BENTHIC MACROINVERTEBRATE, HABITAT, AND WATER CHEMISTRY STUDY OF STATIONS LOCATED ON WILEY BRANCH, OCTOBER 2010.

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BENTHIC MACROINVERTEBRATE, HABITAT, AND WATER CHEMISTRY STUDY OF STATIONS LOCATED ON WILEY BRANCH, OCTOBER 2010

INTRODUCTION

Argus Energy-WV, LLC has constructed several valley fills on unnamed tributaries of Wiley Branch, near the Wayne/Lincoln County line, at Harts, West Virginia. Because the fills directly disturbed several hundred feet of stream, Argus Energy was required to monitor the status of Wiley Branch as part of the mitigation process for stream disturbance and relocation. This monitoring has involved analyzing benthic macroinvertebrate and fisheries populations, physical and chemical water quality, and habitat data. Stations on Wiley Branch have been sampled since 2000. In this current study, two stations were sampled for benthic macroinvertebrates, physical and chemical water quality, and stream habitat. During the October 2009 sampling event, both stations were sampled, therefore, comparisons can be made between the current data and the previous year's data. The results from the previous study may be found in the report titled: "*Benthic Macroinvertebrate, Habitat, and Water Chemistry Study on Stations Located on Wiley Branch, October 2009*" (REI Consultants, Inc., 2010).

Policies within the West Virginia Department of Environmental Protection (WV-DEP) require biological surveys of streams prior to, and after issuance of National Pollutant Discharge Elimination System (NPDES) permits to adequately determine stream biota and potential biological development. This study was conducted in order to add to the ever-growing database of benthic macroinvertebrate, physical habitat, and water chemistry data of streams located both within, and downstream of mining operations at Argus Energy. A secondary purpose of the study was to satisfy the requirements of the United States-Environmental Protection Agency (US-EPA) for the submitting of biological data for documenting the status of the streams for disturbance, and is specific for the stations sampled on those streams.

Biological data, such as aquatic macroinvertebrate and fish populations, in conjunction with physical and chemical water quality, and habitat data, provide valuable information that are used in the permit review process and are ultimately used to assist in establishing NPDES discharge limitations. These data also act as a powerful monitoring tool in identifying possible pollutant sources and/or habitat alterations and subsequent effects.

LOCATION OF STUDY SITES

The study area was located near the town of Harts, West Virginia, in the vicinity of the Wayne/Lincoln County line. Two stations were sampled in order to evaluate and monitor the effects of several valley fills located on unnamed tributaries of Wiley Branch. Wiley Branch is a perennial tributary of the East Fork of Twelvepole Creek. One station was located near the headwaters on the left fork of Wiley Branch, upstream of most mining disturbances, and is referred to as BM-UWB (PHOTOS 1 & 2). A sediment pond has been constructed just upstream of this sampling point, but no fills currently are present upstream of this sampling point. Another station was located near the mouth of Wiley Branch, downstream from mining disturbances, and is referred to as BM-DWB (PHOTOS 3 & 4; FIGURE 1).

METHODS OF INVESTIGATION

A modified EPA Field operations and methods manual for measuring the ecological condition of wade able streams (EPA/620/R-94/004F), EPA Rapid bioassessment protocols for use in streams and wade able rivers (EPA 841-B-99-002), as well as methods outlined in "Interim Chemical/Biological Monitoring Protocol for Coal Mining Permit Applications" (January 19, 2000, US EPA, Region III) were followed in the collection of the benthic macroinvertebrate specimens, water chemistry, and habitat evaluations. Measurements for flow, physical water quality, and chemical water quality were collected on October 7th, 2010 at this station. Benthic macroinvertebrate samples were collected, and the physical habitat of each station was evaluated. The individual methodologies are described below.

Physical Water Quality

Physical water quality was analyzed on-site at each station. Water temperature, pH, and conductivity were measured with an Oakton 300 series pH/CON multi-parameter probe. Dissolved Oxygen was measured using a Hach HQ30d flexi LDO meter. Flow was measured with a Marsh-McBirney™ Model 2000 portable flow meter. Stream widths, depths, and velocities were measured, and the resulting average discharge was reported for each station.

Water Chemistry

Water chemistry samples were collected at each station and returned to R.E.I. Consultants, Incorporated for processing. Parameters analyzed included acidity, alkalinity, total hardness, nitrate/nitrite, chloride, sulfate, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), total phosphorus, dissolved organic carbon, total aluminum, dissolved aluminum, antimony, arsenic, beryllium, cadmium, calcium, chromium, copper, total iron, dissolved iron, lead, total manganese, dissolved manganese, magnesium, mercury, nickel, potassium, selenium, silver, sodium, thallium, and zinc.

Habitat

Habitat was assessed and rated on ten parameters in three categories using a modified version of the EPA Rapid bioassessment protocols for use in streams and wade able rivers (EPA 841-B-99-002). Several habitat measurements were calculated for each of the sampling stations. The individual parameters are described over the next few pages.

Parameter 1. Epifaunal Substrate/Available Cover - Includes the relative quantity and variety of natural structures in the stream. A wide variety and/or abundance of submerged structures in the stream provide macroinvertebrates and fish with a large number of niches, thus increasing habitat diversity.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
1. Epifaunal Substrate & Available Cover	Greater than 70% of substrate la-oracle for epifaunal colonization and fish cover, mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at a stage to allow full colonization potential (i.e. logs/snags that are not new fall and not transient.)	40 to 70% mix of stable habitat well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale.)	20 to 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

Parameter 2. Embeddedness - Refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
2. Embeddedness	Gravel, cobble and boulder particles are 0-25% surrounded by fine sediment.	Gravel, cobble and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble and boulder particles are 50-75% surrounded by fine sediment	Gravel, cobble and boulder particles are 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

Parameter 3. Velocity-Depth Combinations - Relates to the ability of a stream to provide and maintain a stable aquatic environment. The best streams in most high-gradient regions will have all 4 flow patterns present: (1) slow-deep, (2) slow-shallow, (3) fast-deep, and (4) fast-shallow.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
3. Velocity-Depth Combinations	All four velocity/depth patterns present (slow-deep, slow-shallow, fast-deep, fast-shallow.)	Only 3 or 4 velocity/depth patterns present (if fast-shallow is missing, score lower than if missing other regimes.)	May be only 2 velocity/depth patterns present (if fast-shallow or slow-shallow are missing, score low.)	Dominated by one velocity/depth pattern (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

Parameter 4. Sediment Deposition - Measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. Deposition occurs from large-scale movement of sediment. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
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 to 30% of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, sand or fine sediment on old and new bars 30 to 50% of the bottom affected; sediment deposits at obstructions, constrictions and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameter 5. Channel Flow Status - The degree to which the channel is filled with water. The flow status will change as the channel enlarges (e.g., aggrading stream beds with actively widening channels) or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of suitable substrate for aquatic organisms is limited.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
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 substrates exposed.	Water fills 25-75% of the available channel and/or riffle substrate are mostly exposed	Very little water in channel and 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

Parameter 6. Channel Alteration - A measure of large-scale changes in the shape of the stream channel. Channel alteration is present when artificial embankments, rip-rap, and other forms of artificial bank stabilization or structures are present. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
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, i.e. dredging (greater past 20yrs) may be present, but recent channelization is not present.	Channelization may be extensive ; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted.	Banks shared with gabion or cement, over 80% of the stream reach channelized and disrupted. In stream 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

Parameter 7. Frequency of Riffles (or bends) - Measures the sequence of riffles and thus the heterogeneity occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna, therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent, ration of distance between riffles divided by width of the stream <7:1 (generally 5 to 7): variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	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**

Parameter 8. Bank Stability - Measures whether the stream banks are eroded (or have the potential for erosion). Signs of erosion include crumbling, un-vegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of sediment movement and deposition, and suggest a scarcity of cover and organic input to streams.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
8. Bank Stability (score each blank) NOTE: determine left or right side by facing downstream.	Bank stable; evidence of erosion or bank 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, "raw" areas frequent along straight sections and bends; obvious bank sloughing ; 60-100% of bank has erosional scars.
SCORE: (Left Bank)	**LB 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
SCORE: (Right Bank)	**RB 10 9**	**8 7 6**	**5 4 3**	**2 1 0**

Parameter 9. Bank Vegetative Protection - Measures the amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone. This parameter supplies information on the ability of the bank to resist erosion as well as some additional information on the uptake of nutrients by the plants, the control of instream scouring, and stream shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or rip-rap.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
9. Bank Vegetative Protection (score each bank)	More than 90% of the stream bank surface and immediate riparian zones covered by native vegetation, including trees, understory shrubs or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the stream bank surfaces covered by native vegetation, but one class of plant is not well represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the stream bank surface covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE: (Left Bank)	LB 10 9	8 7 6	5 4 3	2 1 0
SCORE: (Right Bank)	RB 10 9	8 7 6	5 4 3	2 1 0

Parameter 10. Riparian Vegetation Zone Width - Measures the width of natural vegetation from the edge of the stream bank out through the riparian zone. The vegetative zone serves as a buffer to pollutants entering a stream from runoff, controls erosion, and provides habitat and nutrient input into the stream.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
10. Riparian Vegetation Zone Width (score each bank riparian zone)	Width of riparian zone > 18 meters; human activities (i.e. parking lots, roadbeds, clear cuts, lawns or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 8-12 meters; human activities have impacted zone a great deal.	Width of riparian zone < 6 meters; little or no riparian vegetation due to human activities.
SCORE: (Left Bank)	LB 10 9	8 7 6	5 4 3	2 1 0
SCORE: (Right Bank)	RB 10 9	8 7 6	5 4 3	2 1 0

Benthic Macroinvertebrate Collection

A modified EPA Rapid bioassessment protocols for use in streams and wade able rivers (EPA 841-B-99-002) as well as methods outlined in "Interim Chemical/Biological Monitoring Protocol For Coal Mining Permit Applications" (January 19, 2000, US EPA, Region III) were followed in the collection of the benthic macroinvertebrate specimens. At each station, macroinvertebrate collections were made on Thursday, October 7th, 2010, via a 0.1 m^2 Surber sampler and a 0.25 m^2 "D-Frame" kick-net sampler. Both samplers were fitted with a 500-µm mesh size net. Three quantitative replicates samples were collected in a riffle area by Surber sampling. Four semi-quantitative "D-Frame" kick-net samples were composited from a riffle/run area to equal 1-m^2 sampling area. Samples were placed in 1-liter plastic containers, preserved in 70% ethanol, and returned to the laboratory for processing. Samples were then picked under microscope and detrital material was discarded only after a second check to insure that no macroinvertebrates had been missed. All macroinvertebrates were identified to lowest practical taxonomic level and enumerated. Several benthic macroinvertebrate metrics were then calculated for each station.

The WV-SCI score and Modified Hilsenhoff Biotic Index (HBI) were calculated using the "200 organism" method. The whole kick sample was spread onto a 100-gridded sieve. Grids were selected at random and picked under dissecting scopes, until 200 (+/- 10%) insects were obtained. Those insects were then identified to the lowest possible taxonomic level, and this data was used to calculate the WV-SCI score and HBI. At least 25% of the 100 grids were picked and identified, and then extrapolated to determine the number of insects in the total kick sample. The number of grids picked for each sample is noted in the data table for that sample (TABLE 6A & 6B). The Surber samples were picked completely, and all insects were identified, but the Surber data was not utilized in the calculation of any metrics. All metrics, excluding the WV-SCI score and HBI, are calculated using the total station abundance.

Benthic Macroinvertebrate Metrics

Several benthic macroinvertebrate measurements were calculated for each of the sampling stations. The individual metrics are described below:

Metric 1. Taxa Richness - Reflects the health of the community through a measurement of the variety of taxa present. Generally increases with increasing water quality, habitat diversity, and habitat suitability. However, the majority should be distributed in the pollution sensitive groups, a lesser amount in the facultative groups, and the least amount in the tolerant groups. Polluted streams shift to tolerant dominated communities.

Metric 2. Modified Hilsenhoff Biotic Index - This index was developed by Hilsenhoff (1987) to summarize overall pollution tolerance of the benthic arthropod community with a single value. Calculated by summarizing the number in a given taxa multiplied by its tolerance value, then divided by the total number of organisms in the sample.

Metric 3. Ratio of Scraper and Filtering Collector Functional Feeding Groups - This ratio reflects the riffle/run community food base and provides insight into the nature of potential disturbance factors. The relative abundance of scrapers and filtering collectors indicate the periphyton community composition, availability of suspended Fine Particulate Organic Material (FPOM) and availability of attachment sites for filtering. Filtering collectors are sensitive to toxicants bound to fine particles and should be the first group to decrease when exposed to steady sources of bound toxicants.

Metric 4. Ratio of Ephemeroptera, Plecoptera, Trichoptera (EPT) and Chironomidae Abundances - This metric uses relative abundance of these indicator groups as a measure of community balance. Good biotic condition is reflected in communities having a fairly even distribution between all four major groups and with substantial representation in the sensitive groups Ephemeroptera, Plecoptera, and Trichoptera. Skewed populations with large amounts of Chironomidae in relation to the EPT indicates environmental stress.

Metric 5. Percent Contribution of Mayflies - This is a measure of community health. A community dominated by relatively few species and individuals of mayflies would possibly indicate environmental stress. An optimal benthic community contains many mayflies from many taxa.

Metric 6. Percent Contribution of Dominant Family - This is also a measure of community balance. A community dominated by relatively few species would indicate environmental stress. A healthy community is dominated by pollution sensitive representation in the Ephemeroptera, Plecoptera, and Trichoptera groups.

Metric 7. EPT Index - This index is the total number of distinct taxa within the Orders: Ephemeroptera, Plecoptera, and Trichoptera. The EPT Index generally increases with increasing water quality. The EPT index summarizes the taxa richness within the pollution sensitive insect orders.

Metric 8. Ratio of Shredder Functional Feeding Group and Total Number of Individuals Collected - Allows evaluation of potential impairment as indicated by the shredder community. Shredders are good indicators of riparian zone impacts.

Metric 9. Simpson's Diversity Index - This index ranges from 0 (low diversity) to almost 1 (high diversity). A healthy benthic macroinvertebrate community should have a higher Simpson's Diversity Index.

Metric 10. Shannon-Wiener Diversity Index - Measures the amount of order in the community by using the number of species and the number of individuals in each species. The value increases with the number of species in the community. A healthy benthic macroinvertebrate community should have a higher Shannon-Wiener Diversity Index.

Metric 11. Shannon-Wiener Evenness - Measures the evenness, or equitability of the community by scaling one of the heterogeneity measures relative to its maximal value when each species in the sample is represented by the same number of individuals. Ranges from 0 (low equitability) to 1 (high equitability).

Metric 12. The West Virginia Stream Condition Index (WV-SCI) is used as a primary indicator of ecosystem health and can identify impairment with respect to a reference (or natural) condition. The index includes six biological attributes (metrics) that represent elements of the structure and function of the bottom-dwelling macroinvertebrate assemblage.

Range	Rank	
78.01 to 100	"Very Good"	Not Impaired
68.01 to 78.00	"Good"	
60.61 to 68.00	"Gray Zone"	
45.01 to 60.60	"Slightly Impaired"	Impaired
22.01 to 45.00	"Moderately Impaired"	
0 to 22.00	"Severely Impaired"	

PHYSICAL DESCRIPTIONS

BM-UWB

This station was located near the headwaters of the left fork of Wiley Branch. The benthic sampling station was located at approximately 37° 59' 21.2" latitude and 82° 15' 53.2" longitude. The substrate has been comprised of approximately 33% sand, 35% gravel, 30% cobble, and 2% boulder. A relatively large portion of the upstream site contains bedrock, and therefore, the samples must be taken in the pool areas which contain much more sand. Also, since the previous sampling event in April 2009, a very large tree has fallen into the main channel just upstream of our historically sampled reach, and resulted in additional erosion and sediment deposition into our sampling location. This substrate composition would provide marginal to sub-optimal aquatic habitat, due to the high percentage sand present. If the percentage of sand continues to increase, aquatic habitat may become more limited. Stream flow was very low (0.016 cubic feet/second) during the sampling event. Physical water quality measurements in the field were as follows: water temperature 7.6°C, Dissolved Oxygen (DO) 10.2 mg/L, pH 7.47, and conductivity 275 µs (TABLE 1). Large Woody Debris (LWD) and Coarse Particulate Organic Matter (CPOM) were both heavy. This station was located in a forested area and had a partly shaded canopy of mixed tree species (PHOTOS 1 & 2).

BM-DWB

This station was located near the mouth of Wiley Branch. The benthic sampling station was located at approximately 37° 58' 48.2" latitude and 82° 16' 24.9" longitude. The substrate was comprised of approximately 30% sand, 35% gravel, and 35% cobbles. This substrate composition would provide marginal aquatic habitat, due to the high percentage of sand and the absence of boulders. If the percentage of sand continues to increase, aquatic habitat may become more limiting. Stream flow was fair (0.399 cubic feet/second) during the sampling event. Physical water quality measurements in the field were as follows: water temperature 8.3°C, Dissolved Oxygen (DO) 10.5 mg/L, pH 7.70, and conductivity 735 µs (TABLE 1). Large Woody Debris (LWD) was sparse and Coarse Particulate Organic Matter (CPOM) was heavy. Both the left and right banks were steep. This station was located in an industrial area, and had a partly-shaded canopy of mixed tree species (PHOTOS 3 & 4).

PHYSICAL AND CHEMICAL WATER QUALITY ANALYSIS

Water quality is a very important factor in determining the viability of the aquatic habitat. Although stream flow, substrate, and stream geomorphology are also important, water quality can be the most limiting function of a stream ecosystem. Heinen (1996) and Jenkins et al. (1995) address the ranges of some chemical water quality constituents within West Virginia watersheds.

Water Quality Parameter	Range for Freshwater Organisms	Source
pH	6 to 9	Stumm and Morgan 1996
Acidity	not available	
Alkalinity	10 to 400 mg/L	Jenkins et al. 1995
Calcium	4 to 160 mg/L	Heinen 1996
Chloride	< 230 mg/L	CSR 46 WVDEP
Conductivity	< 1,000 µs/L	REIC In-house recommendation
TDS	< 500 mg/L	WV State recommendation
Sulfate	< 850 mg/L	Jenkins et al. 1995
Iron	< 1 mg/L	Jenkins et al. 1995
Magnesium	< 28 mg/L	Heinen 1996
Manganese	< 1.0 mg/L	Heinen 1996; Jenkins et al. 1995
Selenium	< 0.005 mg/L	US EPA 1986
Aluminum	< 0.750 mg/L	CSR 47 WVDEP
Hardness	10 to 400 mg/L	Heinen 1996

Physical and chemical water quality was analyzed at both stations located on Wiley Branch. Physical water quality at the upstream station (BM-UWB) showed very low stream flow, adequate Dissolved Oxygen levels (DO), a somewhat alkaline pH value, and slightly elevated conductivity level (TABLE 1). Chemical water quality at this station revealed some trace amounts of nitrate/nitrite, chloride, sulfate, total aluminum, antimony, arsenic, calcium, copper, dissolved iron, total iron, dissolved manganese, total manganese, magnesium, nickel, potassium, and sodium. Levels of total phosphorus, dissolved aluminum, beryllium, cadmium, chromium, lead, mercury, selenium, silver, thallium, and zinc were all below detection limits. Levels of alkalinity, total hardness, Total Suspended Solids (TSS), and Total Dissolved Solids (TDS) were all desirable for this station. Level of acidity was elevated, but there was an adequate amount of alkalinity to offset for any pH problems (TABLE 2). Besides the very low stream flows, the overall water quality was considered desirable at this upstream station located on Wiley Branch, and no variables were at limiting levels.

Physical water quality at the downstream station (BM-DWB) showed fair stream flow, adequate Dissolved Oxygen levels (DO), an alkaline pH value, and a moderately elevated conductivity level (TABLE 1). Chemical water quality at this station revealed some trace amounts of nitrate/nitrite, chloride, sulfate, calcium, copper, dissolved iron, total iron, dissolved manganese, total manganese, magnesium, nickel, potassium, selenium, and sodium. Magnesium levels were elevated and above the recommended range suitable for aquatic organisms. Levels of total phosphorus, dissolved aluminum, total aluminum, antimony, arsenic, beryllium, cadmium, chromium, lead, mercury, silver, thallium, and zinc were all below detection limits. Levels of acidity, alkalinity, and TSS were desirable for this station. Level of total hardness was elevated and could be limiting to sensitive freshwater organisms. TDS and sulfates were elevated, but inside the range suitable for aquatic organisms (TABLE 2). Overall water quality was considered fairly desirable at this downstream station located on Wiley Branch.

