

7d  
Big Spring Creek 2.21.0

ENVIRONMENTAL PROTECTION  
December 28, 1999  
Stream File 2.21.0  
Stream Code 10378

**SUBJECT:** Aquatic Biological Investigation  
Big Spring Creek  
Cumberland County  
May 13, 1999

7-5 p.m.

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#### EXECUTIVE SUMMARY

In 1998 the Department initiated a study of Big Spring Creek to determine if the discharge from the Big Spring Hatchery was impacting the stream. The 1998 study concluded the discharge from the PFBC Big Spring Hatchery was severely impacting Big Spring Creek for at least 1.5 miles. On May 13, 1999, another aquatic macroinvertebrate survey was conducted on Big Spring Creek. The data from the 1999 survey was analyzed using the PA Modified Rapid Bioassessment Protocol (RBP) metric analysis system developed for the 1998 study. This method was developed specifically to evaluate true limestone streams such as Big Spring Creek.

The results of the 1999 survey were very similar to the 1998 survey results. The RBP metric comparison generated scores for the three Big Spring Creek sample stations and placed each station in an overall rating classification category. Stations 1 and 2 were placed in the severely impaired category and station 3 was placed in the non-impaired category. The RBP biological samples indicated the discharge from the PFBC Big Spring Hatchery was severely impacting Big Spring Creek. The impairment at stations 1 and 2 was due to a very abnormally high density of pollution-tolerant organisms compared to the number of pollution-sensitive organisms. This type of macroinvertebrate community generally indicates organic pollution.

The Department is also investigating the possible impacts to aquatic life due to the PFBC Hatchery's use of chemicals to maintain the health of the hatchery fish and the discharge of polychlorinated biphenyls (PCBs).

#### METHODS

The three sample sites used for the 1998 survey were used in the 1999 survey (Figure 1, Table 1). Macroinvertebrates were collected using the PA Modified RBP 3 method. The RBP habitat assessment field data sheets were completed at each site (Table 2). Each macroinvertebrate sample was collected with a D-Frame net, disturbing a minimum area

of 1 x .3 meters at two-selected representative riffle areas. Each sample consisted of two kicking efforts, one collected from a fast riffle/run habitat and one from a slow riffle/run habitat. The two kicking efforts were composited, fixed in a solution of 95% ethanol alcohol and returned to the laboratory for processing. The samples were floated and sorted removing all the macroinvertebrates. All the organisms were placed in a gridded pan containing enough water to allow complete dispersion of the sample. An individual square was randomly selected and all the organisms in that square were removed. The process of selecting squares continued until a subsample of at least 100 organisms was removed. Organisms in the subsample were identified and enumerated (Table 3). Table 4 contains the reference station macroinvertebrate data. The midges were identified to the family level. Flatworms and aquatic earthworms were identified to the class level. Proboscis worms and roundworms were identified to the phylum level and all other macroinvertebrates were identified to the genus level. The data from the subsamples were used in the computation of benthic metrics.

### REFERENCE CONDITION & METRIC ANALYSIS DEVELOPMENT

Big Spring Creek is a very unique stream. It originates from a large limestone spring that literally flows out of the ground to form a moderate size stream. True limestone streams such as Big Spring Creek have a consistent temperature, low gradient and are highly productive. These unique physical and chemical characteristics produce a unique macroinvertebrate community. In order to measure an impact to a limestone stream using RBP metric analysis the Department found comparable reference stations and developed pollution threshold values specific to limestone streams. Sample stations needed to meet certain criteria to be used as reference stations. Samples could only be collected from January to May. Reference stations also needed to have alkalinity greater than 180 mg/l and have a drainage area less than 12.5 sq. miles. The reference samples were collected from Falling Spring Branch, Licking Run and Letort Spring Run. This provided 9 reference samples. The reference condition changed slightly in 1999 due to the addition of another reference sample from Falling Spring Branch.

