

**APPENDIX G**

**FISH HABITAT AND BENTHIC ORGANISM ASSESSMENTS**

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Craig  
COPS

## STELLARTON PIT MINE

### FISH HABITAT And BENTHIC ORGANISM SURVEY

Bear Brook / Middle River - August 26, 1996

#### Introduction:

The following work was carried out to fulfill the requirements for a fish habitat and benthic organism survey as part of the Stellarton Pit Mine development in Stellarton, NS (see NSDOE Approval # 95-052). These data represent samples taken under "low flow" conditions.

#### Methodology:

Fish habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) as described in Ohio Environmental Protection Agency (1989). This is an index of macro-habitat quality that considers the physical factors that affect fish communities and which are generally also important to other aquatic life such as invertebrates. The index (maximum = 100) is based on six interrelated "metrics": substrate, instream cover, channel morphology, riparian and bank conditions, pool and riffle quality, and gradient. A score of 60 or above is considered "good excellent" habitat.

#### Sampling was carried out at the following locations:

- Section A - Bear Brook between the mouth of Bear Brook and the TCH (Highway 104).
- Section B - Bear Brook between Highway 104 and the bridge at Route 289.
- Section C - Bear Brook between water sampling stations 2 and 4.
- Section D - Bear Brook Upstream of water discharge at Station 5.
- Section E - Bear brook at the confluence with Middle River.
- Section F - Middle River - upstream of the mouth of Bear Brook.
- Section G - Middle River - downstream of the mouth of Bear Brook.

Benthic organisms were sampled in each section and in each of three habitats (pool, run, riffle) when present. All sampling areas were very low. All samples were obtained by the use of a (30x30) Surber Sampler. All samples were preserved in the field in 70% isopropyl alcohol. Samples were screened (0.5 mm) and sorted in the laboratory. All organisms were identified to the level of family.

A complete photographic record (35 mm - 3x5 prints) was taken of each section during the sampling period.

**Results:**

**Fish Habitat:**

The scores from the use of the QHEI are shown in Table 1. Scores for Bear brook showed a downward, downstream, trend from Section C to Section E. Section D had a lower score than the rest of the sections in Bear Brook. The habitat scores from Middle River were lower than within Bear Brook (Fig. 1).

Section A is located North of the TCH approximately 500 m from the mouth of Bear Brook. It was roughly 6-10 m wide with depths ranging from 4-17 cm. The beginning of the section is marked by a wing-dam (habitat improvement structure) which helps to cause a riffle-pool sequence followed by a run. The water was very low and even with the wing dam there was just enough water for a pool and a slow run. The substrate is mainly cobble and gravels with good cover provided by undercut banks, overhanging vegetation, and a small pool. The riparian zone is narrow (5-10m) and well vegetated.

Section B is located approximately 50 m downstream from the bridge at Route 289. It was approximately 1-2 m wide with depths ranging from 2.5-8 cm. There is extensive cover here provided by overhanging vegetation, undercut banks, logs and a small pool.

Section C is located near the former sewage treatment plant at a point upstream from the # 2 discharge. This section had a small pool with extensive instream cover provided by logs and other debris. The pool at its deepest was 60 m in depth. There is a well vegetated zone here.

Section D is located 50 m upstream from the railway tracks upstream from the discharge point # 5. This section was characterized by a single small pool (3.7 m wide) with depths ranging from 33-50 cm. There is a vegetated riparian zone although it is dominated by alders and other summer species.

Section E is located at the mouth of Bear Brook as it enters Middle River. This section of stream showed extensive shoreline erosion and heavy siltation. There is some instream cover from logs and boulders but the shoreline does not have a stable plant community. The stream here averaged 3 m in width and 3- 11 cm of water.

Section F and G are located above and below the mouth of Bear Brook respectively. In Terms of fish habitat these two sections were identical. The river was approximately 14 m wide with 8.5-33.5 cm of slow moving water. The habitat was a combination of small riffle and run with some instream cover and a narrow riparian zone, the substrate was predominately bedrock.

**Benthic Organisms**

A summary of benthic invertebrates found at each section is shown in table 2. Please refer to this table for species diversity (taxa richness) and density (#/m2).

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### Benthic Organisms (Continued):

#### Site A Bear Brook between the mouth of Bear Brook and the TCH

**Pool :** This site is characterized by gravel and small rocks. Some filamentous aquatic algae was seen in the sample. The area is dominated by chironomid larvae, but species diversity is low compared to other areas. Ephemeroptera (mayfly) nymphs are all early stage nymphs. Chironomid larvae prefer habitats where vegetation is high, both for food and tube construction. Mayfly nymphs can be found over all bottom types, but prefer water with high oxygen content. Both species are indicators of good fish habitat.

**Run :** This site is also gravelly with vegetation fragments and filamentous algae. Diptera larvae and mayfly nymphs characterize the site. Habitat characteristics are similar to the pool site above.

#### Site B Bear Brook between Highway 104 and Bridge 289

**Pool :** The bottom type at this site is gravel. Vegetation was present. The site is very similar to site A, with chironomid larvae and mayfly nymphs, both in early stages of maturity. Species diversity and numbers are low.

**Riffle :** Bottom type is similar to the pool site—gravel and vegetation fragments. Although chironomid larvae are present in large numbers, the area is dominated by Trichoptera (caddis flies). Coleoptera (beetle) larvae also represent a dominant species. Species diversity is among the highest of all sample areas; similar to Sites E and F (see below). Caddisfly larvae prefer shallow water with good oxygenation. Sand grains and vegetation is necessary for tube construction. Bottom type is not critical. Elmidae (beetle) larvae are characteristic of running water, necessary for the supply of oxygen.

**Run :** The bottom appears to be gravelly with attached vegetation. Caddis fly and chironomid larvae are dominant. Species diversity and density is considerably lower than at the riffle site on the same brook. Both species indicate habitats with vegetation, possibly good fish habitat.

#### Site C Bear Brook between water sampling sites 2 and 4

**Pool :** The area is characterized by gravel bottom with low numbers of mayfly larvae. Species diversity is very low. Mayfly larvae prefer shallow water with high oxygen content. They are indicators of trout streams.

**Run :** Bottom is similar to pool area. Diversity is slightly higher, but dominated by the same species (mayfly). Chironomid and caddisfly larvae are also present. More vegetation may exist here as chironomid and caddisfly larvae require aquatic plants for food and case construction.

#### Site D Bear Brook, Upstream of water discharge station # 5

**Pool:** This site is characterized by gravel and small rocks. Both diversity and numbers are very low. Mayfly and chironomid larvae are present.

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### **Benthic Organisms (continued)**

**Run :** Vegetation was present in this sample. The bottom sediment is presumably gravel. Species diversity is similar to the pool site, with the addition of caddisfly larvae. Density is low. The area can be characterized by shallow, oxygenated water.

#### **Site E Bear Brook confluence with Middle River**

**Run :** This site is characterized by vegetation. Bottom sediment is gravel. Species diversity is very high at this station, as is density. It is dominated by caddis fly larvae and very early stage chironomid larvae. Mayfly larvae and mature and immature beetle are also present. An unidentified Diptera larvae were found at this site which was not found in other samples. Dominant species indicate well oxygenated habitats with sand and vegetation necessary. The area is presumably shallow with some moving water. Both chironomids and mayfly larvae are important fish food.

#### **Site F Middle River upstream of the mouth of Bear Brook**

**Run :** Very little sediment was found in this sample, but it appears to be a gravel bottom. No vegetation was seen. Species diversity was among the highest of all stations at this site. Mayfly larvae numbers are highest at this site. Caddis fly, chironomids and beetle larvae make up the next dominant group. All species indicate shallow, high oxygenated water with sandy-gravel bottoms for case construction (caddisfly/chironomids) or burrowing (mayflies). Chironomids and mayflies require vegetation for food, while caddisfly larvae or filter particles from the water.

#### **Site G Middle River downstream of the mouth of Bear Brook**

**Run :** Very little sediment found in the sample, but it appears to be a gravel bottom. Species diversity and density are low: similar to Site A (pool and run). Species are indicators of shallow, well oxygenated water, suitable for fish habitat.

### **Discussion :**

All the sites sampled (Middle River and Bear Brook) had very low flow conditions. Species of larvae found there were a variety that preferred shallow water and high oxygen habitat. These species of larvae found in these sampling sites were indicators of good fish habitat.

Due to the low flow conditions it was easier to see the effects human activity had on the stream over the years. Also the amount of stream erosion that has been caused due to fluctuation in discharge during flood stage. At the time of the benthic sampling program on Bear Brook the Pictou County Rivers Association were carrying out some summer programs of streambank modification in areas of the Brook that had heavy bank erosion.

The benthic invertebrates observed were both high in number and diversity. This was due to the low flow conditions of the river (Middle River) and the brook (Bear Brook). Both numbers of organisms and the density of the benthic community increased with distance upstream. Section B

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**Discussion (Continued)**

(riffle area) showed the highest richness of taxa (14) and the greatest number of organisms/m<sup>2</sup> (1399). With section E & F following with the next highest in richness of taxa.

**Conclusions :**

QHEI values were lower compared with the QHEI values of April ( high flow) . This was due to the low flow conditions of the stream & river.

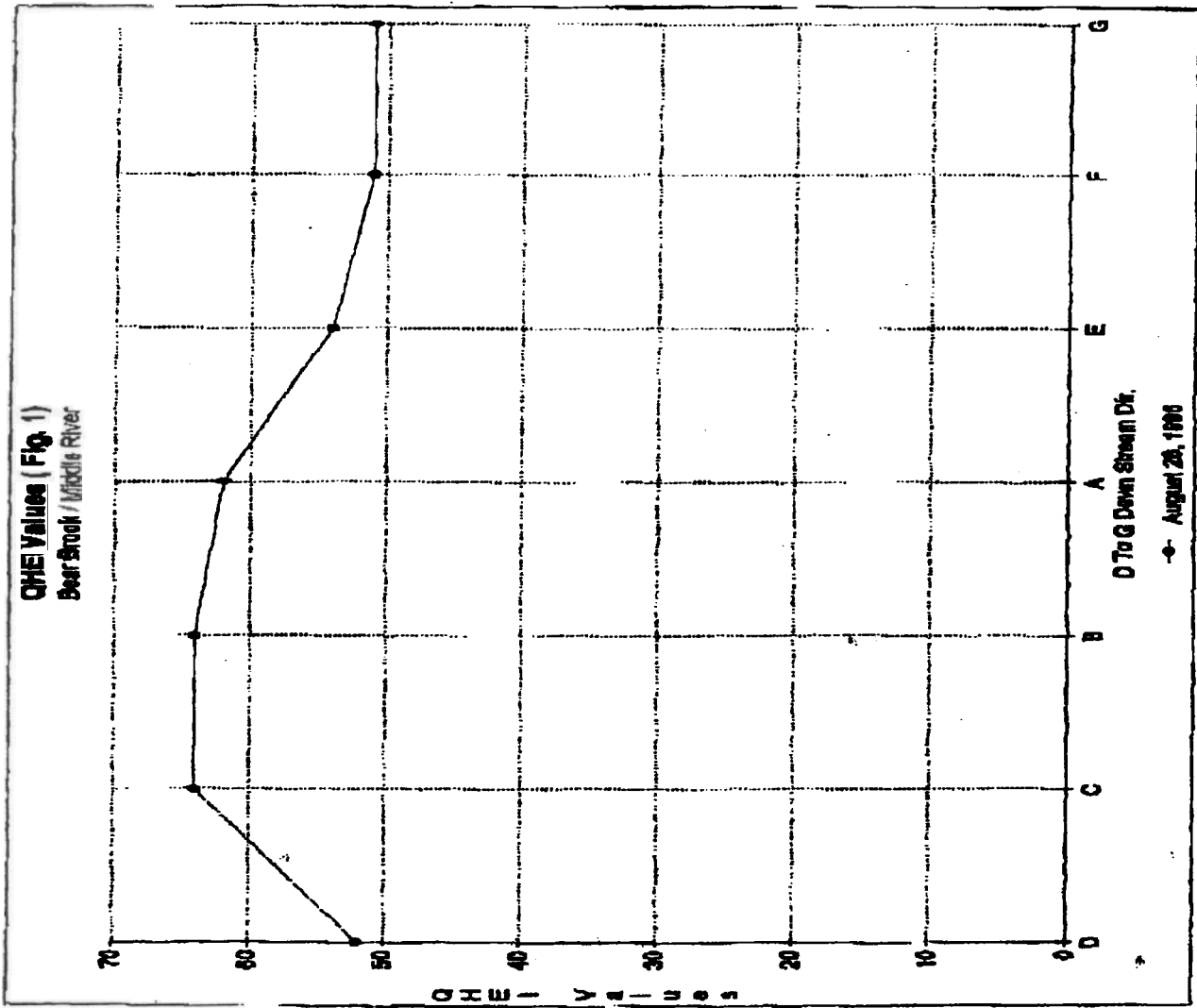
It is suggested that future fish habitat and benthic organism sampling be less extensive and brought closer to the mine. The area to focus on are Sections B and C as they seem to be the areas with the highest number and diversity of benthic invertebrates observed. Both are close to and downstream from discharge points from the mine. Any effect of the mining activity will be picked up at these sections, if monitored regularly, they should detect any deterioration in habitat quality.