A comparison was made between the October 2009 study and this current October 2010 study at the upstream station (BM-UWB) located on Wiley Branch. During the current study, this station generally showed much lower stream flow, lower dissolved oxygen (DO) level, a slightly higher pH value, and a higher conductivity level than the previous October study. Levels of acidity, alkalinity, total hardness, chloride, sulfate, TSS, TDS, antimony, arsenic, calcium, copper, total iron, dissolved manganese, total manganese, magnesium, nickel, potassium, and sodium have all increased slightly since the previous October study. Levels of nitrate/nitrite, total phosphorus, dissolved aluminum, total aluminum, and dissolved iron have all decreased since the previous October study. All other parameters have remained constant since the previous October study. Overall, water quality has remained similar at this station located on Wiley Branch, since the previous October 2009 sampling event.

A comparison was made between the October 2009 study and this current October 2010 study at the downstream station (BM-DWB) located on Wiley Branch. During the current study, this station generally showed a lower stream flow, similar dissolved oxygen (DO) level, a quite higher pH value, and a higher conductivity level than the previous October study. Levels of acidity, alkalinity, toal hardness, nitrate/nitrite, sulfate, TSS, TDS, calcium, copper, magnesium, nickel, potassium, and sodium have all increased slightly since the previous October study. Levels of chloride, total phosphorus, total aluminum, dissolved iron, total iron, dissolved manganese, total manganese, and selenium have all decreased since the previous October study. All other parameters have remained constant since the previous October study. Overall, water quality has remained similar at this station located on Wiley Branch, since the previous October 2009 sampling event.

HABITAT RESULTS

BM-UWB

This station, located near the headwaters of the left fork of Wiley Branch, received poor to sub-optimal substrate and instream cover (primary) ratings, poor to optimal channel morphology (secondary) ratings, and marginal to sub-optimal riparian and bank structure (tertiary) ratings (TABLE 3). "Epifaunal Substrate and Available Cover" was sub-optimal, indicating a 40-70% mix of stable habitat. "Embeddedness" was marginal, due to copious amounts of silt surrounding gravel, cobble, and boulders. "Velocity-Depth Regime" was poor, indicating the sample site was dominated by one velocity/depth regime, in this case slow/shallow. "Sediment Deposition" was poor, because heavy deposits of silt and sand affected greater than 50% of the channel. "Channel Flow Status" was poor. "Channel Alteration" was optimal and "Frequency of Riffles" was poor. Both banks were moderately stable. "Bank Vegetative Protection" was marginal on both banks. "Riparian Zone Width" was optimal on the left bank and marginal on the right bank. At the time of sampling, this site was full of silt from the building of a haul road and slash was present. This station scored a 76 out of a possible 200, and would provide marginal aquatic habitat.

BM-DWB

This station located on Wiley Branch received marginal to sub-optimal substrate and available cover (primary) ratings, sub-optimal to optimal channel morphology (secondary) ratings, and poor to optimal riparian and bank structure (tertiary) ratings (TABLE 3). "Epifaunal Substrate and Available Cover" was sub-optimal, indicating a 40-70% of a mix of stable habitat. "Embeddedness" was sub-optimal, since gravels and cobbles were 25-50% surrounded by deposits of fine materials. "Velocity-Depth Regime" was sub-optimal, indicating that only two of the four depth regimes were present within the reach, in this case no deep sections. "Sediment Deposition" was sub-optimal, since 5-30% of the channel bottom was affected by deposits of fine materials. "Channel Flow Status" was sub-optimal, since water only filled >75% of the available channel. "Channel Alteration" was optimal. "Frequency of Riffles" was optimal, since riffles and bends were frequent throughout the reach. Both banks were moderately stable. "Bank Vegetative Protection" was sub-optimal on both banks. "Riparian Zone Width" was optimal for the left bank and poor for the right bank, due to a road on one side. This station scored a 137 out of a possible 200, and would provide sub-optimal aquatic habitat.

BENTHIC MACROINVERTEBRATE RESULTS

BM-UWB

The total abundance of benthic macroinvertebrates at this station comprised 119 individuals representing 25 taxa (TABLE 4 and TABLE 6A). Eight pollution sensitive (intolerant) taxa (28.6% of the total abundance), nine facultative (intermediate tolerance) taxa (28.6% of the total abundance), and eight tolerant taxa (42.9% of the total abundance) were collected. The sensitive stonefly Leuctra (Family: Leuctridae), accounted for 20.2% of the total abundance, and was the most abundant taxon of aquatic insect at this upstream station on Wiley Branch. The facultative mayfly, Eurylophella (Family: Ephemerellidae), accounted for 12.6% of the total station abundance. The pollution tolerant non-biting midge family, Chironomidae, accounted for 16.0% of the total station abundance. Eleven EPT groups (TABLE 5) were present, and the EPT:Chironomidae Ratio (57 : 19) indicated a benthic community in fairly good biotic condition. The West Virginia Stream Condition Index (WV-SCI) was 81.46, and was considered characteristic of a stream that is not impaired. All of the major functional feeding groups were present; shredders were dominant while filterer/collectors were poorly represented by five individuals. Mayflies, stoneflies, and caddisflies were fairly diverse and fairly abundant for the low overall station abundance. The Simpson's and Shannon-Wiener Diversity indices reflected a community with very good to excellent diversity, and the Shannon-Wiener Evenness value of 0.80 indicated that abundances were very well distributed among the taxa. The Modified Hilsenhoff Biotic Index (HBI) and the relative percentages of the three tolerance groups (sensitive, facultative, and tolerant) indicated a balanced and healthy macroinvertebrate community at this station. The low station abundance, excellent taxa richness, good HBI score, fair EPT:Chironomidae ratio, and good WV-SCI score, along with other metrics, were together indications of desirable water quality and marginal aquatic habitat at this station located upstream on Wiley Branch.

BM-DWB

The total abundance of benthic macroinvertebrates at this station comprised 1,588 individuals representing 19 taxa (TABLE 4 and TABLE 6B). Six pollution sensitive (intolerant) taxa (26.4% of the total abundance), nine facultative (intermediate tolerance) taxa (57.9% of the total abundance), and four tolerant taxa (15.6% of the total abundance) were collected. The sensitive stonefly Leuctra (Family: Leuctridae), accounted for 16.6% of the total abundance. The facultative caddisfly, Cheumatopsyche (Family: Hydropsychidae), accounted for 25.2% of the total station abundance, and was the most abundant taxa of aquatic insect at this downstream station on Wiley Branch. The pollution tolerant non-biting midge family, Chironomidae, accounted for 14.9% of the total station abundance. Nine EPT groups (TABLE 5) were present, and the EPT:Chironomidae Ratio (872 : 236) indicated a benthic community in good biotic condition. The West Virginia Stream Condition Index (WV-SCI) was 72.17, and was considered characteristic of a stream that is not impaired. All of the major functional feeding groups were present; filterer/collectors were dominant. Mayflies were both abundant, but not diverse. Stoneflies were not diverse, but were abundant. Caddisflies were very abundant but only fairly diverse. The Simpson's and Shannon-Wiener

Diversity indices reflected a community with good to very good diversity, and the Shannon-Wiener Evenness value of 0.73 indicated that abundances were well distributed among the taxa. The Modified Hilsenhoff Biotic Index (HBI) and the relative percentages of the three tolerance groups (sensitive, facultative, and tolerant) indicated a fairly well balanced and healthy facultative macroinvertebrate community at this station. The good station abundance, good taxa richness, good HBI score, good EPT:Chironomidae ratio, and good WV-SCI score, along with other metrics, were all indications of fairly desirable water quality and sub-optimal habitat at this station located downstream on Wiley Branch.

DISCUSSION AND CONCLUSIONS

An optimal benthic macroinvertebrate community is characterized by a high relative abundance of pollution sensitive and facultative individuals, high species diversity, and the presence of all functional feeding groups. The quality of the benthic macroinvertebrate community is dependent on water quality, physical habitat characteristics, riparian vegetation, and amount of human disturbance. Optimal physical water quality is characterized by good stream flow all year, neutral pH values, and dissolved oxygen levels >5 mg/l. Good chemical water quality should indicate low levels of total and dissolved metals, low dissolved and suspended solids, and residual buffering capacity.

A substrate containing a large percentage of cobble sized particles, with minimal embeddedness and sediment deposition would provide an optimal physical habitat. Good bank stability, stream side cover comprising native vegetation, and a riparian buffer zone between the stream and human impacts are necessary to provide appropriate nutrient cycling and minimize erosion.

Physical and chemical water quality was analyzed at both stations located on Wiley Branch. The upstream site, BM-UWB, contained fairly desirable water quality and was only limited by the high acidity levels. The downstream Wiley Branch site, BM-DWB, contained fairly desirable water quality, but levels of acidity, total hardness, and magnesium were elevated and were considered to be outside the range suitable for aquatic organisms. The high level of total hardness and magnesium could have potentially been limiting to certain sensitive taxa of aquatic insects. All other variables were relatively low, and were within suitable levels (TABLE 2).

Aquatic habitat was generally considered marginal to sub-optimal at both stations, scoring a 76 out of a possible 200 at BM-UWB and scoring 137 out of 200 at BM-DWB. The upstream station, BM-UWB, was most limited by "Velocity-Depth Regime", "Sediment Deposition", "Channel Flow Status", and "Frequency of Riffles." The downstream station, BM-DWB, was most limited by a short "Riparian Zone Width" due to the close proximity of a road (TABLE 3).

A comparison was made between the October 2009 study and this current October 2010 study at the upstream station (BM-UWB) located on Wiley Branch. The current October 2010 study of BM-UWB revealed 119 individuals collected from 25 taxa, and the benthic community was comprised of 28.6% sensitive individuals, 28.6% facultative individuals, and 42.9% tolerant individuals. The WV-SCI score was 81.46, and was considered characteristic of a stream that is not impaired. For the upstream Wiley Branch site, BM-UWB, during the October 2009 study, 386 individuals collected from 31 taxa, and the benthic community was comprised of 28.0% sensitive individuals, 12.4% facultative individuals, and 59.1% tolerant individuals. The WV-SCI score was 73.74, and was considered characteristic of a stream that is unimpaired. Although the WV-SCI increased during the current study, the overall decrease in station abundance, the loss of six taxa, and the shift towards a more facultative macroinvertebrate community together suggest an overall slight decline at this station since the previous October 2009 study.

For the downstream Wiley Branch site, BM-DWB, during the October 2009 study, 634 individuals were collected from 22 taxa, and the benthic community was comprised of 23.8% sensitive individuals, 44.3% facultative individuals, and 31.9% tolerant individuals. The WV-SCI score was 75.63, and was considered characteristic of a stream that is unimpaired. During the current October 2010 study, there were 1,588 individuals collected from 19 taxa, and the benthic community was comprised of 26.4% sensitive individuals, 57.9% facultative individuals, and 15.6% tolerant individuals. The WV-SCI score was 72.17, and was considered characteristic of a stream that is not impaired. Most changes in the benthic community were minimal and do not suggest an improvement, nor a decline, in the community at this downstream site since October 2009.

FIGURES 2 - 7 show the WV-SCI scores calculated for the current Fall 2010 (October) survey of Wiley Branch as plotted against six different water quality parameters. There appeared to be some correlation between WV-SCI scores and concentrations of conductivity, Total Dissolved Solids (TDS), sulfate, and magnesium; as the concentration of the parameters increased, the WV-SCI score decreased. There did not appear to any correlation between the WV-SCI score and dissolved aluminum and dissolved manganese. FIGURE 8 shows the WV-SCI scores for the current Fall 2010 study as plotted against the habitat scores for the same station. There did not appear to be a correlation between WV-SCI scores and Habitat scores at these two stations located on Wiley Branch. FIGURE 9 shows the WV-SCI scores as plotted against the stream flows. There did not appear to be any correlation between WV-SCI scores and stream flows.

FIGURES 10 - 15 show the WV-SCI scores calculated for the Fall 2000 through Fall 2010 surveys on Wiley Branch as plotted against the same six water quality parameters. There did not appear to be any noticeable correlation between WV-SCI scores and the concentrations of conductivity, TDS, sulfate, dissolved aluminum, magnesium, or dissolved manganese over time. FIGURE 16 shows the calculated WV-SCI scores as plotted against habitat scores. There did not appear to be any correlation between WV-SCI scores and habitat scores over time. FIGURE 17 shows the calculated WV-SCI scores as plotted against stream flows. There did not appear to be any correlation between WV-SCI scores and stream flows over time.

FIGURE 1. Terrain Navigator map showing the approximate location of the study area associated with Wiley Branch. Argus Energy-WV, LLC. October 2010.

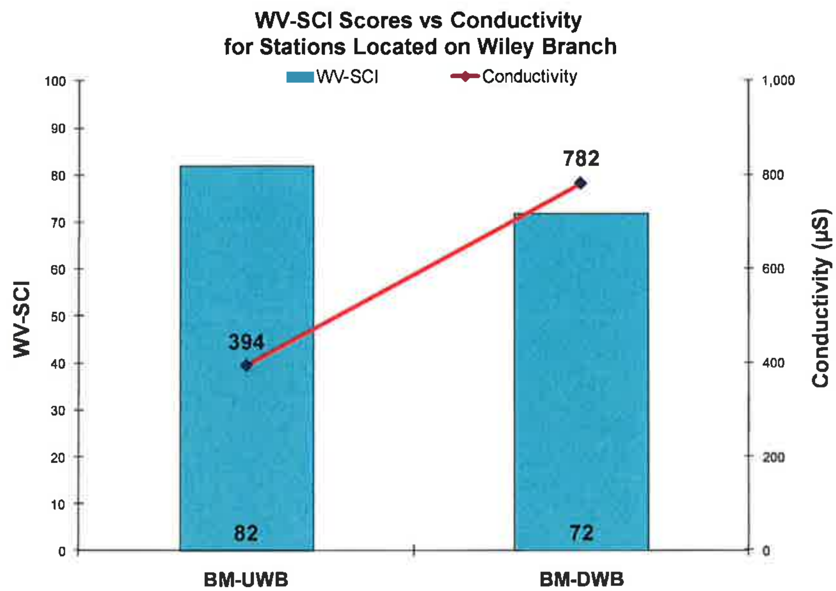

FIGURE 2. WV-SCI scores vs conductivity levels at stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

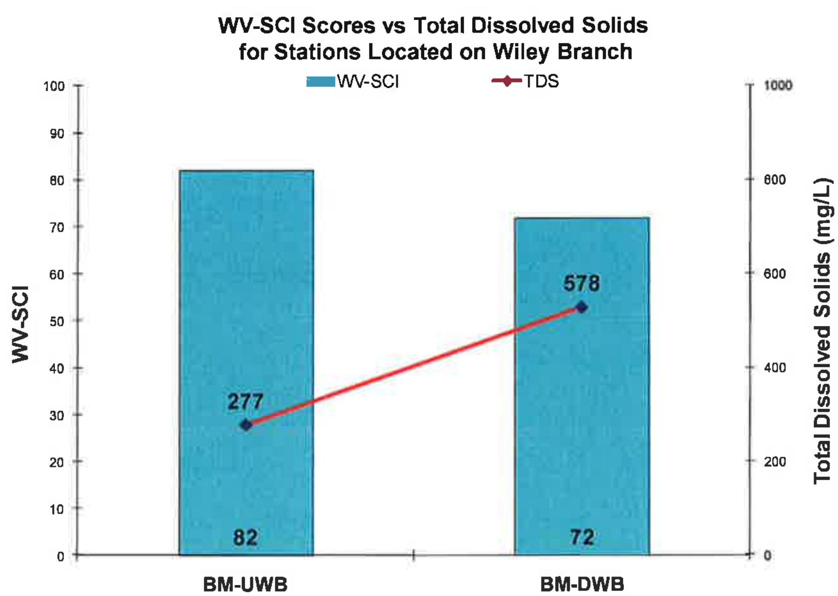

FIGURE 3. WV-SCI scores vs Total Dissolved Solids (TDS) at stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

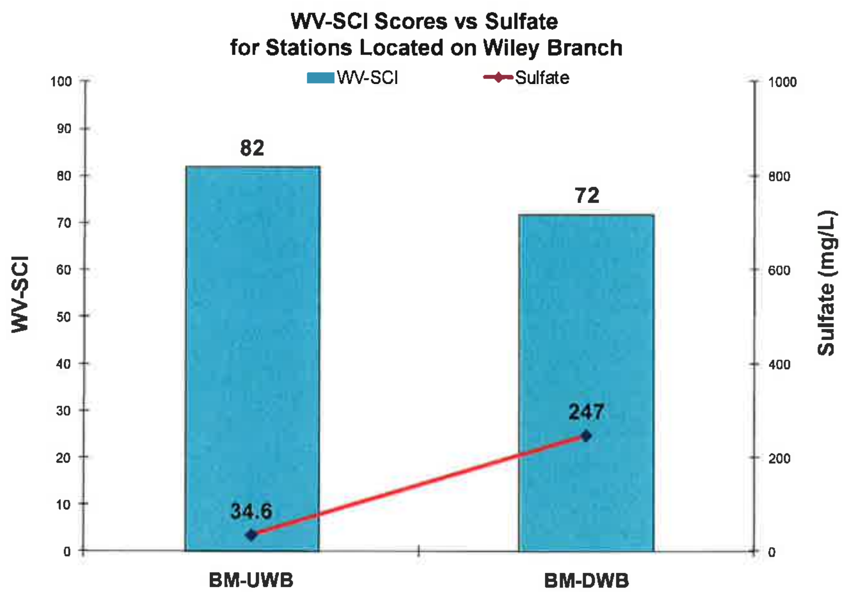

FIGURE 4. WV-SCI scores vs sulfate levels at stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

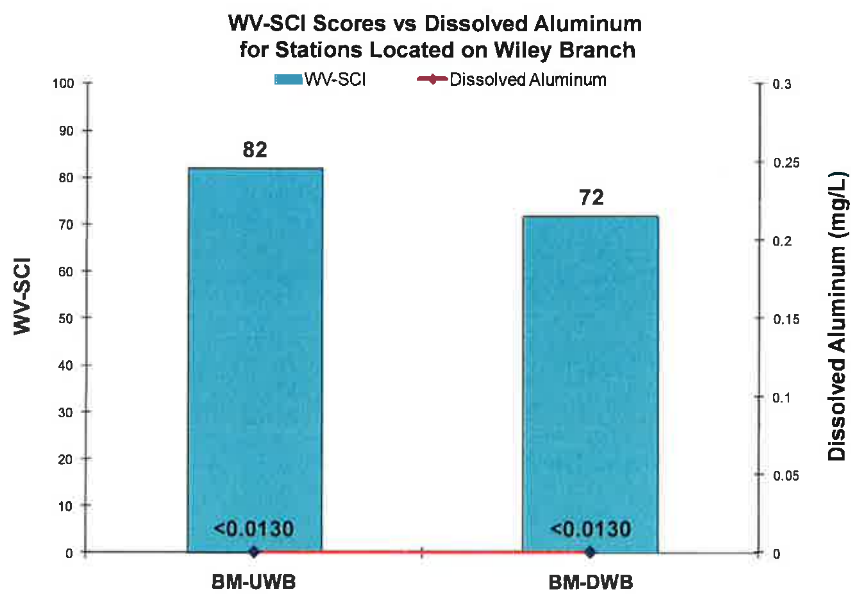

FIGURE 5. WV-SCI scores vs dissolved aluminum levels at stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

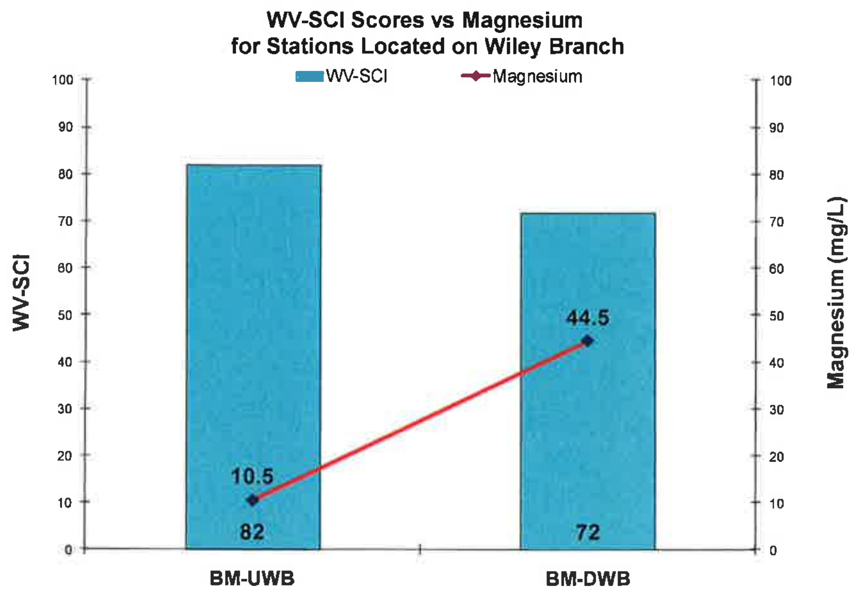

FIGURE 6. WV-SCI scores vs magnesium levels at stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