The first step in this process was the selection of the metrics. The metrics most sensitive to changes in limestone macroinvertebrate communities were chosen: total taxa, EPT taxa, % intolerant, % tolerant, % EPT, HBI, and % Isopoda. Quartile calculations were performed on each metric for the 9 reference stations in order to find the 25<sup>th</sup> percentile and the 75<sup>th</sup> percentile (Table 5). The detection limits or pollution threshold values for impairment were the 25<sup>th</sup> percentile for metrics that decrease with pollution and the 75<sup>th</sup> percentile for metrics that increase with pollution. The pollution threshold values for the seven selected metrics were used to develop a scoring criteria (Table 6). The scoring criteria was established by giving the highest score (5) to metric values equal to or higher than the pollution-detection threshold value for metrics that decrease with pollution or equal to or lower than the pollution-detection threshold value for metrics that increase with pollution. The pollution-detection limit for the total taxa metric was 11 taxa. A sample containing 11 or more taxa would be considered unaffected by pollution and receive a score of 5. The range below the threshold value for decreasing metrics or above the threshold value for increasing metrics was then divided into two equal parts. The resulting three scoring ranges were assigned a score: 5 for non-impaired, 3 for slightly impaired and 1 for severely impaired. The nine reference samples and the three Big Spring Creek samples were scored for each metric and totaled (Table 7). Quartile

calculations were performed on the total scores for the 9 reference samples to establish rating classifications. The classification categories for the bioassessment indices were: non-impaired 35 to 29, slightly impaired 28 to 22, moderately impaired 21 to 14, and severely impaired 13 to 0. In Table 8 the total scores for the reference samples and the Big Spring Creek samples were assigned to their respective classification. This multimetric approach reduces the biological condition of each sample to a single rating classification number. This allows for a quick and easy comparison of sample stations to the reference condition.

## RESULTS

Station 1. Approximately 20 meters upstream from the Big Spring Road Bridge.

This sample station was located downstream of the area known as the "ditch" and about 200 meters downstream of the PFBC Big Spring Hatchery discharge. The riparian zone was marginal. One side of the stream had mowed grass to the edge of the stream and the other side had low bushes. The stream banks were moderately stable. Fish habitat improvement devices were installed within the last 5 years. The substrate was dominated by gravel, but there was an abundant growth of periphyton covering large areas of the gravel. The field habitat assessment yielded a score of 143 out of a possible 240. This score was 11 points lower than last year's score. The habitat was essentially the same, but 3 of the riparian parameters were scored more critically and the "cementing" of the substrate was examined more closely. Depositional areas contained silt, sand and some loose gravel, but in faster flow areas from a depth of about 2 inches down the gravel was cemented or locked together. Vigorous kicking did not break the gravel substrate apart. The instream habitat, which is most critical to the macroinvertebrates, was poor due to cementing of the hyporheic zone. However, with the exception of the cementing the habitat at station 1 was fairly typical of limestone streams and consistent with the habitat at the reference sites.

The biological sampling resulted in a rating classification score of 9 out of a possible 35, placing it in the severely impaired category. There were 6 total taxa collected for a metric score of 3. The sample scored the minimum score of 1 for the other 6 metrics. *Lirceus* (sowbugs) and *Gammarus* (scuds) completely dominated the macroinvertebrate community. Together they accounted for 97% of the organisms. In a limestone stream sample there should normally be a high percentage of Crustacea, but there should still be some pollution-sensitive organisms and the dominant Crustacea should not be the most pollution-tolerant Crustacea, *Lirceus*. The very high density of organisms in the sample and the dominance (83% *Lirceus*) of the community by a pollution-tolerant organism indicated organic enrichment at this sample location.

Station 2. Approximately 10 meters downstream from the Nealy Road Bridge.

This sample station was located about 1.5 miles downstream from the PFBC Big Spring Hatchery discharge. The riparian zone was suboptimal with low to moderately high bushes and small trees lining the stream banks. The riparian zone was impacted by a road and a parking area. The stream banks were moderately stable. The sample site was just downstream of the bridge. The bridge channeled the stream flow through a pipe increasing the velocity and creating a moderately deep riffle. This was the best macroinvertebrate

habitat in the area. The substrate had a fairly good mixture of cobble and gravel, but the embeddedness was about 60%. The upper 3 to 5 inch layer of stones were easy to dislodge, but the lower levels of stones were hard to kick loose. However, the substrate was not cemented as strongly as station 1. The field habitat assessment yielded a score of 148 out of a possible 240. This indicated the habitat for macroinvertebrates was in the sub-optimal category. The high percentage of embeddedness was bad enough to impact the macroinvertebrates. The habitat was fairly typical of limestone streams and consistent with the habitat at the reference sites.