## STELLARTON PIT MINE QUALITATIVE HABITAT EVALUATION INDEX

Bear Brook / Middle River - August 28, 1996

Table 1:

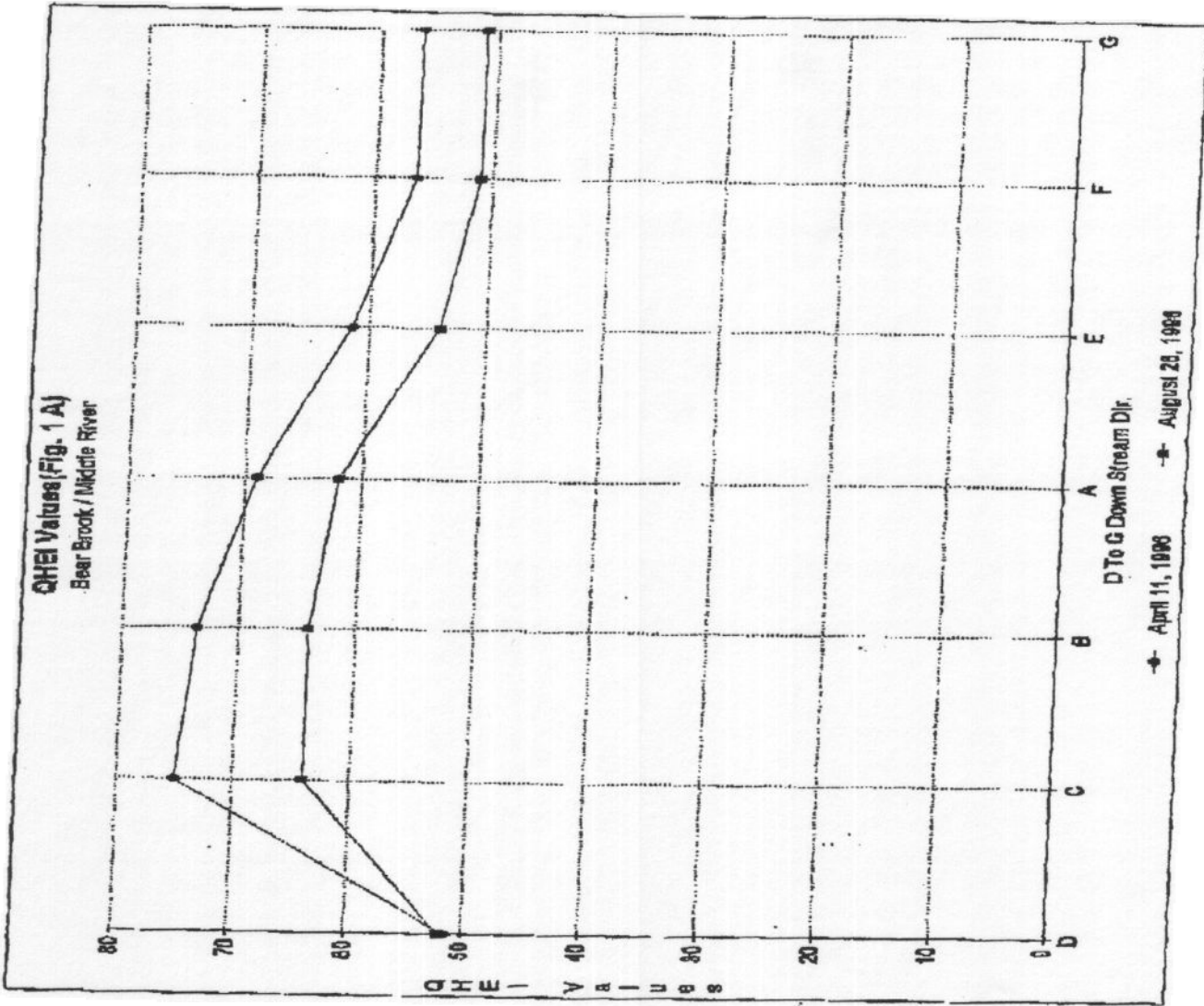
Metric	Max	Section A	Section B	Section C	Section D	Section E	Section F	Section G
Substrate	20	16	10	13	13	11	8	6
Cover	20	13	15	17	13	13	7	7
Channel	20	10	11	11	11	11	14	14
Riparian	10	9	6	7	8	7	8	8
Pool	12	6	7	6	7	0	0	0
Rifle	8	0	4	0	0	2	6	8
Gradient	10	8	10	10	2	10	10	10
TOTAL	100	62	64	64	52	54	51	51



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Table 2. Benthic Invertebrates - Siskiwituk PI Mine - Bear Brook / Middle River - Aug 1994 - Organisms/m<sup>2</sup>

Species	A		B		C		D		E		F		G	
	Pool	Run	Pool	Run	Pool	Run	Pool	Run	Pool	Run	Pool	Run	Pool	Run
Trichoptera														
Trichopteriidae														
Glossosomatidae												33		
Hydropterygidae	33		2222	132	11		44	330	428					11
Ephemeroptera														
Baetidae														
Ephemerellidae	33	22	88	33	155	132	22	121	308	50				
Heptageniidae														
Unidentified														
Diptera														
Anthomyiidae ?		11												
Chironomidae Larva	68	33	44	871	143	55	77	33	581	143	44			
Chironomidae Pupae														
Helicidae														
Rhyacidae														
Tipulidae														
Unidentified														
Plecoptera														
Perlidae														
Coloburina														
Dolichoptera														
Elmidae Larvae														
Elmidae Adults														
Psephenidae														
Unidentified														
Odonata														
Gomphidae ?														
Libellulidae														
Psecteridae														
Unidentified														
Rodentia														
Pipitidae														
Unidentified Egg Mass	11													
Nematoda														
Caenolabidae														
Unidentified Feeg														
Turbellaria														
Total Taxa	4	3	3	14	5	7	2	4	11	14	4			
Organisms/m <sup>2</sup>	143	86	77	8388	330	231	88	1288	1716	121				

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# STELLARTON PIT MINE

## FISH HABITAT And BENTHIC ORGANISM SURVEY

Bear Brook / Middle River - April 23, 1997

### **Introduction:**

The following work was carried out to fulfill the requirements for a fish habitat and benthic organism survey as part of the Stellarton Pit Mine development in Stellarton, NS (see NSDOE Approval # 95-052). These data represent samples taken under "high flow" conditions.

### **Methodology**

Fish habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) as described in Ohio Environmental Protection Agency (1989). This is an index of macro-habitat quality that considers the physical factors that affect fish communities and which are generally also important to other aquatic life such as invertebrates. The index (maximum = 100) is based on six interrelated "metrics": substrate, instream cover, channel morphology, riparian and bank conditions, pool and riffle quality, and gradient. A score of 60 or above is considered "good excellent" habitat.

**Sampling was carried out at the following locations:**

- Section A -** Bear Brook between the mouth of Bear Brook and the TCH (Highway 104).
- Section B -** Bear Brook between Highway 104 and the bridge at Route 289.
- Section C -** Bear Brook between water sampling stations 2 and 4.
- Section D -** Bear Brook Upstream of water discharge at Station 5.
- Section E -** Bear brook at the confluence with Middle River.
- Section F -** Middle River - upstream of the mouth of Bear Brook.
- Section G -** Middle River - downstream of the mouth of Bear Brook.

Benthic organisms were sampled in each section and in each of three habitats (pool, run, riffle) when present. Riffle and run samples were obtained by use of a (30 x 30 cm). Surber sampler. Pools were sampled with an Ekman grab (15 x 15 cm). All samples were preserved in the field in 70 % isopropyl alcohol. Samples were screened (0.5 mm) and sorted in the laboratory. All organisms were identified to the level of family.

## Results

### Habitat:

The scores from the use of the QHEI are shown in Table 1. Scores for Bear brook showed a downward, downstream, trend from Section C to Section E. Section D had a lower score than the rest of the sections in Bear Brook. The habitat scores from Middle River were lower than within Bear Brook ( Fig. 1.).

Section A is located North of the TCH approximately 500 m from the mouth of Bear Brook. It was roughly 7-8 m wide with depths ranging from 20-30 cm. The beginning of the section is marked by a wing-dam (habitat improvement structure) which helps to cause a riffle-pool sequence followed by a run. The substrate is mainly cobble and gravels with good cover provided by undercut banks, overhanging vegetation, and a deep pool. The riparian zone is wide (> 50 m) and well vegetated.

Section B is located approximately 50 m downstream from the bridge at Route 289. It was approximately 5-6 m wide with depths ranging from 15-36 cm. There is extensive cover here provided by overhanging vegetation, undercut banks, logs and a deep pool.

Section C is located near the former sewage treatment plant at a point upstream from the # 2 discharge. This section was dominated by an extensive pool with extensive instream cover provided by loges and other debris. The pool at its deepest was over 1 m in depth. At the lower end of the section there was a riffle habitat (21 cm deep). There is a wide riparian zone here that is well vegetated.

Section D is located 50 m upstream from the railway tracks upstream from the discharge point # 5. This section was approximately 5-6 m wide with depths ranging from 13-25 cm. There is a vegetated riparian zone although it is dominated by alders and other early successional species.

Section E is located at the mouth of Bear Brook as it enters Middle River. This section of stream showed extensive shoreline erosion and heavy siltation. There is some instream cover from logs and boulders but the shoreline does not have a stable plant community. The stream here averaged 7 m in width and 6-40 cm of water.

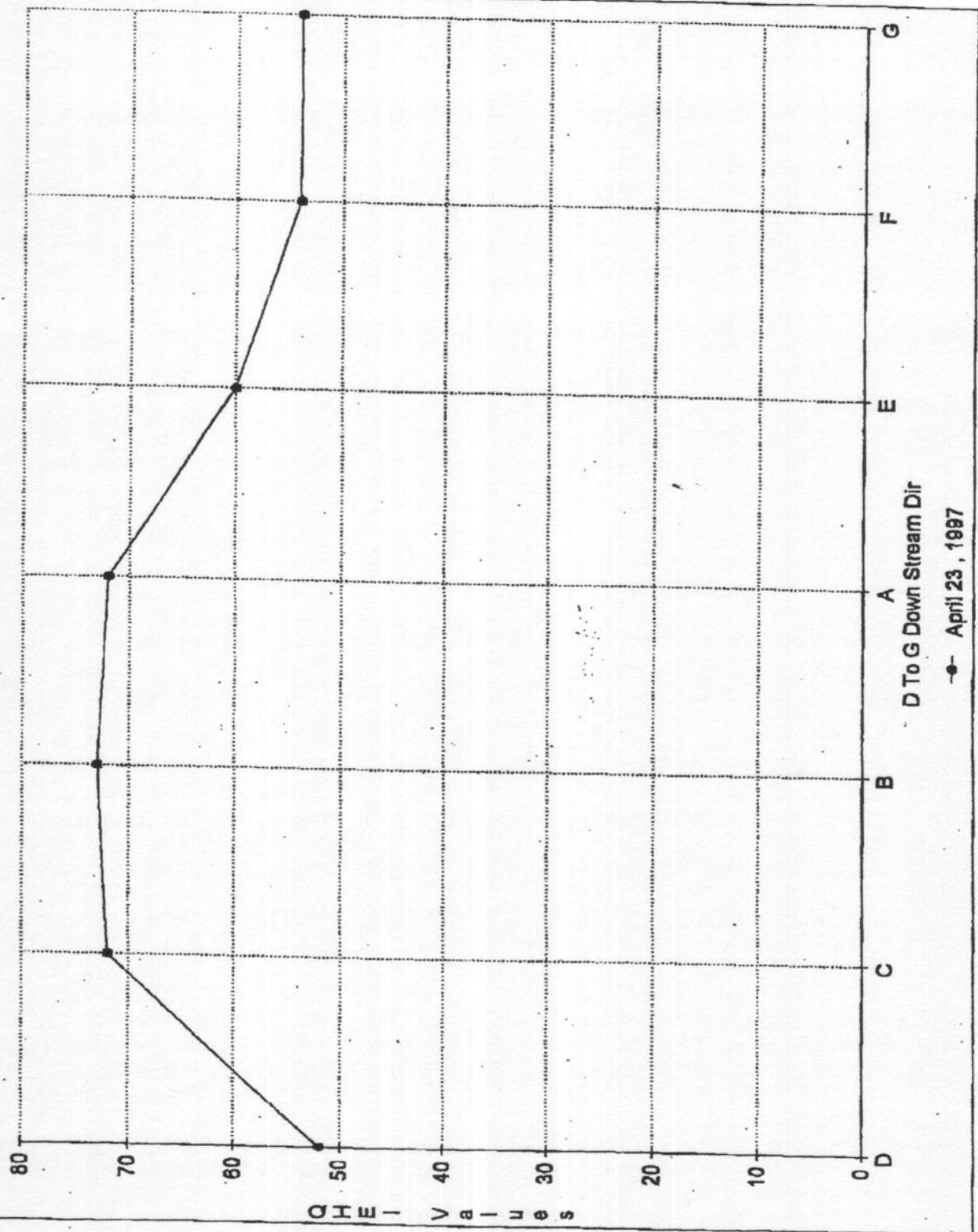
Section F and G are located above and below the mouth of Bear Brook respectively. In Terms of fish habitat these two sections were identical. The river was approximately 30 m wide with 80-90 cm of fast moving water. The habitat was a combination of riffle and run with some instream cover and a wide riparian zone. the substrate was predominately bedrock.