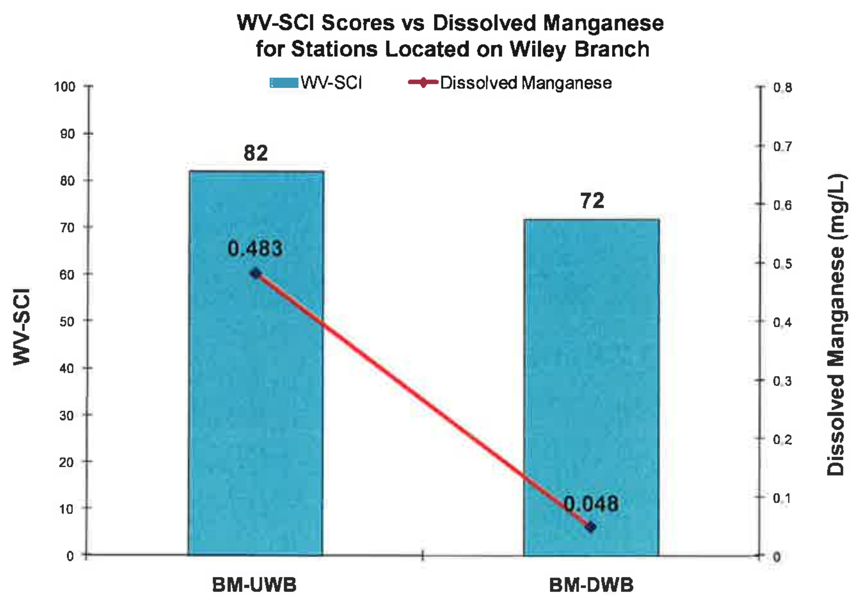

FIGURE 7. WV-SCI scores vs dissolved manganese levels at stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

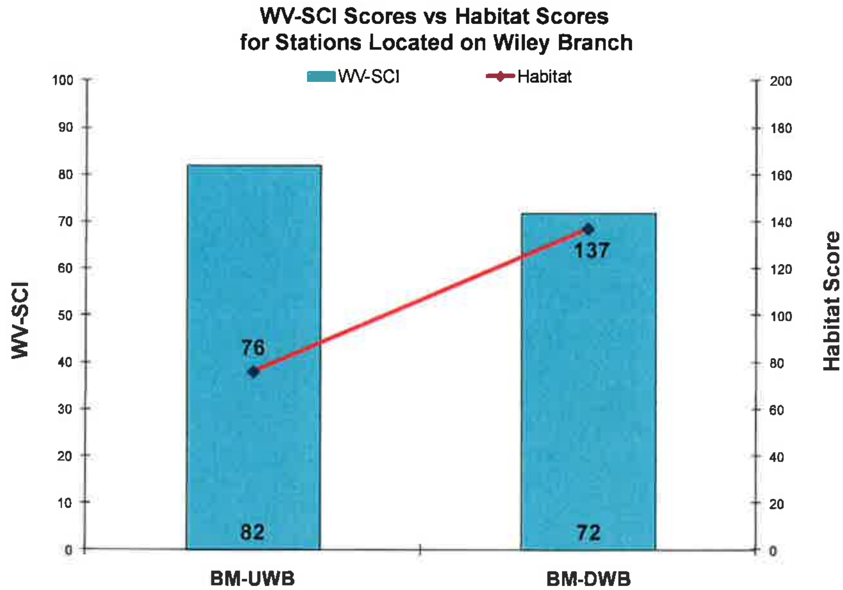

FIGURE 8. WV-SCI scores vs habitat scores at stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

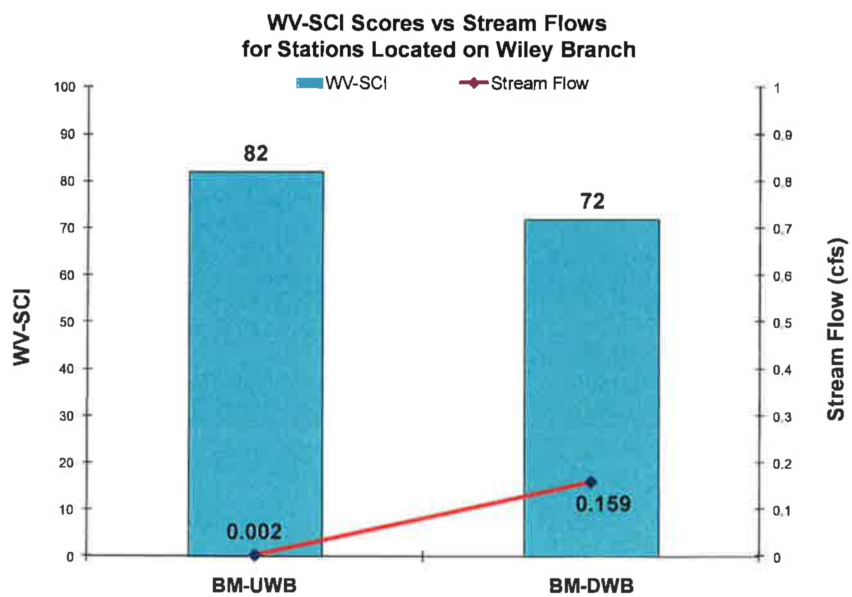

FIGURE 9. WV-SCI scores vs stream flow measurements for stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

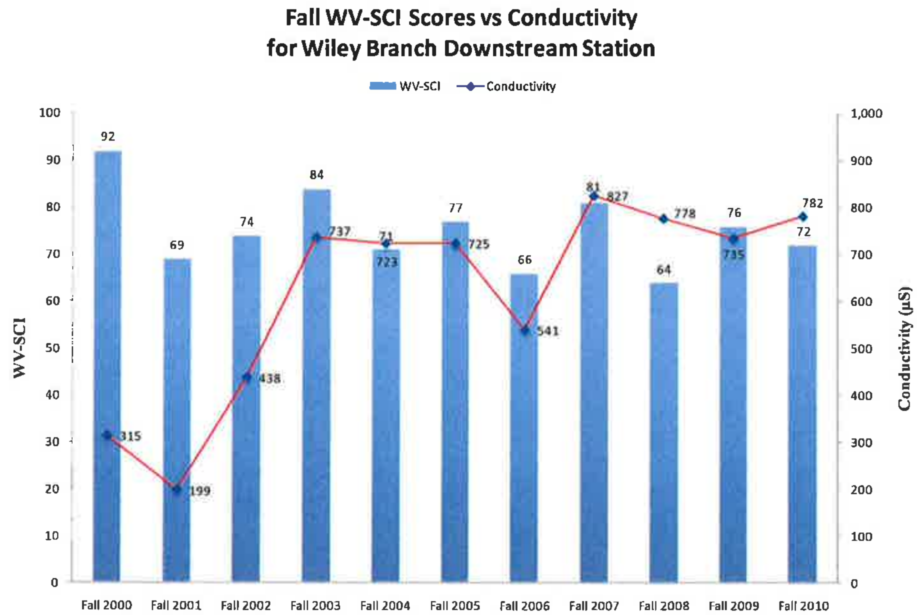

FIGURE 10. WV-SCI scores vs conductivity levels at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

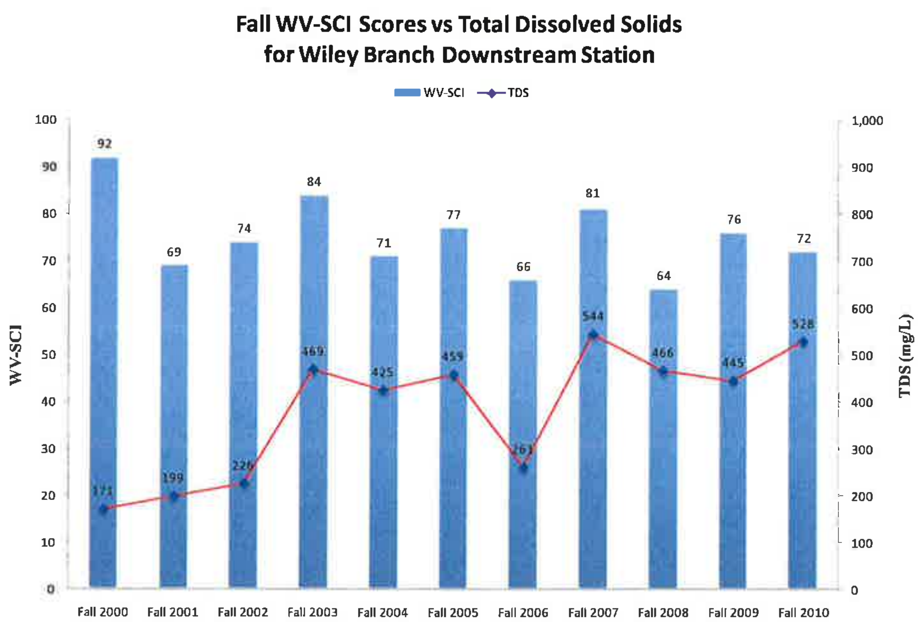

FIGURE 11. WV-SCI scores vs Total Dissolved Solids (TDS) at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

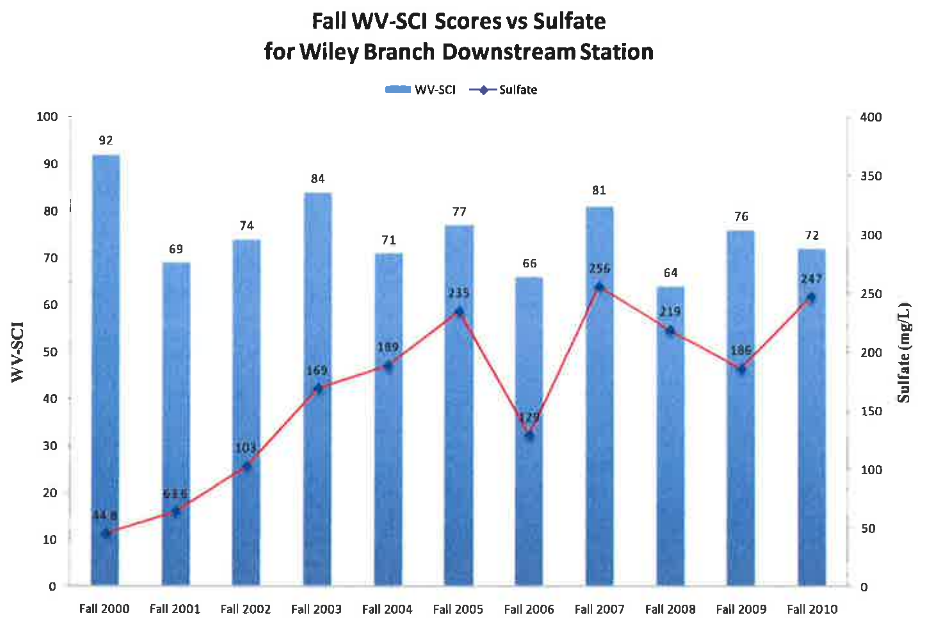

FIGURE 12. WV-SCI scores vs sulfate levels at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

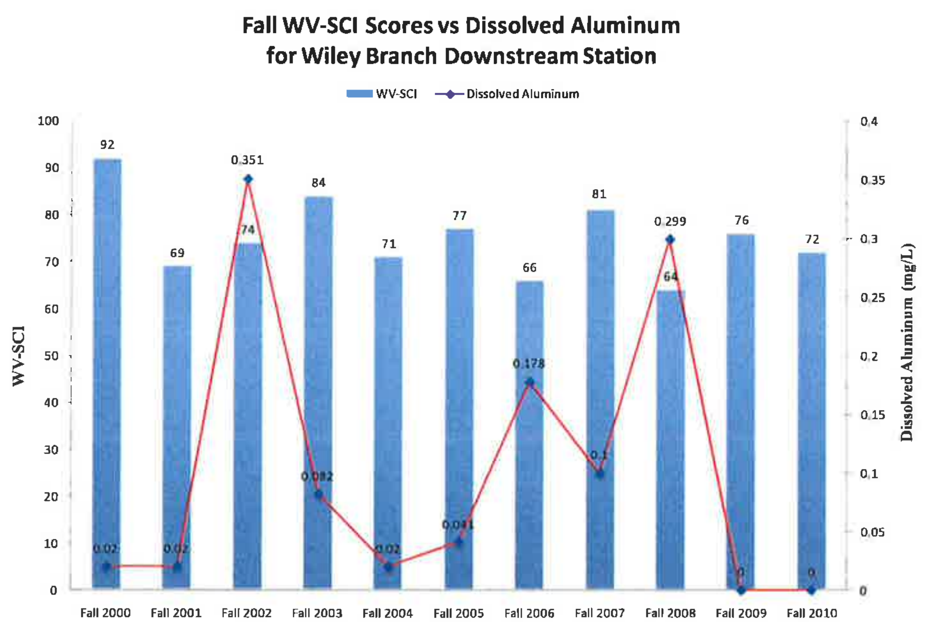

FIGURE 13. WV-SCI scores vs dissolved aluminum levels at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

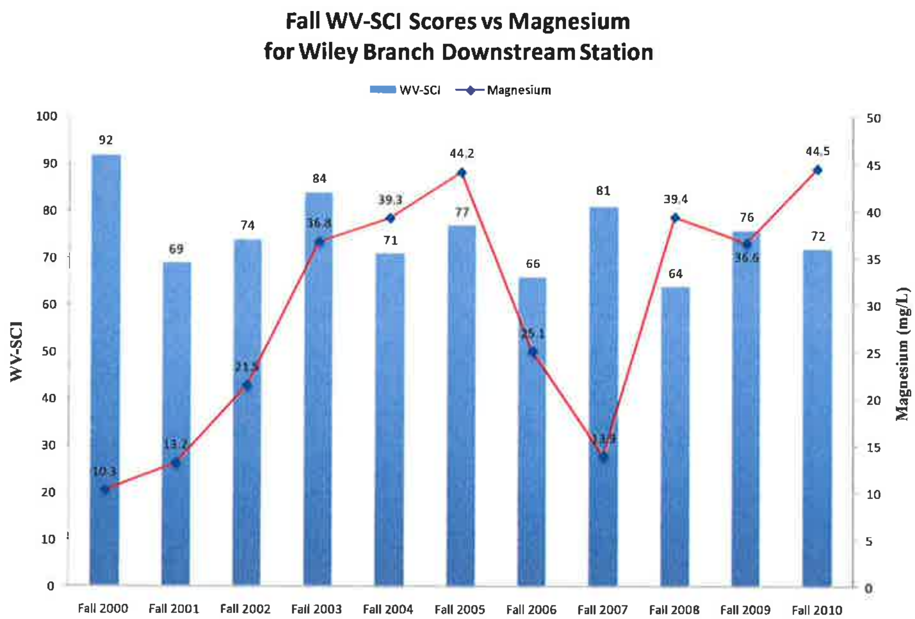

FIGURE 14. WV-SCI scores vs magnesium levels at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

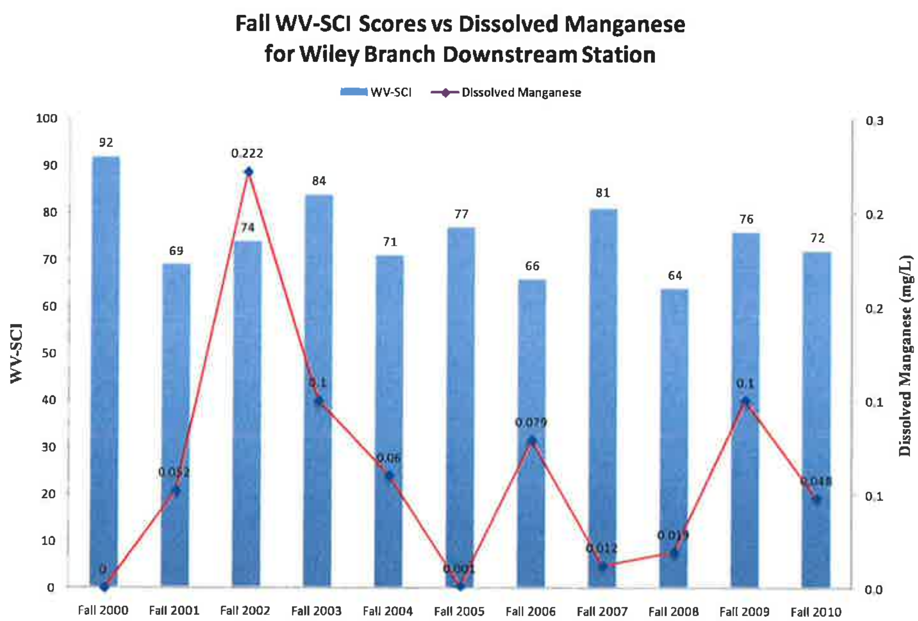

FIGURE 15 WV-SCI scores vs dissolved manganese levels at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

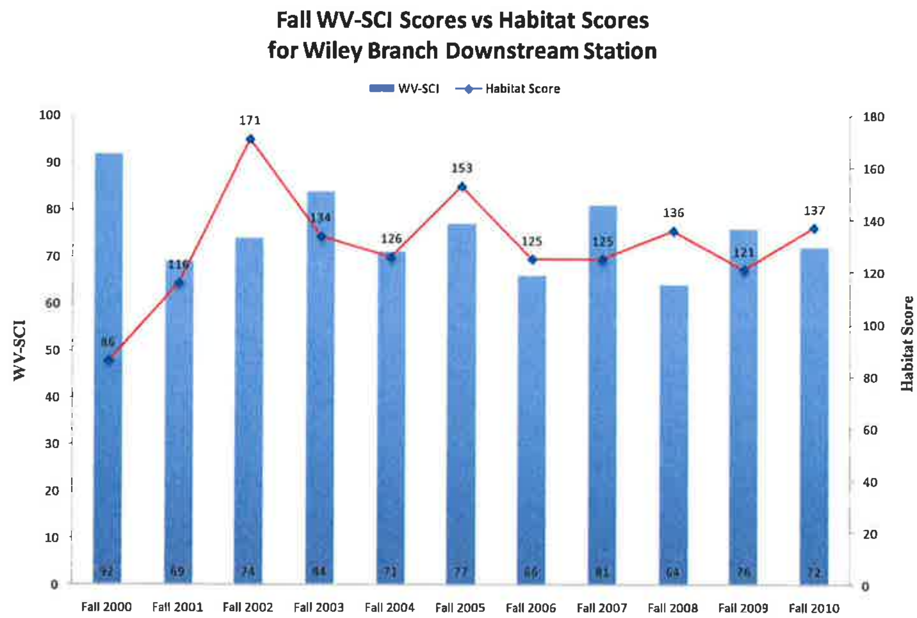

FIGURE 16. WV-SCI scores vs habitat scores at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

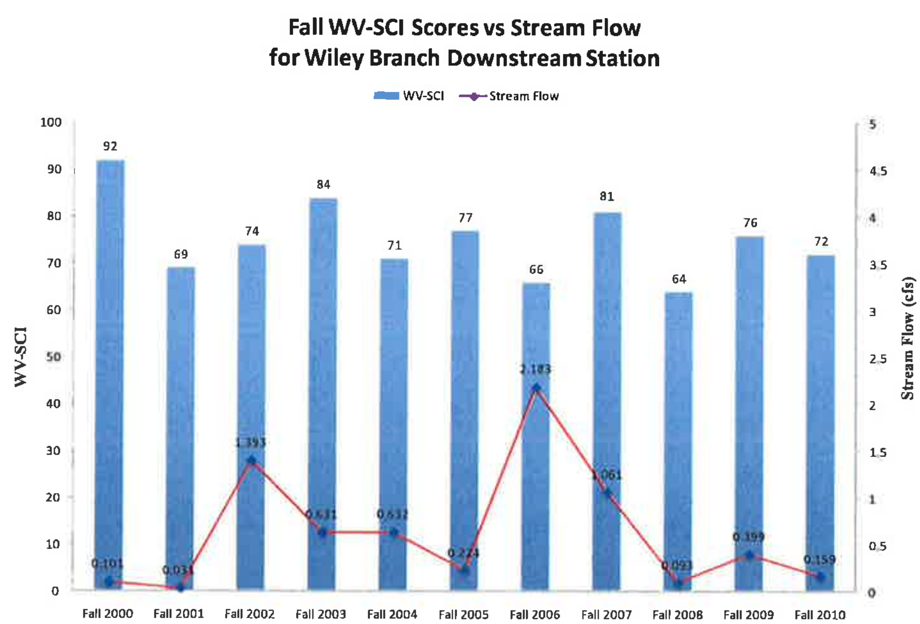

FIGURE 17. WV-SCI scores vs stream flow measurements at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

PHOTO 1. Looking upstream from station BM-UWB, located upstream on Wiley Branch. Argus Energy-WV, LLC. October 2010.

