

MONTANORE PROJECT

An Assessment of Benthic Communities
in Response to Nutrient Enrichment
Due to Mining Activities

Preliminary Report--1991

By:

Carlene E. Farmer

Western Technology and Engineering, Inc.
P.O. Box 6045
3005 Airport Road
Helena, MT 59604

For:

Noranda Minerals
2501 Catlin Drive, Suite 201
Missoula, MT 59801

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I. INTRODUCTION

A. Purpose

This preliminary report addresses the issue of nutrient impacts to Libby Creek due to mining activities in 1991. Nitrate levels in Libby Creek exceeded recommended state levels in summer and fall 1991; subsequently, mining activity was halted. This report examines macroinvertebrate and periphyton data from two stations on Libby Creek, L10 above the mine and L9 below the mine, for the sampling periods in 1991 to determine the effects of the nitrate increase on stream biota.

Laboratory analysis of macroinvertebrate and periphyton samples for the rest of the Montanore stations is in progress. A complete annual aquatic biological monitoring report will be submitted this spring subsequent to completion of data analysis.

B. Acknowledgements and personnel

The 1991 Montanore Project aquatic monitoring program was funded by Noranda, Inc. Doug Parker, Noranda-Missoula, provided input on the program. Dan Meyers administered the contract from the Libby office. Susan Feeback, Noranda-Libby, assisted with field work and provided information on access to sample sites. Erich Weber, Helena, conducted the periphyton analysis and interpretation; the discussions on periphyton are excerpted from his report to WESTECH. Patrick Farmer assisted with spring field work. Kim Rieser assisted with field work and lab analysis. Tom Butts also assisted with lab analysis.

II. RESULTS/DISCUSSION

A. Macroinvertebrates

Table 1 presents seasonal and annual comparisons of macroinvertebrate data from the two Libby Creek stations. Seasonal taxa totals for these two stations in 1991 are presented in Appendix A.

Benthic populations were much higher in 1991 than 1990 but flow events were not as dramatic in 1991. Species diversity (total taxa) was greater at the upper station in 1991 but about the same at the lower station both years. Typically, mayflies predominate (54-80%) in the Libby Creek system with 40-54% of those being the family Heptagenidae. This pattern was repeated both years at the upper Libby Creek station but in 1991 stoneflies (Plecoptera) were the overall abundant organism (73.4%) at the lower Libby Creek station (Figure 1). This reversal was due to exceptionally high numbers of the stonefly *Taenionema* sp. at the lower station in the fall of 1991. A total of 2856 specimens of this stonefly were collected from L9 with the four Hess and one kick net sample. During that same collecting period only 309 *Taenionema* sp. were collected from the upper Libby Creek station, L10. This winter stonefly is typically most abundant in the fall but generally does not exceed mayfly numbers. However, in 1991 it accounted for 64% of the organisms collected from the lower Libby Creek station, L9.

A comparison of the Shannon Diversity Index (SDI) for the two stations in fall 1991 further reflects the shift in community balance that

Table 1. Summary of macroinvertebrate data for stations L10 and L9,
Montanore Project area.

SEASONAL-1991		L10			L9	
	Spring	Summer	Autumn	Spring	Summer	Autumn
Total Number	823	1967	3063	190	1793	4460
Total Taxa	29	30	39	19	34	33
Ephemeroptera %	69.3	54.1	60.9	75.8	79.6	12.7
Plecoptera %	14.6	23.2	25.0	15.3	11.5	73.4
Trichoptera %	2.8	2.9	10.6	3.2	2.2	13.1
Other %	13.4	19.8	3.5	5.8	6.7	0.8
Heptagenid %	51.6	40.4	49.1	50.6	54.1	10.8
Scraper %	55.5	29.6	26.4	45.9	33.7	74.6
<u>Drunella doddsii</u> %	0.7	7.6	1.3	2.1	12.8	1.3
<u>Taenionema</u> sp. %	2.8	2.9	10.1	0.5	0.0	64.0
Hydropsychid %	0	0	3.3	0	0	9.1
Chironomid %	6.0	14.4	0.8	1.1	4.0	0
Shannon Diversity	3.3	3.4	3.7	3.2	3.1	2.2
ANNUAL-1991 (1990)		L10(1990)			L9(1990)	
Total Number		5853 (901)			6441 (1163)	
Total Taxa		53 (33)			46 (45)	
Ephemeroptera %		59.8 (67.3)			33.2 (58.2)	
Plecoptera %		23.0 (18.3)			54.5 (27.7)	
Trichoptera %		6.9 (2.8)			9.7 (4.0)	
Other %		10.4 (11.7)			2.6 (10.1)	
Heptagenid %		47.1 (47.5)			24.0 (40.8)	
Scraper %		39.3 (37.4)			62.4 (52.7)	
<u>Drunella doddsii</u> %		3.3 (2.1)			4.5 (5.5)	
<u>Taenionema</u> sp. %		5.3 (0.8)			44.4 (13.6)	
Hydropsychid %		1.7 (0.2)			6.3 (0.2)	
Chironomid %		6.1 (2.0)			1.1 (4.6)	
Shannon Diversity		3.9 (3.5)			3.0 (3.8)	