**STELLARTON PIT MINE**  
**QUALITATIVE HABITAT EVALUATION INDEX**  
**Bear Brook / Middle River - April 23, 1997**

**Table 1:**

Metric	Max	Section	Section	Section	Section	Section	Section	Section
		A	B	C	D	E	F	G
Substrate	20	16	16	17	18	16	6	6
Cover	20	13	13	9	7	7	5	5
Channel	20	19	17	14	13	18	18	18
Riparian	10	7	7	8	8	5	6	6
Pool	12	7	5	9	0	0	0	0
Riffe	8	2	5	5	4	4	7	7
Gradient	10	8	10	10	2	10	10	10
TOTAL	100	72	73	72	52	60	54	54

QHEI Values(Fig- 1 A)  
Bear Brook / Middle River



D To G Down Stream Dir  
-e- April 23, 1997

## Benthic Organisms

### Bear Brook/Middle River benthic samples - April 23, 1997

Mayfly nymphs are beginning to emerge. This species was one of the dominant organisms found in all but one sample. The greatest number were found at the confluence of Bear Brook and Middle River (Site E). Chironomid larvae are present in high numbers at site B on Bear Brook. This was the only site with vegetation present in the sample which is preferred by these larva. Caddis fly larvae and stonefly nymphs were also present, although in smaller numbers. Species diversity, abundance and total numbers per station are given in Tables 1 and 2.

#### **Site A Bear Brook**

**Riffle-** Bottom type at this site consists of gravel and small rocks. It is similar to the pool sampled in August 1996. Species diversity is average compared with other sites during this period. Species collected included caddis fly larvae, mayfly and stonefly nymphs. Both nymph species were present in the previous year's sampling.

**Run-** This site consisted of gravel bottom with no evidence of vegetation. Species diversity is slightly higher than average for the sites sampled during this period. Mayfly nymphs, diptera larvae, and stonefly nymphs were present. Presence of these nymphs indicates oxygen-rich water. Both are herbivore-detrital feeders and prefer sediment covered with leaf litter and detritus.

#### **Site B Bear Brook**

**Pool-** This site was gravelly with no vegetation present. Species diversity and abundance were very low. One stonefly adult was identified.

**Riffle-** Bottom type is similar to the pool site although some decaying wood fragments were found. Chironomids and mayfly nymphs are dominant. Chironomids are found everywhere in aquatic vegetation and on the bottoms of all types of fresh water. Chironomid larvae are primarily herbivorous, preferring algae and organic detritus. Both chironomids and mayflies form an important prey species for young and adult fish. Chironomids were present in high numbers at this site during the August 1996 sampling period.

**Run-** This station represented the highest abundance and greatest diversity of all stations sampled in April. Chironomid larvae were dominant as they were in the late summer sampling period. Stonefly and mayfly nymphs also occurred. Bottom sediment consisted of fine gravel with a small amount of vegetation.

#### **Site C Bear Brook**

**Pool-** This site is characterized by gravel bottom and low numbers of organisms. Species diversity and abundance is similar to the late summer sampling period (August 1996)

**Riffle-** The bottom at this site is gravel with some small stones. Species diversity is one of the highest of sampled areas on Bear Brook. Species collected include mayflies, chironomids and stoneflies. Abundance was also very high at this site.

#### **Site D Bear Brook**

**Riffle-** A small amount of decomposing vegetation was found at this site. Bottom sediment was gravel. Only one mayfly nymph was found. This was also low in diversity and abundance in the August 1996 samples.

**Run-** This site is characterized by low numbers of species and of organisms. The bottom was gravel with no vegetation seen at this time. Two species of caddis fly larvae and one mayfly nymph was found.

#### **Site E Bear Brook at Middle River**

**Run-** The bottom sediment at this site was gravelly with no vegetation at this time. The dominant species found was mayfly nymphs, although stonefly nymphs, Diptera larvae and caddis fly larvae were also present. This site was very high in abundance during the August sampling period and continues to be one of the highest along Bear Brook.

#### **Site F Middle River**

**Run-** This site had only a small number of mayfly nymphs present. The bottom was gravel but vegetation was not present in the sample. Both diversity and abundance are very low at Site F.

#### **Site G Middle River**

**Run-** The bottom type at this site is gravel. No vegetation was found. No organisms were present.



## **Bear Brook/Middle River Benthic Overview**

The dominant organisms found in the April samples were mayfly nymphs. They were present in all locations, except Site B (pool). Chironomid larvae abundance is also high, particularly at Site B (run). Stonefly nymphs and caddis fly larvae were also represented in most samples.

Species abundance and overall diversity is lower than the August 1996 samples. This is due in part to the time of year (spring vs late summer) and to an apparently late spring.

**TABLE 1. BENTHIC INVERTEBRATES APRIL 1997  
 TOTAL NUMBER PER STATION AND  
 DIVERSITY**

Section	A	A	B	B	B	C	C	D	D	E	F	G
	Riffle	Run	Pool	Riffle	Run	Pool	Riffle	Riffle	Run	Run	Run	Run
Trichoptera												
Brachycentridae									1			
Hydropsychidae	1			1	1				1	2		
Ephemeroptera												
<i>Caeris</i> sp.				1								
Ephemerellidae	3	1					1	1	2	9	1	
Heptageniidae				2	3		3				2	
Leptophlebiidae?		1			1	1						
Diptera												
Chironominae				3	18		1					
Unid. larvae		1								2		
Unid. pupae										1		
Plecoptera												
Nemouridae					2		3					
Perlodidae adult			1									
Perlodidae nymph	1	1								3		
Annelida-unidentified		1	1		1	1	1					
Total Number/Station	5	5	2	7	26	2	9	1	4	17	3	0
Diversity (# taxon/stn)	3	5	2	4	6	2	5	1	3	4	2	0

**TABLE 2. BENTHIC INVERTEBRATES APRIL 1997  
ABUNDANCE (NUMBER OF ORGANISMS PER M<sup>2</sup>)**

Section	A	A	B	B	B	C	C	D	D	E	F	G
	Riffle	Run	Pool	Riffle	Run	Pool	Riffle	Riffle	Run	Run	Run	Run
Trichoptera												
Brachycentridae									11			
Hydropsychidae	11			11	11				11	22		
Ephemeroptera												
Caeris sp.				11								
Ephemerellidae	33	11					11	11	22	100	11	
Heptageniidae				22	33		33				22	
Leptophlebiidae?		11			11	11						
Diptera												
Chironominae				33	200		11					
Unid. larvae		11								22		
Unid. pupae										11		
Plecoptera												
Nemouridae					22		33					
Perlodidae adult			11									
Perlodidae nymph	11	11								33		
Annelida-identified		11	11		11	11	11					
Total #/m <sup>2</sup>	56	56	22	78	289	22	100	11	44	189	33	0

# Fish Habitat and Benthic Organism Survey

## Bear Brook - Middle River

April 11, 1996

### Introduction.

The following work was carried out to fulfil the requirements for a fish habitat and benthic organism survey as part of the Pioneer Coal strip mine development in Stellarton, NS (see NSDOE Approval # 95-052). These data represent conditions "prior to any ground disturbance associated with the surface mine". They also represent samples taken under "high flow" conditions.

### Methodology

Fish habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) as described in Ohio Environmental Protection Agency (1989). This is an index of macro-habitat quality that considers the physical factors that affect fish communities and which are generally also important to other aquatic life such as invertebrates. The index (maximum = 100) is based on six interrelated "metrics": substrate, instream cover, channel morphology, riparian and bank condition, pool and riffle quality, and gradient. A score of 60 or above is considered "good - excellent" habitat.

Sampling was carried out at the following locations:

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- Section D - Bear Brook upstream of water discharge at Station 5.
- Section E - Bear Brook at the confluence with Middle River.
- Section F - Middle River - upstream of the mouth of Bear Brook.
- Section G - Middle River - downstream of the mouth of Bear Brook.

Benthic organisms were sampled in each section and in each of three habitats (pool, run, riffle) when present. Riffle and run samples were obtained by use of a (30 x 30 cm) Surber sampler. Pools were sampled with an Ekman grab (15 x 15 cm). All samples were preserved in the field in 70% isopropyl alcohol. Samples were screened (0.5 mm) and sorted in the laboratory. All organisms were identified to the level of family.

A complete photographic record (35 mm - 3x5 prints) was taken of each section during the sampling period.

## Results:

### Fish Habitat

The scores from the use of the QHEI are shown in Table 1. Scores for Bear Brook showed a downward, downstream, trend from Section C to Section E. Section D scored the lowest and, except for it, habitat scores from Middle River were lower than within Bear Brook (Fig. 1).

Section A is located North of the TCH approximately 500 m from the mouth of Bear Brook. It was roughly 16-20 m wide with depths ranging from 20-65 cm. The beginning of the section is marked by a wing-dam (habitat improvement structure) which helps to cause a riffle-pool sequence followed by a run. The substrate is mainly cobble and gravels with good cover provided by undercut banks, overhanging vegetation, and a deep pool. The riparian zone is wide (> 50 m) and well vegetated.

Section B is located approximately 50 m downstream from the bridge at Route 289. It was approximately 6-8 m wide with depths ranging from 5-55 cm. There is extensive cover here provided by overhanging vegetation, undercut banks, logs and a deep pool.

Section C is located near the former sewage treatment plant at a point upstream from the # 2 discharge. This section was dominated by an extensive pool with extensive instream cover provided by logs and other debris. The pool at its deepest was over 1 m in depth. At the lower end of the section there was a riffle habitat (5 cm deep). There is a wide riparian zone here that is well vegetated.

Section D is located 50 m upstream from the railway tracks upstream from the discharge point # 5. This section was characterized by a single large pool (8-9 m wide) with depths ranging from 59-80 cm. There is a vegetated riparian zone although it is dominated by alders and other early successional species.

Section E is located at the mouth of Bear Brook as it enters Middle River. This section of stream showed extensive shoreline erosion and heavy siltation. There is some instream cover from logs and boulders but the shoreline does not have a stable plant community. The stream here averaged 5 m in width and 25-40 cm of water.

Sections F and G are located above and below the mouth of Bear Brook respectively. In terms of fish habitat these two sections were identical. The river was approximately 30 m wide with 80-90 cm of fast moving water. The habitat was a combination of riffle and run with some instream cover and a wide, well established riparian zone. The substrate was predominately bedrock.

### Benthic Organisms

A summary of benthic invertebrates found at each Section is shown in Table 2. Benthic organisms were found in all Sections and habitat types except for the riffle habitat of Section C. The greatest diversity (4-5 taxonomic groups) was found in pools in Sections C and D respectively. These habitats also showed the greatest overall abundance of organisms per sample.

## Discussion:

The area of Middle River studied is, at this time of year, primarily a riffle/run habitat that is excellent for fish feeding and movement through the stream. There is little cover offered at this location which, along with the absence of pools, lowered the QHEI value.

Fish habitat in Bear Brook is quite variable. This study indicates that all fish habitats investigated are already degraded to some extent. Habitat in Bear Brook improves as you move further upstream. The only anomaly is section D and this is because it was made up of only one habitat type - a pool. Immediately upstream of Section D is a riffle area that was sampled (Table 2) and above that the habitat improves significantly as the stream passes through a heavily wooded area.

The results indicate that human activity has degraded this stream over the years in many ways including streambank modification, stream crossings, and sewerage discharge. The stream also suffers through large fluctuations in discharge as evidenced by the indication of flood stage and the extensive streambank erosion evident throughout some of the lower reaches.

The benthic invertebrates observed were both low in number and diversity. The changing conditions of much of the habitat have clearly impacted on their populations. Both numbers of organisms and the diversity of the benthic community increase with distance upstream. Section D showed the highest richness of taxa (5) and the greatest number of organisms/m<sup>2</sup> (1776). These data suggest that impacts have/are occurring in the stream and that these are cumulative as you move downstream.

## Conclusions:

QHEI values are inherently higher at this time of year because of the impact that the amount of water has on the index. This study should be repeated during conditions of low flow (August) for a comparison with these values. The combination of QHEI analysis and the photographic record should allow for the estimation of changes to the habitat over time.

Under normal operating conditions it will be difficult to isolate the changes in stream habitat and benthic organisms as a result of the strip mine activity compared with changes from other human activity in the area. Of course, if there is accidental discharge of sediment or polluted water a cause and effect relationship would be possible.

It is suggested that future fish habitat and benthic organism sampling be less extensive and brought closer to the mine. The areas to focus on are Sections B and C. Both are close to and downstream from discharge points from the mine. Any effect of the mining activity will be picked up at these sections and, if monitored regularly, they should detect any deterioration in habitat quality.

## References:

- Ohio Environmental Protection Agency. 1989. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Planning and Assessment. 42 p.