PHOTO 2. Looking downstream from station BM-UWB, located upstream on Wiley Branch. Argus Energy-WV, LLC. October 2010.

PHOTO 3. Looking upstream from station BM-DWB, located downstream on Wiley Branch. Argus Energy-WV, LLC. October 2010.

PHOTO 4. Looking downstream from station BM-DWB, located downstream on Wiley Branch. Argus Energy-WV, LLC. October 2010.

TABLE 1. Physical water quality and approximate GPS locations for stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

	SAMPLING STATION	
	BM-UWB	BM-DWB
PHYSICAL WATER QUALITY		
Flow (ft^3/s)	0.002	0.159
Temperature (°C)	11.6	11.3
Dissolved Oxygen (mg/L)	7.64	10.48
pH (SI Units)	7.74	8.24
Conductivity (µs)	394	782
GPS READING		
Latitude	37°59'22.4"	37°58'47.7"
Longitude	82°15'53.0"	82°16'26.1"

TABLE 2. Chemical water quality for stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

PARAMETER	SAMPLING STATION BM-UWB	SAMPLING STATION BM-DWB
Acidity (mg/l)	7.3	3.0
Alkalinity (mg/l)	163	173
Total Hardness (mg/l)	208	404
Nitrate/Nitrite (mg/l)	0.07	0.39
Chloride (mg/l)	3.94	2.33
Sulfate (mg/l)	34.6	247
TSS (mg/l)	11	3
TDS (mg/l)	277	528
Total Phosphorous (mg/l)	<0.020	<0.020
Total Organic Carbon (mg/l)	4.01	3.11
Dissolved Aluminum (mg/l)	<0.0130	<0.0130
Total Aluminum (mg/l)	0.043	<0.0130
Antimony (mg/l)	0.0004	<0.00020
Arsenic (mg/l)	0.0011	<0.00100
Beryllium (mg/l)	<0.00020	<0.00020
Cadmium (mg/l)	<0.00020	<0.00020
Calcium (mg/l)	66.0	88.5
Chromium (mg/l)	<0.00100	<0.00100
Copper (mg/l)	0.0012	0.0014
Dissolved Iron (mg/l)	0.036	0.084
Total Iron (mg/l)	0.359	0.180
Lead (mg/l)	<0.00020	<0.00020
Dissolved Manganese (mg/l)	0.483	0.048
Total Manganese (mg/l)	0.521	0.058
Magnesium (mg/l)	10.5	44.5
Mercury (mg/l)	<0.00010	<0.00010
Nickel (mg/l)	0.0034	0.0034
Potassium (mg/l)	3.20	6.14
Selenium (mg/l)	<0.00100	0.0011
Silver (mg/l)	<0.00100	<0.00100
Sodium (mg/l)	4.05	9.74
Thallium (mg/l)	<0.00020	<0.00020
Zinc (mg/l)	<0.00300	<0.00300

TABLE 3. High gradient habitat scores associated with stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

	SAMPLING STATION	
	BM-UWB	BM-DWB
Primary – Substrate and Available Cover		
1. Epifaunal Substrate and Available Cover (0-20)	12	11
2. Embeddedness (0-20)	6	13
3. Velocity-Depth Regime (0-20)	2	14
Secondary – Channel Morphology		
4. Sediment Deposition (0-20)	1	13
5. Channel Flow Status (0-20)	2	14
6. Channel Alteration (0-20)	16	16
7. Frequency of Riffles (0-20)	2	16
Tertiary – Riparian and Bank Structure		
8. Bank Stability (0-10)		
Left Bank	8	8
Right Bank	7	7
9. Bank Vegetative Protection (0-10)		
Left Bank	4	8
Right Bank	3	6
10. Riparian Zone Width (0-10)		
Left Bank	9	9
Right Bank	4	2
Total Score	76	137

Note: The scoring for each	Optimal	Sub-optimal	Marginal	Poor
Primary	16-20	11-15	6-10	0-5
Secondary	16-20	11-15	6-10	0-5
Tertiary	9-10	6-8	3-5	0-2

TABLE 4. Total abundances and sensitivities of benthic macroinvertebrates collected in the kicknet sample from stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

TAXON	SAMPLING STATION	
	BM-UWB	BM-DWB
Insecta		
Ephemeroptera (Mayflies)		
Ameletidae	1	
Ameletus (S)		
Ephemerellidae		
Eurylophella (F)	15	20
Heptageniidae		
Maccaffertium (F)		12
Isonychiidae		
Isonychia (S)		120
Leptophlebiidae		
Leptophlebia (S)	8	
Plecoptera (Stoneflies)		
Chloroperlidae		
Alloperla (S)	2	
Leuctridae		
Leuctra (S)	24	264
Peltoperlidae		
Peltoperla (S)	1	
Perlidae		
Acroneuria (S)	1	
Taeniopterygidae		
Taeniopteryx (S)		8
Trichoptera (Caddisflies)		
Hydropsychidae		
Cheumatopsyche (F)	1	400
Diplectrona (S)	2	
Hydropsyche (F)	1	16
Philopotamiidae		
Chimarra (F)	1	28
Wormaldia (S)		4
Hemiptera (True Bugs)		
Veliidae		
Microvelia (T)	7	
Diptera (Trueflies)		
Certopogonidae		
Bezzia (T)	1	

TABLE 4. Continued.

TAXON	SAMPLING STATION	
	BM-UWB	BM-DWB
Chironomidae (T)	19	236
Empididae		
Hemerodromia (T)	1	4
Simuliidae		
Simulium (T)		32
Tabanidae		
Chrysops (T)	2	
Tipulidae		
Limnophila (F)	1	
Tipula (F)	7	68
Coleoptera (Beetles)		
Elmidae		
Optioservus (F)	5	260
Stenelmis (F)	2	84
Psephenidae		
Ectopria (F)	1	
Odonata (Dragonflies)		
Gomphidae		
Lanthus (S)	1	20
Megaloptera (Hellgrammites)		
Corydalidae		
Nigronia (S)	2	4
Annelida		
Oligochaeta (Aquatic Worms)		
Lumbricidae (T)	12	
Decapoda (Crayfish)		
Cambaridae		
Cambarus (T)		4
Collembola (Springtails) (T)	1	
Nematomorpha (Horsehair Worms) (T)		4
Total Individuals	119	1,588
Total Taxa	25	19

TABLE 4. Continued.

TAXON	SAMPLING STATION	
	BM-UWB	BM-DWB
Sensitive Individuals (%)	34 (28.6%)	420 (26.4%)
# Sensitive Taxa	8	6
Facultative Individuals (%)	34 (28.6%)	920 (57.9%)
# Facultative Taxa	9	9
Tolerant Individuals (%)	51 (42.9%)	248 (15.6%)
# Tolerant Taxa	8	4

( ) Classification of Pollution Indicator Organisms
(S) = Sensitive (F) = Facultative (T) = Tolerant (U) = Unclassified

TABLE 5. Selected benthic macroinvertebrate metrics for the stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

	SAMPLING STATION	
	BM-UWB	BM-DWB
Metric 1. Taxa Richness		
	25	19
Metric 2. Modified Hisenhoff Biotic Index (HBI score)		
	3.72	3.76
Metric 3. Ratio of Scrapers to Collector/Filterers		
	23 : 5	376 : 600
Metric 4. Ratio of Ephemeroptera, Plecoptera, and Trichoptera (EPT) to Chironomidae Abundances		
	57 : 19	872 : 236
Metric 5. Percent Contribution of Mayflies		
	20.2%	9.6%
Metric 6. Percent Contribution of Dominant Taxa		
	20.2% Leuctra	25.2% Cheumatopsyche
Metric 7. EPT Index		
	11	9
Metric 8. Percent of Shredders to total		
	26.9%	21.4%
Metric 9. Simpson's Diversity Index		
	0.90	0.85
Metric 10. Shannon-Wiener Diversity Index		
	3.72	3.11
Metric 11. Shannon-Wiener Evenness		
	0.80	0.73
Metric 12. West Virginia Stream Condition Index (WV-SCI score)		
	81.46	72.17

TABLE 6A. Total abundances and sensitivities of benthic macroinvertebrates collected per sample at station BM-UWB, located upstream on Wiley Branch. Argus Energy-WV, LLC. October 2010.

TAXON	SAMPLING STATION			
	BM-UWB			
	S1	S2	S3	Kick (100/100)
Insecta				
Ephemeroptera (Mayflies)				
Ameletidae				
Ameletus (S)				1
Ephemerellidae				
Eurylophella (F)	3	2	6	15
Leptophlebiidae				
Leptophlebia (S)				8
Plecoptera (Stoneflies)				
Chloroperlidae				
Alloperla (S)		2	1	2
Leuctridae				
Leuctra (S)	9	25	21	24
Peltoperlidae				
Peltoperla (S)				1
Perlidae				
Acroneuria (S)	1			1
Perlodidae (S)			1	
Taeniopterygidae				
Taeniopteryx (S)		1		
Trichoptera (Caddisflies)				
Hydropsychidae				
Cheumatopsyche (F)				1
Diplectrona (S)		2		2
Hydropsyche (F)				1
Philopotamiidae				
Chimarra (F)	1			1
Rhyacophilidae				
Rhyacophila (S)		1		
Diptera (Trueflies)				
Certopogonidae				
Atrichopogon (T)		1		
Bezzia (T)	2		1	1
Chironomidae (T)	11	11	4	19
Empididae				
Hemerodromia (T)				1

TABLE 6A. Continued.

TAXON	SAMPLING STATION			
	BM-UWB			
	S1	S2	S3	Kick (100/100)
Tabanidae				
Chrysops (T)				2
Tipulidae				
Hexatoma (S)			1	
Limnophila (F)				1
Molophilus (F)			1	
Tipula (F)	3	4	4	7
Coleoptera (Beetles)				
Dryopidae				
Helichus (F)			1	
Elmidae				
Optioservus (F)	1	1		5
Stenelmis (F)				2
Psephenidae				
Ectopria (F)	1			1
Odonata (Dragonflies)				
Gomphidae				
Lanthus (S)		1		1
Megaloptera (Hellgrammites)				
Corydalidae				
Nigronia (S)				2
Hemiptera (True Bugs)				
Veliidae				
Microvelia (T)	1			7
Annelida				
Oligochaeta (Aquatic Worms)				
Lumbricidae (T)				12
Decapoda (Crayfish)				
Cambaridae				
Cambarus (T)		1		
Collembola (Springtails) (T)				1

TABLE 6A. Continued.

TAXON	SAMPLING STATION			
	BM-UWB			
	S1	S2	S3	Kick (100/100)
Salamander larvae* (U)			2	
Total Individuals	33	52	41	119
Total Taxa	10	12	10	25

* Not included in abundance or taxa calculations. For observation only.
( ) Classification of Pollution Indicator Organisms
(S) = Sensitive (F) = Facultative (T) = Tolerant (U) = Unclassified

TABLE 6B. Total abundances and sensitivities of benthic macroinvertebrates collected per sample at station BM-DWB, located downstream on Wiley Branch. Argus Energy-WV, LLC. October 2010.

TAXON	SAMPLING STATION			
	BM-DWB			
	S1	S2	S3	Kick (25/100)
Insecta				
Ephemeroptera (Mayflies)				
Ephemerellidae				
Eurylophella (F)		4		5
Heptageniidae				
Maccafertium (F)	1			3
Isonychiidae				
Isonychia (S)	3		11	30
Plecoptera (Stoneflies)				
Leuctridae				
Leuctra (S)	22	4	39	66
Taeniopterygidae				
Taeniopteryx (S)				2
Trichoptera (Caddisflies)				
Hydropsychidae				
Cheumatopsyche (F)	9	3	30	100
Hydropsyche (F)				4
Hydroptilidae				
Hydroptila (T)		1		
Philopotamiidae				
Chimarra (F)		1		7
Wormaldia (S)				1
Hemiptera (True Bugs)				
Veliidae				
Rhagovelia (T)		4		
Diptera (Trueflies)				
Ceratopogonidae				
Bezzia (T)		1		
Chironomidae (T)	9	90	27	59
Empididae				
Hemerodromia (T)				1
Simuliidae				
Simulium (T)	4	1	7	8

TABLE 6B. Continued.

TAXON	SAMPLING STATION BM-DWB			
	S1	S2	S3	Kick (25/100)
Tipulidae				
Antocha (S)		2		
Tipula (F)	3	2	3	17
Coleoptera (Beetles)				
Elmidae				
Dubiraphia (T)		1		
Optioservus (F)	10	4	5	65
Stenelmis (F)		1		21
Odonata (Dragonflies)				
Gomphidae				
Lanthus (S)			1	5
Megaloptera (Hellgrammites)				
Corydalidae				
Nigronia (S)				1
Annelida				
Oligochaeta (Aquatic Worms)				
Lumbricidae (T)		1		
Decapoda (Crayfish)				
Cambaridae				
Cambarus (T)				1
Nematomorpha (Horsehair Worms) (T)		1		1
Total Individuals	61	121	123	397
Total Taxa	8	16	8	19

( ) Classification of Pollution Indicator Organisms
(S) = Sensitive (F) = Facultative (T) = Tolerant (U) = Unclassified

TABLE 7. Total abundances and sensitivities of the 200-bug count (+/- 10%) benthic subsample used to calculate the WV-SCI score and HBI for stations located on Wiley Branch. Argus Energy-WV, LLC. October 2010.

TAXON	SAMPLING STATION	
	BM-UWB (100/100)	BM-DWB (12/100)
Insecta		
Ephemeroptera (Mayflies)		
Ameletidae		
Ameletus (S)	1	
Ephemerellidae		
Eurylophella (F)	15	2
Heptageniidae		
Maccaffertium (F)		1
Isonychiidae		
Isonychia (S)		18
Leptophlebiidae		
Leptophlebia (S)	8	
Plecoptera (Stoneflies)		
Chloroperlidae		
Alloperla (S)	2	
Leuctridae		
Leuctra (S)	24	33
Peltoperlidae		
Peltoperla (S)	1	
Perlidae		
Acroneuria (S)	1	
Taeniopterygidae		
Taeniopteryx (S)		2
Trichoptera (Caddisflies)		
Hydropsychidae		
Cheumatopsyche (F)	1	65
Diplectrona (S)	2	
Hydropsyche (F)	1	4
Philopotamiidae		
Chimarra (F)	1	5
Wormaldia (S)		1
Hemiptera (True Bugs)		
Veliidae		
Microvelia (T)	7	

TABLE 7. Continued.

TAXON	SAMPLING STATION	
	BM-UWB (100/100)	BM-DWB (12/100)
Diptera (Trueflies)		
Certopogonidae		
Bezzia (T)	1	
Chironomidae (T)	19	33
Empididae		
Hemerodromia (T)	1	
Simuliidae		
Simulium (T)		2
Tabanidae		
Chrysops (T)	2	
Tipulidae		
Limnophila (F)	1	
Tipula (F)	7	12
Coleoptera (Beetles)		
Elmidae		
Optioservus (F)	5	35
Stenelmis (F)	2	10
Psephenidae		
Ectopria (F)	1	
Odonata (Dragonflies)		
Gomphidae		
Lanthus (S)	1	3
Megaloptera (Hellgrammites)		
Corydalidae		
Nigronia (S)	2	
Annelida		
Oligochaeta (Aquatic Worms)		
Lumbricidae (T)	12	
Decapoda (Crayfish)		
Cambaridae		
Cambarus (T)		1
Collembola (Springtails) (T)	1	

TABLE 7. Continued.

TAXON	SAMPLING STATION	
	BM-UWB (100/100)	BM-DWB (12/100)
Nematomorpha (Horsehair Worms) (T)		1
Total Individuals	119	228
Total Taxa	25	17

( ) Classification of Pollution Indicator Organisms
(S) = Sensitive (F) = Facultative (T) = Tolerant (U) = Unclassified

APPENDIX A

PRECIPITATION DATA

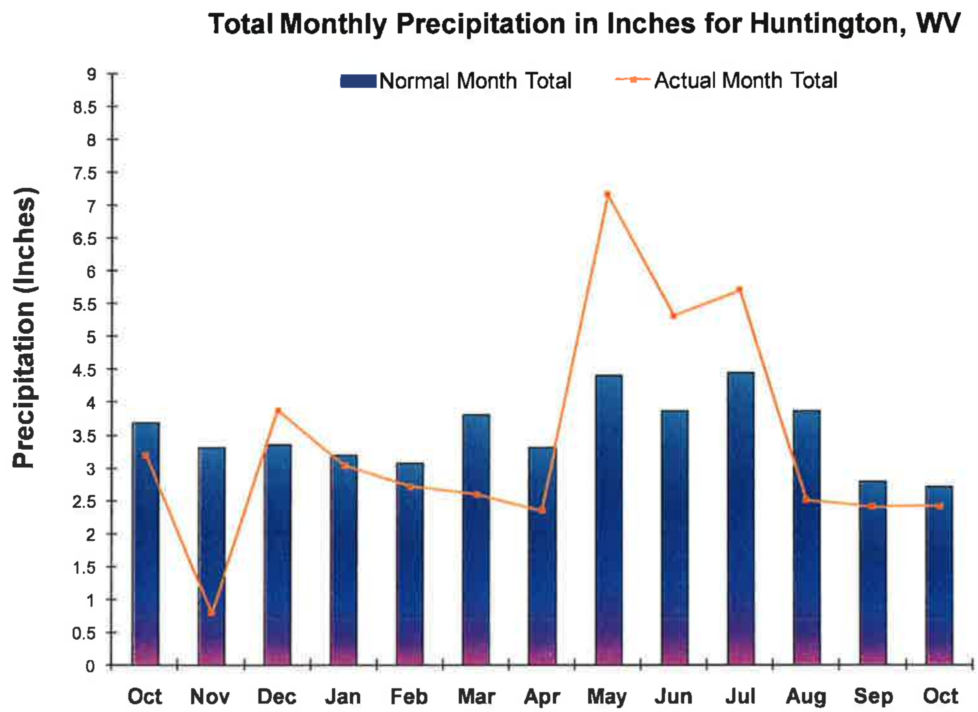

FIGURE A-1. Total monthly precipitation for Huntington, WV from October 2009 to October 2010 (www.weatherunderground.com; accessed Nov 12, 2010).