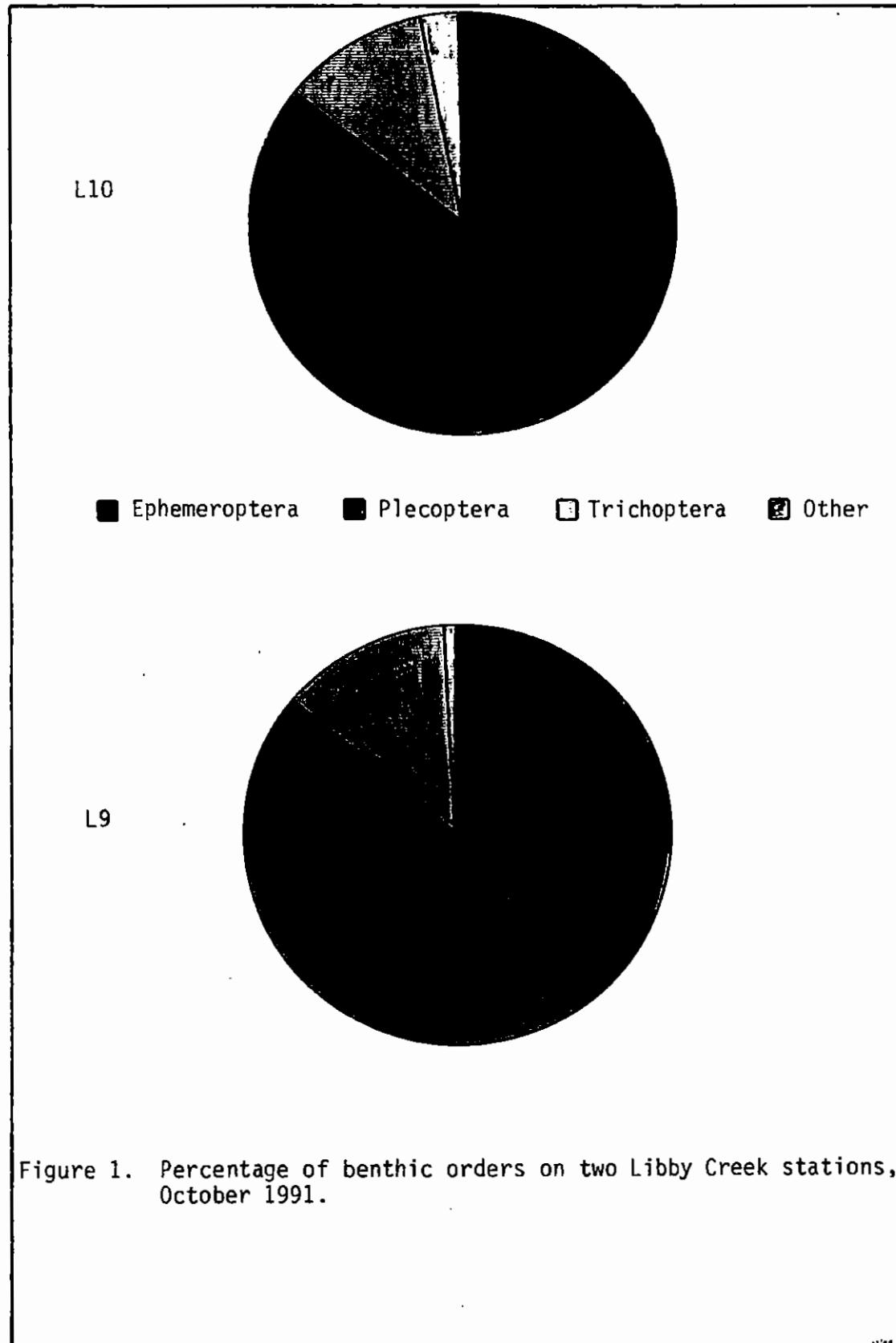


Figure 1. Percentage of benthic orders on two Libby Creek stations, October 1991.

occurred. The station above the mine, L10, had an SDI of 3.7 while the station below the mine, L9, had an SDI of 2.2. A lower SDI generally indicates the presence of pollution however, these values need to be interpreted judiciously.

The stonefly *Taenionema* sp. is a scraper that feeds by removing periphyton from the substrate. It is also a "clean water" stonefly with a low tolerance for pollution (Tolerance Quotient = 48). The Libby Creek system is typically nutrient poor and capable of supporting only moderate benthic populations. *Taenionema* sp., like other organisms in a limited environment, is an opportunist able to respond to favorable conditions such as an abundant food supply resulting from a nutrient increase.

Even though the higher nitrate levels noticeably affected Libby Creek's macroinvertebrate populations, the effect was not adverse in terms of eradicating sensitive species nor permitting the predominance of pollution tolerant species. For example, the mayfly *Drunella doddsi*, is one of the most pollution intolerant organisms in Libby Creek. It is found most abundantly in summer but usually does not exceed about 10% of the total organisms collected. The nutrient enrichment at L9 in 1991 did not detrimentally affect this sensitive species. Likewise, the caddisfly order *Hydropsychidae*, is highly pollution tolerant (TQ = 108) and though numbers of this taxa did increase at L9 in October 1991, 405 compared to 102 at L10, it still only accounted for 9.1% of the total organisms. Another group which typically increases with

pollution is the midge, Chironomidae. In October, there were more chironomids at L10 ($26 = 0.8\%$) than at L9 ($1 = >1\%$).

B. Periphyton

The estimated relative abundance of non-diatom algae at sites L9 and L10 for the May, August and October sampling events are presented in Tables 1-3 in Appendix B.

In May, the non-diatom algae at site L9 downstream of Montanore were dominated by three genera of blue-green algae. Diatoms, although present, were relatively rare. Upstream, site L10 had but a single genus of blue-green algae (a genus that also occurred at L9), and diatoms were virtually absent from the sample.

In August, the two sites had more in common than during May. Three genera of blue-green algae again dominated at L9, while two of the same genera occurred in comparable numbers at site L10. However, a genus of green algae (*Zygnema*) that was abundant at L10 was not found at L9. Diatom numbers at L10 were again much lower than at L9.

In October, the non-diatom algal floras at the two sites were quite dissimilar. Several genera of green algae found at site L9 were absent from site L10, while the one genus they shared (*Ulothrix*) was much more numerous at L9. Again, *Zygnema* was a dominant taxon at L10 but was totally absent from L9. Blue-green algae were more numerous at site L9, although the same genera were present at L10. Diatoms were present

in comparable numbers at both sites.

While similarities do exist between the non-diatom algal floras found at L9 and L10 during each of the monitoring events, several differences between the two sites suggest that water quality and/or physical conditions were not the same at both sites. The differences were particularly pronounced in May. The extremely sparse periphyton at L10, common in mountain streams following harsh winter and early spring conditions, contrasted sharply with the relatively heavy periphyton growth seen at L9. This suggests nutrient enrichment at the latter site, possibly coupled with higher instream temperatures. By August, periphyton growth at L10 had caught up somewhat with that at L9. However, the absence of the genus *Zygnema* at site L9, which was abundant at site L10, suggests that the low levels of nutrients and dissolved solids and the cool water temperatures preferred by this taxon may have been lacking at L9. This was also observed in October. Additionally, several genera of green algae known to prefer somewhat elevated inorganic nutrient levels were present only at site L9 in October.

Diatom proportional count data for the May, August and October sampling events are presented in Tables 4-6 in Appendix B. The dominant taxa, based on percent relative abundance (PRA) values, the number of species counted (also known as species richness) and the Shannon diversity values are of primary interest in assessing the condition of the diatom community.

In May, diatoms were all but absent at site L10 and the sample contained only two species. A diatom proportional count could not be performed even though the fixed mount had been prepared with highly concentrated sample material. At site L9, a total of 21 species were counted. This species richness value remained constant at L9 for all three sampling dates. The Shannon diversity of 2.66 was the lowest of any of the samples counted, due largely to the nearly 50% relative abundance of *Diatoma mesodon*. This taxon prefers cold water low in dissolved solids, with low to moderate inorganic nutrient levels. *Diatoma mesodon* was the dominant or co-dominant taxon at L9 and L10 on virtually all sampling dates.

In August, diatoms were still very sparse at site L10, but adequate numbers were present to permit a somewhat truncated proportional count. The species richness value of 14 at L10 was significantly less than the 21 counted at site L9. And as at site L9 in May, a high PRA value for *Diatoma mesodon* resulted in a lower Shannon diversity value (2.93) at L10. Site L9 had a relatively high Shannon diversity value of 3.22.

