EII Calculation for High Gradient Streams in Eastern Kentucky Coalfield (Version 2002.6)
****(Family Level Taxonomy - All Habitats)****

Project ID:	LRN-2012-00914
Stream/Reach:	**Mine Area H Intermittent**
Assessment Objectives:	**Existing Conditions**

EII	Model
NA	Ecological Integrity Index (MBI + Habitat Integrity + Conductivity)
0.72	Ecological Integrity Index (Habitat Integrity + Conductivity)

>>>>>>>

Enter quantitative or categorical measure from Field Data Sheet in shaded cells

Variables	Measure	Units	Subindex
RBP Habitat Parameters			
1. Epifaunal Substrate	10	no units	
2. Embeddedness	11	no units	
3. Velocity/Depth Regime	8	no units	
4. Sediment Deposition	10	no units	
5. Channel Flow Status	10	no units	
6. Channel Alteration	16	no units	
7. Freq. Of Riffles (bends)	16	no units	
8. Bank stability (both combined)	16	no units	
9. Veg. Protection (both combined)	18	no units	
10. Riparian Width (both combined)	18	no units	
Total Habitat Score	**133**	no units	
Habitat Integrity Index			**0.43**
Macroinvertebrate Data - Family Level (All Habitats)			
11. Family Taxa Richness		# of taxa sampled	
12. Family EPT Richness		# of EPT species sampled	
13. % Ephemeroptera		% Mayflies (0-100)	
14. % Chironomidae & Oligochaeta		% Midges & Worms (0-100)	
15. mFBI		no units	
Macroinvertebrate Bioassessment	**NA**	no units	**NA**
Conductivity	**90**	microMHOs	**1.00**

EII Calculation for High Gradient Streams in Eastern Kentucky Coalfield (Version 2002.6)
****(Family Level Taxonomy - All Habitats)****

Project ID:	LRN-2012-00914
Stream/Reach:	**Mine Area I**
Assessment Objectives:	**EXISTING CONDITIONS**

EII	Model
NA	Ecological Integrity Index (MBI + Habitat Integrity + Conductivity)
0.68	Ecological Integrity Index (Habitat Integrity + Conductivity)

>>>>>>>

Enter quantitative or categorical measure from Field Data Sheet in shaded cells

Variables	Measure	Units	Subindex
RBP Habitat Parameters			
1. Epifaunal Substrate	11	no units	
2. Embeddedness	15	no units	
3. Velocity/Depth Regime	10	no units	
4. Sediment Deposition	9	no units	
5. Channel Flow Status	14	no units	
6. Channel Alteration	19	no units	
7. Freq. Of Riffles (bends)	13	no units	
8. Bank stability (both combined)	12	no units	
9. Veg. Protection (both combined)	18	no units	
10. Riparian Width (both combined)	18	no units	
Total Habitat Score	**139**	no units	**Subindex**
Habitat Integrity Index			**0.49**
Macroinvertebrate Data - Family Level (All Habitats)			
11. Family Taxa Richness	0	# of taxa sampled	
12. Family EPT Richness	0	# of EPT species sampled	
13. % Ephemeroptera	0	% Mayflies (0-100)	
14. % Chironomidae & Oligochaeta	0	% Midges & Worms (0-100)	
15. mFBI	0	no units	
Macroinvertebrate Bioassessment	**NA**	no units	**NA**
Conductivity	**195**	microMHOs	**0.87**

EII Calculation for High Gradient Streams in Eastern Kentucky Coalfield (Version 2002.6)
****(Family Level Taxonomy - All Habitats)****

Project ID:	LRN-2012-00914
Stream/Reach:	**Mine Area J Lower**
Assessment Objectives:	**EXISTING CONDITIONS**

EII	Model
NA	Ecological Integrity Index (MBI + Habitat Integrity + Conductivity)
0.84	Ecological Integrity Index (Habitat Integrity + Conductivity)

>>>>>>>

Enter quantitative or categorical measure from Field Data Sheet in shaded cells

Variables	Measure	Units	Subindex
RBP Habitat Parameters			
1. Epifaunal Substrate	18	no units	
2. Embeddedness	16	no units	
3. Velocity/Depth Regime	12	no units	
4. Sediment Deposition	13	no units	
5. Channel Flow Status	13	no units	
6. Channel Alteration	19	no units	
7. Freq. Of Riffles (bends)	16	no units	
8. Bank stability (both combined)	13	no units	
9. Veg. Protection (both combined)	18	no units	
10. Riparian Width (both combined)	18	no units	
Total Habitat Score	**156**	no units	
Habitat Integrity Index			**0.77**
Macroinvertebrate Data - Family Level (All Habitats)			
11. Family Taxa Richness		# of taxa sampled	
12. Family EPT Richness		# of EPT species sampled	
13. % Ephemeroptera		% Mayflies (0-100)	
14. % Chironomidae & Oligochaeta		% Midges & Worms (0-100)	
15. mFBI		no units	
Macroinvertebrate Bioassessment	**NA**	no units	**NA**
Conductivity	**182.5**	microMHOs	**0.91**

EII Calculation for High Gradient Streams in Eastern Kentucky Coalfield (Version 2002.6)
****(Family Level Taxonomy - All Habitats)****

Project ID:	LRN-2012-00914
Stream/Reach:	**Mine Area J Upper**
Assessment Objectives:	**Existing Conditions**

EII	Model
NA	Ecological Integrity Index (MBI + Habitat Integrity + Conductivity)
0.73	Ecological Integrity Index (Habitat Integrity + Conductivity)

>>>>>>>

Enter quantitative or categorical measure from Field Data Sheet in shaded cells

Variables	Measure	Units	Subindex
RBP Habitat Parameters			
1. Epifaunal Substrate	16	no units	
2. Embeddedness	16	no units	
3. Velocity/Depth Regime	10	no units	
4. Sediment Deposition	12	no units	
5. Channel Flow Status	10	no units	
6. Channel Alteration	16	no units	
7. Freq. Of Riffles (bends)	16	no units	
8. Bank stability (both combined)	13	no units	
9. Veg. Protection (both combined)	18	no units	
10. Riparian Width (both combined)	16	no units	
Total Habitat Score	143	no units	
Habitat Integrity Index			0.55
Macroinvertebrate Data - Family Level (All Habitats)			
11. Family Taxa Richness		# of taxa sampled	
12. Family EPT Richness		# of EPT species sampled	
13. % Ephemeroptera		% Mayflies (0-100)	
14. % Chironomidae & Oligochaeta		% Midges & Worms (0-100)	
15. mFBI		no units	
Macroinvertebrate Bioassessment	NA	no units	NA
Conductivity	182.5	microMHOs	0.91

EII Calculation for High Gradient Streams in Eastern Kentucky Coalfield (Version 2002.6)
****(Family Level Taxonomy - All Habitats)****

Project ID:	LRN-2012-00914
Stream/Reach:	**Mine Area K**
Assessment Objectives:	**Existing Conditions**

EII	Model
NA	Ecological Integrity Index (MBI + Habitat Integrity + Conductivity)
0.20	Ecological Integrity Index (Habitat Integrity + Conductivity)

