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INNOVATIVE RECLAMATION TECHNOLOGIES & ENGINEERING CO., INC.

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FILE COPY

June 23, 2008

DVO 6-24
DAT 7-7
DRM 7-7
File - TN0071633

Mr. Douglas K. Siddell, Supervisor
Technical Group
Office of Surface Mining
Reclamation and Enforcement
710 Locust Street, Second Floor
Knoxville, Tennessee 37902

Subject: Crossville Coal Inc – Mine No. 1 - OSM Permit #3190
Macroinvertebrate Surveys

Dear Mr. Siddell:

Attached for your review is the bi-annual stream survey conducted for the spring time of the year for 2008. This macroinvertebrate survey was performed by Pennington and Associates, Inc. and included stream flow measurements and collection of water quality samples. The stream surveys (2 locations) were conducted on April 17, 2008 and indicated that the benthic macroinvertebrate community at each station was diverse and represents aquatic communities under little or no impairment.

The analyses of the collected water quality samples are included with this transmittal. The analyses of the collected PAH samples indicated all parameters to be below detection limits.

Please note that this letter along with the attached stream survey report constitute the reporting requirements for this aquatic and water quality monitoring plan. If you have any questions or need further information, please contact me at the address given above or telephone (423)-566-1915.

Sincerely,

Tim K. Slone, PE, PLS
On Behalf of Crossville Coal

Attachment
Enclosures

cc: Mr. Mike Webster, Crossville Coal Inc
Mr. Don Owens, TDEC 7006 2150 0002 8671 1790
USFW 7006 2150 0002 8671 1783
National Park Service 7006 2150 0002 8671 1776
Big South Fork NRRA 7006 2150 0002 8671 1431
File

FILE: CCI-Macro Submission Letter.doc

BENTHIC MACROINVERTEBRATE SURVEY
ROGERS AND ISLAND CREEKS
CUMBERLAND AND MORGAN COUNTIES, TENNESSEE

APRIL 2008

FOR

HILLS BOROUGH RESOURCES USA
CROSSVILLE COAL, INC.
P.O. Box 267
Harriman, Tennessee 37748

PREPARED BY

Pennington and Associates, Inc.
570 East 10th Street
Cookeville, Tennessee 38501
931-526-6038

EXECUTIVE SUMMARY

The objectives of the April 17, 2008 study included the physio-chemical and benthic macroinvertebrate community characterizations of Rogers Creek and Island Creek in the vicinity of Crossville Coal, Inc. removal operations. Both stations were sampled for benthic macroinvertebrate community composition, physio-chemical composition, (pH, temperature, conductivity, and dissolved oxygen) and habitat characterization.

Physical conditions at the two stations were similar with a substrate of boulder, cobble and gravel. Flow was approximately 6.6 cfs at Rogers Creek and 43 cfs at Island Creek. Habitat was assessed to be "Not Impaired" at both stations. In terms of water quality, differences between the creek stations were minimal.

Benthic macroinvertebrates were collected and analyzed according to Tennessee Bioassessment procedures and additional community measures as presented by Pennington and Associates, Inc. (2006). Additional community structure analyses included Shannon's Index of Diversity, Pielou's Evenness, Jaccard's Coefficient and Percent Similarity. Both Creeks support a diverse benthic macroinvertebrate community within each study reach. At least 27 species were taken from Rogers Creek and 32 from Island Creek. Stonefly species were dominant at both locations. Diversity Indices and evenness values were high at both locations, indicative of diverse benthic community structure existing under good water quality conditions. A comparison of the stations using Tennessee's Bioassessment metrics has both stations scoring as non-impaired and supporting.

In conclusion, it appears that the benthic macroinvertebrate community at both stations is diverse and represents aquatic communities under little or no impairment.

INTRODUCTION

Pennington and Associates, Inc. (PAI) surveyed Rogers Creek and Island Creek downstream of Crossville Coal, Inc. company's operations, Cumberland County, Tennessee on April 17, 2008. The survey was conducted to determine physio-chemical and benthic macroinvertebrate fauna characteristics of the creeks below the influence of the coal removal operations. The survey was accomplished as part of a permit requirement and followed the established protocols established by the State of Tennessee (TDEC 2006).

Since macroinvertebrate populations are more indicative of the relative health of a stream, attention is normally focused on this group. Macroinvertebrates are found in all aquatic habitats, they are less mobile than most other groups of aquatic organisms, such as fish, they are easily collected, and most have relatively long periods of development in the aquatic environment. Thus, macroinvertebrate species should reflect deleterious events that have occurred in the aquatic environment during any stage of their development.

SAMPLING LOCATION

Sampling locations are shown in Figures 1 and 2.

Rogers Creek – Located in Cumberland County, just upstream confluence with Yellow Creek, Latitude N36^{0}00.115', Longitude W084^{0}47.001' (Figure 1).

Island Creek – Located in Morgan County, approximately one mile upstream confluence with Emory River at road crossing near Catoosa, Latitude N36^{0}03.182', longitude W084^{0}40.030' (Figure 2).

Figure 1. Roger's Creek, 4/17/08.

