BIOLOGICAL INTEGRITY OF BILLMAN CREEK, PARK COUNTY, MONTANA BASED ON THE COMPOSITION AND STRUCTURE OF THE BENTHIC ALGAE COMMUNITY

Prepared for:

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October 21, 2000

SUMMARY

On July 21, 2000, periphyton samples were collected from two stations on Billman Creek near Livingston, Montana for the purpose of assessing whether the creek is water-quality limited and in need of TMDLs. The samples were collected following DEQ standard operating procedures, processed and analyzed using standard methods for periphyton, and evaluated following modified USEPA rapid bioassessment protocols for wadeable streams.

Billman Creek is unique among small streams in the area in that it heads at a relatively low elevation, has a mud bottom, and flows through agricultural land. For this reason, Billman Creek metrics were compared to criteria for both mountain streams and prairie streams.

An unusually large percentage of motile diatoms indicated that both sites on Billman Creek were impaired by sediment. The upper site was severely impaired for a mountain stream and moderately impaired based on criteria for prairie streams. The lower site was moderately impaired for a mountain stream but only slightly impaired for a prairie stream. All other diatom metrics indicated no impairment or only minor impairment.

Both sites showed signs of nutrient enrichment. However, dominance by filamentous green algae, the presence of euglenoid algae, and a lower value for the pollution index indicated that Station 2 received more nutrient loading than Station 1.

Both sites had a small number of teratological cells, perhaps indicating small concentrations of toxic chemicals. And both sites had only small percentages of diatoms in the family Epithemiaceae, which may indicate that nitrogen concentrations were not limiting to algal growth in Billman Creek. The two sites had less than 40% of their diatom assemblages in common.

INTRODUCTION

This report evaluates the biological integrity, support of aquatic life uses, and probable causes of impairment to those uses, in Billman Creek near Livingston, Montana. The purpose of this report is to provide information that will help the State of Montana determine whether Billman Creek is water-quality limited and in need of TMDLs.

The federal Clean Water Act directs states to develop water pollution control plans (Total Maximum Daily Loads or TMDLs) that set limits on pollution loading to water-quality limited waters. Water-quality limited waters are lakes and stream segments that do not meet water-quality standards, that is, that do not fully support their beneficial uses. The Clean Water Act and USEPA regulations require each state to (1) identify waters that are water-quality limited, (2) prioritize and target waters for TMDLs, and (3) develop TMDL plans to attain and maintain water-quality standards for all water-quality limited waters.

Evaluation of use support in this report is based on the species composition and structure of the periphyton (benthic algae, phytobenthos) community at two stream sites that were sampled on July 21, 2000. The periphyton community is a basic biological component of all aquatic ecosystems. Periphyton accounts for much of the primary production and biological diversity in Montana streams (Bahls et al. 1992).

Plafkin et al. (1989) and Stevenson and Bahls (1999) list several advantages of using periphyton in biological assessments:

- Algae are universally present in large numbers in all streams and unimpaired periphyton assemblages typically support a large number (>30) of species;

- Algae have rapid reproduction rates and short life cycles, making them useful indicators of short-term impacts;

- As primary producers, algae are most directly affected by physical and chemical factors, such as temperature, nutrients, dissolved salts, and toxins;

- Sampling is quick, easy and inexpensive, and causes minimal damage to resident biota and their habitat;

- Standard methods and criteria exist for evaluating the composition, structure, and biomass of algal associations;

- Identification to species is straightforward for the diatoms, for which there is a large body of taxonomic and ecological literature;

- Excessive algae growth in streams is often correctly perceived as a problem by the public.

- Periphyton and other biological communities reflect the *biological integrity*[1] of waterbodies; restoring and maintaining the biological integrity of waterbodies is a goal of the federal Clean Water Act;

- Periphyton and other biological communities integrate the effects of different stressors and provide a measure of their aggregate impact; and

- Periphyton and other biological communities may be the only practical means of evaluating impacts from non-point sources of pollution where specific ambient criteria do not exist (e.g., impacts that degrade habitat or increase nutrients).