In October, diatoms were numerous at both sites. Species richness values were fairly comparable, with 17 species counted at L10, and 21 once again at L9. Shannon diversity at L10 was considerably higher than at L9, 3.39 versus 3.03 at the latter.

Overall, the diatom floras at sites L9 and L10 were very similar, and had a high number of dominant taxon in common between them in the

August and October data. And of those diatom species that could be considered dominant (those having a PRA of greater than 3) the majority were forms that prefer cool, nutrient-poor water low in dissolved solids, and are considered to be intolerant of pollution.

III. CONCLUSIONS

The Libby Creek system is populated by species accustomed to limited food supply and the vagaries of the environment. Such extreme environmental diversity sets the stage for opportunistic responses by biota under less limiting conditions. Not only was the annual flow regime more "normal" in 1991 but nutrients were more abundant. As a consequence of nitrate loading to Libby Creek during mining operations in 1991, station L9 below the mine experienced enhanced periphyton populations. The proliferation of this food supply permitted the winter stonefly, *Taenionema* sp., to be present in numbers not seen prior to 1991.

This dramatic shift in biological communities reflects the addition of nutrients to the system; however, with the exception of the green algae, *Zygnema*, the loading was not sufficient to "pollute" the stream in the sense that the predominance of pollution tolerant organisms nor the demise of sensitive taxa resulted. Although *Zygnema* prefers low levels of nutrients and dissolved solids and cool water temperatures, it is known at this time if one of these factors or competition by other, more robust species accounted for the absence of this taxa at L9.

Since another monitoring event is not scheduled until spring 1992, it is also not known what effect the suspension of mining activities and concurrent nutrient loading has had on the enhanced biological populations. Nor is it possible to speculate at this time, what the long-term effect of continuance of the nutrient loading would have on stream biota in Libby Creek. The more thorough annual aquatic biological monitoring report will further address these issues.

Appendix A. Seasonal macroinvertebrate data, 1991.

Macroinvertebrate Data-Montanore, May 1991
Libby Creek, LLO #4

	For Each Taxa			Major Group			TV	TQ	TFC
	No.	No./sq.m.	Percent of Total	Total Number	Percent of Total				
Ephemeroptera				570	69.26				
Baetis sp.	80	173	9.7				4	72	cg
Caudatella hystrix	0	0	0.0				1	nn	cg
Drunella coloradensis/ flavilimna	23	50	2.6				1	18	sc
Drunella doddsi	6	13	0.7				1	4	sc
Drunella spinifera	0	0	0.0				1	24	sc
Drunella sp.	0	0	0.0				0	48	sc
Ephemerella sp.	0	0	0.0				1	48	sc
Serratella sp.	0	0	0.0				1	24	cg
Cinygma sp.	0	0	0.0				4	21	sc
Cinygma sp.	237	512	28.8				4	21	sc
Epcorus sp.	188	406	22.8				4	21	sc
Rhithrogena sp.	26	60	3.4				4	21	cg
Paraleptophlebia sp.	0	0	0.0				2	24	cg
Ameletus sp.	8	17	1.0				7	48	cg
Plecoptera				120	14.58				
Capniidae	11	24	1.3				1	32	sh
Katoporla pardita	0	0	0.0				1	24	cg
Sweltsa/Sowelliia sp.	70	151	8.3				1	24	pr
Deepaxia augusta	0	0	0.0				0	18	sh
Paraleuctra sp.	0	0	0.0				0	18	sh
Parlimnia sp.	0	0	0.0				0	18	sh
Leuctridae	4	9	0.5				0	18	sh
Nemoura sp.	0	0	0.0				2	24	sh
Viscota cataractae	7	15	0.9				2	nn	sh
Zapada cinctipes	0	0	0.0				2	16	sh
Zapada columbiana	0	0	0.0				2	16	sh
Nemouridae	13	32	1.8				2	36	sh
Xoraperla brevis	6	13	0.7				2	24	sh
Acronemuria abnormis	0	0	0.0				1	6	pr
Dorconemuria theodora	0	0	0.0				1	18	pr
Hesperoperla pacifica	0	0	0.0				1	18	pr
Perlidae	4	9	0.5				1	nn	pr
Isoperla sp.	0	0	0.0				2	48	pr
Megarcys sp.	3	6	0.4				2	24	pr
Setevana bradleyi	0	0	0.0				2	nn	pr
Perlodidae	0	0	0.0				2	nn	pr
Taenionema sp.	0	0	0.0				2	48	sc
Trichoptera				23	2.79				
Micrasema sp.	0	0	0.0				1	24	sh
Anagapetus sp.	2	4	0.2				0	24	sc
Glossosoma sp.	0	0	0.0				0	24	sc
Arctopechya grandis	0	0	0.0				4	18	cf
Parapsyche elisia	3	6	0.4				4	6	cf
Hydropsychidae	0	0	0.0				4	108	nn
Agraylea sp.	0	0	0.0				4	108	cg
Ochrotrichia sp.	0	0	0.0				4	108	cg
Lepidostoma sp.	0	0	0.0				1	18	sh
Apatania sp.	0	0	0.0				4	18	sc
Eccidiomyia sp.	0	0	0.0				4	24	cg
Beothrema alicia	1	2	0.1				4	8	sc
Oligophlebodes sp.	0	0	0.0				4	24	sc
Limnephilidae	0	0	0.0				4	108	nn
Wormaldia sp.	0	0	0.0				3	24	cf
Rhyacophila Angelita	3	6	0.4				0	18	pr
Rhyacophila Bettani	0	0	0.0				0	18	pr
Rhyacophila Bifila/Coloraden	0	0	0.0				0	18	pr
Rhyacophila Brunnea	0	0	0.0				0	18	pr
Rhyacophila Hyalinita	1	2	0.1				0	18	pr
Rhyacophila Iranda	0	0	0.0				0	18	pr
Rhyacophila Sibirica	7	15	0.9				0	18	pr
Rhyacophila Vaccua	6	13	0.7				0	18	pr
Rhyacophila verrula	0	0	0.0				0	18	pr
Rhyacophila vespulse	0	0	0.0				0	18	pr
Rhyacophila sp.	0	0	0.0				0	18	pr
Trichoptera pupae	0	0	0.0				nn	nn	na
Other				110	13.37		5	108	cg
Annelida	49	106	6.0						
Coleoptera-Elatidae									
Cleptelmis sp.	0	0	0.0				4	108	cg
Heterlimnius sp.	0	0	0.0				4	108	cg
Lara sp.	0	0	0.0				4	108	sh
Narpus sp.	0	0	0.0				4	108	cg
Taitzovia sp.	0	0	0.0				4	108	cg
Elmidae	0	0	0.0				4	108	cg
Collembola	0	0	0.0				nn	nn	na
Diptera									
Agathous sp.	1	2	0.1				0	2	sc
Caratopogonidae	0	0	0.0				6	108	pr
Chironomidae	49	106	6.0				6	108	cg/f
Oreocoton sp.	1	2	0.1				6	nn	pr
Simuliidae	2	4	0.2				6	108	cf
Antocha sp.	0	0	0.0				3	24	cg
Dicranota sp.	7	15	0.9				3	24	pr
Haxatoma sp.	0	0	0.0				3	36	pr
Pedicia sp.	0	0	0.0				3	36	pr
Tipula sp.	1	2	0.1				3	36	sh
Hydracarina	0	0	0.0				3	108	pr
Mollusca	0	0	0.0				8	108	cg
Nematoda	0	0	0.0				nn	nn	na
Turbellaria	0	0	0.0				4	108	pr