>>>>>>>

Enter quantitative or categorical measure from Field Data Sheet in shaded cells

Variables	Measure	Units	Subindex
RBP Habitat Parameters			
1. Epifaunal Substrate	6	no units	
2. Embeddedness	15	no units	
3. Velocity/Depth Regime	5	no units	
4. Sediment Deposition	14	no units	
5. Channel Flow Status	10	no units	
6. Channel Alteration	12	no units	
7. Freq. Of Riffles (bends)	9	no units	
8. Bank stability (both combined)	12	no units	
9. Veg. Protection (both combined)	18	no units	
10. Riparian Width (both combined)	18	no units	
Total Habitat Score	**119**	no units	**Subindex**
Habitat Integrity Index			**0.29**
Macroinvertebrate Data - Family Level (All Habitats)			
11. Family Taxa Richness		# of taxa sampled	
12. Family EPT Richness		# of EPT species sampled	
13. % Ephemeroptera		% Mayflies (0-100)	
14. % Chironomidae & Oligochaeta		% Midges & Worms (0-100)	
15. mFBI		no units	
Macroinvertebrate Bioassessment	**NA**	no units	**NA**
Conductivity	**730**	microMHOs	**0.10**

EII Calculation for High Gradient Streams in Eastern Kentucky Coalfield (Version 2002.6)
****(Family Level Taxonomy - All Habitats)****

Project ID:	LRN-2012-00914
Stream/Reach:	**Mine Area L Perennial**
Assessment Objectives:	**EXISTING CONDITIONS**

EII	Model
NA	Ecological Integrity Index (MBI + Habitat Integrity + Conductivity)
0.75	Ecological Integrity Index (Habitat Integrity + Conductivity)

>>>>>>>

Enter quantitative or categorical measure from Field Data Sheet in shaded cells

Variables	Measure	Units	Subindex
RBP Habitat Parameters			
1. Epifaunal Substrate	10	no units	
2. Embeddedness	13	no units	
3. Velocity/Depth Regime	10	no units	
4. Sediment Deposition	12	no units	
5. Channel Flow Status	6	no units	
6. Channel Alteration	16	no units	
7. Freq. Of Riffles (bends)	17	no units	
8. Bank stability (both combined)	18	no units	
9. Veg. Protection (both combined)	18	no units	
10. Riparian Width (both combined)	20	no units	
Total Habitat Score	**140**	no units	**Subindex**
Habitat Integrity Index			**0.50**
Macroinvertebrate Data - Family Level (All Habitats)			
11. Family Taxa Richness		# of taxa sampled	
12. Family EPT Richness		# of EPT species sampled	
13. % Ephemeroptera		% Mayflies (0-100)	
14. % Chironomidae & Oligochaeta		% Midges & Worms (0-100)	
15. mFBI		no units	
Macroinvertebrate Bioassessment	**NA**	no units	**NA**
Conductivity	**100**	microMHOs	**1.00**

EII Calculation for High Gradient Streams in Eastern Kentucky Coalfield (Version 2002.6)
****(Family Level Taxonomy - All Habitats)****

Project ID:	LRN-2012-00914
Stream/Reach:	**Mine Area L Intermittent**
Assessment Objectives:	**EXISTING CONDITIONS**

EII	Model
NA	Ecological Integrity Index (MBI + Habitat Integrity + Conductivity)
0.75	Ecological Integrity Index (Habitat Integrity + Conductivity)

>>>>>>>

Enter quantitative or categorical measure from Field Data Sheet in shaded cells

Variables	Measure	Units	Subindex
RBP Habitat Parameters			
1. Epifaunal Substrate	10	no units	
2. Embeddedness	13	no units	
3. Velocity/Depth Regime	10	no units	
4. Sediment Deposition	12	no units	
5. Channel Flow Status	6	no units	
6. Channel Alteration	16	no units	
7. Freq. Of Riffles (bends)	17	no units	
8. Bank stability (both combined)	18	no units	
9. Veg. Protection (both combined)	18	no units	
10. Riparian Width (both combined)	20	no units	
Total Habitat Score	**140**	no units	
Habitat Integrity Index			**0.50**
Macroinvertebrate Data - Family Level (All Habitats)			
11. Family Taxa Richness		# of taxa sampled	
12. Family EPT Richness		# of EPT species sampled	
13. % Ephemeroptera		% Mayflies (0-100)	
14. % Chironomidae & Oligochaeta		% Midges & Worms (0-100)	
15. mFBI		no units	
Macroinvertebrate Bioassessment	**NA**	no units	**NA**
Conductivity	**100**	microMHOs	**1.00**

EII Calculation for High Gradient Streams in Eastern Kentucky Coalfield (Version 2002.6)
****(Family Level Taxonomy - All Habitats)****

Project ID:	LRN-2012-00914
Stream/Reach:	**Mine Area M Perennial**
Assessment Objectives:	**Existing Conditions**

EII	Model
NA	Ecological Integrity Index (MBI + Habitat Integrity + Conductivity)
0.79	Ecological Integrity Index (Habitat Integrity + Conductivity)

>>>>>>>

Enter quantitative or categorical measure from Field Data Sheet in shaded cells

Variables	Measure	Units	Subindex
RBP Habitat Parameters			
1. Epifaunal Substrate	15	no units	
2. Embeddedness	15	no units	
3. Velocity/Depth Regime	11	no units	
4. Sediment Deposition	11	no units	
5. Channel Flow Status	13	no units	
6. Channel Alteration	17	no units	
7. Freq. Of Riffles (bends)	16	no units	
8. Bank stability (both combined)	13	no units	
9. Veg. Protection (both combined)	16	no units	
10. Riparian Width (both combined)	18	no units	
Total Habitat Score	**145**	no units	
Habitat Integrity Index			**0.58**
Macroinvertebrate Data - Family Level (All Habitats)			
11. Family Taxa Richness		# of taxa sampled	
12. Family EPT Richness		# of EPT species sampled	
13. % Ephemeroptera		% Mayflies (0-100)	
14. % Chironomidae & Oligochaeta		% Midges & Worms (0-100)	
15. mFBI		no units	
Macroinvertebrate Bioassessment	**NA**	no units	**NA**
Conductivity	**100**	microMHOs	**1.00**

EII Calculation for High Gradient Streams in Eastern Kentucky Coalfield (Version 2002.6)
****(Family Level Taxonomy - All Habitats)****

Project ID:	LRN-2012-00914
Stream/Reach:	**Mine Area N**
Assessment Objectives:	**EXISTING CONDITIONS**

EII	Model
NA	Ecological Integrity Index (MBI + Habitat Integrity + Conductivity)
0.70	Ecological Integrity Index (Habitat Integrity + Conductivity)

>>>>>>>

Enter quantitative or categorical measure from Field Data Sheet in shaded cells

Variables	Measure	Units	Subindex
RBP Habitat Parameters			
1. Epifaunal Substrate	12	no units	
2. Embeddedness	15	no units	
3. Velocity/Depth Regime	5	no units	
4. Sediment Deposition	12	no units	
5. Channel Flow Status	6	no units	
6. Channel Alteration	17	no units	
7. Freq. Of Riffles (bends)	12	no units	
8. Bank stability (both combined)	16	no units	
9. Veg. Protection (both combined)	16	no units	
10. Riparian Width (both combined)	18	no units	
Total Habitat Score	**129**	no units	**Subindex**
Habitat Integrity Index			**0.39**
Macroinvertebrate Data - Family Level (All Habitats)			
11. Family Taxa Richness		# of taxa sampled	
12. Family EPT Richness		# of EPT species sampled	
13. % Ephemeroptera		% Mayflies (0-100)	
14. % Chironomidae & Oligochaeta		% Midges & Worms (0-100)	
15. mFBI		no units	
Macroinvertebrate Bioassessment	**NA**	no units	**NA**
Conductivity	**100**	microMHOs	**1.00**

EII Calculation for High Gradient Streams in Eastern Kentucky Coalfield (Version 2002.6)
****(Family Level Taxonomy - All Habitats)****