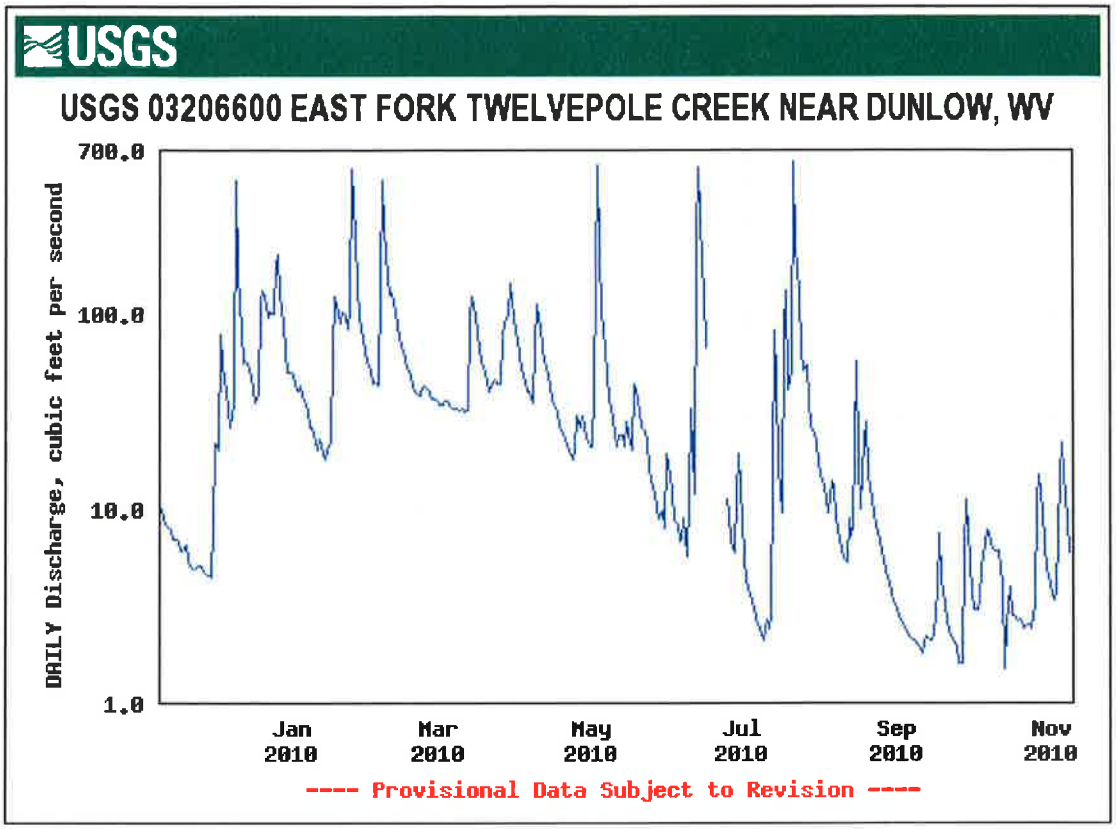

FIGURE A-2. Daily stream discharge data for the East Fork of Twelvepole Creek near Dunlow, WV (waterdata.usgs.gov; accessed November 9, 2010).

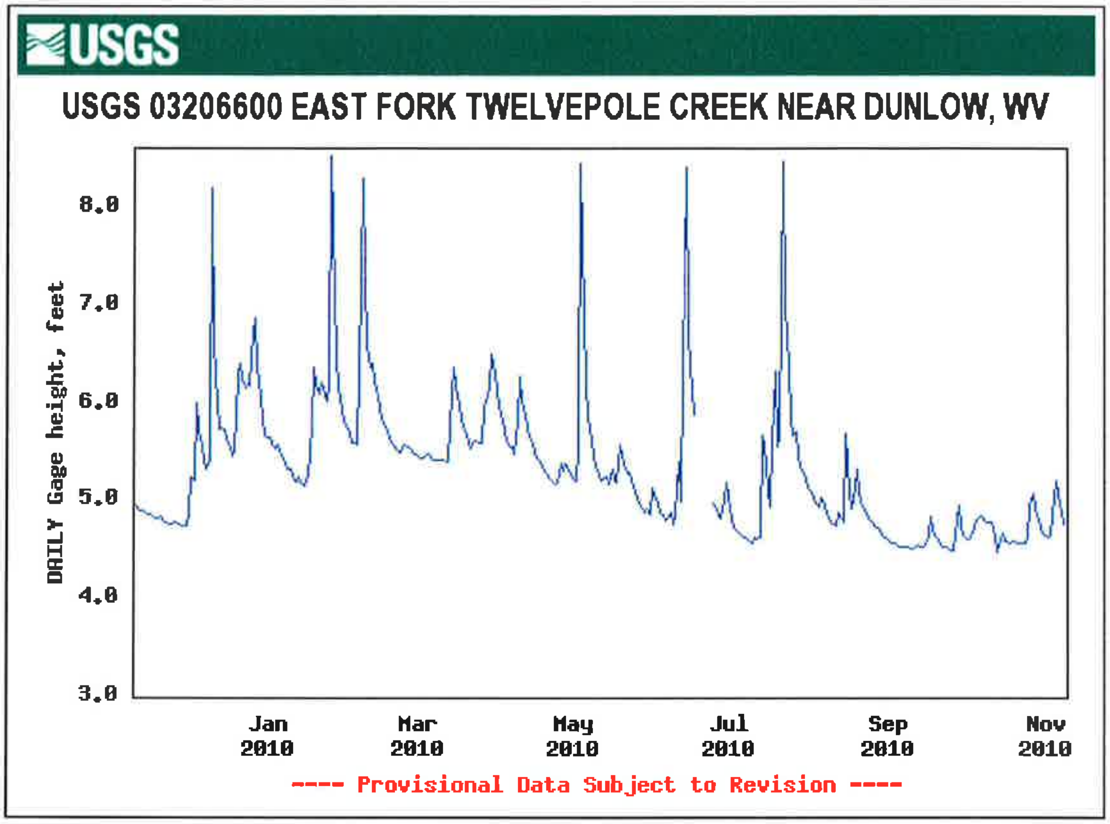

FIGURE A-3. Daily stream gauge height data for the East Fork of Twelvepole Creek near Dunlow, WV (waterdata.usgs.gov; accessed November 9, 2010).

BENTHIC MACROINVERTEBRATE, HABITAT, AND WATER CHEMISTRY STUDY OF STATIONS LOCATED ON WILEY BRANCH, OCTOBER 2011.

Conducted For:

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January 27, 2012

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BENTHIC MACROINVERTEBRATE, HABITAT, AND WATER CHEMISTRY STUDY OF STATIONS LOCATED ON WILEY BRANCH, OCTOBER 2011.

INTRODUCTION

Argus Energy-WV, LLC has constructed several valley fills on unnamed tributaries of Wiley Branch, near the Wayne/Lincoln County line, at Harts, West Virginia. Because the fills directly disturbed several hundred feet of stream, Argus Energy was required to monitor the status of Wiley Branch as part of the mitigation process for stream disturbance and relocation. This monitoring has involved analyzing benthic macroinvertebrate and fisheries populations, physical and chemical water quality, and habitat data. Stations on Wiley Branch have been sampled since 2000. In this current study, two stations were sampled for benthic macroinvertebrates, physical and chemical water quality, and stream habitat. During the October 2010 sampling event, the same two stations were sampled, therefore, comparisons can be made between the current data and the previous year's data. The results from the previous study may be found in the report titled: "*Benthic Macroinvertebrate, Habitat, and Water Chemistry Study on Stations Located on Wiley Branch, October 2010*" (REI Consultants, Inc., 2010).

Policies within the West Virginia Department of Environmental Protection (WV-DEP) require biological surveys of streams prior to, and after issuance of National Pollutant Discharge Elimination System (NPDES) permits to adequately determine stream biota and potential biological development. This study was conducted in order to add to the ever-growing database of benthic macroinvertebrate, physical habitat, and water chemistry data of streams located both within, and downstream of mining operations at Argus Energy. A secondary purpose of the study was to satisfy the requirements of the United States-Environmental Protection Agency (US-EPA) for the submitting of biological data for documenting the status of the streams for disturbance, and is specific for the stations sampled on those streams.

Biological data, such as aquatic macroinvertebrate and fish populations, in conjunction with physical and chemical water quality, and habitat data, provide valuable information that are used in the permit review process and are ultimately used to assist in establishing NPDES discharge limitations. These data also act as a powerful monitoring tool in identifying possible pollutant sources and/or habitat alterations and subsequent effects.

LOCATION OF STUDY SITES

The study area was located near the town of Harts, West Virginia, in the vicinity of the Wayne/Lincoln County line. Two stations were sampled in order to evaluate and monitor the effects of several valley fills located on unnamed tributaries of Wiley Branch. Wiley Branch is a perennial tributary of the East Fork of Twelvepole Creek. One station was located near the headwaters on the left fork of Wiley Branch, upstream of most mining disturbances, and is referred to as BM-UWB (PHOTOS 1 & 2; FIGURE 1). A sediment pond has been constructed just upstream of this sampling point, but no fills currently are present upstream of this sampling point. Another station was located near the mouth of Wiley Branch, downstream from mining disturbances, and is referred to as BM-DWB (PHOTOS 3 & 4; FIGURE 1).

METHODS OF INVESTIGATION

A modified EPA Field operations and methods manual for measuring the ecological condition of wade able streams (EPA/620/R-94/004F), EPA Rapid bioassessment protocols for use in streams and wade able rivers (EPA 841-B-99-002), as well as methods outlined in "Interim Chemical/Biological Monitoring Protocol for Coal Mining Permit Applications" (January 19, 2000, US EPA, Region III) were followed in the collection of the benthic macroinvertebrate specimens, water chemistry, and habitat evaluations. Measurements for flow, physical water quality, and chemical water quality were collected on October 9th, 2011 at this station. Benthic macroinvertebrate samples were collected, and the physical habitat of each station was evaluated. The individual methodologies are described below.

Physical Water Quality

Physical water quality was analyzed on-site at each station. Water temperature, pH, and conductivity were measured with an Oakton 300 series pH/CON multi-parameter probe. Dissolved Oxygen was measured using a Hach HQ30d flexi LDO meter. Flow was measured with a Marsh-McBirney™ Model 2000 portable flow meter. Stream widths, depths, and velocities were measured, and the resulting average discharge was reported for each station.

Water Chemistry

Water chemistry samples were collected at each station and returned to R.E.I. Consultants, Incorporated for processing. Parameters analyzed included acidity, alkalinity, total hardness, nitrate/nitrite, chloride, sulfate, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), total phosphorus, dissolved organic carbon, total aluminum, dissolved aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, copper, total iron, dissolved iron, lead, total manganese, dissolved manganese, magnesium, mercury, nickel, potassium, selenium, silver, sodium, thallium, and zinc.

Habitat

Habitat was assessed and rated on ten parameters in three categories using a modified version of the EPA Rapid bioassessment protocols for use in streams and wade able rivers (EPA 841-B-99-002). Several habitat measurements were calculated for each of the sampling stations. The individual parameters are described over the next few pages.

Parameter 1. Epifaunal Substrate/Available Cover - Includes the relative quantity and variety of natural structures in the stream. A wide variety and/or abundance of submerged structures in the stream provide macroinvertebrates and fish with a large number of niches, thus increasing habitat diversity.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
1. Epifaunal Substrate & Available Cover	Greater than 70% of substrate la-oracle for epifaunal colonization and fish cover, mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at a stage to allow full colonization potential (i.e. logs/snags that are not new fall and not transient.)	40 to 70% mix of stable habitat well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale.)	20 to 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**

Parameter 2. Embeddedness - Refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
2. Embeddedness	Gravel, cobble and boulder particles are 0-25% surrounded by fine sediment.	Gravel, cobble and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble and boulder particles are 50-75% surrounded by fine sediment	Gravel, cobble and boulder particles are 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**

Parameter 3. Velocity-Depth Combinations - Relates to the ability of a stream to provide and maintain a stable aquatic environment. The best streams in most high-gradient regions will have all 4 flow patterns present: (1) slow-deep, (2) slow-shallow, (3) fast-deep, and (4) fast-shallow.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
3. Velocity-Depth Combinations	All four velocity/depth patterns present (slow-deep, slow-shallow, fast-deep, fast-shallow.)	Only 3 or 4 velocity/depth patterns present (if fast-shallow is missing, score lower than if missing other regimes.)	May be only 2 velocity/depth patterns present (if fast-shallow or slow-shallow are missing, score low.)	Dominated by one velocity/depth pattern (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**

Parameter 4. Sediment Deposition - Measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. Deposition occurs from large-scale movement of sediment. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
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 to 30% of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, sand or fine sediment on old and new bars 30 to 50% of the bottom affected; sediment deposits at obstructions, constrictions and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE:	**20 19 18 17 16**	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1 0**

Parameter 5. Channel Flow Status - The degree to which the channel is filled with water. The flow status will change as the channel enlarges (e.g., aggrading stream beds with actively widening channels) or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of suitable substrate for aquatic organisms is limited.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
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 substrates exposed.	Water fills 25-75% of the available channel and/or riffle substrate are mostly exposed	Very little water in channel and 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**

Parameter 6. Channel Alteration - A measure of large-scale changes in the shape of the stream channel. Channel alteration is present when artificial embankments, rip-rap, and other forms of artificial bank stabilization or structures are present. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
6. Channel Alteration	Channelization or dredging absent or minimal ; stream with nonnal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e. dredging (greater past 20yrs) may be present, but recent channelization is not present.	Channelization may be extensive ; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted.	Banks shared with gabion or cement, over 80% of the stream reach channelized and disrupted. In stream 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**

Parameter 7. Frequency of Riffles (or bends) - Measures the sequence of riffles and thus the heterogeneity occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna, therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent, ration of distance between riffles divided by width of the stream <7:1 (generally 5 to 7): variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	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**

Parameter 8. Bank Stability - Measures whether the stream banks are eroded (or have the potential for erosion). Signs of erosion include crumbling, un-vegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of sediment movement and deposition, and suggest a scarcity of cover and organic input to streams.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
8. Bank Stability (score each bank) NOTE: determine left or right side by facing downstream.	Bank stable; evidence of erosion or bank 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, "raw" areas frequent along straight sections and bends; obvious bank sloughing ; 60-100% of bank has erosional scars.
SCORE: (Left Bank)	**LB 10 9**	**8 7 6**	**5 4 3**	**2 1 0**
SCORE: (Right Bank)	**RB 10 9**	**8 7 6**	**5 4 3**	**2 1 0**

Parameter 9. Bank Vegetative Protection - Measures the amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone. This parameter supplies information on the ability of the bank to resist erosion as well as some additional information on the uptake of nutrients by the plants, the control of instream scouring, and stream shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or rip-rap.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
9. Bank Vegetative Protection (score each bank)	More than 90% of the stream bank surface and immediate riparian zones covered by native vegetation, including trees, understory shrubs or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the stream bank surfaces covered by native vegetation, but one class of plant is not well represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the stream bank surface covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE: (Left Bank)	LB 10 9	8 7 6	5 4 3	2 1 0
SCORE: (Right Bank)	RB 10 9	8 7 6	5 4 3	2 1 0

Parameter 10. Riparian Vegetation Zone Width - Measures the width of natural vegetation from the edge of the stream bank out through the riparian zone. The vegetative zone serves as a buffer to pollutants entering a stream from runoff, controls erosion, and provides habitat and nutrient input into the stream.

HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
10. Riparian Vegetation Zone Width (score each bank riparian zone)	Width of riparian zone > 18 meters; human activities (i.e. parking lots, roadbeds, clear cuts, lawns or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 8-12 meters; human activities have impacted zone a great deal.	Width of riparian zone < 6 meters; little or no riparian vegetation due to human activities.
SCORE: (Left Bank)	LB 10 9	8 7 6	5 4 3	2 1 0
SCORE: (Right Bank)	RB 10 9	8 7 6	5 4 3	2 1 0

Benthic Macroinvertebrate Collection

A modified EPA Rapid bioassessment protocols for use in streams and wade able rivers (EPA 841-B-99-002) as well as methods outlined in "Interim Chemical/Biological Monitoring Protocol For Coal Mining Permit Applications" (January 19, 2000, US EPA, Region III) were followed in the collection of the benthic macroinvertebrate specimens. At each station, macroinvertebrate collections were made on Monday, October 9th, 2011, via a 0.25 m^2 "D-Frame" kick-net sampler. The sampler was fitted with a 500-µm mesh size net. Four semi-quantitative "D-Frame" kick-net samples were composited from a riffle/run area to equal 1-m^2

sampling area. Samples were placed in 1-liter plastic containers, preserved in 70% ethanol, and returned to the laboratory for processing. Samples were then picked under microscope and detrital material was discarded only after a second check to insure that no macroinvertebrates had been missed. All macroinvertebrates were identified to lowest practical taxonomic level and enumerated. Several benthic macroinvertebrate metrics were then calculated for each station.

The WV-SCI score and Modified Hilsenhoff Biotic Index (HBI) were calculated using the "200 organism" method. The whole kick sample was spread onto a 100-gridded sieve. Grids were selected at random and picked under dissecting scopes, until 200 (+/- 20%) insects were obtained. Those insects were then identified to the lowest possible taxonomic level, and this data was used to calculate the WV-SCI score and HBI. At least 25% of the 100 grids were picked and identified, and then extrapolated to determine the number of insects in the total kick sample. The number of grids picked for each sample is noted in the data table for that sample (TABLE 6). All metrics, excluding the WV-SCI score and HBI, are calculated using the total station abundance.

Benthic Macroinvertebrate Metrics

Several benthic macroinvertebrate measurements were calculated for each of the sampling stations. The individual metrics are described below:

Metric 1. Taxa Richness - Reflects the health of the community through a measurement of the variety of taxa present. Generally increases with increasing water quality, habitat diversity, and habitat suitability. However, the majority should be distributed in the pollution sensitive groups, a lesser amount in the facultative groups, and the least amount in the tolerant groups. Polluted streams shift to tolerant dominated communities.

Metric 2. Modified Hilsenhoff Biotic Index - This index was developed by Hilsenhoff (1987) to summarize overall pollution tolerance of the benthic arthropod community with a single value. Calculated by summarizing the number in a given taxa multiplied by its tolerance value, then divided by the total number of organisms in the sample.

Metric 3. Ratio of Scraper and Filtering Collector Functional Feeding Groups - This ratio reflects the riffle/run community food base and provides insight into the nature of potential disturbance factors. The relative abundance of scrapers and filtering collectors indicate the periphyton community composition, availability of suspended Fine Particulate Organic Material (FPOM) and availability of attachment sites for filtering. Filtering collectors are sensitive to toxicants bound to fine particles and should be the first group to decrease when exposed to steady sources of bound toxicants.

Metric 4. Ratio of Ephemeroptera, Plecoptera, Trichoptera (EPT) and Chironomidae Abundances - This metric uses relative abundance of these indicator groups as a measure of community balance. Good biotic condition is reflected in communities having a fairly even distribution between all four major groups and with substantial representation in the sensitive groups Ephemeroptera, Plecoptera, and Trichoptera. Skewed populations with large amounts of Chironomidae in relation to the EPT indicates environmental stress.

Metric 5. Percent Contribution of Mayflies - This is a measure of community health. A community dominated by relatively few species and individuals of mayflies would possibly indicate environmental stress. An optimal benthic community contains many mayflies from many taxa.

Metric 6. Percent Contribution of Dominant Family - This is also a measure of community balance. A community dominated by relatively few species would indicate environmental stress. A healthy community is dominated by pollution sensitive representation in the Ephemeroptera, Plecoptera, and Trichoptera groups.

Metric 7. EPT Index - This index is the total number of distinct taxa within the Orders: Ephemeroptera, Plecoptera, and Trichoptera. The EPT Index generally increases with increasing water quality. The EPT index summarizes the taxa richness within the pollution sensitive insect orders.

Metric 8. Ratio of Shredder Functional Feeding Group and Total Number of Individuals Collected - Allows evaluation of potential impairment as indicated by the shredder community. Shredders are good indicators of riparian zone impacts.

Metric 9. Simpson's Diversity Index - This index ranges from 0 (low diversity) to almost 1 (high diversity). A healthy benthic macroinvertebrate community should have a higher Simpson's Diversity Index.

Metric 10. Shannon-Wiener Diversity Index - Measures the amount of order in the community by using the number of species and the number of individuals in each species. The value increases with the number of species in the community. A healthy benthic macroinvertebrate community should have a higher Shannon-Wiener Diversity Index.

Metric 11. Shannon-Wiener Evenness - Measures the evenness, or equitability of the community by scaling one of the heterogeneity measures relative to its maximal value when each species in the sample is represented by the same number of individuals. Ranges from 0 (low equitability) to 1 (high equitability).

Metric 12. The West Virginia Stream Condition Index (WV-SCI) is used as a primary indicator of ecosystem health and can identify impairment with respect to a reference (or natural) condition. The index includes six biological attributes (metrics) that represent elements of the structure and function of the bottom-dwelling macroinvertebrate assemblage.

Range	Rank	
78.01 to 100	"Very Good"	Not Impaired
68.01 to 78.00	"Good"	
60.61 to 68.00	"Gray Zone"	
45.01 to 60.60	"Slightly Impaired"	Impaired
22.01 to 45.00	"Moderately Impaired"	
0 to 22.00	"Severely Impaired"	

PHYSICAL DESCRIPTIONS

BM-UWB

This station was located near the headwaters of the left fork of Wiley Branch. The benthic sampling station was located at approximately 37° 59' 22.4" latitude and 82° 15' 52.7" longitude. The substrate has been comprised of approximately 33% sand, 35% gravel, 30% cobble, and 2% boulder. A relatively large portion of the upstream site contains bedrock, and therefore, the samples must be taken in the pool areas which contain much more sand. This substrate composition would provide marginal to sub-optimal aquatic habitat, due to the high percentage sand present. If the percentage of sand continues to increase, aquatic habitat may become more limited. Stream flow was low (0.019 cubic feet/second) during the sampling event. Physical water quality measurements in the field were as follows: water temperature 15.5°C, Dissolved Oxygen (DO) 7.81 mg/L, pH 7.30, and conductivity 247 µs (TABLE 1). Large Woody Debris (LWD) and Coarse Particulate Organic Matter (CPOM) were both heavy. This station was located in a forested area and had a partly shaded canopy of mixed tree species (PHOTOS 1 & 2).