TOTAL NUMBER = 823 EPT Abund. = 713 SDI = 3.3
 TOTAL TAMA = 29 EPT/Chiron. = 14.55
 STD = 34.6 COEF. VAR. = 21.01
 MEAN = 163 SE MEAN = 9.55

Macroinvertebrate Data-Montanore, May 1991
Libby Creek, LV #3

	For Each Taxa			Major Group			IV	VII	VFC
	No.	No./sq.m.	Percent of Total	Total Number	Percent of Total				
Ephemeroptera				144	75.79				
Beetis sp.	37	80	19.5				4	72	cg
Caudatella hystrix	0	0	0.0				1	nn	cg
Drunella coloradensis/ flavolinea	6	13	3.2				1	18	sc
Drunella doddei	4	9	2.1				1	4	sc
Drunella spinifera	0	0	0.0				1	24	sc
Drunella sp.	0	0	0.0				0	48	sc
Ephemerella sp.	0	0	0.0				1	48	sc
Serratella sp.	0	0	0.0				1	24	cg
Cinygma sp.	0	0	0.0				4	21	sc
Cinygma sp.	48	104	25.3				4	21	sc
Epeorus sp.	25	54	13.2				4	21	sc
Rhytrogena sp.	23	50	12.1				4	21	cg
Paraleptophlebia sp.	0	0	0.0				2	24	cg
Amelitus sp.	1	2	0.5				7	48	cg
Plecoptera				29	13.26				
Capniidae	0	0	0.0				1	32	sh
Kathroperla perdita	0	0	0.0				1	24	cg
Sweltsa/Suwallia sp.	19	41	10.0				1	24	pr
Deepaxia augusta	0	0	0.0				0	18	pr
Paraluctra sp.	0	0	0.0				0	18	sh
Parlomyia sp.	0	0	0.0				0	18	sh
Luctridae	1	2	0.5				0	18	sh
Nemouridae	0	0	0.0				2	24	sh
Visoka cataractae	1	2	0.5				2	nn	sh
Tapada cinctipes	0	0	0.0				2	16	sh
Tapada columbiana	0	0	0.0				2	16	sh
Nemouridae	4	9	2.1				2	36	sh
Yoraperla brevis	2	4	1.1				2	24	sh
Acroneruria abnormis	0	0	0.0				1	6	pr
Dorconeruria theodora	0	0	0.0				1	18	pr
Hesperoperla pacifica	0	0	0.0				1	18	pr
Perlidae	0	0	0.0				1	nn	pr
Isoperla sp.	0	0	0.0				2	48	pr
Megarcys sp.	1	2	0.5				2	24	pr
Setivena bradleyi	0	0	0.0				2	nn	pr
Perlodidae	0	0	0.0				2	nn	pr
Taenionema sp.	1	2	0.5				2	48	sc
Trichoptera				6	3.16				
Micrasemina sp.	0	0	0.0				1	24	sh
Anagapetus sp.	0	0	0.0				0	24	sc
Glossosoma sp.	3	6	1.6				0	24	sc
Arctopsyche grandis	0	0	0.0				4	18	cf
Parapsyche elisia	0	0	0.0				4	6	cf
Hydropsychidae	0	0	0.0				4	108	nn
Agraylea sp.	0	0	0.0				4	108	cg
Ochrotrichia sp.	0	0	0.0				4	108	cg
Lepidostoma sp.	0	0	0.0				1	18	sh
Apatania sp.	0	0	0.0				4	18	sc
Ecclisomyia sp.	0	0	0.0				4	24	cg
Nectremma alicia	0	0	0.0				4	8	sc
Oligophlebiidae sp.	0	0	0.0				4	24	sc
Limnephilidae	0	0	0.0				4	108	nn
Wormaldia sp.	0	0	0.0				3	24	cf
Rhyacophilidae Angelita	1	2	0.5				0	18	pr
Rhyacophilidae Bettani	0	0	0.0				0	18	pr
Rhyacophilidae Riffle/Colorado	0	0	0.0				0	18	pr
Rhyacophilidae Brunnea	0	0	0.0				0	18	pr
Rhyacophilidae Hyalinata	0	0	0.0				0	18	pr
Rhyacophilidae Iranda	0	0	0.0				0	18	pr
Rhyacophilidae Sibirica	2	4	1.1				0	18	pr
Rhyacophilidae Vacua	0	0	0.0				0	18	pr
Rhyacophilidae verrula	0	0	0.0				0	18	pr
Rhyacophilidae vespulosa	0	0	0.0				0	18	pr
Rhyacophilidae sp.	0	0	0.0				0	18	pr
Trichoptera pupae	0	0	0.0				nn	nn	na
Other				11	5.79				
Annelida	9	19	4.7				5	108	cg
Coleoptera-Elmidae									
Cleptelmis sp.	0	0	0.0				4	108	cg
Heterelmis sp.	0	0	0.0				4	108	cg
Lara sp.	0	0	0.0				4	108	sh
Narpus sp.	0	0	0.0				4	108	cg
Zaitzevia sp.	0	0	0.0				4	108	cg
Elmidae	0	0	0.0				4	108	cg
Collembola	0	0	0.0				nn	nn	na
Diptera									
Agathon sp.	0	0	0.0				0	2	sc
Caratopogonidae	0	0	0.0				6	108	pr
Chironomidae	2	4	1.1				6	108	cg/f
Oreocetoton sp.	0	0	0.0				6	nn	pr
Simuliidae	0	0	0.0				6	108	cf
Antocha sp.	0	0	0.0				3	24	cg
Dicranota sp.	0	0	0.0				3	24	pr
Hexatomidae	0	0	0.0				3	36	pr
Pediocia sp.	0	0	0.0				3	36	pr
Tipula sp.	0	0	0.0				3	36	sh
Hydracarina	0	0	0.0				5	108	pr
Mollusca	0	0	0.0				8	108	cg
Nematoda	0	0	0.0				nn	nn	na
Turbellaria	0	0	0.0				4	108	pr
TOTAL NUMBER =	190			129			SDI =	3.2	
TOTAL TAXA =	19			89.50					
STD =	7.6			COEF. VAR. =	20.06				
MEAN =	38			SE MEAN =	9.12				