Periphyton is a diverse assortment of simple photosynthetic organisms called algae, and other microorganisms that live attached to or in close proximity of the stream bottom. Most algae, such as the diatoms, are microscopic. Diatoms are distinguished by having a cell wall composed of opaline glass--hydrated amorphous silica. Diatoms often carpet a stream bottom with a slippery brown film.

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[1] *Biological integrity* is defined as "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region" (Karr and Dudley 1981).

Some algae, such as the filamentous greens, are conspicuous and their excessive growth may be aesthetically displeasing, deplete dissolved oxygen, interfere with fishing and fish spawning, clog water filters and irrigation intakes, create tastes and odors in drinking water, and cause other problems.

PROJECT AREA AND SAMPLING SITES

The project area is located in Park County near the city of Livingston, Montana (pop. 7,414). Billman Creek heads west of Livingston at Bozeman Pass (el. 5,760 feet) and flows easterly for about 15 miles to where it enters the Yellowstone River just south of Livingston. For most of its length, Billman Creek parallels Interstate Highway 90 and the main line of the Burlington Northern & Santa Fe Railway.

The Billman Creek watershed is within the Montana Valley and Foothill Prairies Ecoregion (Woods et al. 1999). The surface geology consists of upper Cretaceous volcaniclastic deposits of the Livingston Group and lower Mesozoic calcareous sandstone, shale, and limestone of the Ellis Group (Renfro and Feray 1972). Vegetation is mixed grassland on silty-clay soils (USDA 1976). Billman Creek is very different from most of the other small streams in the area in that it has a mud bottom and flows through agricultural land (Patrick Newby, MDEQ, personal communication).

Periphyton samples were collected at two sites on July 21, 2000 (Map 1, Table 1). The upper site (Station 1) is located just upstream of Miner Creek and the Cokedale Road, and about 5 miles upstream from the mouth of Billman Creek. The elevation of this sampling site is about 4,900 feet. The lower site (Station 2) is located at the mouth of Billman Creek at an elevation of about 4,500 feet. Billman Creek is classified B-1 in the Montana Surface Water Quality Standards.

METHODS

Periphyton samples were collected by Patrick Newby of the MDEQ Monitoring and Data Management Bureau following standard operating procedures of the MDEQ Planning, Prevention, and Assistance Division.

Using appropriate tools, microalgae were scraped, brushed, or sucked from natural substrates in proportion to the rank of those substrates at the study site. Macroalgae were picked by hand in proportion to their abundance at the site. All collections of microalgae and macroalgae were pooled into a common container and preserved with Lugol's solution.

The samples were examined to estimate the relative abundance and rank by biovolume of diatoms and genera of soft (non-diatom) algae according to the method described in Bahls (1993). Soft algae were identified using Dillard (1999), Prescott (1978), Smith (1950), and Whitford and Schumacher (1984). These books also served as references on the ecology of the soft algae, along with Palmer (1977).

After the identification of soft algae, the raw periphyton samples were cleaned of organic matter using sulfuric acid, and permanent diatom slides were prepared using Naphrax, a high refractive index mounting medium, following *Standard Methods for the Examination of Water and Wastewater* (APHA 1998). Between 416 and 418 diatom cells (832 to 836 valves) were counted at random and identified to species. The following were used as the main taxonomic and autecological references for the diatoms: Krammer and Lange-Bertalot 1986, 1988, 1991a, 1991b; Patrick and Reimer 1966, 1975. Lowe (1974) was also used as an ecological reference for the diatoms.

The diatom proportional counts were used to generate an

array of diatom association metrics (Table 2). A metric is a characteristic of the biota that changes in some predictable way with increased human influence (Barbour et al. 1999).

Metric values from Billman Creek were compared to numeric biocriteria or threshold values developed for streams in the Rocky Mountain and Great Plains Ecoregions of Montana (Tables 3 and 4). These criteria are based on metric values measured in least-impaired reference streams (Bahls et al. 1992) and on metric values measured in streams that are known to be impaired by various sources and causes of pollution (Bahls 1993). Because metrics from both sites indicated impairment (see Table 6), Protocol II (Bahls 1993) could not be used.

The criteria in Tables 3 and 4 distinguish among four levels of impairment and three levels of aquatic life use support: no impairment or only minor impairment (full support); moderate impairment (partial support); and severe impairment (nonsupport). These impairment levels correspond to excellent, good, fair, and poor *biological integrity*, respectively.