**Table 1. QUALITATIVE HABITAT EVALUATION INDEX**

**Bear Brook/Middle River - April 11, 1996**  
 (for location of each section - see text)

METRIC: (Max.)	Section A	Section B	Section C	Section D	Section E	Section F	Section G
Substrate (20)	14	12	9	4	16	9	9
Cover (20)	12	16	16	13	10	5	5
Channel (20)	16	16	17	17	16	16	16
Riparian (10)	10	9.5	9	8.5	5.5	9.5	9.5
Pool (12)	4	4	9	7	0	0	0
Riffle (8)	5	6	5	0	4	7	7
Gradient (10)	8	10	10	2	10	10	10
<b>TOTAL: (100)</b>	<b>69</b>	<b>73.5</b>	<b>75</b>	<b>51.5</b>	<b>61.5</b>	<b>56.5</b>	<b>56.5</b>

Fig. 1

**QHEI Values from Bear Br./Middle River  
April, 1996**

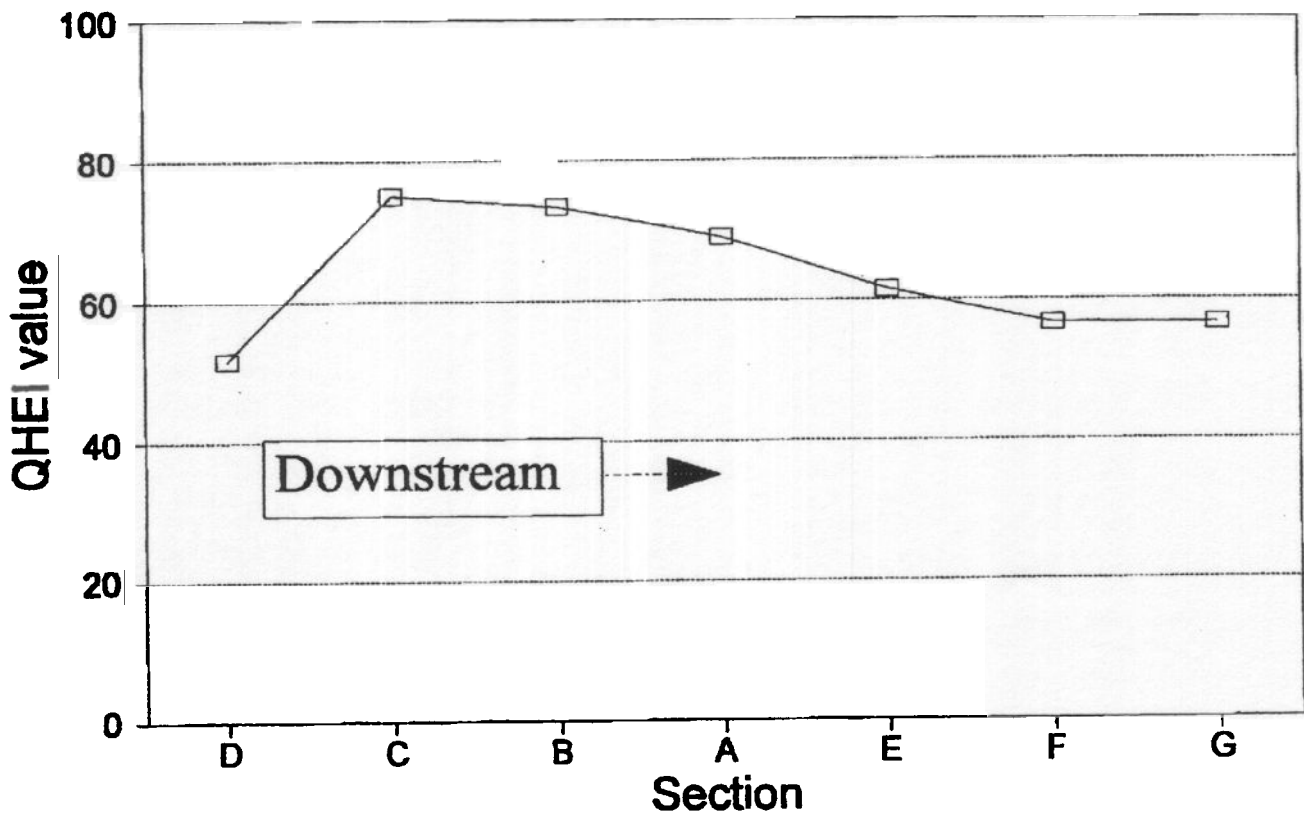




Table 2. Benthic Invertebrates - Pioneer Coal - Bear Brook/Middle River - April, 1996 - Organisms/m2

Section:	A riffle	A run	B riffle	B run	B pool	C riffle	C pool	D pool	"D" riffle	E run	F run	G run
Trichoptera											11	
Brachycentridae												
Hydropsychidae			22									
Ephemeroptera												
Caenidae	11	11						44.4				
Ephemerellidae	11							44.4				11
Heptageniidae							88.8		11			
Potamanthidae												
Siphonuridae												
Diptera												
Anthericidae		11										
Ceratopogonidae		11			44			44.4				
Chironomidae	44		11	11			888	1598				
Plecoptera												
Capniidae (Adult)											11	
Perlodidae			11									
Coleoptera												
Elmidae							88.8					
Elmidae (Adult)									11			
Collembola												
Isotomidae										11		
Oligochaeta												
Lumbriculidae							21					
Mollusca												
Gastropoda:												
Physidae								44.4				
TOTAL Taxa(Richness)	3	3	3	1	1	0	4	5	2	1	2	1
Organisms/m2	66	33	44	11	44	0	1087	1776	22	11	22	11

Note: ("D" sample was taken immediately above Section D)

Fisheries and Oceans / Pêches et Océans

Habitat Management Division  
Maritime Region  
P.O. Box 5030  
Moncton, NB  
E1C 9B6

VIA FAX

AUG 2 1996

CLASSER  
J.M.R.  
C.R.C.

Our file #:  
5321-3-92-001

Mr. Craig S. James, P.Eng.  
Pioneer Coal Limited  
P.O. Box 1328  
Antigonish, Nova Scotia  
B2G 2L7

Dear Mr. James

**RE: Stellarton Surface Mine: Fish Habitat And Benthic Organism Survey**

We have reviewed draft results of the fish habitat and benthos survey undertaken to fulfill the requirements of your company's approval to operate (NSDOE Approval # 95-052). In general, we are satisfied with the approach and the work undertaken to date.

It is suggested in the conclusions of the draft report (page 3) that the fish habitat survey (QHEI analysis) be repeated during low flow and that future fish habitat and benthos sampling be less extensive and brought closer to the mine.

We concur with the conclusion that at least one more survey of habitat (QHEI) should be conducted at the same sampling stations during low flow. However, we are also of the opinion that benthos sampling at the same stations is required before consideration should be given to reducing the amount and geographic extent of sampling. This will not only provide an additional data set but will allow for sampling during a low flow period and seasonal variation in benthic populations. Low numbers and low diversity observed in the April, 1996 sampling may be due, in part, to high flows. A repeat sampling during August, 1996 is recommended.

Please call me (tel. 506-851-6383) if you have any questions.

Yours truly,

W.B. Ritchie  
Habitat Assessment Biologist

/pc

cc C. MacInnis

Canada





Our File Number:

11-93-0026

August 12, 1996

Pioneer Coal Limited  
P.O. Box 929  
Westville, Nova Scotia  
B0K 2A0

**ATTENTION: Ken Holt, Environmental Technologist**

Dear Mr. Holt:

Further to your letter regarding the reduction of monitoring for fish habitat benthic organism survey please be advised the Department is not prepared to allow reduction at this time. Find attached a letter from DFO to Craig James regarding this same issue. Ensure no change occurs to this survey unless prior written approval is obtained from this Department. Should you have any questions or concerns do not hesitate to contact me.

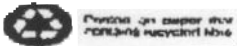
Yours truly,



Penny McLeod  
Manager  
Pictou District Office

PMcL/hd  
Attachment

cc: C. James  
C. MacInnis  
B. Ritchie  
B. Matlock



## STELLARTON PIT MINE

### FISH HABITAT AND BENTHIC ORGANISM SURVEY

Bear Brook / Middle River - August 11, 1998

#### Introduction:

The following work was carried out to fulfill the requirements for a fish habitat and benthic organism survey as part of the Stellarton Pit Mine development in Stellarton, NS (see NSDOE Approval # 95-052). This data represent samples taken under "low flow" conditions.

#### Methodology:

Fish habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) as described in Ohio Environmental Protection Agency (1989). This is an index of macro-habitat quality that considers the physical factors that affect fish communities and which are generally also important to other aquatic life such as invertebrates. The index (maximum = 100) is based on six interrelated "metrics": substrate, instream cover, channel morphology, riparian and bank conditions, pool and riffle quality, and gradient. A score of 60 or above is considered "good to excellent" habitat.

Sampling was carried out at the following locations:

- Section A - Bear Brook between the mouth of Bear Brook and the TCH (Highway 104).
- Section B - Bear Brook between Highway 104 and the bridge at Route 289.
- Section C - Bear Brook between water sampling stations 2 and 4.
- Section D - Bear Brook Upstream of water discharge at Station 5.
- Section E - Bear brook at the confluence with Middle River.
- Section F - Middle River - upstream of the mouth of Bear Brook.
- Section G - Middle River - downstream of the mouth of Bear Brook.

Benthic organisms were sampled in each section and in each of three habitats (pool, run, riffle) when present. Riffle and run samples were obtained by use of a (30 x 30 cm) Surber sampler. Pools were sampled with an Ekman grab (15 x 15 cm). All samples were preserved in the field in 70 % isopropyl alcohol. Samples were screened (0.5 mm) and sorted in the laboratory. All organisms were identified to the level of family.

## Results

### Habitat:

The scores from the use of the QHEI are shown in Table 1. Scores for Bear brook showed an upward downstream trend from Section D to Section A. With a downward, downstream trend from section A to section E. Section D had a lower score than the rest of the sections in Bear Brook. The habitat scores from Middle River were lower than within Bear Brook ( Fig. 1.).

Section A is located North of the TCH approximately 500 m from the mouth of Bear Brook. It was 4 m wide with depths ranging from 3-11 cm. The beginning of the section is marked by a wing-dam (habitat improvement structure) which helps to cause a riffle-pool sequence followed by a run. The substrate is mainly cobble and gravels with good cover provided by undercut banks, overhanging vegetation, and a pool. The riparian zone is narrow ( 1- 5 m) and well vegetated.

Section B is located approximately 50 m downstream from the bridge at Route 289. It was approximately 3 m wide with depths ranging from 3- 17 cm. There is extensive cover here provided by overhanging vegetation, undercut banks , logs and a pool.

Section C is located near the former sewage treatment plant at a point upstream from the # 2 discharge. This section was dominated by an extensive pool with extensive instream cover provided by logs and other debris. The pool at its deepest was 62 cm in depth. At the lower end of the section there was a run habitat ( 16 cm deep). There is a narrow riparian zone here that is well vegetated.

Section D is located 50 m upstream from the railway tracks upstream from the discharge point # 5. This section was approximately 7 m wide with depths ranging from 9-38 cm. There is a vegetated riparian zone although it is dominated by alders and other early successional species.

Section E is located at the mouth of Bear Brook as it enters Middle River. This section of stream showed extensive shoreline erosion and heavy siltation. There is alot of instream cover from logs and boulders and other debris. The shoreline in summer has a stable plant community. The stream is approximately 3.6 m in width with depths ranging from 4-11 cm of water.

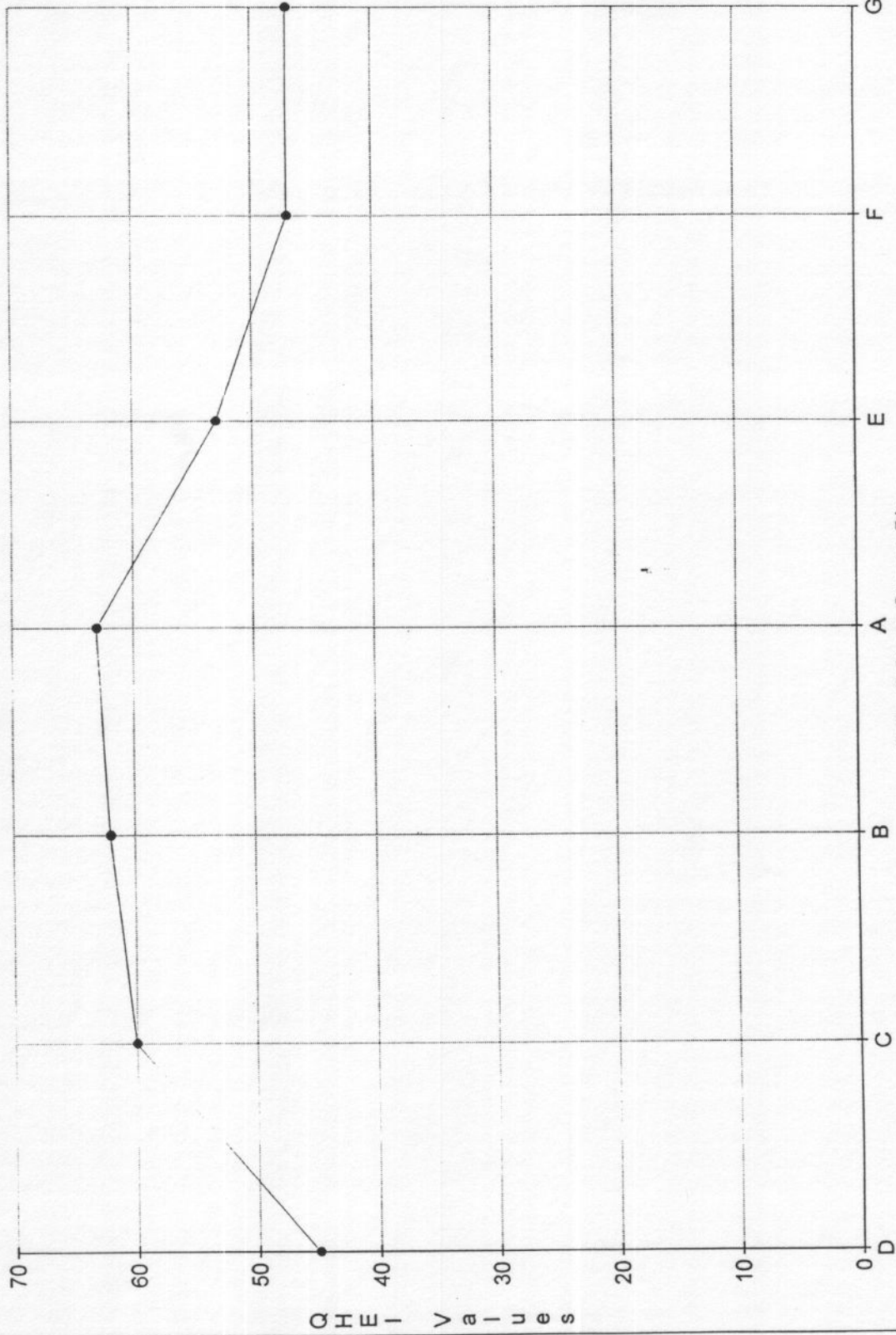
Section F and G are located above and below the mouth of Bear Brook respectively. In Terms of fish habitat these two sections were identical. The river was approximately 30 m wide with 12-31 cm of slow moving water. The habitat was a run with some instream cover and a wide riparian zone. the substrate was predominately bedrock.