Macroinvertebrate Data-Montanore, August 1991
Libby Creek, Li0 #12

	For Each Taxa			Major Group			TV	TQ	FFG
	No.	No./sq.m.	Percent of Total	Total Number	Percent of Total				
Ephemeroptera				1065	54.14				
Baetis sp.	89	192	4.5				4	72	cg
Caudatella hystrix	0	0	0.0				1	nn	cg
Drunella coloradensis/ flavidines	8	17	0.4				1	18	sc
Drunella doddsii	149	322	7.6				1	4	sc
Drunella spinifera	0	0	0.0				1	24	sc
Drunella sp.	0	0	0.0				0	48	sc
Ephemerella sp.	0	0	0.0				1	48	sc
Serratella sp.	0	0	0.0				1	24	cg
Cinygma sp.	0	0	0.0				4	21	sc
Cinygma sp.	0	0	0.0				4	21	sc
Epeorus sp.	420	907	21.4				4	21	sc
Rhithrogena sp.	373	806	19.0				4	21	cg
Paraleptophlebia sp.	0	0	0.0				2	24	cg
Ameletus sp.	26	56	1.3				7	48	cg
Plecoptera				457	23.23				
Capniidae	12	26	0.6				1	32	sh
Kathroperla pardita	0	0	0.0				1	24	cg
Stictoptera/Smullia sp.	238	514	12.1				1	24	pr
Despaxia augusta	26	56	1.3				0	18	sh
Paraleuctra sp.	0	0	0.0				0	18	sh
Parlomyia sp.	0	0	0.0				0	18	sh
Luctridae	0	0	0.0				0	18	sh
Nemoura sp.	2	4	0.1				2	24	sh
Viscosa cataractae	24	52	1.2				2	nn	sh
Tropidoptera cinctipes	0	0	0.0				2	16	sh
Tropidoptera columbiana	77	166	3.9				2	16	sh
Nemouridae	0	0	0.0				2	36	sh
Yoraperla brevis	12	26	0.6				2	24	sh
Acronemura abnormis	0	0	0.0				1	6	pr
Dorconemura theodora	0	0	0.0				1	18	pr
Hesperoperla pacifica	0	0	0.0				1	18	pr
Parlidae	8	17	0.4				1	nn	pr
Isoperla sp.	0	0	0.0				2	48	pr
Megarcys sp.	0	0	0.0				2	24	pr
Setodes bradleyi	0	0	0.0				2	nn	pr
Perlodidae	58	125	2.9				2	nn	pr
Taenionema sp.	0	0	0.0				2	48	sc
Trichoptera				56	2.85				
Micrasema sp.	0	0	0.0				1	24	sh
Anagapetus sp.	0	0	0.0				0	24	sc
Glossosoma sp.	3	6	0.2				0	24	sc
Arctoplyche grandis	0	0	0.0				4	18	cf
Paraplyche elisia	10	22	0.5				4	6	cf
Hydropsychidae	0	0	0.0				4	108	nn
Agraylea sp.	0	0	0.0				4	108	cg
Ochrotrichia sp.	0	0	0.0				4	108	cg
Lepidostoma sp.	0	0	0.0				1	18	sh
Apatania sp.	0	0	0.0				4	18	sc
Ecclesomyia sp.	0	0	0.0				4	24	eg
Neothremma alicia	4	9	0.2				4	8	sc
Oligophlebodes sp.	0	0	0.0				4	24	sc
Limnephilidae	7	15	0.4				4	108	nn
Normaldia sp.	0	0	0.0				3	24	cf
Rhyacophilic Angelita	0	0	0.0				0	18	pr
Rhyacophilic Bettani	0	0	0.0				0	18	pr
Rhyacophilic Riffila/Coloradan	0	0	0.0				0	18	pr
Rhyacophilic Brunnea	0	0	0.0				0	18	pr
Rhyacophilic Hyalinata	0	0	0.0				0	18	pr
Rhyacophilic Iranda	0	0	0.0				0	18	pr
Rhyacophilic Sibirica	0	0	0.0				0	18	pr
Rhyacophilic Vaccua	9	19	0.5				0	18	pr
Rhyacophilic Verrula	0	0	0.0				0	18	pr
Rhyacophilic vespula	0	0	0.0				0	18	pr
Rhyacophilic sp.	22	48	1.1				0	18	pr
Trichoptera pupae	1	2	0.1				nn	nn	na
Other				389	19.78				
Annelida	73	162	3.8				5	108	cg
Coleoptera-Elmidae									
Cleptelmis sp.	0	0	0.0				4	108	cg
Heterelmis sp.	0	0	0.0				4	108	cg
Lara sp.	0	0	0.0				4	108	sh
Parpus sp.	0	0	0.0				4	108	cg
Taitzevia sp.	0	0	0.0				4	108	cg
Elmidae	0	0	0.0				4	108	cg
Collembola	0	0	0.0				nn	nn	na
Diptera									
Agathomyia sp.	0	0	0.0				0	2	sc
Ceratopogonidae	0	0	0.0				6	108	pr
Chironomidae	284	613	14.4				6	108	cg/f
Oreoceton sp.	2	4	0.1				6	nn	pr
Simuliidae	5	11	0.3				6	108	cf
Antocha sp.	0	0	0.0				3	24	cg
Dicranota sp.	6	13	0.3				3	24	pr
Hexatomidae	2	4	0.1				3	36	pr
Pedicia sp.	2	4	0.1				3	36	pr
Tipula sp.	0	0	0.0				3	36	sh
Hydracarina	0	0	0.0				5	108	pr
Mollusca	0	0	0.0				8	108	cg
Nematoda	0	0	0.0				nn	nn	na
Turbellaria	13	28	0.7				4	108	pr

TOTAL NUMBER = 1967 EPT Abund. = 1578 SDI = 3.4
 TOTAL TAXA = 30 EPT/Chiron. = 5.56
 STD = 73.2 COEF. VAR. = 18.61
 MEAN = 393 SE MEAN = 8.46