The biological sampling resulted in a rating classification score of 11 out of a possible 35, placing it in the severely impaired category. In 1998 the site only scored 7. Five of the metrics still only scored the minimum score of 1, but there was an increase in total taxa and EPT taxa with each of these metrics scoring 3. This slight improvement over last year was over shadowed by the extremely high density of *Lirceus* (sowbugs) collected. *Lirceus* accounted for 77% of the organisms collected and it was estimated that 15,000 *Lirceus* were collected in the sample. The complete dominance of the macroinvertebrate community by a pollution-tolerant organism indicated organic enrichment at this sample location.

Station 3. Approximately 30 meters downstream from the Route 641 Bridge.

Station 3 was about 3.4 miles downstream of the PFBC Big Spring Hatchery discharge. This site was located in the town of Newville. The stream seemed to be fairly well buffered from the town. Urban runoff did not appear to be a problem. The riparian zone was poor and the stream banks were fairly stable. Just upstream was a dam that formed a long impoundment on the stream. The substrate had a fair mixture of cobble and gravel. There was a small area of good rock substrate to sample, but overall the riffle was poorly developed and moderately to severely embedded (50% to 70%). The field habitat assessment yielded a score of 129 out of a possible 240. This indicated the habitat for macroinvertebrates was marginal. The embeddedness problem was severe enough to impact the macroinvertebrate community. Overall station 3 had the lowest quality habitat.

The biological sampling resulted in a rating classification score of 31, placing it in the non-impaired category. The macroinvertebrate community at station 3 was very different from stations 2 and 3. Hydropsychidae (caddisflies), not *Lirceus*, dominated the macroinvertebrate community. There was an increase in diversity including several EPT taxa. Taxa richness was good with 14 taxa collected and scored 5. There were 6 EPT taxa for a score of 5. Percent tolerant organisms was low and scored 5. The percent EPT organisms was high at 63% and scored 5. The percent Isopoda and the percent intolerant were fair and scored 3 for each metric.

Based on a limestone-stream type metric analysis this sample site showed good water quality. This could be due to the station being downstream of the PFBC discharge impact zone. The impoundment may also have helped to negate the impact from the PFBC discharge. The impoundment may have consumed any remaining organic material from the PFBC discharge and the overflow from the impoundment, about an eight-foot drop, would add oxygen to the water. However, there could be an additional reason for the change in the macroinvertebrate community. A review of all the sample data indicates the community at station 3 may not be a pure limestone community. The impoundment exposes the water to greater temperature changes. An increase in the range of

temperatures at station 3 would increase the diversity of the macroinvertebrate community and improve the metric scores.

## CONCLUSIONS

The RBP metric comparison generated scores for the 3 sample stations and placed each station in an overall rating classification category. The maximum rating classification score for a sample was 35. Station 1 scored 9 and station 2 scored 11 placing both stations in the severely impaired category. Station 3 had a score of 31 and was placed in the non-impaired category. The RBP biological samples collected in 1999 indicated there was no appreciable change in the macroinvertebrate community of Big Spring Creek since 1998. The PFBC Big Spring Hatchery discharge severely impacted Big Spring Creek for 1.5 miles and the impact probably extends approximately another 1.0 mile to the impounded area. The impairment at stations 1 and 2 was due to an abnormally high-density of pollution-tolerant organisms compared to the number of pollution-sensitive organisms. This type of macroinvertebrate community is usually found where there is organic enrichment.

cc: Bob Frey, Water Management  
John Arway, PA Fish & Boat Commission  
Larry Jackson, PA Fish & Boat Commission  
Stream File 2.21.0 (Big Spring Creek)

**FIGURE 1.** Sample station location for an aquatic biological investigation of Big Spring Creek, Cumberland County, May 13, 1999. Reproduced from the Newville USGS Quad.