Quality Assurance. Several steps were taken to assure that the study results are accurate and reproducible.

Upon receipt of the samples, station and sample information were recorded in a laboratory notebook and the samples were assigned a unique number compatible with the Montana Diatom Database, e.g., 1992-01. The first part of this number (1992) designates the sampling site (Billman Creek Station 1); the second part of this number (01) designates the number of periphyton samples that have been collected at this site to date for which data have been entered into the Montana Diatom Database.

Sample observations and analyses of soft (non-diatom) algae were recorded in a lab notebook along with station and sample information provided by MDEQ. A portion of the raw sample was used to make duplicate diatom slides. After completing the diatom proportional count, the slide used for the count will be deposited in the University of Montana Herbarium in Missoula. The other slide will be retained by *Hannaea* in Helena.

On completion of the project, station information, sample information, and diatom proportional count data will be entered into the Montana Diatom Database.

RESULTS AND DISCUSSION

Results are presented in Tables 5 and 6, which are located near the end of this report following the Literature Cited section. Spreadsheets containing completed diatom proportional counts, with species' pollution tolerance classes (PTC) and percent abundances, are attached as Appendix A.

SAMPLE NOTES

Station 1. The sample from this site was very silty and the diatom assemblage was dominated by *Navicula* species.

Station 2. The sample from this site was also very silty. The diatom assemblage was dominated by *Melosira varians* and extremely long "board fences" (filaments) of *Fragilaria* species (later confirmed to be *Fragilaria capucina*).

NON-DIATOM ALGAE

The periphyton sample from **Station 1** was dominated by chrysophycean algae: diatoms and *Vaucheria* (Table 5). Although rare, the large green alga *Closterium* ranked third in biovolume. The cyanobacterium *Oscillatoria* ranked fourth.

The filamentous green alga *Spirogyra* dominated the sample from **Station 2** (Table 5). *Oedogonium*, another filamentous green, was abundant and ranked second, while diatoms were also abundant and ranked third in biovolume. Two other filamentous green algae--*Cladophora* and *Mougeotia*--ranked 4th and 5th. These are

all common and widespread algae that may become a nuisance in waters that are enriched with nutrients. *Spirogyra, Oedogonium,* and *Mougeotia* are particularly abundant in warmer standing or slow-moving waters.

The abundance of green algae and diatoms relative to cyanobacteria probably indicates moderate nutrient enrichment at both sites on Billman Creek. Generally, cyanobacteria (blue-green algae) indicate lower nutrient levels in mountain streams in Montana (Bahls et al. 1992). They cannot compete with diatoms and green algae under moderate to heavy nutrient loading. The presence of an euglenoid alga (*Phacus*) at **Station 2** suggests some organic loading at this site.

DIATOMS

Together with *Surirella minuta*, four species of *Navicula* dominated the diatom assemblage at **Station 1** (Table 6). Most of these species are somewhat tolerant of organic loading and nutrient enrichment, and they are all motile species adapted to living in aggrading or depositional habitats.

Most diatom metrics at **Station 1** indicate good or excellent biological integrity (Table 6). However, the unusually high percentage of motile taxa resulted in a siltation index that indicates severe impairment for a mountain stream. When compared to siltation criteria for plains streams, the siltation index still indicates moderate impairment and partial support of aquatic life uses (Table 6). This comparison (with prairie stream criteria) is probably valid given the unique nature of Billman Creek (Patrick Newby, MDEQ, personal communication).

Although the percentage of motile taxa at **Station 2** was smaller (Table 6), it nevertheless indicates moderate impairment for a mountain stream and minor impairment for a plains stream.

While not motile, the two most abundant diatoms at **Station 2**--*Fragilaria capucina* and *Melosira varians*--are unattached, tychoplanktonic species that thrive under low-flow conditions. In slowly-flowing streams, *Melosira varians* is known to develop massive growths consisting of long brown streamers (Krammer & Lange-Bertalot 1991a). All other metrics indicate good to excellent biological integrity at **Station 2**.