Macroinvertebrate Data-Montanore, August 1991
Libby Creek, L9 #11

	For Each Taxa			Major Group			TV	TQ	PPG
	No.	No./sq.m.	Percent of Total	Total Number	Percent of Total				
Ephemeroptera				1428	79.04				
Baetis sp.	210	454	11.7				4	72	cg
Caudatella hystrix	0	0	0.0				1	nn	cg
Drunella coloradensis/ flavilinea	12	26	0.7				1	18	sc
Drunella doddsi	230	497	12.8				1	4	sc
Drunella spinifera	0	0	0.0				0	48	sc
Drunella sp.	0	0	0.0				1	48	sc
Ephemerella sp.	0	0	0.0				1	24	cg
Serratella sp.	0	0	0.0				4	21	sc
Gingyma sp.	0	0	0.0				4	21	sc
Cinygmulia sp.	32	69	1.8				4	21	sc
Epcorus sp.	327	706	18.2				4	21	sc
Rhithrogena sp.	612	1322	34.1				4	21	cg
Paraleptophlebia sp.	0	0	0.0				2	24	cg
Ameletus sp.	5	11	0.3				7	48	cg
Plecoptera				206	11.49				
Capniidae	1	2	0.1				1	32	sh
Kathroperla perdita	3	6	0.2				1	24	cg
Sweltsa/Sutellia sp.	74	160	4.1				1	24	pr
Despaxia augusta	5	11	0.3				0	18	sh
Paraleuctra sp.	0	0	0.0				0	18	sh
Parclimyia sp.	0	0	0.0				0	18	sh
Luctridae	0	0	0.0				0	18	sh
Remora sp.	0	0	0.0				2	24	sh
Viscata cataractae	7	15	0.4				2	nn	sh
Tapada cinctipes	0	0	0.0				2	16	sh
Tapada columbiana	63	136	3.5				2	16	sh
Hemouridae	0	0	0.0				2	36	sh
Yoraperla brevis	7	15	0.4				2	24	sh
Acroneuria anomalis	0	0	0.0				1	6	pr
Doroneuria theodora	1	2	0.1				1	18	pr
Hesperoperla pacifica	1	2	0.1				1	nn	pr
Perlidae	4	9	0.2				2	48	pr
Isoperla sp.	0	0	0.0				2	24	pr
Megarcys sp.	20	43	1.1				2	nn	pr
Setevana bradleyi	0	0	0.0				2	nn	pr
Perlodidae	20	43	1.1				2	48	sc
Taenionema sp.	0	0	0.0				2	48	sc
Trichoptera				39	2.18				
Micrasema sp.	0	0	0.0				1	24	sh
Anagapetus sp.	0	0	0.0				0	24	sc
Glossosoma sp.	1	2	0.1				0	24	sc
Arctopsyche grandis	0	0	0.0				4	18	cf
Parapsyche elisia	7	15	0.4				4	6	cf
Hydropsychidae	0	0	0.0				4	108	nb
Agrylea sp.	0	0	0.0				4	108	cg
Ochrotrichia sp.	0	0	0.0				4	108	cg
Lepidostoma sp.	0	0	0.0				1	18	sh
Apatania sp.	0	0	0.0				4	18	sc
Ecdyonuridae sp.	0	0	0.0				4	24	cg
Nectrema alicia	2	4	0.1				4	8	sc
Oligophlebodes sp.	0	0	0.0				4	24	sc
Limnephilidae	0	0	0.0				4	108	nn
Normaldia sp.	0	0	0.0				3	24	cf
Rhyacophilidae	0	0	0.0				0	18	pr
Rhyacophilus Angelita	0	0	0.0				0	18	pr
Rhyacophilus Bettani	0	0	0.0				0	18	pr
Rhyacophilus Bifilia/Coloradan	0	0	0.0				0	18	pr
Rhyacophilus Brunnea	2	4	0.1				0	18	pr
Rhyacophilus Hyalinata	0	0	0.0				0	18	pr
Rhyacophilus Iranda	8	17	0.4				0	18	pr
Rhyacophilus Sibirica	0	0	0.0				0	18	pr
Rhyacophilus Vacua	4	9	0.2				0	18	pr
Rhyacophilus Verrula	0	0	0.0				0	18	pr
Rhyacophilus vegeta	0	0	0.0				0	18	pr
Rhyacophilus sp.	14	30	0.8				0	18	pr
Trichopteran pupae	1	2	0.1				nn	nn	na
Other				120	6.69				
Annelida	23	50	1.3				5	108	cg
Colleoptera-Elimidae									
Cleptalmis sp.	0	0	0.0				4	108	cg
Heterlimnius sp.	0	0	0.0				4	108	cg
Lara sp.	0	0	0.0				4	108	sh
Narpus sp.	0	0	0.0				4	108	cg
Taitzevia sp.	0	0	0.0				4	108	cg
Elmidae	1	2	0.1				4	108	cg
Collembola	0	0	0.0				nn	nn	na
Diptera									
Agathon sp.	0	0	0.0				0	2	sc
Caratopogonidae	0	0	0.0				6	108	pr
Chironomidae	71	153	4.0				6	108	cg/f
Oreocetona sp.	4	9	0.2				6	nn	pr
Simuliidae	3	6	0.2				6	108	cf
Antocha sp.	0	0	0.0				3	24	cg
Dicranota sp.	7	15	0.4				3	24	pr
Hexatomidae	0	0	0.0				3	36	pr
Pedicia sp.	0	0	0.0				3	36	pr
Tipula sp.	0	0	0.0				3	36	sh
Hydracarina	0	0	0.0				3	108	pr
Mollusca	0	0	0.0				8	108	cg
Rotifera	0	0	0.0				nn	nn	na
Turbellaria	11	24	0.6				4	108	pr
TOTAL NUMBER =	1793			1673					
TOTAL TAXA =	34			23.56					
STD =	81.0			COEF. VAR. =					
MEAN =	359			SE MEAN =					
				10.27					