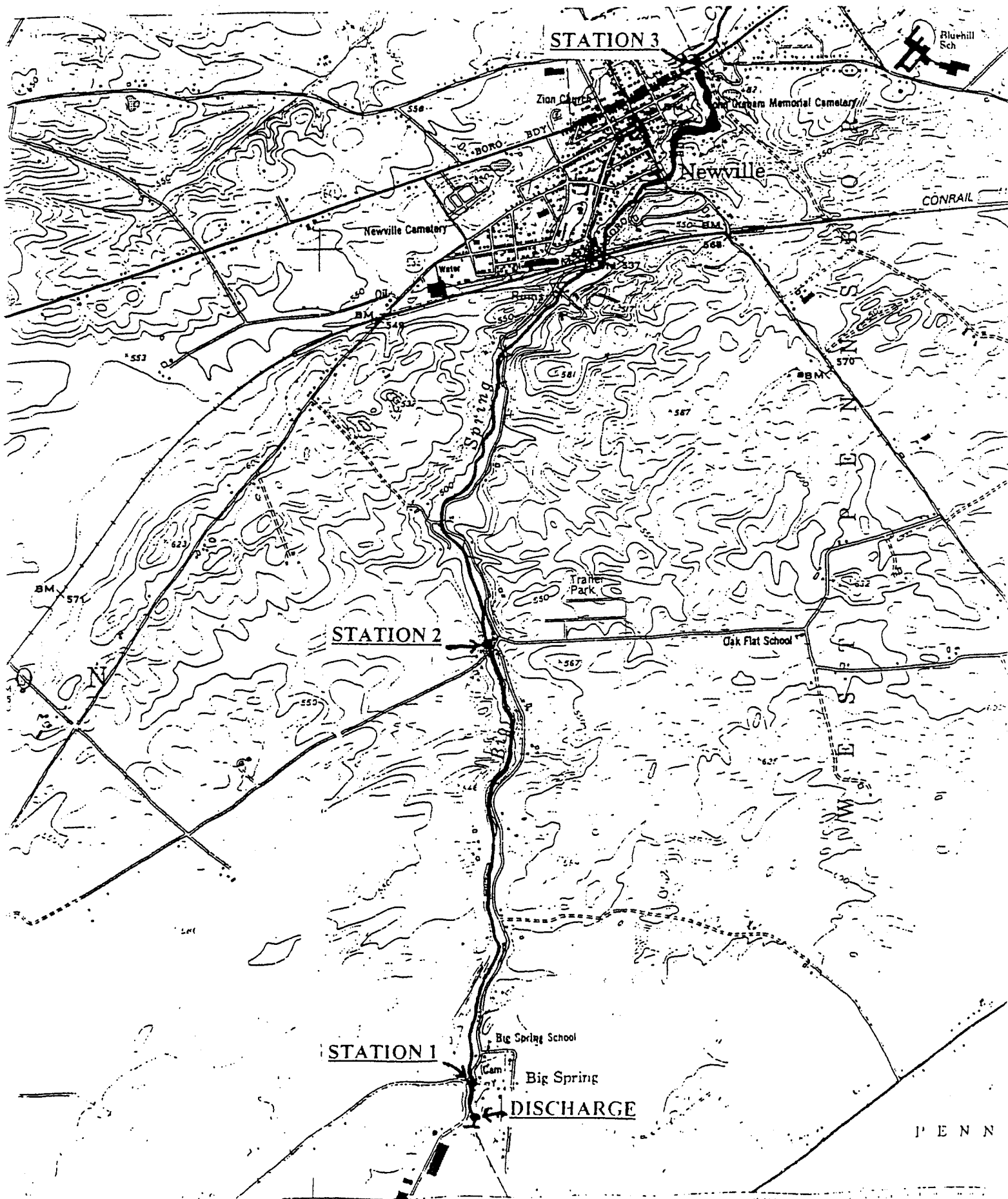


TABLE 1

Big Spring Creek  
May 13, 1999  
Sampling Station Locations

STATION	RIVER MILES	TOWNSHIP	COUNTY	USGS QUAD	INCHES WEST	INCHES NORTH
1	4.61	North Newton	Cumberland	Newville	4.56	0.94
2	3.25	North Newton	Cumberland	Newville	4.44	4.38
3	1.2	North Newton	Cumberland	Newville	2.88	9.00