Project ID:	LRN-2012-00914
Stream/Reach:	**Mine Area O**
Assessment Objectives:	**Existing Conditions**

EII	Model
NA	Ecological Integrity Index (MBI + Habitat Integrity + Conductivity)
0.59	Ecological Integrity Index (Habitat Integrity + Conductivity)

>>>>>>>

Enter quantitative or categorical measure from Field Data Sheet in shaded cells

Variables	Measure	Units	Subindex
RBP Habitat Parameters			
1. Epifaunal Substrate	10	no units	
2. Embeddedness	15	no units	
3. Velocity/Depth Regime	5	no units	
4. Sediment Deposition	14	no units	
5. Channel Flow Status	6	no units	
6. Channel Alteration	17	no units	
7. Freq. Of Riffles (bends)	10	no units	
8. Bank stability (both combined)	12	no units	
9. Veg. Protection (both combined)	18	no units	
10. Riparian Width (both combined)	18	no units	
Total Habitat Score	**125**	no units	
Habitat Integrity Index			**0.35**
Macroinvertebrate Data - Family Level (All Habitats)			
11. Family Taxa Richness		# of taxa sampled	
12. Family EPT Richness		# of EPT species sampled	
13. % Ephemeroptera		% Mayflies (0-100)	
14. % Chironomidae & Oligochaeta		% Midges & Worms (0-100)	
15. mFBI		no units	
Macroinvertebrate Bioassessment	**NA**	no units	**NA**
Conductivity	**210**	microMHOs	**0.83**

EII Calculation for High Gradient Streams in Eastern Kentucky Coalfield (Version 2002.6)
****(Family Level Taxonomy - All Habitats)****

Project ID:	LRN-2012-00914
Stream/Reach:	**Mine Area P Ephemeral**
Assessment Objectives:	**Existing Conditions**

EII	Model
NA	Ecological Integrity Index (MBI + Habitat Integrity + Conductivity)
0.53	Ecological Integrity Index (Habitat Integrity + Conductivity)

>>>>>>>

Enter quantitative or categorical measure from Field Data Sheet in shaded cells

Variables	Measure	Units	Subindex
RBP Habitat Parameters			
1. Epifaunal Substrate	11	no units	
2. Embeddedness	15	no units	
3. Velocity/Depth Regime	4	no units	
4. Sediment Deposition	6	no units	
5. Channel Flow Status	2	no units	
6. Channel Alteration	18	no units	
7. Freq. Of Riffles (bends)	16	no units	
8. Bank stability (both combined)	14	no units	
9. Veg. Protection (both combined)	14	no units	
10. Riparian Width (both combined)	13	no units	
Total Habitat Score	113	no units	
Habitat Integrity Index			0.23
Macroinvertebrate Data - Family Level (All Habitats)			
11. Family Taxa Richness		# of taxa sampled	
12. Family EPT Richness		# of EPT species sampled	
13. % Ephemeroptera		% Mayflies (0-100)	
14. % Chironomidae & Oligochaeta		% Midges & Worms (0-100)	
15. mFBI		no units	
Macroinvertebrate Bioassessment	NA	no units	NA
Conductivity	210	microMHOs	0.83

EII Calculation for High Gradient Streams in Eastern Kentucky Coalfield (Version 2002.6)
****(Family Level Taxonomy - All Habitats)****

Project ID:	LRN-2012-00914
Stream/Reach:	**Mine Area P Intermittent**
Assessment Objectives:	**Existing Conditions**

EII	Model
NA	Ecological Integrity Index (MBI + Habitat Integrity + Conductivity)
0.56	Ecological Integrity Index (Habitat Integrity + Conductivity)

>>>>>>>

Enter quantitative or categorical measure from Field Data Sheet in shaded cells

Variables	Measure	Units	Subindex
RBP Habitat Parameters			
1. Epifaunal Substrate	11	no units	
2. Embeddedness	15	no units	
3. Velocity/Depth Regime	8	no units	
4. Sediment Deposition	6	no units	
5. Channel Flow Status	5	no units	
6. Channel Alteration	18	no units	
7. Freq. Of Riffles (bends)	16	no units	
8. Bank stability (both combined)	14	no units	
9. Veg. Protection (both combined)	14	no units	
10. Riparian Width (both combined)	13	no units	
Total Habitat Score	**120**	no units	
Habitat Integrity Index			**0.30**
Macroinvertebrate Data - Family Level (All Habitats)			
11. Family Taxa Richness		# of taxa sampled	
12. Family EPT Richness		# of EPT species sampled	
13. % Ephemeroptera		% Mayflies (0-100)	
14. % Chironomidae & Oligochaeta		% Midges & Worms (0-100)	
15. mFBI		no units	
Macroinvertebrate Bioassessment	**NA**	no units	**NA**
Conductivity	**210**	microMHOs	**0.83**

BIOLOGICAL SYSTEMS CONSULTANTS, INC.

Nally & Hamilton Enterprises, Inc.
Permit # 848-0290
Fish and Wildlife Resource Information
Aquatic Biological Assessment
of Mill Creek in Harlan County Kentucky
BSC # 2914

P.O. Box 54954
Lexington, KY 40555
(859)263-4142

Nally & Hamilton Enterprises, Inc.
Permit # 848-0290
Fish and Wildlife Resource Information
Aquatic Biological Assessment
of Mill Creek in Harlan County Kentucky
BSC # 2914

Prepared for:

Kentucky Division of Water
The Kentucky Department of Natural Resources
The United States Fish and Wildlife Service

Prepared by:

Biological Systems Consultants, Inc.
P.O. Box 54954
Lexington, Kentucky 40555-4954

10/27/2009

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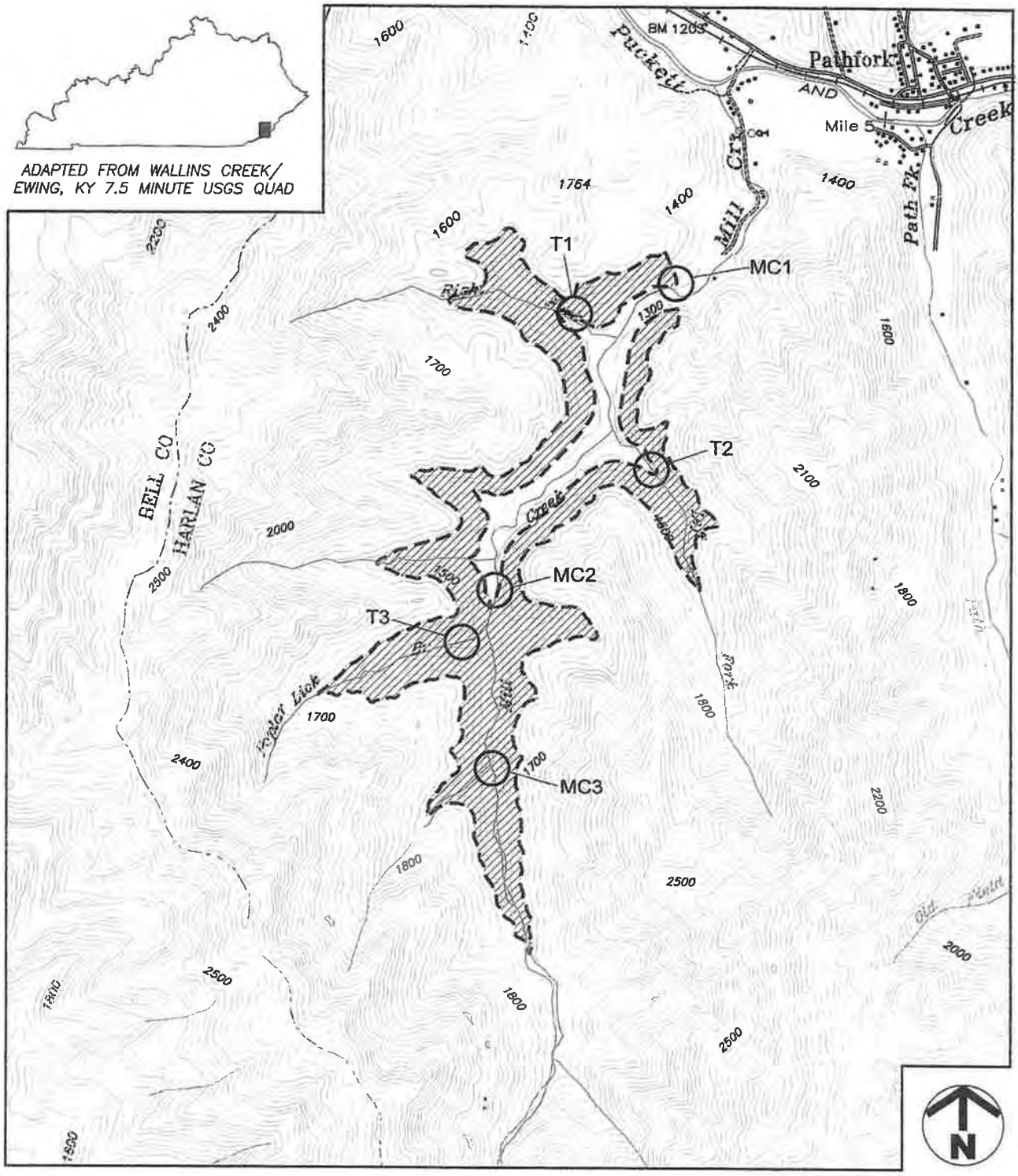
Executive Summary