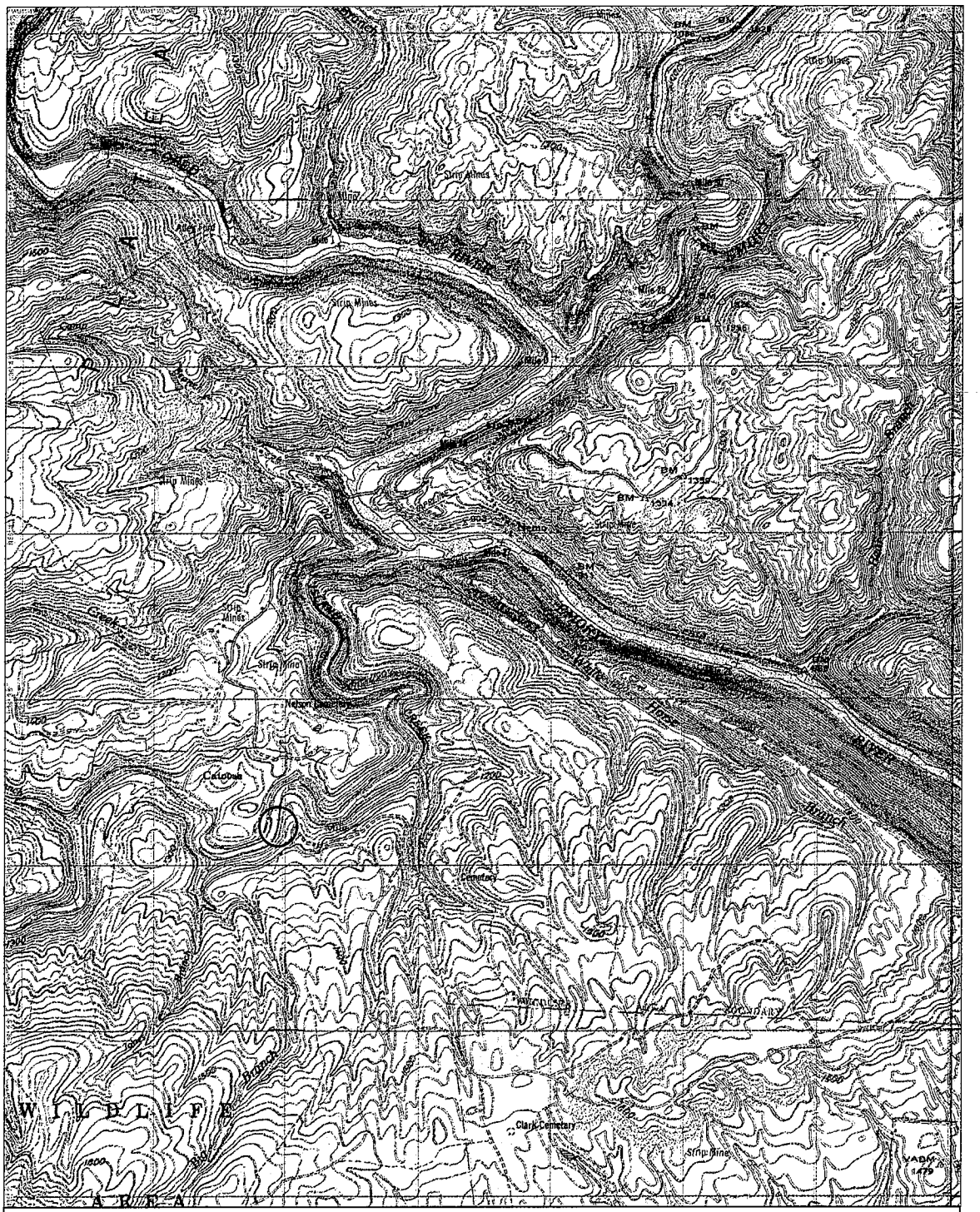

Figure 2. Island Creek, 4/17/08.

PHYSICAL CHARACTERSTICS

Rogers Creek and Island Creek originate on the Cumberland Plateau at an elevation of approximately 2300 feet. Rogers Creek in Cumberland County flows northwest to its confluence with Yellow Creek while Island Creek in Morgan County flows east to northeast to the Emory River. Usage of the watershed is primarily agriculture, forest and some coal mining.

Physical characteristics of the sampling sites are summarized in Table 1. Rogers Creek was approximately 24 feet wide (Photo 2) 8 inches deep and had a flow determination to be near 6.6 cfs. A pebble count had the substrate at Rogers Creek to consist of mostly boulders (43%) cobble (28%) and gravel (13%). Island Creek (Photo 1) was 36 feet wide and 10 inches deep. The flow at Island Creek was near 43 cfs. The substrate at Island Creek was mostly cobble (54%), gravel (21%), boulder (17%) and small amounts of sand (7%). Habitat at both locations scored as non-impaired.

MATERIALS AND METHODS

At each of the two stations, two ~1m^2 semi-quantitative riffle kick samples (SQKICK) were taken in the runs and riffles at the area of low and high velocity. The two ~ 1m^2 Kicks were taken in equal proportions using a coarse 500 μm mesh kick seine. In the field, the samples were transferred to plastic containers labeled on the outside and inside of the containers and preserved with 10% formalin.

In the laboratory, all benthic samples were washed in a 120-micron mesh screen. After washing, the macroinvertebrates were removed from the detritus using Tennessee Protocols (200 +/- 20% individuals) under 5x magnification and preserved in 85% ethanol. The organisms were identified to the lowest practical taxonomic level (genus) using available keys (Pennington and Associates, Inc. 2006) and counted. Identifications were made with a stereomicroscope (7X to 60X). Slide mounts were made of the chironomids, simuliids, oligochaetes and small crustaceans, and identifications were made with a compound microscope. The chironomids, simuliids, and oligochaetes were cleared for 24 hours in cold 10% KOH. Temporary mounts were made in glycerin and the animals returned to 80% ethanol after identification. When permanent mounts were desired, the organisms were transferred to 95% ethanol for 30 minutes and mounted in euperol.

SUBSTRATE DETERMINATION

A classification of substrate based on the size scale proposed by Wentworth (Compton 1962) was used to categorized the substrate. A 100 pebble count was conducted at each location following procedures developed by Bevenger and King (1995). This classification of detrital sediments is by grain diameter and is as follows:

Diameters	Approximate Inch Equivalents	Name of Loose Aggregate
>256 mm	>10 inch	Boulder
64 to 256 mm	2.5 to 10 inch	Cobble
2 to 64 mm	0.08 to 2.5 inch	Gravel
1/16 to 2 mm	0.002 to 0.08 inch	Sand
1/256 to 1/16 mm	0.00015 to 0.002 inch	Silt
<1/256 mm	<0.00015 inch	Clay

COMMUNITY STRUCTURE MEASURES

Core benthic macroinvertebrate community metrics were calculated for each station and compared to the Tennessee ecoregion reference data base (TDEC 2006). Seven core metrics were calculated and include:

1. **Taxa Richness (TR)** – Total number of distinct taxa (genera for comparison to Tennessee ecoregion data). In general, increasing taxa richness reflects increasing water quality, habitat diversity and habitat suitability (KDOW 2002).

2. **Ephemeroptera, Plecoptera, and Trichoptera Richness (EPT)** – Total number of distinct taxa within the generally pollution sensitive insect orders of EPT. This index value will usually increase with increasing water quality, habitat diversity and habitat stability. (Plafkin et al. 1989).