BM-DWB

This station was located near the mouth of Wiley Branch. The benthic sampling station was located at approximately 37° 58' 48.2" latitude and 82° 16' 26.0" longitude. The substrate was comprised of approximately 30% sand, 35% gravel, and 35% cobbles. This substrate composition would provide marginal aquatic habitat, due to the high percentage of sand and the absence of boulders. If the percentage of sand continues to increase, aquatic habitat may become more limiting. Stream flow was good (0.532 cubic feet/second) during the sampling event. Physical water quality measurements in the field were as follows: water temperature 16.3°C, Dissolved Oxygen (DO) 9.81 mg/L, pH 8.11, and conductivity 657 µs (TABLE 1). Large Woody Debris (LWD) was sparse and Coarse Particulate Organic Matter (CPOM) was heavy. Both the left and right banks were steep. This station was located in an industrial area, and had a partly-shaded canopy of mixed tree species (PHOTOS 3 & 4).

PHYSICAL AND CHEMICAL WATER QUALITY ANALYSIS

Water quality is a very important factor in determining the viability of the aquatic habitat. Although stream flow, substrate, and stream geomorphology are also important, water quality can be the most limiting function of a stream ecosystem. Heinen (1996) and Jenkins et al. (1995) address the ranges of some chemical water quality constituents within West Virginia watersheds.

Water Quality Parameter	Range for Freshwater Organisms	Source
pH	6 to 9	Stumm and Morgan 1996
Acidity	not available	
Alkalinity	10 to 400 mg/L	Jenkins et al. 1995
Calcium	4 to 160 mg/L	Heinen 1996
Chloride	< 230 mg/L	CSR 46 WVDEP
Conductivity	< 1,000 µs/L	REIC In-house recommendation
TDS	< 500 mg/L	WV State recommendation
Sulfate	< 850 mg/L	Jenkins et al. 1995
Iron	< 1 mg/L	Jenkins et al. 1995
Magnesium	< 28 mg/L	Heinen 1996
Manganese	< 1.0 mg/L	Heinen 1996; Jenkins et al. 1995
Selenium	< 0.005 mg/L	US EPA 1986
Aluminum	< 0.750 mg/L	CSR 47 WVDEP
Hardness	10 to 400 mg/L	Heinen 1996

Physical and chemical water quality was analyzed at both stations located on Wiley Branch. Physical water quality at the upstream station (BM-UWB) showed good stream flow, adequate Dissolved Oxygen levels (DO), a somewhat alkaline pH value, and good conductivity level (TABLE 1). Chemical water quality at this station revealed some trace amounts of nitrate/nitrite, chloride, sulfate, dissolved aluminum, total aluminum, barium, calcium, dissolved iron, lead, dissolved manganese, potassium, and sodium. Levels of total phosphorus, antimony, arsenic, beryllium, cadmium, chromium, copper, mercury, nickel, selenium, silver, thallium, and zinc were all below detection limits. Levels of alkalinity, acidity, total hardness, Total Suspended Solids (TSS), and Total Dissolved Solids (TDS) were all desirable for this station (TABLE 2). The overall water quality was considered desirable at this upstream station located on Wiley Branch.

Physical water quality at the downstream station (BM-DWB) showed adequate stream flow, adequate Dissolved Oxygen levels (DO), a somewhat alkaline pH value, and a moderately elevated conductivity level (TABLE 1). Chemical water quality at this station revealed some trace amounts of nitrate/nitrite, chloride, sulfate, total aluminum, barium, calcium, copper, dissolved iron, total iron, lead, dissolved manganese, total manganese, nickel, potassium, selenium, sodium, and zinc. Levels of total phosphorus, dissolved aluminum, antimony, arsenic, beryllium, chromium, mercury, silver, and thallium were all below detection limits. Levels of alkalinity, acidity, total hardness, Total Suspended Solids (TSS), and Total Dissolved Solids (TDS) were all desirable for this station (TABLE 2). Magnesium levels were slightly elevated. Overall water quality was considered fairly desirable at this downstream station located on Wiley Branch.

A comparison was made between the October 2010 study and this current October 2011 study at the upstream station (BM-UWB) located on Wiley Branch. During the current study, this station generally showed much stream flow, higher dissolved oxygen (DO) level, a lower pH value, and a lower conductivity level than the previous October study. Levels of nitrate/nitrite, total phosphorous, total organic carbon, total aluminum, copper, total iron, dissolved manganese, total manganese, and zinc have increased slightly since the October 2010 survey. Levels of alkalinity, total hardness, chloride, sulfate, TSS, TDS, antimony, arsenic, calcium, magnesium, nickel, potassium, silver, and sodium have all decreased since October 2010. All other parameters have remained constant since the previous October study. Overall, water quality has remained similar at this station located on Wiley Branch, since the previous October 2010 sampling event.

A comparison was made between the October 2010 study and this current October 2011 study at the downstream station (BM-DWB) located on Wiley Branch. During the current study, this station generally showed a higher stream flow, lower dissolved oxygen (DO) level, a lower pH value, and a lower conductivity level than the previous October study. Levels of TSS, copper, total iron, lead, zinc have all increased since the October 2010. Levels of alkalinity, total hardness, nitrate/nitrite, chloride, sulfate, TDS, antimony, calcium, total organic carbon, dissolved iron, dissolved manganese, total manganese, magnesium, nickel, potassium, selenium, and sodium have decreased since the previous October 2010 study. All other parameters have remained constant since the previous October 2010 study. Overall, water quality has remained similar at this station located on Wiley Branch, since the previous October 2010 sampling event.

HABITAT RESULTS

BM-UWB

This station, located near the headwaters of the left fork of Wiley Branch, received marginal substrate and in-stream cover (primary) ratings, poor to sub-optimal channel morphology (secondary) ratings, and poor to sub-optimal riparian and bank structure (tertiary) ratings (TABLE 3). "Epifaunal Substrate and Available Cover" was marginal, indicating a 20-40% mix of stable habitat. "Embeddedness" was marginal, due to copious amounts of silt surrounding gravel, cobble, and boulders. "Velocity-Depth Regime" was marginal, indicating the sample site was dominated by one velocity/depth regime, in this case slow/shallow.

"Sediment Deposition" was poor, because heavy deposits of silt and sand affected greater than 50% of the channel. "Channel Flow Status" was poor. "Channel Alteration" was marginal and "Frequency of Riffles" was sub-optimal. Both banks were moderately to sub-optimally stable. "Bank Vegetative Protection" was marginal on both banks. "Riparian Zone Width" was poor on the left bank and marginal on the right bank. This station scored a 74 out of a possible 200, and would provide poor to marginal aquatic habitat.

BM-DWB

This station located on Wiley Branch received poor to optimal substrate and available cover (primary) ratings, poor to sub-optimal channel morphology (secondary) ratings, and poor to sub-optimal riparian and bank structure (tertiary) ratings (TABLE 3). "Epifaunal Substrate and Available Cover" was marginal, indicating a 20-40% of a mix of stable habitat. "Embeddedness" was optimal, since gravels and cobbles were less than 25% surrounded by deposits of fine materials. "Velocity-Depth Regime" was poor, indicating that only one of the four depth regimes were present within the reach, in this case no deep sections. "Sediment Deposition" was marginal, since 50% of the channel bottom was affected by deposits of fine materials. "Channel Flow Status" was marginal, since water only filled less than 75% of the available channel. "Channel Alteration" was marginal. "Frequency of Riffles" was poor, since the reach was dominated by flat, shallow water. The left bank was marginally stable, while the right bank was sub-optimally stable. "Bank Vegetative Protection" was marginal on both banks. "Riparian Zone Width" was marginal for the left bank and poor for the right bank, due to a road on one side. This station scored an 88 out of a possible 200, and would provide poor to marginal aquatic habitat.

BENTHIC MACROINVERTEBRATE RESULTS

BM-UWB

The total abundance of benthic macroinvertebrates at this station comprised 135 individuals representing 23 taxa (TABLE 4 and TABLE 6). Eight pollution sensitive (intolerant) taxa (21.5% of the total abundance), ten facultative (intermediate tolerance) taxa (26.7% of the total abundance), and five tolerant taxa (51.9% of the total abundance) were collected. The tolerant aquatic worm, Lumbricidae (Family: Annelida), accounted for 23.0% of the total abundance, and was the most abundant taxon at this upstream station on Wiley Branch. The tolerant truefly, Family Chironomidae accounted for 18.5% of the total station abundance. Nine EPT groups (TABLE 5) were present, and the EPT:Chironomidae Ratio (39 : 25) indicated a benthic community in fairly good biotic condition. The West Virginia Stream Condition Index (WV-SCI) was 72.95, and was considered characteristic of a stream that is not impaired. All of the major functional feeding groups were present; shredders were dominant while filterer/collectors were poorly represented. Mayflies, stoneflies, and caddisflies were fairly diverse and fairly abundant for the low overall station abundance. The Simpson's and Shannon-Wiener Diversity indices reflected a community with very good diversity, and the Shannon-Wiener Evenness value of 0.81 indicated that abundances were well distributed among the taxa. The Modified Hilsenhoff Biotic Index (HBI) and the relative percentages of the three tolerance groups (sensitive, facultative, and tolerant) indicated a somewhat balanced, healthy, and primarily tolerant macroinvertebrate community at this station. The low station abundance, good taxa richness, good HBI score, fair EPT:Chironomidae ratio, and good WV-SCI score, along with other metrics, were together indications of desirable water quality, but somewhat limiting aquatic habitat at this station located upstream on Wiley Branch.

BM-DWB

The total abundance of benthic macroinvertebrates at this station comprised 245 individuals representing 24 taxa (TABLE 4 and TABLE 6). Six pollution sensitive (intolerant) taxa (31.7% of the total abundance), ten facultative (intermediate tolerance) taxa (35.7% of the total abundance), and eight tolerant taxa (51.9% of the total abundance) were collected. The sensitive stonefly Leuctra (Family: Leuctridae), accounted for 23.7% of the total abundance. The facultative mayfly, Eurylophella (Family: Ephemerellidae), accounted for 6.53% of the total station abundance. The pollution tolerant non-biting midge family, Chironomidae, accounted for 26.8% of the total station abundance, and was the most abundant taxa of aquatic insect at this downstream station on Wiley Branch. Eight EPT groups (TABLE 5) were present, and the EPT:Chironomidae Ratio (152 : 87) indicated a benthic community in good biotic condition. The West Virginia Stream Condition Index (WV-SCI) was 73.44, and was considered characteristic of a stream that is not impaired. All of the major functional feeding groups were present; filterer/collectors and scrapers were present in equal proportions. Mayflies were both not very abundant and diverse. Stoneflies were not diverse, but were abundant. Caddisflies were abundant but not diverse. The Simpson's and Shannon-Wiener Diversity indices reflected a community with good diversity, and the Shannon-Wiener Evenness value of 0.72 indicated that abundances were well distributed among the taxa. The Modified Hilsenhoff Biotic Index (HBI) and the relative percentages of the three tolerance groups (sensitive, facultative, and tolerant) indicated a fairly well balanced and healthy facultative macroinvertebrate community at this station. The low station abundance, good taxa richness, good HBI score, fair EPT:Chironomidae ratio, and good WV-SCI score, along with other metrics, were together indications of desirable water quality, but somewhat limiting aquatic habitat at this station located downstream on Wiley Branch.

DISCUSSION AND CONCLUSIONS

An optimal benthic macroinvertebrate community is characterized by a high relative abundance of pollution sensitive and facultative individuals, high species diversity, and the presence of all functional feeding groups. The quality of the benthic macroinvertebrate community is dependent on water quality, physical habitat characteristics, riparian vegetation, and amount of human disturbance. Optimal physical water quality is characterized by good stream flow all year, neutral pH values, and dissolved oxygen levels >5 mg/l. Good chemical water quality should indicate low levels of total and dissolved metals, low dissolved and suspended solids, and residual buffering capacity.

A substrate containing a large percentage of cobble sized particles, with minimal embeddedness and sediment deposition would provide an optimal physical habitat. Good bank stability, stream side cover comprising native vegetation, and a riparian buffer zone between the stream and human impacts are necessary to provide appropriate nutrient cycling and minimize erosion.

Physical and chemical water quality was analyzed at both stations located on Wiley Branch. The upstream site, BM-UWB, contained fairly desirable water quality. The downstream Wiley Branch site, BM-DWB, also contained fairly desirable water quality, and revealed only somewhat elevated conductivity, but was well within the range suitable for aquatic organisms (TABLE 1).

Aquatic habitat was generally considered marginal at both stations, scoring a 74 out of a possible 200 at BM-UWB and scoring 88 out of 200 at BM-DWB. The upstream station, BM-UWB, was most limited by "Sediment Deposition". The downstream station, BM-DWB, was most limited by a short "Riparian Zone Width" due to the close proximity of a road (TABLE 3).

A comparison was made between the October 2010 study and this current October 2011 study at the upstream station (BM-UWB) located on Wiley Branch. The current October 2011 study of BM-UWB revealed 135 individuals collected from 23 taxa, and the benthic community was comprised of 21.5% sensitive individuals, 26.7% facultative individuals, and 51.9% tolerant individuals. The WV-SCI score was 72.95, and was considered characteristic of a stream that is in good biotic condition. For the upstream Wiley Branch site, BM-UWB, during the October 2010 study, 119 individuals collected from 25 taxa, and the benthic community was comprised of 28.6% sensitive individuals, 28.6% facultative individuals, and 42.9% tolerant individuals. The WV-SCI score was 81.46, and was considered characteristic of a stream that is unimpaired and in very good condition. Because the WV-SCI decreased during the current study, there was a loss of two taxa, and the very slight shift towards a more tolerant macroinvertebrate community, an overall slight decline at this station may have occurred since the previous October 2010 study.

For the downstream Wiley Branch site, BM-DWB, during the October 2010 study, 1,588 individuals were collected from 19 taxa, and the benthic community was comprised of 26.4% sensitive individuals, 57.9% facultative individuals, and 15.6% tolerant individuals. The WV-SCI score was 72.17, and was considered characteristic of a stream that is not impaired and in good condition. During the current October 2011 study, there were 245 individuals collected from 24 taxa, and the benthic community was comprised of 31.7% sensitive individuals, 35.7% facultative individuals, and 51.9% tolerant individuals. The WV-SCI score was 73.44, and was considered characteristic of a stream that is not impaired and in good condition. Although there was a dramatic decrease in total station abundance, the gain of five taxa and slightly higher WV-SCI score suggest a similar macroinvertebrate community.

FIGURES 2 - 7 show the WV-SCI scores calculated for upstream station BM-UWB comparing the current October 2011 survey and the previous October 2010 survey of Wiley Branch as plotted against six different water quality parameters. There appeared to be some correlation between WV-SCI scores and concentrations of dissolved manganese; as the concentration of the parameters increased, the WV-SCI score decreased. There did not appear to be any correlation between the WV-SCI score and conductivity, dissolved aluminum, magnesium, Total Dissolved Solids (TDS), or sulfate. FIGURE 8 shows the WV-SCI scores for the current Fall 2011 study as plotted against the habitat scores for the same station in Fall 2010. There did appear to be a correlation between WV-SCI scores and habitat scores at these two stations located on Wiley Branch. FIGURE 9 shows the WV-SCI scores as plotted against the stream flows, as habitat scores decreased, WV-SCI scores decreased. There appeared to be an inverse correlation between WV-SCI scores and stream flows; as the stream flow increased, the WV-SCI score decreased.

FIGURES 10 - 13 show the WV-SCI scores calculated for the Fall 2000 through Fall 2011 surveys on Wiley Branch as plotted against the same four water quality parameters. There did not appear to be any noticeable correlation between WV-SCI scores and the concentrations of conductivity, TDS, sulfate, and dissolved aluminum over time. FIGURE 14 shows the calculated WV-SCI scores as plotted against habitat scores. There did not appear to be any correlation between WV-SCI scores and habitat scores over time.

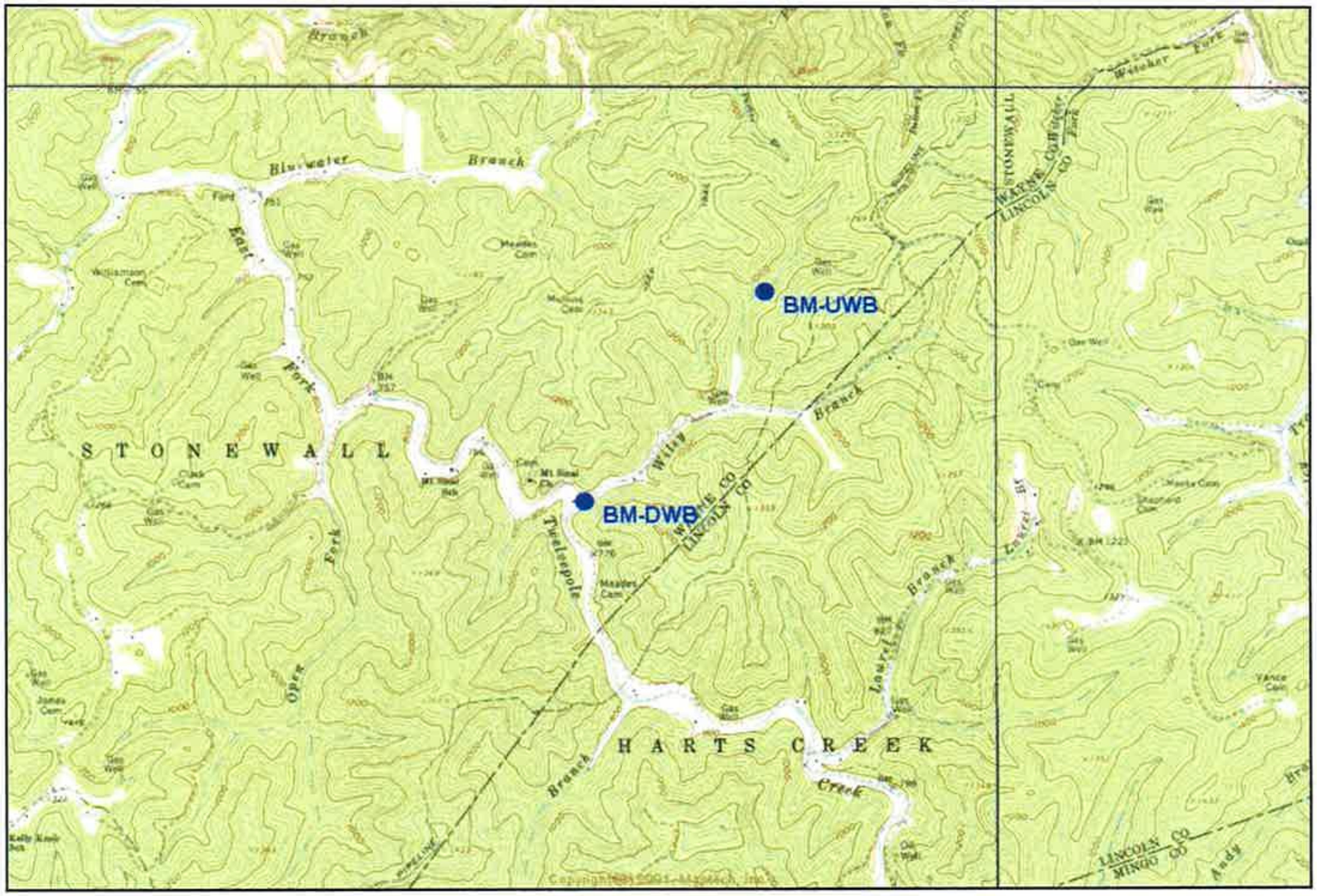

FIGURE 1. Terrain Navigator map showing the approximate location of the study area associated with Wiley Branch. Argus Energy-WV, LLC. October 2011.