The following report is being submitted to the Kentucky Division of Water (KDOW), Kentucky Department for Natural Resources (DNR) on behalf of Nally & Hamilton Enterprises, Inc., Kentucky DNR permit # 848-0290. It specifically addresses DNR's correspondence(Appendix A) requesting fish and wildlife resource information in the form of an aquatic survey of Mill Creek. As illustrated in the report, the investigations show that Mill Creek contains a low-moderate EPT index and a poor fish population. This is most likely due to disturbances within the watershed. These findings are those as found to exist on the dates of the investigation and in those areas as investigated.

1.0 Introduction

The following report is being presented to the DNR on behalf of Nally & Hamilton Enterprises, Inc. It is a final report and is being submitted as a one time frequency macroinvertebrate sampling and fish inventory for Mill Creek located in Harlan County, KY. A discussion of findings and field methods are provided in the text and the fall sampling results are included in Appendix A. The attached Figure1 illustrates sampling point and station locations. The following Section 2.0 describes the sampling techniques used for data collection and a summary of findings is then provided in Section 3.0. Section 4.0 provides conclusions of the study.



LEGEND

APPROXIMATE PERMIT BOUNDARY

MACROINVERTEBRATE/
PHYSICOCHEMICAL
SAMPLE STATION

0' 2000'
SCALE FEET

BIOLOGICAL SYSTEMS CONSULTANTS, INC.

SAMPLE STATION LOCATION MAP		
CLIENT: NALLY & HAMILTON ENTERPRISES, INC.		
LOCATION: MILL CREEK		
PROJECT: 2914	PERMIT NO.: 848-0290	DATE: 05/09

2728-NALLY-IC(MAY09)

2.0 Findings

The following text includes Tables 1 and 2 which illustrate laboratory analysis and biometrics of the macroinvertebrate sampling and Table 3 which provides results of the fish inventory. Appendix B should be referenced for the KDOW high gradient assessment forms.

2.1 Macroinvertebrates

Macroinvertebrates were sampled August 4th, 2009 by Biological Systems Consultants personnel and included stations MC1, MC2, and MC3 in the main branch of Mill Creek as well as three tributaries, stations T1, T2, and T3.A one square meter net was used for the sampling stations, and a multi-habitat sample was also collected. All samples were collected in accordance with the Kentucky February 2008 Standard Operating Procedure (SOP) manual "Methods for Assessing Biological Integrity of Surface waters in Kentucky". As such two samples were taken per station as described below.

Riffle Sample

The one square meter sampling method, as described in the KDOW February 2008 SOP Manual, " Methods for Assessing Biological Integrity of Surface Waters in Kentucky", was used for macroinvertebrate collection. As such, macroinvertebrates were collected from four 0.25 m2 quadrate kick net samples stratified within the thalwag of cobble-boulder riffle habitat. Two kick net samples were allocated to each of two distinct riffles that are separated by at least one pool or run, dislodging benthos by vigorously disturbing in front of the net. Large rocks and leaves were hand washed into the net and all four samples were composited into a 600 µm mesh bucket to yield a 1 m2 semi-quantitative sample.

Multi-Habitat Sample

The multihabitat qualitative sample consisted of three leafpacks, three jabs in sticks and wood, three jabs in soft sediment, three jabs in undercut banks/submerged roots, hand picking of five small pool boulders and approximately two linear feet of woody debris. This sample was kept separate from the riffle sample for laboratory analysis and combined for the biometrics.

Macroinvertebrate Analysis

Upon completion of field sorting, specimens were placed in a 70% ethanol solution and transported to the laboratory where they were identified to the lowest practical taxon. Metrics included: taxa richness, total number of individuals, EPT taxa, %EPT taxa, % Ephemeroptera, % Dominance, m% EPT, HBI, mHBI, %clingers and %Chironomidae + % Oligochaeta and functional feeding group. Tables 1, 2, 3, and 4 provide the results of the macroinvertebrate sampling.

2.3 Fish Sampling

A fish inventory was performed for stations MC1 and MC2. Each station was divided into smaller segments (200meters) and electro-shocked with a Smith Root model 12A backpack electro-shocker. A total count of the fish population was recorded (Table 3) along with the shocking times.

Table 1. Benthic macroivertebrates collected from Mill Creek and tributaries 04 August 2009 (Kick net and habitat search)

TAXON	STATIONS							
	MC1	MC2	MC3	T1	T2	T3	FFG*	TV**
OLIGOCHAETA								
Lumbriculidae/Lumbriculus sp.		4	2	1		2	CG	7.3
EPHEMEROPTERA								
Baetidae/Baetis sp	7		1				CG	5.4
Heptageniidae/Stenonema spp.		1			1		SC	1.3
PLECOPTERA								
Leuctridae/Leuctra sp.	1	2					SH	0.7
Perlidae/Acroneuria carolinensis		4			2		PR	0.0
Perlodidae/Yugus kirchneri		1	1			2	PR	0.0
Pteronarcyidae/Pteronarcys proteus					1		SH	1.7
MEGALOPTERA								
Corydalidae/Corydalus cornutus	1	1	3				PR	5.2
Corydalidae/Nigronia serricornis		5					PR	5.0
TRICHOPTERA								
Hydropsychidae/Ceratopsyche slossonae		1	1				CG	0.0
Hydropsychidae/Ceratopsyche sparna	2	10	6	1			CF	3.2
Hydropsychidae/Cheumatopsyche spp.	3	67	26	6	3		CF	8.2
Hydropsychidae/Diplectrona modesta				10		6	CF	2.2
Philopotamidae/Chimarra sp.			13				CF	2.8
COLEOPTERA								
Dryopidae/Helichus sp.		1					SC	4.6
Elmidae/Optioservus sp.	2	8					SC	2.4