The pollution index declined slightly between **Station 1** and **Station 2** (Table 6), indicating a small increase in organic loading between these sites. Both sites had a small number of teratological cells, perhaps indicating small concentrations of toxic chemicals. And both sites had small percentages of diatoms in the family Epithemiaceae, which may indicate that nitrogen concentrations are not limiting to algal growth in Billman Creek.

Station 1 and **Station 2** had less than 40% of their diatom assemblages in common (Table 6). Stations on adjacent reaches of the same stream, without intervening tributaries or pollution sources, usually have at least 60% of their diatom associations in common (Bahls 1993).

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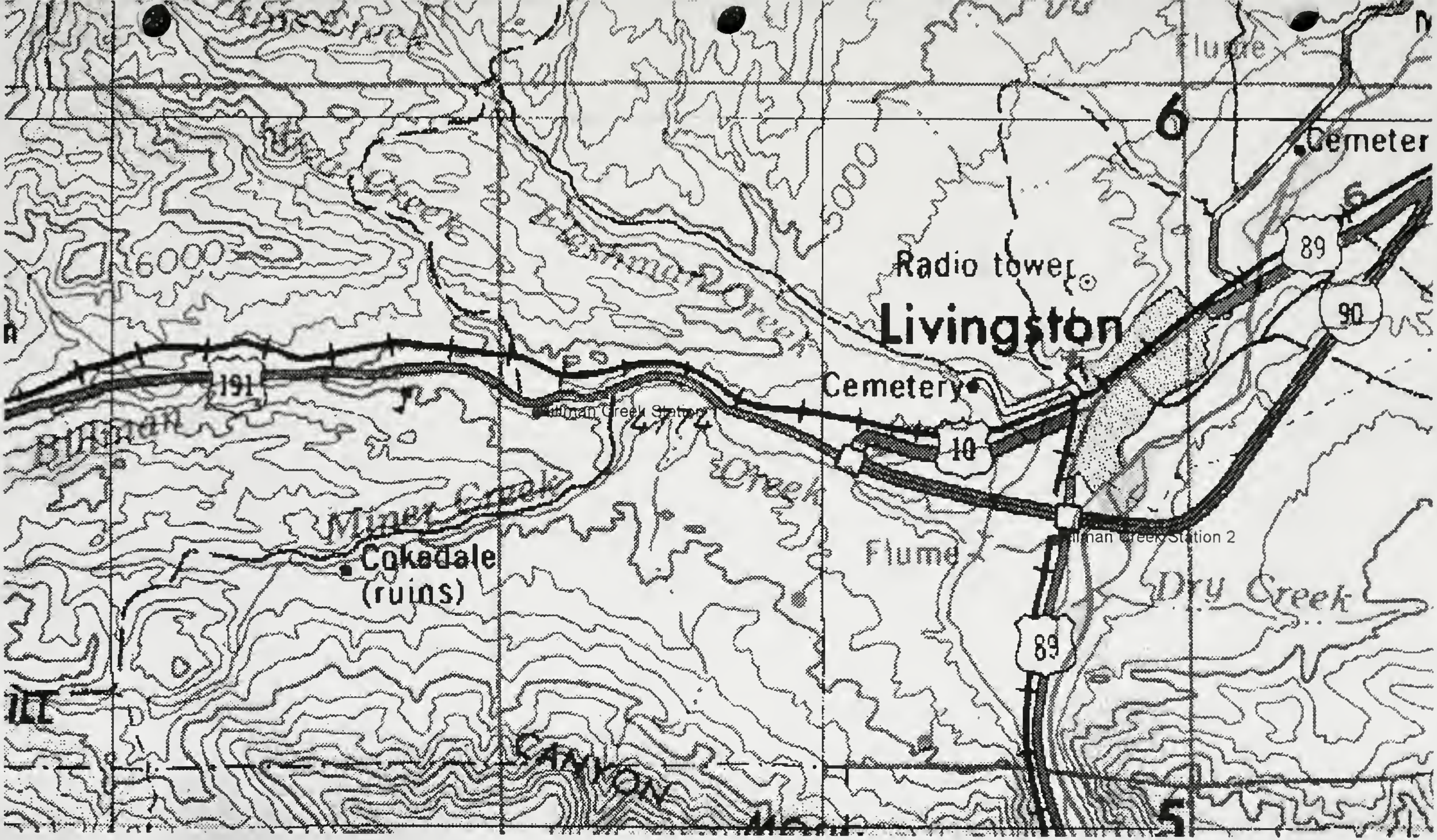

