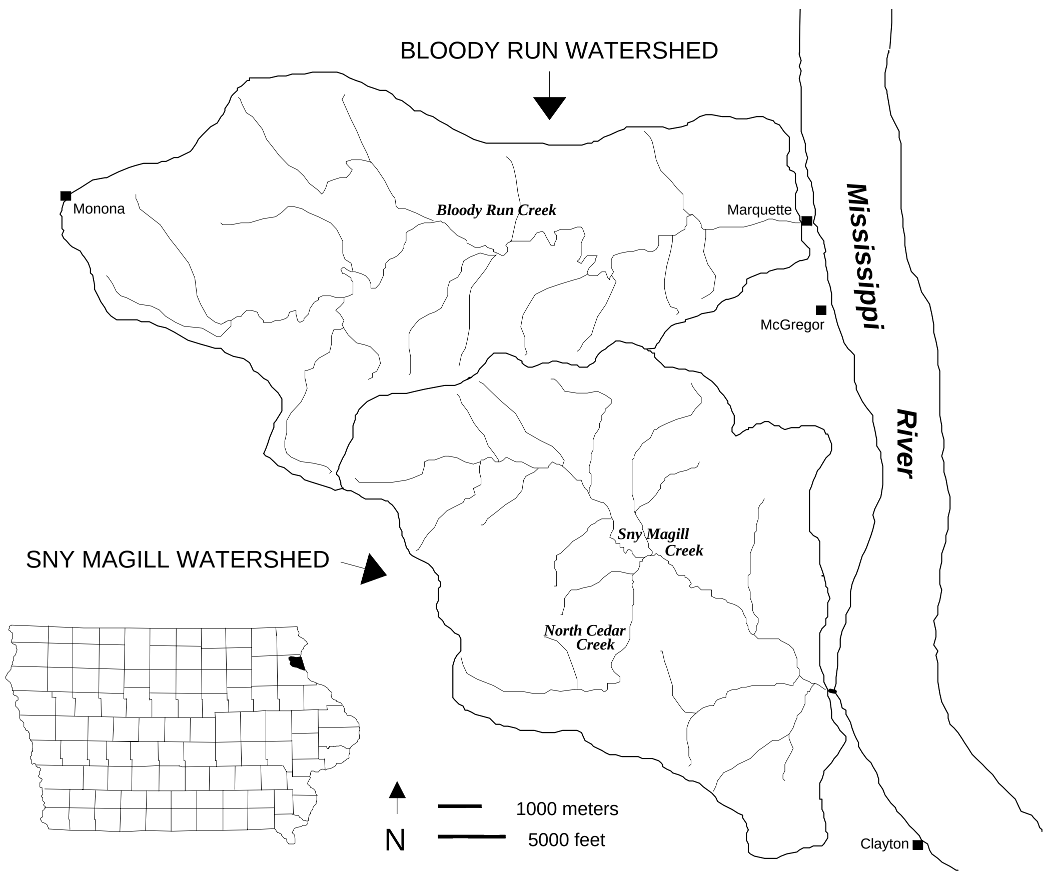
SNY MAGILL NONPOINT SOURCE POLLUTION MONITORING PROJECT, CLAYTON COUNTY, IOWA: WATER YEAR 1994

Geological Survey Bureau
Technical Information Series 36



Iowa Department of Natural Resources
Larry J. Wilson, Director
May 1996

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Prepared by

L.S. Seigley[1], G. Wunder[2], S. A. Gritters[3], T.F. Wilton[4], J.E. May[5], M.W. Birmingham[6], M.D. Schueller[6], N. Rolling[7], and J. Tisl[8]

[1] Iowa Department of Natural Resources, Geological Survey Bureau
109 Trowbridge Hall, Iowa City, IA 52242-1319

[2] Iowa Department of Natural Resources, Fisheries Bureau
RR #1; State Fish Hatchery, Decorah, IA 52101

[3] Iowa Department of Natural Resources, Fisheries Bureau
Bellevue Research Station, RR 3, Box 1, Bellevue, IA 52031

[4] Iowa Department of Natural Resources, Water Quality Bureau
Wallace State Office Building, Des Moines, IA 50319

[5] U.S. Geological Survey - Water Resources Division
Federal Building, Room 269, 400 S. Clinton St., Iowa City, IA 52240

[6] University of Iowa Hygienic Laboratory
University of Iowa Oakdale Campus, Iowa City, IA 52242

[7] Iowa State University Extension, Sny Magill Hydrologic Unit Area
P.O. Box 417, 111 W. Green St., Postville, IA 52162-0417

[8] U.S. Department of Agriculture, Natural Resources Conservation Service
117 Gunder Road, P.O. Box 547, Elkader, IA 52043-0547

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ACKNOWLEDGEMENTS

The Sny Magill Nonpoint Source Pollution Monitoring Project is supported, in part, by the U.S. Environmental Protection Agency, Region VII, Kansas City, through a 319-Nonpoint Source Program Grant to the Iowa Department of Natural Resources (IDNR). Analytical support is provided by the University of Iowa Hygienic Laboratory (UHL) in Iowa City and Des Moines, and the Sedimentary Geochemistry Laboratory, Geology Department, University of Iowa.

This report represents the compilation of reports summarizing the third year (Water Year 1994) of water-quality monitoring efforts in the Sny Magill and Bloody Run watersheds by various agencies. Fish assessments were completed by Gaige Wunder and Scott Gritters of the IDNR-Fisheries Bureau; the habitat assessment was directed by Tom Wilton of the IDNR-Water Quality Bureau, with the assistance of Mike Birmingham, Todd Hubbard, and Jim Luzier from UHL, and Janet Gastineau and Ralph Turkle of the IDNR-Water Quality Bureau; stream discharge and suspended sediment data was collected and compiled by Jim Cerveny, Jim Wellman, Von Miller, and Jayne May of the U.S. Geological Survey (USGS) in Iowa City, and by local observers William Gruver and Joseph Kruse; benthic work was conducted by Mike Birmingham and Mike Schueller; and water-quality sampling for physical and chemical parameters was completed by Rodney Rovang, Dave McIlrath, Jennifer McLimans, Sandy Mason, and Chris Harmon of Effigy Mounds National Monument, and Bob Rowden, Deb Quade, Bob Libra, K.D. Rex, Carol Thompson, Karen Mumford, Mary Skopec, Paul VanDorpe, and Lynette Seigley of the IDNR-Geological Survey Bureau. Nick Rolling (Iowa State University Extension; ISUE) and Jeff Tisl (Natural Resources Conservation Service; NRCS) coordinated the Sny Magill HUA Project. Don Newbern of the Natural Resources Conservation Service (NRCS) provided land management information from North Cedar Creek watershed. ISUE conducted the farm practice surveys in the Sny Magill and Bloody Run watersheds.

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Pat Lohmann oversaw the design and layout of this report. Mary Skopec provided editorial comments and reviewed the final version of this report. Angie Bowman provided many of the graphics in this report. Mary Clare Jones and Angie Bowman managed the water-quality database.

SNY MAGILL NONPOINT SOURCE POLLUTION MONITORING PROJECT, CLAYTON COUNTY, IOWA: WATER YEAR 1994

Iowa Department of Natural Resources, Geological Survey Bureau
Technical Information Series 36, 1996, 85 p.

L.S. Seigley, G. Wunder, S.A. Gritters, T.F. Wilton, J.E. May,
M.W. Birmingham, M.D. Schueller, N. Rolling, and J. Tisl

ABSTRACT

Since 1992, a consortium of state and federal agencies has been monitoring the water quality of Sny Magill and Bloody Run creeks as part of the Sny Magill Watershed Nonpoint Source Pollution Monitoring Project. The objective of this project is to monitor improvements in the quality of water in Sny Magill Creek resulting from the implementation of two land treatment programs in the Sny Magill watershed. Water Year 1994 represents the third year of water-quality monitoring.

Hydrologically, Water Year 1994 marked the return of more typical conditions after the heavy rains of 1993. Precipitation during Water Year 1994 was 100% of normal. For Water Year 1994, annual mean discharge was 23.4 cfs for Sny Magill Creek and 26.1 cfs for Bloody Run Creek. Total suspended-sediment loads declined from 1993 levels; the total suspended-sediment load was 4,775 tons at SN1 and 3,117 tons at BR1. Water Year 1994 marked the first time during the three-year monitoring period that the annual sediment load was greater for SN1 than BR1. The annual suspended-sediment load per unit drainage area was also greater for SN1, nearly twice as great as BR1. For the three-year monitoring period, average nitrate concentrations were the highest for Water Year 1994. Average triazine herbicide concentrations were 0.14 mg/L for SN1 and 0.44 mg/L for BR1; both represented declines from 1993 levels.

A total of 2,014 fish were sampled in Water Year 1994 as part of the annual fish assessment. The fish species sampled were similar to those sampled during previous years and are typical of Iowa cold-water streams. Based on survey results, each watershed was dominated by a single species: the fantail darter in Sny Magill and the slimy sculpin in Bloody Run. The types and number of species showed minor fluctuations from year to year. These fluctuations appear to be a normal response to variations in rainfall and conditions of the stream. A 1994 survey by the Iowa Department of Natural Resources of several trout streams in northeast Iowa reported natural trout reproduction in several of the streams, including natural brook trout reproduction in North Cedar Creek. North Cedar Creek is a tributary to Sny Magill Creek and site of one of the land treatment programs.

The habitat assessment for Water Year 1994 showed a predictable response to the lower, more stable flow rates of 1994. Average stream widths and depths were less, estimates of herbaceous streambank vegetation were higher, and the amount of unstable streambank was lower. At several sites, the amount of periphyton colonization and rooted aquatic vascular plants increased, perhaps reflecting the lower, more stable flow conditions in 1994.

Overall, the benthic macroinvertebrate communities being sampled in Sny Magill and Bloody Run watersheds have remained relatively constant. A total of 66 benthic

macroinvertebrate taxa were collected in 1994, a decline from 1993 levels and an increase from 1992 levels. The same four taxa, as in past years, comprised about two-thirds of the population sampled. There were no major changes in the community composition, and fluctuations that did occur did so in both watersheds. The HBI and % dominant taxa metrics showed consistent trends in Sny Magill but not in Bloody Run. A decline in the overall annual HBI means in Sny Magill suggests some improvement in water quality that may not be occurring in Bloody Run. The % dominant taxa also declined at Sny Magill sites relative to the Bloody Run sites. It is too early to conclude that this improvement is the result of land treatment activities in the Sny Magill watershed. Based on HBI ratings, the water quality at the sites was rated as “good” to “very good,” similar to previous years. Two of the sites in the Sny Magill watershed, sites SN2 and SNWF, moved into the “excellent” category.

INTRODUCTION

The Sny Magill Watershed Nonpoint Source Pollution Monitoring Project, an interagency effort, is designed to monitor and assess improvements in water quality resulting from two U.S. Department of Agriculture land treatment projects in the Sny Magill watershed. The Sny Magill Watershed Project is supported, in part, by a Nonpoint Source Program (Section 319, Clean Water Act) grant from the U.S. Environmental Protection Agency, Region VII.

The Sny Magill Watershed project area includes Sny Magill Creek and North Cedar Creek (henceforth referred to as the Sny Magill watershed) (Figure 1). Sny Magill and North Cedar creeks are Class "B" cold-water streams located in northeastern Iowa. North Cedar Creek is a tributary of Sny Magill Creek. The creeks, managed for "put and take" trout fishing by the Iowa Department of Natural Resources, are two of the more widely used recreational fishing streams in the state.

The entire Sny Magill watershed is agricultural, with no industry or urban areas. Sny Magill and North Cedar creeks are affected by water pollutants related to agricultural landuse and management, primarily excess sediment, animal waste, nutrients, and pesticides. Two U.S. Department of Agriculture land treatment projects implemented in the watershed allow producers to make voluntary changes in farm management practices that will result in improved water quality.

A paired-watershed approach is being used to monitor improvements in water quality in Sny Magill watershed. Bloody Run Creek watershed is serving as the control watershed (Figure 1). In an ideal paired-watershed design, monitoring of two similar watersheds occurs during a calibration period of two to three years, during which time both watersheds are managed in a similar manner. Following the calibration period, one of the watersheds (e.g., Sny Magill) is treated with practices and structures designed to reduce the delivery of pollutants to the creek; the other watershed remains untreated. Both watersheds are monitored while treatment occurs and for two to three years after treatment is completed.

Bloody Run Creek watershed was selected as the control watershed because Bloody Run and Sny Magill watersheds are similar in size (Sny Magill drains 35.6 mi^2; Bloody Run drains 37.6 mi^2), the groundwater hydrogeology and known surface water characteristics are similar, and their proximity to one another minimizes rainfall variation.

There are five monitoring components to the Sny Magill Watershed Project: (1) primary sites near the mouth of both Sny Magill and Bloody Run creeks are equipped with U.S. Geological Survey (USGS) stream gages to measure daily discharge and suspended sediment, (2) an annual habitat assessment is conducted along stretches of both stream corridors, (3) biomonitoring of benthic macroinvertebrates occurs on a bi-monthly basis (April-October), (4) an annual fisheries survey is conducted, and (5) primary sites and several other sites on both creeks are sampled for chemical and physical parameters on a weekly to monthly basis.

IMPLEMENTATION PROGRAMS

Sny Magill watershed has been the site of two U.S. Department of Agriculture land treatment programs: the Sny Magill Creek Cold Water Stream Water Quality Improvement Project (Sny Magill Hydrologic Unit Area) and the North Cedar Creek Water-Quality Special Project. The projects are intended to provide producers with technical assistance that prompts voluntary changes in farm management practices. These changes are intended to result in improved water quality in Sny Magill and North Cedar creeks. The North Cedar Creek Project began in 1988 and was completed in 1994. The Sny Magill Hydrologic Unit Area (HUA) project began in 1991 and is ongoing.

Sny Magill Creek Hydrologic Unit Area

The Sny Magill Creek Hydrologic Unit Area (HUA) Project includes all of the Sny Magill watershed except for the North Cedar Creek subwatershed, which is included in the North Cedar Creek Water-Quality Special Project. The

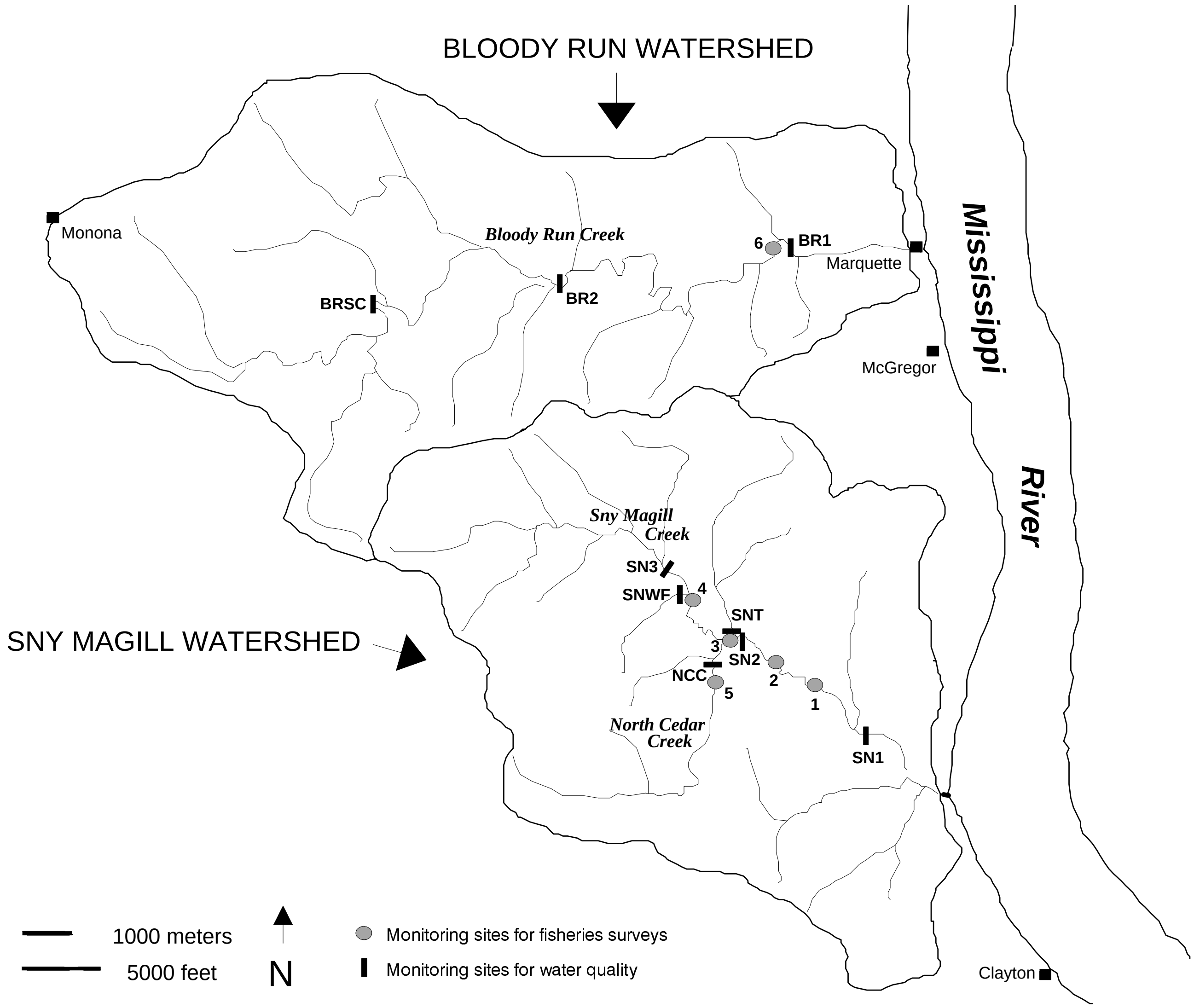

Figure 1. Location of the Sny Magill and Bloody Run watersheds, and the monitoring sites for the fisheries surveys and for water quality.

goal is to provide technical assistance, information and education programs, and cost-share assistance to producers that prompt voluntary changes in farm management practices. These changes are intended to result in improved water quality in Sny Magill Creek. Iowa State University Extension, the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (formerly the Soil Conservation Service), and the USDA Farm Services Agency (formerly the Agricultural Stabilization and Conservation Service) are cooperating agencies.

Table 1 summarizes, on an annual basis, the practices that have been applied as part of the Sny Magill HUA project. In addition to the practices listed in Table 1, other activities have occurred. The following are a few examples and are summarized from the 1994 annual report for the project (Sny Magill Creek Cold Water Stream Water Quality Improvement, 1994). A soil bioengineering demonstration of streambank stabilizing practices was initiated to compare the long-term effectiveness of soil bioengineering to traditional practices such as rip-rap. Manure fertility demonstrations were completed on seven new cooperator farms to encourage growers to take full nutrient credit for manure applied. An effort was made to develop Integrated Crop Management (ICM) service providers to ensure that ICM services will be available from the private sector after the Sny Magill HUA project is completed. Training sessions were held and, where there previously were none, there are now five ICM service providers in the area. As a result of ICM activities, 33,625 less pounds of phosphate, 128 less pounds of alachlor, and 1,450 less pounds of corn rootworm insecticide were applied in the Sny Magill watershed. The crop consultant model for implementation of ICM has not been practical for this part of Iowa. In response, project staff designed an education-based nutrient and pest management program that depends on the producers becoming skilled enough to develop and implement their own farm nutrient and pest management plan.

As part of the information and education programs, tours and presentations were held to update interested individuals on the project's progress. The media outreach program has included development of demonstration plot brochures, press releases, and publication of the Water Watch newsletter.

In 1992, a baseline survey was conducted of Sny Magill farming operators on their farming practices. In late summer 1994, a mid-point survey was completed of Sny Magill farming operators and, at the same time, a baseline survey was conducted of land operators in the Bloody Run watershed.

Prior to implementation of the HUA, it was estimated that 69,550 tons of sediment/year were being delivered to Sny Magill Creek. Since inception of the HUA, the amount of sediment/year being delivered to Sny Magill Creek has been reduced to 49,460 tons (Sny Magill Creek Cold Water Stream report, 1994). This 20,090 tons represents a 29% reduction. One of the goals of the HUA is a 50% reduction (goal of 34,775 tons) in actual sediment delivered to Sny Magill Creek (Figure 2).

North Cedar Creek Water-Quality Special Project

In 1988, the North Cedar Creek Water-Quality Special Project was initiated. The project was designed to implement land treatment practices to control sediment erosion into North Cedar Creek. The primary concerns were depletion of soil from upland areas by excessive soil erosion and the loss of cold-water fish habitat from excess sediment in North Cedar Creek. North Cedar Creek is managed for "put and take" trout fishing (both brown and brook trout) by the Iowa Department of Natural Resources. The stream is designated by the State of Iowa as "high quality waters" and is to be protected against further degradation of water quality (Iowa DNR, 1989). One of the purposes of the North Cedar Creek project was to maintain or improve water quality of North Cedar Creek. The watershed project included the area drained by North Cedar Creek (approximately 3,220 acres), a tributary to Sny Magill Creek. Agencies involved in the project included the Clayton County Soil Conservation District, the Iowa Department of Natural Resources Fish and Wildlife Division, the Upper Explorerland Resource Conservation and Development Area, and the U.S. Department of Agriculture Natural Resources Conservation Service. Available funds have been used and the project was completed in fiscal year 1994.

Table 2 summarizes the types and acreage/number of practices implemented during the project. Overall, the project was relatively successful in terms of the percentage of planned practices that were applied. Over 97% of the planned terraces, 50% of the grade stabilization structures (some of these were changed to terrace structures), and 50% of the agricultural waste structures were implemented. The total allocation for this project was $201,090 (Newbern, 1994).

Although this project did not have an associated water quality monitoring component, there have been indications of qualitative improvements associated with project implementation. During

Table 1. Summary, for 1991-1994, of practices applied as part of the Sny Magill Hydrologic Unit Area.

	Practice Number and Activity	Number Installed
1990-1991	328 Rotation	310 acres
	329 Conservation Tillage	34 acres
	330 Contouring	3 acres
	344 Residue Management	152 acres
	585 Stripcropping	48 acres
	600 Terrace	8,000 feet
	612 Tree Planting	5 acres
	620 Outlet	4,476 feet
	650 Windbreak Renovation	1 acre
	Timber Management Plans	64 acres
1992	327 Conservation Cover	38 acres
	328 Rotation	514 acres
	329 Conservation Tillage	451 acres
	330 Contouring	214 acres
	344 Residue Management	130 acres
	386 Field Border	4,200 feet
	410 Grade Stabilization Structure	83
	510 Pasture & Hayland Management	382 acres
	585 Buffer Strips	95 acres
	585 Stripcropping	10 acres
	590 Nutrient Management - Nitrogen	1,259 acres
	590 Nutrient Management - Phosphorus	1,259 acres
	595 Pesticide Management	1,259 acres
	600 Terrace	64,070 feet
	620 Outlet	30,827 feet
	638 Water & Sediment Control Basin	17
	990 Well Testing	10 wells tested
	Timber Management Plans	327 acres
	More Effective Use/Application of Nitrogen	2.76 lb reduction - acre weighted avg. on 1,300 acres
1993	327 Conservation Cover	201 acres
	328 Rotation	1,169 acres
	329 Conservation Tillage	155 acres
	330 Contouring	15 acres
	344 Residue Management	11 acres
	386 Field Border	5,200 feet
	556 Plan Grazing	114 acres
	585 Buffer Strips	224 acres
	590 Nutrient Management - Nitrogen	3,428 acres
	590 Nutrient Management - Phosphorus	3,428 acres
	595 Pesticide Management	3,428 acres
	600 Terrace	42,720 feet
	606 Subsurface Drain	355 feet
	620 Outlet	26,038 feet
	638 Water & Sediment Control Basin	4
	990 Well Testing	159 wells tested

Table 1. Continued.