Table 1. Benthic macroivertebrates collected from Mill Creek and tributaries 04 August 2009 (Kick net and habitat search)

TAXON	STATIONS							
	MC1	MC2	MC3	T1	T2	T3	FFG*	TV**
Elmidae/Stenelmis sp.	1						SC	5.1
Psephenidae/Psephenus herricki	2	1			3		SC	5.4
Psephenidae/Ectopria nervosa					1		SC	4.2
DIPTERA								
Chironomidae/Diamesa sp.		3					CG	8.1
Chironomidae/Krenopelopia	2		7	4	1		PR	6.2
Chironomidae/Orthocladius/Cricotopus	1	1	1		1		CG	7.3
Simuliidae/Simulium sp.		1	1				CF	4.0
Tipulidae/Dicranota	3	7	4		1		PR	0.0
Tipulidae/Hexatoma	2	2			1		PR	4.3
Tipulidae/Molophilus sp.					2		SH	5.0
Tipulidae/Tipula sp.	2	1	1	1	1		SH	7.3
ODONATA								
Gomphidae/Stylogomphus albistylus		10			1		PR	4.7
Cordulegastridae/Cordulegaster sp.				1			PR	5.7
DECAPODA								
Cambaridae/Cambarus sp.		2	2	4	1	3	CG	4.9
Cambaridae/Orconectes sp.		4	1		2		CG	5.5
ISOPODA								
Asellidae/Lirceus sp.		3					CG	7.9
TAXA RICHNESS	13	23	15	8	15	4		
TNI	29	140	70	28	22	13		

Table 1. Benthic macroivertebrates collected from Mill Creek and tributaries 04 August 2009 (Kick net and habitat search)

TAXON	STATIONS							
	MC1	MC2	MC3	T1	T2	T3	FFG*	TV**
EPT TAXA	4	7	6	3	4	2		
%EPT TAXA	30.8	30.4	40	37.5	26.7	50		
%Ephemeroptera	25	0.7	1.4	0.0	4.8	0		
%Dominance	25	47.9	37.1	41.7	14.3	54.6		
m%EPT TAXA	23.1	26.1	33.3	25	20	50		
MHBI	4.93	5.89	5.45	5.79	5.29	3.87		
%Clingers	32.1	70.7	70	70.8	38.1	72.7		
%Chironomidae	10.7	2.9	11.4	16.7	9.50	0.00		
%Chironomidae +% Oligochaeta	10.7	5.7	14.3	20.8	9.5	18.2		
MBI (headwaters)	47	47	46	40	38	47		

* Functional Feeding Groups PR=Predator, SH=Shredder, SC=Scraper, CF=Collector Filterer, CG=Collector Gatherer
**Tolerance Values (KDOW)

Table 2. Benthic macroivertebrates collected from Mill Creek and tributaries, 04 August 2009 (habitat search)

TAXON	STATIONS					
	MC1-H	MC2-H	MC3-H	T1-H	T2-H	T3-H
PLECOPTERA						
Perlodidae/yugus kirchneri						1
DIPTERA						
Chironomidae/Orthocladius/Cricotopus					1	
Tipulidae/Molophilus sp.	1			1		
Tipulidae/Tipula sp.				1		
ODONATA						
Cordulegastridae/Cordulegaster				1		
DECAPODA						
Cambaridae/Cambarus sp.				1		1
TAXA RICHNESS	1	0	0	4	1	2
TOTAL NUMBER OF INDIVIDUALS	1	0	0	4	1	2

		Table Three						
		Fish Census						
			Otober 22, 2009					
			Mill Creek					
Species			Station ID					
		MC1		**MC2**				
Creek chub								
(Semotilus atromaculatus)		81		33				
Stone roller								
(Campostoma anamalum)		12						
Blacknose dace								
(Rhinichtys atratulus)		32		19				
Blackside dace								
(Phoxinus cumberlandensis)								
Fantail darter								
(Etheostoma flabellare)								
Rainbow darter								
(Etheostoma caeruleum)								
Fathead minnow								
(Pimephales promelas)								
Redbreast sunfish								
(Lepomis auritus)								
Arrow darter								
(Etheostoma sagitta)								
Hog sucker								
(Hypentelium nigricans)								
Small mouth bass								
(Micropterus dolomieu)								
Greenside darter								
(Etheostoma biennioides)								
Emerald darter								
(Etheostoma baileyl)								
White sucker								
(Catostomus commersoni)								
Rosefin shiner								
(Lythrurus ardens)								
Stripetail darter								
(Etheostoma kennicotti)		2						
Southern Redbelly dace								
(Phoxinus erythrogaster)								
Green sunfish								
(Lepomis cyanellus)								
Longear sunfish								
(Lepomis megalotis)								
Bluntnose minnow								
(Pimephales notatus)								
Golden shiner								
(Notemigonus crysoleucas)								
Bluegill								
(Lepomis macrochirus)								
Shock Time(ms)		361		382				
		SC870		SC840				

3.0 Summary of Findings

The following discussions include the findings of the macroinvertebrate investigations and fish inventory for Mill Creek. The KDOW field forms should be referenced in Appendix B for the site conditions at the time of sampling.

3.1 Macroinvertebrates

The following narratives provide descriptions of findings as presented in section 2.0 and the previously presented Tables 1, 2 and 3 should be referenced for the discussions. Appendix B should also be referenced for habitat and site characteristics. These discussions include the combined riffle and habitat sample.

Station MC1

Of the 13 taxa in the sample, four (4) EPT taxa (30.8%) were found(Table 1). Twenty-nine (29) individuals were identified. Ephemeropterans comprised 25% of the sample, the mayfly Baetis showed the highest percentage dominance (25%), the MBI value (headwaters) was 42, the modified Hilsenhoff Biotic Iindex was 4.93 and clingers made up 32 % of the sample. Chironomids comprised 10.4% of the sample and no oligochaetes were found.

Station MC2

One-hundred and forty (140) individuals were found at station 2 (Table 1). Of the 23 taxa in the sample, 7 EPT taxa (30.4%) were found. Ephemeropterans made up 0.7% of the sample, the caddisfly Cheumatpsyche showed the highest percentage dominance (47.9%), the modified Hilsenhoff Biotic Index was 5.89, Clingers made up 71% of the sample and the MBI value (headwaters) was 47. Chironomids made up 2.9% of the sample and the % Chironomidae +% Oligochaete value was 5.7%.

Station MC3

Seventy (70) individuals were found at this station (Table 1). Of the 15 taxa in the sample, 6 EPT (40%) were found. Ephemeropterans made up 1.4% of the sample, the caddisfly Cheumatopsyche showed the highest percentage of dominance (37.1%), the modified Hilsenhoff Biotic Index was 5.45 and clingers made up 70% of the sample. Chironomids made up11.4% of the sample and the MBI value (headwaters) was 46.

Station T1

Twenty-eight (28) individuals were identified at this station (Table 1). Of the 8 taxa in the sample, 3 EPT taxa (37.5%) were found. No ephemeropterans were found in the sample, the caddisfly Diplectrona showed the highest percentage of dominance (41.7%), the modified Hilsenhoff Biotic Index was 5.79, clingers comprised 71% of the sample and chironomids made up 16.7%. The % Chironomidae +% Oligochaeta value was 20.8% and The MBI value (headwaters) was 40.

Station T2

Twenty-two (22) individuals were found in this sample (Table 1). Of the 15 taxa, 4 were identified as EPT taxa (26.7%). Ephemeropterans comprised 4.8% of the sample, the caddisfly Diplectrona and the beetle Psephenus showed the highest percentage dominance (14.3%), the modified Hilsenhoff Biotic index was 5.29, Clingers made up 38% of the sample and chironomids made up 9.5% of the sample. The MBI value (headwaters) was 38.

