Grapevine Creek. Monitoring and sampling methods are described in detail in the following sections:

7.1 Structures

In stream structures were visually assessed in the field for noticeable changes to structure configuration. Photographs of the structures were taken in order to compare to the previous years pictures of the structures. All constructed Cross Vanes appear stable, while there are no apparent visual differences from the current configuration when compared to the as-built configuration. Representative photographs depicting the current Cross Vane configuration are located in Attachments 2 and 3.

Lick Fork

Lick Fork restoration involved the construction of 37 rock Cross Vanes and one step-pool complex structure. Mitigation practices began at the upper weir (0+00) and terminated at the access road to Pond 2 (31+88), amassing a total stream length of 3,188 lf. The step-pool complex structure (0+00 to 0+50) continues to provide energy dissipation and maintains erosion control within the steep graded channel below Pond 3 of the adjacent Remining No. 3 mine (Permit No. S-4006-00). Cross Vanes were located at approximately 84 foot intervals, approximately 6 bankfull widths, throughout the remaining length of the stream (0+50 to 31+88).

Cross Vanes 27 to 30 were relocated from their proposed As-built positions to upstream positions during construction, due to bedrock restraints occurring at the proposed locations within the channel. These structures appear stable and have formed new pools within the stream.

Representative photographs depicting the current Cross Vane configuration are located in the map in Attachment 2.

Grapevine Creek

Grapevine Creek restoration involved the construction of 13 rock Cross Vanes, amassing a total of 1300 lf of stream restoration. Cross Vanes were located at approximately 84 foot intervals, approximately 6 bankfull widths, throughout the remaining length of the stream. Representative photographs depicting the current Cross Vane configuration are located in the map in Attachment 3.

7.2 Erosion Control

Stream morphology was visually examined to determine if erosion has been controlled during the past year. Stream channels and restoration structures were visually inspected to determine stability conditions, both laterally and vertically. Lick Fork and lower Grapevine Creek appear to have a similar morphology to the channel form assessed immediately after as-built completion. Since no noticeable bank instabilities have occurred as a result of undercut banks, it is concluded that the in-stream structures have successfully dissipated energy, relieved near bank stresses and achieved lateral stability. No undercutting was observed upstream from any of the installed structures.

Lick Fork

There is an increasing amount of large woody debris within the upper reach of the Lick Fork restoration. In November of 2005, a large tree was observed in the stream near Cross Vane 35. A large amount of the woody debris is directly on top of the structure, however, after 1 year there does not appear to be any stability issues associated with this Cross Vane. The large woody debris within Lick Fork will be monitored to determine if any negative impacts begin to occur. In 2007, woody debris was observed directly on top of Cross Vanes 16 and 19. There have been no negative impacts observed in the past year due to the accumulation of woody debris on these structures. Some large woody debris within stream channels is beneficial to the aquatic ecosystems; however, channel stability should be monitored closely in areas where the debris is present.

During annual monitoring conducted in 2006 there was only one stability issue associated with the Cross Vanes. Cross Vane 22 showed most of the water within the channel flowing directly over the Cross Vane as intended, a smaller amount of water was flowing into a gap and underneath the left wing of the Cross Vane. During the 2008 annual monitoring Cross Vane 22 was stabilized and appeared to be functioning properly.

There were no major corrective measures necessary after conducting the annual monitoring for 2008 in Lick Fork or the lower portion of Grapevine Creek.

Grapevine Creek

No stability issues associated with Cross Vanes were observed during annual monitoring conducted in 2007. Cross Vanes exhibited no changes in appearance.

7.3 Vegetation

Six representative sections, vantage points, with long continual vistas of riparian disturbances along the stream were used to quantify the vegetative progression of the restored sites in comparison to the pre-existing vegetative conditions. Vantage Points 1 through 5 were located along Lick Fork, while 6 was located along the lower potion of Grapevine Creek (Attachment 6). Each Vantage Point has an upstream and downstream photograph except for Vantage Point 2, which is located alongside the haulroad at the lower end of the culvert crossing. An upstream photograph at this location would not adequately represent riparian areas of concern. Vantage Point photographs and visual evaluations conducted in the field were used to document and compare annual site assessments. Vantage point pictures for 2008 can be found in Attachment 6.

During construction, precautions were taken to minimize disturbances to the existing riparian zone. Precautions included leaving larger trees intact and putting hay bails downstream to impede sediment movement relating to Cross Vane construction. After completion of the in-steam structures, disturbed areas were seeded to maintain bank stability and reduce erosion. Fertilizer was applied during seeding at the rate of 600 lbs/ac. The fertilizer rate was 10-20-10. Wood cellulose mulch was applied at the time of seeding to provide moisture retention and adhesion for the seed mixture for Lick Fork. Since vegetation was established with at least 80 percent aerial coverage there was no need for re-seeding or re-mulching.

Both Lick Fork and the lower section of Grapevine Creek had increases in the number of trees found within the riparian zone due to the planting of new trees. With the addition of these new trees and the larger trees that were left, the canopy cover will increase. This increase in canopy cover will provide shading of the stream which will aid in controlling temperature fluctuations within the stream. This will allow for a more constant temperature regime which will aid in the establishment of benthic communities and fish assemblages.

Lick Fork

The vegetative seed mixture applied to the streambanks was a combination of grasses that naturally occur on streambanks and was selected for optimal growth. The grass mixture included Switchgrass (*Pannicum virgatum*), Redtop (*Agrostis alba*), and Japanese Millet (*Echinochloa crugallo frumenta*) as determined in the CMP. Ground cover was established immediately after disturbance. Vegetation progress was evaluated and is evident in the annual Vantage Point pictures (Attachment 5). The grasses have created a protective vegetative cover on the impacted banks.

Tree planting occurred during December of 2004 when the trees became available from the nursery. Trees were planted on five foot staggered intervals immediately above the restored stream channel. The trees selected for the riparian zone enhancement are native to riparian zones and include Silky Dogwood (*Cornus florida*), Sycamore (*Plantinus occidentalis*), and Willow Cuttings (*Salix purpurea*). These trees will help supply bank stability in order to help prevent erosion, shade the stream, and produce Course Particulate Organic Matter (CPOM) for the aquatic ecosystem.