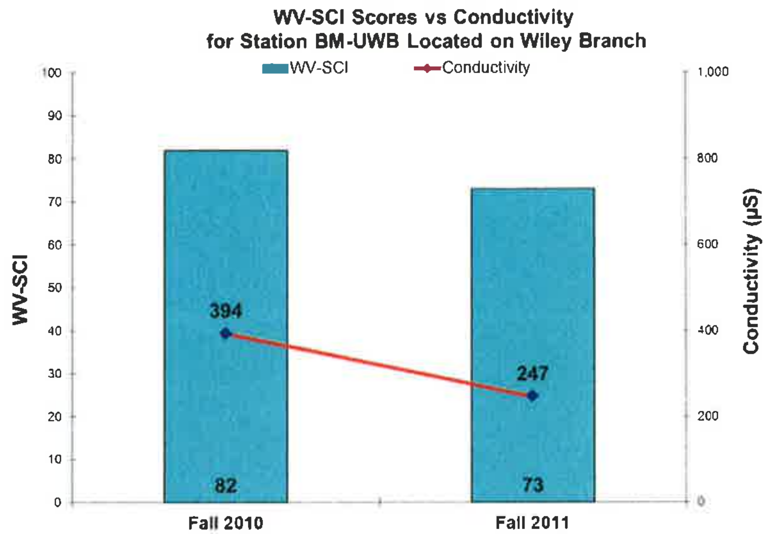

FIGURE 2. WV-SCI scores vs conductivity levels at station BM-UWB located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

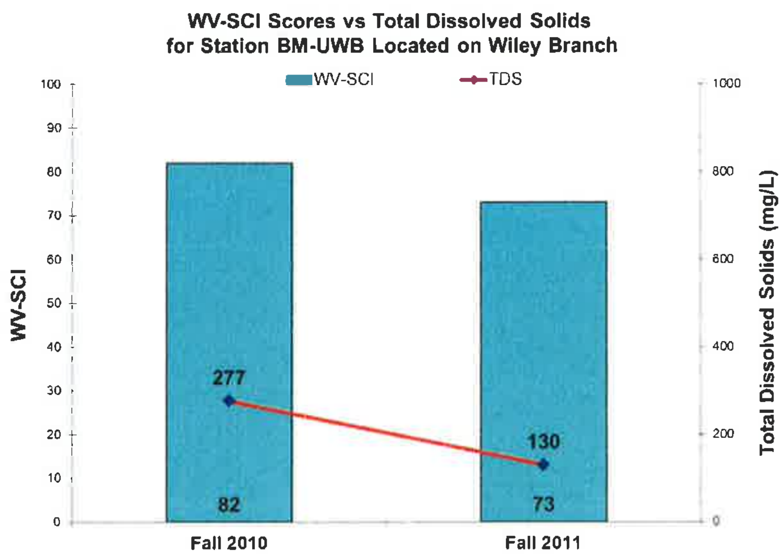

FIGURE 3. WV-SCI scores vs Total Dissolved Solids (TDS) at station BM-UWB located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

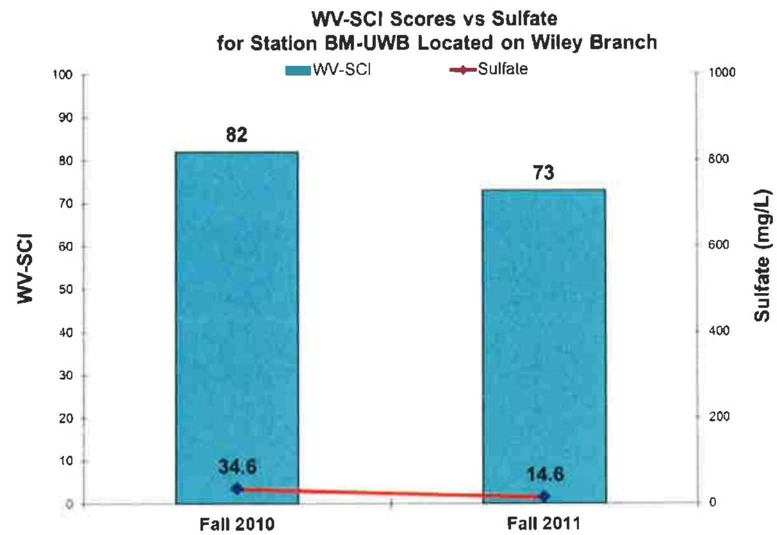

FIGURE 4. WV-SCI scores vs sulfate levels at station BM-UWB located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

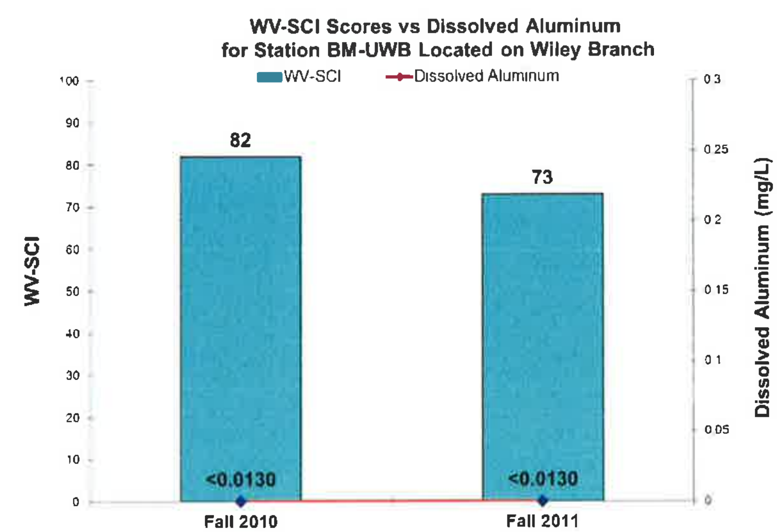

FIGURE 5. WV-SCI scores vs dissolved aluminum levels at station BM-UWB located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

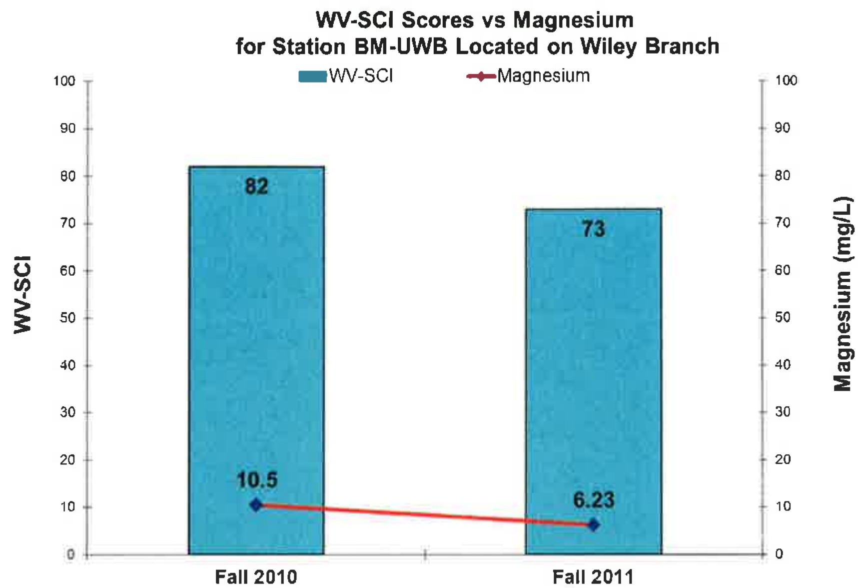

FIGURE 6. WV-SCI scores vs magnesium levels at station BM-UWB located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

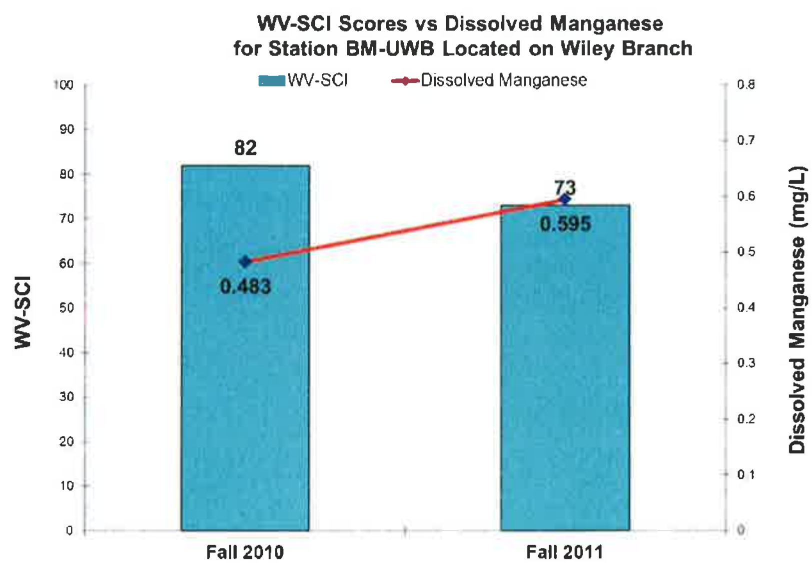

FIGURE 7. WV-SCI scores vs dissolved manganese levels at station BM-UWB located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

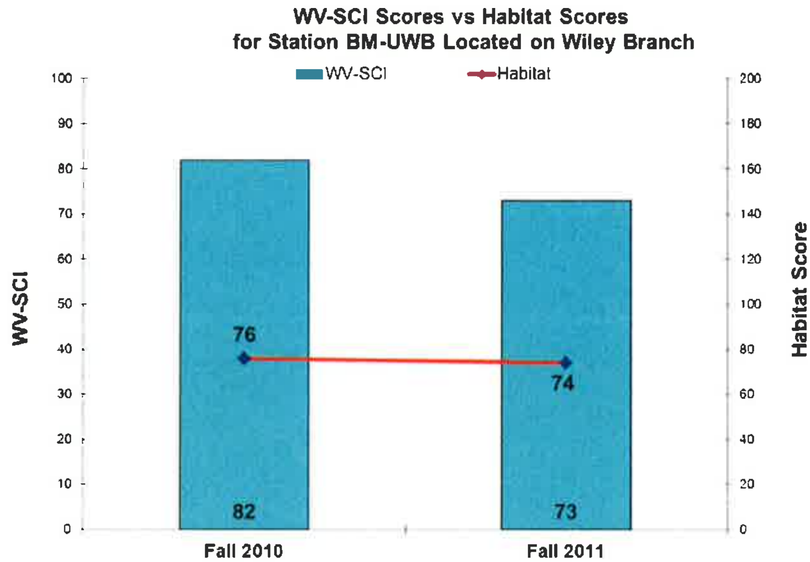

FIGURE 8. WV-SCI scores vs habitat scores at station at BM-UWB located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

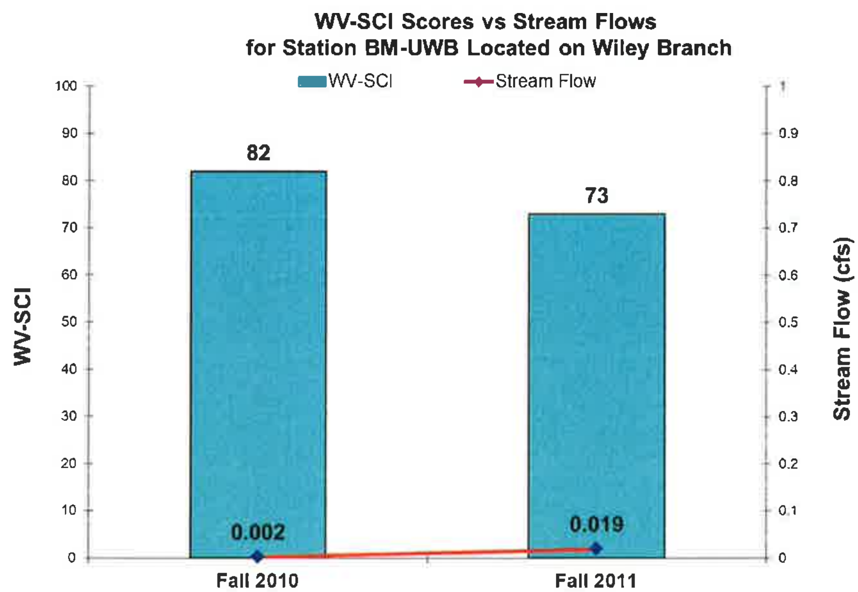

FIGURE 9. WV-SCI scores vs stream flow measurements at station BM-UWB located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

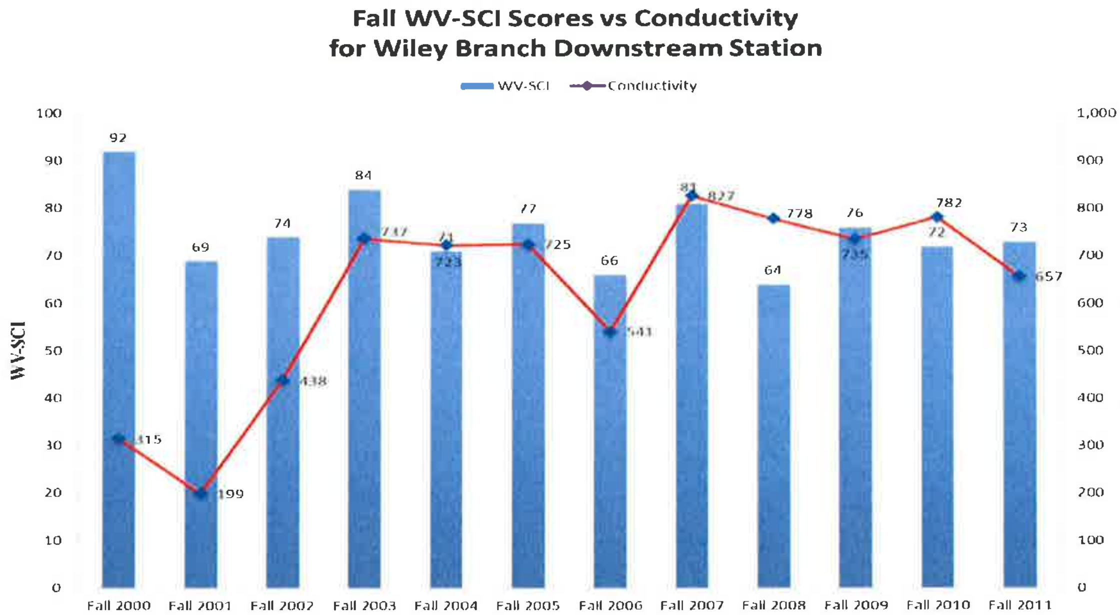

FIGURE 10. WV-SCI scores vs conductivity levels at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

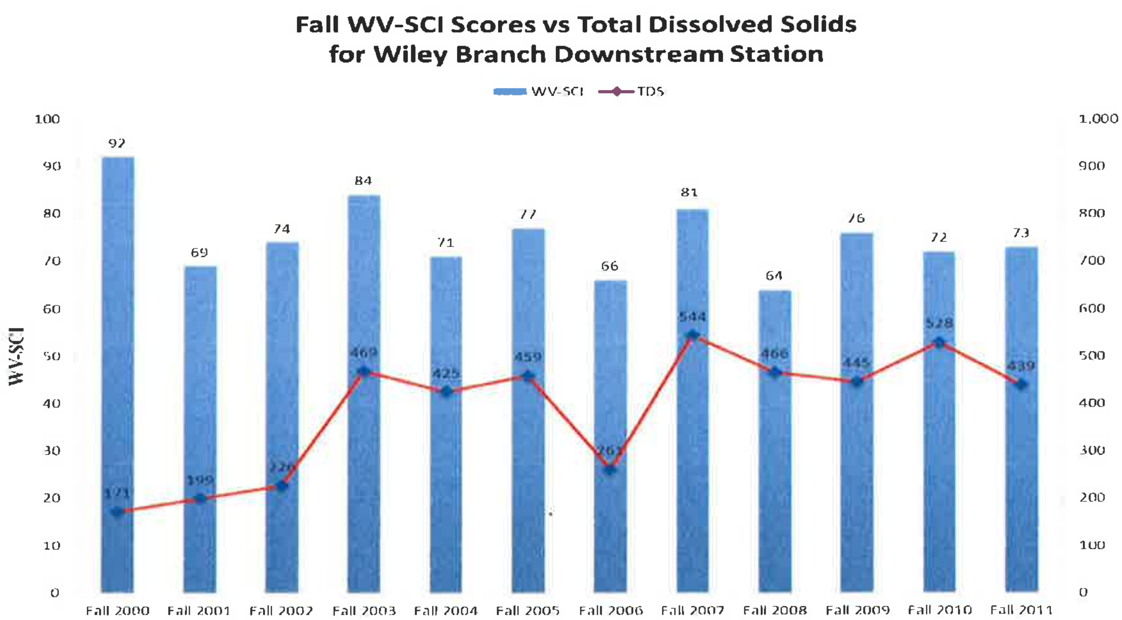

FIGURE 11. WV-SCI scores vs Total Dissolved Solids (TDS) at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

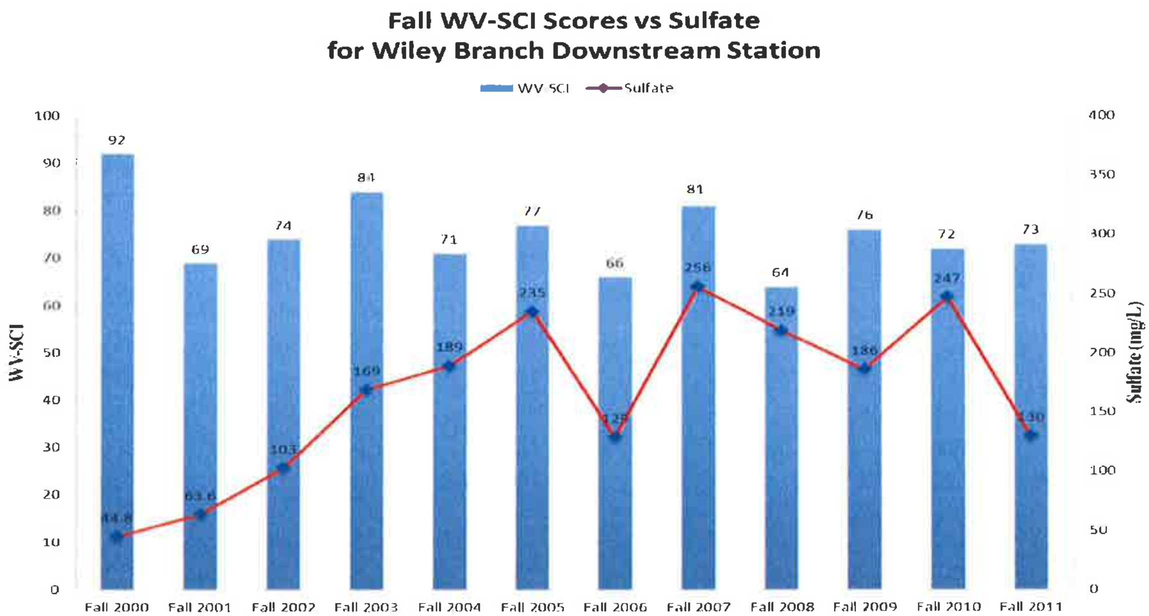

FIGURE 12. WV-SCI scores vs sulfate levels at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

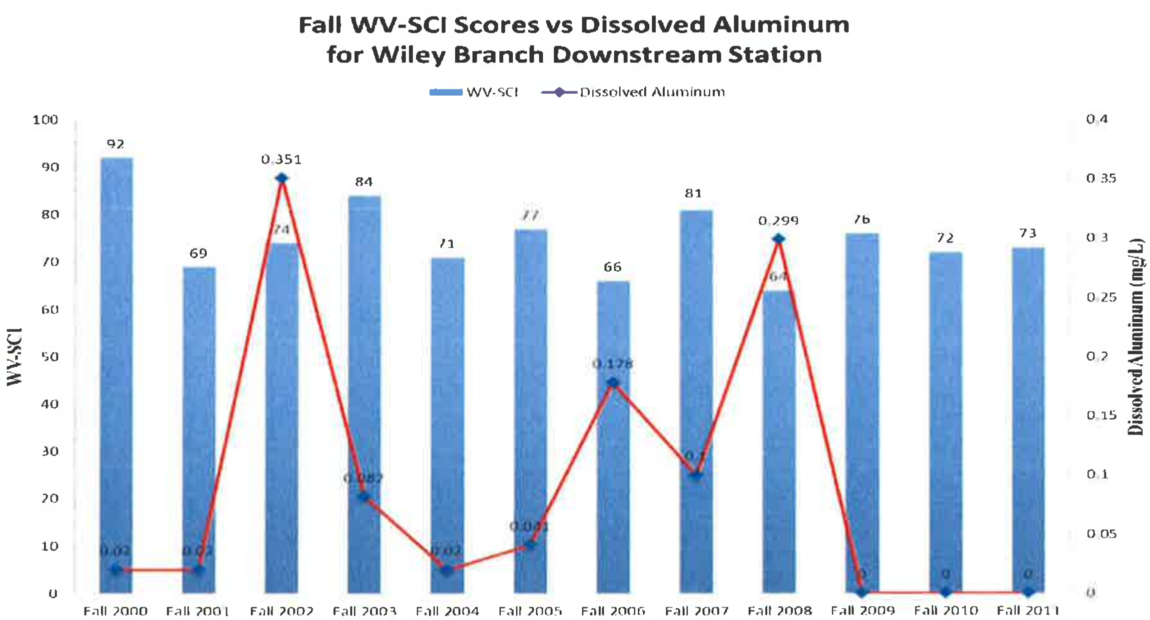

FIGURE 13. WV-SCI scores vs dissolved aluminum levels at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