3. **North Carolina Biotic Index (NCBI)** – The Biotic Index was originally developed by Hilsenhoff (1982) as a rapid method for evaluating water quality in Wisconsin streams by summarizing the overall pollution tolerance of a benthic arthropod community with a single value from 0-5. Hilsenhoff (1987) later refined the index and expanded the scale from 0-10. The biotic index is an average of tolerance values, and measures saprobity (pertaining to tolerance of organic enrichment) and to some extent trophism. Range of the index ranges from 0 (no apparent organic pollution) to 10 (severe organic pollution). Tennessee and KDOW use tolerance values developed by North Carolina Division of Environmental Management (NCDEM) (NCDENR 2006) and these values were used in this study. An increasing Biotic Index value indicates decreasing water quality. The formula for the Biotic Index is as follows:

$$\text{NCBI} = \sum \frac{x_i t_i}{n}$$

Where: x_i = number of individuals within a taxon
t_i = tolerance value of a taxon
n = total number of individuals in the sample

According to Hilsenhoff (1987) the calculated Biotic Index values for Wisconsin streams reflect the following:

Biotic Index	Water Quality	Degree of Organic Pollution
0.00 - 3.50	Excellent	No apparent organic pollution
3.51 - 4.50	Very Good	Possibly slight organic pollution
4.51 - 5.50	Good	Some organic pollution
5.51 - 6.50	Fair	Fairly significant organic pollution
6.51 - 7.50	Fairly Poor	Significant organic pollution
7.51 - 8.50	Poor	Very significant organic pollution
8.51 - 10.00	Very Poor	Severe organic pollution

Historically, NCDEM used the following modified Hilsenhoff Biotic Index scale to assign water quality condition in North Carolina streams for three ecoregions.

Condition	Mountain	Piedmont	Coastal Plain
Excellent	<4.05	<5.19	<5.47
Good	4.06-4.88	5.19-5.78	5.47-6.05
Good to Fair	4.89-5.74	5.79-6.48	6.06-6.72
Fair	5.75-7.00	6.49-7.48	6.73-7.73
Poor	>7.00	>7.48	>7.73

The state of Tennessee uses a four tier scoring criteria which is based on Hilsenhoff's values calibrated for each Tennessee ecoregion. TDEC's scoring criteria for biotic index values for streams of the interior plateau ecoregions are as follows.

Ecoregion	Non-impaired	Slightly Impaired	Moderately Impaired	Severely Impaired
Cumberland Plateau (68a)	<4.78	4.78-6.51	6.52-8.26	>8.26
Western Pennyroyal Karst (71e)	<5.09	5.09-6.72	6.73-8.36	>8.36
Western Highland Rim (71g)	<4.69	4.69-6.45	6.46-8.23	>8.23
Eastern Highland Rim (71f)	"	"	"	"
Outer Nashville Basin (71h)	"	"	"	"
Inner Nashville Basin (71i)	<5.49	5.49-6.99	7.00-8.49	>8.49

4. **Percent Ephemeroptera, Plecoptera and Trichoptera (EPT Abundance):**

$$\% \text{ EPT} = \frac{\text{Number of EPT individuals}}{\text{Total Number of individuals}} \text{ X } 100$$

5. **Percent Oligochaeta and Chironomidae (%OC)** – This metric measures the relative abundance of these generally pollution tolerant organisms. Increasing abundances of oligochaetes and chironomids suggests decreasing water quality and/or habitat conditions. % OC = Number of OC individuals

$$\% \text{ OC} = \frac{\text{Number of OC individuals}}{\text{Total Number of Individuals}} \text{ X100}$$

6. **Percent Nutrient Tolerant Organisms (%NUTOL) –**

$$\% \text{ NUTOL} = \frac{\text{Total number of } \textit{Cheumatopsyche, Lirceus, Physella, Baetis, Psephenus, Stenelmis, Simulium, Elimia, Oligochaeta, Polypedilum, Rheotanytarsus, Stenacron, Cricotopus and Chironomus}}{\text{Total individuals in sample}} \text{ X100}$$

7. **Percent Clingers** (Percent contribution of organisms that build fixed retreats or have adaptations to attach to surfaces in flowing water)-

$$\% \text{ Clingers} = \frac{\text{Total number of clinger individuals}}{\text{Total individuals in sample}} \text{ X100}$$

The seven metrics; **1.** Taxa richness, **2.** EPT taxa, **3.** NCBI, **4.** % EPT, **5.** %OC, **6.** % NUTOL and **7.** % Clingers calculated for the two stream locations were compared to the Tennessee ecoregion reference streams. The data for the two stream locations were equalized by assigning a score of 6 (non-impaired), 4 (slightly impaired), 2 (moderately impaired), or 0 (severely impaired) based on comparison to the Tennessee Ecoregion reference data base (TDEC 2006). The scores were summed to determine biological condition of each of the stream locations.

Brower and Zar (1984) provide a detailed discussion of a variety of techniques for measuring community structure. The use of diversity indices is based upon the observation that

normally undisturbed environments support communities with large numbers of species having no individuals present in overwhelming abundance. If the species of a disturbed community are ranked by numerical abundance, there may be relatively few species with large numbers of individuals. Mean diversity is affected by both "richness" of species (or abundance of different species) and by the distribution of individuals among the species. High species diversity indicates a highly complex community.

Species diversity was estimated using Shannon's Index of Diversity (H):

$$H = -\sum p_i \log p_i$$

where p_i is the proportion of the total number of individuals occurring in species i ($p_i=n_i/N$), N is the total number of individuals in all species.

Diversity indices take into account both the species richness and the evenness of the individuals' distribution among the species. Separate measures of these two components of diversity are often desirable. Species richness can be expressed simply as the number of species in the community. Evenness may be expressed by considering how close a set of observed species abundance are to those from an aggregation of species having maximum possible diversity for a given N and S (Brower and Zar 1984).

Evenness is calculated as follows:

$$\text{Pielou } J' = H/H_{max}$$

where H is calculated diversity and H_{max} is maximum possible diversity.