## TABLE 2

Big Spring Creek

May 13, 1999

Habitat Assessment Summary

HABITAT PARAMETER	STATIONS		
	1	2	3
1. Instream Cover	11	8	10
2. Epifaunal Substrate	10	12	8
3. Embeddedness	3	7	5
4. Velocity/Depth Regimes	18	19	17
5. Channel Alterations	17	19	15
6. Sediment Deposits	12	5	6
7. Frequency of Riffles	6	6	8
8. Channel Flow Status	20	20	20
9. Condition of Banks	13	16	15
10. Bank Vegetative Protection	14	16	15
11. Bank Vegetative Disruption	10	10	4
12. Riparian Zone	9	10	6
<b>TOTAL SCORE</b>	<b>143</b>	<b>148</b>	<b>129</b>

Maximum Score 240

TABLE 3

Big Spring Creek  
RBP Subsamples, May 13, 1999  
Semi-Quantitative Macroinvertebrate Data

TAXA	MOD. HBI	STATIONS		
		#1	#2	#3
TURBELLARIA (Flatworms)	7	-	-	1
NEMATODA (Roundworms)	9	-	-	1
ANNELIDA (Earthworms, Leeches)				
<i>Oligochaeta</i>	10	4	-	4
<i>Helobdella</i>	6	-	-	-
ISOPODA (Sowbugs)				
<i>Lirceus</i>	8	273	557	19
AMPHIPODA (Scuds)				
<i>Gammarus</i>	6	46	152	11
EPHEMEROPTERA (Mayflies)				
<i>Baetis</i>	6	-	-	3
<i>Ephemerella</i>	1	-	2	20
<i>Paraleptophlebia</i>	1	-	-	-
<i>Stenonema</i>	3	-	-	3
TRICHOPTERA (Caddisflies)				
<i>Cheumatopsyche</i>	5	-	1	38
<i>Goera</i>	0	-	1	-
<i>Hydropsyche</i>	4	-	-	26
<i>Hydroptila</i>	6	-	-	1
<i>Micrasema</i>	2	-	-	-
<i>Neophylax</i>	3	1	-	-
<i>Polycentropus</i>	6	-	-	-
COLEOPTERA (Beetles)				
<i>Stenelmis</i>	5	-	-	1
DIPTERA (Midges, Flies)				
Chironomidae spp.	6	3	14	16
<i>Hemerodromia</i>	6	-	-	1
<i>Simulium</i>	6	-	-	-
GASTROPODA (Snails)				
<i>Fossaria</i>	7	-	-	-
Physidae	8	2	-	-
TOTAL TAXA		6	6	14
TOTAL ORGANISMS		329	727	145
EPT		1	3	6

TABLE 4

Spring Reference Streams  
RBP Subsamples  
Semi-Quantitative Macroinvertebrate Data