Map 1

'Bozeman; MT,WY'; Scale: 1" = 1,191Mi 1,917Mt 6,290Ft, 1 Mi = 0.839" , 1 cm = 755Mt

Table 1. Location of periphyton stations on Billman Creek sampled July 21, 2000: Station codes, sample numbers in the Montana Diatom Database, and latitudes and longitudes. Stations are listed in order from upstream to downstream.

Location	Station Code	Sample Number	Latitude/ Longitude
Billman Creek above Miner Creek	Station 1	1992-01	45 39 28 110 39 58
Billman Creek at mouth near Livingston	Station 2	1993-01	45 38 31 110 34 21

Table 2. Diatom association metrics used to evaluate biological integrity in Montana streams: reference, range of values in Montana streams, and expected direction of metric response to increasing anthropogenic perturbation or natural stress.

Metric	Reference	Range of Values	Expected Response
Shannon Species Diversity	Bahls 1979	0.00-5.00+	Decrease[1]
Pollution Index[2]	Bahls 1993	1.00-3.00	Decrease
Siltation Index[3]	Bahls 1993	0.00-90.0+	Increase
Disturbance Index[4]	Barbour *et al*. 1999	0.00-100.0	Increase
No. Species Counted	Bahls 1979, 1993	0-100+	Decrease[1]
Percent Dominant Species	Barbour *et al*. 1999	5.0-100.0	Increase
Percent Abnormal Cells	McFarland *et al*. 1997	0.0-20.0+	Increase
Similarity Index	Whittaker 1952	0.0-80.0+	Decrease
Percent Epithemiaceae	Stevenson & Pan 1999	0.0-80.0+	Decrease
Percent Aerophiles	Johansen 1999	0.0-100	Increase

[1] Shannon diversity and species richness may increase somewhat in naturally nutrient-poor mountain streams in response to slight to moderate increases in nutrients or sediment.

[2] Composite numeric expression of the pollution tolerances assigned by Lange-Bertalot (1979) to the common diatom species.

[3] Sum of the percent abundances of all species in the genera *Navicula*, *Nitzschia*, and *Surirella*, plus the species *Cymbella sinuata*.

[4] Percent abundance of *Achnanthes minutissima*.

Table 3. Criteria for rating levels of biological integrity, environmental impairment or natural stress, and aquatic life use support in wadeable **mountain** streams of Montana using selected metrics for benthic diatom associations. The lowest rating for any one metric is the overall rating for the study site.

Biological Integrity/ Impairment or Natural Stress/Use Support	Diversity Index (Shannon)	Pollution Index	Siltation Index	Disturbance Index	Number of Species Counted	Percent Dominant Species	Percent Abnormal Cells	Similarity Index[1]
Excellent None/Full Support	>2.99	>2.50	<20.0	<25.0	>29	<25.0	0.0	>59.9
Good/Minor Full Support	2.00-2.99	2.01-2.50	20.0-39.9	25.0-49.9	20-29	25.0-49.9	>0.0-<1.0	40.0-59.9
Fair/Moderate Partial Support	1.00-1.99	1.50-2.00	40.0-59.9	50.0-74.9	10-19	50.0-74.9	1.0-9.9	20.0-39.9
Poor/Severe Nonsupport	<1.00	<1.50	>59.9	>74.9	<10	>74.9	>9.9	<20.0

[1] The Similarity Index or Percent Community Similarity (Whittaker 1952) may be used to compare a study site to an unimpaired upstream control site on the same stream. This metric measures the degree of floristic similarity between diatom associations at the two sites and is the sum of the smaller of the two percent abundance values for each species that is common to both sites. Adjacent riffles on the same stream, without intervening tributaries or environmental perturbations, will generally have at least 60% of their diatom floras in common (Bahls 1993). PCS may also be used to guage the relative amount of impairment or recovery that occurs between adjacent study sites: >59.9% = very similar floras, no change; 40.0-59.9% = somewhat similar floras, minor change; 20.0-39.9% = somewhat dissimilar floras, moderate change; <20.0% = very dissimilar floras, major change.