Tree saplings were difficult to identify during the annual vegetation survey of 2005. Some saplings were identified; however, it was difficult to determine many tree species since much of the leaves had dropped. The vegetation survey for the 2006 Annual Report was conducted in September, when saplings were easier to identify. The planted sycamore appeared to have the largest presence, while willow cuttings were common. Dogwood were identified but were less frequent. Greater observations of sycamore and willow were observed in the upstream areas of Lick Fork opposed to the lower section of Grapevine.

Common vegetation, apart from the planted species, identified throughout the Vantage Point areas included jewel weed (*Impatiens capensis*), joe pye weed (*Eupatorium fistulosum*), knotweed (*Polygonum aviculare*), colts foot (*Tussilago farfara*), lespedeza (*Lespedeza sp.*), and grass species.

Mitigation areas were examined to determine if invasive species such as knotweed or kudzu had invaded. The areas along the haulroads were seeded by CAM to provide erosion control for the newly constructed haulroads, as per their permit. The seed mix used included lespedeza. Due to the heavy propagation of the lespedeza species in areas surrounding the upper mitigation areas of Lick Fork and evidence of the species invading some sites, it is evident that invasive species could present problems in the upstream reach of Lick Fork. Knotweed was also observed in the lower reach of Lick Fork, but was less frequent than the lespedeza. Efforts may be considered to maintain native species within these sites if the invasive species is deemed controllable.

Grapevine Creek

The vegetative seed mixture applied to the streambanks was a combination of grasses that naturally occur on streambanks and was selected for optimal growth. The grass mixture included Switchgrass (*Pannicum virgatum*), Redtop (*Agrostis alba*), and Japanese Millet (*Echinochloa crugallo frumenta*) as determined in the CMP. Vegetation progress was evaluated.

Tree planting occurred during March of 2006 when the trees became available from the nursery. Trees were planted on five foot staggered intervals immediately above the restored stream channel. The trees selected for the riparian zone enhancement are native to riparian zones and include Black Cherry (*Prunus serotina*), Sycamore (*Plantinus occidentalis*), and Willow Cuttings (*Salix purpurea*). These trees will help supply bank stability to prevent erosion, shade the stream and produce Course Particulate Organic Matter (CPOM) for the aquatic ecosystem.

The vegetation survey for the 2006 Annual Report was conducted in September, when saplings were easier to identify. The planted sycamore appeared to have the largest presence, while willow cuttings were much less common. The black cherry saplings did not appear to survive.

Common vegetation, apart from the planted species, identified throughout the Vantage Point areas include jewel weed (*Impatiens capensis*), coltsfoot (*Tussilago farfara*), autumn olive (*Eleagnus umbellate*), and stinging nettle (*Urtica dioica*).

Mitigation areas were examined to determine if invasive species such as knotweed or kudzu had invaded. Knotweed was observed in the lower portion of Grapevine Creek. There was evidence of small amounts of knotweed in some mitigation areas. These areas will be assessed in the future to determine if action should be taken.

7.4 Benthic Macroinvertebrate Survey Analysis

Benthic macroivertebrates were monitored to help assess the overall health of the restored stream. However, benthic population, including the presence of certain species, will not be used for the gauge of success for this restoration project.

Benthic macroinvertebrates were sampled in accordance with the Standard Conditions for Environmental Assessments on Wadeable Streams issued by the West Virginia Division of Natural Resources and Scientific Collection Permits, which are based upon the United States Environmental Protection Agency (EPA) Rapid Bioassessment Protocols for use in Streams and Wadeable Rivers. This survey provides taxonomical baseline data on the benthic macroinvertebrates collected, substrate composition, habitat composition, and physical stream characteristics present between October 15, 2008 and December 15, 2008.

Three benthic macroinvertebrate sites were chosen based on stream features, pre-determined Vantage Points and on the Rapid Bioassessment Protocols for use in Streams and Wadeable Rivers.[8] Approximate locations of the collection sites in relation to proposed permit boundaries, stream delineation, valley fills, and associated sediment ponds are indicated in Attachment 1.

Samples were collected with a 0.5 meter rectangular dipnet. The bottom substrate was disturbed for approximately $0.25m^2$ by foot and hand in front of the net. The coarse Particular Organic Matter (CPOM) and Fine Particulate Organic mater (FPOM) were allowed to flow into the dipnet. After suspended materials settled the net was lifted from the sample location. The net contents were washed into a five-gallon bucket. Larger materials (pebbles > 20 mm, leaves or sticks) were washed and discarded from the sample. The sample was poured into a sieve to remove excess water and fine soil particles. The sieve was rinsed into a one liter sample container. This procedure was repeated until four riffle/run sections were sampled. After completion of the final sample location the rectangular kick net and five gallon bucket were closely examined for any remaining debris and or macroinvertebrates. Remaining debris and or macroinvertebrates found were placed into the sample container. Ninety-five percent ethanol was added to each sample for preservation.

Benthic Macroinvertebrates sample sorting and identification was based on a 200 $\pm$ 20 percent organism sub-sample procedure. Samples were rinsed and spread evenly over a 36 cm x 30 cm pan. A 6 cm x 6 cm grid was placed over the sample and random generated numbers determined the grid that would be identified. This was repeated until a sub-sample of 220 organisms was removed. All grids were inspected in situations where 200 organisms were not present. Species were identified to the family level using the key in Aquatic Insects of North America. Attachment 5 contains benthic survey results in detail, habitat assessments, stream characterization, representative photographs, watershed features and sediment/substrate types.