**Macroinvertebrate Data-Montanore, October 1991
Libby Creek, L10 #20**

TOTAL NUMBER =
TOTAL TAXA =
STD =
MEAN =

3063
39
103.6
613

EPT Abund. = 295
 EPT/Chiron. = 113.6
 COEF. VAR. = 16.9
 SE MEAR = 7.6

SDI = 3.7

Macroinvertebrate Data-Montanore, October 1991
Libby Creek, 19 #19

	For Each Taxa			Major Group				
	No.	No./sq.m.	Percent of Total	Total Number	Percent of Total	IV	V	VI
Ephemeroptera				568	12.74			
Baetis sp.	18	39	0.4			4	72	cg
Caudatella hystrix	0	0	0.0			1	nn	cg
Drunella coloradensis/								
flavilimes	0	0	0.0			1	18	sc
Drunella doddsi	56	121	1.3			1	4	sc
Drunella spinifera	0	0	0.0			1	24	sc
Drunella sp.	0	0	0.0			0	48	sc
Ephemerella sp.	0	0	0.0			1	48	sc
Saccatella sp.	0	0	0.0			1	24	cg
Cingyma sp.	0	0	0.0			4	21	sc
cinygma sp.	31	110	1.1			4	21	sc
Epeorus sp.	325	702	7.3			4	21	sc
Rhithrogena sp.	107	231	2.4			4	21	cg
Paraleptophlebia sp.	1	2	0.0			2	24	cg
Ameletus sp.	10	22	0.2			7	48	cg
Plecoptera				3272	73.40			
Capniidae	4	9	0.1			1	32	sh
Katoporula pardita	0	0	0.0			1	24	cg
Sweltsa/Sweltia sp.	49	106	1.1			1	24	pr
Despaxia angusta	1	2	0.0			0	18	sh
Paraleuctra sp.	0	0	0.0			0	18	sh
Parlomyia sp.	0	0	0.0			0	18	sh
Loctridae	0	0	0.0			0	18	sh
Hemoura sp.	0	0	0.0			2	24	sh
Visoka cataractae	3	6	0.1			2	nn	sh
Zapada cinctipes	0	0	0.0			2	16	sh
Zapada colombiana	253	546	5.7			2	16	sh
Hescouridae	0	0	0.0			2	36	sh
Varparala brevis	4	9	0.1			2	24	sh
Acroseuria abnormalis	0	0	0.0			1	6	pr
Doroneuria theodora	0	0	0.0			1	18	pr
Hesperoperla pacifica	0	0	0.0			1	18	pr
Perlidae	18	39	0.4			1	nn	pr
Inoperla sp.	0	0	0.0			2	48	pr
Megarcysa sp.	46	99	1.0			2	24	pr
Setevana bradleyi	0	0	0.0			2	nn	pr
Perlidae	38	82	0.9			2	nn	pr
Taenionema sp.	2856	6169	64.1			2	48	sc
Trichoptera				562	13.06			
Hicrasma sp.	0	0	0.0			1	24	sh
Anagapetus sp.	0	0	0.0			0	24	sc
Glossosoma sp.	38	82	0.9			0	24	sc
Arctopsyche grandis	0	0	0.0			4	18	cf
Parapsyche elisia	8	17	0.2			4	6	cf
Hydropsychidae	405	875	9.1			4	108	nn
Agrayiles sp.	0	0	0.0			4	108	cg
Ochrotrichia sp.	0	0	0.0			4	108	cg
Lepidostoma sp.	0	0	0.0			1	18	sh
Apataniidae sp.	0	0	0.0			4	18	sc
Eccimomyia sp.	2	4	0.0			4	24	cg
Neothremma alicia	0	0	0.0			4	8	sc
Oligophlebiodes sp.	0	0	0.0			4	24	sc
Limnephilidae	2	4	0.0			4	108	nn
Wormaldia sp.	0	0	0.0			3	24	cf
Rhyacophilida Angelita	1	2	0.0			0	18	pr
Rhyacophilida Betteni	2	4	0.0			0	18	pr
Rhyacophilida Bifilia/Coloradensis	0	0	0.0			0	18	pr
Rhyacophilida Brunnea	6	13	0.1			0	18	pr
Rhyacophilida Hyalinata	28	60	0.6			0	18	pr
Rhyacophilida Iranda	0	0	0.0			0	18	pr
Rhyacophilida Sibirica	0	0	0.0			0	18	pr
Rhyacophilida Vacca	90	194	2.0			0	18	pr
Rhyacophilida Verrola	0	0	0.0			0	18	pr
Rhyacophilida vulpina	0	0	0.0			0	18	pr
Rhyacophilida sp.	0	0	0.0			0	18	pr
Trichopteran pupae	0	0	0.0			nn	nn	na
Other				36	0.81			
Annelida	0	0	0.0			5	108	cg
Coleoptera-Elimidae								
Cleptelmis sp.	0	0	0.0			4	108	cg
Heterlimnius sp.	1	2	0.0			4	108	cg
Lara sp.	0	0	0.0			4	108	sh
Narpus sp.	0	0	0.0			4	108	cg
Zaitzevia sp.	0	0	0.0			4	108	cg
Elmidae	0	0	0.0			4	108	cg
Collembola	0	0	0.0			nn	nn	na
Diptera								
Agathox sp.	0	0	0.0			0	2	sc
Ceratopogonidae	0	0	0.0			5	108	pr
Chironomidae	1	2	0.0			6	108	cg/f
Oreoceten sp.	4	9	0.1			6	nn	pr
Simuliidae	0	0	0.0			6	108	cf
Antocha sp.	0	0	0.0			3	24	cg
Dicranota sp.	19	41	0.4			3	24	pr
Hexatomidae	0	0	0.0			3	36	pr
Pedicia sp.	0	0	0.0			3	36	pr
Tipula sp.	0	0	0.0			3	36	sh
Hydracarina	0	0	0.0			5	108	pr
Mollusca	0	0	0.0			8	108	cg
Nematoda	0	0	0.0			nn	nn	na
Turbellaria	11	24	0.2			4	108	pr
TOTAL NUMBER =	4458			EPT Abund. =	4422		SDI =	2.2
TOTAL TAXA =	32			EPT/Chiron. =	4422.00			
STD =	312.3			COEF. VAR. =	35.03			
MEAN =	892			SE MEAN =	15.92			

Appendix B. Seasonal periphyton data, 1991.

Table 1. Estimated relative abundance of diatoms and genera of non-diatom algae in periphyton samples collected during 1991 Montanore baseline monitoring.

R=rare; C=common; VC=very common; A=abundant; VA=very abundant

Sampling Date:	May 1991	
Stream Name:	Libby Cr.	Libby Cr.
Site Number:	L9	L10
ID Number:	P003A	P004A
<u>ALGAE</u>		
<u>Bacillariophyta (diatoms)</u>		
All genera collectively	R	*
<u>Chlorophyta (green algae)</u>		
Cylindrocapsa	R	
<u>Cyanophyta (blue-green algae)</u>		
Aphanocapsa	VC	C
Oscillatoria	R	
Phormidium	VA	
Tolypothrix	C	

*Extremely sparse sample; no diatom frustules seen after thorough scan.

Table 2. Estimated relative abundance of diatoms and genera of non-diatom algae in periphyton samples collected during 1991 Montanore baseline monitoring.

R=rare; C=common; VC=very common; A=abundant; VA=very abundant

Sampling Date:	August 1991	
Stream Name:	Libby Cr.	Libby Cr.
Site Number:	L9	L10
ID Number:	P003B	P004B
ALGAE		
<u>Bacillariophyta (diatoms)</u>		
All genera collectively	C	R
<u>Chlorophyta (green algae)</u>		
Cylindrocapsa	R	
Ulothrix	R	C
Zygnema		A
<u>Chrysophyta (yellow-green algae)</u>		
Hydrurus		C
<u>Cyanophyta (blue-green algae)</u>		
Aphanocapsa	C	VC
Oscillatoria	VA	VA
Phormidium	VC	

Table 3. Estimated relative abundance of diatoms and genera of non-diatom algae in periphyton samples collected during 1991 Montanore baseline monitoring.