	Practice Number and Activity	Number Installed
1993 (con't)	Timber Management Plans	50 acres
	More Effective Use/Application of Nitrogen	17.2 lb reduction - acre weighted avg. on 2,035 acres
	More Effective Use/Application of Phosphorous	2.1 lb reduction - acre weighted avg. on 3,428 acres
1994	328 Rotation	352 acres
	329 Conservation Tillage	132 acres
	330 Contouring	609 acres
	342 Critical Area	20 acres
	344 Residue Management	68 acres
	386 Field Border	15,800 feet
	412 Grassed Waterway	1 acre
	585 Buffer Strips	132 acres
	590 Nutrient Management - Nitrogen	2,750 acres
	590 Nutrient Management - Phosphorus	2,750 acres
	595 Pesticide Management	2,750 acres
	600 Terrace	52,910 feet
	620 Outlet	28,902 feet
	638 Water & Sediment Control Basin	11
	Timber Management Plans	64 acres
	More Effective Use/Application of Nitrogen	24.0 lb reduction - acre weighted avg. on 1,650 acres
	More Effective Use/Application of Phosphorous	12.2 lb reduction - acre weighted avg. on 2,750 acres
SUMMARY	327 Conservation Cover	591 acres
	328 Rotation	2,345 acres
	329 Conservation Tillage	772 acres
	330 Contouring	841 acres
	342 Critical Area	20 acres
	344 Residue Management	361 acres
	386 Field Border	25,200 feet
	410 Grade Stabilization Structure	83
	412 Grassed Waterway	1 acre
	510 Pasture and Hayland Management	382 acres
	556 Plan Grazing	114 acres
	585 Buffer Strips	451 acres
	585 Strip Cropping	58 acres
	600 Terrace	167,700 feet
	606 Subsurface Drain	355 feet
	612 Tree Planting	5 acres
	620 Outlet	90,243 feet
	638 Water and Sediment Control Basin	32 acres
	650 Windbreak Renovation	1 acre
	Timber Management Plans	441 acres

Sources: Sny Magill Creek cold water stream water quality improvement reports (1991,1992,1993, 1994).

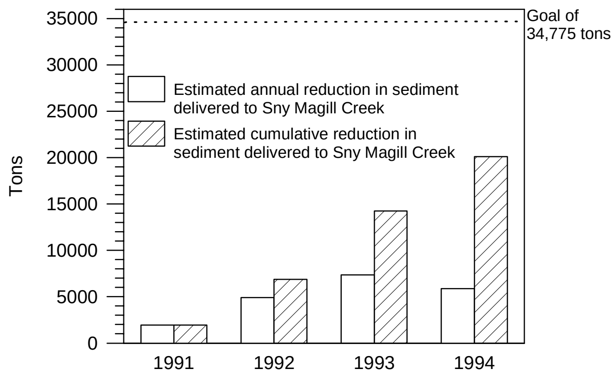

Figure 2. Estimated reduction in sediment delivered to Sny Magill Creek, on an annual and cumulative basis, as a result of the Sny Magill HUA.

Table 2. Summary, through 1994, of practices applied as part of the North Cedar Creek Water-Quality Special Project.

	Practice Number/Activity	Number Installed
Prior to 1991	313/Agricultural Waste Structure	2
	410/Grade Stabilization Structure	4
	600/Terrace	61,100 feet
	600/Old Terrace Repair	200 feet
	620/Outlet	32,091 feet
1991	410/Grade Stabilization Structure	1
	600/Terrace	11,895 feet
	620/Outlet	6,613 feet
1992	600/Terrace	8,235 feet
	620/Outlet	4,604 feet
1993	600/Terrace	20,755 feet
	620/Outlet	14,086 feet
1994	410/Grade Stabilization Structure	1
	600/Terrace	7,735 feet
	620/Outlet	7,512 feet
Summary	313 Agricultural Waste Structure	2
	410 Grade Stabilization Structure	6
	600 Terrace	109,720 feet
	600 Old Terrace Repair	200 feet
	620 Outlet	64,906 feet

Sources: Newbern (1991, 1992, 1993, 1994) and Jeff Tisl (personal communication)

1978-1980, the IDNR conducted a program to establish a naturally-reproducing brook trout population in North Cedar Creek. Success was poor and the program was terminated in 1980 (North Cedar Creek, 1986). Now, however, a 1994 IDNR survey of several trout streams in northeast Iowa reported natural trout reproduction in seven of the 15 streams surveyed, including brook trout reproduction in North Cedar Creek (Gaige Wunder, personal communication; Reber, 1995). Several possible reasons have been cited for the improved reproduction in these streams, including the Conservation Reserve Program and terracing. Both have had a positive impact on the reduction of sediment entering streams. Through an annual survey, the IDNR plans to determine whether the same streams continue to show natural reproduction, and whether natural reproduction occurs at any additional sites.

New funding, available through the Sny Magill Creek Watershed Project (a continuation of the Sny Magill HUA with funding from the Iowa Department of Agriculture and Land Stewardship-Division of Soil Conservation and the U.S. Environmental Protection Agency Section 319), will allow additional work to be completed in North Cedar Creek watershed as needed.

FARM PRACTICES SURVEY

In the winter of 1992, Iowa State University Extension conducted a baseline survey of farm operators within the Sny Magill watershed (Iowa State University Extension, 1992). The survey was done to collect ideas and information from farm operators on their farming operation for project planning purposes. In late summer 1994, a mid-project survey of Sny Magill participants was completed to update information on current farming practices and to assess the impact of the Sny Magill HUA. At the same time, a survey form was mailed to land operators within the Bloody Run Creek watershed to gather baseline information about their farming practices. Summaries of the survey results were published as Iowa State University Extension publications (Iowa State University Extension, 1995[a]; Iowa State University Extension, 1995[b]).

The 1994 Sny Magill survey was given to 45 farmers; twenty-seven (60%) responded (Iowa State University Extension, 1995[a]). The survey contained questions about fertilizer rates and prac-

Table 3. Summary of farming practices in Sny Magill and Bloody Run watersheds based on farm operator surveys conducted by Iowa State University Extension.

	Sny Magill(a)	Bloody Run(b)
Number responding to survey? (# responding)	34	52
Fertilizer application rates (lbs N/acre)		
corn following alfalfa	76	52
second year corn after alfalfa	120	130
corn after corn	130	138
What information or source of information is used to determine N rates? (number responding)		
yield goals	20	28
past experiences	11	32
Are aware of the late-spring soil nitrogen soil test (# responding)	22	30
Groundwater quality and farm profitability (# responding)		
Is groundwater contamination an environmental problem in your county?	30	39
Is groundwater contamination an important environmentla problem on your farm?	17	12
Can farmers in the area reduce N applied without significant reduction in profitability?	21	27
Felt that in addition to environmental benefit, need proven profitability before adopting new technology or practice.	20	33
Livestock inventory and manure management (# responding)		
Respondents with livestock	21	47
Test manure for accurate value of nutrient availability	3	5
Rotate manure applications among different fields	31	43
Adjust fertilizer rates to reflect manure contributions	19	32
Respondents characteristics		
Range in survey respondents ages	30-61	30-61
Average total acres farmed (acres)	377	412
Range in total acres farmed (acres)	18-800	50-1500
Did not hold off-farm job	25	38
Land inventoried		
owner operated	76%	69%
rented	24%	31%

(a) from Iowa State University Extension (1992)
(b) from Iowa State University Extension (1995b)

tices. Seventy-three percent of those surveyed responded they had decreased their nitrogen (N) rates in the last three years. Twenty-seven percent indicated no change in N application rates. Average N fertilizer rates per acre on corn showed minimal change from 1991 to 1993. Average nitrogen rates on corn following corn increased from 130 lbs N/acre in 1991 to 138 lbs N/acre in 1993. Average nitrogen rates on corn following a good alfalfa stand declined from 76 in 1991 to 70 lbs N/acre in 1993.

The survey also addressed the management of manure for crop nutrients. Eighty percent of the respondents rotate manure applications among different fields, 75% adjust fertilizer rates to reflect manure contribution, and 23% test their manure for a more accurate value of its nutrient availability.

The majority of corn acres in 1993 (98%) were treated with an herbicide. Since 1991, 36% have reported reducing herbicide rates, and 63% have reported reducing insecticide rates.

Responses to survey questions on farm operator characteristics were unchanged from 1991 to 1994.

The 1994 Bloody Run survey was given to land operators within the Bloody Run Creek watershed; fifty-two farm operators responded (Iowa State University Extension, 1995[b]). This survey was similar to the survey used in the Sny Magill watershed in 1992. Table 3 compares some of the results of the 1994 survey of Bloody Run watershed residents to the 1992 survey of Sny Magill watershed residents.

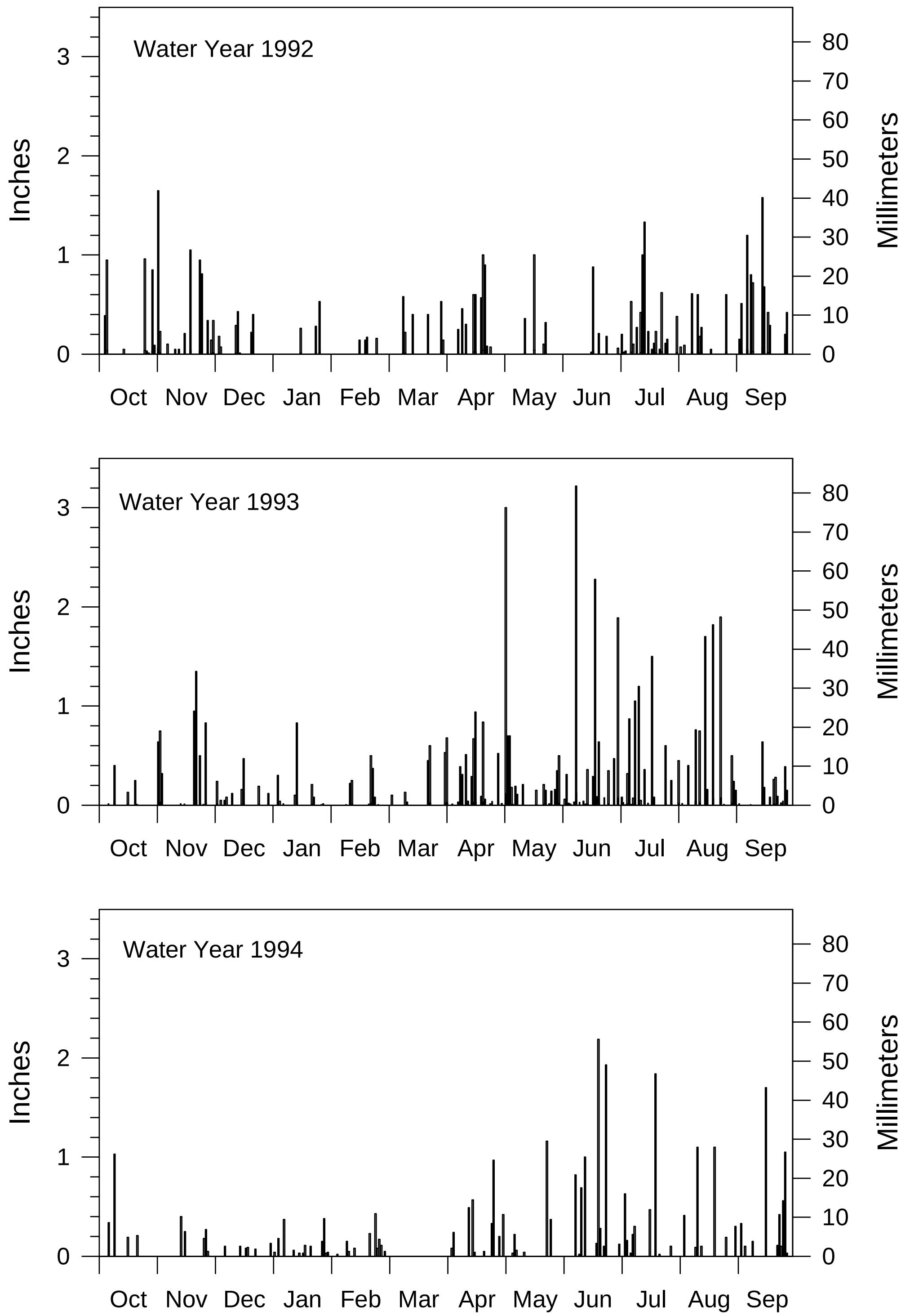

Figure 3. Daily precipitation for the Prairie du Chien, Wisconsin, climatic station; water years 1992-1994.

Table 4. Daily precipitation (in inches) for the Prairie du Chien, Wisconsin climatic station; Water Year 1994.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
						Prairie du Chien						
1	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.42	0.00	0.12	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.18	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.33
4	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.63	0.41	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.16	0.00	0.10
6	0.34	0.00	0.10	0.37	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.03	0.00	0.00
8	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.06	0.82	0.22	0.00	0.00
9	1.03	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.30	0.00	0.15
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.09	0.00
11	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.69	0.00	1.10	0.00
12	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.04	0.00	0.00	0.00	0.00
13	0.00	0.40	0.00	0.00	0.00	0.00	0.49	0.00	1.00	0.00	0.10	0.00
14	0.00	0.00	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.25	0.00	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.00	0.00
16	0.19	0.00	0.00	0.03	0.00	0.00	0.04	0.00	0.00	0.00	0.00	1.70
17	0.00	0.00	0.08	0.11	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00
18	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00
20	0.00	0.00	0.00	0.10	0.23	0.00	0.00	0.00	2.19	1.84	1.10	0.00
21	0.21	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.28	0.00	0.00	0.00
22	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.11
23	0.00	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.10	0.00	0.00	0.42
24	0.00	0.00	0.00	0.00	0.08	0.00	0.00	1.16	1.93	0.00	0.00	0.10
25	0.00	0.18	0.00	0.00	0.17	0.00	0.33	0.00	0.00	0.00	0.00	0.56
26	0.00	0.27	0.00	0.15	0.11	0.00	0.97	0.37	0.00	0.00	0.19	1.05
27	0.00	0.05	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
28	0.00	0.00	0.00	0.03	0.05	0.00	0.00	0.00	0.00	0.10	0.00	0.00
29	0.00	0.00	0.00	0.04		0.00	0.20	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.13	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	0.00		0.00	0.00		0.00		0.00		0.00	0.30	
Total	1.77	1.15	0.57	1.52	1.37	0.00	2.97	2.30	7.16	3.89	3.29	4.55
								Water year total = 30.54 inches				

Source: Wisconsin State Climatology Office (personal communication)

PRECIPITATION

Rainfall was measured at sites SN1 (Sny Magill) and BR1 (Bloody Run; Figure 1) using standard tipping-bucket rain gages attached to the U.S. Geological Survey (USGS) stream gages. Rainfall was recorded by the data-collection platform and transmitted via satellite to the database.

Some rainfall data is missing for Water Year 1994 from sites SN1 and BR1. To provide a complete year of rainfall data for Water Year 1994, rainfall data from a climatic station located in nearby Prairie du Chien, Wisconsin, was used (Table 4 and Figure 3). Rainfall at the Prairie du Chien site was 30.54 inches (775.7 mm) for Water Year 1994. The long-term average rainfall for this site, based on data collected from 1961-1990, is 30.60 inches (777.2 mm) (Wisconsin State Climatology Office, personal communication). Rainfall for the Prairie du Chien site for Water Year 1994 was 0.06 inches (1.5 mm) below normal, or 99.8% of normal. Based on data from the Prairie du Chien climatic station, Water Year 1992 was 124% of normal, and Water Year 1993 was 169% of normal. The maximum recorded daily rainfall at Prairie du Chien for Water Year 1994 was 2.19 inches (55.6 mm) and occurred on June 20, 1994. The maximum monthly rainfall, 7.16 inches (181.9 mm), occurred during June 1994. The June total was 206% of the monthly normal.

Rainfall data for sites SN1 and BR1 is in Table 5. The rainfall record for site BR1 was 84% complete and 75% complete for site SN1. The maximum recorded daily rainfall from the available record at site BR1 was 2.92 inches (74.2 mm) on June 20, 1994 and 2.40 inches (61.0 mm) at site SN1 on June 22, 1994.

Table 5. Daily precipitation (in inches) in the Bloody Run and Sny Magill watersheds; Water Year 1994.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
						Site BR1						
1	0.00	0.00	0.01	0.03	0.00	0.00*	0.00	0.01	0.00	0.13	---	---
2	0.00	0.00	0.00	0.00	0.00	0.01*	0.00	0.00	0.00	0.00	---	---
3	0.00	0.00	0.00	0.00	0.00	0.00*	0.00	0.00	0.00	0.05	---	---
4	0.00	0.00	0.00	0.00	0.00	0.00*	0.18	0.00	0.00	0.46	---	---
5	0.00	0.00	0.07	0.00	0.00	0.00*	0.16	0.05	0.00	0.00	---	---
6	0.25	0.00	0.08	0.00	0.00	0.00*	0.00	0.00	0.00	0.10	---	---
7	0.00	0.00	0.00	0.00	0.00	0.01*	0.00	0.28	0.77	0.56	---	---
8	0.48	0.00	0.00	0.00	0.00	0.00*	0.03	0.00	0.03	0.47	---	---
9	0.42	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	---	---
10	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.00	---	---
11	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.04	0.01	0.00	---	---
12	0.00	0.46	0.05	0.00	0.00	0.00	0.70	0.00	0.12	0.05	---	---
13	0.00	0.00	0.05	0.00	0.17*	0.00	0.10	0.00	0.94	0.06	---	---
14	0.01	0.17	0.09	0.00	0.28*	0.00	0.27	0.26	0.00	0.51	---	---
15	0.25	0.02	0.00	0.00*	0.00*	0.00	0.32	0.00	0.00	0.00	---	---
16	0.00	0.00	0.00	0.00*	0.00*	0.00	0.00	0.00	0.00	0.22	---	---
17	0.00	0.00	0.19	0.00*	0.00*	0.00	0.00	0.00	0.00	0.00	---	---
18	0.05	0.00	0.00	0.00*	0.00*	0.00	0.00	0.00	0.19	0.00	---	---
19	0.01	0.00	0.00	0.00*	0.21*	0.05	0.00	0.00	0.02*	1.80	---	---
20	0.14	0.00	0.01	0.00*	0.16*	0.07	0.11	0.00	2.92	0.02	---	---
21	0.00	0.00	0.00	0.04*	0.00*	0.01	0.01	0.00	0.00	0.00	---	---
22	0.00	0.00	0.00	0.00*	0.00*	0.00	0.00	0.00	---	0.00	---	---
23	0.00	0.00	0.00	0.19*	0.00*	0.00	0.00	1.10	---	0.03	---	---
24	0.00	0.00	0.00	0.00*	0.08*	0.00	0.00	0.09	---	0.01	0.00	---
25	0.00	0.56	0.00	0.00*	0.01*	0.00*	0.32	0.63	---	0.00	0.17	---
26	0.00	0.00	0.00	0.00*	0.01*	0.01	0.20	0.00	0.00	0.00	0.01	---
27	0.00	0.00	0.00	0.00*	0.00*	0.00	0.00	0.00	0.00	0.10	0.01	---
28	0.00	0.00	0.00	0.00*	0.09*	0.00	0.28	0.00	0.00	0.00	0.00	---
29	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.01	---
30	0.00	0.00	0.00	0.00		0.00	0.48	0.00	0.00	0.00	0.51	---
31	0.00		0.08	0.00		0.00		0.00		0.00	0.00	
Total	1.62	1.22	0.63	0.27*	1.01*	0.17*	3.16	2.46	5.56+	4.58	0.71+	
						Site SN1						
1	0.00	0.00	0.01	0.02	0.00	0.10	0.00	0.00	0.00	---	---	---
2	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	---	---	---
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	---	---	---
4	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.14	---	---	---
5	0.00	0.00	0.07	0.00	0.00	0.00	0.07	0.11	0.00	---	---	---
6	0.25	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	---	---	---
7	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.25	0.05	---	---	---
8	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	---	---	---
9	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	---	---	---
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	---	---	---
11	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	---	---	---
12	0.00	0.34	0.00	0.00	0.00	0.00	0.66	0.00	0.00	---	---	---
13	0.00*	0.00	0.02	0.00	0.14	0.00	0.04	0.00	0.03	---	---	---
14	0.00*	0.18	0.10	0.00	0.28	0.02	0.25	0.24	0.00	---	---	---
15	0.00*	0.02	0.00	0.00	0.00	0.00	0.29	0.00	0.00	---	---	---
16	0.00*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	---	---	---
17	0.00*	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	---	---	---
18	0.00*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	---	---	---
19	0.00	0.00	0.00	0.00	0.22	0.02	0.00	0.00	0.07	---	---	---
20	0.10	0.00	0.01	0.00	0.14	0.08	0.10	0.00	0.01	---	---	---
21	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.00	0.00	---	---	---
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.40	---	---	---
23	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.22	0.17	---	---	---
24	0.00	0.00	0.00	0.00	0.10	0.00	0.03	0.00	0.00	---	---	---
25	0.00	0.44	0.00	0.00	0.01	0.00	0.18	0.00*	0.00	---	---	---
26	0.00	0.01	0.00	0.00	0.02	0.01	0.21	0.01*	0.00	---	---	---
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	---	---	---
28	0.00	0.00	0.00	0.00	0.08	0.00	0.19	0.00	0.00	---	---	---
29	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	---	---	---
30	0.01	0.00	0.00	0.02		0.00	0.57	0.01	0.00	---	---	---
31	0.00		0.04	0.00		0.00		0.00		---	---	
Total	1.11	0.99	0.46	0.29	0.99	0.27	2.88	0.87*	2.89			

* estimate

--- no record

FISH ASSESSMENT RESULTS

In October 1994, the Iowa Department of Natural Resources-Fisheries Bureau inventoried the forage fish population at five locations in the Sny Magill watershed (four sites on the main stem of Sny Magill Creek and one site on North Cedar Creek, a tributary to Sny Magill Creek) and one site in the Bloody Run watershed (Figure 1). These six sites have been sampled annually since 1992. In September 1991, during the pre-project period, only the four locations on the main stem of Sny Magill Creek were sampled.

The October 1994 collection date was chosen to minimize stocked trout numbers and angler interference with fish sampling personnel. Sampling gear consisted of two backpack-mounted stream electrofishing units operated at 100 volts DC and 100 pulses per second. Small seines (1/4-inch bar measure) were used to block the upper and lower sample site boundaries and limit inter-site fish movement. All fish captured were identified to species, enumerated, and immediately released downstream. All sample runs were made upstream through approximately 300 feet (91 m) of mixed pool-riffle habitat.

Previous results of fish assessments conducted in Bloody Run and Sny Magill watersheds can be found in Wunder and Stahl (1994; 1991 survey), and Seigley and others (1994; 1992 and 1993 surveys). Below is a summary of the 1994 results from Wunder and Gritters (1995).

Water Year 1994

Table 6 summarizes the relative abundance of the forage fish species sampled in 1994. The fish species sampled were similar to previous years. The combined numbers of fish from the four sites on the main stem of Sny Magill Creek were dominated by fantail darter, white sucker, blacknose dace, longnose dace, brook stickleback, burbot, bluntnose minnow, johnny darter, creek chub, and central stoneroller (Table 6). Rainbow and brown trout were also sampled at all four sites but comprised <1% to 7% of the sampled populations. Fifty-one percent of the sample population was fantail darter and 35% white sucker. Other species each contributed 8% or less to the sample population.