Table 4. Criteria for rating levels of biological integrity, environmental impairment or natural stress, and aquatic life use support in wadeable **plains** streams of Montana using selected metrics for benthic diatom associations. The lowest rating for any one metric is the overall rating for the study site.

Biological Integrity/ Impairment or Natural Stress/Use Support	Diversity Index (Shannon)	Pollution Index	Siltation Index	Disturbance Index	Number of Species Counted	Percent Dominant Species	Percent Abnormal Cells	Similarity Index[1]
Excellent None/Full Support	>3.99	>2.25	<50.0	<25.0	>39	<25.0	0.0	>59.9
Good/Minor Full Support	3.00-3.99	1.76-2.25	50.0-69.9	25.0-49.9	30-39	25.0 49.9	>0.0-<1.0	40.0-59.9
Fair/Moderate Partial Support	2.00-2.99	1.25-1.75	70.0-89.9	50.0-74.9	20-29	50.0-74.9	1.0-9.9	20.0-39.9
Poor/Severe Nonsupport	<2.00	<1.25	>89.9	>74.9	<20	>74.9	>9.9	<20.0

[1] The Similarity Index or Percent Community Similarity (Whittaker 1952) may be used to compare a study site to an unimpaired upstream control site on the same stream. This metric measures the degree of floristic similarity between diatom associations at the two sites and is the sum of the smaller of the two percent abundance values for each species that is common to both sites. Adjacent riffles on the same stream, without intervening tributaries or environmental perturbations, will generally have at least 60% of their diatom floras in common (Bahls 1993). PCS may also be used to guage the relative amount of impairment or recovery that occurs between adjacent study sites: >59.9% = very similar floras, no change; 40.0-59.9% = somewhat similar floras, minor change; 20.0-39.9% = somewhat dissimilar floras, moderate change; <20.0% = very dissimilar floras, major change.

Table 5. Relative abundance of cells and rank by biovolume of diatoms and genera of non-diatom algae in periphyton samples collected from Billman Creek near Livingston, Montana on July 21, 2000.

Taxa	Relative Abundance and (Rank)	
	Station 1	Station 2
Chlorophyta (green algae)		
Cladophora		occasional (5)
Closterium	rare (3)	
Mougeotia		common (4)
Oedogonium		abundant (2)
Spirogyra		dominant (1)
Euglenophyta (euglenoid algae)		
Phacus		rare (7)
Chrysophyta (golden algae)		
Bacillariophyceae (diatoms)	frequent (1)	abundant (3)
Vaucheria	frequent (2)	
Cyanophyta (cyanobacteria)[1]		
Oscillatoria	occasional (4)	occasional (6)

[1] Formerly known as blue-green algae.

Table 6. Percent abundance of major diatom species[1] and values of selected diatom association metrics for periphyton samples collected from Billman Creek near Livingston, Montana on July 21, 2000.

Species/Metric (Pollution Tolerance Class)[3]	Percent Abundance/Metric Values[2]			
	Mountain Criteria		Plains Criteria[4]	
	Sta. 1	Sta. 2	Sta. 1	Sta. 2
Fragilaria capucina (2)		8.65		
Melosira varians (2)		14.78		
Navicula capitatoradiata (2)	11.96	0.60		
Navicula gregaria (2)	9.81	2.64		
Navicula lanceolata (2)	27.03	6.97		
Navicula tripunctata (3)	6.22	0.84		
Nitzschia palea (1)	3.95	7.09		
Nitzschia paleacea (2)		5.89		
Surirella minuta (2)	11.00	6.25		
Cells Counted	418	416		
Total Species	51	83		
Species Counted	50	77		
Species Diversity	3.92	5.04		
Percent Dominant Species	27.03	14.78	27.03	
Disturbance Index	1.67	2.64		
Pollution Index	2.14	2.10	2.14	2.10
Siltation Index	**87.70**	**54.76**	**87.70**	54.76
Percent Abnormal Cells	0.96	0.84	0.96	0.84
Percent Epithemiaceae	0.00	0.24		
Similarity Index	37.56			

[1] A major diatom species is here considered to be one that accounts for 5% or more of the cells in one or more samples of a sample set.