R=rare; C=common; VC=very common; A=abundant; VA=very abundant

Sampling Date: October 1991		
Stream Name:	Libby Cr.	Libby Cr.
Site Number:	L9	L10
ID Number:	P003C	P004C
<u>ALGAE</u>		
<u>Bacillariophyta (diatoms)</u>		
All genera collectively	C	C
<u>Chlorophyta (green algae)</u>		
Closterium	R	
Cosmarium	R	
Cylindrocapsa	VC	
Mougeotia	R	
Staurastrum	C	
Ulothrix	VA	C
Zygnema		VA
<u>Cyanophyta (blue-green algae)</u>		
Aphanocapsa	C	R
Calothrix		R
Oscillatoria	VC	R
Phormidium	R	C
<u>Rhodophyta (red algae)</u>		
Audouinella		R

Moss also present in both samples.

Table 4. Diatom proportional count data, 1991 Montanore baseline monitoring.
 N=number of frustules counted. PRA= percent relative abundance.
 ("p" indicates species seen during floristic scan but not during count.)

Sampling date: May 1991		Libby Cr.	Libby Cr.
Stream name:	<th>L9</th> <th>L10*</th>	L9	L10*
Site number:			
ID number:		003A	004A
SPECIES			
Achnanthes lanceolata	2	0.56	
A. linearis	17	4.78	
A. marginulata	3	0.84	
A. minutissima	60	16.85	p
A. species 1	3	0.84	
A. subrostrata	1	0.28	
Amphora perpusilla	1	0.28	
Anomoeoneis vitrea	p		
Aulacosiera alpigena	5	1.40	
Cymbella amphicephala	p		
C. silesiaca	1	0.28	
Diatoma anceps	5	1.40	
D. mesodon	177	49.72	p
Eunotia bilunaris	1	0.28	
E. minor	7	1.97	
E. musicola	8	2.25	
E. paludosa	3	0.84	
E. subarcuatooides	17	4.78	
Fragilaria capucina	25	7.02	
F. construens	1	0.28	
Frustulia rhombooides	p		
Gomphonema angustatum	1	0.28	
G. parvulum	8	2.25	
Meridion circulare	10	2.81	
Navicula gallica	p		
Nitzschia palea	p		
Pinnularia divergentissima	p		
Frustules Counted:	356	0	
Total Species:	27	2	
Species Counted:	21	0	
Shannon Diversity:	2.66	—	

*Diatom frustules too sparse to count despite highly concentrated sample.

Table 5. Diatom proportional count data, 1991 Montanore baseline monitoring.
 N=number of frustules counted. PRA= percent relative abundance.
 ("p" indicates species seen during floristic scan but not during count.)

Sampling date: August 1991		Libby Cr.		Libby Cr.	
Stream name:		L9		L10	
Site number:		003B		004B	
ID number:					
SPECIES	N	PRA	N	PRA	
<i>Achnanthes lanceolata</i>	2	0.56	1	1.19	
<i>A. linearis</i>	14	3.91	2	2.38	
<i>A. marginulata</i>	2	0.56			
<i>A. minutissima</i>	53	14.80	7	8.33	
<i>A. species 1</i>	15	4.19	3	3.57	
<i>A. subrostrata</i>	2	0.56			
<i>Aulacosiera alpigena</i>	6	1.68	p		
<i>Cymbella cesatii</i>	1	0.28			
<i>C. minuta</i>			p		
<i>C. silesiaca</i>	2	0.56	3	3.57	
<i>Diatoma anceps</i>	15	4.19	5	5.95	
<i>D. mesodon</i>	119	33.24	34	40.48	
<i>Diatomella balfouriana</i>	p				
<i>Eunotia bilunaris</i>	4	1.12			
<i>E. exigua</i>	3	0.84			
<i>E. minor</i>	1	0.28	p		
<i>E. musicola</i>	12	3.35	1	1.19	
<i>E. paludosa</i>	25	6.98	5	5.95	
<i>E. subarcuatoides</i>	38	10.61	6	7.14	
<i>Fragilaria capucina</i>	34	9.50	12	14.29	
<i>Frustulia rhomboides</i>	p		p		
<i>Gomphonema angustatum</i>	1	0.28			
<i>G. bipunctatum</i>	p				
<i>G. olivaceum</i>			p		
<i>G. parvulum</i>	7	1.96	1	1.19	
<i>Hannaea arcus</i>	2	0.56	1	1.19	
<i>Meridion circulare</i>	p		3	3.57	
<i>Navicula cryptocephala</i>	p				
<i>N. gallica</i>	p				
<i>Tabellaria flocculosa</i>	p		p		
Frustules Counted:	358		84 *		
Total Species:	28		20		
Species Counted:	21		14		
Shannon Diversity:	3.22		2.93		

*Very sparse sample; was not possible to count 350-400 frustules.

Table 6. Diatom proportional count data, 1991 Montanore baseline monitoring.
 N=number of frustules counted. PRA= percent relative abundance.
 ("p" indicates species seen during floristic scan but not during count.)

Sampling date: October 1991		Libby Cr.		Libby Cr.	
Stream name:		L9		L10	
Site number:		003C		004C	
ID number:					
SPECIES	N	PRA	N	PRA	
<i>Achnanthes linearis</i>	4	1.09	1	0.27	
<i>A. marginulata</i>	3	0.82			
<i>A. minutissima</i>	30	8.15	62	16.67	
<i>A. species 1</i>	15	4.08	43	11.56	
<i>A. species 2</i>	4	1.09			
<i>Aulacosiera alpigena</i>	3	0.82	2	0.54	
<i>Cymbella cesatii</i>	p		7	1.88	
<i>C. minuta</i>	1	0.27			
<i>C. reinhardtii</i>	p				
<i>C. silesiaca</i>	12	3.26	11	2.96	
<i>Diatoma anceps</i>	p		2	0.54	
<i>D. mesodon</i>	75	20.38	62	16.67	
<i>Eunotia exigua</i>	6	1.63			
<i>E. minor</i>	15	4.08	35	9.41	
<i>E. musicola</i>	15	4.08	1	0.27	
<i>E. paludosa</i>	36	9.78	5	1.34	
<i>E. subarcuatoides</i>	132	35.87	33	8.87	
<i>Fragilaria capucina</i>	7	1.90	18	4.84	
<i>Frustulia rhomboides</i>	1	0.27			
<i>Gomphonema angustatum</i>	p				
<i>G. clavatum</i>			12	3.23	
<i>G. parvulum</i>	5	1.36	30	8.06	
<i>Hannaea arcus</i>	1	0.27	1	0.27	
<i>Hantzschia amphioxys</i>	p				
<i>Meridion circulare</i>	1	0.27	47	12.63	
<i>Navicula angusta</i>	p				
<i>N. mutica</i>	1	0.27	p		
<i>Neidium affine</i>	p				
<i>N. bisulcatum</i>	p				
<i>Nitzschia dissipata</i>	1	0.27			
<i>Tabellaria flocculosa</i>	p		p		
Frustules Counted:	368		372		
Total Species:	30		19		
Species Counted:	21		17		
Shannon Diversity:	3.03		3.39		