Community similarity between sites is measured by Jaccards Coefficient, and Percent Similarity.

$$\text{Jaccards Coefficient} = \frac{C}{S_1 + S_2 - C}$$

where S = Species in each community (S_1 is reference Community)

and C = Species common to both communities

Percent Similarity, for a two-community comparison, is calculated as follows: The number of individuals in each species is calculated as a fractional portion of the total community. The

value for species i in community 1 is compared to the value for species i in community 2. The lower of the two is tabulated. This procedure is followed for each species. The tabulated list (of the lower of each pair of values) is summed. The sum is defined as the Percent Similarity of the two communities.

PHYSICAL AND CHEMICAL PARAMETERS

The physical and field chemical parameters measured included pH, dissolved oxygen, temperature, conductivity, stream width, depth, velocity and flow. Values of pH were determined at each station with a Fisher Accument Field pH meter. Dissolved oxygen and temperature were determined with an YSI Model 51 Dissolved Oxygen Meter. Temperature was also verified with a field centigrade thermometer. A LaMotte conductivity meter was used to measure conductivity. Width of the streambed was taken at each station using a tape measure. Depth was taken at approximate one-foot intervals across the stream at the location used for width measurements. Average depth was determined by adding the readings taken across the stream at each location used for width measurement and dividing by one more than the number of readings. This is to allow for 0 depth at each side (Lagler 1973). Velocity was measured approximately every two feet across the stream with a Gurley Flow Meter. Approximate flow was determined by the following formula:

$$R = V\ D\ a\ W$$

Where R is equal to the volume of flow in cubic feet per second (cfs); W is average width in feet; D is average depth in feet; V is the velocity (ft/sec); and a is a constant for correction of stream velocity (0.8 if the bottom is strewn with rocks and coarse gravel, 0.9 if smooth).

RESULTS AND DISCUSSION

Physical characteristics of the two stations are listed in Table 1. Table 2 contains all water quality data collected from each location. A list of all species of aquatic benthic macroinvertebrates, assigned tolerance values and functional feeding groups from each station are shown in Table 3. A summary of benthic community measures is presented in Table 4. A summary of Tennessee Bioassessment metrics and scores is presented in Table 5. All field data including habitat assessment field data sheets are presented in the appendix.

In terms of physical habitat for aquatic life, both stations rated a score considered "Not Impaired" (Table 1). Both sites were similar in physical habitat with the exception of Rogers Creek having a sixth the flow of Island Creek. The substrate at both sites was a mixture of boulder and cobbles with smaller amounts of gravel.

Water quality information shown in Table 2 indicates pH near neutral (7.38-6.98) at both creek stations. As in 2007, conductivity measurements were only slightly higher at Rogers Creek (73μs) when compared to Island Creek (63 μs). Temperature ranged from 9.7 ^{o}C at Rogers Creek to 10.6 ^{0}C at Island Creek. Dissolved oxygen ranged from 10.13 mg/l at Rogers Creek to 10.28 mg/l at Island Creek.

Both Creeks support diverse aquatic communities within each study reach. A minimum of 48 aquatic species was taken from the two sites (Table 3). Rogers Creek had a minimum of 27 species while Island Creek had 32 species. The stonefly *Amphinemura sp.* (35.6%) was again dominant in Rogers Creek and co-dominant (28.3%) in Island Creek (Table 3). The stonefly *Leuctra sp.* was again dominant (31.3%) at the Island Creek location.

The summary of diversity values listed in Table 4 (3.3 at both) indicates that the populations at both locations were very diverse and representative of streams with good water quality (Weber 1973). The diversity value reflects the distribution of individuals among the species where an even distribution of individuals among species would yield the maximum diversity value and the restriction of individuals to a few species would produce a low diversity value.

The evenness values shown in Table 4 were 0.7 at Rogers Creek and 0.67 at Island Creek. According to Weber (1973), values of equitability between 0.6 to 0.8 are representative of streams in the southeast unaffected by oxygen demanding wastes.

A comparison of the stations using Tennessee Bioassessment metrics presented in Table 5 has both sites as non-impaired when compared to the target scores of Bioregion 68a (Biocriteria Tables in Tennessee Department of Environment and Conservation, 2006). Rogers Creek scored 36 out of 42 while Island Creek scored 42 out of a maximum of 42.

A comparison of the two sites using species in common (Table 4) shows Rogers Creek and Island Creek had less than 1/4 their species in common (0.23). In terms of percent similarity (Table 4) the two stations were 53.1% comparable.

A revised Biotic Index was introduced by Hilsenhoff (1987) and is used as metric No. 5 in Table 4. The Hilsenhoff Biotic Index value 2.45 calculated for the communities at Island Creek and the value 3.03 at Rogers Creek indicate non-impaired conditions or "Excellent" water quality conditions when using Hilsenhoff's (1987) scoring criteria.

CONCLUSIONS

Rogers Creek and Island Creek are species rich and support diverse aquatic fauna. Biotic Index values for the benthic macroinvertebrate communities at both stations are representative of "Very Good to Excellent" water quality conditions. Both locations scored as non-impaired when compared to the Tennessee Reference stream database. It appears that the benthic communities at both stations are diverse and indicate little or no impairment.

Photo 1. Island Creek, 4/17/08.

Photo 2. Rogers Creek, 4/17/08.

Table 1. Physical Characteristics of Island and Rogers Creeks, April 17, 2008.

PARAMETER	STATION	
	ROGERS CREEK	ISLAND CREEK
WIDTH (FT)	24	36
AVERAGE DEPTH (FT)	0.66	0.84
[a] VELOCITY (FT/SEC)	0.52	1.77
FLOW (FT^3/SEC)	6.6	42.8
HABITAT ASSESSMENT SCORE	171	183
	Not Impaired	Not Impaired
SUBSTRATE (Pebble Count)		
Silt/Clay	2.9	
Very Fine Sand		
Fine Sand		1
Medium Sand	1.9	4.9
Coarse Sand	1.0	
Very Coarse Sand		1.0
Fine Gravel	4.8	3.0
Medium Gravel	5.8	
Coarse Gravel	2.9	9.8
Very Coarse Gravel		7.8
Small Cobble	9.6	30.4
Large Cobble	18.3	17.6
Small Boulder	17.3	5.9
Medium Boulder	13.5	
Large-Very Large Boulder	13.5	16.7
Bedrock	8.7	2.9

[a] A correction for stream velocity (0.8 if bottom is strewn with cobble and coarse gravel, 0.9 if smooth)

Table 2. Water Quality Characteristics of Island and Rogers Creeks, April 17, 2008.