The North Cedar Creek sample was comprised primarily of fantail darter (84%) and blacknose dace (15%) (Table 6). Burbot contributed less than 1% to the sample population. Brown and brook trout were also sampled and made up <1% of the sampled population. The most common fish sampled in Bloody Run Creek were slimy sculpin (96%), white sucker (2%), blacknose dace (1%), and fantail darter (<1%).

Comparison of Water Years 1992, 1993, and 1994

Fish species collected were common to this type of stream habitat and were indicative of typical Iowa cold-water streams. A majority of the fish species noted are similar to those sampled in previous years (Table 7). Exceptions include the reappearance of brook stickleback and creek chub. Brook stickleback comprised 3% of the forage fish population at the four main stem Sny Magill sites in 1992, were not present in 1993, and represented 1% of the population in 1994. Creek chub comprised <1% of the population in 1992 and 1994, and was not inventoried in 1993. At the North Cedar Creek site, longnose dace, creek chub, and bluntnose minnow were not found in 1994. Also at North Cedar Creek, burbot were sampled again in 1994; burbot initially were located in 1992 but not in 1993. In the Bloody Run Creek sample, longnose dace and central stoneroller were not found in 1994 after being present in 1993.

Species added or deleted each year probably result from a combination of small sample size and/or minor population fluctuations. A total of 1,570 fish were collected in 1992, 1,338 fish in 1993, and 2,014 in 1994. In all years of the survey, a majority of the stream forage fish populations were dominated by a single species: the fantail darter in Sny Magill watershed and the slimy sculpin in Bloody Run watershed.

Table 8 lists, by each species tolerance to environmental contaminants, the fish species sampled as part of this project. This environmental

Table 6. Relative abundance of forage fish species sampled from six sites in Sny Magill and Bloody Run creeks; October 1994.

	Number (%)							
Species	Site 1 (a) Sny Magill 1994	Site 2 (b) Sny Magill 1994	Site 3 (c) Sny Magill 1994	Site 4 (d) Sny Magill 1994	Site 5 (e) North Cedar (Sny Magill) 1994	Site 6 Bloody Run 1994	Sny Magill sites 1,2,3,4 (f) 1994	All sites 1994
Campostoma anomalum Central stoneroller	1 (<1%)						1 (<1%)	1 (<1%)
Catostomus commersoni White sucker	93 (25%)	294 (46%)	30 (25%)	7 (8%)		15 (2%)	424 (35%)	439 (22%)
Cottus cognatus Slimy sculpin						650 (96%)		650 (32%)
Culaea inconstans Brook stickleback		9 (1%)					9 (1%)	9 (<1%)
Etheostoma flabellare Fantail darter	225 (61%)	272 (42%)	70 (58%)	56 (67%)	101 (84%)	3 (<1%)	623 (51%)	727 (36%)
Etheostoma nigrum Johnny darter		2 (<1%)					2 (<1%)	2 (<1%)
Lota lota Burbot				5 (6%)	1 (1%)		5 (<1%)	6 (<1%)
Phoxinus erythrogaster Redbelly dace								
Pimephales notatus Bluntnose minnow	2 (1%)			2 (2%)			4 (<1%)	4 (<1%)
Rhinicthys atratulus Blacknose dace	2 (1%)	66 (10%)	19 (16%)	9 (11%)	18 (15%)	8 (1%)	96 (8%)	122 (6%)
Rhinicthys cataractae Longnose dace	43 (12%)	3 (<1%)	2 (2%)	4 (5%)			52 (4%)	52 (3%)
Semotilus atromaculatus Creek chub	2 (1%)						2 (<1%)	2 (<1%)
Total	368	646	121	83	120	676	1,218	2,104

(a) Rainbow and brown trout were also sampled but made up <1% of the sampled populations.
(b) Rainbow and brown trout were also sampled but made up <1% of the sampled populations.
(c) Rainbow and brown trout were also sampled but made up 7% of the sampled populations.
(d) Rainbow and brown trout were also sampled but made up 2% of the sampled populations.
(e) Brown and brook trout were also sampled but made up <1% of the sampled populations.
(f) Rainbow and brown trout were also sampled but made up <1% of the sampled populations.

tolerance rating is from Plafkin and others (1989). The environmental tolerance rating classifies each fish species based on its tolerance to various chemical and physical disturbances. Species classified as intolerant are typically the first species to disappear following a disturbance. Of the 12 species identified in Sny Magill, Bloody Run, and North Cedar creeks, four are classified as tolerant, seven as intermediate, and one (longnose dace) as intolerant. Table 9 is a summary, based on the environmental tolerance rating, of the fish composition of the five sites in the Sny Magill watershed and the one site in the Bloody Run watershed. The percent of the one intolerant species, the longnose dace, increased from 1992 to 1993 and decreased from 1993 to 1994 for both watersheds. The percent of the population composed of the seven intermediate species increased from 1992 to 1993 for both watersheds. From 1993 to 1994, the population in the Sny Magill watershed decreased from 71% to 52% and increased from 79% to 96% in the Bloody Run watershed. The tolerant fish species population of both watersheds declined from 1992 to 1993, increased from 1993 to 1994 for Sny Magill, and declined from 1993 to 1994 for Bloody Run.

It appears that the annual fluctuations in fish populations noted in the three survey years continues to be normal responses to variations in precipitation, runoff, water clarity, and water stage, both within and below the stream sampling sites. The reduction or loss of redbelly dace in the Sny Magill watershed continued in 1994. An increase in population levels of white sucker was very significant, becoming the second most numerous species from the sites located on the main stem of Sny Magill Creek. Overall, the relative abundance of the other major species remained similar. North Cedar Creek retained two dominant species, the fantail darter and blacknose dace, and showed minor fluctuations in the lesser abundant species. There was a significant increase in the slimy sculpin population in 1994 on Bloody Run Creek, increasing from 43% of the overall population in 1993 to 96% in 1994. Other species contributed less than 4% of the fish population in Bloody Run during 1994.

HABITAT ASSESSMENT

The habitat assessment was designed to characterize stream habitat conditions and to test standardized habitat evaluation methods developed for use on cold-water streams in Iowa. Procedures involved measuring and observing instream and streamside habitat variables at a series of ten regularly-spaced, cross-sectional stream transects within a predefined reach. The sampling procedures used are described in Habitat Evaluation Data Collection Procedures (Iowa DNR, 1991), a document prepared by the IDNR-Water Quality Bureau for standardization of cold-water stream data collection procedures in Iowa. Observational methods were patterned after those described by Hamilton and Bergersen (1984), Platts and others (1983), and several other sources (Lyons, 1990; OEPA, 1989; Pajak, 1987; Rankin, 1989; Simonson and Kaminski, 1990).

The results of the 1991 baseline habitat evaluation conducted for Sny Magill and Bloody Run watersheds are summarized in Wilton (1994), and a summary of the habitat assessments conducted in 1992 and 1993 is included in Seigley and others (1994).

Water Year 1994

Aquatic habitat assessments were completed August 29-30, 1994, at eight water quality locations; six in Sny Magill and two in Bloody Run (Figure 1; site BRSC was not included). The assessments were completed by personnel from the Iowa Department of Natural Resources-Water Quality Bureau (IDNR) and the University of Iowa Hygienic Laboratory (UHL) working in teams of two or more observers. Habitat evaluation participants in 1994 were Mike Birmingham, Todd Hubbard, and Jim Luzier from UHL, and Janet Gastineau, Ralph Turkle, and Tom Wilton from IDNR.

The aquatic habitat data for Water Year 1994 is summarized in Appendix I. The definitions of the habitat variables appear in Table 10. For the 1994 habitat assessment, stream flows were low, near baseflow conditions, and had been for several days. During the 1994 habitat assessment, average stream flow was 11.9 cfs (0.34 cms) for sites located on the main stem of Sny Magill and Bloody Run, and 1.53 cfs (0.04 cms) for the three tributary sites to Sny Magill. For the habitat assessment in 1992, the average stream flow for the main stem sites was 8.83 cfs (0.25 cms) and 1.53 cfs (0.04 cms) for the tributary sites. In 1993, average flow was 21.5 cfs (0.61 cms) for the main stem sites and 4.00 cfs (0.11 cms) for the tributaries.

Several habitat variables showed somewhat predictable responses to the lower, more stable flow rates of 1994. Average stream widths and

Table 7. Relative abundance of forage fish species sampled from six sites in Sny Magill and Bloody Run for water years 1992, 1993, and 1994.

	Number (%)					
Species (common name)	Site 1 Sny Magill 1992	Site 1 Sny Magill 1993	Site 1 Sny Magill 1994	Site 2 Sny Magill 1992	Site 2 Sny Magill 1993	Site 2 Sny Magill 1994
Campostoma anomalum (Central stoneroller)	-	7 (5%)	1 (<1%)	-	14 (4%)	-
Catostomus commersoni (White sucker)	-	6 (4%)	93 (25%)	-	27 (8%)	294 (46%)
Cottus cognatus (Slimy sculpin)	-	-	-	-	-	-
Culaea inconstans (Brook stickleback)	2 (<1%)	-	-	36 (6%)	-	9 (<1%)
Etheostoma flabellare (Fantail darter)	91 (41%)	130 (86%)	225 (61%)	401 (66%)	164 (46%)	272 (42%)
Etheostoma nigrum (Johnny darter)	-	-	-	16 (3%)	8 (2%)	2 (<1%)
Lota lota (Burbot)	-	-	-	-	-	-
Phoxinus erythrogaster (Redbelly dace)	1 (<1%)	-	-	1 (<1%)	9 (3%)	-
Pimephales notatus (Bluntnose minnow)	6 (3%)	-	2 (<1%)	35 (6%)	6 (2%)	-
Rhinicthys atratulus (Blacknose dace)	122 (54%)	7 (5%)	2 (<1%)	114 (19%)	78 (22%)	66 (10%)
Rhinicthys cataractae (Longnose dace)	-	1 (<1%)	43 (12%)	-	53 (15%)	3 (<1%)
Semotilus atromaculatus (Creek chub)	2 (<1%)	-	2 (<1%)	2 (<1%)	-	-
Total	224	151	368	605	359	646

Species (common name)	Site 3 Sny Magill 1992	Site 3 Sny Magill 1993	Site 3 Sny Magill 1994	Site 4 Sny Magill 1992	Site 4 Sny Magill 1993	Site 4 Sny Magill 1994
Campostoma anomalum (Central stoneroller)	-	-	-	3 (3%)	3 (2%)	-
Catostomus commersoni (White sucker)	-	4 (3%)	30 (25%)	-	6 (4%)	7 (8%)
Cottus cognatus (Slimy sculpin)	-	-	-	-	-	-
Culaea inconstans (Brook stickleback)	1 (<1%)	-		3 (3%)	-	-
Etheostoma flabellare (Fantail darter)	307 (79%)	112 (94%)	70 (58%)	41 (38%)	119 (74%)	56 (67%)
Etheostoma nigrum (Johnny darter)	6 (2%)	-	-	16 (15%)	1 (1%)	-
Lota lota (Burbot)	-	1 (1%)	-	-	-	5 (6%)
Phoxinus erythrogaster (Redbelly dace)	-	-	-	-	-	-
Pimephales notatus (Bluntnose minnow)	1 (<1%)	-	-	-	-	2 (2%)
Rhinicthys atratulus (Blacknose dace)	62 (16%)	2 (2%)	19 (16%)	44 (40%)	29 (18%)	9 (11%)
Rhinicthys cataractae (Longnose dace)	11 (3%)	-	2 (2%)	2 (2%)	2 (1%)	4 (5%)
Semotilus atromaculatus (Creek chub)	-	-	-	-	-	-
Total	388	119	121	109	160	83

Table 7. Continued.

Species (common name)	Site 5 Sny Magill (North Cedar) 1992	Site 5 Sny Magill (North Cedar) 1993	Site 5 Sny Magill (North Cedar) 1994	Site 6 Bloody Run 1992	Site 6 Bloody Run 1993	Site 6 Bloody Run 1994
	Number (%)					
Campostoma anomalum (Central stoneroller)	1 (1%)	-	-	-	1 (<1%)	-
Catastomus commersoni (White sucker)	-	-	-	-	34 (10%)	15 (2%)
Cottus cognatus (Slimy sculpin)	-	-	-	64 (52%)	153 (43%)	650 (96%)
Culaea inconstans (Brook stickleback)	-	-	-	-	-	-
Etheostoma flabellare (Fantail darter)	60 (50%)	99 (52%)	101 (84%)	25 (20%)	91 (25%)	3 (<1%)
Etheostoma nigrum (Johnny darter)	-	-	-	-	-	-
Lota lota (Burbot)	1 (1%)	-	1 (1%)	-	-	-
Phoxinus erythrogaster (Redbelly dace)	1 (1%)	-	-	-	-	-
Pimephales notatus (Bluntnose minnow)	1 (1%)	7 (4%)	-	-	-	-
Rhinicthys atratulus (Blacknose dace)	53 (44%)	84 (44%)	18 (15%)	29 (23%)	37 (10%)	8 (1%)
Rhinicthys cataractae (Longnose dace)	-	1 (1%)	-	6 (5%)	41 (11%)	-
Semotilus atromaculatus (Creek chub)	3 (3%)	1 (1%)	-	-	-	-
Total	120	192	120	124	357	676

Species (common name)	Sny Magill sites 1,2,3,4 1992	Sny Magill sites 1,2,3,4 1993	Sny Magill sites 1,2,3,4 1994	Sny Magill/ Bloody Run Sites 1992	Sny Magill/ Bloody Run Sites 1993	Sny Magill/ Bloody Run Sites 1994
Campostoma anomalum (Central stoneroller)	3 (<1%)	24 (3%)	1 (<1%)	4 (<1%)	25 (2%)	1 (<1%)
Catastomus commersoni (White sucker)	-	43 (5%)	424 (35%)	-	77 (6%)	439 (22%)
Cottus cognatus (Slimy sculpin)	-	-	-	64 (4%)	153 (11%)	650 (32%)
Culaea inconstans (Brook stickleback)	42 (3%)	-	9 (1%)	42 (3%)	-	9 (<1%)
Etheostoma flabellare (Fantail darter)	840 (63%)	525 (67%)	623 (51%)	925 (59%)	715 (53%)	727 (36%)
Etheostoma nigrum (Johnny darter)	38 (3%)	9 (1%)	2 (<1%)	38 (2%)	9 (1%)	2 (<1%)
Lota lota (Burbot)	-	1 (<1%)	5 (<1%)	1 (<1%)	1 (<1%)	6 (<1%)
Phoxinus erythrogaster (Redbelly dace)	2 (<1%)	9 (1%)	-	3 (<1%)	9 (1%)	-
Pimephales notatus (Bluntnose minnow)	42 (3%)	6 (1%)	4 (<1%)	43 (3%)	13 (1%)	4 (<1%)
Rhinicthys atratulus (Blacknose dace)	342 (26%)	116 (15%)	96 (8%)	424 (27%)	237 (18%)	122 (6%)
Rhinicthys cataractae (Longnose dace)	13 (1%)	56 (7%)	52 (4%)	19 (1%)	98 (7%)	52 (3%)
Semotilus atromaculatus (Creek chub)	4 (<1%)	-	2 (<1%)	7 (<1%)	1 (<1%)	2 (<1%)
Total	1,326	789	1,218	1,570	1,338	2,014

Table 8. Environmental tolerance of fish species identified in Sny Magill and Bloody Run creeks.

Species	Common Name	Tolerance
Catostomus commersoni	White sucker	tolerant
Pimephales notatus	Bluntnose minnow	tolerant
Rhinicthys atratulus	Blacknose dace	tolerant
Semotilus atromaculatus	Creek chub	tolerant
Campostoma anomalum	Central stoneroller	intermediate
Cottus cognatus	Slimy sculpin	intermediate
Culaea inconstans	Brook stickleback	intermediate
Etheostoma flabellare	Fantail darter	intermediate
Etheostoma nigrum	Johnny darter	intermediate
Lota lota	Burbot	intermediate
Phoxinus erythrogaster	Redbelly dace	intermediate
Rhinicthys cataractae	Longnose dace	intolerant

From Plafkin and others (1989; Appendix D)

Table 9. Percent composition of Sny Magill and Bloody Run watersheds based on environmental tolerance of fish species.

	Tolerant Species (4 species)	Intermediate Species (7 species)	Intolerant Species (1 species)
Sny Magill Watershed (5 sites)			
1992	29%	69%	1%
1993	21%	71%	7%
1994	43%	52%	4%
Bloody Run Watershed (1 site)			
1992	23%	67%	5%
1993	20%	79%	11%
1994	3%	96%	0%

Table 10. Definitions of habitat variables appearing in Appendix I.

Site	See Figure 1
STREAM REACH DIMENSIONS:	
Area	Surface area of stream reach evaluated (square feet).
Length	Length of stream reach evaluated (feet).
Flow	Stream flow in cubic feet per second.
Average width	Average stream width from 10 transect measurements (feet).
Maximum depth	Maximum depth in stream reach evaluated (feet).
Average transect maximum depth	Average maximum depth (thalweg depth) measured at 10 transects (feet).
Average depth	Average depth measured at 50 points along 10 transect lines (feet).
INSTREAM HABITAT:	
Dominant habitat type	Predominant type of habitat found in stream reach (i.e., pool, riffle, run).
Riffle repeat frequency (X average width)	Frequency in which riffles repeat in stream reach (expressed as multiple of average stream width in meters).
% reach with instream cover	Percentage of reach area comprised of suitable cover for adult fish.
Dominant cover type	Predominant type of cover found (i.e., pool, undercut bank, woody debris).
% reach with pool habitat	Percentage of reach area comprised of pool habitat.
Dominant pool size class	Predominant pool class in reach (1=large and deep; 2=moderate size and depth; 3=small and shallow).
% reach with silt deposition	Percentage of stream bottom affected by sediment deposition.
% reach with scoured substrate	Percentage of stream bottom affected by scouring.
% reach with vascular aquatic vegetation	Percentage of stream bottom covered by aquatic vegetation.
Dominant vascular aquatic vegetation type	Predominant type of aquatic vegetation.
SUBSTRATE COMPOSITION	
% clay	% of 50 substrate observations from 10 transects comprised of this type of substrate.
% silt	" " "
% sand	" " "
% gravel	" " "
% cobble	" " "
% boulder	" " "
% wood	
% other	" " "
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:	
Periphyton colonization amount	Degree of periphyton colonization (i.e., light, moderate, heavy).
Dominant periphyton form	Predominant form of periphyton found (i.e., filamentous, non filamentous).
Average embeddedness rating	Average rating of percent large substrate (cobble and boulder) surface area that is embedded in fine substrate particles at riffle and run transects (embeddedness rating scale: 1 = >75%; 2 = 75-50%; 3 = 50-25%; 4 = 25-0%).
STREAMSIDE OBSERVATIONS:	
Average stream shading rating	Average rating (20 observations) of percentage stream area shaded. Rating scale for streambank variables: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.
Average streambank tree coverage rating	Average rating (20 observations) of % streambank area covered by tree canopy.
Average streambank shrub coverage rating	Average rating (20 observations) of % streambank area covered by shrub canopy.
Average streambank herbaceous coverage rating	Average rating (20 observations) of % streambank area covered by herbaceous vegetation.
Average streambank instability rating	Average rating (20 observations) of % streambank area that is eroding or unstable.

depths were generally less in 1994 compared to 1993. Estimates of herbaceous stream bank vegetation were higher in 1994, and ratings of the amount of unstable stream bank were lower in 1994 compared to 1993. The amount of periphyton colonization and rooted aquatic vascular plants increased at several sites, perhaps reflecting lower, more stable flow conditions in 1994.

Future assessments of the habitat data will include analysis of variability among observer measurements, site characterization/comparison, and trend analysis.

BENTHIC BIOMONITORING RESULTS

Benthic biomonitoring of the Sny Magill and Bloody Run creeks during Water Year 1994 was completed by personnel from the University of Iowa Hygienic Laboratory in April, June, August, and October of 1994.

Benthic macroinvertebrate samples were collected using a Modified Hess bottom sampler with a 505 µm mesh netting. Schueller and others (1992) determined the Modified Hess bottom sampler to be the preferred sampling method for these two streams over kicknets or Hester-Dendy artificial substrates. A total of 96 samples were collected at eight water quality sites during the 1994 sampling season (Figure 1; benthic biomonitoring was not completed at site BRSC). Samples were collected in triplicate at each location for each of the four sample collection dates. All samples were fixed in a 10% formalin solution and returned to the laboratory. Physical and chemical data, consisting of stream discharge, periphyton estimates, temperature, pH, and dissolved oxygen measurements, were taken and recorded at all sites on each sampling date (see Birmingham et al., 1995). Laboratory processing and data analysis were performed as described in the Environmental Protection Agency's Rapid Bioassessment Protocols (RBP) for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish (Plafkin et al., 1989).

Birmingham and Kennedy (1994) summarized historical biological water-quality data available from Sny Magill and Bloody Run watersheds, Schueller and others (1992; 1994) summarized baseline monitoring conducted in 1991 for both watersheds, Schueller and others (1993; 1994) and Seigley and others (1994) included benthic results from water years 1992 and 1993. Below is a summary of the Water Year 1994 results from Birmingham and others (1995).

Water Year 1994

A total of 66 benthic macroinvertebrate taxa were collected in the Sny Magill and Bloody Run watersheds during 1994. A total of 60 taxa were collected in 1992 and 73 taxa in 1993. Figure 4 shows the total number of taxa collected per sampling site. Site BR1 had the greatest number (38) of taxa collected in 1994. The predominant class of organisms collected, as in past years, was the class Insecta (Arthropoda), with the phylas Annelida, Platyhelminthes, Nematoda, and Mollusca also represented.

The total number of taxa collected per site in 1994 decreased from 1993 at every site but NCC, which showed a small increase (Figure 4). The 1994 values are generally similar to the 1992 results at all sites except BR1, which had 13 more taxa in 1994 than in 1992.

Benthic community composition continued to be dominated by four taxa (Figure 5). For the third year, *Ceratopsyche slossonae*, Chironomidae, *Baetis tricaudatus*, and *Optioservus fastiditus* comprised about two-thirds of the riffle community. No major changes in community composition was evident in either watershed and the fluctuations that occurred are generally present in both watersheds.

Metrics were calculated for all eight sites (Table 11; Table 12 provides a description of the metrics). Hilsenhoff Biotic Index (HBI) values (Table 13) declined for the third consecutive year at all sites except NCC and BR1. Based on the HBI values, all stations had a "very good" water quality rating except SN2, SNWF, and BR2. Sites SN2 and SNWF moved into the "excellent" category and site BR2 remained in the "good" category for the third year. For the second year, SNWF had the greatest change in HBI, declining from 2.21 in

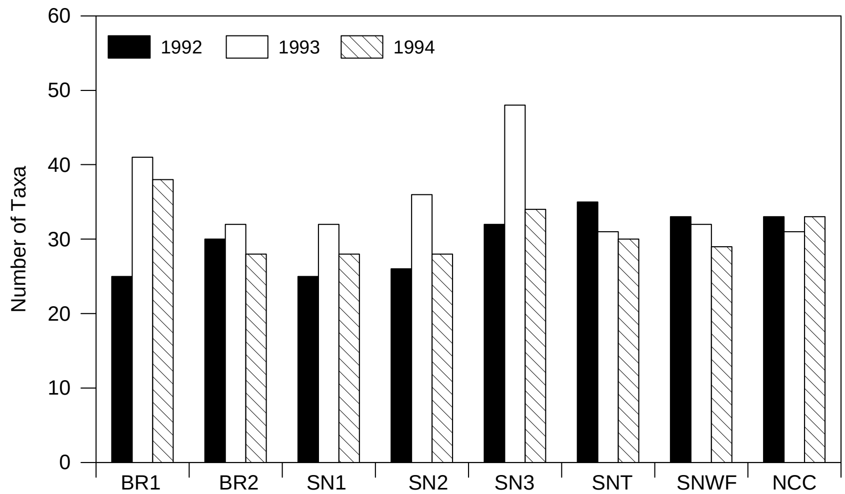

Figure 4. Comparison of the total number of benthic taxa collected per sampling site in the Sny Magill and Bloody Run watersheds during the 1992, 1993, and 1994 sampling seasons (from Birmingham and others, 1995).