**STELLARTON PIT MINE**  
**QUALITATIVE HABITAT EVALUATION INDEX**  
**Bear Brook / Middle River - August 11, 1998**

**Table 1:**

<b>Metric</b>	<b>Max</b>	<b>Section</b>	<b>Section</b>	<b>Section</b>	<b>Section</b>	<b>Section</b>	<b>Section</b>	<b>Section</b>
		<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>
Substrate	20	19	18	19	17	17	14	14
Cover	20	16	16	13	9	9	6	6
Channel	20	11	11	11	11	11	11	11
Riparian	10	3	2	2	2	2	3	3
Pool	12	4	5	5	4	0	0	0
Riffe	8	0	0	0	0	4	3	3
Gradient	10	10	10	10	2	10	10	10
<b>TOTAL</b>	<b>100</b>	<b>63</b>	<b>62</b>	<b>60</b>	<b>45</b>	<b>53</b>	<b>47</b>	<b>47</b>

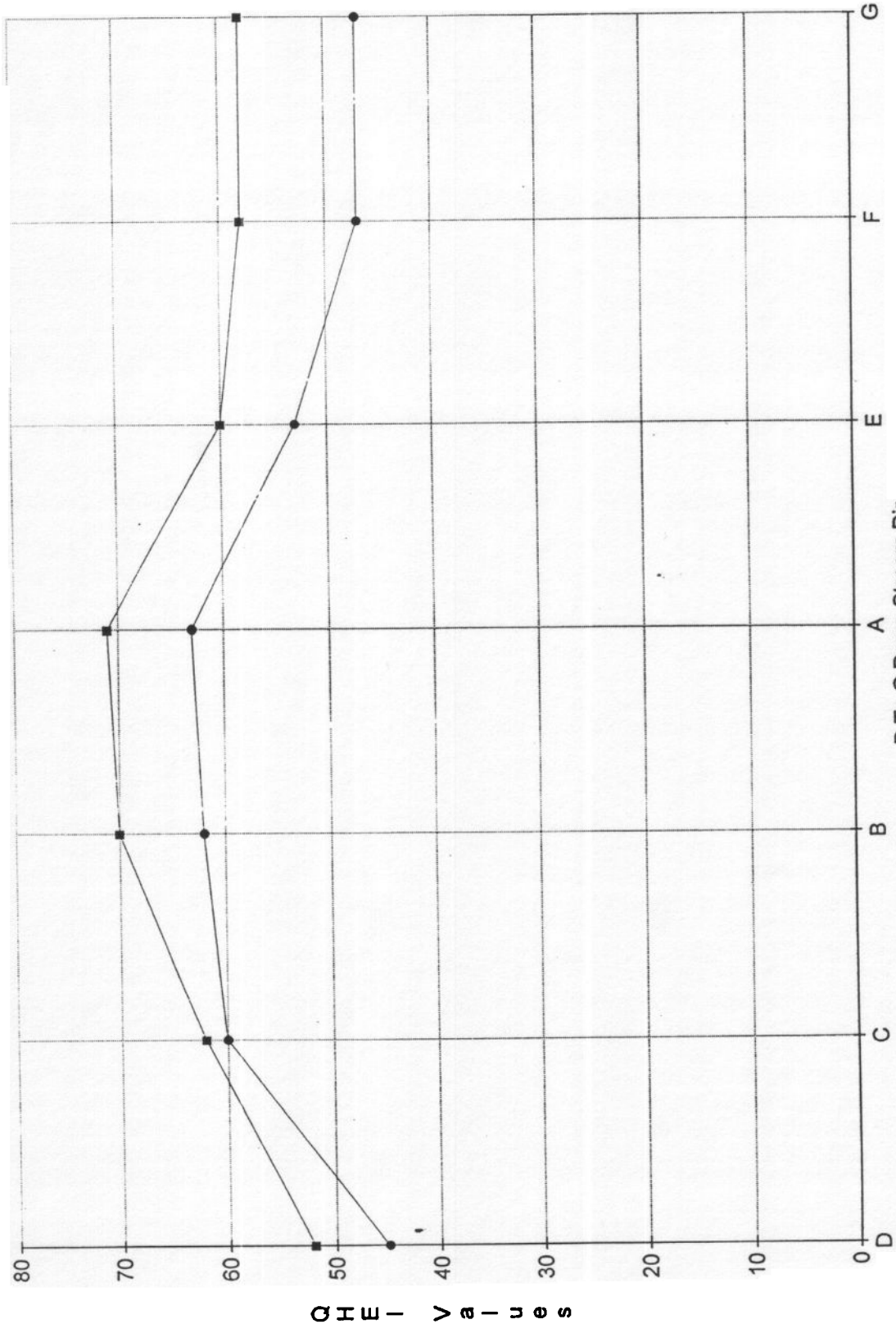
**QHEI Values ( Fig - 1 )**  
Bear Brook / Middle River



D To G Down Stream Dir

● August 11, 1998

**QHEI Values ( Fig - 1 A )**  
Bear Brook / Middle River



● August 11, 1998    ■ April 23, 1998

D To G Down Stream Dir



**Bear Brook/Middle River Benthic Samples**  
**August 11, 1998**

**Site A Bear Brook**

**Run-** Bottom type at this site is sand/gravel. Species sampled here were predominately chironomid larvae with some caddis fly larvae. Species composition is similar to previous sampling periods, but both species diversity and numbers are considerably higher this year than in the past (Tables 1 and 2)

**Pool-** This site is characterized by a sand/gravel bottom with filamentous algal mats. Chironomid larvae and leeches were dominant. Both species composition and abundance are different than in the spring.

**Site B Bear Brook**

**Run-**The bottom at this site is cobble/rock with filamentous algae growing throughout the area. Species diversity and abundance is moderate and not much different than in the past. The mayfly, *Caenis* sp., was dominant.

**Pool-** This pool, although probably cobble/rock, had sand and wood fibers in the sample. No algae was seen. Species composition is similar to the run section, with the exception of a three-spined stickleback found in the pool. This species has been found in this area in the past.

**Site C Bear Brook**

**Run-** This site is characterized by cobble/gravel bottom. The number of organisms is low and species composition is dominated by chironomid larvae. This site is very similar previous sampling periods.

**Pool-** This site is characterized by cobble/gravel bottom with algal mats. The number of organisms slightly higher than other stations. Chironomid larvae dominate the area.

**Site D Bear Brook**

**Pool-** This site is characterized by a large open pool with a gravel/rock bottom. Algae is present. Species diversity and abundance are very low. Chironomid larvae were present, as in previous samples.

**Site E Bear Brook**

**Run-** The bottom sediment at this site is gravel with algal mats. The dominant species found was chironomid larvae and beetle larvae. Small gastropods were also present. Species diversity is very high, as is abundance, in contrast to the spring samples. This site is typically one of the more productive sites along the survey.

**Site F Middle River**

**Run-** This site is a fast moving run with considerable instream vegetation (filamentous algae). Several species of mayflies, as well as chironomids and beetle larvae were found. Species diversity is high at Site F, as is abundance. There would appear to be an increase in abundance and diversity over last year's sampling.

**Site G Middle River**

**Run-** The bottom type at this site is gravel with many fines. Dominant species were chironomid larvae. Very few other species found. This site is usually low in both diversity and abundance.

**Bear Brook/Middle River Benthic Samples**  
**August 11, 1998**

**Overview**

Species diversity and abundance are similar to previous sampling periods, with the exception of Site F which is much higher this year. Site E which was low in the spring samples showed a high diversity this time. Mayfly nymphs, chironomid larvae and beetles dominate the samples. Annelids, gastropods and caddis fly larvae are present in small numbers. This would appear to be typical of the sites on Bear Brook and Middle River.

Site E (Bear Brook) and Site F (Middle River) show the greatest abundance and diversity of organisms. Site F is typically high in productivity (as measured by abundance and diversity).

TABLE 1. BENTHIC INVERTEBRATES, AUGUST 1998  
TOTAL NUMBER PER STATION AND DIVERSITY

Section	A	A	B	B	C	C	D	E	F	G
	Run	Pool	Run	Pool	Run	Pool	Pool	Run	Run	Run
<b>Copepoda</b>								1		
Temoridae										
<b>Trichoptera</b>										
Hydroptilidae	10				2			3		
Hydropsychidae								6	6	
unidentified	1			1				3	2	
<b>Ephemeroptera</b>										
Baetidae	1								22	
<i>Caenis</i> sp.	1	1	26	7				1		
Heptageniidae	2									
Leptophlebiidae	4								57	
unidentified	3	1		1				3		1
<b>Diptera</b>										
Chironomidae larvae	50	26	8	14	8	40	4	38	26	3
Chironomidae pupae	3		1			1		2		
Heleidae										1
Rhagionidae								27		
Tanypodinae	5	3	1	4	2	8		6	4	1
Tipulidae			1						2	
unidentified										
<b>Plecoptera</b>										
Taeniopterygidae								3	1	
Chloroperidae										
unidentified										
<b>Coleoptera</b>										
Dytiscidae								1		
Elmid larvae	1			1				21	26	1
Elmid adult	1							1	3	
<i>Psephenus</i> sp.								2	6	
<b>Odonata</b>										
Corduliidae									2	
<b>Hemiptera</b>										
<i>Rhagovelia obesa</i>								2		
unidentified						1	1			
<b>Annelid</b>					5		5			
<b>Gastropoda</b>										
Phasidae		1						38		
unidentified			2			1		3		
<b>Bivalve</b>			1	2		2				
<b>Hirudinea</b>										
Glossiphoniidae		13	2							
<b>Nematoda</b>			2		1	7				
<b>Fish</b>										
<i>Gasterosteus aculeatus</i>				1						
<i>Raja</i> sp. tadpole							2			
<b>Total #/station</b>	82	45	44	31	18	62	12	136	157	7
<b># taxon/station</b>	12	6	9	8	5	8	4	18	12	5

**TABLE 2. BENTHIC INVERTEBRATES, AUGUST 1998  
ABUNDANCE (NUMBER OF ORGANISMS PER M<sup>2</sup>)**

Section	A	A	B	B	C	C	D	E	F	G
	Run	Pool	Run	Pool	Run	Pool	Pool	Run	Run	Run
<b>Copepoda</b>										
Temoridae								11		
<b>Trichoptera</b>										
Hydroptilidae	111				22			33		
Hydropsychidae								67	67	
unidentified	11			11				33	22	
<b>Ephemeroptera</b>										
Baetidae	11								242	
<i>Caenis</i> sp.	11	11	289	78				11		
Heptageniidae	22									
Leptophlebiidae	44								633	
unidentified	33	11		11				33		11
<b>Diptera</b>						22				
Chironomidae larvae	556	289	89	155	89	444	44	422	289	33
Chironomidae pupae	33		11			11		22		
Heleidae										11
Rhagionidae								22		
Tanypodinae	56	33	11	44	22	89		67	44	11
Tipulidae			11						22	
unidentified										
<b>Plecoptera</b>										
Taeniopterygidae								33	11	
Chloroperidae										
unidentified										
<b>Coleoptera</b>										
Dytiscidae								11		
Elmid larvae	11			11				231	286	11
Elmid adult	11							11	33	
<i>Psephenus</i> sp.								22	67	
<b>Odonata</b>										
Corduliidae									22	
<b>Hemiptera</b>										
<i>Rhagovelia obesa</i>								22		
unidentified						11	11			
<b>Annelid</b>					56		56			
<b>Gastropoda</b>										
Phasidae		11						418		
unidentified			22			11		33		
<b>Bivalve</b>			11	22		22				
<b>Hirudinea</b>										
Glossiphoniidae		143	22							
<b>Nematoda</b>			22		11	78				
<b>Fish</b>										
<i>Gasterosteus aculeatus</i>				11						
<i>Raja</i> sp. tadpole							22			
<b>Total #/m<sup>2</sup></b>	<b>902</b>	<b>495</b>	<b>488</b>	<b>344</b>	<b>200</b>	<b>688</b>	<b>133</b>	<b>1510</b>	<b>1743</b>	<b>78</b>

**STELLARTON PIT MINE**  
**FISH HABITAT And BENTHIC ORGANISM SURVEY**

**Bear Brook / Middle River - April 12, 1999**

**Introduction:**

The following work was carried out to fulfill the requirements for a fish habitat and benthic organism survey as part of the Stellarton Pit Mine development in Stellarton, NS (see NSDOE Approval # 95-052). This data represent samples taken under "high flow" conditions.

**Methodology:**

Fish habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) as described in Ohio Environmental Protection Agency (1989). This is an index of macro-habitat quality that considers the physical factors that affect fish communities and which are generally also important to other aquatic life such as invertebrates. The index (maximum = 100) is based on six interrelated "metrics": substrate, instream cover, channel morphology, riparian and bank conditions, pool and riffle quality, and gradient. A score of 60 or above is considered "good to excellent" habitat.

Sampling was carried out at the following locations:

- Section A - Bear Brook between the mouth of Bear Brook and the TCH (Highway 104).
- Section B - Bear Brook between Highway 104 and the bridge at Route 289.
- Section C - Bear Brook between water sampling stations 2 and 4.
- Section D - Bear Brook Upstream of water discharge at Station 5.
- Section E - Bear brook at the confluence with Middle River.
- Section F - Middle River - upstream of the mouth of Bear Brook.
- Section G - Middle River - downstream of the mouth of Bear Brook.