[2] Underlined values indicate good biological integrity, minor impairment, and full support of aquatic life uses; **bold values** indicate fair biological integrity, moderate impairment, and partial support of aquatic life uses; **underlined and bold values** indicate poor biological integrity, severe impairment, and non-support of aquatic life uses; all other values indicate excellent biological integrity, no impairment, and full support of aquatic life uses when compared to diatom criteria for mountain and plains streams in Tables 3 and 4.

[3] 3 = sensitive to pollution; 2 = tolerant of pollution; 1 = most tolerant of pollution.

[4] Only metric values that exceed diatom biocriteria for plains streams are shown.

APPENDIX A: DIATOM PROPORTIONAL COUNTS

Sample	Genus/Species/Variety	Pollution Tolerance Class	Count	Percent
199201	Achnanthes lanceolata	2	3	0.36
199201	Achnanthes minutissima	3	14	1.67
199201	Amphora libyca	3	6	0.72
199201	Amphora pediculus	3	27	3.23
199201	Cocconeis placentula	3	36	4.31
199201	Cyclotella meneghiniana	2	3	0.36
199201	Cymatopleura solea	2	4	0.48
199201	Frustulia vulgaris	2	2	0.24
199201	Gyrosigma spencerii	2	1	0.12
199201	Navicula acceptata	2	2	0.24
199201	Navicula agrestis	1	6	0.72
199201	Navicula capitata	2	12	1.44
199201	Navicula capitatoradiata	2	100	11.96
199201	Navicula cincta	1	1	0.12
199201	Navicula cryptotenella	2	15	1.79
199201	Navicula gregaria	2	82	9.81
199201	Navicula halophiloides	1	2	0.24
199201	Navicula lanceolata (Ag.) E.	2	226	27.03
199201	Navicula menisculus	2	2	0.24
199201	Navicula minima	1	2	0.24
199201	Navicula pupula	2	2	0.24
199201	Navicula reichardtiana	2	14	1.67
199201	Navicula soehrensis v. muscicola	3	1	0.12
199201	Navicula tripunctata	3	52	6.22
199201	Navicula vandamii	2	2	0.24
199201	Navicula veneta	1	2	0.24
199201	Navicula viridula	2	4	0.48
199201	Neidium binodeformis	3	2	0.24
199201	Nitzschia acicularis	2	2	0.24
199201	Nitzschia aequorea	2	2	0.24
199201	Nitzschia apiculata	2	4	0.48
199201	Nitzschia calida	2	6	0.72
199201	Nitzschia capitellata	2	7	0.84
199201	Nitzschia dissipata	3	9	1.08
199201	Nitzschia frustulum	2	3	0.36
199201	Nitzschia gracilis	2	1	0.12
199201	Nitzschia heufleriana	3	3	0.36
199201	Nitzschia hungarica	2	1	0.12
199201	Nitzschia inconspicua	2	1	0.12
199201	Nitzschia linearis	2	21	2.51
199201	Nitzschia palea	1	33	3.95
199201	Nitzschia recta	3	3	0.36
199201	Nitzschia sigmoidea	3	3	0.36
199201	Nitzschia sublinearis	2	1	0.12
199201	Nitzschia supralitorea	2	3	0.36
199201	Nitzschia vermicularis	2	5	0.60
199201	Reimeria sinuata	3	6	0.72

Sample	Genus/Species/Variety	Pollution Tolerance Class	Count	Percent
199201	Rhoicosphenia curvata	3	0	0.00
199201	Surirella minuta	2	92	11.00
199201	Synedra parasitica	2	1	0.12
199201	Synedra ulna	2	4	0.48