1992, to 1.80 in 1993, and to 1.55 in 1994. SNWF rated in the "excellent" category on all four sampling dates during 1994. There appears to be no consistent seasonal (month of collection) trends related to HBI, though high HBI values were often observed in June at many of the sites.

A ranking method was developed to evaluate all of the metrics for each site. Each metric was given the same weight in the calculation. Each site was ranked from one to eight ("best" to "worst," respectively) for each of the metrics in Table 11. The average rank for a site was determined by summing the ranks and dividing by the number of metrics. The site with the "best" overall water quality was the site with the lowest average rank. The 1994 results of this ranking procedure are similar to the 1993 findings (Table 14). Sites BR2 and SN1 continued to have high overall value ranks, suggesting poorer water quality relative to the other sites. Sites SNWF and NCC maintained low overall value ranks, indicating better water quality relative to the other sites. The greatest changes from 1993 to 1994 occurred at sites SNT and BR1, which nearly switched rankings. The sites that showed substantial changes between 1992 and 1993 appear to have stabilized their ranks in 1994.

Discussion and Conclusions

Hydrologically, Water Year 1994 marked a return of more typical conditions after the heavy rains of 1993. The higher flows during 1993 may have enhanced microhabitat diversity which may explain the peak in total taxa per site which occurred in both watersheds in 1993. There is also some indication that sudden high flows may have displaced organisms which typically occur in the tributaries to downstream sites. For example, two caddisflies were collected from only sites SNT and SNWF (both tributary sites) in 1992 and 1994, but were found at several of the sites on the main stem of Sny Magill in 1993. Also, the three tributary sites in the Sny Magill watershed (NCC, SNT, SNWF) all showed slight declines in total taxa collected in 1993 while all other sites displayed increases. Other benthic community metrics appear to have been unaffected by the three-year flow regime, displaying directional trends in both watersheds.

Two metrics showed consistent trends in the Sny Magill watershed and no discernible trends in Bloody Run. A consistent decline in not only the overall annual HBI means, but the HBI values at individual sites in the Sny Magill watershed, sug-

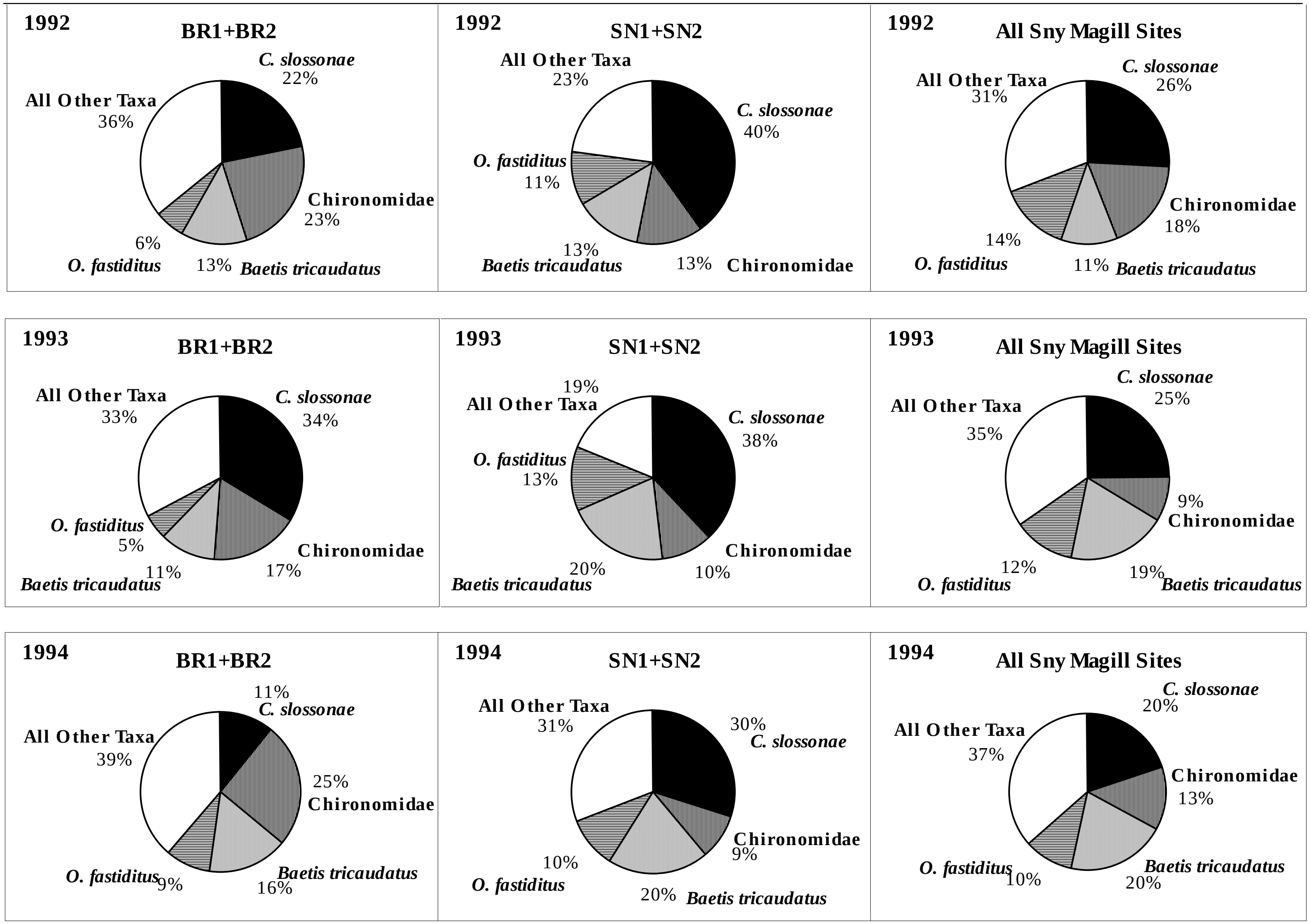

Figure 5. Comparison of predominant benthic taxa relative percent composition from the 1992, 1993, and 1994 sampling seasons in the Sny Magill and Bloody Run watersheds (from Birmingham and others, 1995).

Table 11. Mean (n=12) metric values and standard deviations (in parentheses) for Modified Hess benthic macroinvertebrate samples collected in the Bloody Run and Sny Magill watersheds during the 1994 sampling season.

METRICS	SN1	SN2	SN3	SNT	SNWF	NCC	BR1	BR2
Taxa Richness	13.67	12.92	11.50	12.25	12.92	11.25	13.75	12.25
standard deviation	(2.57)	(2.87)	(1.78)	(1.71)	(3.00)	(2.26)	(2.53)	(1.86)
rank	2	3.5	7	5.5	3.5	8	1	5.5
HBI	1.88	2.45	2.04	1.73	2.23	1.90	1.55	1.93
standard deviation	(0.25)	(0.29)	(0.21)	(0.18)	(0.36)	(0.39)	(0.15)	(0.24)
rank	3	8	6	2	7	4	1	5
EPT Index	7.50	7.67	6.50	7.17	8	6.00	9.42	7.58
standard deviation	(2.32)	(2.71)	(1.17)	(0.94)	(2.22)	(1.91)	(2.23)	(1.88)
rank	5	3	7	6	2	8	1	4
% Dominant Taxa	32.83	40.25	37.00	34.83	36.58	45.58	28.75	27.50
standard deviation	(6.95)	(11.30)	(7.86)	(8.90)	(10.14)	(16.13)	(8.07)	(5.32)
rank	3	8	5	6	7	4	2	1
EPT/Chironomidae	27.82	2.56	22.30	20.18	4.38	25.95	30.38	35.88
standard deviation	(32.35)	(4.28)	(34.92)	(21.70)	(6.06)	(30.21)	(29.61)	(32.60)
rank	3	8	5	6	7	4	2	1
Scrapers/Filters Collectors	0.20	0.16	0.19	0.24	0.17	0.43	0.40	0.50
standard deviation	(0.14)	(0.11)	(0.26)	(0.25)	(0.22)	(0.43)	(0.19)	(0.32)
rank	5	8	6	4	7	2	3	1
Scrapers/Filtering Collectors	0.81	0.48	0.36	0.47	0.31	6.92	1.26	1.33
standard deviation	(0.81)	(0.27)	(0.48)	(0.20)	(0.30)	(10.74)	(0.68)	(1.82)
rank	4	5	7	6	8	1	3	2

from Birmingham and others (1995)

Table 12. Explanation of the metrics used for analysis of the benthic macroinvertebrate samples collected from the Sny Magill and Bloody Run watersheds.

Taxa Richness

The total number of taxa (genera and/or species) present in a community is a measure of benthic community health. The number of taxa generally increases with increasing habitat diversity, habitat suitability, and improving water quality.

Hilsenhoff Biotic Index (HBI)

The HBI measures the overall pollution tolerance of a benthic community, and generally indicates organic pollution in communities inhabiting rock or gravel riffles. Tolerance values are assigned to each taxa collected and range from zero to five. A zero value is given to taxa collected in unaltered streams of very high water quality, and a value of five is given to taxa known to inhabit severely polluted or disturbed streams. The number of individuals of each taxon is multiplied by the tolerance value assigned to that taxon and divided by the total number of individuals in the sample. The taxa values are added and the sum is the HBI. The HBI value increases as water quality decreases.

EPT Index

The EPT taxa metric is the number of distinct taxa within the generally pollution-sensitive insect orders of Ephemeroptera, Plecoptera, and Trichoptera (mayfly, stonefly, and caddisfly). An increasing value indicates a higher number of EPT taxa and improved water quality.

Percent Contribution of Dominant Taxa

This metric is a measure of the percent contribution of the numerically dominant taxon to the total number of organisms sampled, and is a reflection of community evenness and redundancy. A high degree of community redundancy, as reflected in a high proportion of the dominant taxa (>40%) may be indicative of impairment.

Ratio of EPT and Chironomidae Abundance

This metric is a ratio of the number of specimens collected from the orders of Ephemeroptera, Plecoptera, and Trichoptera to the abundance of Chironomidae at each site. Populations having a high number of pollution tolerant Chironomidae relative to the more sensitive groups will have a lower EPT/Chironomidae value and may indicate environmental stress. An increasing numerical value indicates a greater abundance of the more sensitive EPT taxa.

Ratio of Scraper and Filtering Collector Functional Feeding Groups

The Scraper/Filtering Collector ratio reflects the community foodbase and community balance in terms of function. The number of scrapers present increases with increased abundance of diatoms and decreases as filamentous algae increases. Filtering Collector feeding groups tend to increase with the availability of suspended fine particulate organic matter (FPOM) and as filamentous algae and aquatic mosses increase (attachment sites).

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from Plafkin and others (1989)

Table 13. Water quality ratings based on Hilsenhoff Biotic Index values (Hilsenhoff, 1982) and mean (n=3) HBI values from sites in the Sny Magill and Bloody Run watersheds.

Hilsenhoff Biotic Index values	Water quality rating	Degree of Organic Pollution
0.00 - 1.75	Excellent	No organic pollution
1.76 - 2.25	Very Good	Possible slight organic pollution
2.26 - 2.75	Good	Some organic pollution
2.76 - 3.50	Fair	Significant organic pollution
3.51 - 4.25	Poor	Very significant organic pollution
4.26 - 5.00	Very Poor	Severe organic pollution

	SN1	SN2	SN3	SNT	SNWF	NCC	Mean
1992	2.24	1.99	2.58	2.04	2.21	2.18	2.20
1993	2.08	1.87	2.34	1.97	1.80	1.90	1.99
1994	2.04	1.73	2.23	1.90	1.55	1.93	1.90

	BR1	BR2	Mean	SN1+SN2
1992	2.06	2.42	2.24	2.11
1993	2.02	2.31	2.16	1.97
1994	1.88	2.45	2.16	1.89

modified from Birmingham and others (1995)

Table 14. Overall metric value rank for benthic macroinvertebrates collected from the Sny Magill and Bloody Run watersheds during 1992-1994.

SITE	1992	1993	1994
SNWF	2.5	1	1
NCC	1	2	2
SNT	4	3.5	6
SN2	5	3.5	4
BR1	6	5	3
SN3	8	6	5
BR2	2.5	7	8
SN1	7	8	7

modified from Birmingham and others (1995) gests a real improvement in water quality that may not be occurring in Bloody Run. It is important to mention that BR1 has also shown consistent improvement. This decline is negated, however, when comparing all sites on Bloody Run to all sites on Sny Magill because of an increase in the HBI value at site BR2 for 1994. The decrease in % dominant taxa is also fairly consistent at individual sites in the Sny Magill watershed. The pattern does not hold for SNT and SNWF, but these sites may require special consideration. Headwater streams are often naturally unproductive and of low benthic macroinvertebrate diversity (Hilsenhoff, 1977; Plafkin et al., 1989). It is possible that improvements in the water quality of smaller streams with discrete spring sources may actually lower the diversity (taxa richness, EPT index) and increase % dominance. This will be evaluated as more years of data are accumulated.

The relatively low variability associated with the HBI will likely make it the metric most sensitive to subtle changes in water quality and therefore the most useful of the metrics in this study. Taxa richness and EPT indices also generally have low variability (Plafkin et al., 1989) and may also prove valuable. Metrics that utilize percents and ratios will have greater fluctuations (Plafkin et al., 1989).

Overall, the benthic macroinvertebrate riffle communities being sampled in the Sny Magill and Bloody Run watersheds have remained constant since sampling began. The same four taxa continue to comprise about two-thirds of the organisms collected, and wholesale changes in community taxa composition are not expected. Water quality, based on HBI ratings, was good to very good to begin with, and any improvement in water quality will likely result in shifts in the proportions of species already present, as opposed to "new" species becoming established. The consistent decline in HBI values at sites in the Sny Magill watershed strongly suggests some improvement in water quality. It is premature to conclude that this improvement is the result of land treatment activities in the watershed. The next several years of sampling should indicate whether a causal relationship exists between land treatment activities and HBI values or that the observed changes are related to short-term climatic factors or other natural cycles.

STREAM AND SUSPENDED SEDIMENT DISCHARGE

Stream and suspended sediment discharge data were collected in the Sny Magill and Bloody Run watersheds by the U.S. Geological Survey. Stream stage was monitored continually at sites SN1 and BR1, and both creeks were sampled daily for suspended sediment. Monthly stream discharge measurements were made at seven supplemental sites (BRSC, BR2, SN3, SNWF, NCC, SNT, and SN2; Figure 1), including several tributaries to Sny Magill Creek and several sites on the main stem of Sny Magill and Bloody Run creeks. The Water Year 1994 hydrologic data in this report represents the data reported in May and others (1995). Discharge and sediment data for Sny Magill and Bloody Run creeks for water years 1992 and 1993 can be found in Kalkhoff and Eash (1994), Seigley and others (1994), Southard and others (1993), and Gorman and others (1992).

Water Year 1994

Discharge

Sny Magill

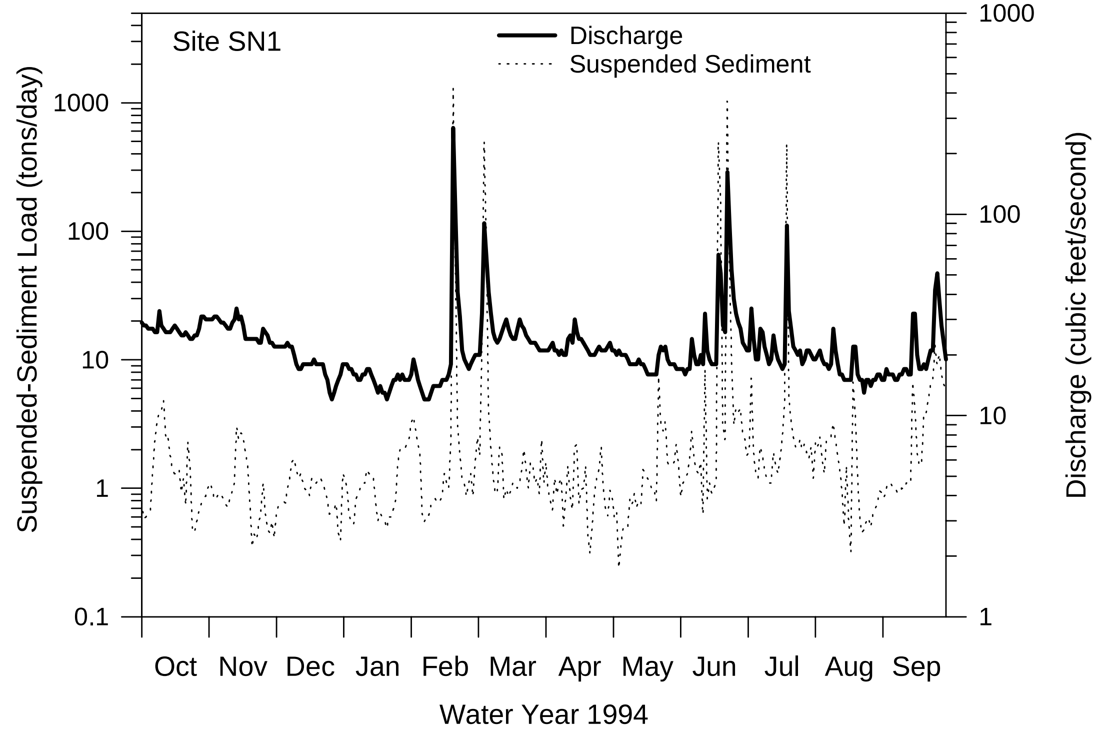
Daily average discharges for Sny Magill Creek (site SN1) for Water Year 1994 are listed in Table 15 and illustrated in Figure 6. Figure 7 shows the discharge for site SN1 for water years 1992 through 1994. Discharge was greatest during Water Year 1993 as a result of the above-normal rainfall. The daily average discharge at site SN1 for Water Year 1994 was 23.4 cfs (0.66 cms). The maximum daily average discharge (268 cfs; 7.59 cms) occurred on February 19, 1994, and the minimum daily average discharge (12 cfs; 0.34 cms) was recorded on several dates: December 26, 1993, January 20, 1994, and February 6-8, 1994. Stream discharge duration is shown in Figure 8. Daily average discharge exceeded 15 cfs (0.42 cms) 90% of the year and exceeded 30 cfs (0.85 cms) 10% of the year. The variability in discharge on a monthly

Table 15. Daily mean discharge at sites SN1 (Sny Magill) and BR1 (Bloody Run); Water Year 1994.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Site BR1 (Discharge in cubic feet per second)												
1	31	31	27	23	19	24*	21	25	20	25	21	24
2	30	30	27	24	18	25	22	24	20	26	21	24
3	30	30	28	24	18	27*	22	24	20	26	21	25
4	29	29	28	24	18	26*	23	24	20	25	23	27
5	29	30	28	25	17	40*	24	25	20	23	22	25
6	28	31	27	24	17	75*	24	24	19	21	22	24
7	28	31	27	23*	16*	54*	23	24	23	21	21	24
8	29	29	26	22*	15*	33*	23	24	20	27	21	24
9	41	28	26	20*	14*	26	22	22	19	24	22	25
10	35	28	26	21*	15*	24	23	23	20	23	30	24
11	34	28	26	21	16*	23	23	23	20	22	26	22
12	33	30	26	23	15	24	25	23	19	23	24	21
13	33	30	25	25	16	29	25	23	35	24	23	20
14	31	29	25	23*	16	29	23	24	22	26	23	20
15	32	30	24	21*	15	31	26	23	20	23	23	21
16	32	29	24	19*	15	27	24	23	19	23	23	24
17	31	28	24	18*	15	25	24	23	19	22	23	20
18	31	29	25	17*	15	24	23	22	20	22	22	20
19	29	28	25	16*	302	24	23	23	30	22	30	20
20	29	29	25	17*	121	24	25	22	29	96	27	22
21	30	28	25	16*	45	26	24	22	24	42	22	23
22	30	28	25	17*	33	25	24	23	28	33	23	30
23	30	27	24*	19*	29	24	23	29	58	26	21	28
24	30	27	25*	18*	27*	24	22	29	40	26	21	26
25	30	29	22*	20*	25*	24	24	25	29	23	22	35
26	30	30	20*	21*	23*	23	24	25	27	25	23	42
27	30	30	18*	20*	22*	24	25	22	26	23*	21	36
28	31	29	19*	19*	23*	24	26	21	25	23*	22	31
29	31	28	20*	19*	---	23	25	21	26	22	23	32
30	31	28	22*	19	---	23	26	20	25	22	25	30
31	31	---	23*	20	---	22	---	20	---	21	25	---
TOTAL	959	871	762	638	940	876	711	725	742	830	716	769
MEAN	30.9	29.0	24.6	20.6	33.6	28.3	23.7	23.4	24.7	26.8	23.1	25.6
MEDIAN	30	29	25	20	18	24	24	23	21	23	23	24
MAX	41	31	28	25	302	75	26	29	58	96	30	42
MIN	28	27	18	16	14	22	21	20	19	21	21	20
AC-FT	1900	1730	1510	1270	1860	1740	1410	1440	1470	1650	1420	1530
CFSM	0.91	0.85	0.72	0.60	0.98	0.83	0.69	0.69	0.72	0.78	0.68	0.75
IN.	1.05	0.95	0.83	0.70	1.02	0.95	0.77	0.79	0.81	0.90	0.78	0.84
Site SN1 (Discharge in cubic feet per second)												
1	29	30	22	18	19*	20*	21	23	17	22	19	15
2	28	30	22	18	17*	20	21	21	17	21	19	15
3	28	31	22	17	15*	20	21	21	17	21	20	17
4	27	31	22	17	14*	32	22	20	16	34	21	16
5	27	30	22	16	13*	90	23	21	17	24	19	16
6	27	29	23	16*	12*	61	21	20	17	19	18	16
7	26	29	22	15*	12*	41	21	20	24	19	18	15
8	26	28	22	15*	12*	32	20	20	20	27	17	15
9	33	27	20	16*	13*	26	21	19	18	26	18	16
10	28	27	18	16*	14*	24	20	18	18	22	27	16
11	27	29	17	17	14*	23	20	18	20	20	21	17
12	26	30	17	17	14*	24	24	18	18	18	18	17
13	26	34	18	16	14	26	25	18	32	19	16	16
14	26	30	18	15*	15	28	23	19	21	25	16	16
15	27	31	18	14*	15	30	30	18	19	21	15	32
16	28	28	18	13*	15	27	26	18	18	19	15	32
17	27	24	18	14*	16	25	24	17	18	18	15	20
18	26	24	19	13*	18	24	24	16	18	17	15	17
19	25	24	18	13*	268	24	23	16	63	18	22	17
20	25	24	18	12*	102	27	22	16	51	88	22	18
21	26	24	18	13*	41	30	21	16	28	33	16	17
22	25	24	18	14*	31	28	20	16	26	27	15	19
23	24	23	16*	15*	21	27	20	20	162	22	15	21
24	24	23	15*	15*	19*	25	20	22	94	21	13	21
25	25	27	13*	16	18*	24	21	21	53	20	15	42
26	25	26	12*	15	17*	23	22	22	38	21	15	51
27	27	25	13*	16	18*	23	21	19	32	18	14	38
28	31	23	14*	15	19*	23	21	18	29	19	15	28
29	31	23	15*	15*	---	22	21	18	27	21	15	23
30	30	22	16*	15*	---	21	22	18	23	21	16	19
31	30	---	18	16*	---	21	---	17	---	20	16	---
TOTAL	840	810	562	473	816	891	661	584	971	741	536	638
MEAN	27.1	27.0	18.1	15.3	29.1	28.7	22.0	18.8	32.4	23.9	17.3	21.3
MEDIAN	27	27	18	15	16	25	21	18	21	21	16	17
MAX	33	34	23	18	268	90	30	23	162	88	27	51
MIN	24	22	12	12	12	20	20	16	16	17	13	15
AC-FT	1670	1610	1110	938	1620	1770	1310	1160	1930	1470	1060	1270
CFSM	0.98	0.98	0.66	0.55	1.06	1.04	0.8	0.68	1.17	0.87	0.63	0.77
IN.	1.13	1.09	0.76	0.64	1.10	1.20	0.89	0.79	1.31	1.00	0.72	0.86