Benthic organisms were sampled in each section and in each of three habitats (pool, run, riffle) when present. Riffle and run samples were obtained by use of a (30 x 30 cm) Surber sampler. Pools were sampled with an Ekman grab (15 x 15 cm). All samples were preserved in the field in 70 % isopropyl alcohol. Samples were screened (0.5 mm) and sorted in the laboratory. All organisms were identified to the level of family.

## Results

### Habitat:

The scores from the use of the QHEI are shown in Table 1. Scores for Bear brook showed an upward, downstream, trend from Section D to Section A. With a downward, downstream, trend from section A to section E. Section D had a lower score than the rest of the sections in Bear Brook. The habitat scores from Middle River were lower than within Bear Brook ( Fig. 1.).

Section A is located North of the TCH approximately 500 m from the mouth of Bear Brook. It was 5 m wide with depths ranging from 9-36 cm. The beginning of the section is marked by a wing-dam (habitat improvement structure) which helps to cause a riffle-pool sequence followed by a run. The substrate is mainly cobble and gravels with good cover provided by undercut banks, overhanging vegetation, and a pool. The riparian zone is narrow ( 5 - 10 m) and well vegetated.

Section B is located approximately 50 m downstream from the bridge at Route 289. It was approximately 5.6 m wide with depths ranging from 6- 46 cm. There is extensive cover here provided by overhanging vegetation, undercut banks, logs and a pool.

Section C is located near the former sewage treatment plant at a point upstream from the # 2 discharge. This section was dominated by an extensive pool with extensive instream cover provided by logs and other debris. The pool at its deepest was 85 cm in depth. At the lower end of the section there was a wide riparian zone that is well vegetated.

Section D is located 50 m upstream from the railway tracks upstream from the discharge point # 5. This section was approximately 6.2 m wide with depths ranging from 3-44 cm. There is a vegetated riparian zone although it is dominated by alders and other early successional species. At the lower end of the section there was a run habitat ( 18 cm deep).

Section E is located at the mouth of Bear Brook as it enters Middle River. This section of stream showed extensive shoreline erosion and heavy siltation. There is alot of instream cover from logs and boulders and other debries. The shoreline dose not have a stable plant community. The stream is approximately 3.6 m in width with depths ranging from 5-20 cm of water.

Section F and G are located above and below the mouth of Bear Brook respectively. In Terms of fish habitat these two sections were identical. The river was approximately 30 m wide with 5-85 cm of fast moving water. The habitat was a run with some instream cover and a wide riparian zone. the substrate was predominately bedrock.

**STELLARTON PIT MINE**  
**QUALITATIVE HABITAT EVALUATION INDEX**

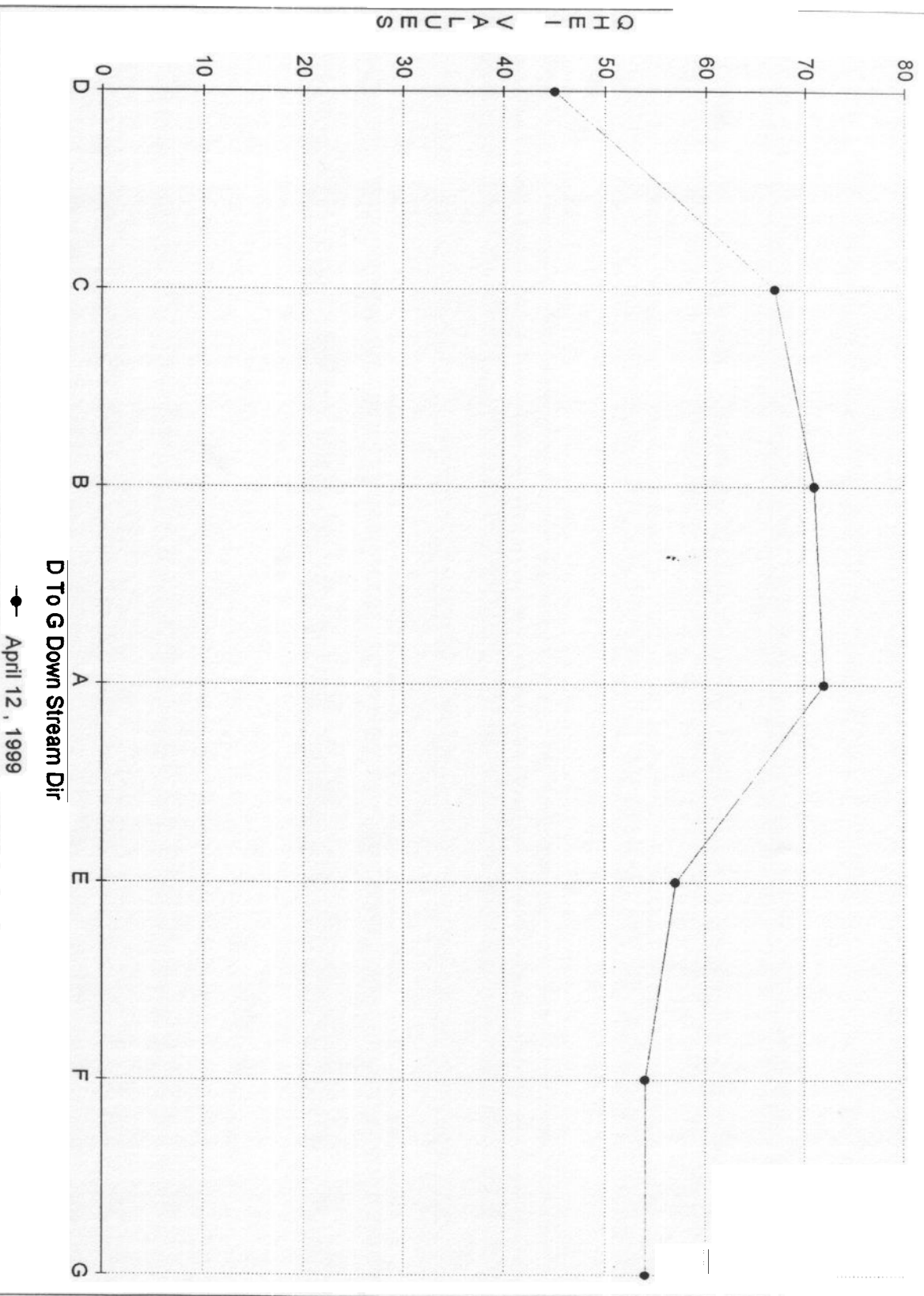
**Bear Brook / Middle River - April 12, 1999**

**Table 1:**

Metric	Max	Section	Section	Section	Section	Section	Section	Section
		A	B	C	D	E	F	G
Substrate	20	17	17	17	13	17	10	10
Cover	20	13	13	10	9	5	5	5
Channel	20	20	20	16	13	18	19	19
Riparian	10	2	2	2	2	2	3	3
Pool	12	5	3	7	2	0	0	0
Riffe	8	5	6	5	4	5	7	7
Gradient	10	10	10	10	2	10	10	10
<b>TOTAL</b>	100	72	71	67	45	57	54	54



**QHEI Values (Fig - 1)**  
Bear Brook / Middle River



—●— April 12, 1999

## **Bear Brook/Middle River Benthic Samples**

**April 12, 1999**

### **Site A Bear Brook**

**Run-** Bottom type at this site is sand/gravel. Community structure was dominated by mayflies with smaller numbers of stoneflies and caddisflies. This structure is slightly different from the previous year, with greater diversity but fewer numbers in the current samples (Table 1).

**Riffle-** Bottom type at this site is also sand/gravel. Species composition included mayfly nymphs, caddis fly larvae, and chironomid larvae. (Table 1). Species diversity and abundance are both higher than last spring. No evidence of algae was seen in the samples as in the past.

**Pool-** This site is characterized by a gravel/cobble bottom. Mayflies and stonefly nymphs were the only species found here. Abundance is very low (see Table 2), as in the past.

### **Site B Bear Brook**

**Pool-** This site had a gravel/sand bottom covered with detritus. A small number of annelids were found at this site (Table 1). This site was also low in abundance and diversity when sampled in 1997.

**Run-** Bottom type at this location is gravel/cobble. Species composition is dominated by mayflies and chironomid larvae. This is typical of this site. Other species found here include stonefly nymphs, annelids and nematodes. Abundance is high at this location which is similar to last year's sampling.

**Riffle-** Bottom type at this site is very similar to the run/pool bottom. Abundance is similar to many of the sites sampled on Bear Brook. Chironomid larvae and caddis flies are dominant, with smaller numbers of mayflies and stonefly nymphs. Chironomids were also dominant in the previous years' samples. Abundance is relatively unchanged.

### **Site C Bear Brook**

**Riffle-** This site is characterized by cobble/gravel bottom. The number of organisms is low and species composition is dominated by annelids. This site is typically low in diversity and abundance.

**Pool-** This area is a sandy-gravel area dominated by chironomid larvae. Only small numbers of other organisms were present, including mayfly and stonefly nymphs. Abundance is higher this year than in previous years, although it was not sampled in 1998 (Table 2).

### **Site D Bear Brook**

**Run-** This site is located at an open stretch of the brook with little vegetation, either instream or as cover. The bottom is gravel with some rocks. It is typically low in species diversity and abundance. Chironomid larvae dominated whereas blackfly larvae, mayfly and stonefly nymphs were found in small numbers in the past.

**Riffle-** This site is also low in abundance and diversity (Table 1). It is dominated by the infaunal annelid as in the past. This site consistently has few organisms.

**Site D Bear Brook, con't**

**Pool-** This site is characterized by a large open pool with a gravel/rock bottom. Chironomid larvae were present, as in previous samples. Species diversity is typically low but abundance is considerably higher this year due to high numbers of chironomids. Mayfly nymphs dominated the spring 1998 samples.

**Site E Bear Brook**

**Run-** The bottom sediment at this site is gravel. Species diversity is usually low in the spring, as is abundance. Species composition consisted of mayfly nymphs and chironomids. Both diversity and abundance increase greatly during the summer months.

**Riffle-** Bottom sediment at this site is sand-gravel. Mayfly nymphs were present in high numbers. Elmidae larvae and chironomids were also common. Abundance and diversity are both much higher this spring than in the 1998.

**Site F Middle River**

**Run-** This site is a fast moving run with considerable instream vegetation in the summer (filamentous algae). Several species of mayflies, as well as chironomids and caddisfly larvae were found. Species diversity is highest at Site F, as is abundance. This site remains highly productive.

**Site G Middle River**

**Run-** The bottom type at this site is gravel with many fines. Small amounts of vegetation and wood fibers were found. Dominant species were chironomids and mayfly nymphs. Abundance at this site varies and is moderately high this spring. It is typically low in the spring.

**Bear Brook/Middle River Benthic Samples**  
**April 12, 1999**

**Overview**

Species diversity and abundance are similar to previous sampling periods, with the exception of that Site E (riffle) and Site D (pool) which are much higher than last year. Abundance at Site C (pool) has increased since 1997. The runs at Sites B and F continue to be high in productivity. Mayfly nymphs and chironomid larvae dominate the samples. Annelids, stone fly, beetle larvae, and caddis fly larvae are present in small numbers. This would appear to be typical of the sites on Bear Brook and Middle River.

Site B (Bear Brook run) and Site F (Middle River) show the greatest abundance and diversity of organisms. Site B is typically high in productivity (as measured by abundance and diversity). Site F has also increased since 1997 and remains the most productive site sampled.

**TABLE 1. BENTHIC INVERTEBRATES, APRIL 1999**  
**Total Number and Diversity**

Section	A Run	A Riffle	A Pool	B Pool	B Run	B Riffle	C Riffle	C Pool	D Run	D Riffle	D Pool	E Run	E Riffle	F Run	G Run
<b>Trichoptera</b>															
Brachycentridae														5	1
Hydroptilidae															
Hydropsychidae	2	2				6								1	
Polycentropodidae					1										
<b>Ephemeroptera</b>															
Baetidae		2	1			2									1
Ephemerella	7	3	2		1							1	11	4	7
Leptophlebiidae														15	1
Heptageniidae									1				1	9	
Siphonuridae														1	
Tricorythidae															
Saenidae	3				6	3		2					4	3	5
Unidentified					2					1				7	
<b>Diptera</b>															
Anthomyiidae					7										
Chironomidae larvae	1	2			14	6	2	11	5		21	1	6	14	5
Chironomidae pupae						1		1	1		1				
Heleidae								2			1		1		
Tanyptodinae		1			1	1				4				1	
Simuliidae								1							
Tabanidae	2														
Tipulidae					1										
Unidentified	2													1	
<b>Hemiptera</b>															
Unidentified									1						
<b>Plecoptera</b>															
Taeniopterygidae					2					1					
Chloroperidae	2	1	2			2	1	2							
Perlidae			1												
Perlodidae					1						1			1	
Unidentified									1					1	2
<b>Isopoptera</b>															
Elmid larvae	1	1			1								6		
Elmid adult														1	
<i>Psephenus sp.</i>														1	
Hydracarina														1	
<b>Turbellaria</b>												1			
<b>Annelid</b>		1		1	6		6		1	9	3		1	1	1
<b>Gastropoda</b>															1
<b>Nematoda</b>					3								2		
<b>Total #/station</b>	20	13	6	1	46	21	9	19	9	16	27	3	32	67	24
<b>Total taxon/station</b>	8	8	4	1	13	7	3	6	5	5	5	3	8	17	9



**STELLARTON PIT MINE APRIL 18, 2000  
HABITAT AND BENTHIC ORGANISM SURVEY  
BEAR BROOK / MIDDLE RIVER**

**STELLARTON PIT MINE  
FISH HABITAT SURVEY BEAR BROOK / MIDDLE RIVER APRIL 18, 2000**

**Introduction :**

The following work was carried out to fulfill the requirement for fish habitat and benthic organism surveys as part of the Stellarton Pit Mine development in Stellarton, Nova Scotia ( NSDOE Approval # 95-152 Amendment #2 ). This data represents samples taken under high flow conditions.