The Ranges and ranks of the WVSCI are shown in Table 3

[8] Site locations for benthic samples were based upon the EPA Interim Chemical and Biological Protocols for Mountaintop Removal

Table 3. Scoring Criteria for the WVSCI

<table>
<tr><th colspan="2">WVSCI Scoring Criteria</th></tr>
<tr><td rowspan="3">Not-Impaired</td><td>78.01-100 = Very Good</td></tr>
<tr><td>68.01-78.00 = Good</td></tr>
<tr><td>60.61-68.00 = “Gray Zone”</td></tr>
<tr><td rowspan="3">Impaired</td><td>45.01-60.60 = Slightly Impaired</td></tr>
<tr><td>22.01-45.00 = Moderately Impaired</td></tr>
<tr><td>0-22.00 = Severely Impaired</td></tr>
</table>

8.0 Proposed or Implemented Corrective Measures

No major corrective measures are necessary to assure structure stability, since all structures are intact and functioning as intended.

9.0 Discussion of Success Criteria

Annual monitoring has been conducted on Lick Fork for the Remining No. 2 mine to evaluate success of the restoration plan. Mitigation actions should produce a more stable stream channel with an equivalent or improved ecosystem in the areas of temporary and permanent impacts associated with valley fills. The CMP stipulates completion of in-stream structures (As-Built) and seeding of the stream restoration area within Lick Fork and the lower portion of Grapevine Creek. The project will be deemed a success once the following has occurred: 1) Restored stream channels have been constructed, 2) Vigorous vegetation has been established in appropriate areas, 3) Native species are present in over 80 percent of the mitigation sites, 4) The reclamation bond for the operation is released by the WVDEP.

Control structures were established within Lick Fork and Grapevine Creek to create a more complex habitat, dissipate energy within the channel, and control the anticipated erosion stresses. One step-pool complex structure and 37 rock Cross Vanes were constructed to stabilize Lick Fork. Thirteen Cross Vanes were constructed within the lower portion of Grapevine Creek. To quantify success of the in-stream structures, stability conditions were visually examined and compared to initial as-built configurations. All 50 water control structures are functioning as intended.

Stream morphology was visually examined to determine if erosion had been controlled during the past year. The stream channel was inspected to determine if the bed and banks were stable, both laterally and vertically. Since no noticeable bank instabilities have occurred since the mitigation actions, it is concluded that the in-stream structures have successfully dissipated energy and relieved near bank stresses.

Riparian zone enhancement involved seeding with native grasses and planting with native shrubs and trees. These restoration practices have been implemented in order to increase soil stability, reduce erosion potential, and enhance the aquatic habitat by providing shade and CPOM to the ecosystem. A riparian zone will provide the opportunity for ecological functions to return to the stream that existed prior to mitigation.

Annual Vantage Point photographs have proven to be an efficient method to determine the naturalization of vegetation within the mitigation sites. The 3 species of trees (Silky Dogwood, Sycamore, and Willow) that were planted along Lick Fork were observed. There is lespedeza along the haul road next to Lick Fork. This lespedeza was seeded by CAM to control erosion of the constructed road. The lespedeza grows quickly and shades out light for other plant species. These areas will be monitored and, as the mitigation sites mature, if the invasive species can be controlled corrective actions will be taken.

Three species of trees were planted along Grapevine Creek (black cherry, sycamore, willow). Sycamore and willow were identified along the lower portion of Grapevine Creek. The black cherry saplings observed did not survive. The presence of some invasive species including knotweed and autumn olive will need to be monitored.

The stream restoration techniques implemented thus far more than compensate (4488 lf of restored channel) for the anticipated impacts to jurisdictional waters (1531 lf of impacted channel). The mitigation efforts above what is required (2957 lf) may be use by CAM to offset future impacts to jurisdictional waters. The completion of mitigation efforts will provide a habitat with the potential for an increase in the number and diversity of taxa within the streams.

10.0 Conclusions

Mitigation actions have increased channel stability, decreased erosion potential by reducing near bank stresses with water control structures, and established a vegetative cover. It is anticipated that an equivalent or improved ecosystem will develop in the areas of temporary and permanent impacts associated with valley fills. Results from the annual monitoring conducted during September of 2006 will be compared to future monitoring to evaluate habitat, vegetative progression and channel morphology.

No major corrective measures associated with channel stability were found to be necessary. Channel geometry appeared stable, with structures intact and functioning as intended. The infiltration of invasive species may present problems in the future. Vegetation will be monitored and if the invasive species are controllable, corrective action may be taken.

Benthic macroinvertebrate surveys indicate that the ecological stream health of Lick Fork and Grapevine Creek has remained relatively consistent from 2008 to 2006. This is based on the number of biota collected, improved habitat scores, and WVSCI scores. The habitat assessment scores continued to be higher than in 2006, remaining in the suboptimal range. The increase in scores and increase in number of organisms is indicative that the stream health is improving since 2006.

The restoration plan has accomplished the primary restoration objective: to achieve long-term physical structure and stability of the channel. Planted saplings will be monitored closely during the next calendar year to determine their survival status. Stream restoration has been completed. This year's annual report has demonstrated success of the mitigation actions: channel stability, and establishment of a vegetative cover.

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08229- Benthic Macroinvertebrate Survey (11-11-08)
Central Appalachia Mining, LLC
Remining No. 2 Surface Mine

Annual Benthic Monitoring Results for Lick Fork and Lower Grapevine Creek, 2008

1.0 Introduction

Central Appalachia Mining (CAM) of Pikeville, Kentucky contracted Heritage Technical Associates, Inc. (HTA) of Chapmanville, West Virginia to conduct Benthic Macroinvertebrate monitoring on Lick Fork and Lower Grapevine Creek near the town of Edgarton in the Magnolia District, Mingo County, West Virginia. The purpose of annual monitoring is to compare annual assessments, which will show improvements or impairments to the health of Lick Fork and Lower Grapevine Creek. This report will be included in the Annual Monitoring Report, which will be submitted to the United States Army Corps of Engineers (USACE) to fulfill mitigation requirements.