TAXA	MOD HBI	Letort 1 May-96	Letort 2 May-96	Letort May-98	Lick Apr.-91	Lick 1 Jan.-93	Lick 2 Jan.-93	Falling Apr.-91	Falling May-98	Falling May-99
TURBELLARIA (Flatworms)	7	-	-	-	1	-	-	-	-	-
NEMATODA (Roundworms)	9	-	-	-	-	-	-	-	-	1
ANNELIDA (Earthworms)										
<i>Helobdella</i>	6	-	-	-	-	-	-	-	-	1
Oligochaeta	10	-	-	-	-	10	2	30	1	3
HYDRACHNIDAE (Water Mites)		-	-	-	-	-	1	-	-	-
ISOPODA (Sowbugs)										
<i>Caecidotea</i>	6	-	-	-	-	-	-	-	1	-
<i>Lirceus</i>	8	5	18	16	-	-	-	-	-	-
AMPHIPODA (Scuds)										
<i>Gammarus</i>	6	37	21	42	62	74	41	49	157	115
DECAPODA (Crayfish)										
<i>Cambarus</i>	6	-	-	-	1	-	-	1	-	-
EPHEMEROPTERA (Mayflies)										
<i>Baetis</i>	6	3	1	5	36	5	19	2	9	1
<i>Ephemerella</i>	1	67	47	98	33	82	1	15	8	6
<i>Drunella</i>	0	-	-	-	10	-	8	-	-	-
<i>Paraleptophlebia</i>	1	-	-	-	-	-	-	-	11	3
PLECOPTERA (Stoneflies)										
Capniidae	3	-	-	-	-	-	2	-	-	-
<i>Leuctra</i>	2	-	-	-	16	-	10	-	-	-
Perlidae	3	-	-	-	1	-	-	-	-	-
<i>Sweltsa</i>	0	-	-	-	-	1	-	-	-	-
MEGALOPTERA (Alderflies)										
<i>Sialis</i>	4	-	-	-	-	-	-	1	-	-
TRICHOPTERA (Caddisflies)										
<i>Cheumatopsyche</i>	5	-	3	-	-	-	-	1	-	-
<i>Goera</i>	0	-	-	-	-	-	-	-	-	1
<i>Hydropsyche</i>	4	-	8	-	3	-	-	-	-	-
<i>Hydroptila</i>	6	-	-	-	-	-	2	-	-	-
<i>Leucotrichia</i>	6	1	4	-	-	-	-	-	-	-
<i>Micrasema</i>	2	-	-	-	-	-	-	1	1	3
<i>Neophlax</i>	3	-	-	-	-	1	-	-	-	-
<i>Ochrotrichia</i>	4	-	-	-	-	-	4	-	-	-
<i>Polycentropus</i>	6	-	-	-	-	-	-	-	-	1
<i>Pycnopsyche</i>	4	-	-	-	-	2	-	-	-	-
<i>Rhyacophila</i>	1	-	-	-	3	-	1	-	-	-

Continued on the Next Page

**TABLE 5**

**Reference Condition Metric Selection  
Quartile Analysis of 12 Possible Metrics**

NAME	PAGE	INTERMEDIATE (METS-4)	INTERMEDIATE (METS-6)	INTERMEDIATE (METS-8)	INTERMEDIATE (METS-10)	INTERMEDIATE (METS-12)	MINIMUM	1ST QUANTILE	MEDIAN	3RD QUANTILE	MAXIMUM	% DOMINANT TAXA		
Falling Spring Br.	990504	9	3	13	6	4	5.67	80	7	10	9	80	0	Gammarus
Falling Spring Br.	980513	10	2	9	4	3	5.53	81	10	15	10	81	0	Gammarus
Falling Spring Br.	910424	29	13	13	4	2	6.41	41	13	17	13	41	0	Gammarus
Letort Spring Run	980511	58	9	7	2	1	3.25	58	58	61	58	25	9	Ephemereilla
Letort Spring Run 1	960514	47	5	11	3	1	3.53	47	47	49	47	26	3	Ephemereilla
Letort Spring Run 2	960514	31	13	11	5	2	4.55	31	31	41	36	14	12	Ephemereilla
Lick Run	910424	29	0	16	7	6	4.50	28	19	46	29	28	0	Gammarus
Lick Run 1	930127	48	3	14	5	4	3.58	37	37	41	41	33	0	Ephemereilla
Lick Run 2	930127	15	4	14	8	6	5.42	32	6	33	19	29	0	Chironomidae
Minimum		9	0	7	2	1	3.25	28	6	10	9	14	0	
1st Quartale		10	3	11	4	3	3.58	32	10	17	13	26	0	
Median		29	4	13	5	3	4.55	41	19	41	29	29	0	
3rd Quartale		47	9	14	6	4	5.53	48	37	46	39	41	0	
Maximum		58	13	16	8	6	6.41	81	58	61	58	81	12	

X-Indicates Selected Metrics

Reference Stations: Drainage Area = <12.5 sq. mi.  
Alkalinity =>180 mg/l  
Sample Period = Jan. to May