**Methodology :**

Fish habitat was evaluated using the Qualitative Habitat Evaluation Index ( QHEI ) as described by the Ohio Environmental Protection Agency ( 1989 ). This is an index of macro-habitat quality that considers the physical factors that affect fish communities and which are generally also important to other aquatic life, such as invertibrates. The index ( maximum = 100 ) is based on seven interrelated " metrics " : substrate, instream cover, channel morphology, riparian and bank conditions, pool quality, riffle quality and gradient. A score of 60 or above is considered " good to excellent " habitat.

Sampling was carried out at the following locations :

Section A - Bear Brook approximately 500 meters from the mouth of Bear Brook.

Section B - Bear Brook 50 meters downstream of Route 289.

Section C - Bear Brook between water sampling stations 2 and 4.

Section D - Bear Brook upstream of the former water sampling station 5.

Section E - Bear Brook at the confluence of Middle River.

Section F - Middle River upstream of the mouth of Bear Brook.

Section G - Middle River downstream of the mouth of Bear Brook.

## **FISH HABITAT RESULTS**

Scores from the use of the QHEI are shown in table 1. Scores for Bear Brook showed an upward, downstream trend from Section D to Section A, and a downward downstream trend from Section A to Section E. Section D had the lowest score. Scores from Middle River were lower than those within Bear Brook, with the exception of Section D, and Section E at the mouth of Bear Brook. The majority of scores from Bear Brook show the area to be good fish habitat.

Section A begins approximately 500 meters from the mouth of Bear Brook. It was 5 meters wide with depths ranging from 5 - 25 centimeters. The beginning of this section is marked by a wing dam ( habitat improvement structure ) which helps to cause a riffle-pool sequence, followed by a run. The substrate here is mainly cobble and gravels with good cover provided by undercut banks, overhanging vegetation, and a pool. The riparian zone is narrow ( 5 - 10 meters ) and well vegetated.

Section B begins 50 meters downstream from the bridge at Route 289. It was 5.2 meters wide with depths ranging from 8 - 50 centimeters ( max. pool depth ). There is extensive cover here provided by overhanging vegetation, undercut banks, logs, and a pool.

Section C is located near the former sewage treatment plant at a point upstream from the #2 discharge station. This section is dominated by a large pool with extensive instream cover provided by logs and other debris. The pool was 90 centimeters in depth. The lower end of the pool leads to a riffle / run sequence.

Section D is located 50 meters upstream from the railway tracks, and upstream of the former #5 discharge station. This section was approximately 6 meters wide with depths ranging from 3 - 21 centimeters. There is a vegetated riparian zone dominated by alders and other early successional species. The lower part of this section contained a run habitat with a depth of 22 centimeters.

Section E is located at the mouth of Bear Brook as it enters Middle River. This section of stream showed extensive shoreline erosion, and heavy siltation. The shoreline does not have a stable plant community. The stream is approximately 3 meters in width, with depths ranging from 5 - 20 centimeters.

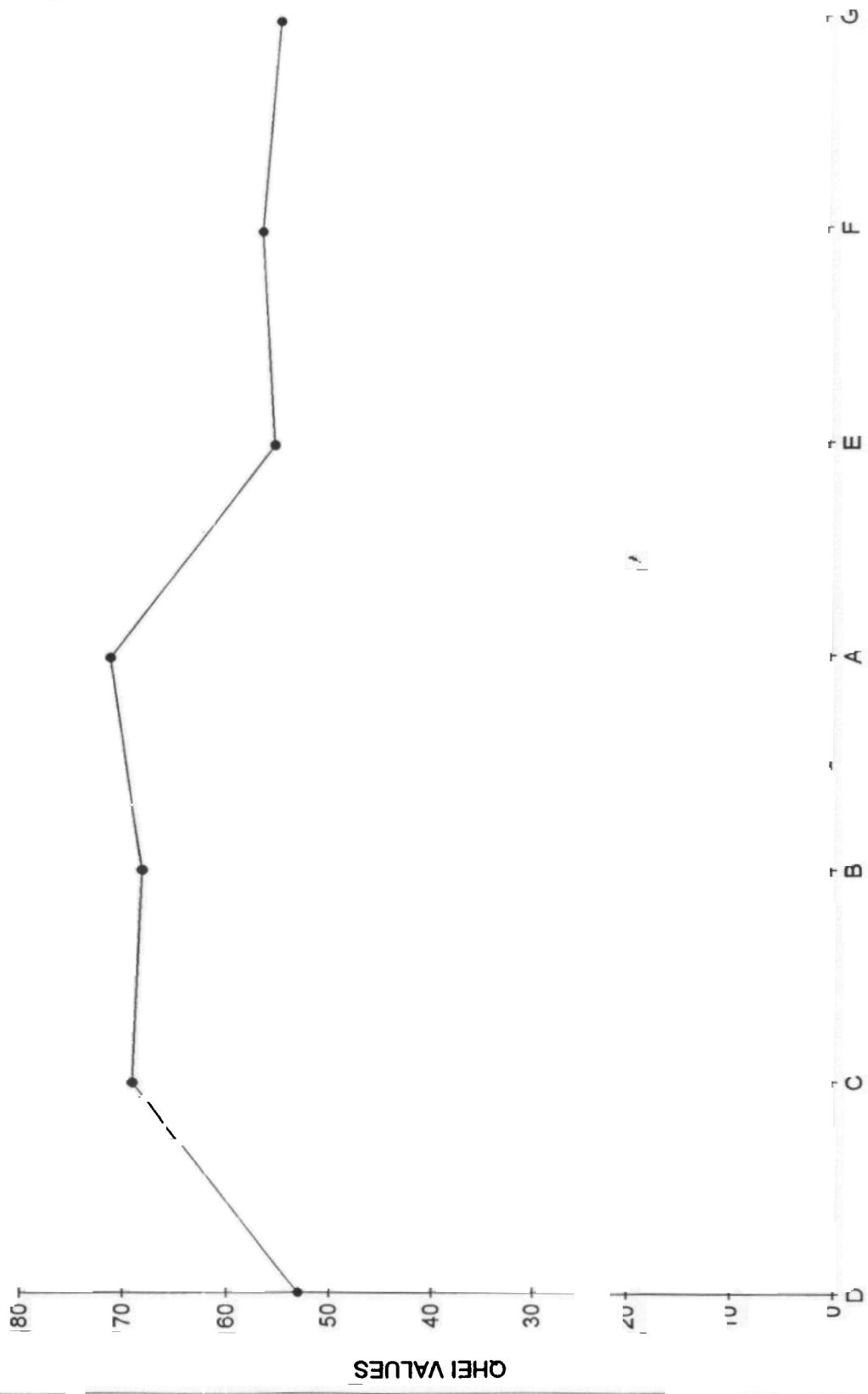
Sections F and G are located above and below the mouth of Bear Brook respectively. In terms of fish habitat these two stations were very similar. Middle river was approximately 30 meters wide, with 3 - 70 centimeters of fast moving water at these stations. The habitat was a run with a wide riparian zone and a substrate predominated by bedrock.



**BEAR BROOK / MIDDLE RIVER QUALITATIVE HABITAT EVALUATION INDEX SCORES**  
**TABLE 1**

<b>Metric</b>	<b>Max.</b>	<b>Section A</b>	<b>Section B</b>	<b>Section C</b>	<b>Section D</b>	<b>Section E</b>	<b>Section F</b>	<b>Section G</b>
Substrate	20	15	15	14	15	15	12	12
Cover	20	11	15	16	11	3	3	1
Channel	20	16	13	13	13	16	15	15
Riparian	10	8	7	7	7	7	8	8
Pool	12	5	5	7	2	0	0	0
Riffle	8	6	3	2	3	4	8	8
Gradient	10	10	10	10	2	10	10	10
<b>TOTAL</b>		<b>71</b>	<b>68</b>	<b>69</b>	<b>53</b>	<b>55</b>	<b>56</b>	<b>54</b>

**QHEI Values (Fig -1)**  
Bear Brook / Middle River



D To G Down Stream Dir.  
—●— April 18, 2000

**Bear Brook/Middle River Benthic Samples**  
**April 18, 2000**

**Site A Bear Brook**

**Pool-** This site is characterized by a sandy bottom (Figure 1). No organisms were found during this sampling period. Abundance is typically low at this site.

**Run-** Bottom type at this site is sand/gravel (Figure 2). Community structure was dominated by mayflies with very few numbers of other invertebrates. Although biomass is low, species diversity is among the highest of all sampled sites. Adult stoneflies were found for the first time. Community structure is similar to 1999. (Table 1).

**Riffle-** Bottom type at this site is also sand/gravel (Figure 3). Species composition included mayfly nymphs, beetle and chironomid larvae. Adult stoneflies were present (Table 1). Species diversity and abundance are similar to last spring. No evidence of algae was seen in the samples as in the past.

**Site B Bear Brook**

**Pool-** This site has a sandy bottom covered with detritus (Figure 4). No organisms were found during this sampling period (Table 1). This site was also low in abundance and diversity when sampled in 1997 and 1999. This area is very shallow with little or no cover.

**Run-** Bottom type at this location is gravel/cobble (Figure 5). Species composition is dominated by mayflies, stoneflies and beetles. This is typical of this site during spring. Abundance is high at this location, as is diversity (Tables 1 and 2).

**Riffle-** Bottom type at this site is very similar to the run/pool bottom (Figure 6). Abundance is low compared to the other sites sampled on Bear Brook (Table 2). Small numbers of chironomid and beetle larvae, caddis flies and stonefly nymphs were present. Chironomids dominated in the previous years' samples. Abundance is relatively unchanged.

**Site C Bear Brook**

**Riffle-** This site is characterized by cobble/gravel bottom (Figure 7). As in the past, the number of organisms is low and species composition is dominated by annelids. This site is typically low in diversity and abundance.

**Pool-** This area is a sandy-gravel area (Figure 8). Species diversity was extremely low (a single species) as was abundance (Table 2). This site has been dominated by chironomid larvae in the past. Abundance is much lower than in previous sampling periods, but similar to other pool areas in Bear Brook which exhibited low biomass in April 2000 (Table 1).

**Run-** This site has a gravel/sand bottom (Figure 9) and is an area of low abundance and diversity. A few chironomid larvae were found this spring. This run was last sampled in 1998 and was dominated by chironomid larvae at that time.

#### **Site D Bear Brook**

**Run-** This site is located at an open stretch of the brook with little vegetation, either instream or as cover. The bottom is gravel with some rocks (Figure 10). Abundance is higher than in the past. It is typically low in species diversity and abundance. Chironomid larvae and mayfly nymphs dominated whereas blackfly larvae, mayfly and stonefly nymphs were found in small numbers in the past.

**Riffle-** This site is characterized by a rocky/gravel bottom with little cover. Abundance and diversity is usually low, but was among one of the highest in abundance during this sampling period (Table 2). It is dominated by infaunal annelids as in the past, but mayflies, chironomids and stonefly nymphs were also present.

#### **Site E Bear Brook**

**Riffle-** Bottom sediment at this site is similar to Site D (Figure 12). Mayfly nymphs were present in high numbers. Chironomids were also common. Abundance and diversity are high, as in the previous sampling periods.

**Run-** The bottom sediment at this site is also rocky-gravel (Figure 13). Species diversity is usually low in the spring, as is abundance. Species composition consisted primarily of chironomids. Both diversity and abundance increase greatly during the summer months.

#### **Site F Middle River**

**Run-** This site is a fast moving run with considerable instream vegetation in the summer (filamentous algae). This can be seen in Figure 14. Several species of mayflies, as well as chironomids were found. Species diversity is highest at Site F, as is abundance. This site remains highly productive.

#### **Site G Middle River**

**Run-** The bottom type at this site is gravel with many fines (Figures 15 and 16). Dominant species were stonefly and mayfly nymphs. Abundance at this site varies and is moderately high this spring. This is similar to spring of 1999.

**Bear Brook/Middle River Benthic Samples**  
**April 18, 2000**

**Overview**

Early spring nymphs and larvae are emerging. Mayfly, stonefly and chironomids were the dominant species found in Bear Brook and Middle River. Caddis fly larvae are less common than previously. Overall abundance is similar to spring 1999.

Species diversity is similar to previous sampling periods, with the exception of Site C (riffle) and Site C (pool). Abundance at Site C riffle was much higher this year and similar to the other riffle sites in Bear Brook. Abundance at Site C pool was much lower than last spring, but has been typically low. The runs at Sites B and F continue to be high in productivity. Mayfly nymphs and chironomid larvae dominate the samples. Stonefly adults and nymphs are higher this year than in the past. Annelids, beetle larvae, and caddis fly larvae are present in small numbers. This would appear to be typical of the sites on Bear Brook and Middle River.

Site B (Bear Brook run) and Site F (Middle River) show the greatest abundance and diversity of organisms. Site B is typically high in productivity (as measured by abundance and diversity). Site F has also increased since 1997 and remains the most productive site sampled. The riffle sites at C and E were also high this spring.