Station T3

Thirteen (13) individuals were found in this sample (Table 1). Of the four (4) taxa, two (2) EPT (50%) were found. No ephemeropterans were identified, the caddisfly Diplectrona showed the highest percentage dominance (54.6%), the modified Hilsenhoff Biotic Index was 3.87, no chironomids were found, the % Chironomidae +% Oligochaeta value was 18.2% and the MBI value (headwaters) was 47. Clingers made up 73% of the sample.

Composited Riffle and Habitat Summary

The summer (04 August 2009) sampling period in Mill Creek and tributaries yielded 302 individuals (Table 1). A total of thirty-two (32) taxa were identified from the six stations. Of these taxa, eleven (11) (34.4%) belonged to the insect orders Ephemeroptera (2), Plecoptera (4), and Trichoptera (5) (EPT). Taxa richness ranged from 4-23; the average was 13. The percentage of EPT taxa ($\bar{x}$ = 35.9; range 26.7-50) was low at most stations. The modified Hilsenhoff Biotic Index ($\bar{x}$ = 5.2; 3.87-5.89) was average at most stations. Chironomids ranged from 0.0-16.7; $\bar{x}$ = 8.5%. The MBI values (headwaters) ranged from 38-47; $\bar{x}$ = 43.3. Clingers ranged from 32.1-72.7%; $\bar{x}$ = 59.1%.

Habitat Summary

The summer (04 August 2009) sampling period in Mill Creek and tributaries yielded only eight (8) individuals (Table 2). A total of six (6) taxa were identified from the samples. Only one (1) EPT taxon was found.

3.3 Fish Inventory

The results of the fish inventory were presented on table 3. As shown, the stream contains a poor fish community with only three species captured.

The following section 4.0 contains the conclusions of the study.

4.0 Conclusions

The aquatic investigation of Mill Creek found the stream and its tributaries to contain a low-moderate EPT value and poor fish community. These findings are those as found on the dates of the investigation and in those areas as were investigated.

Appendix A
DNR Correspondence

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR NATURAL RESOURCES

Steven L. Beshear
Governor

Division of Mine Permits
2 Hudson Hollow
Frankfort, Kentucky 40601
Phone (502) 564-2320
Fax (502) 564-6764
www.minepermits.ky.gov

Leonard K. Peters
Secretary

Carl E. Campbell
Commissioner

February 21, 2009

DON ROBERTS
LOGOS ENGINEERING
PO BOX 350
MANCHESTER KY 40962

RE: Nally & Hamilton Enterprises, Inc.
Application # 848-0290 NW

Dear Mr. Roberts:

The Division of Mine Permits has conducted the critical resources review of the above referenced application. Attached are the Division's findings, listed by application item, describing the issues that must be addressed. The findings for each application item are summarized below.

11.1 Areas Designated Unsuitable for Mining: None identified
12.2 General Description of Mining and Reclamation Operations: BMPs recommended, Stream restoration
13.1 Cultural or Historic Resources: Archaeological survey required
14.1 Fish and Wildlife Information: T/E species identified - Indiana bat
14.4 Fish and Wildlife Survey: Required as listed below
Indiana bat survey or PEP
Aquatic Survey
21.11 Fish and Wildlife Enhancement Plan: Required

These attachments and supporting documentation must be incorporated into the appropriate sections of the comprehensive application.

Significant changes from the preliminary application or to the mine plan may require additional environmental review.

If you have any questions concerning this matter, please contact the review biologist, Thomas Barbour, or archaeologist, Rose Moore, Critical Resources Review Section, at (502) 564-2320.

Sincerely,

Davie R. Ransdell

Davie Ransdell, Supervisor
Critical Resources Review Section
Division of Mine Permits

Enclosure to Applicant
c: Rose Moore (e)
Thomas Barbour (e)
Mark Dennen, SHPO
Mike Hardin, KDFWR
Lee Andrews, USFWS
Permit File – w/enclosure (e)

Appendix B
KDOW High Gradient Field Forms

Appendix A-1 High Gradient Stream Data Sheet

STREAM NAME: M Cr	LOCATION:
STATION #: MC MILE:	BASIN/WATERSHED:
LAT.: 36°44'56.7" LONG.: 32°25'31.6"	COUNTY: H USGS 7.5 TOPO:
DATE: 7/5/2 TIME: 4:00 ☐AM ☒PM	INVESTIGATORS: MCL

TYPE SAMPLE: ☐ P-CHEM ☒ Macroinvertebrate ☐ FISH ☐ BACT.

WEATHER: Now Past 24 hours — Has there been a heavy rain in the last 7 days?

- ☐ ☐ Heavy rain ☒ Yes ☐ No
- ☐ ☐ Steady rain — Air Temperature 95 °C. Inches rainfall in past 24 hours _____ in.
- ☐ ☒ Intermittent showers — 30 % Cloud Cover
- ☐ ☐ Clear/sunny

P-Chem: Temp(°C) 21.5 D.O. (mg/l) .01 %Saturation X pH(S.U.) 8.50 Cond. 550 ☐ Grab

INSTREAM WATERSHED FEATURES:
Stream Width 12-21 ft
Range of Depth .25-.5 ft
Average Velocity .5 ft/s
Discharge ___ cfs
Est. Reach Length 0.5

LOCAL WATERSHED FEATUREES:
Predominant Surrounding Land Use:

☒ Surface Mining	☐ Construction	☒ Forest
☒ Deep Mining	☐ Commercial	☐ Pasture/Grazing
☐ Oil Wells	☐ Industrial	☐ Silviculture
☐ Land Disposal	☐ Row Crops	☐ Urban Runoff/Storm Sewers

Hydraulic Structures:
☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other

Stream Flow:
☐ Dry ☐ Pooled ☐ Low ☒ Normal
☒ High ☐ Very Rapid or Torrential

Stream Type:
☒ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation: Dom. Tree/Shrub Taxa
Dominate Type:
☐ Trees ☐ Shrubs
☐ Grasses ☐ Herbaceous
Number of strata 2

Canopy Cover:
☐ Fully Exposed (0-25%)
☐ Partially Exposed (25-50%)
☒ Partially Shaded (50-75%)
☐ Fully Shaded (75-100%)

Channel Alterations:
☐ Dredging
☐ Channelization
(☐Full ☐Partial)

Substrate ☐Est. ☐P.C.	Riffle 100 %	Run ___ %	Pool ___ %
Silt/Clay (<0.06 mm)	20		
Sand (0.06 – 2 mm)	20		
Gravel (2-64 mm)	20		
Cobble (64 – 256 mm)	0		
Boulders (>256 mm)	30		
Bedrock			

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	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
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) 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% (80% for low-gradient) 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
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel 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
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 than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio 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
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks 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 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants 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 streambank surfaces 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 streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative 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 6-12 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 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

MC1

Total Score 19 **NOTES/COMMENTS:**

Appendix A-1 High Gradient Stream Data Sheet

STREAM NAME: [illegible]	LOCATION:
STATION #: [illegible] MILE:	BASIN/WATERSHED:
LAT.: [illegible] LONG.: [illegible]	COUNTY: [illegible] USGS 7.5 TOPO:
DATE: 7/28/99 TIME: [illegible] ☐AM ☑PM	INVESTIGATORS: [illegible]

TYPE SAMPLE: ☐ P-CHEM ☐ Macroinvertebrate ☐ FISH ☐ BACT.

WEATHER: Now Past 24 hours / Has there been a heavy rain in the last 7 days?