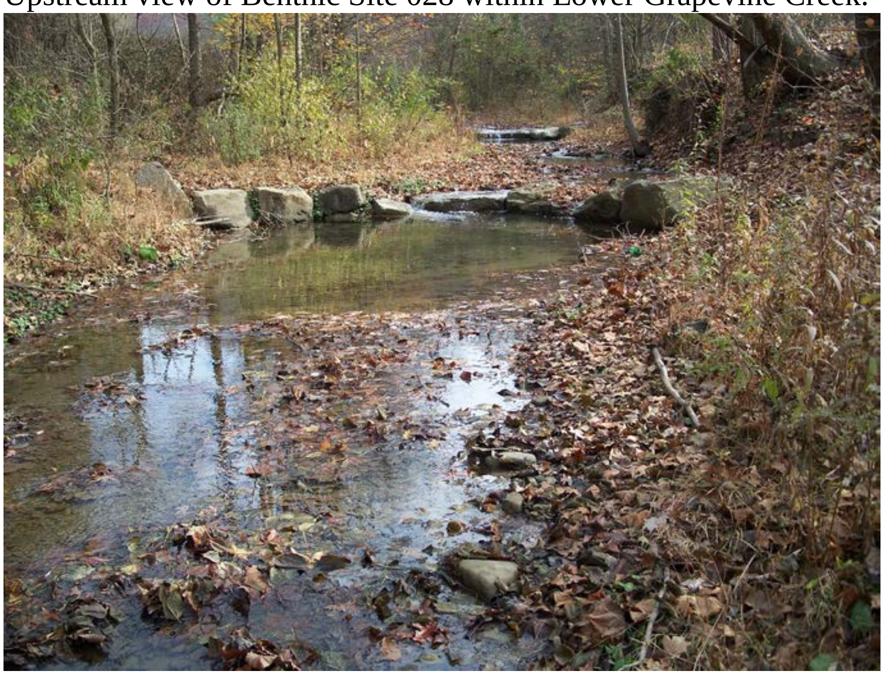
Benthics are monitored to help assess ecological stream health. Monitoring has been conducted for the past three years (2006, 2007, and 2008). This year's (2008) data will be compared to results from previous years. Sampling methods were conducted in accordance with the Rapid Bioassessment Protocols for use in Streams and Wadeable Rivers (RBP) by the Environmental Protection Agency (EPA). This is the third annual sampling event for Lick Fork and the second annual sampling for Lower Grapevine Creek. The survey provides taxonomical data for benthic organisms and assesses substrate, habitat, and physical characteristics.

2.0 Site Location

Survey sites are located on Lick Fork and Lower Grapevine Creek near the town of Edgarton in Mingo County, West Virginia. Two sites are sampled annually for monitoring purposes. The Lick Fork Site is located within a riffle/run section at (37º 34' 58", 82º 06' 51") and extends downstream 100 meters. The Lower Grapevine Creek Site is located within a riffle/run section at (37º 34' 44", 82º 07' 12") and also extends downstream 100 meters. The stream reach areas were determined based on RBPs. A location map that reveals the approximate location of the benthic collection sites is located at the end of the narrative. Representative photographs illustrating each benthic site for 2008 are located below:

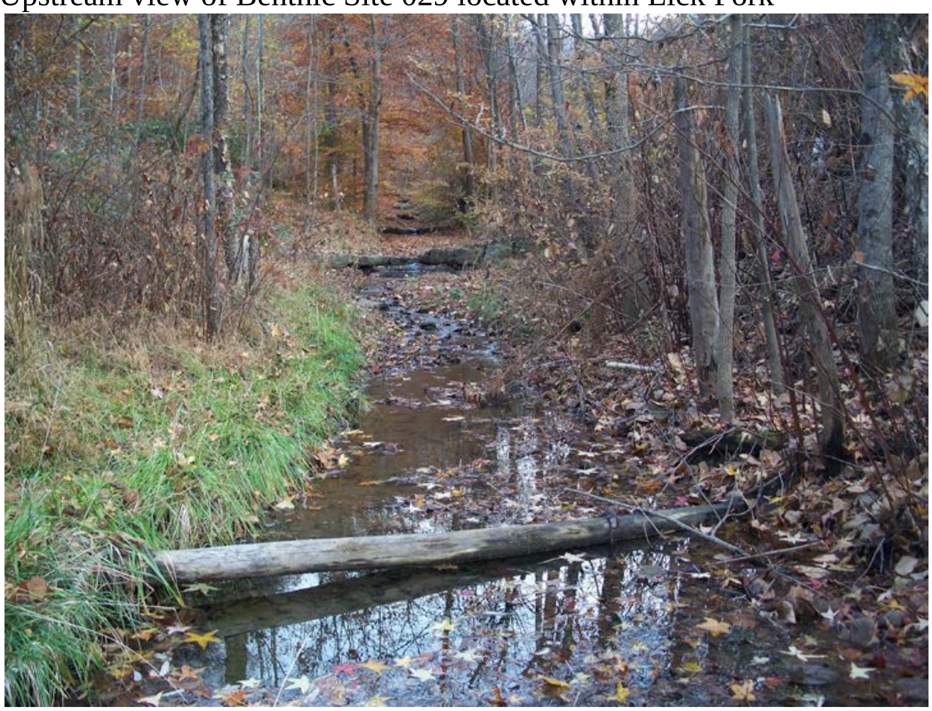
Downstream view of Benthic Site 028 within Lower Grapevine Fork.

Upstream view of Benthic Site 028 within Lower Grapevine Creek.



Downstream view of Benthic Site 029 located within Lick Fork

Upstream view of Benthic Site 029 located within Lick Fork



3.0 Methods and Materials

3.1 Habitat Analysis

Habitat characteristics were assessed in the field using the high gradient data sheets from the RBPs (Table 1). Habitat scores were rated for ten parameters in three categories (primary, secondary and tertiary). Primary components analyze substrate and instream cover, secondary components assess channel morphology, and tertiary components address riparian zones and stream banks. Primary and secondary parameters are evaluated a on a numerical scale of 0 to 20, while tertiary components are ranked on a scale of 0-10.