* estimated value

Source: May and others (1995)



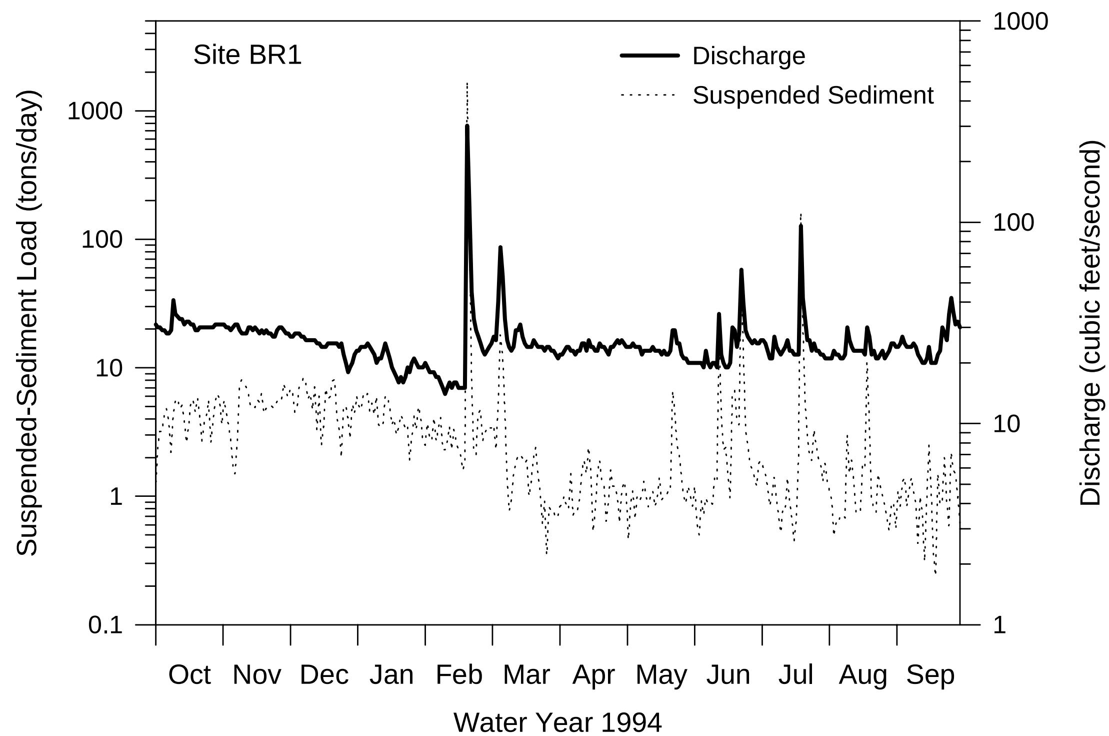


Figure 6. Summary of stream discharge and mean daily suspended-sediment loads for sites SN1 (Sny Magill) and BR1 (Bloody Run) during Water Year 1994.

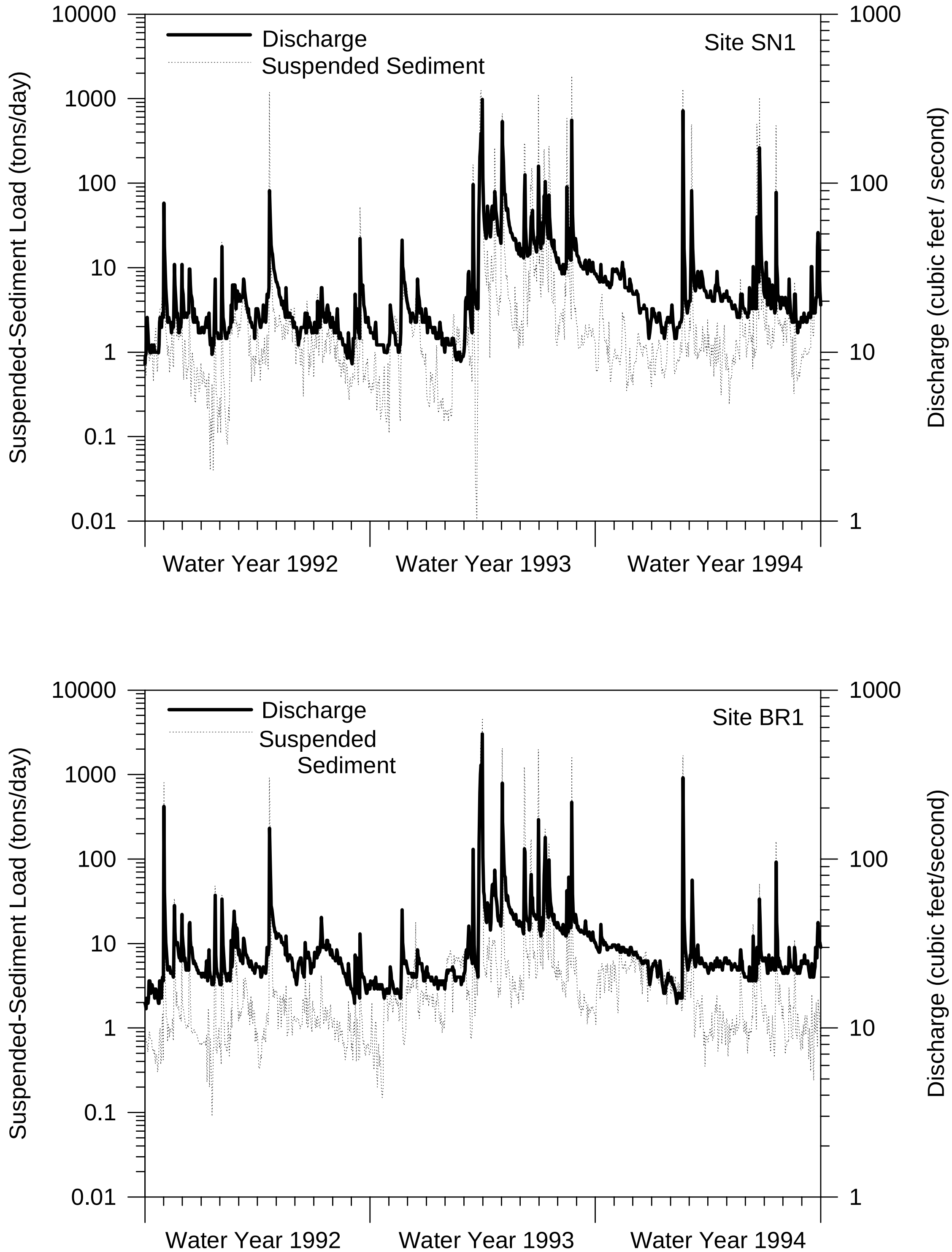


Figure 7. Summary of stream discharge and mean daily suspended-sediment loads for sites SN1 (Sny Magill) and BR1 (Bloody Run) during water years 1992-1994.

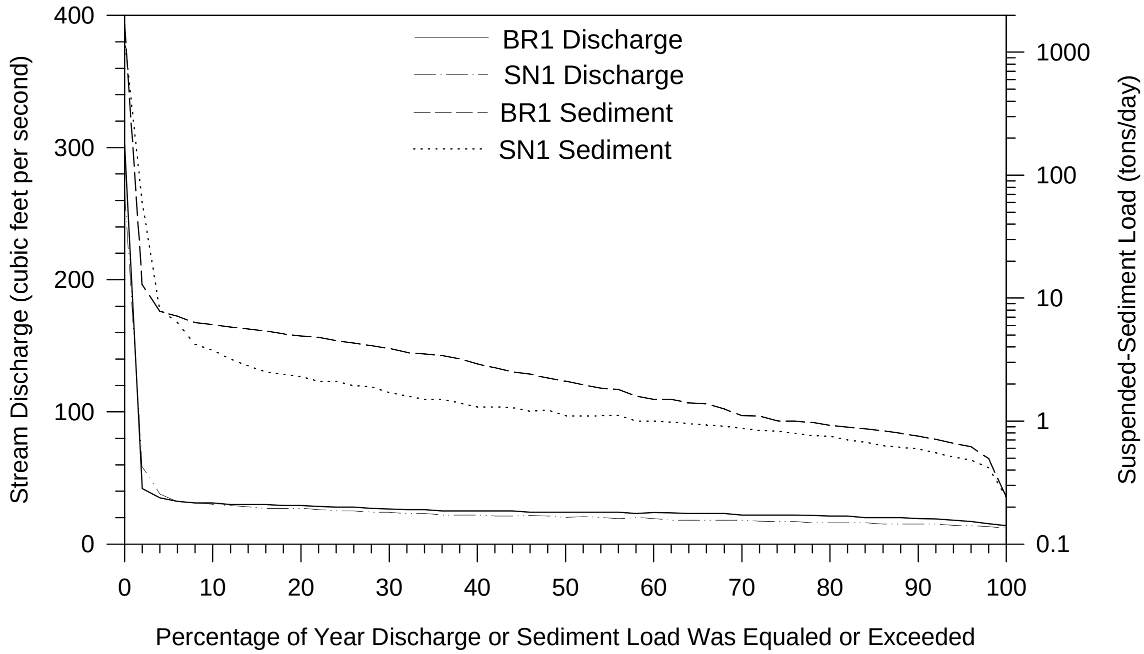


Figure 8. Percentage of Water Year 1994 that stream and suspended-sediment load was equaled or exceeded for sites SN1(Sny Magill) and BR1 (Bloody Run).

basis is shown in Figure 9. Monthly median values were calculated from the daily average discharge for all days of each month. The box plots illustrate the percentiles for the discharge data on a monthly basis. The horizontal line within the shaded box represents the median. At site SN1, the greatest monthly median discharge during Water Year 1994 was 27 cfs (0.76 cms) in October and November 1993, and the smallest monthly median discharge was 15 cfs (0.42 cms) in January 1994. The high discharge in October and November represents the lingering effects of the flood of 1993.

Bloody Run

Daily average discharges for Bloody Run at site BR1 are listed in Table 15 and illustrated in Figure 6. Figure 7 shows the discharge for site BR1 for water years 1992 through 1994. The daily average discharge at site BR1 for Water Year 1994 was 26.1 cfs (0.74 cms). The maximum daily average discharge (302 cfs; 8.55 cms) occurred on February 19, 1994, and the minimum daily mean discharge (14 cfs; 0.40 cms) was recorded on February 9, 1994. Stream discharge duration is shown in Figure 8. Daily average discharge exceeded 19 cfs (0.54 cms) 90% of the year and exceeded 31 cfs (0.88 cms) 10% of the year. The variability in discharge on a monthly basis is shown in Figure 10. At site BR1, the greatest monthly median discharge from Water Year 1994 was 30 cfs (0.85 cms) in October 1993, and the smallest monthly median discharge was 17.5 cfs (0.50 cms) in February 1994. The high discharge that occurred during the first few months of Water Year 1994, including October 1993, represents the continuation of elevated discharge associated with the flood of 1993.

Supplemental Sites

Stream discharge, stage, and mean velocity were measured monthly at seven supplemental sites in the Bloody Run and Sny Magill watersheds during Water Year 1994 (Table 16). The greatest measured discharge at the supplemental sites in the

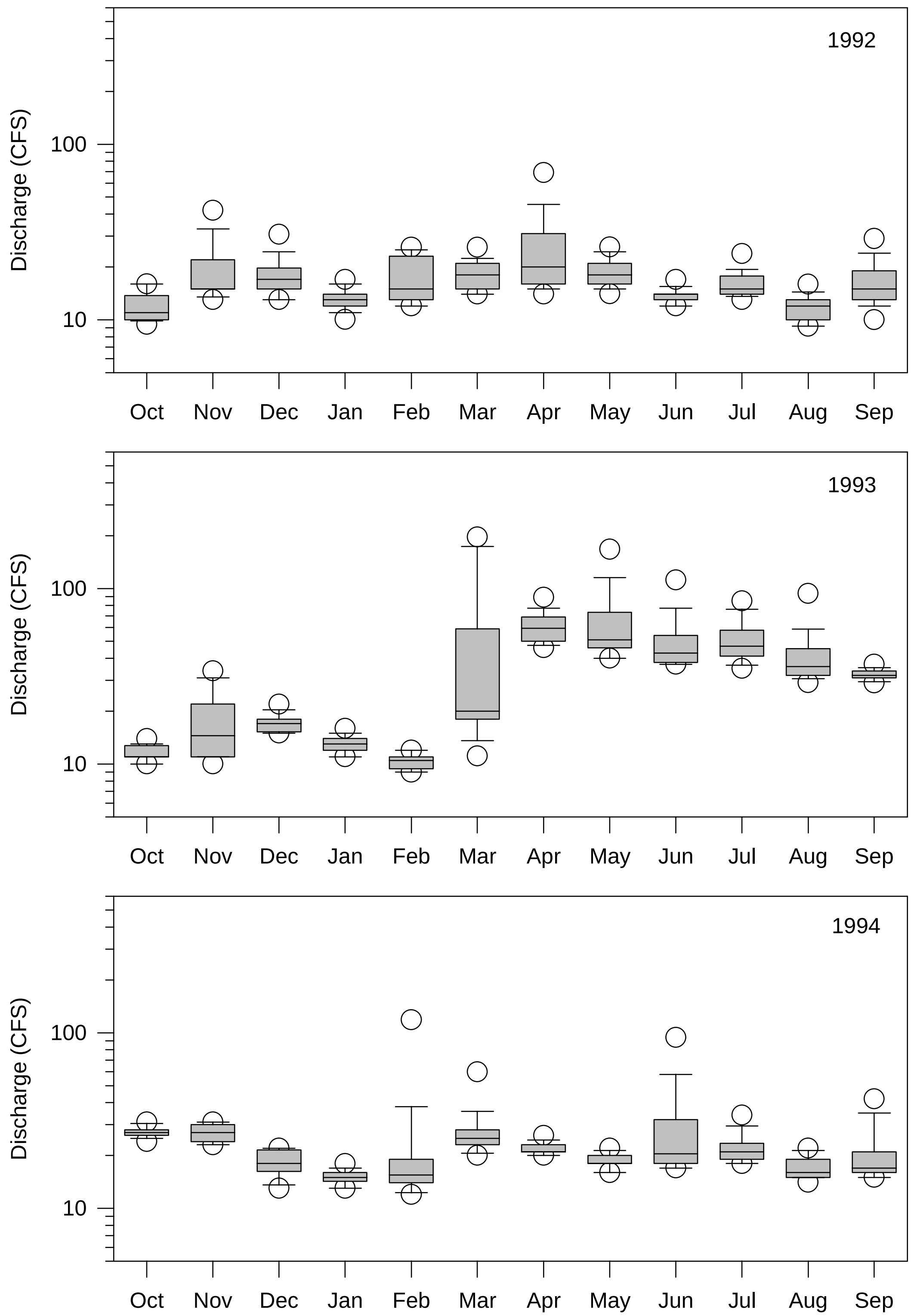


Figure 9. Box plots of discharge on a monthly basis for site SN1 (Sny Magill) for water years 1992-1994. Box plots illustrate the 25th, 50th, and 75th percentiles; the whiskers indicate the 10th and 90th percentiles; and the circles represent the 5th and 95th percentiles.

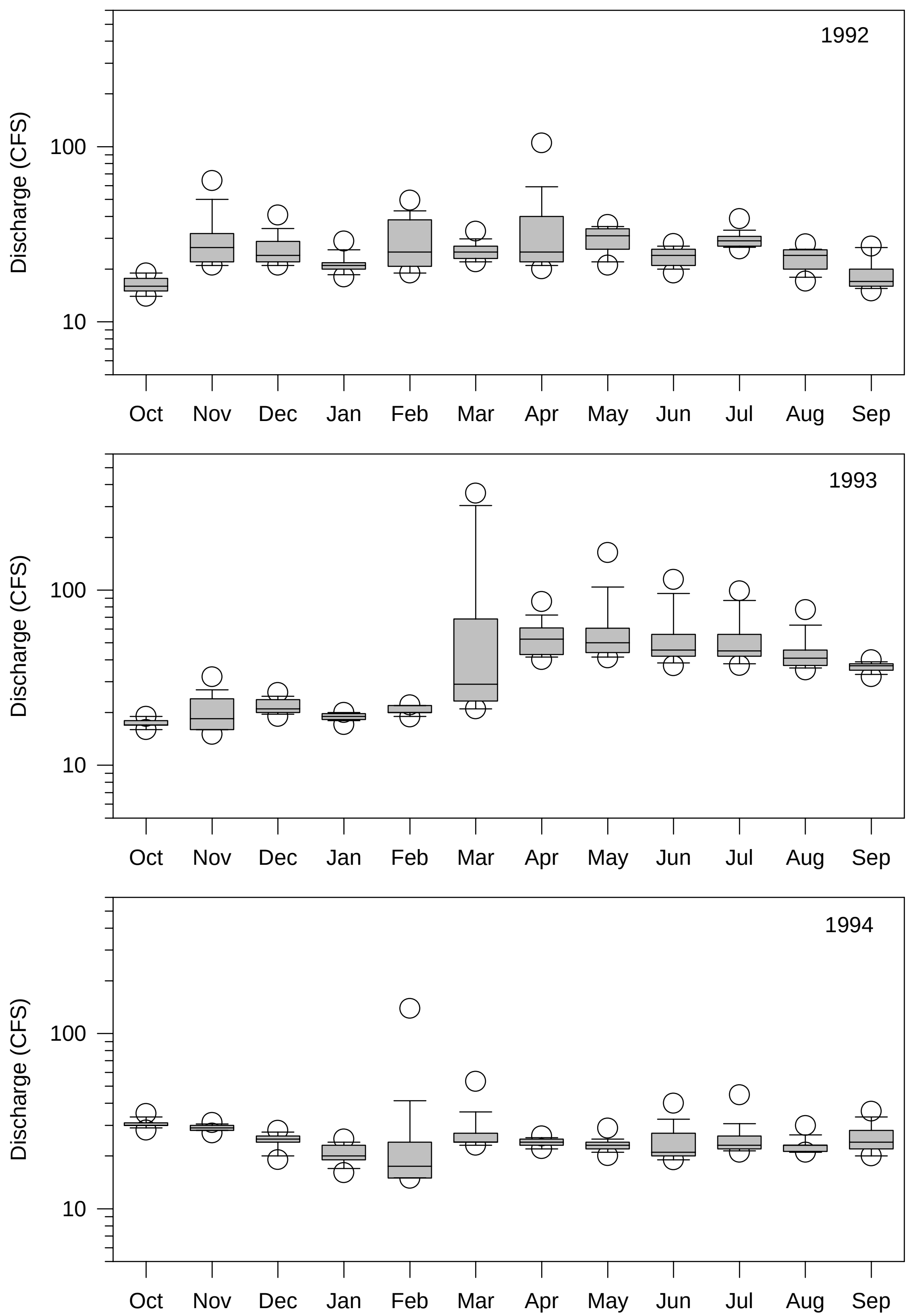


Figure 10. Box plots of discharge on a monthly basis for site BR1 (Bloody Run) for water years 1992-1994. Box plots illustrate the 25th, 50th, and 75th percentiles; the whiskers indicate the 10th and 90th percentiles; and the circles represent the 5th and 95th percentiles.

Bloody Run watershed occurred during the February 1994 sampling for both sites (BRSC and BR2). For the five supplemental sites in the Sny Magill watershed (SN3, SNWF, NCC, SNT, and SN2), the greatest measured discharge occurred during November 1993 for site SN3, March 1994 for site SNT, and August 1994 for sites SNWF, SN2, and NCC.

Suspended Sediment

Suspended-sediment samples were collected daily by local observers at sites SN1 and BR1 (Figure 1). Suspended-sediment concentrations were determined by the U.S. Geological Survey sediment laboratory in Iowa City, using standard filtration and evaporation techniques (Guy, 1969). The wet-sieve method was used to determine the sand and silt-clay fractions (Guy, 1969; Matthes et al., 1992). Stream stage at these two sites was recorded continuously and stream-discharge measurements were made monthly.

Sny Magill

Daily suspended-sediment concentrations and loads for site SN1 are listed in Table 17. The maximum daily mean suspended-sediment concentration at site SN1 was 1,470 mg/L on February 19, 1994 (Table 17), and the minimum daily mean suspended-sediment concentration was 4 mg/L on May 5, 1994. At site SN1, the maximum monthly median sediment concentration for Water Year 1994 was 34 mg/L in September 1994 and the minimum 11 mg/L in November 1993.

Figure 6 is a plot of the daily suspended-sediment loads for Sny Magill. Overall, on a daily basis, suspended-sediment loads were higher for Bloody Run than Sny Magill during the first five months of the water year. The elevated suspended-sediment loads may be a lingering effect of the flood during 1993. From March 1994 on, suspended-sediment loads tended to be higher for Sny Magill than Bloody Run. During high discharge periods, suspended-sediment loads were higher for Sny Magill. Mean daily suspended-sediment discharge in 1994 exceeded 0.60 tons 90% of the year, exceeded 1.1 tons 50% of the year, and exceeded 3.8 tons 10% of the year (Figure 8). Figure 11 shows the variability in monthly sediment loads at site SN1 for water years 1992 through 1994. For Water Year 1994, the maximum monthly median sediment load was 2.0 tons/day in September 1994, and the minimum was 0.83 tons/day in November 1993. The maximum monthly discharge of sediment, 1,828 tons, or 38% of the annual total, occurred in June 1994, and the minimum suspended-sediment load (31 tons or 0.6%) occurred in December 1993 (Tables 17 and 18). Suspended-sediment loads were greatest during Water Year 1993 as a result of above normal rainfall.

The total suspended-sediment load at site SN1 for Water Year 1994 was 4,775 tons (Table 17). This represents an average loss of 173 tons/mi^2 for the drainage area above the gaging station. The maximum daily suspended-sediment load was 1,290 tons on February 19, 1994, which accounted for 27% of the annual total. The majority of the annual sediment was discharged from the Sny Magill watershed during February 1994 (29%) and June 1994 (38%) (Table 18).

Bloody Run

Daily suspended-sediment concentrations and loads for site BR1 are listed in Table 19. The maximum daily mean suspended-sediment concentration at site BR1 was 1,780 mg/L on February 19, 1994, and the minimum daily mean suspended-sediment concentration was 4 mg/L on September 19, 1994. For Water Year 1994, the maximum monthly median sediment concentration at site BR1 was 86 mg/L in December 1993 and the minimum 14.5 mg/L in September 1994.