- ☐ ☐ Heavy rain — ☐ Yes ☐ No
- ☐ ☐ Steady rain — Air Temperature [illegible] °C. Inches rainfall in past 24 hours ____ in.
- ☐ ☒ Intermittent showers — [illegible] % Cloud Cover
- ☐ ☐ Clear/sunny

P-Chem: Temp(°C) [illegible] D.O. (mg/l) [illegible] %Saturation [illegible] pH(S.U.) [illegible] Cond. [illegible] ☐ Grab

INSTREAM WATERSHED FEATURES:

Stream Width [illegible] ft
Range of Depth [illegible] ft
Average Velocity [illegible] ft/s
Discharge ____ cfs
Est. Reach Length [illegible]

LOCAL WATERSHED FEATUREES:

Predominant Surrounding Land Use:

- ☒ Surface Mining
- ☐ Deep Mining
- ☐ Oil Wells
- ☐ Land Disposal
- ☐ Construction
- ☐ Commercial
- ☐ Industrial
- ☐ Row Crops
- ☒ Forest
- ☐ Pasture/Grazing
- ☐ Silviculture
- ☐ Urban Runoff/Storm Sewers

Hydraulic Structures: ☐ Dams ☐ Bridge Abutments ☐ Island ☐ Waterfalls ☐ Other

Stream Flow: ☐ Dry ☐ Pooled ☐ Low ☒ Normal ☐ High ☐ Very Rapid or Torrential

Stream Type: ☐ Perennial ☒ Intermittent ☐ Ephemeral ☐ Seep

Riparian Vegetation: Dom. Tree/Shrub Taxa [illegible]
Dominate Type: ☐ Trees ☒ Shrubs ☐ Grasses ☐ Herbaceous
Number of strata [illegible]

Canopy Cover:
- ☐ Fully Exposed (0-25%)
- ☐ Partially Exposed (25-50%)
- ☐ Partially Shaded (50-75%)
- ☒ Fully Shaded (75-100%)

Channel Alterations: ☐ Dredging ☐ Channelization (☐Full ☐Partial)

Substrate ☐Est. ☐P.C.	Riffle [illegible] %	Run ____ %	Pool [illegible] %
Silt/Clay (<0.06 mm)	[illegible]		[illegible]
Sand (0.06 – 2 mm)	[illegible]		[illegible]
Gravel (2-64 mm)	[illegible]		[illegible]
Cobble (64 – 256 mm)	[illegible]		[illegible]
Boulders (>256 mm)	[illegible]		
Bedrock			

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	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
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

4. **Sediment Deposition**	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) 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% (80% for low-gradient) 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
5. **Channel Flow Status**	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel 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
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 than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. **Frequency of Riffles (or bends)**	Occurrence of riffles relatively frequent; ratio 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
8. **Bank Stability (score each bank)** Note: determine left or right side by facing downstream.	Banks 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 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. **Vegetative Protection** (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants 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 streambank surfaces 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 streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. **Riparian Vegetative 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 6-12 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 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 76 **NOTES/COMMENTS:**

Appendix A-1 High Gradient Stream Data Sheet

STREAM NAME: Lt Fk Mill Cr	LOCATION:
STATION #: 12 MILE:	BASIN/WATERSHED:
LAT.: 36°41'34" LONG.: 83°28' 37.3	COUNTY: Harlan USGS 7.5 TOPO:
DATE: 7/16/09 TIME: 1:30 ☐AM ☑PM	INVESTIGATORS: JM/SL

TYPE SAMPLE: ☐P-CHEM ☑Macroinvertebrate ☐FISH ☐BACT.

WEATHER: Now Past 24 hours ✓ Has there been a heavy rain in the last 7 days?
- ☐ ☐ Heavy rain ☑ Yes ☐ No
- ☐ ☐ Steady rain Air Temperature 66 °C. Inches rainfall in past 24 hours _____ in.
- ☐ ☑ Intermittent showers 30 % Cloud Cover
- ☐ ☐ Clear/sunny

P-Chem: Temp(°C) 21.7 D.O. (mg/l) 0.02 %Saturation ✓ pH(S.U.) 8.07 Cond. 220 ☑ Grab

INSTREAM WATERSHED FEATURES:
Stream Width 6-9 ft
Range of Depth _____ ft
Average Velocity 0.2 ft/s
Discharge _____ cfs
Est. Reach Length 0.5

LOCAL WATERSHED FEATUREES:
Predominant Surrounding Land Use:
- ☐ Surface Mining
- ☐ Deep Mining
- ☑ Oil Wells
- ☐ Land Disposal
- ☐ Construction
- ☐ Commercial
- ☐ Industrial
- ☐ Row Crops
- ☑ Forest
- ☐ Pasture/Grazing
- ☐ Silviculture
- ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:
☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other

Stream Flow:
☐ Dry ☐ Pooled ☐ Low ☐ Normal
☐ High ☐ Very Rapid or Torrential

Stream Type:
☐ Perennial ☑ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation: Dom. Tree/Shrub Taxa Beech/Pop
Dominate Type:
☑ Trees ☑ Shrubs
☐ Grasses ☑ Herbaceous
Number of strata 3

Canopy Cover:
☐ Fully Exposed (0-25%)
☐ Partially Exposed (25-50%)
☑ Partially Shaded (50-75%)
☐ Fully Shaded (75-100%)

Channel Alterations:
☐ Dredging
☐ Channelization
(☐Full ☐Partial)

Substrate ☐Est. ☐P.C.	Riffle 80 %	Run ___ %	Pool 20 %
Silt/Clay (<0.06 mm)	20		30
Sand (0.06 – 2 mm)	10		20
Gravel (2-64 mm)	10		10
Cobble (64 – 256 mm)	30		20
Boulders (>256 mm)	30		20
Bedrock			

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	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
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

4 **Sediment Deposition**	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) 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% (80% for low-gradient) 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
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel 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
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 than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio 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
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks 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 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants 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 streambank surfaces 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 streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative 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 6-12 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 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

12

Total Score [ ] **NOTES/COMMENTS:**

Appendix A-1 High Gradient Stream Data Sheet

STREAM NAME: Mill Creek	LOCATION:
STATION #: MC2 MILE:	BASIN/WATERSHED:
LAT.: 36° 44' 14.41" LONG.: 83 29' 02.6"	COUNTY: Harlan USGS 7.5 TOPO:
DATE: 7/28/09 TIME: 12:15 ☐AM ☒PM	INVESTIGATORS: SR/SL

TYPE SAMPLE: ☒P-CHEM ☐Macroinvertebrate ☐ FISH ☐ BACT.

WEATHER: Now Past 24 hours
- ☐ ☐ Heavy rain
- ☐ ☒ Steady rain
- ☐ ☐ Intermittent showers
- ☐ ☐ Clear/sunny

Has there been a heavy rain in the last 7 days? ☐Yes ☐No

Air Temperature 86 °C. Inches rainfall in past 24 hours _____ in.