Primary and secondary numerical scores range from optimal (20 to 16), suboptimal (15 to 11), marginal (10 to 6) and poor (5 to 0). Tertiary category ranges are optimal (10 to 9), suboptimal (8 to 6), marginal (5 to 3) and poor (2 to 0). Primary components relate to substrate and instream cover. Habitat categories include epifaunal substrate/available cover, embededdness, and velocity-depth regimes. Categories are described below;

- Epifaunal substrate and available cover refers to the quantity and variety of natural structures in the stream. The greater variety of submerged structures increases habitat conditions for aquatic organisms by increasing niche space.
- Embeddedness is the extent in which rocks and snags are surrounded by the substrate of the stream bottom. Generally when there is a high degree of embeddedness there is less surface area available to macroinvertebrates and fishes, decreasing options for shelter, spawning and egg incubation.
- Velocity depth regime determines the presence of stable aquatic environments within stream channels. High quality streams have four flow patterns present including slow-deep, slow-shallow, fast-deep and fast-shallow.

The secondary, channel morphology, components include sediment deposition, channel flow status, channel alteration and frequency of riffles and are described below;

- Sediment deposition is the amount of sediment that has accumulated within the channel and the resultant channel alterations. High quantities of sediment deposition are indicators of an unstable and changing environment that is not suitable for many aquatic organisms.
- Channel flow status refers to the amount of water filling the channel bed. Flow status will fluctuate during different seasons. When water does not fill much of the streambed, the amount of suitable substrate for aquatic organisms is limited.
- Channel alteration assesses the large-scale changes in stream morphology. Altered channels have less habitat areas for aquatic organisms and plants than naturally occurring channels. Examples of

channel alteration include artificial embankments, artificial bank stabilization, and rip-rap.

- Frequency of riffles or bends measures the sequence of riffles within the stream. High quality habitat areas and diverse fauna are located in riffle areas, thus a greater frequency of riffles generally increases diversity of aquatic communities.

Tertiary components relate to streambanks and surrounding vegetative communities. Categories include bank stability, bank vegetative protection and riparian zone width and are presented below:

- Bank stability measures the degree of erosive sediment that enters the stream. Eroding streambanks indicate that there may be a sediment transport problem, a lack of vegetative cover, and decreased organic contribution.
- Bank vegetative protection assesses the degree of vegetative cover on streambanks. The establishment of vegetation decreases the erosion potential and provides food and refuge to aquatic organisms
- Riparian vegetation zone is the width of natural vegetation from the edge of the streambank throughout the riparian zone. The riparian zone controls erosion, generates habitat and nutrient inputs into the stream, and buffers pollutants from runoff or erosion.

Table 1. Habitat field assessment sheet for high gradient streams (RBPs).

	Habitat Parameter	Condition Category			
		Optimal	**Suboptimal**	**Marginal**	**Poor**
Primary Components	**1. Epifaunal Substrate and Available Cover**	> 70% substrate favorable for epifaunal colonization and fish cover, mix of snags, submerged logs, undercut banks, or cobble and at stage to allow full colonization potential (logs are not new fall and not transient).	40-70% mix of stable habitat; has full colonization potential; adequate habitat for population maintenance; presence of additional substrate in the form of new fall, not yet prepared for colonization.	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	2. Embeddedness	Gravel, cobble, and boulder particles 0-25% surrounded by fine sediment. Cobble layering provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.	Gravel, cobble, and boulder particles more than 75% surrounded by fine sediment.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	3. Velocity-Depth Combinations	Four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing, score Lower than if missing other regimes).	2 of 4 regimes present (if fast-shallow or slow-shallow missing, score low).	Determined by 1 velocity/depth regime (usually slow-deep).
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Table 1 Continue. Habitat Field Assessment sheets for High Gradient streams (RBPs).

	Habitat Parameter	Condition Category			
		Optimal	**Suboptimal**	**Marginal**	**Poor**
Secondary Components	**4. Sediment Deposition**	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fines on bars; 30-50% of bottom affected; deposits at obstructions and bends; moderate deposition of pools.	Heavy deposits of fines, increased bar development; > 50% of bottom changing frequently; pools almost absent due to deposition.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	5. Channel Flow Status	Water reaches base of both Lower banks, and minimal amount of channel substrate is exposed.	Water fills > 75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel, mostly present as standing pools.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments: evidence of past channelization (dredging) may be present, recent channelization (within 20 yrs) not present.	Channelization may be extensive; embankments or shoring structures present on both banks: and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement: over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	7. Frequency of riffles or bends	Riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1; variety of habitat is key. In streams where riffles are continuous, boulder or natural obstruction placement is key.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of > 25.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Tertiary Components	**8. Bank Stability (left and right bank)**	Banks stable; evidence of erosion or banks failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; frequent; obvious bank sloughing; 60-100% of bank has erosion scars.
	Score per bank	10 9	8 7 6	5 4 3	2 1 0
	9. Vegetation Protection	> 90% of streambank surfaces and riparian zone covered by native vegetation; vegetative disruption minimal or not evident; almost all plants allowed to grow naturally.	70-90% of streambank covered by native vegetation, one class of plants is not well-represented; disruption evident but not affecting plant growth potential.	50-70% of streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or cropped vegetation common.	Less than 50% of the streambank surfaces covered by vegetation; disruption is very high.
	Score per bank	10 9	8 7 6	5 4 3	2 1 0
	10. Riparian Vegetative Zone	Riparian zone > 18 meters; human activities (parking lots, roadbeds, clear-cuts) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Riparian zone width 6-12m; human activities impacted zone a great deal.	Riparian zone < 6m; little riparian vegetation due to human activities.
	Score per bank	10 9	8 7 6	5 4 3	2 1 0

3.2 Benthic Macroinvertebrate Collection and Analysis

Benthic sampling was initiated by walking the stream and assessing the characteristics (frequency of riffle/run, pools, etc.). A 100 meter representative stream reach was chosen based on these characteristics. Samples were collected with a 0.5 meter rectangular dipnet. The bottom substrate was disturbed for approximately $0.25m^2$ by foot and hand in front of the net. Coarse Particular Organic Matter (CPOM) and Fine Particulate Organic mater (FPOM) were allowed to flow into the dipnet. After suspended materials settled the net was lifted from the sample location. Net contents were washed into a three-gallon bucket. Larger materials (pebbles > 20 mm, leaves or sticks) were washed and discarded from the sample in the field. This procedure was repeated until a minimum of 2 m^2 composited sample was collected. Once the $2m^2$ was collected, the sample was poured through a #30 mesh sieve to remove excess water and fine soil particles. The sieve was rinsed into a one liter sample container and preserved with 95% ethanol.