PARAMETER	STATION	
	ROGERS CREEK	ISLAND CREEK
Ph (Std. Units)	7.38	6.98
Dissolved Oxygen (mg/l)	10.13	10.28
Temperature (^{0}C)	9.7	10.6
Conductivity (*us*/cm)	73	63
Turbidity	Clear	Clear

Table 3. Benthic Macroinvertebrates Collected From Cumberland County, Tennessee, April 17, 2008.

SPECIES	T.V.	F.F.G.	CL	Island Creek	Rogers Creek
PLATYHELMINTHES					
Turbellaria					
Tricladida					
Dugesiidae					
Cura sp.	**5**			1	
ANNELIDA					
Oligochaeta		**CG**			
Tubificida					
Enchytraeidae	**9.8**	**CG**		1	
ARTHROPODA					
Crustacea					
Amphipoda	**7.4**	**CG**			
Gammaridae					
Gammarus sp.	**9.1**	**SH**			1
Decapoda					
Cambaridae	**7.5**				
Cambarus sp.	**7.6**	**CG**		1	
Insecta					
Ephemeroptera					
Ameletidae		**CG**			
Ameletus sp.	**2.4**	**CG**		2	10
Baetidae	**6.1**	**CG**			
Baetis sp.	**4.5**	**CG**			1
Plauditus sp.	**4.5**	**CG**		8	27
Ephemerellidae	**1.9**	**SC**			
Ephemerella sp.	**2**	**SC**	**CL**	9	13
Eurylophella sp.	**4.3**	**SC**	**CL**	5	
Heptageniidae	**1.5**	**SC**	**CL**		3
Leptophlebiidae	**1.8**	**CG**			1
Odonata					
Gomphidae	**5**	**P**			
Lanthus sp.	**1.8**	**P**		2	
Plecoptera					
Chloroperlidae	**0.7**	**P**			
Haploperla brevis				3	10
Leuctridae	**0.2**	**SH**			
Leuctra sp.	**0.7**	**SH**	**CL**	62	20
Nemouridae	**1.2**	**SH**			
Amphinemura sp.	**3.3**	**SH**		56	67
Peltoperlidae		**SH**			1
Perlidae	**1.5**	**P**	**CL**		1

Table 3. Benthic Macroinvertebrates Collected From Cumberland County, Tennessee, April 17, 2008.

SPECIES	T.V.	F.F.G.	CL	Island Creek	Rogers Creek
Acroneuria sp.	1.5	P	CL	1	
Acroneuria abnormis	1.5	P	CL	9	
Perlodidae	1.6	P	CL		
Diploperla sp.	2.1				1
Isoperla sp.	1.5	P	CL		10
Megaloptera					
Corydalidae		P			
Corydalus cornutus	5.2	P	CL	1	
Nigronia serricornis	5.3	P	CL	2	
Trichoptera					
Hydropsychidae	2.9	FC	CL	1	
Lepidostomatidae	0.9	SH			
Lepidostoma sp.	0.9	FC		5	2
Leptoceridae	2.7	CG			
Mystacides sepulchralis	2.7	CG			1
Philopotamidae		FC	CL		
Chimarra obscurus	2.8	FC	CL	1	
Dolophilodes sp.	0.8	FC	CL		1
Polycentropodidae	4	FC	CL		
Polycentropus sp.	3.5	FC	CL	4	
Rhyacophilidae		P	CL		
Rhyacophila sp.	0.7	P	CL	2	1
Coleoptera					
Dryopidae					
Helichus basalis	4.6	SC	CL	3	
Elmidae		CG			
Oulimnius latiusculus	1.8	CG	CL	4	
Psephenidae		SC			
Psephenus herricki	2.4	SC	CL	2	
Diptera					
Chironomidae					
Conchapelopia sp.	4.5	P		1	
Dicrotendipes neomodestus	8.1	CG		1	
Orthocladius sp.	6	CG			1
Orthocladius lignicola	6	CG			1
Parametriocnemus sp.	3.7	CG		1	2
Polypedilum illinoense	5.7	SH		1	
Tanytarsus sp.	6.8	FC		1	2
Tribelos fuscicorne				2	
Tvetenia paucunca	3.7	CG			2
Empididae	7.6	P			
Hemerodromia sp.	7.6	P			1
Simuliidae	3.5	FC	CL		

Table 3. Benthic Macroinvertebrates Collected From Cumberland County, Tennessee, April 17, 2008.

SPECIES	T.V.	F.F.G.	CL	Island Creek	Rogers Creek
Prosimulium sp.	4	FC	CL	4	
Simulium sp.	4	FC	CL		3
Tipulidae	4.9	SH			
Antocha sp.	4.3	CG	CL		4
Hexatoma sp.	4.3	P		1	
Tipula sp.	7.3	SH		1	1
TOTAL NO. OF ORGANISMS				**198**	**188**
TOTAL NO. OF TAXA				**32**	**27**

Table 4. Benthic Macroinvertebrate Community Measures, Rogers and Island Creeks, April 17, 2007.

METRIC	ROGERS CREEK	ISLAND CREEK
Taxa Richness-Genera	27	32
Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa Richness	17	14
Percent EPT	90.43%	84.85%
Percent Oligochaetes and Chironomids	4.26%	4.04%
North Carolina Biotic Index (NCBI)	3.03	2.45
Percent NUTOL	1.60%	2.02%
Percent Clingers	29.79%	55.56%
Shannon Diversity	3.33	3.37
Pielou's Evenness	0.70	0.67
Jaccard's Coefficient (Rogers Creek)		0.229
Percent Similarity (Rogers Creek)		53.1

Table 5. Summary of Tennessee Bioassessment Metrics, Protocol K, Rogers and Island Creeks, April 17, 2008.