TABLE 4

TAXA	MOD HBI	Letort 1 May-96	Letort 2 May-96	Letort May-98	Lick Apr.-91	Lick 1 Jan.-93	Lick 2 Jan.-93	Falling Apr.-91	Falling May-98	Falling May-99
<b>COLEOPTERA (Beetles)</b>										
<i>Optioservus</i>	4	17	2	3	8	7	-	-	-	-
<i>Promoresia</i>	2	-	-	-	-	22	-	-	-	-
<b>DIPTERA (Midges, Flies)</b>										
<i>Antocha</i>	3	-	-	-	2	1	-	-	-	-
<i>Chelifera</i>	6	-	-	-	1	-	4	-	-	-
Chironomidae spp.	6	6	-	3	29	15	44	10	5	5
<i>Chrysops</i>	7	-	-	-	-	-	-	1	-	-
Muscidae	6	-	-	-	-	1	-	-	-	-
<i>Simulium</i>	6	4	43	2	17	1	-	-	-	2
<i>Tipula</i>	4	-	-	-	1	1	-	-	-	-
<b>GASTROPODA (Snails)</b>										
<i>Fossaria</i>	7	1	-	-	-	-	-	4	-	1
<i>Gyraulus</i>	6	2	4	-	-	-	-	1	-	-
Physidae	8	1	1	-	-	-	-	3	2	-
<b>BIVALVIA (Clams)</b>										
<i>Sphaeriidae</i>	8	-	-	-	-	-	3	-	-	-
<b>TOTAL TAXA</b>		11	11	7	16	14	14	13	9	13
<b>TOTAL ORGANISMS</b>		44	152	169	224	223	142	119	195	143
<b>EPT</b>		2	5	2	7	5	8	4	4	6



**TABLE 6**

**METRIC SCORING CRITERIA  
BASED ON THE REFERENCE CONDITION**

Metric	Scope for Detecting Impairment	Scoring Criteria		
		5	3	1
Total Taxa	<25th	$\geq 11$	10-6	<6
EPT	<25th	$\geq 4$	3-2	<2
% Intolerant	<25th	$\geq 15$	14.9-7.4	<7.4
% Tolerant	>75th	$\leq 9$	10-44	>44
% EPT	<25th	$\geq 17$	16.9-8.5	<8.5
HBI	>75th	$\leq 5.53$	5.54-7.02	>7.02
% Isopoda	>75th	$\leq 3$	3.1-52	>52

Used a top range of 80% for % Tolerant  
Used a top range of 8.5 for HBI

**TABLE 7**

**Big Spring Creek  
Reference Streams  
Macroinvertebrate Metric Scores**

Metric	Big Spring		Falling Spr. 98		Falling Spr. 98		Falling Spr. 91		Falling Spr. 98		Falling Spr. 96		Falling Spr. 96		HBI		Falling Spr. 98		Falling Spr. 96			
	Count	Score	Count	Score	Count	Score	Count	Score	Count	Score	Count	Score	Count	Score	Count	Score	Count	Score	Count	Score		
Total Taxa	6	3	6	3	14	5	13	5	9	3	13	5	7	3	11	5	11	5	16	5	14	5
EPT Taxa	1	1	3	3	6	5	6	5	4	5	4	5	2	3	3	3	5	5	7	5	5	5
% Intolerant	0	1	0	1	16	5	9	3	10	3	29	5	58	5	47	5	31	5	29	5	48	5
% Tolerant	85	1	77	1	17	3	3	5	2	5	13	3	9	5	5	13	3	0	5	3	5	4
% EPT	0	1	1	1	63	5	10	3	15	3	17	5	61	5	49	5	41	5	46	5	41	5
HBI	7.71	1	7.51	1	5.02	5	5.67	3	5.53	5	6.41	3	3.25	5	3.53	5	4.55	5	4.50	5	3.58	5
% Isopoda	83	1	77	1	13	3	0	5	0	5	0	5	9	3	3	5	12	3	0	5	0	5
Total Score		9		11		31		29		29		31		29		33		31		35		35

Maximum Score = 35  
1st Quartile = 29

**TABLE 8**

**Big Spring Creek**

**May 13, 1999**

**Rating Classifications for Bioassessment Indices**

Station	Non-Impaired	Slightly Impaired	Moderately Impaired	Severely Impaired
	≥ 29	28-22	21-15	<14
Big Spring Run #1				9
Big Spring Run #2				11
Big Spring Run #3	31			
Falling Spring Br. 99	29			
Falling Spring Br. 98	29			
Falling Spring Br. 91	31			
Letort Spring Run 98	29			
Letort Spring Run 96 #1	33			
Letort Spring Run 96 #2	31			
Lick Run 91	35			
Lick Run 93 #1	35			
Lick Run 93 #2	35			

**Maximum Score 35**