Sample	Genus/Species/Variety	Pollution Tolerance Class	Count	Percent
199301	Achnanthes conspicua	3	2	0.24
199301	Achnanthes lanceolata	2	1	0.12
199301	Achnanthes minutissima	3	22	2.64
199301	Amphora libyca	3	9	1.08
199301	Amphora montana	2	2	0.24
199301	Amphora pediculus	3	33	3.97
199301	Aulacoseira italica	3	1	0.12
199301	Cocconeis pediculus	3	5	0.60
199301	Cocconeis placentula	3	14	1.68
199301	Cyclotella meneghiniana	2	1	0.12
199301	Cyclotella ocellata	3	1	0.12
199301	Cymatopleura elliptica	2	1	0.12
199301	Cymatopleura solea	2	10	1.20
199301	Cymbella affinis	3	7	0.84
199301	Cymbella mexicana	3	2	0.24
199301	Cymbella silesiaca	2	2	0.24
199301	Diatoma mesodon	3	2	0.24
199301	Diatoma tenuis	2	0	0.00
199301	Diatoma vulgaris	3	13	1.56
199301	Epithemia sorex	3	2	0.24
199301	Eunotia minor	2	2	0.24
199301	Fragilaria brevistriata	3	4	0.48
199301	Fragilaria capucina	2	72	8.65
199301	Fragilaria vaucheriae	2	2	0.24
199301	Frustulia vulgaris	2	1	0.12
199301	Gomphonema angustatum	2	4	0.48
199301	Gomphonema olivaceum	3	12	1.44
199301	Gomphonema parvulum	1	2	0.24
199301	Gomphonema truncatum	3	2	0.24
199301	Melosira varians	2	123	14.78
199301	Navicula accomoda	1	2	0.24
199301	Navicula agrestis	1	2	0.24
199301	Navicula capitata	2	4	0.48
199301	Navicula capitatoradiata	2	5	0.60
199301	Navicula cincta	1	2	0.24
199301	Navicula cryptotenella	2	7	0.84
199301	Navicula gregaria	2	22	2.64
199301	Navicula halophiloides	1	2	0.24
199301	Navicula lanceolata (Ag.) E.	2	58	6.97
199301	Navicula menisculus	2	3	0.36
199301	Navicula microcari	2	2	0.24
199301	Navicula minima	1	16	1.92
199301	Navicula pupula	2	9	1.08
199301	Navicula pygmaea	2	0	0.00
199301	Navicula reichardtiana	2	10	1.20
199301	Navicula sp.	2	2	0.24
199301	Navicula tripunctata	3	7	0.84

Sample	Genus/Species/Variety	Pollution Tolerance Class	Count	Percent
199301	Navicula veneta	1	2	0.24
199301	Navicula viridula	2	9	1.08
199301	Neidium dubium	3	0	0.00
199301	Nitzschia acicularis	2	4	0.48
199301	Nitzschia angustata	2	5	0.60
199301	Nitzschia apiculata	2	12	1.44
199301	Nitzschia calida	2	4	0.48
199301	Nitzschia capitellata	2	4	0.48
199301	Nitzschia dissipata	3	20	2.40
199301	Nitzschia frustulum	2	8	0.96
199301	Nitzschia gracilis	2	6	0.72
199301	Nitzschia heufleriana	3	1	0.12
199301	Nitzschia hungarica	2	2	0.24
199301	Nitzschia incognita	2	11	1.32
199301	Nitzschia inconspicua	2	6	0.72
199301	Nitzschia liebetruthii	2	2	0.24
199301	Nitzschia linearis	2	13	1.56
199301	Nitzschia microcephala	1	2	0.24
199301	Nitzschia palea	1	59	7.09
199301	Nitzschia paleacea	2	49	5.89
199301	Nitzschia perminuta	3	2	0.24
199301	Nitzschia recta	3	0	0.00
199301	Nitzschia sigmoidea	3	0	0.00
199301	Nitzschia sociabilis	2	8	0.96
199301	Nitzschia supralitorea	2	10	1.20
199301	Nitzschia vermicularis	2	10	1.20
199301	Reimeria sinuata	3	2	0.24
199301	Rhoicosphenia curvata	3	10	1.20
199301	Stauroneis smithii	3	2	0.24
199301	Stephanodiscus medius	2	1	0.12
199301	Stephanodiscus minutulus	2	1	0.12
199301	Surirella angusta	1	0	0.00
199301	Surirella minuta	2	52	6.25
199301	Synedra fasciculata	2	4	0.48
199301	Synedra parasitica	2	1	0.12
199301	Synedra ulna	2	3	0.36