METRIC	ROGERS CREEK		ISLAND CREEK	
	Value	Score	Value	Score
1. Taxa Richness (TR)	27	4	32	6
2. EPT Richness (EPT)	17	6	14	6
3. Percent EPT	90.43	6	84.85	6
4. Percent Oligochaetes and Chironomids (OC)	4.26	6	4.04	6
5. North Carolina Biotic Index (NCBI)	3.03	6	2.45	6
6. Percent Clingers	29.79	2	55.56	6
7. Percent NUTOL	1.60	6	2.02	6
TOTAL VALUE		36		42
INDEX SCORE	Nonimpaired Supporting		Nonimpaired Supporting	

Target score for Ecoregion 68a (Cumberland Plateau) from January thru June is 32.

REFERENCES

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APPENDIX

STREAM SURVEY INFORMATION

STATION NUMBER:
STREAM NAME: Rocky Crk
STATION LOCATION: Cumberland Co. TN
COUNTY CODE:(FIPS) (STATE CODE)
WBID#/HUC:
HUC NAME:
LAT/LONG DEC: 36.00194° 84.78538
ECOLOGICAL SUBREGION:
USGS QUAD:
PROJECT/PURPOSE:

ASSESSORS:
DATE: 4/17/08
TIME: 9:30 AM EST
STREAM MILE:
STREAM ORDER:
ADB SEGMENT
3Q20:
ELEVATION (ft):
GAZETTEER PAGE

SAMPLES COLLECTED

Aquatic Life Assessed: (Macroinvertebrates) Fish Algae Other:
Type of benthic sample: BIORECON (SQ KICK) SQ BANK DENDY SURBER OTHER
CHEMICALS (Y) N

FIELD MEASUREMENTS

METERS USED: YSI DO Fisher Accumet Corning Cond.

pH	7.38	SU
CONDUCTIVITY	73	UMHOS
TEMPERATURE	9.7	°C

DISSOLVED OXYGEN 10.13 PPM
TIME
OTHERS Clear

Previous 48 hours Precip: UNKNOWN (NONE) LITTLE MODERATE HEAVY FLOODING
Ambient Weather: (SUNNY) CLOUDY BREEZY RAIN: SNOW AIR TEMP:

WATERSHED CHARACTERISTICS

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE		URBAN	5	RESID	
CROPS		INDUSTRY		OTHER	
FOREST	90	MINING	5		

IMPACTS: rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES				SOURCES			
Pesticides	(0200)	Flow Alter.	(1500)	Point Source: Indust	(0100)	Unknown	(9000)
Metals	(0500)	Habitat Alt.	(1600)	Logging	(2000)	Municipal	(2000)
Ammonia	(0600)	Thermal Alt.	(1400)	Construction;Land Devel	(3200)	Mining	(5000) 5
Chlorine	(0700)	Pathogens	(1700)	U/S Dam	(8800)	Road /bridge	(3100)
Nutrients	(0900)	Oil & grease	(1900)	Riparian loss	(7600)	Urban Runoff	(4000)
pH	(1000)	Unknown	(0000)	Agriculture: Row crop	(1000)	Bank destabilization	(7700)
Organic Enrichment / Low D.O.		Siltation	(1100)	Livestock grazing-riparian	(1410)	Intensive Feedlot	(1600)
Other:			(1200)	Other:		Dredging	(7200)

PHYSICAL STREAM CHARACTERISTICS

SURROUNDING LAND USE:

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE			URBAN			RESID.		
CROPS			INDUSTRY			OTHER		
FOREST	100	100	MINING					

% CANOPY COVER: Estimated: Open(0-10) Partly Shaded(11-45) Mostly Shaded(46-80) Shaded(>80)
Measured: U/S D/S LB RB
BANK HEIGHT (m): HIGH WATER MARK (m):

SEDIMENT DEPOSITS: (NONE) SLIGHT MODERATE EXCESSIVE BLANKET
TYPE: SLUDGE MUD SAND SILT (NONE) OTHER Contaminated Y or N
TURBIDITY (CLEAR) SLIGHT MODERATE HIGH OPAQUE
ALGAE PRESENT? NONE (SLIGHT) MODERATE CHOKING TYPE
AQUATIC VEGET. ROOTED FLOATING TYPE None
ADDITIONAL COMMENTS:(oil sheen, odor, colors)

Rogers Crk 4/17/08

STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)			
WIDTH (m)	24		
REACH LENGTH (m)			

Staff Gauge/Bench Ht: ____
VELOCITY (FS) ____
FLOW (CFS) ____
HABITAT ASSESSMENT SCORE #:
RR # ____ GP # ____

Gradient (sample reach): Flat Low Mode. (High) Cascade
Size (stream width): V. Small (<1.5m) Small (1.5-3m) (Med (3-10m)) Large (10-25m) Very Lrg (>25m)

SUBSTRATE (Complete either particle count or estimate substrate (%))

Particle Count - 100 measured particles (mm). Circle one: RIFFLE → RUN See Pebble Count

size (mm)	description	abbreviation	Record measured particle size. Use abbrev. below for smaller sizes.
<0.062	silt/clay	c/	1-10
0.062-0.125	very fine sand	vfs	11-20
0.125-.250	fine sand	fs	21-30
0.25-0.50	med sand	ms	31-40
0.5-1.0	coarse sand	cs	41-50
1.0-2.0	very coarse sand	(use actual size)	51-60
2.0-64.0	gravel	(use actual size)	61-70
64-256	cobble	(use actual size)	71-80
256-4096	boulder	(use actual size)	81-90
---	bedrock	bdrx	91-100
---	woody debris	wood	

See Pebble Count Sheet

SUBSTRATE (%) (Visual estimates)

	RIFFLE	RUN	POOL
BOULDER (> 10")	%	%	%
COBBLE (2.5-10")	%	%	%
GRAVEL (0.1-2.5")	%	%	%
BEDROCK	%	%	%
SAND (gritty)	%	%	%

	RIFFLE	RUN	POOL
CLAY (slick)	%	%	%
SILT	%	%	%
DETRITUS (CPOM)	%	%	%
MUCK-MUD (FPOM)	%	%	%
MARL (shell frags.)	%	%	%

STREAM USE SUPPORT

WATER WITHDRAWL NOTED

CLASSIFIED FOR:
Dom: H2O Supply
TIER II/TIER III
Trout >>
ind. H2O Supply
Navigation
Nat. Repr?