Benthic macroinvertebrate sample sorting and identification was based on a 200 ± 20% organism sub-sample procedure. Samples were rinsed and spread evenly over a 6cm x 6cm gridded, 36 cm x 30 cm sorting pan, and allowed to soak in water. A random number list was generated and used to determine the grid number that would be picked. This was repeated until a sub-sample of 220 organisms was removed. All grids were selected and picked (complete pick) in situations where 200 organisms were not present. Species were identified to family level using the key in Aquatic Insects of North America.

A benthic bench sheet was completed and the data was entered into the WVSCI Calculation Database for Contractors and Consultants. The West Virginia Stream Condition Index (WVSCI) was calculated. The WVSCI is used as an indicator of ecosystem health, and can identify impairment with respect to a reference. The WVSCI includes six metrics that represent elements of the structure and function of the macroinvertebrate assemblage. The six metrics include EPT (Ephemeroptera, Plecoptera, Trichoptera) Taxa, Total Taxa, % EPT, % Chironomidae, % Two Dominant Taxa and HBI (Hilsenoff Family Biotic Index. Ranges and ranks of the WVSCI are shown in Table 2.

Table 2. Scoring Criteria for the WVSCI.

WSCI Scoring Criteria	
Not-Impaired	78.01-100 = Very Good
	68.01-78.00 = Good
	60.61-68.00 = "Gray Zone"
Impaired	45.01-60.60 = Slightly Impaired
	22.01-45.00 = Moderately Impaired
	0-22.00 = Severely Impaired

3.3 Channel Material Assessment

Channel substrates influence benthic habitats. Generally, sandy or finer substrates are poor habitats due to the shifting nature of bed, a lack of suitable attachment sites, and poor food conditions.

Channel materials were assessed using the modified Wolman pebble count method (Rosgen, 1993a). The sampling method is based on the frequency of riffle/pools occurring within a channel reach that is 20 to 30 bankfull channel widths in lengths. The percent of channel features per reach were determined. The sample size was at least 100 observations. The particles were sampled in the Zig-Zag method due to the stream width (<2m). Samples were selected on the "first blind touch" to avoid the potential for bias. This technique ensures that a representative pebble count is obtained through proportional sampling of channel features.

3.4 Water Quality Assessment

Water samples were collected on November 11, 2008. The samples were sent to Appalachian States Analytical, L.L.C. for analysis. The parameters analyzed are Total Suspended Solids (TSS), Total Iron (Fe), Alkalinity, Total Manganese (Mn), Specific Conductance (SC), Total Aluminum (Al), Lab pH, Total Hot Acidity, Dissolved Aluminum (Al), and Total Dissolved Solids (TDS).

Water quality is an important factor in determining the viability of aquatic habitats. Poor water quality is a limiting factor for intolerant benthic macroinvertebrates. Table 3 below shows the freshwater organisms ranges for some water quality parameters.

Table 3. Water quality ranges for freshwater organisms.

Water Quality Parameter	Range for Freshwater Organisms	Source
pH	6 to 9	Stumm and Morgan 1996
Total Hot Acidity	Not available	
Alkalinity	10 to 400 mg/L	Jenkins et al. 1995
TDS	Not available	
Iron	< 1 mg/L	Jenkins et al. 1995
Manganese	< 1.0 mg/L	Heinen 1996; Jenkins et al. 1995
Aluminum	< 0.087 mg/L	Jenkins et al. 1995
TSS	Not available	

4.0 Results

4.1 Habitat Assessment

Habitat assessment results conducted on Lick Fork and Lower Grapevine Creek for three subsequent years were compared for annual monitoring purposes. Assessments were performed on November 11, 2008; December 11, 2007; and November 9, 2006. A summary of habitat analyses per site is discussed below and presented in Tables 4 and 5.

Lick Fork was typically characterized with optimal and suboptimal conditions for primary and secondary components, while tertiary ratings were generally optimal and suboptimal. Primary component scores indicated that the stream has some cover for aquatic organisms, stable channel materials, limited embeddedness, and the presence of all 4 velocity-depth regimes. Secondary component scores indicated that the stream has limited sediment deposition and water flowing in the majority of the channel, with riffles occurring relatively frequently. Primary and Secondary component rating for Lick Fork typically showed a slight increased or remained constant from 2006 to 2008. Exceptions include Sediment Deposition and Channel Flow Status. In 2008 there was a reported increase in bar formation, while the channel flow was lower than previous years. The low flow is likely contributed to the dry year of 2008.

Tertiary components were characterized as optimal and suboptimal. This indicated that streambanks were stable and covered with a sufficient amount of vegetation, although non-native species were present. The riparian zone width was generally rated as adequate. Lick Fork received an overall habitat rating of 158 in 2008, 162 in 2007, and in 145 in 2006.

Lower Grapevine Creek was typically characterized with optimal and suboptimal conditions for primary and secondary components, while tertiary ratings were generally suboptimal and marginal. Primary component scores indicated that the stream has some cover for aquatic organisms, stable dominant channel materials, limited embeddedness, and the presence of 3 velocity-depth regimes. Secondary component scores indicated that the stream had limited sediment deposition and water flowing in the entire channel, with riffles occurring relatively frequently. Channel alteration was the only secondary category that received inconsistent scores. Assesment results from 2008 and 2007 were directly comparable and consistently higher than 2006 data. The only category with a substantially lower rating was Channel Flow Status, which is likely a direct result of the dry year.