Figure 6 is a plot of the daily suspended-sediment loads for Bloody Run. Overall, on a daily basis, suspended-sediment loads were higher for Bloody Run than Sny Magill. Mean daily suspended-sediment discharge exceeded 0.75 tons 90% of the year, exceeded 2.1 tons 50% of the year, and exceeded 6.1 tons 10% of the year in Water Year 1994 (Figure 8). Figure 12 shows the variability in monthly sediment loads at site BR1 for

Table 16. Stage, mean velocity, and discharge measurements at supplemental sites in Sny Magill and Bloody Run watersheds; Water Year 1994.

Site	Date	Stage (Feet below reference mark)	Mean velocity (feet/sec)	Discharge (cubic feet/sec)	Site	Date	Stage (Feet below reference mark)	Mean velocity (feet/sec)	Discharge (cubic feet/sec)
BRSC	10/18/93	18.36	0.50	7.19	NCC	10/19/93	9.77	0.75	5.00
	11/16/93	18.40	0.50	6.81		11/16/93	9.79	0.63	3.81
	12/10/93	18.44	0.45	6.32		12/9/93	9.81	1.42	4.44
	1/11/94	18.50	0.38	5.33		1/11/94	9.89	0.62	3.12
	2/22/94	18.49	0.56	7.88		2/24/94	9.85	0.51	2.96
	3/10/94	18.49	0.49	6.60		3/10/94	9.83	0.66	3.63
	4/20/94	18.53	0.38	4.94		4/22/94	9.85	0.51	2.86
	5/3/94	18.50	0.37	5.01		5/3/94	9.84	0.48	2.63
	6/22/94	18.57	0.39	4.64		6/22/94	9.87	0.74	2.85
	7/28/94	18.57	0.40	4.90		7/28/94	9.85	0.42	2.43
	8/9/94	18.54	0.35	4.19		8/10/94	9.69	0.81	5.71
	9/20/94	18.55	0.41	4.45		9/19/94	9.87	0.39	2.11
BR2	10/18/93	17.40	0.55	16.4	SNT	10/19/93	12.38	0.92	1.98
	11/16/93	17.48	0.34	13.8		11/16/93	12.39	1.03	1.87
	12/10/93	17.49	0.89	15.6		12/9/93	12.43	0.80	1.47
	1/11/94	17.46	0.85	12.7		1/11/94	12.52	0.64	1.17
	2/22/94	17.49	0.59	18.1		2/24/94	12.58	1.13	1.85
	3/10/94	17.48	0.63	15.6		3/10/94	12.58	1.17	2.27
	4/20/94	17.58	0.36	10.8		4/22/94	12.64	0.92	1.59
	5/3/94	17.58	0.36	10.8		5/3/94	12.66	0.95	1.68
	6/22/94	17.57	0.34	10.2		6/21/94	13.25	0.55	1.81
	7/28/94	17.63	0.45	9.37		7/28/94	13.23	0.92	1.34
	8/9/94	17.63	0.33	7.78		8/10/94	13.22	1.65	1.92
	9/20/94	17.64	0.68	10.8		9/19/94	13.28	0.45	1.00
SN3	10/19/93	18.12	0.67	6.06	SN2	10/19/93	20.76	0.73	20.8
	11/16/93	18.17	0.97	6.34		11/16/93	20.83	0.69	19.3
	12/9/93	18.17	0.97	6.25		12/9/93	20.84	1.06	20.1
	1/11/94	18.27	0.90	5.37		1/11/94	20.94	0.54	13.8
	2/24/94	18.10	0.49	6.04		2/24/94	20.98	0.73	20.8
	3/4/94	18.23	1.05	6.08		3/10/94	20.94	0.68	17.1
	4/22/94	18.26	0.55	3.90		4/22/94	20.92	0.59	15.2
	5/3/94	18.23	0.72	4.09		5/3/94	20.98	0.59	14.9
	6/21/94	18.26	0.48	3.37		6/22/94	21.04	0.63	14.3
	7/28/94	18.28	0.76	2.93		7/28/94	21.03	0.56	12.2
	8/10/94	18.15	0.88	8.22		8/10/94	21.02	1.09	25.0
	9/19/94	18.27	0.38	3.26		9/19/94	21.16	0.58	11.2
SNWF	10/19/93	10.37	0.48	4.12					
	11/16/93	10.32	0.47	4.00					
	12/9/93	10.37	1.24	2.52					
	1/11/94	9.69	0.41	3.01					
	2/24/94	9.71	0.62	3.29					
	3/10/94	10.44	0.49	3.34					
	4/22/94	10.50	0.44	2.75					
	5/3/94	10.50	0.48	2.95					
	6/21/94	10.44	0.48	2.75					
	7/28/94	10.51	0.38	2.22					
	8/10/94	10.39	0.72	4.79					
	9/19/94	10.52	0.47	2.55					

Source: May and others (1995)

Table 17. Daily mean suspended-sediment concentration and daily suspended-sediment load at site SN1 on Sny Magill Creek; Water Year 1994.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Mean daily suspended-sediment concentration, in milligrams per liter											
1	10	13	11	26	71	29	20	15	32	40	24	22
2	8	12	12	22	63	47	28	15	19	31	45	20
3	8	10	13	13	54	33	17	11	26	33	39	23
4	8	10	13	12	49	84	13	12	27	63	44	26
5	9	11	13	12	18	1020	11	4	29	29	34	25
6	17	11	16	19	17	451	21	7	38	25	28	23
7	33	11	20	22	19	37	16	9	43	23	51	25
8	45	10	27	25	19	24	21	10	32	29	52	23
9	43	10	32	26	21	18	22	9	29	26	53	21
10	53	11	29	26	20	14	9	17	27	24	45	23
11	66	12	28	31	22	15	16	16	30	23	41	22
12	34	13	27	29	20	33	23	19	13	22	39	24
13	36	32	24	27	21	28	13	15	75	22	31	25
14	25	29	21	29	22	11	11	15	15	28	23	24
15	19	32	20	20	32	12	27	15	21	27	13	46
16	18	33	18	16	27	12	31	29	19	25	38	45
17	17	30	23	17	23	14	12	28	21	34	14	35
18	20	23	22	17	45	17	15	27	23	51	8	33
19	14	12	23	16	1470	16	17	25	746	72	78	35
20	17	5	24	15	175	14	24	22	798	1000	57	77
21	11	7	24	17	27	14	8	23	43	55	29	80
22	35	6	23	16	23	19	6	19	34	46	14	98
23	22	8	22	17	22	27	10	99	1040	42	12	112
24	7	11	20	20	22	20	17	50	193	38	13	120
25	7	14	18	39	18	16	22	38	63	38	14	112
26	8	9	20	48	23	25	24	53	29	42	15	66
27	9	7	19	46	27	24	37	32	50	41	13	110
28	9	7	20	49	17	18	18	30	49	43	16	102
29	10	9	11	54	---	20	12	30	58	32	17	108
30	11	7	9	59	---	16	10	32	42	31	18	112
31	12	---	28	73	---	43	---	46	---	39	22	---
	Suspended-sediment load, in tons per day											
1	0.77	1.1	0.65	1.2	3.6	1.6	1.1	0.96	1.5	2.4	1.2	0.92
2	0.58	0.97	0.73	1.0	2.9	2.5	1.6	0.86	0.86	1.8	2.3	0.84
3	0.60	0.81	0.75	0.61	2.2	1.8	0.98	0.60	1.1	1.9	2.1	1.0
4	0.62	0.84	0.79	0.55	1.9	12	0.80	0.66	1.2	7.2	2.5	1.1
5	0.66	0.92	0.77	0.52	0.63	497	0.68	0.24	1.3	1.9	1.7	1.1
6	1.3	0.90	0.99	0.82	0.55	89	1.2	0.37	1.7	1.3	1.3	1.0
7	2.3	0.83	1.2	0.89	0.62	4.1	0.90	0.49	2.8	1.2	2.4	1.0
8	3.2	0.75	1.6	1.0	0.62	2.1	1.1	0.51	1.7	2.1	2.4	0.93
9	3.9	0.71	1.7	1.1	0.74	1.3	1.2	0.49	1.4	1.8	2.5	0.91
10	4.0	0.83	1.4	1.1	0.76	0.92	0.51	0.83	1.3	1.4	3.2	1.0
11	4.8	0.95	1.2	1.4	0.83	0.92	0.87	0.75	1.6	1.2	2.4	0.98
12	2.4	1.1	1.3	1.3	0.76	2.1	1.5	0.91	0.63	1.1	1.8	1.1
13	2.5	3.0	1.1	1.2	0.79	2.0	0.88	0.71	8.4	1.1	1.4	1.1
14	1.8	2.4	0.98	1.2	0.87	0.82	0.68	0.78	0.83	1.9	0.95	1.1
15	1.4	2.7	0.99	0.76	1.3	0.99	2.1	0.74	1.1	1.5	0.51	6.7
16	1.3	2.5	0.88	0.56	1.1	0.86	2.2	1.4	0.91	1.3	1.5	4.0
17	1.3	1.9	1.2	0.64	1.0	0.95	0.76	1.3	1.0	1.7	0.58	1.9
18	1.4	1.5	1.1	0.60	2.4	1.1	0.98	1.2	1.1	2.4	0.32	1.5
19	0.93	0.79	1.1	0.56	1290	1.1	1.0	1.1	498	4.5	6.7	1.6
20	1.2	0.35	1.2	0.49	61	1.0	1.5	0.97	177	478	3.7	3.8
21	0.74	0.44	1.2	0.60	3.1	1.1	0.43	0.97	3.2	5.0	1.3	3.8
22	2.3	0.40	1.1	0.60	1.9	1.4	0.31	0.80	2.4	3.3	0.60	4.9
23	1.4	0.52	0.95	0.69	1.2	2.0	0.53	7.4	1030	2.5	0.45	6.3
24	0.48	0.67	0.81	0.81	1.1	1.4	0.93	3.1	60	2.1	0.48	6.7
25	0.45	1.1	0.63	1.6	0.87	1.0	1.2	2.8	9.3	2.1	0.55	13
26	0.55	0.64	0.65	2.0	1.1	1.6	1.4	3.3	3.1	2.4	0.59	9.2
27	0.67	0.48	0.67	2.0	1.3	1.5	2.1	1.6	4.2	2.0	0.50	11
28	0.75	0.45	0.76	2.0	0.87	1.1	1.0	1.5	3.9	2.2	0.63	7.7
29	0.84	0.55	0.45	2.2	---	1.2	0.69	1.5	4.2	1.9	0.69	6.5
30	0.87	0.41	0.39	2.4	---	0.90	0.61	1.6	2.6	1.7	0.77	5.6
31	1.0	---	1.3	3.2	---	2.4	---	2.2	---	2.1	0.95	---
Total:	47.01	31.51	30.54	35.60	1386.01	639.76	31.74	42.64	1828.33	545.00	48.97	108.28
										Water year total: 4775.39		
Mean:	1.50	1.10	0.99	1.10	50.00	21.00	1.10	1.40	61.00	18.00	1.60	3.60
Median:	1.20	0.83	0.99	1.00	1.10	1.40	0.98	0.96	1.70	1.90	1.30	2.00
Maximum	4.80	3.00	1.70	3.20	1290.00	497.00	2.20	7.40	1030.00	478.00	6.70	13.00
Minimum:	0.45	0.35	0.39	0.49	0.55	0.82	0.31	0.24	0.63	1.10	0.32	0.84

Source: May and others (1995)

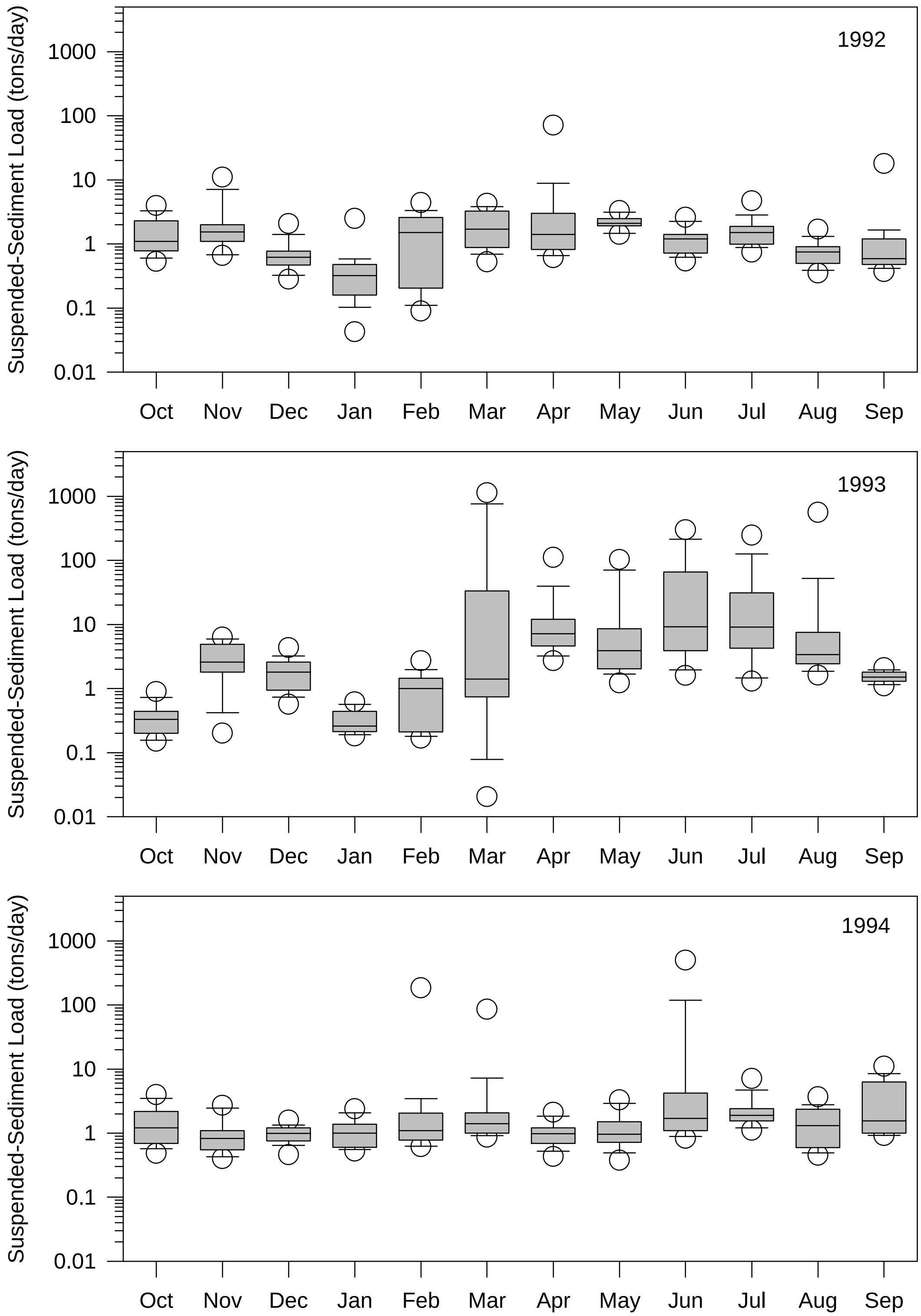


Figure 11. Box plots of suspended-sediment loads on a monthly basis for site SN1 (Sny Magill) for water years 1992-1994. Box plots illustrate the 25th, 50th, and 75th percentiles; the whiskers indicate the 10th and 90th percentiles; and the circles represent the 5th and 95th percentiles.

Table 18. Monthly sediment load at sites SN1 (Sny Magill) and BR1 (Bloody Run) as a percent of the total sediment load for each water year.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Sny Magill												
1992	3	6	1	1	3	3	68	4	2	3	1	5
1993	<1	1	<1	<1	<1	38	5	8	18	9	20	<1
1994	1	1	1	1	29	13	1	1	38	11	1	2
Bloody Run												
1992	<1	34	2	3	5	2	46	2	2	2	1	1
1993	<1	<1	<1	<1	1	50	4	11	21	4	8	<1
1994	4	5	5	4	62	3	1	1	4	7	1	1

water years 1992 through 1994. For Water Year 1994, the maximum monthly median sediment load was 5.7 tons/day in December 1993, and the minimum was 0.9 tons/day in August 1994. The greatest monthly discharge of sediment, 1,926 tons or 62% of the annual total, occurred in February 1994 (Tables 18 and 19). This was the result of spring snow melt and rainfall that occurred during February. The minimum monthly suspended-sediment load (32 tons or 1%) occurred in September 1994 (Table 19).

The total suspended-sediment load at site BR1 for Water Year 1994 was 3,117 tons (Table 19). This represents an average loss of 91 tons/mi^2 for the drainage area above the gaging station. This loss is one-half of what it was for Sny Magill during Water Year 1994. The maximum daily suspended-sediment load was 1,690 tons on February 19, 1994, and accounted for 54% of the annual total. Table 18 summarizes the monthly sediment load as a percent of the total for each water year. For Water Year 1994, the majority of sediment (62%) was discharged from the watershed during February 1994.

Discussion

Hydrologically, Water Year 1994 marked a return to more typical climatic conditions after the heavy rains of 1993. Precipitation during Water Year 1994 was 100% of normal. Table 20 is a summary of the discharge and sediment data for water years 1992 through 1994. Annual mean discharge and suspended sediment loads from both streams declined from 1993 to 1994, yet 1994 levels were higher than in 1992. During Water Year 1994, Sny Magill had a higher annual mean discharge per square mile drainage (0.85 cfs/mi^2) than Bloody Run (0.76 cfs/mi^2). For the first time since sampling began, a greater amount of sediment was discharged from Sny Magill (4,775 tons) than Bloody Run (3,117 tons) during Water Year 1994, and Sny Magill had a greater annual suspended sediment load per unit area (173 tons/mi^2) than Bloody Run (91 tons/mi^2).

For both streams, the majority of sediment discharged occurred during a very short period of time. During Water Year 1994, seven days (not necessarily consecutive days) accounted for 85% of the total sediment load discharged from Sny Magill and 68% of the sediment from Bloody Run (Table 20). The 85% for Sny Magill was the highest percent from that site for the three years of monitoring. The 68% for Bloody Run was the lowest of all three years of monitoring at that site. The greater amount of sediment discharged from Sny Magill than Bloody Run during 1994 was probably the result of more intense rainfalls in the Sny Magill watershed as suggested by the fact that 85% of the sediment discharged from Sny Magill occurred during seven days compared to 68% for Bloody Run.

The greater amount of sediment discharging from Sny Magill during Water Year 1994 may be

Table 19. Daily mean suspended-sediment concentration and daily suspended-sediment load at site BR1 on Bloody Run Creek; Water Year 1994.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean daily suspended-sediment concentration, in milligrams per liter												
1	14	68	94	81	71	52	12	20	16	27	24	9
2	30	56	85	72	59	49	14	16	22	28	20	16
3	41	45	59	93	57	50	14	7	12	24	17	12
4	41	35	62	88	86	33	17	13	9	23	8	17
5	56	21	97	92	60	45	13	16	17	20	11	21
6	63	18	105	69	73	91	12	10	14	15	10	13
7	52	32	117	86	95	86	24	15	16	18	12	17
8	28	92	105	73	57	55	12	14	16	19	13	21
9	39	107	80	112	60	21	13	17	17	15	11	15
10	59	101	90	63	67	12	13	20	16	11	35	14
11	63	94	66	60	82	15	16	16	25	9	22	7
12	54	77	100	57	56	22	24	13	26	13	30	18
13	57	63	49	89	76	22	28	17	153	12	21	14
14	45	66	88	95	65	27	23	16	74	20	12	6
15	29	61	38	88	56	25	34	13	43	14	12	16
16	41	71	54	71	51	28	25	15	45	11	12	39
17	66	72	105	83	40	26	8	23	28	8	29	21
18	67	81	86	66	45	30	12	15	18	11	29	6
19	58	58	90	78	1780	16	25	17	67	27	92	4
20	73	61	117	94	385	19	29	17	84	527	47	25
21	51	71	118	90	65	29	20	18	63	180	16	13
22	33	70	60	75	25	35	18	17	48	59	13	11
23	46	68	53	71	27	22	10	54	237	40	13	27
24	52	68	29	40	60	17	15	51	103	30	27	13
25	69	70	83	54	69	10	25	37	41	29	19	6
26	32	65	95	74	44	14	18	31	34	50	17	19
27	47	69	84	62	51	5	19	23	26	41	15	17
28	66	94	54	97	57	13	15	18	23	33	11	18
29	75	86	96	79	---	12	9	16	20	31	9	11
30	66	78	74	51	---	13	15	21	18	23	13	8
31	43	---	96	45	---	11	---	19	--	32	13	---
Suspended-sediment load, in tons per day												
1	1.1	5.6	6.9	5.1	3.7	3.4	0.69	1.3	0.84	1.8	1.3	0.56
2	2.4	4.5	6.3	4.7	2.9	3.4	0.83	1.1	1.2	1.9	1.1	1.1
3	3.2	3.6	4.5	6.1	2.7	3.6	0.87	0.46	0.62	1.7	0.94	0.84
4	3.2	2.8	4.7	5.8	4.1	2.3	1.0	0.87	0.50	1.5	0.49	1.3
5	4.3	1.7	7.3	6.3	2.7	4.9	0.83	1.1	0.92	1.2	0.63	1.4
6	4.8	1.5	7.7	4.6	3.4	18	0.79	0.66	0.72	0.84	0.62	0.83
7	3.9	2.7	8.4	5.3	4.1	13	1.50	1.0	0.97	1.0	0.71	1.1
8	2.2	7.2	7.5	4.3	2.3	4.9	0.71	0.92	0.87	1.4	0.72	1.4
9	4.3	8.1	5.7	6.0	2.3	1.5	0.79	1.0	0.91	0.96	0.68	1.1
10	5.5	7.7	6.3	3.6	2.7	0.77	0.78	1.3	0.87	0.70	3.0	0.88
11	5.8	7.1	4.7	3.4	3.5	0.93	0.97	1.0	1.4	0.52	1.5	0.43
12	4.8	6.2	7.1	3.7	2.3	1.5	1.60	0.83	1.3	0.81	1.9	1.0
13	5.1	5.0	3.3	6.1	3.3	1.8	1.90	1.0	17	0.80	1.3	0.74
14	3.9	5.2	6.0	5.9	2.7	2.1	1.50	1.1	4.4	1.4	0.75	0.31
15	2.6	4.9	2.5	5.0	2.3	2.1	2.4	0.83	2.3	0.92	0.76	0.97
16	3.5	5.6	3.5	3.6	2.1	2.0	1.6	0.97	2.4	0.66	0.75	2.5
17	5.5	5.4	6.9	4.0	1.6	1.8	0.53	1.4	1.5	0.45	1.8	1.1
18	5.6	6.3	5.7	3.0	1.8	1.9	0.76	0.93	0.97	0.65	1.7	0.36
19	4.5	4.4	6.0	3.4	1690	1.0	1.5	1.0	6.1	2.0	11	0.24
20	5.8	4.8	7.9	4.3	155	1.3	1.9	1.0	6.7	161	3.8	1.5
21	4.2	5.4	8.1	3.9	8.4	2.0	1.3	1.1	4.1	21	0.97	0.86
22	2.7	5.2	4.1	3.4	2.2	2.4	1.2	1.1	3.6	5.3	0.80	0.92
23	3.7	4.9	3.4	3.6	2.1	1.5	0.64	6.6	51	2.9	0.75	2.0
24	4.2	4.9	2.0	1.9	4.4	1.1	0.91	4.5	13	2.1	1.5	0.91
25	5.6	5.5	4.9	2.9	4.7	0.61	1.6	2.5	3.2	1.9	1.2	0.59
26	2.6	5.3	5.1	4.2	2.7	0.92	1.2	2.1	2.5	3.3	1.0	2.2
27	3.8	5.6	4.1	3.3	3.0	0.35	1.2	1.4	1.8	2.5	0.84	1.6
28	5.4	7.5	2.8	5.0	3.5	0.82	1.0	1.0	1.6	2.0	0.68	1.5
29	6.3	6.5	5.2	4.1	---	0.78	0.62	0.88	1.4	1.8	0.54	0.99
30	5.6	5.9	4.4	2.6	---	0.79	1.1	1.2	1.2	1.3	0.87	0.62
31	3.6	---	6.0	2.5	---	0.68	---	1.0	---	1.8	0.90	---
Total:	129.70	157.00	169.00	131.60	1926.50	84.15	34.22	43.15	135.89	228.11	45.50	31.85
										Water year total: 3116.67		
Mean:	4.20	5.20	5.50	4.20	69.00	2.70	1.10	1.40	4.50	7.40	1.50	1.10
Median:	4.20	5.40	5.70	4.10	2.80	1.80	1.00	1.00	1.50	1.50	0.90	1.00
Maximum	6.30	8.10	8.40	6.30	1690.00	18.00	2.40	6.60	51.00	161.00	11.00	2.50
Minimum:	1.10	1.50	2.00	1.90	1.60	0.35	0.53	0.46	0.50	0.45	0.49	0.24