POSTED FOR:
Bacteriological Advis.
Do Not Consume
Precautionary
Fish Tissue Advis.:

SUPPORT STATUS:
FULLY SUPPORTING (FS) PARTIALLY SUPPORTING (PS) SUPPORTING, BUT THREATENED (TH) NONSUPPORTING (NS)

Photos Y or N Roll/Disc # Photo #ID 1033.JPG 1034.JPG #/ID
#/ID #/ID

STREAM SKETCH (include flow direction, reach distance, distance from bridge, sampling points, tribs, outfalls, livestock access, riparian area etc:)

Depths	CTS/min
4"	27
6"	31
7"	45
14"	21
11"	31 cfs/min
11"	0.52 ft/sec
8"	
9"	
7"	
2"	
79	7.9
	0.66

0.52 ft/sec
0.66 ft
24 ft wide
8.24 ft3/sec
Correction Factor X 0.8
6.59
6.6 CFS

9.5 PEBBLE COUNT

PEBBLE COUNT

Stream Name: Rogers Crk Date: 4/17/08

Point of Assessment:

County: River Basin: WRD#

Ecoregion: Stream Order:

Lat/Long coordinates: 36.00194° 84.78338°

Assessors: Time:

Size Class	Size Range (mm)	Count	Total	%Cum.
Silt/Clay	<0.062 - 0.002	///	3	2.9%
SAND				
Very Fine	0.062-0.125 - 0.005			
Fine	0.125-0.25 - 0.01			
Medium	0.25-0.50 - 0.02	//	2	1.9%
Coarse	0.50-1.0 - 0.04	/	1	1.0%
Very Coarse	1-2 - 0.08			
GRAVEL				
Very Fine	2-4 - 0.16	/		
Fine	4-6 - 0.24	/		
	6-8 - 0.31	///	5	4.8%
Medium	8-12 - 0.47	///		
	12-16 - 0.63	///	6	5.8%
Coarse	16-24 - 0.9	//		
	24-32 - 1.3	/	3	2.9%
Very Coarse	32-48 - 1.9			
	48-64 - 2.5			
COBBLE				
Small	64-96 - 3.8	/		
	96-128 - 5.0	//// ////	10	9.6%
Large	128-192 - 7.6	////		
	192-256 - 10.1	//// //// ////	19	18.3%
BOULDER				
Small	256-384 - 15.1	1.25' //// //// //		
	384-512 - 20.1	1.7' //// /	18	17.3%
Medium	512-1024 - 40.3	3.3' //// //// ////	14	13.5%
Large-Very Large	1024-4096 - 161.2	13.4' //// //// ////	14	13.5%
BEDROCK		//// ////	9	8.7%

63

total 104

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (FRONT)

STREAM NAME Rogers Crk	LOCATION
STATION #	ECOREGION
LAT 36.00194° LONG 84.70338°	RIVER BASIN
WBID/HUC	INVESTIGATORS
FORM COMPLETED BY Wendell Pennington	DATE 4/17/08 TIME 9:30 (AM) PM

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 col··zation potential; adequate habitat for maintenance of populations; presence of additional substrate in the from of newfall, but not yet prepared for colonization (may rate at high end of scale)	20-40% mix of stable 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
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 76% 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
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow) (Slow is<0.3m/s deep is >0.5m)	Only 3 of the 4 regimes present (if fast-shallow is missing score lower than 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
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
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.	Waters 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

Rogers Creek
4/17/08

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (BACK)

Station ID Rogers Crk Date 4/17/08

Habitat Parameter	Optimal	Suboptimal	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 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
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 5-7); 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 >35.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
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 area; "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 Protective (score each bank) Note: determine left or right side by facing downstream	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 171

STREAM SURVEY INFORMATION

STATION NUMBER:
STREAM NAME: Sland CR
STATION LOCATION: Morgan Co. TN
COUNTY CODE:(FIPS) (STATE CODE)
WBID#/HUC:
HUC NAME:
LAT/LONG DEC: 36.05306° 84.66728°
ECOLOGICAL SUBREGION:
USGS QUAD:
PROJECT/PURPOSE:

ASSESSORS:
DATE: 4/17/08
TIME: 12:14 EST
STREAM MILE:
STREAM ORDER:
ADB SEGMENT
3Q20:
ELEVATION (ft):
GAZETTEER PAGE

SAMPLES COLLECTED

Aquatic Life Assessed: (Macroinvertebrates) Fish Algae Other:
Type of benthic sample: BIORECON (SQ KICK) SQ BANK DENDY SURBER OTHER
CHEMICALS (Y) or N

FIELD MEASUREMENTS

METERS USED: YSI D.O. PH Fisher Accumet Corning Conductivity

pH	6.98	SU
CONDUCTIVITY	63	UMHOS
TEMPERATURE	10.6	°C

DISSOLVED OXYGEN 10.28 PPM
TIME
OTHERS Clear

Previous 48 hours Precip: UNKNOWN (NONE) LITTLE MODERATE HEAVY FLOODING
Ambient Weather: (SUNNY) CLOUDY BREEZY RAIN SNOW AIR TEMP:

WATERSHED CHARACTERISTICS (Approximate watershed boundary)

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE		URBAN		RESID	
CROPS		INDUSTRY		OTHER	
FOREST	100	MINING			

IMPACTS: rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES			SOURCES		
Pesticides (0200)	Flow Alter. (1500)		Point Source: Indust (0100)	Unknown (9000)	
Metals (0500)	Habitat Alt. (1600)		Logging (2000)	Municipal (2000)	
Ammonia (0600)	Thermal Alt. (1400)		Construction;Land Devel (3200)	Mining (5000)	
Chlorine (0700)	Pathogens (1700)		U/S Dam (8800)	Road /bridge (3100)	
Nutrients (0900)	Oil & grease (1900)		Riparian loss (7600)	Urban Runoff (4000)	
pH (1000)	Unknown (0000)		Agriculture: Row crop (1000)	Bank destabilization (7700)	
Organic Enrichment / Low D.O.	Siltation (1100)		Livestock grazing-riparian (1410)	Intensive Feedlot (1600)	
Other:	(1200)		Other:	Dredging (7200)	

PHYSICAL STREAM CHARACTERISTICS (LENGTH OF STREAM REACH ASSESSED (m))