Tertiary components were primarily characterized as suboptimal and marginal. This indicated that streambanks were moderately stable but some erosion areas were present. Streambanks had insufficient riparian zone widths and were covered with vegetation, although some non-native species were present and bare patches visible. Riparian zone width was the most inconsistently rated tertiary component. Results are comparable for all years, except for Riparian Zone width, which was rated poor in 2006 and marginal in

2007 and 2008.The overall habitat rating in 2008 was 147, in 2007 was 149, and in 2006 was 116.

Table 4. Habitat scores per year on Lick Fork.

Component	Habitat Category	Lick Fork Year 08	Year 07	Year 06
Primary Range (20 - 0)	**1. Epifaunal Substrate**	18	16	14
	2. Embeddedness	16	14	12
	3. Velocity/Depth Regime	15	16	15
Secondary Range (20 - 0)	**4. Sediment Deposition**	11	13	14
	5. Channel Flow Status	13	16	16
	6. Channel Alteration	18	17	10
	7. Frequency of Riffles	16	16	18
Tertiary Range (10 - 0)	**8a. Left Bank Stability**	8	9	8
	8b. Right Bank Stability	8	9	8
	9a. Vegetative Protection (Left Bank)	9	9	9
	9a. Vegetative Protection (Right Bank)	9	9	9
	10a. Riparian Zone (Left)	8	9	2
	10b. Riparian Zone (Right)	9	9	10
	Overall Score	**158**	**162**	**145**

* Total Scoring Categories: Optimal: 200-166, Suboptimal: 165-113, Marginal: 112-61, Poor: < 61

Table 5. Habitat scores per year on Lower Grapevine Creek.

Component	Habitat Category	Lower Grapevine Creek		
		Year 08	Year 07	Year 06
Primary Range (20 - 0)	1. Epifaunal Substrate	16	15	11
	2. Embeddedness	16	16	14
	3. Velocity/Depth Regime	15	15	13
Secondary Range (20 - 0)	4. Sediment Deposition	17	17	14
	5. Channel Flow Status	12	17	18
	6. Channel Alteration	15	14	9
	7. Frequency of Riffles	17	18	14
Tertiary Range (10 - 0)	8a. Left Bank Stability	8	7	6
	8b. Right Bank Stability	7	6	5
	9a. Vegetative Protection (Left Bank)	6	8	5
	9a. Vegetative Protection (Right Bank)	8	6	5
	10a. Riparian Zone (Left)	5	5	1
	10b. Riparian Zone (Right)	5	5	1
Overall Score		**147**	**149**	**116**

4.2 Benthic Analysis

Benthic sampling was conducted on Lick Fork and Lower Grapevine Creek for three subsequent years for annual monitoring purposes. Sampling was performed on November 11, 2008, December 11, 2007, and November 9, 2006. A summary of benthic results per site is discussed below and presented in Table 6. The metric scoring per year and site is portrayed in Table 7.

A total of 201 benthic organisms, representing 6 orders and 11 families, were identified for Lick Fork in 2008. Elmidae and Chironomidae were the dominant species identified. No Ephemeroptera species were identified in the subsample, Plecoptera were relatively abundant but similar, while Trichoptera were abundant but also not diverse. Results from 2008 yielded a WVSCI metric score of 59.42, while 2007 data yielded a score of 71.4 and 2006 data yielded a score of 57.93.

A total of 238 benthic organisms, representing 4 orders and 12 families, were identified for Lower Grapevine Creek in 2008. Elmidae species represented greater than half of the identified sample. Plecoptera and Trichoptera species were common but similar, while only one Ephemeroptera species was identified. In 2008 benthic metrics yielded a WVSCI score of 68.03, while in the WVSCI was 79.49 in 2007 and which is just over the ranking threshold for “good” stream conditions. The 2008 WVSCI score and dominant organisms are comparable to data from previous years

Table 6. Total number of identified benthic taxa per site and year.

Scientific Name	Lick Fork			Lower Grapevine		
	Year 08	Year 07	Year 06	Year 08	Year 07	Year 06
Collembola						
Entomobryidae		1				
Isotomidae		1				
Coleoptera						
Elmidae	47	10	2	113	20	33
Chrysomelidae		1				
Diptera						
Athericidae				1		
Ceratopogonidae	2					
Chironomidae	56	6	13	17	14	11
Empididae	4	1	1			1
Simuliidae				1		
Tipulidae	8		4		3	1
Oligochaeta	1	2	4		1	37
Ephemoroptera						
Ameletidae					1	
Baetidae		3				6
Caenidae		1			5	
Ephemerellidae					1	
Isonychiidae				1		16
Plecoptera						
Capniidae		4		38	40	40
Chloroperlidae				7		
Leuctridae	8			8		
Peltoperlidae					1	
Perlodidae					1	
Taeniopterygidae	19	14	6	19	12	24
Trichoptera						
Hydropsychidae	26	27	164	31	16	32
Philopotamidae	30	7	31	1	11	12
Psychomyiidae				1		
Megaloptera						
Corydalidae					2	
Odonata						
Gomphidae	1					1
Total	**201**	**71**	**225**	**238**	**128**	**214**

Table 7. Benthic metric scores per site and year.

	Lick Fork			Lower Grapevine		
Benthic Metrics	**Year 2008**	**Year 2007**	**Year 2006**	**Year 2008**	**Year 2007**	**Year 2006**
% 2 Dominant Taxa Score	78.17	75.66	21.27	58.3	84.73	102.1
% Chironomidae Score	73.53	93.9	95.85	94.46	90.6	96.5
% EPT Score	46.01	80.4	100.04	49.87	76.99	68.03
HBI Score	78.04	77.72	71.03	89.43	91.76	77.14
EPT Taxa Score	30.77	46.15	23.08	61.54	69.23	46.15
Total Taxa Score	50	54.55	36.36	54.55	63.64	54.55
WVSCI	**59.42**	**71.4**	**57.93**	**68.03**	**79.49**	**73.73**

* WVSCI Scores (Not Impaired): Very good: >78, Good: 68.01-78, Gray zone: 60.61-68
* WVSCI Scores (Impaired): Slightly: 45.01-60.6, Moderately: 22.01-45, Severe: <22

4.3 Channel Materials

To assess channel substrate materials, a pebble count was conducted for the benthic sites within Lick Fork and Lower Grapevine Creek. Dominant channel materials for both streams were gravel followed by cobble. Results were relatively consistent for the sampling years. Percentages of measured substrates are shown below in Table 8.