Source: May and others (1995)

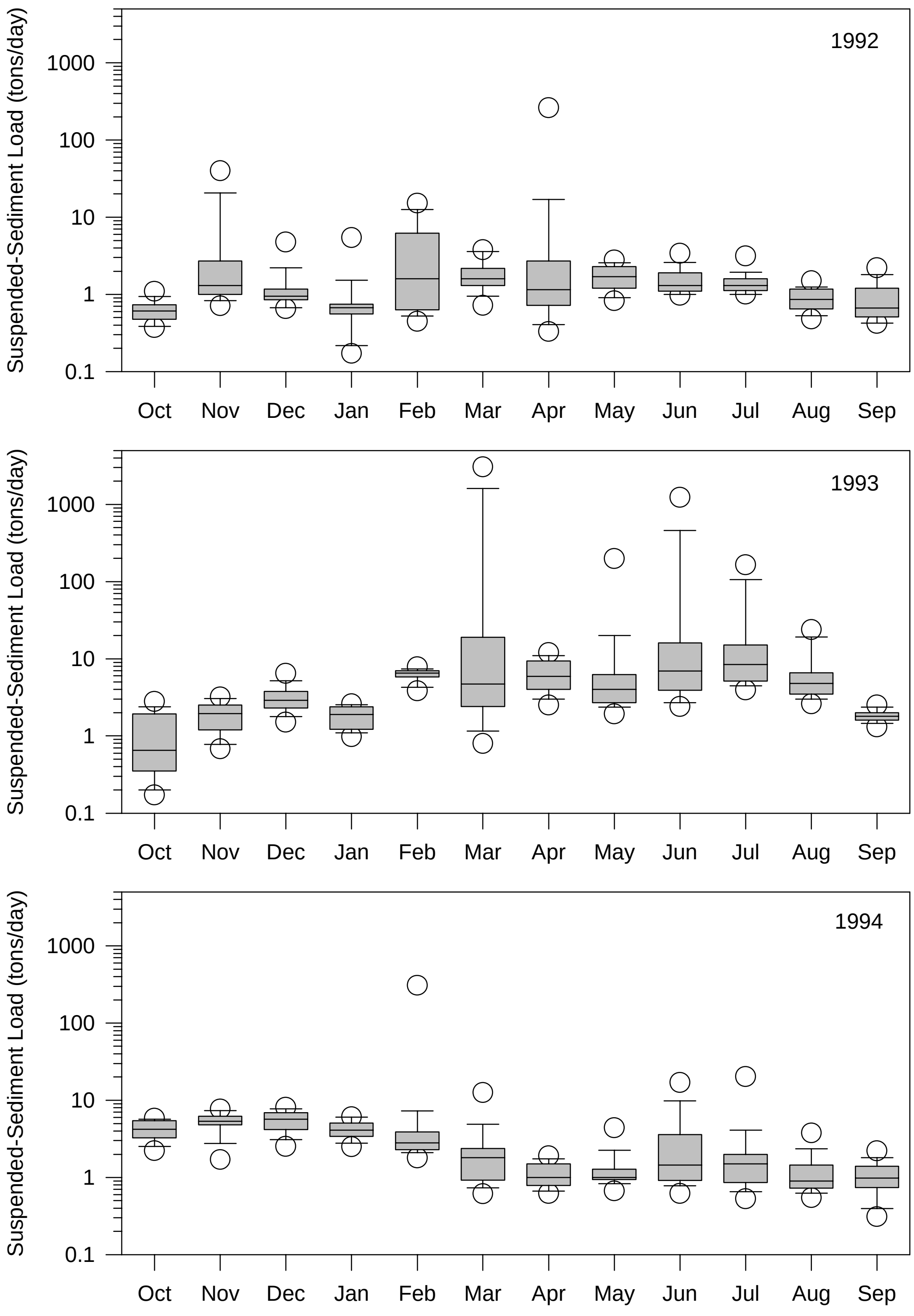


Figure 12. Box plots of suspended-sediment loads on a monthly basis for site BR1 (Bloody Run) for water years 1992-1994. Box plots illustrate the 25th, 50th, and 75th percentiles; the whiskers indicate the 10th and 90th percentiles; and the circles represent the 5th and 95th percentiles.

related to the unusual rainfall conditions during Water Year 1993 and the flushing of sediment through the system. The two USDA land treatment programs have implemented an extensive number of terraces and sediment control structures in the Sny Magill watershed relative to Bloody Run. With the heavy rains of 1993, most of the moveable sediment in Bloody Run may have been flushed through the system whereas sediment control structures limited the movement of sediment in Sny Magill. The higher sediment load in Sny Magill for Water Year 1994 may reflect a delayed movement of available sediment.

WATER QUALITY MONITORING RESULTS

Water quality was monitored at six sites in the Sny Magill watershed and three sites in the Bloody Run watershed (Figure 1). Table 21 summarizes the chemical parameters analyzed, method detection limit, and method description and reference. Monitoring was conducted by personnel from the Iowa Department of Natural Resources-Geological Survey Bureau (IDNR-GSB) and the U.S. National Park Service-Effigy Mounds National Monument. Sites BRSC, SN2, and SNT were sampled monthly; all other sites were sampled weekly. Appendix II is a statistical summary of the results for Water Year 1994 on an annual basis for all sites and on a quarterly basis for sites sampled weekly. Water-quality results for water years 1992 and 1993 are in Seigley and others (1994).

Water Year 1994

Mean values for water-quality parameters monitored are summarized in Table 22 for weekly sites and in Table 23 for monthly sites. Field measurements included temperature, specific conductance, dissolved oxygen, and turbidity. Mean temperatures for Water Year 1994 varied from 9 to 11 °C. Mean specific conductance values were in the 600 to 700 µS/cm (microsiemens per centimeter) range. Of the three years of monitoring, mean specific conductance values were the highest during Water Year 1994 for all sites. Mean dissolved oxygen concentrations were relatively high, ranging from 11 to 12 mg/L. Turbidity values were low, with annual means varying from 3.6 to 9.5 NTU. The mean turbidity values for 1994 were the lowest of the three years of monitoring, except for site BR2.

Median fecal coliform counts for Water Year 1994 varied from 15 to 220 organisms per 100 ml. The highest median fecal count (220) occurred at BR2. Median fecal counts for Water Year 1994 were the lowest of the three-year monitoring period for all sites except SNT, SN2, and BRSC; all three are sampled monthly and this trend may reflect sampling frequency.

Mean annual nitrate-N concentrations ranged from 2.4 to 10.7 mg/L. For the three-year monitoring period, mean annual nitrate-N concentrations were the highest in Water Year 1994 for seven of the nine sites. Only sites NCC and BR1 had lower nitrate-N mean concentrations for Water Year 1994. Mean nitrate-N concentrations declined in a downstream direction, from 5.2 to 2.9 mg/L for sites on Sny Magill, and from 10.7 to 5.7 mg/L for sites on Bloody Run. Mean annual ammonia-N concentrations were low, with concentrations from 0.1 to 0.2 mg/L for all sites. Biological Oxygen Demand (BOD) was measured only at sites SN1 and BR1. Mean BOD concentrations for Water Year 1994 for both sites were <1 mg/L, the lowest mean value for both sites during the three years of monitoring. Total phosphorus averaged <0.1 mg/L at site SN1 and 0.1 mg/L at site BR1. Mean annual triazine concentrations, determined by immuno assay analysis, were 0.14 µg/L for site SN1 and 0.44 µg/L for site BR1. Mean triazine concentrations declined from Water Year 1993 to Water Year 1994 for both sites.

Table 22 includes annual mean concentrations of several other anions. For Water Year 1994, nitrite-N concentrations were low, ranging from 0.01 to 0.02 mg/L; mean phosphorus concentrations were below the detection limit of 0.03 mg/L for all sites; and mean fluoride concentrations were 0.1 to 0.2 mg/L.

For Water Year 1994, mean sulfate concentrations ranged from 20.3 to 33.6 mg/L. Site SNWF has consistently higher sulfate concentrations. Mean sulfate concentrations from sites in Bloody

Table 20. Summary of discharge and sediment data for water years 1992-1994.

	Water Year 1992	Water Year 1993	Water Year 1994
Prairie du Chien, WI rainfall (percent of normal)	38.03 inches (124%)	51.85 inches (169%)	30.54 inches (99.8%)
Annual mean discharge (cubic feet per second)			
Sny Magill	17.1	36.6	23.4
Bloody Run	26.3	42.1	26.1
Annual mean discharge per square mile drainage			
Sny Magill	0.62	1.33	0.85
Bloody Run	0.77	1.23	0.76
Maximum daily discharge (cubic feet per second)			
Sny Magill	90	313	268
Bloody Run	205	550	302
Total suspended sediment discharge (tons/year)			
Sny Magill	1,940	13,086	4,775
Bloody Run	2,720	22,174	3,117
Annual suspended sediment load per unit area (tons per square mile)			
Sny Magill	70	474	173
Bloody Run	79	647	91
% of total sediment load represented by 7 days with greatest daily loads (not necessarily consecutive days)			
Sny Magill	73%	58%	85%
Bloody Run	78%	74%	68%
% of annual discharge represented by 7 days with greatest daily sediment loads			
Sny Magill	6%	10%	9%
Bloody Run	7%	14%	8%

Table 21. Summary of chemical parameters analyzed for and method detection limits for those parameters.

Analyte	Lab	Method Detection	Sample Holding Time	Method Description & Reference
Fecal bacteria	UHL-IC	count	8 hours	Standard Method 9222D (APHA, 1985) using media fecal coliform at 44.5 °C.
Nitrate & nitrite-N	UHL-DM	0.10 mg/L	28 days	Automated, copper-cadmium reduction & colorimetric quantitation, EPA Method 353.2 (USEPA, 1983).
Ammonia-N	UHL-DM	0.10 mg/L	28 days	Automated, phenate reaction, & colorimetric quantitation, EPA Method 350.1 & 350.2 (USEPA, 1983).
Organic-N	UHL-DM	0.10 mg/L	28 days	Total Kjeldahl procedure, semi-automated block digester, AAII, colorimetric quantitation, EPA Method 351.2 (USEPA, 1983).
Anions	SGL			Ion chromatography using a Waters Ion Chromatograph (Waters Ion Chromatography Cookbook, 1989).
Bromide		0.06 mg/L	14 days	
Chloride		0.02 mg/L	14 days	
Fluoride		0.04 mg/L	14 days	
Nitrate		0.10 mg/L	14 days	
Nitrite		0.04 mg/L	14 days	
Phosphorus		0.03 mg/L	14 days	
Sulfate		0.10 mg/L	14 days	
Total P	UHL-DM	0.10 mg/L	28 days	Colorimetric, automated, block digester, EPA Method 365.4 (USEPA, 1983).
5-Day BOD	UHL-DM	1.00 mg/L	48 hours	Samples incubated in dark for 5 days at 20 °C, Standard Method 507 (APHA, 1985).
IMA for triazine herbicides	UHL-IC	0.10 μg/L	14 days	Immuno assay using spectrophotometric measurement & analysis; Millipore triazine kit.

UHL-DM: University Hygienic Laboratory, Des Moines
UHL-IC: University Hygienic Laboratory, Iowa City
SGL: Sedimentary Geochemistry Laboratory, Iowa City

Table 22. Mean water quality parameters for sites monitored weekly in Sny Magill and Bloody Run watersheds; water years 1992-1994.

Parameter	Units	SN1 1992	SN1 1993	SN1 1994	SN3 1992	SN3 1993	SN3 1994	NCC 1992	NCC 1993	NCC 1994
n		52	52	52	52	52	52	52	52	52
Drainage Area	sq. mi.	27.6	27.6	27.6	7.2	7.2	7.2	6.0	6.0	6.0
Row Crop	%	27.6%	27.6%	27.6%	25.6%	25.6%	25.6%	33.4%	33.4%	33.4%
Temperature	degrees C	10	8	10	10	9	11	9	8	10
Specific Conductance	μS/cm	516	512	611	544	546	651	507	515	603
Dissolved Oxygen	mg/L	9	9	11	9	9	11	9	10	11
Turbidity	NTU	13.3	15.4	7.8	8.2	12.3	4.2	8.7	13.1	5.0
NO2+NO3-N	mg/L	1.9	2.5	2.9	3.4	3.8	5.2	2.3	3.2	2.4
Ammonia-N	mg/L	<0.1	0.2	0.2	0.1	0.2	0.2	<0.1	0.2	0.2
Organic-N	mg/L	0.2	0.3	0.2						
Fecal Bacteria *(median)*	count/100 ml	110	78	43	70	105	50	20	40	15
Total P	mg/L	0.1	0.2	<0.1						
BOD	mg/L	1	1	<1						
IMA-triazine herbicides	μg/L	0.14	0.40	0.14						
Nitrate-N	mg/L	2.1	2.6	2.8	3.6	3.9	5.2	2.2	3.3	2.4
Nitrite-N	mg/L	0.08	0.03	0.02	0.08	0.03	0.01	0.08	0.03	0.01
Phosphorus	mg/L	0.03	<0.03	<0.03	0.04	<0.03	<0.03	<0.03	<0.03	<0.03
Sulfate	mg/L	26.5	24.6	25.5	26.1	23.4	24.2	26.5	25.1	27.3
Fluoride	mg/L	0.3	0.2	0.1	0.3	0.2	0.1	0.3	0.3	0.1
Chloride	mg/L	6.5	7.0	7.6	8.4	8.7	10.6	7.0	7.7	6.8
Bromide	mg/L	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Chloride/Nitrate-N		3.4	2.8	2.7	2.5	2.3	2.0	3.0	2.4	2.8

Parameter	Units	SNWF 1992	SNWF 1993	SNWF 1994	BR1 1992	BR1 1993	BR1 1994	BR2 1992	BR2 1993	BR2 1994
n		52	52	52	52	52	52	12	52	52
Drainage Area	sq. mi.	3.1	3.1	3.1	34.3	34.3	34.3	24.5	24.5	24.5
Row Crop	%	22.3%	22.3%	22.3%	41.9%	41.9%	41.9%	51.7%	51.7%	51.7%
Temperature	degrees C	9	9	10	10	9	11	8	9	10
Specific Conductance	μS/cm	545	549	636	524	539	610	573	571	673
Dissolved Oxygen	mg/L	9	9	11	10	10	12	9	9	11
Turbidity	NTU	10.0	9.8	5.1	11.1	14.9	7.4	9.1	15.4	9.2
NO2+NO3-N	mg/L	2.6	3.3	3.6	5.0	5.7	5.8	8.7	8.7	9.5
Ammonia-N	mg/L	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.3	0.2
Organic-N	mg/L				0.4	0.6	0.2			
Fecal Bacteria *(median)*	count/100 ml	340	250	185	85	85	60	330	460	220
Total P	mg/L				0.2	0.2	0.1			
BOD	mg/L				2	1	<1			
IMA-triazine herbicides	μg/L				0.40	0.67	0.44			
Nitrate-N	mg/L	2.7	3.1	3.6	4.9	5.9	5.7	8.9	9.4	10.2
Nitrite-N	mg/L	0.08	0.03	0.01	0.08	0.03	0.02	0.08	0.04	0.02
Phosphorus	mg/L	<0.03	<0.03	<0.03	0.04	<0.03	<0.03	0.03	0.03	<0.03
Sulfate	mg/L	34.0	31.8	33.6	21.0	20.1	20.3	20.9	20.1	21.2
Fluoride	mg/L	0.3	0.2	0.1	0.2	0.3	0.1	0.3	0.3	0.1
Chloride	mg/L	7.4	7.5	8.6	9.7	11.0	11.4	13.8	15.2	17.3
Bromide	mg/L	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Chloride/Nitrate-N		2.8	2.3	2.4	1.9	1.9	2.0	1.6	1.7	1.7

Table 23. Mean water quality parameters for sites monitored monthly in Sny Magill and Bloody Run watersheds; water years 1992-1994.

Parameter	Units	SN2 1992	SN2 1993	SN2 1994	SNT 1992	SNT 1993	SNT 1994	BRSC 1992	BRSC 1993	BRSC 1994
n		12	12	12	12	12	12	52	12	12
Drainage Area	sq. mi.	22.5	22.5	22.5	3.2	3.2	3.2	10.5	10.5	10.5
Row Crop	%	28.0%	28.0%	28.0%	39.6%	39.6%	39.6%	58.3%	58.3%	58.3%
Temperature	degrees C	8	8	9	8	8	9	10	8	10
Specific Conductance	µS/cm	512	523	633	515	520	609	582	574	700
Dissolved Oxygen	mg/L	8	9	12	9	8	11	10	11	11
Turbidity	NTU	8.7	9.7	5.5	6.5	8.3	6.4	17.5	12.7	7.5
NO2+NO3-N	mg/L	2.5	3.0	3.4	2.8	2.9	3.6	8.8	9.4	10.5
Ammonia-N	mg/L	<0.1	0.2	0.1	<0.1	0.2	0.1	0.3	0.2	0.2
Fecal Bacteria *(median)*	count/100 ml	150	65	170	60	70	80	620	110	180
Nitrate-N	mg/L	2.5	2.9	3.4	2.2	2.8	3.7	9.0	9.8	10.7
Nitrite-N	mg/L	0.07	0.10	0.02	0.06	0.04	0.02	0.11	0.05	0.02
Phosphorus	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.06	<0.03	<0.03
Sulfate	mg/L	27.5	25.3	25.4	23.7	21.9	22.1	26.0	24.1	25.3
Fluoride	mg/L	0.3	0.2	0.1	0.3	0.3	0.1	0.3	0.3	0.2
Chloride	mg/L	7.0	7.2	8.0	7.0	7.7	9.0	15.5	16.2	18.2
Bromide	mg/L	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Chloride/Nitrate-N		2.8	2.4	2.4	2.5	2.7	2.4	1.8	1.7	1.7

Run were low relative to Sny Magill. Chloride concentrations from Sny Magill sites varied from 6.8 to 10.6 mg/L. Bloody Run sites ranged from 11.4 to 18.2 mg/L. Chloride concentrations declined downstream in both Sny Magill and Bloody Run, a trend similar to nitrate-N concentrations. The annual mean chloride concentrations for Water Year 1994 were the highest reported during the three years of sampling except for site NCC.

During the three-year monitoring period, the ratio of chloride to nitrate-N has declined at both the upstream (SN3) and downstream site (SN1) on Sny Magill. This decline occurred even though mean nitrate-N and chloride concentrations in Water Year 1994 were at their highest of the three-year monitoring period. The ratio, however, has remained relatively unchanged through time at the upstream (BR2) and downstream (BR1) sites on Bloody Run.

Temporal Trends

Figure 13 shows the fecal bacteria counts for all sites during Water Year 1994. Sites SN2, SNT, and BRSC were sampled monthly; all other sites were sampled weekly. Fecal coliform counts varied among the sites. The fecal counts declined for most sites during October and November, remained low during the winter months, and increased during the spring and summer months. For Water Year 1994, the fecal bacteria counts for most sites were the highest during the late spring-early summer months.

Figure 14 shows nitrate+nitrite-N concentrations from all sites. Most sites showed a general decline in concentrations throughout the year and a decline from upstream to downstream locations on the main stem of both Sny Magill and Bloody Run. Concentrations were most variable at site BR2. At the end of Water Year 1993, nitrate+nitrite-

N concentrations were increasing at most sites; the first few months of Water Year 1994 reflect a continuation of elevated concentrations.

Figure 15 shows chloride concentrations for all sites. Chloride concentrations do not show as pronounced a decline throughout the water year as nitrate+nitrite-N concentrations. A general decline in chloride concentrations occurred from the winter months to the spring months. Rather than continuing to decline during the remainder of the water year as nitrate+nitrite-N concentrations did, chloride concentrations leveled off or increased at most sites. Chloride concentrations at the main stem sites on Sny Magill and Bloody Run showed the same trend as seen in the nitrate+nitrite-N data: a decline in chloride concentrations from upstream sites to downstream sites.

Figure 16 shows BOD levels from sites SN1 and BR1. Over one-half of the samples from both sites had BOD concentrations below the detection limit. All of the elevated BOD concentrations coincided with runoff events. The elevated BOD concentration that occurred at both sites at the beginning of November was not associated with an increase in discharge.

Figure 17 shows triazine herbicide concentrations at sites SN1 and BR1. At site SN1, 15% of the samples collected contained detectable levels of triazines, as did 100% of the samples from BR1. Triazine concentrations at SN1 averaged 0.14 μg/L and 0.44 μg/L for site BR1. Peak concentrations occurred during the May to July period. For Water Year 1994, maximum concentrations were 1.47 μg/L for SN1 and 4.89 μg/L for BR1.

Temporal Trends for Water Years 1992 through 1994

Figures 18 and 19 show the discharge and suspended-sediment load data for sites SN1 and BR1 for water years 1992-1994. The data is summarized by percentiles on a seasonal basis. Each water year was divided into four seasons: October, November, December; January, February, March; April, May, June; and July, August, September. The above normal rainfall conditions of Water Year 1993 are illustrated by the elevated

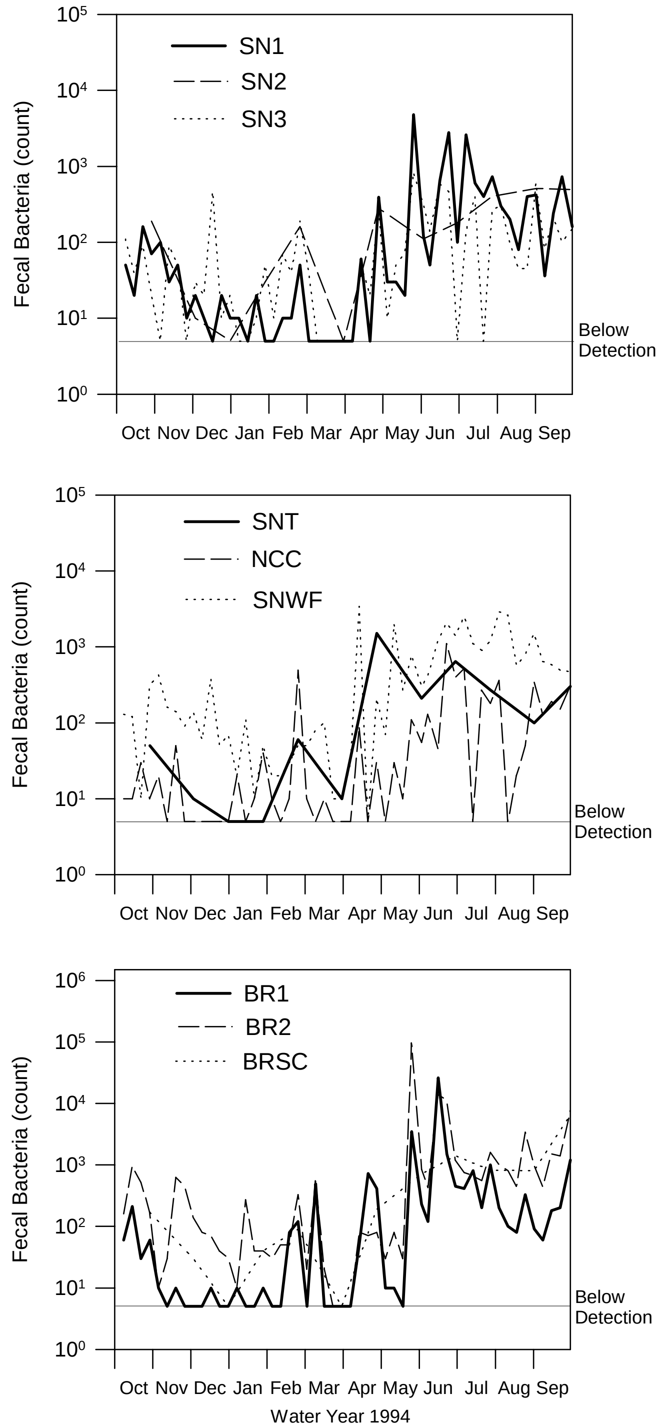


Figure 13. Fecal bacteria counts for all sites during Water Year 1994.