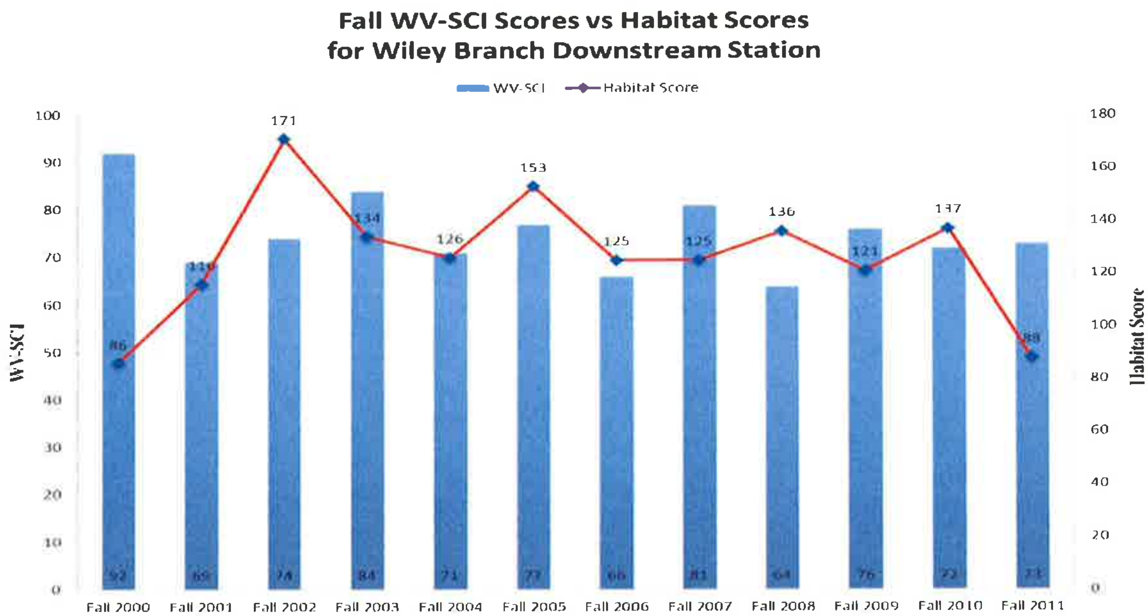

FIGURE 14. WV-SCI scores vs habitat scores at the downstream station (BM-DWB) located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

PHOTO 1. Looking upstream from station BM-UWB, located upstream on Wiley Branch. Argus Energy-WV, LLC. October 2011.

PHOTO 2. Looking downstream from station BM-UWB, located upstream on Wiley Branch. Argus Energy-WV, LLC. October 2011.

PHOTO 3. Looking upstream from station BM-DWB, located downstream on Wiley Branch. Argus Energy-WV, LLC. October 2011.

PHOTO 4. Looking downstream from station BM-DWB, located downstream on Wiley Branch. Argus Energy-WV, LLC. October 2011.

TABLE 1. Physical water quality and approximate GPS locations for stations located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

	SAMPLING STATION	
	BM-UWB	BM-DWB
PHYSICAL WATER QUALITY		
Flow (ft^3/s)	0.019	0.532
Temperature (°C)	15.5	16.3
Dissolved Oxygen (mg/L)	7.81	9.81
Field pH (SI Units)	7.30	8.11
Field Conductivity (μs)	247	657
GPS READING		
Latitude	37°59'22.4"	37°58'48.3"
Longitude	82°15'52.7"	82°16'26.0"

TABLE 2. Chemical water quality for stations located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

PARAMETER	SAMPLING STATION	
	BM-UWB	BM-DWB
Acidity (mg/l)	7.3	7.4
Alkalinity (mg/l)	98.0	152
Total Hardness (mg/l)	122	343
Lab pH (SI Units)	6.67	7.60
Lab Conductivity (µs)	253	680
Nitrate/Nitrite (mg/l)	0.11	0.22
Chloride (mg/l)	3.21	1.83
Sulfate (mg/l)	14.6	130
TSS (mg/l)	6	6
TDS (mg/l)	130	439
Total Phosphorous (mg/l)	0.04	< 0.020
Total Organic Carbon (mg/l)	4.25	2.71
Dissolved Aluminum (mg/l)	< 0.0120	< 0.0120
Total Aluminum (mg/l)	0.054	< 0.0120
Antimony (mg/l)	< 0.00020	< 0.00020
Arsenic (mg/l)	< 0.00100	< 0.00100
Barium (mg/l)	0.0675	0.0796
Beryllium (mg/l)	< 0.00020	< 0.00020
Cadmium (mg/l)	< 0.00020	< 0.00020
Calcium (mg/l)	38.6	75.0
Chromium (mg/l)	< 0.00100	< 0.00100
Copper (mg/l)	0.0013	0.0022
Dissolved Iron (mg/l)	0.359	0.060
Total Iron (mg/l)	0.883	0.273
Lead (mg/l)	< 0.00020	0.0005
Dissolved Manganese (mg/l)	0.595	0.042
Total Manganese (mg/l)	0.604	0.046
Magnesium (mg/l)	6.23	37.7
Mercury (mg/l)	< 0.00010	< 0.00010
Nickel (mg/l)	0.0023	< 0.00200
Potassium (mg/l)	2.30	5.37
Selenium (mg/l)	< 0.00100	< 0.00100
Silver (mg/l)	< 0.00100	< 0.00100
Sodium (mg/l)	2.73	7.94
Thallium (mg/l)	< 0.00020	< 0.00020
Zinc (mg/l)	0.0060	0.0708

TABLE 3. High gradient habitat scores associated with stations located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

	SAMPLING STATION	
	BM-UWB	BM-DWB
<u>Primary – Substrate and Available Cover</u>		
1. Epifaunal Substrate and Available Cover (0-20)	9	9
2. Embeddedness (0-20)	7	16
3. Velocity-Depth Regime (0-20)	7	5
<u>Secondary – Channel Morphology</u>		
4. Sediment Deposition (0-20)	3	11
5. Channel Flow Status (0-20)	4	10
6. Channel Alteration (0-20)	6	10
7. Frequency of Riffles (0-20)	12	4
<u>Tertiary – Riparian and Bank Structure</u>		
8. Bank Stability (0-10)		
Left Bank	5	3
Right Bank	6	6
9. Bank Vegetative Protection (0-10)		
Left Bank	5	5
Right Bank	3	4
10. Riparian Zone Width (0-10)		
Left Bank	2	3
Right Bank	5	2
Total Score	74	88

Note: The scoring for each	Optimal	Sub-optimal	Marginal	Poor
Primary	16-20	11-15	6-10	0-5
Secondary	16-20	11-15	6-10	0-5
Tertiary	9-10	6-8	3-5	0-2

TABLE 4. Total abundances and sensitivities of benthic macroinvertebrates collected in the kicknet sample from stations located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

TAXON	SAMPLING STATION	
	BM-UWB	BM-DWB
Insecta		
Ephemeroptera (Mayflies)		
Baetidae		
Acerpenna (F)	1	
Ephemerellidae		
Eurylophella (F)	13	4
Heptageniidae		
Maccaffertium (F)		21
Stenacron (F)	3	
Isonychiidae		
Isonychia (S)		5
Leptophlebiidae		
Leptophlebia (T)	4	
Plecoptera (Stoneflies)		
Leuctridae		
Leuctra (S)	5	77
Perlidae		
Eccoptura (S)		1
Perlodidae (S)	6	
Taeniopterygidae (S)	1	
Trichoptera (Caddisflies)		
Hydropsychidae		
Cheumatopsyche (F)		36
Diplectrona (S)	5	5
Philopotamiidae		
Chimarra (F)		3
Rhyacophilidae		
Rhyacophila (S)	1	
Diptera (Trueflies)		
Ceratopogonidae		
Bezzia (T)	8	4
Chironomidae (T)	25	87
Empididae		
Hemerodromia (T)		5
Simuliidae		
Simulium (F)		3
Tabanidae		
Chrysops (T)	2	

TABLE 4. Continued.

TAXON	SAMPLING STATION	
	BM-UWB	BM-DWB
Tipulidae		
Hexatoma (S)	9	
Limnophila (F)	3	
Tipula (F)	8	21
Odonata (Dragonflies/Damselflies)		
Calopterygidae		
Calopteryx (T)		1
Gomphidae		
Lanthus (S)	1	3
Coleoptera (Beetles)		
Curculionidae (F)	1	
Dryopidae		
Helichus (F)	1	1
Elmidae		
Dubiraphia (T)		1
Optioservus (F)	1	19
Stenelmis (F)	2	7
Psephenidae		
Ectopria (F)	3	1
Megaloptera (Hellgrammites)		
Corydalidae		
Nigronia (S)	1	12
Annelida		
Oligochaeta (Aquatic Worms)		
Lumbricidae (T)	31	4
Decapoda (Crayfish) (T)		
Cambaridae		
Cambarus (T)		3
Nematomorpha (Horsehair Worms) (T)		1
Pupae*(U)	2*	4*
Total Individuals	135	325
Total Taxa	23	24

TABLE 4. Continued.

TAXON	SAMPLING STATION	
	BM-UWB	BM-DWB
Sensitive Individuals (%)	29 (21.5%)	103 (31.7%)
# Sensitive Taxa	8	6
Facultative Individuals (%)	36 (26.7%)	116 (35.7%)
# Facultative Taxa	10	10
Tolerant Individuals (%)	70 (51.9%)	106 (32.6%)
# Tolerant Taxa	5	8

* Not Included in abundance or taxa calculations. For observation only.
( ) Classification of Pollution Indicator Organisms
(S) = Sensitive (F) = Facultative (T) = Tolerant (U) = Unclassified

TABLE 5. Selected benthic macroinvertebrate metrics for the stations located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

	SAMPLING STATION	
	BM-UWB	BM-DWB
Metric 1. Taxa Richness		
	23	24
Metric 2. Modified Hisenhoff Biotic Index (HBI score)		
	4.90	3.75
Metric 3. Ratio of Scrapers to Collector/Filterers		
	22 : 5	52 : 52
Metric 4. Ratio of Ephemeroptera, Plecoptera, and Trichoptera (EPT) to Chironomidae Abundances		
	39 : 25	152 : 87
Metric 5. Percent Contribution of Mayflies		
	15.6%	9.2%
Metric 6. Percent Contribution of Dominant Taxa		
	23.0% Lumbricidae	26.8% Chironomidae
Metric 7. EPT Index		
	9	8
Metric 8. Percent of Shredders to total		
	12.6%	30.5%
Metric 9. Simpson's Diversity Index		
	0.89	0.85
Metric 10. Shannon-Wiener Diversity Index		
	3.67	3.31
Metric 11. Shannon-Wiener Evenness		
	0.81	0.72
Metric 12. West Virginia Stream Condition Index (WV-SCI score)		
	72.95	73.44

TABLE 6. Total abundances and sensitivities of the 200-bug count (+/- 20%) benthic subsample used to calculate the WV-SCI score and HBI for stations located on Wiley Branch. Argus Energy-WV, LLC. October 2011.

TAXON	SAMPLING STATION	
	BM-UWB (100/100)	BM-DWB (75/100)
Insecta		
Ephemeroptera (Mayflies)		
Baetidae		
Acerpenna (F)	1	
Ephemerellidae		
Eurylophella (F)	13	3
Heptageniidae		
Maccaffertium (F)		16
Stenacron (F)	3	
Isonychiidae		
Isonychia (S)		4
Leptophlebiidae		
Leptophlebia (T)	4	
Plecoptera (Stoneflies)		
Leuctridae		
Leuctra (S)	5	58
Perlidae		
Eccoptura (S)		1
Perlodidae (S)	6	
Taeniopterygidae (S)	1	
Trichoptera (Caddisflies)		
Hydropsychidae		
Cheumatopsyche (F)		27
Diplectrona (S)	5	4
Philopotamiidae		
Chimarra (F)		2
Rhyacophilidae		
Rhyacophila (S)	1	
Diptera (Trueflies)		
Ceratopogonidae		
Bezzia (T)	8	3
Chironomidae (T)	25	65
Empididae		
Hemerodromia (T)		4
Simuliidae		
Simulium (F)		2

TABLE 6. Continued.

TAXON	SAMPLING STATION	
	BM-UWB (100/100)	BM-DWB (75/100)
Tabanidae		
Chrysops (T)	2	
Tipulidae		
Hexatoma (S)	9	
Limnophila (F)	3	
Tipula (F)	8	16
Odonata (Dragonflies/Damselflies)		
Calopterygidae		
Calopteryx (T)		1
Gomphidae		
Lanthus (S)	1	2
Coleoptera (Beetles)		
Curculionidae (F)	1	
Dryopidae		
Helichus (F)	1	1
Elmidae		
Dubiraphia (T)		1
Optioservus (F)	1	14
Stenelmis (F)	2	5
Psephenidae		
Ectopria (F)	3	1
Megaloptera (Hellgrammites)		
Corydalidae		
Nigronia (S)	1	9
Annelida		
Oligochaeta (Aquatic Worms)		
Lumbricidae (T)	31	3
Decapoda (Crayfish) (T)		
Cambaridae		
Cambarus (T)		2
Nematomorpha (Horsehair Worms) (T)		1

TABLE 6. Continued.

TAXON	SAMPLING STATION BM-UWB (100/100)	BM-DWB (75/100)
Pupae*(U)	2*	3*
Total Individuals	135	245
Total Taxa	23	24

* Not Included in abundance or taxa calculations. For observation only.
( ) Classification of Pollution Indicator Organisms
(S) = Sensitive (F) = Facultative (T) = Tolerant (U) = Unclassified

APPENDIX A

PRECIPITATION DATA

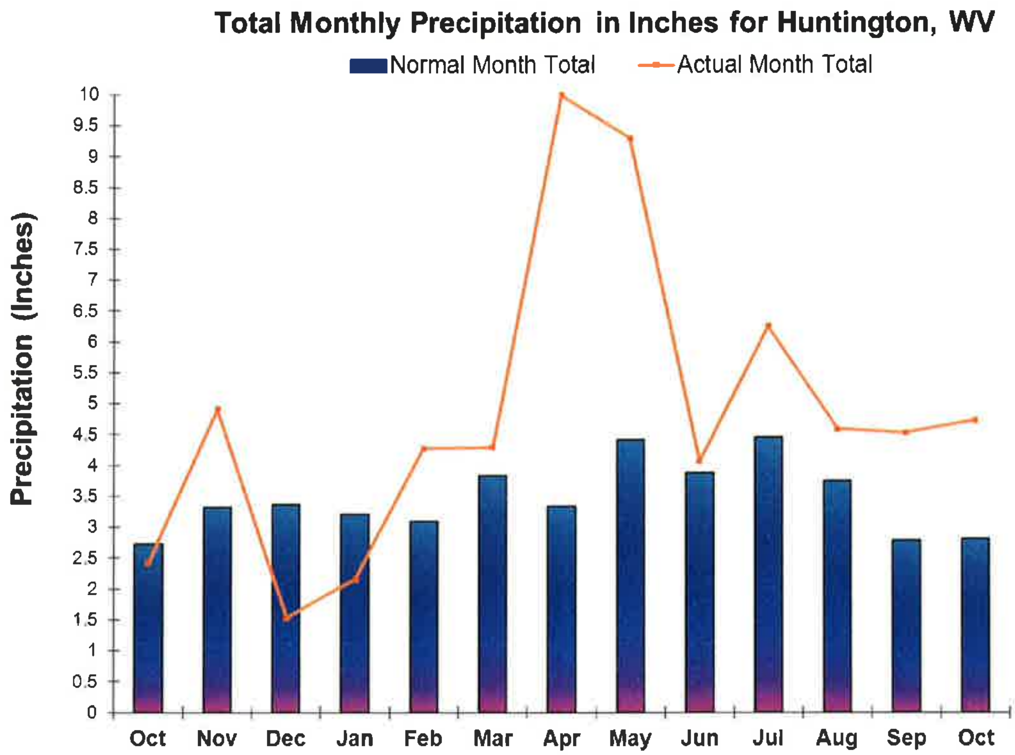

FIGURE A-1. Total monthly precipitation for Huntington, WV from October 2010 to October 2011 (www.weatherunderground.com; accessed Nov. 12, 2011).

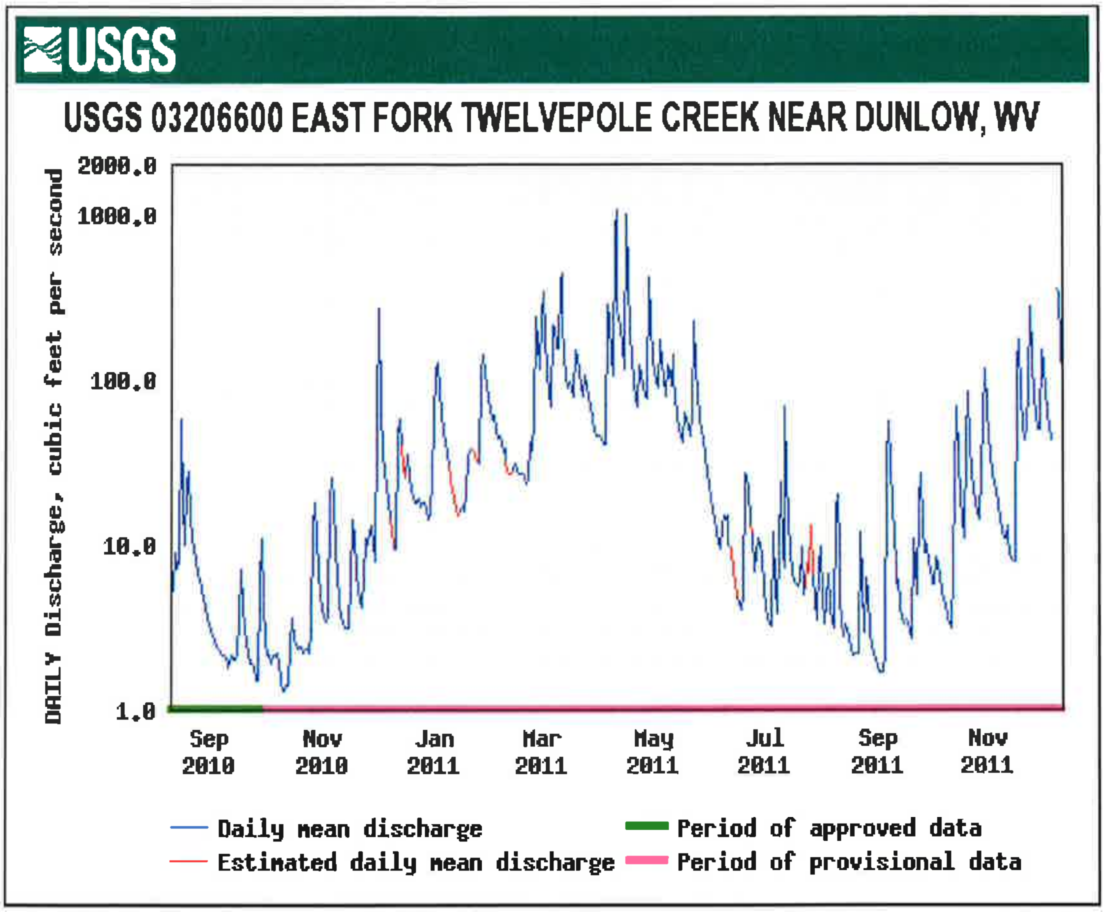

FIGURE A-2. Daily stream discharge data for the East Fork of Twelvepole Creek near Dunlow, WV (waterdata.usgs.gov; accessed January 26, 2012