Table 8. Percent Substrate based on total count per site and year.

Benthic Site	**silt/clay (%)**	**sand (%)**	**gravel (%)**	**cobble (%)**	**boulder (%)**	**bedrock (%)**
Lick Fork 2008	0	13	64	19	4	0
Lick Fork 2007	3	8	68	17	4	0
Lick Fork 2006	4	9	45	34	8	0
Lower Grapevine 2008	0	18	56	20	6	0
Lower Grapevine 2007	0	17	52	25	6	0
Lower Grapevine 2006	3	2	52	31	13	0

4.4 Water Quality

Water samples were collected from Site 029 located in Lick Fork and Site 028 located in lower Grapevine Creek. Water quality results for the two sites are listed below in Table 9.

Table 9. Water Quality results for Site 029 ('08) /Site 012 ('07) / Site 006 ('06) and Site 028 ('08) / Site 014 ('07) / Site 005 ('06)

Sample ID	DATE	TSS (mg/L)	Fe, Total (mg/L)	Alkalinity (mg/L)	Mn, Total (mg/L)	SC (umhos/cm)	Al, Total (mg/L)	pH, Lab	Total Hot Acidity (mg/L)	Al, Dissolved (mg/L)	TDS (mg/L)
028 (2008)	11/11/08	3	<0.03	73	<0.01	1360	<0.05	7.70	<1.0	<0.05	1314
014 (2007)	12/12/07	3	0.03	45	0.50	1590	0.16	7.14	<1.0	0.05	1114
005 (2006)	11/09/06	3	0.03	100	0.75	1290	0.40	7.15	<1.0	0.30	1524
029 (2008)	11/11/08	6	<0.03	54	0.03	3000	<0.05	7.69	<1.0	<0.05	2614
012 (2007)	12/12/07	42	0.08	60	0.06	1030	0.15	7.17	<1.0	0.06	722
006 (2006)	11/09/06	2	<0.03	88	0.21	764	0.22	7.20	<1.0	0.08	678

5.0 Discussion and Conclusions

An optimal benthic community has good species diversity, the presence of all functional feeding groups, and high WVSCI scores. A strong macroinvertebrate community is dependent on water quality, physical habitat characteristics, riparian vegetation and the amount of external disturbances. Optimal physical habitat conditions consists of a large percentage of cobble sized particles with minimal embeddedness and sediment deposition. Stable banks with good vegetation coverage and an adequate riparian buffer zone are necessary for increasing nutrient cycling and minimizing the erosion potential.

5.1 Channel Materials

Habitat assessments conducted for all monitoring years generated "Suboptimal" Total Habitat scores for both Lick Fork and Lower Grapevine Creek. Assessments performed in 2008 and 2007 were more consistent and generally yielded higher scores than 2006 assessments. Lick Fork received higher scores than Lower Grapevine Creek during all assessment years, largely due to higher tertiary component scores.

Assessment results indicate that habitat characteristics of Lick Fork are best described as "Suboptimal." The site received an overall habitat rating of 158 in 2008, 162 in 2007, and 145 in 2006. Primary, secondary, and, tertiary components were generally rated on the lower end of the optimal scale or the higher end of the suboptimal scale. General consistency among component ratings indicate that Lick Fork has not experienced any new stability issues and is maintaining equilibrium.

Assessment results from 2008 to 2006 indicate that habitat characteristics for Lower Grapevine Creek are best described as "Suboptimal." The site received an Overall Habitat Rating of 147 in 2008, 149 in 2007, and 116 in 2006. Primary and secondary components were generally rated optimal and suboptimal, while tertiary components received suboptimal and marginal scores. Component scores for 2008 and 2007 were directly comparable, while scores for 2006 were typically slightly lower.

5.2 Benthic Analyses

Benthic assessments conducted in 2008 correspond well to 2006 assessments for both Lick Fork and Lower Grapevine Creek. Analyses from 2007 were not directly comparable because the 200 organisms required for complete WVSCI metric analyses were not identified.

Analyses from 2008 and 2006 characterize Lick Fork as "Slightly Impaired." Results from 2007 were considered skewed because only 71 out of the required 200 organisms were identified for analyses. Analyses yielded a WVSCI score of 59.42 in 2008, 71.4 in 2007, and 57.93 in 2006. Dominant species identified for all sampling years were relatively consistent with Elmidae, Chironomidae, Taeniopterygidae, Hydropsychidae, and Philopotamidae representing the majority of organisms.

Analyses from 2008 and 2006 characterize Lower Grapevine Creek as in "Good" condition. In 2007 only 128 out of the required 200 organisms were identified, thus results were considered skewed. Analyses yielded a WVSCI score of 68.03 in 2008, 79.49 in 2007, and 73.73 in 2006. Results from 2008 and 2006 analyses were directly comparable, with the dominant species identified overlapping for both years. These dominant species included: Elmidae, Chironomidae, Capniidae, Taeniopterygidae, and Hydropsychidae.

5.3 Conclusions

Annual monitoring results indicate that ecological stream health of Lick Fork and Grapevine Creek has remained relatively consistent from 2008 to 2006. The dominant benthic organisms identified for both streams were generally more pollution tolerant organisms. Lower Grapevine Creek had greater diversity and was in better stream health. The number of organisms per amount of sample was significantly greater within Lower Grapevine Creek, while it was much more difficult to obtain the 200 organism requirement for Lick Fork.

Future benthic surveys will allow for comparisons to past benthic surveys and habitat assessments. These comparisons will be used to monitor and assess stream conditions and indicate improvements or impairments to the ecological health of the stream.

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