30 % Cloud Cover

P-Chem: Temp(°C) 22.7 D.O. (mg/l)_____ %Saturation X pH(S.U.) 8.9 Cond. 720 ☒Grab

INSTREAM WATERSHED FEATURES:
Stream Width 10-12 ft
Range of Depth .75-1 ft
Average Velocity 0.5 ft/s
Discharge _____ cfs
Est. Reach Length 215

LOCAL WATERSHED FEATUREES:
Predominant Surrounding Land Use:
- ☐ Surface Mining
- ☐ Deep Mining
- ☒ Oil Wells
- ☐ Land Disposal
- ☐ Construction
- ☐ Commercial
- ☐ Industrial
- ☐ Row Crops
- ☒ Forest
- ☐ Pasture/Grazing
- ☐ Silviculture
- ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:
☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other

Stream Flow:
☐ Dry ☐ Pooled ☐ Low ☒ Normal
☐ High ☐ Very Rapid or Torrential

Stream Type:
☐ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation: Dom. Tree/Shrub Taxa
Dominate Type:
☐ Trees ☐ Shrubs
☐ Grasses ☐ Herbaceous
Number of strata ____

Canopy Cover:
☐ Fully Exposed (0-25%)
☐ Partially Exposed (25-50%)
☐ Partially Shaded (50-75%)
☐ Fully Shaded (75-100%)

Channel Alterations:
☐ Dredging
☐ Channelization
(☐Full ☐Partial)

Substrate ☐Est. ☐P.C.	Riffle 40 %	Run ____ %	Pool 10 %
Silt/Clay (<0.06 mm)	20		70
Sand (0.06 – 2 mm)	10		15
Gravel (2-64 mm)	10		20
Cobble (64 – 256 mm)	50		15
Boulders (>256 mm)	10		5
Bedrock			

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	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
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) 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% (80% for low-gradient) 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
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel 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
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 than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio 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
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks 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 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants 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 streambank surfaces 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 streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative 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 6-12 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 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 115 **NOTES/COMMENTS:**

Appendix A-1 High Gradient Stream Data Sheet

STREAM NAME: Mill Creek	LOCATION:
STATION #: T3 MILE:	BASIN/WATERSHED: Pitch Fk / Cumberland
LAT.: 36 44' 10.3 LONG.: 83°29' 0.64"	COUNTY: Harlan USGS 7.5 TOPO:
DATE: 7/28/09 TIME: 12:15 ☐AM ☒PM	INVESTIGATORS: SL / JM

TYPE SAMPLE: ☐ P-CHEM ☒ Macroinvertebrate ☐ FISH ☐ BACT.

WEATHER: Now Past 24 hours
- ☐ Heavy rain
- ☐ ☒ Steady rain
- ☐ Intermittent showers
- ☐ Clear/sunny

Has there been a heavy rain in the last 7 days? ☐ Yes ☐ No

Air Temperature 83 °C. Inches rainfall in past 24 hours _____ in.

80 % Cloud Cover

P-Chem: Temp(°C) 20.7 D.O. (mg/l) 0.05 %Saturation X pH(S.U.) 7.43 Cond. 110 ☐ Grab

INSTREAM WATERSHED FEATURES:
Stream Width 6-9 ft
Range of Depth 1-12 ft
Average Velocity 0.25 ft/s
Discharge _____ cfs
Est. Reach Length 0.75

LOCAL WATERSHED FEATUREES:
Predominant Surrounding Land Use:
- ☒ Surface Mining
- ☐ Deep Mining
- ☐ Oil Wells
- ☐ Land Disposal
- ☐ Construction
- ☐ Commercial
- ☐ Industrial
- ☐ Row Crops
- ☒ Forest
- ☐ Pasture/Grazing
- ☐ Silviculture
- ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:
☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other

Stream Flow:
☐ Dry ☐ Pooled ☐ Low ☒ Normal
☐ High ☐ Very Rapid or Torrential

Stream Type:
☐ Perennial ☒ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:
Dominate Type:
☒ Trees ☒ Shrubs
☐ Grasses ☐ Herbaceous
Number of strata 2

Dom. Tree/Shrub Taxa: beech, syc., pop

Canopy Cover:
☐ Fully Exposed (0-25%)
☐ Partially Exposed (25-50%)
☒ Partially Shaded (50-75%)
☐ Fully Shaded (75-100%)

Channel Alterations:
☐ Dredging
☐ Channelization
(☐Full ☐Partial)

Substrate ☐Est. ☐P.C.	Riffle 65 %	Run ____ %	Pool 35 %
Silt/Clay (<0.06 mm)	10		30
Sand (0.06 – 2 mm)	10		20
Gravel (2-64 mm)	20		25
Cobble (64 – 256 mm)	30		25
Boulders (>256 mm)	30		
Bedrock			

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 (12) 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	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
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0

4. **Sediment Deposition**	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) 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% (80% for low-gradient) 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
5. **Channel Flow Status**	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel 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
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 than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. **Frequency of Riffles (or bends)**	Occurrence of riffles relatively frequent; ratio 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
8. **Bank Stability (score each bank)** Note: determine left or right side by facing downstream.	Banks 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 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. **Vegetative Protection** (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants 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 streambank surfaces 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 streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. **Riparian Vegetative 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 6-12 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 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

T3

Total Score 105 **NOTES/COMMENTS:**

Appendix A-1 High Gradient Stream Data Sheet

STREAM NAME: Mill Creek	LOCATION:
STATION #: MC3 MILE:	BASIN/WATERSHED:
LAT.: 36 43' 53.4" LONG.: 83° 29' 02.6"	COUNTY: Harlan USGS 7.5 TOPO:
DATE: 7/28/09 TIME: 11:15 ☒AM ☐PM	INVESTIGATORS: JR/CL

TYPE SAMPLE: ☐P-CHEM ☐Macroinvertebrate ☐FISH ☐BACT.

WEATHER: Now Past 24 hours
- ☐ ☐ Heavy rain
- ☐ ☐ Steady rain
- ☐ ☒ Intermittent showers
- ☐ ☐ Clear/sunny

Has there been a heavy rain in the last 7 days? ☒Yes ☐No

Air Temperature _____ °C. Inches rainfall in past 24 hours _____ in.

_____ % Cloud Cover

P-Chem: Temp(°C) 22.1 D.O. (mg/l) 12 %Saturation _____ pH(S.U.) 8.17 Cond 850 ☒Grab

INSTREAM WATERSHED FEATURES:
Stream Width 10 ft
Range of Depth 0.1-0.5 ft
Average Velocity .25 ft/s
Discharge _____ cfs
Est. Reach Length 0.5

LOCAL WATERSHED FEATUREES:
Predominant Surrounding Land Use:
- ☒ Surface Mining
- ☐ Deep Mining
- ☐ Oil Wells
- ☐ Land Disposal
- ☒ Construction
- ☐ Commercial
- ☐ Industrial
- ☐ Row Crops
- ☐ Forest
- ☐ Pasture/Grazing
- ☐ Silviculture
- ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:
☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other

Stream Flow:
☐ Dry ☐ Pooled ☐ Low ☐ Normal
☒ High ☐ Very Rapid or Torrential

Stream Type:
☐ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:
Dominate Type:
☒ Trees ☐ Shrubs
☐ Grasses ☐ Herbaceous
Number of strata 3

Dom. Tree/Shrub Taxa: Sycamore

Canopy Cover:
- ☐ Fully Exposed (0-25%)
- ☐ Partially Exposed (25-50%)
- ☒ Partially Shaded (50-75%)
- ☐ Fully Shaded (75-100%)

Channel Alterations:
- ☐ Dredging
- ☐ Channelization
- (☐Full ☐Partial)

Substrate ☐Est. ☐P.C.	Riffle 100 %	Run ____ %	Pool ____ %
Silt/Clay (<0.06 mm)	20		
Sand (0.06 – 2 mm)	15		
Gravel (2-64 mm)	5		
Cobble (64 – 256 mm)	20		
Boulders (>256 mm)	40		
Bedrock			

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	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
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) 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% (80% for low-gradient) 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
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel 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
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 than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
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SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants 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 streambank surfaces 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 streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
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SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

MC3

Total Score [ ] **NOTES/COMMENTS:**

Appendix C
Literature Cited