SURROUNDING LAND USE:

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE			URBAN			RESID		
CROPS			INDUSTRY			OTHER		
FOREST	100	100	MINING					

% CANOPY COVER: Estimated: Open(0-10) (Partly Shaded(11-45)) Mostly Shaded(46-80) Shaded(>80)
Measured: U/S D/S LB RB
BANK HEIGHT (m): HIGH WATER MARK (m):

SEDIMENT DEPOSITS: NONE SLIGHT MODERATE EXCESSIVE BLANKET
TYPE: SLUDGE MUD SAND SILT OTHER Contaminated Y or N
TURBIDITY (CLEAR) SLIGHT MODERATE HIGH NONE
ALGAE PRESENT? NONE (SLIGHT) MODERATE CHOKING TYPE
AQUATIC VEGET. ROOTED FLOATING TYPE Nom.
ADDITIONAL COMMENTS:(oil sheen, odor, colors) Clear

Island Crk 4/17/08 STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

	RIFFLE	RUN	POOL
DEPTH (m)			
WIDTH (m)	36'		
REACH LENGTH (m)			

Staff Gauge/Bench Ht: ____
VELOCITY (FS) ____
FLOW (CFS) ____
HABITAT ASSESSMENT SCORE #: ____
RR # ____ GP # ____

Gradient (sample reach): Flat Low Mode. (High) Cascade
Size (stream width): V. Small (<1.5m) Small (1.5-3m) (Med (3-10m)) (Large (10-25m)) Very Lrg (>25m)

SUBSTRATE (Complete either particle count or estimate substrate (%))

Particle Count - 100 measured particles (mm). Circle one: RIFFLE RUN

size (mm)	description	abbreviation
<0.062	silt/clay	cl
0.062-0.125	very fine sand	vfs
0.125-.250	fine sand	fs
0.25-0.50	med sand	ms
0.5-1.0	coarse sand	cs
1.0-2.0	very coarse sand	(use actual size)
2.0-64.0	gravel	(use actual size)
64-256	cobble	(use actual size)
256-4096	boulder	(use actual size)
---	bedrock	bdrx
---	woody debris	wood

Record measured particle size. Use abbrev. below for smaller sizes.

1-10									
11-20									
21-30									
31-40									
41-50									
51-60									
61-70									
71-80									
81-90									
91-100									

SUBSTRATE (%) (Visual estimates) See Pebble Count Sheet

	RIFFLE	RUN	POOL
BOULDER (> 10")	%	%	%
COBBLE (2.5-10")	%	%	%
GRAVEL (0.1-2.5")	%	%	%
BEDROCK	%	%	%
SAND (gritty)	%	%	%

	RIFFLE	RUN	POOL
CLAY (slick)	%	%	%
SILT	%	%	%
DETRITUS (CPOM)	%	%	%
MUCK-MUD (FPOM)	%	%	%
MARL (shell frags.)	%	%	%

STREAM USE SUPPORT WATER WITHDRAWL NOTED

CLASSIFIED FOR:
Dom: H2O Supply
TIER II/TIER III
Trout >>

Ind. H2O Supply
Navigation
Nat. Repr?

POSTED FOR:
Bacteriological Advis.
Do Not Consume
Precautionary
Fish Tissue Advis.:

SUPPORT STATUS;
FULLY SUPPORTING (FS) PARTIALLY SUPPORTING (PS) SUPPORTING, BUT THREATENED (TH) NONSUPPORTING (NS)

Photos ? Y or N Roll/Disc # Photo #ID 1035.JPG 1036.JPG #/ID
#/ID #/ID

STREAM SKETCH (include flow direction, reach distance, distance from bridge, sampling points, tribs, outfalls, livestock access, riparian area etc:)

36' wide Depths CFS/Min

	7"	72
1.77 ft/sec	12"	132
0.84 ft	11"	76
36 ft	10"	78
53.52	9"	100
Correction Factor 0.8	9"	166
42.8 cfs	14"	140
	11"	86
	8"	850
	91	10.11
		0.84 ft

1.77 ft/s
106.25

State of TN Page 2 3/12/02

9.5 PEBBLE COUNT

PEBBLE COUNT

Stream Name: Island Creek Date: 4/17/08

Point of Assessment:

County: Morgan River Basin: WRD#:

Ecoregion: Stream Order:

Lat/Long coordinates:

Assessors: Pennington and Associates Time: 1254

Project: DJ DJW

Size Class	Size Range (mm) Inches	Count	Total	% Cum.
Silt/Clay	<0.062 <0.002			
SAND				
Very Fine	0.062-0.125 -0.005			
Fine	0.125-0.25 -0.01	/	1	1%
Medium	0.25-0.50 -0.02	////	4	4.9%
Coarse	0.50-1.0 -0.04			
Very Coarse	1-2 -0.08	/	1	1%
GRAVEL				
Very Fine	2-4 -0.16	/	1	1%
Fine	4-6 -0.24	/		
	6-8 -0.31	/	2	2%
Medium	8-12 -0.47			
	12-16 -0.63	////		
Coarse	16-24 -0.9	////		
	24-32 -1.3	//	10	9.8%
Very Coarse	32-48 -1.9	//		
	48-64 -2.5	//// /	8	7.8%
COBBLE				
Small	64-96 -3.8	//// ////		
	96-128 -5.0	//// //// //// //// //	31	30.4%
Large	128-192 -7.6	//// ////		
	192-256 -10.1	//// ////	18	17.6%
BOULDER				
Small	256-384 -15.1	1.25' ////		
	384-512 -20.1	1.7' /	6	5.9%
Medium	512-1024 -40.3	3.3' //// ////		
Large-Very Large	1024-4096 -161.3	13.4' //// //// //	17	16.7%
BEDROCK		///	3	2.9%

63

102

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME Island Crk	LOCATION	
STATION # _____ RIVERMILE _____	STREAM CLASS	
LAT N36.05306° LONG W84.66728°	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS Pennington & Associates, Inc		
FORM COMPLETED BY Wendell Pennington	DATE 4/17/08 TIME 1254 AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

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				
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				
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow 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				
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% 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				
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				

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Island Creek 4/17/08

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	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 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 183