TABLE 1. BENTHIC INVERTEBRATES, APRIL 2000  
Total Number and Diversity

Section	A Run	A Riffle	A Pool	B Pool	B Run	B Riffle	C Riffle	C Pool	C Run	D Run	D Riffle	E Run	E Riffle	F Run	G Run
optera															
chironomidae	3														
ptilidae									1						
psychidae	1				2	2						3			
centropodidae														1	
acrophilidae							1								
ntified	1														
neroptera															
nidae					3		2	1	1	2	5				
emera						1				2					
merella	6	1										1	10		2
phlebiidae															
stagenidae						1				3	1		2	22	7
stauridae							1				1		2	5	1
ythidae										1					
ntified										1				1	
era															
myiidae															
onidae larvae	1	1			18	2	2		5	6	4	4	6	17	2
onidae pupae													1		
idae adult														1	
idae														1	
odinae		2								1					
aridae						1									
idae	1				1	1					1		1		
ntified		2											1	1	
ptera															
optera															
nidae larvae					2										
idae adult	1	1					1						1	1	1
pperidae							1								
nouridae						1									
idae	1	1													
idae					3		2				2	1	1	2	10
opterygidae					5	4	3							1	2
ntified															
ptera															
idae		1													
id larvae		3			4	2	3		1	1			2		3
spharus sp.	1													1	
ntified														2	
ata															
mphidae													1	1	
aloptera															
isop.										1					
id	1						16			1	9		1		
tropoda	1												2	1	
idae														2	
toda					2						1				
total #/station	18	12	0	0	40	15	32	1	7	20	24	6	34	60	28
station	11	8	0	0	9	9	10	1	3	11	8	3	14	16	8

TABLE 2. BENTHIC INVERTEBRATES, APRIL 2000  
Abundance (Number per m<sup>3</sup>)

Section	A Run	A Riffle	A Pool	B Pool	B Run	B Riffle	C Riffle	C Pool	C Run	D Run	D Riffle	E Run	E Riffle	F Run	G Run
insecta															
beetles															
hydrophilidae	33														
scaphiopharyngidae										11					
scaphiopharyngidae	11				22	22							33		
scaphiopharyngidae														11	
scaphiopharyngidae							11								
scaphiopharyngidae	11														
hemiptera															
scaphiopharyngidae					33		22	11	11	22	56				
scaphiopharyngidae						11				22					
scaphiopharyngidae	67	11										11	111		22
scaphiopharyngidae															
scaphiopharyngidae						11				33	11		22	244	78
scaphiopharyngidae							11				11		22	56	11
scaphiopharyngidae										11					
scaphiopharyngidae										11				11	
trichoptera															
trichoptera															
trichoptera	11	11			200	22	22		56	67	44	44	67	189	22
trichoptera pupae													11		
trichoptera adult														11	
trichoptera														11	
trichoptera		22								11					
trichoptera						11									
trichoptera	11				11	11					11		11		
trichoptera		22											11	11	
diptera															
diptera															
diptera larvae					22										
diptera adult	11	11					11						11	11	11
diptera							11								
diptera	11	11													
diptera					33		22				22	11	11	22	111
diptera					56	44	33							11	22
diptera															
diptera		11													
diptera larvae		33			44	22	33		11	11			22		33
diptera sp.	11													11	
diptera														22	
cnidaria															
cnidaria													11	11	
cnidaria										11					
cnidaria	11						178			11	100		11		
cnidaria	11												22	11	
cnidaria														22	
cnidaria					22						11				
cnidaria	199	132	0	0	443	165	354	11	78	221	268	66	376	665	310

## **Bear Brook/Middle River Invertebrate Samples** **June 5, 2001**

### **Overview**

Mayfly nymphs and chironomid larvae dominated all sites, including pools. Stonefly nymphs, annelids and beetle larvae were also found in significant numbers in Bear Brook and Middle River. Total abundance in Bear Brook is similar to that of April 2000, although Site A was much higher and Sites D and E were lower. Abundance in the upstream station on Middle River did not change but the downstream station was much lower.

Species diversity is similar to previous sampling periods. Pool sites continue to be low in productivity, while run and riffle sites are much higher and very similar to each other. Mayfly nymphs and chironomid larvae dominate the samples. Annelids, beetle larvae, and fly larvae are present in small numbers. This is typical of the sites on Bear Brook. Diversity and species composition in Middle River above Bear Brook are consistent with previous years, however, a lower diversity and different composition was noted in the downstream site (G) this year.

Site A (Bear Brook) and Site F (Middle River) show the greatest abundance and diversity of organisms. Sites B and D are considerably lower in productivity (as measured by abundance and diversity) than previously. Site F continues to be the most productive site sampled. These changes may be due in part to the higher water levels and later sampling period than in the past.



## **Bear Brook Invertebrate Monitoring**

Table 1 shows species composition and diversity, while Table 2 shows species abundance at each site.

### **Site A**

All areas at this site are located downstream of the mine site immediately above a highway culvert (See Figure 1). The area is a shallow open section of the brook dominated by a gravel/cobble bottom. Both the run and riffle sites sampled this year contained larger-sized sediment than in previous years. Water levels were high during the sampling period.

**Pool-** The pool site is a shallow gravel area just upstream of a small tributary. It is a typically poor habitat where only chironomids and beetle larvae were found. These species were the two most dominant species throughout the study area.

**Run-** This site showed a much higher abundance than, but similar diversity to last year's sampling. Chironomid larvae and mayfly nymphs dominated the community. Abundance was among the highest of all stations which is atypical of this site.

**Riffle-** Abundance at this site was much higher during this spring's study. The area is populated by mayflies and chironomids, as in previous years. Bottom type is cobble/rock.

### **Site B**

Site B is a rocky section of Bear Brook located downstream of the Highway 289 bridge (See Figures 2 and 3). During this year's study, the stream was high with a fast flow. No pool sample was collected because of the high flows.

**Riffle-** This site showed less abundance than last year and a slightly different species composition than in previous years. Small numbers of Diptera (fly) larvae were present this year, while chironomids have dominated in the past. Bottom type was gravel/cobble as in the past.

**Run-** The run at Site B was a gravel/cobble area. It typically has a high abundance of mayflies, stoneflies, and beetle larvae. During this spring's study, abundance was down and species composition was dominated by chironomid larvae

**Riffle/Run-** A third area was sampled at this site which was more open, deeper and sandier than the surrounding stream. This is representative of the pool area. This area had a low abundance and few species of invertebrates.

### **Site C**

Site C is located behind the mine and beyond the operation area. It is a deep, shaded area of the stream. The bottom type is cobble/gravel, with the exception of the pool, which is a mixture of sand and gravel (See Figures 4 and 5).

Pool- Species abundance and diversity is extremely low at this site. This is typical for the pool areas of Bear Brook. Abundance is similar to April 2000.

Run- Species abundance is slightly higher at this site than in the past, although it is typically low. Species composition is similar to last year (chironomid larvae and mayfly nymphs). Chironomids typically populate this site.

Riffle- Chironomids, mayflies, stoneflies, beetle and caddisfly larvae were found at this site. Annelids were notably absent. This area has not been sampled each year, but is among the highest abundances and species diversity of all the sampled areas.

### **Site D**

This site is located at a wide open section of the brook behind the overburden site. During this spring's sampling, water levels were high with a fast flow (See Figures 6 and 7).

Run- This site has a sandy, gravel bottom. Both abundance and diversity were lower this year than in the past, although it is generally lower than other areas of the brook. Small numbers of mayfly nymphs and chironomids were sampled this year. Species composition is similar to last spring's sampling period.

Riffle- This site is characterized by a sandy/gravel bottom with little stream cover. Diversity and abundance are typically low at this site, with mayflies and beetle larvae found in very small numbers. Infaunal annelids were considerably fewer in numbers this year than in the past.

### **Site E**

Riffle- This site is located at the confluence of Bear Brook and Middle River (See Figure 8). It is an open area with a cobble/gravel bottom. The water level was high during sampling. Species abundance was much lower than usual at this site and consisted of mayfly nymphs and chironomids. These organisms are found commonly at this site as well as throughout the study area.

## **Middle River Invertebrate Monitoring**

### **Site F-**

Run- This site is a deep, fast moving run located upstream of the mouth of Bear Brook (See Figure 9). It is largely cobble with some gravel. This site continues to be the most productive of the study area. Caddisfly larvae, mayfly and stonefly nymphs, as well as fly larvae and oligochaetes were common. Abundance and diversity was the highest of all sites.

### **Site G-**

Run- This site is located below Bear Brook on Middle River. It is a sandy/gravel area with little cover. Species abundance and diversity, which vary considerably at this site, was low. It is dominated by chironomid larvae. Typically, this site is dominated by stonefly and mayfly nymphs.

**TABLE 1. BENTHIC INVERTEBRATES, JUNE 2001**  
**Total Number and Diversity**

Section	A Run	A Riffle	A Pool	B Riffle	B Run	B Riffle /Run	C Riffle	C Pool	C Run	D Run	D Riffle	E Riffle	F Run	G Run
<b>Trichoptera</b>														
Brachycentridae		4						1					1	
Helicopsychidae													1	
Hydroptilidae	1													
Hydropsychidae	1	4					1							
Limnephilidae						1								
Polycentropodidae		2										1		
Sericostomatidae	2													
Unidentified														
Pupae													1	
Cases													6	
<b>Ephemeroptera</b>														
<b>Baetidae</b>														
Caenidae	1			1	1		1	1	2		2	1	5	
<i>Ephemerella</i> sp	3	9		1									6	
Heptageniidae		1					1				2		5	
Potamonthidae										3				
Siphonuridae							1							
Unidentified	13	13			1		3		3		1	6	9	
<b>Diptera</b>														
<b>Chironomidae larvae</b>														
Chironomidae pupae	3	2		2			4	1	4	1	1	3	9	7
<b>Chironomidae tubes</b>														
Culicidae-adult				1										
Heleidae					1									
Rhagionidae														
Simuliidae				1			2							
<b>Hemiptera</b>														
Gerridae													1	
<b>Plecoptera</b>														
Chloroperiidae							1							
Nemouridae		2			1									
Perlidae							1						2	
Perlodidae		1				1								
Unidentified		1												
<b>Coleoptera</b>														
<b>Dytiscidae</b>														
Elmid larvae	1		1		1		3	1			3		6	1
Elmid adult														
<i>Psephenus</i> sp.													6	
Unidentified														
<b>Odonata</b>														
<b>Aeshnidae</b>														
Cordulegastridae											1			
Gomphidae													3	
Libellulidae														
Unidentified						1								
<b>Nematode</b>														
<b>Annelid</b>														
Oligochaeta		19		1	1	3			5	1			7	
<b>Bivalve</b>														
Unionidae												1	1	2
<b>Total #/station</b>	<b>55</b>	<b>68</b>	<b>3</b>	<b>9</b>	<b>10</b>	<b>7</b>	<b>26</b>	<b>4</b>	<b>16</b>	<b>5</b>	<b>10</b>	<b>12</b>	<b>71</b>	<b>10</b>
<b>Total taxon/station</b>	<b>9</b>	<b>12</b>	<b>2</b>	<b>8</b>	<b>7</b>	<b>5</b>	<b>11</b>	<b>4</b>	<b>5</b>	<b>3</b>	<b>6</b>	<b>5</b>	<b>17</b>	<b>3</b>

TABLE 2. BENTHIC INVERTEBRATES, JUNE 2001  
Abundance (Number per m<sup>3</sup>)

Section	A Run	A Riffle	A Pool	B Riffle	B Run	B Riffle /Run	C Riffle	C Pool	C Run	D Run	D Riffle	E Riffle	F Run	G Run
<b>Trichoptera</b>														
Brachycentridae		44						11					11	
Helicopsychidae													11	
Hydroptilidae	11													
Hydropsychidae	11	44					11							
Limnephilidae						11								
Polycentropodidae		22										11		
Sericostomatidae	22													
Unidentified														
Pupae													11	
Cases													67	
<b>Ephemeroptera</b>														
<b>Baetidae</b>														
Caenidae	11			11	11		11	11	22		22	11	56	
<i>Ephemerella</i> sp	33	100		11									67	
Heptageniidae		11					11				22		56	
Potamonthidae										33				
Siphonuridae							11							
Unidentified	144	144			11		33		33		11	67	100	
<b>Diptera</b>														
Chironomidae larvae	333	111	22	11	44	11	89	11	44	11	11	33	100	78
Chironomidae pupae	33	22		22			44							
Chironomidae tubes														
Culicidae-adult				11										
Heleidae					11									
Rhagionidae														
Simuliidae				11			22							
Unidentified														
<b>Hemiptera</b>														
Gerridae													11	
<b>Plecoptera</b>														
Chloroperlidae							11							
Nemouridae		22			11									
Perlidae							11						22	
Perlodidae		11				11								
Unidentified		11												
<b>Coleoptera</b>														
<b>Dytiscidae</b>														
Elmid larvae	11		11		11		33	11			33		67	11
Elmid adult														
<i>Psaphenus</i> sp.													67	
Unidentified														
<b>Odonata</b>														
<b>Aeshnidae</b>														
Cordulegasstridae											11			
Gomphidae													33	
Libellulidae														
Unidentified						11								
<b>Nematode</b>														
Annellid				11					22				22	
Oligochaete		211		11	11	33			56	11			78	
<b>Bivalve</b>														
Unionidae												11	11	22
<b>Total #/m<sup>3</sup></b>	<b>611</b>	<b>755</b>	<b>33</b>	<b>100</b>	<b>100</b>	<b>78</b>	<b>289</b>	<b>45</b>	<b>178</b>	<b>56</b>	<b>111</b>	<b>133</b>	<b>788</b>	<b>111</b>