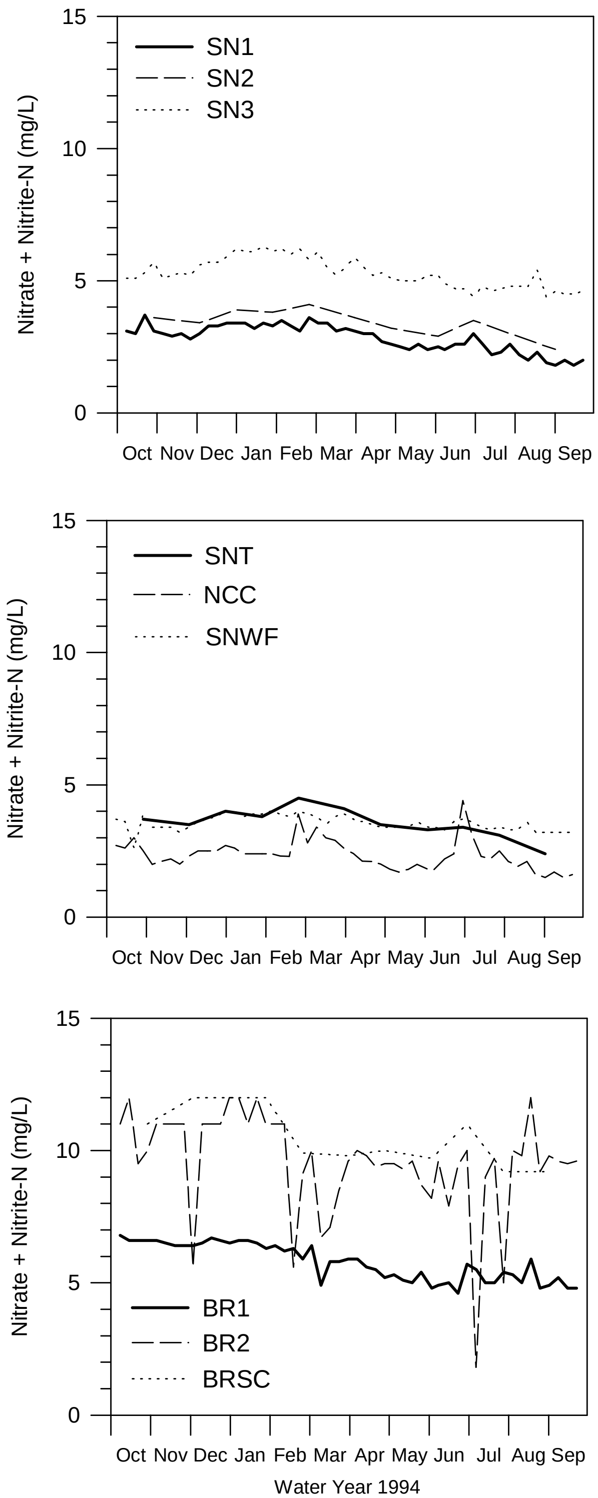


Figure 14. Nitrate+nitrite-N concentrations for all sites during Water Year 1994.

discharge and sediment loads during that year. Discharge during Water Year 1993 was abnormally high for both SN1 and BR1; the highest 10th percentile for discharge during Water Year 1993 was greater than the highest 90th percentile for any of the other water years.

Figures 20, 21, and 22 are percentile summaries on a seasonal basis for fecal coliform bacteria, nitrate+nitrite-N, and chloride, respectively. Fecal coliform bacteria counts showed a seasonal trend, with increases during the summer months and declines during the winter months. Nitrate and chloride did not show as much of a seasonal trend. Both nitrate and chloride increased during Water Year 1993 and began to decline during Water Year 1994.

Triazine herbicide concentrations showed a seasonal trend, with increased concentrations occurring during the spring and summer months (Figure 23). Both SN1 and BR1 showed a steady decline in concentration in the fall/winter after highs during the spring/summer months. Median triazine concentrations, on a water-year basis, increased from 1992 to 1993, then declined in 1994 to concentrations at or slightly higher than 1992. The percent detection of triazine herbicides at site BR1 remained relatively unchanged during the three years of sampling, ranging from 90 to 100%. At site SN1, however, the percent detection declined from 60% in 1992, to 45% in 1993, and to 15% in 1994.

SUMMARY

Water Year 1994 was the third complete year of the Sny Magill Watershed Nonpoint Source Pollution Monitoring Project. Hydrologically, Water Year 1994 represented more typical conditions as precipitation was 100% of normal. The return to more normal rainfall conditions following 1993 was reflected in some of the monitoring data. Some water-quality parameter concentrations declined from 1993 to 1994, whereas others increased. Stream discharge and suspended-sediment loads declined from 1993 to 1994, however, sediment loads were greater at SN1 than BR1 for the first time since sampling began. This was probably the result of a few more intense rainfall events in Sny Magill watershed relative to Bloody Run. As in past years, very few days accounted for most of the sediment discharged from both Sny Magill and Bloody Run creeks. A total of seven days accounted for 85% of the sediment discharged from Sny Magill watershed and 68% from Bloody Run watershed. Triazine herbicide concentrations declined from 1993 to 1994. The percent detection of triazine herbicides at site BR1 remained relatively unchanged during the three years of monitoring, whereas the percent detection declined at site SN1. For Water Year 1994, nitrate concentrations were at the highest levels yet of the monitoring period. Nitrate concentrations were elevated at the beginning of Water Year 1994. These elevated concentrations represented a continuation of flood-related effects of Water Year 1993. Nitrate concentrations declined during the latter half of Water Year 1994.

The fish assessment data was dominated by two fish species; the fantail darter was the dominant species in Sny Magill and the slimy sculpin was the dominant species in Bloody Run. The greatest number of fish species were sampled in Water Year 1994. The fluctuations in annual totals appear to be a normal response to sampling conditions and not indicative of responses to land treatment activities in the Sny Magill watershed.

The habitat assessment reflected the return to normal rainfall and stream conditions. Stream flows, widths, and depths were lower than 1993 levels, estimates of herbaceous streambank vegetation were higher, and less streambank was reported as unstable.

The number of benthic taxa declined from Water Year 1993 to Water Year 1994, but was greater than Water Year 1992 numbers. The HBI and % dominant taxa metrics showed overall declines at the Sny Magill sites but not at the Bloody Run sites. This trend suggests that some improvement in water quality may be occurring in Sny Magill and not Bloody Run. Additional years of data collection will determine whether this trend is significant or related to short-term climatic factors.

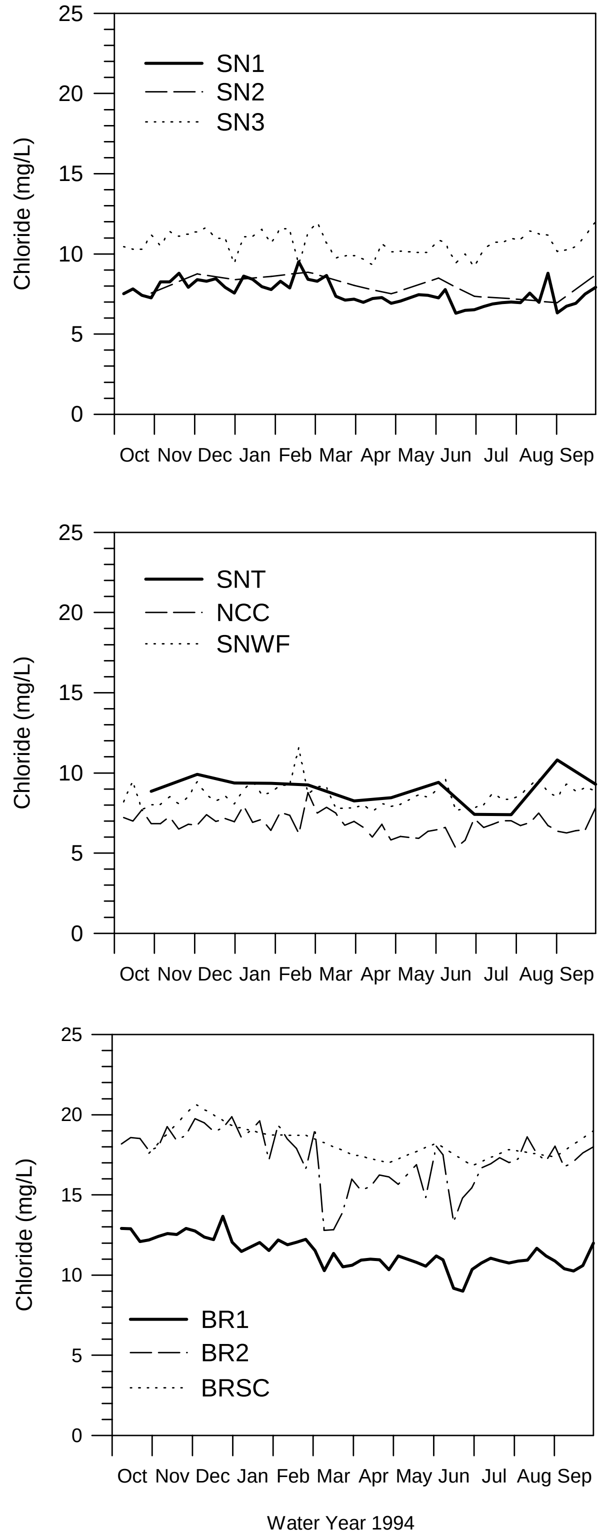


Figure 15. Chloride concentrations for all sites during Water Year 1994.

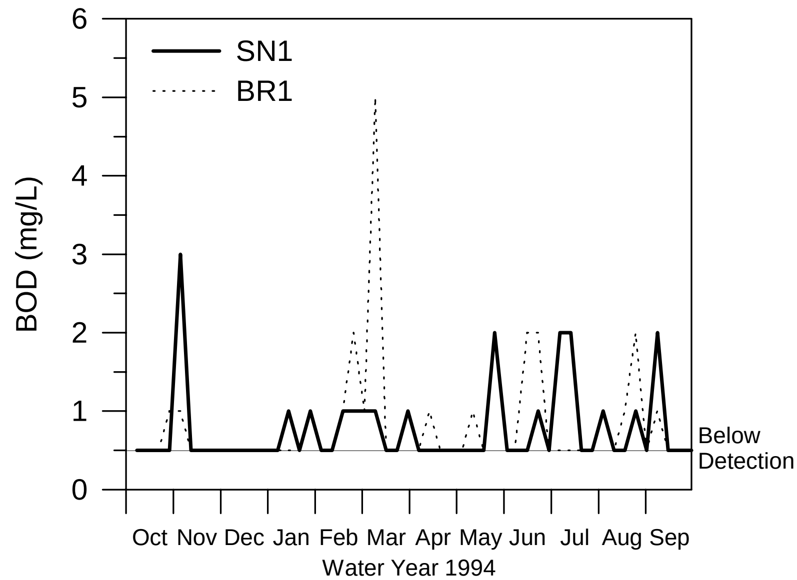


Figure 16. BOD concentrations for sites SN1 (Sny Magill) and BR1 (Bloody Run) during Water Year 1994.

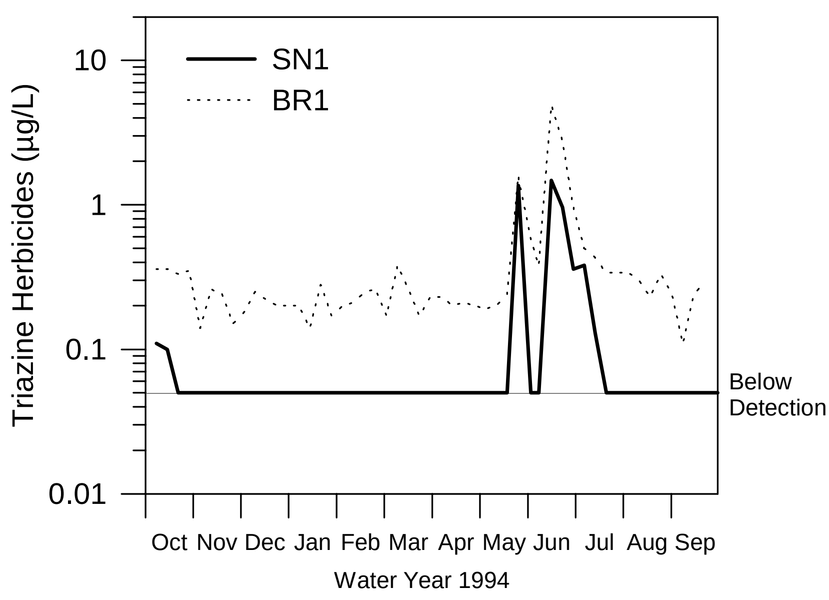


Figure 17. Triazine herbicide concentrations for sites SN1 (Sny Magill) and BR1 (Bloody Run) during Water Year 1994.

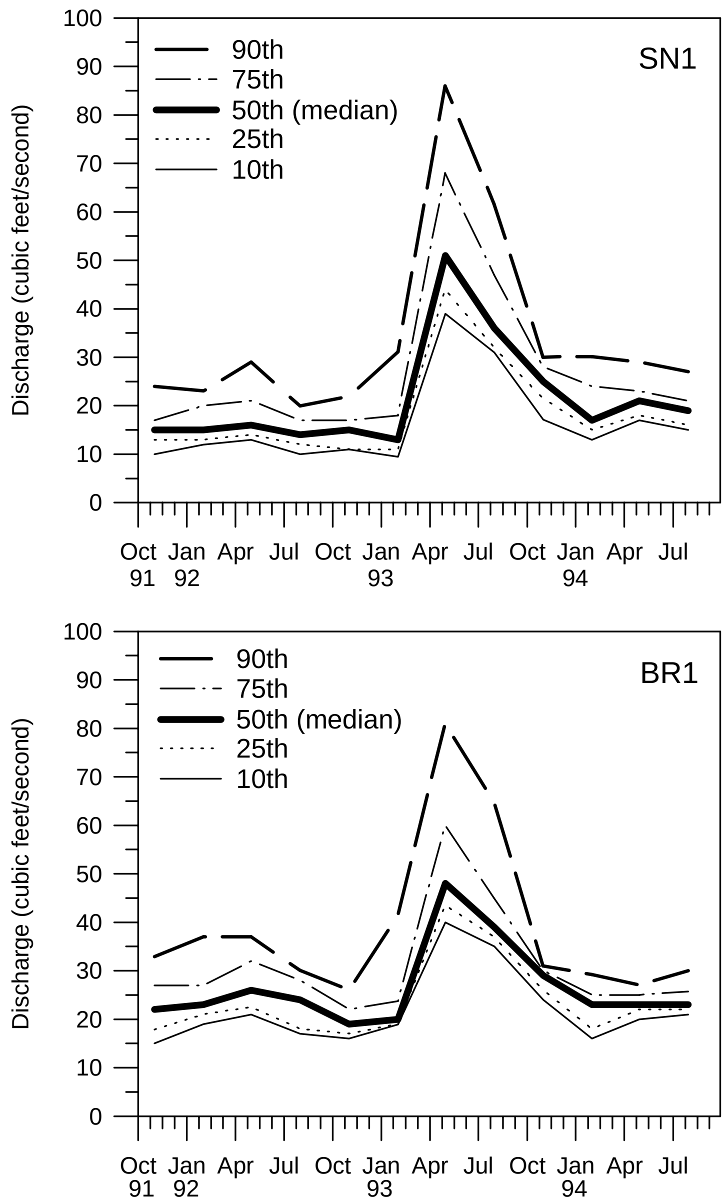


Figure 18. Percentiles, on a seasonal basis, for discharge for sites SN1 (Sny Magill) and BR1 (Bloody Run) for water years 1992-1994. Water years divided into four seasons: Oct, Nov, Dec; Jan, Feb, Mar; Apr, May, Jun; and Jul, Aug, Sep.

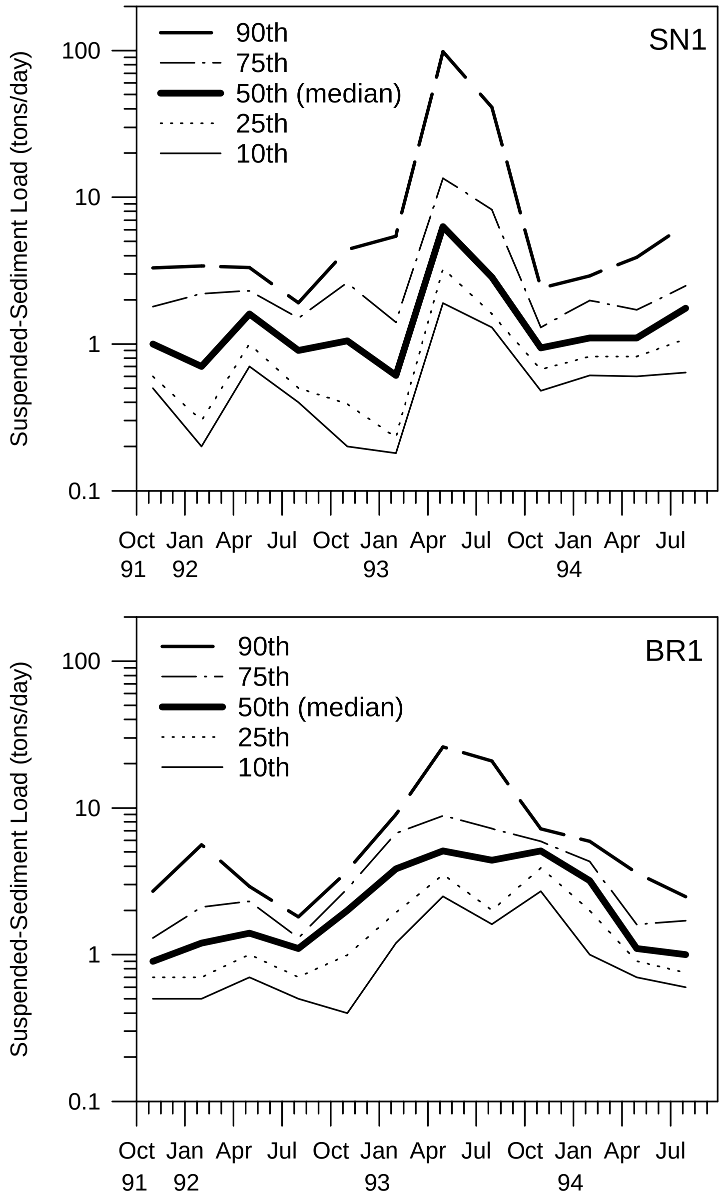


Figure 19. Percentiles, on a seasonal basis, for suspended-sediment loads for sites SN1 (Sny Magill) and BR1 (Bloody Run) for water years 1992-1994. Water years divided into four seasons: Oct, Nov, Dec; Jan, Feb, Mar; Apr, May, Jun; and Jul, Aug, Sep.

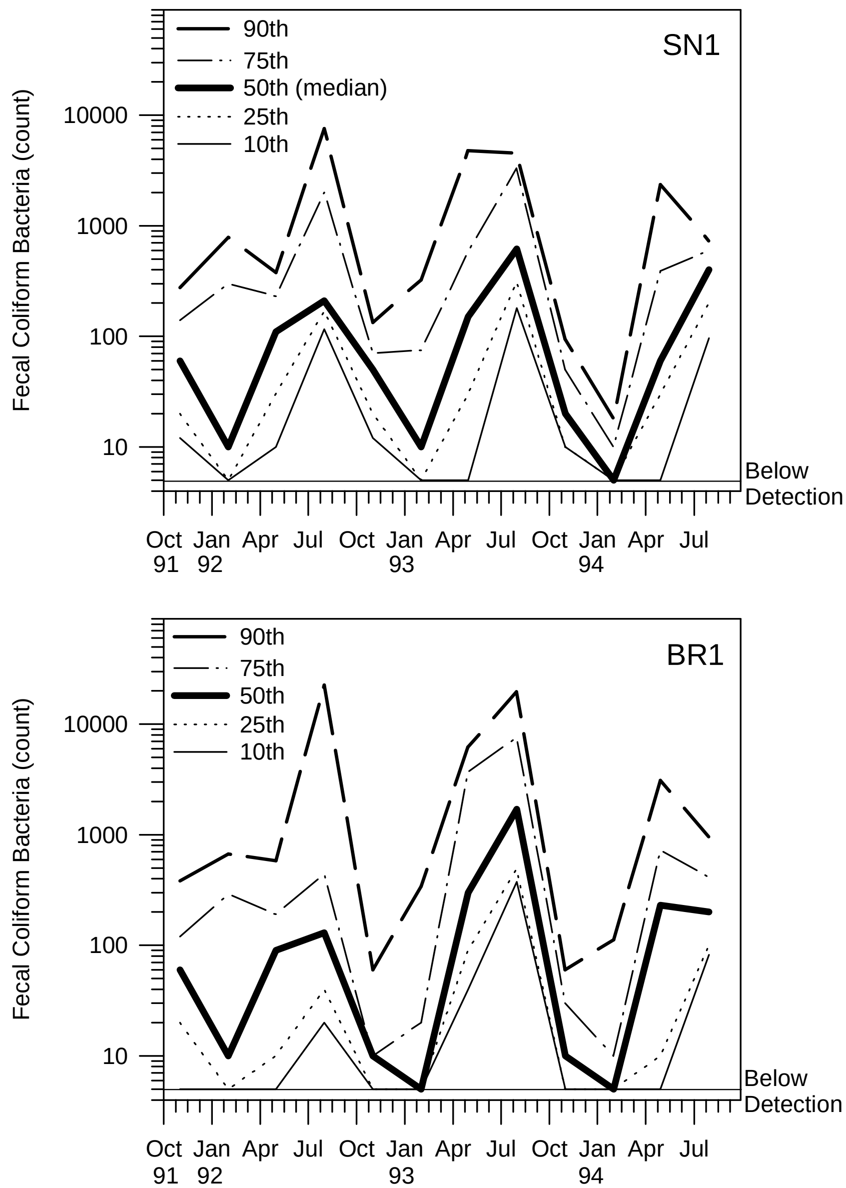


Figure 20. Percentiles, on a seasonal basis, for fecal coliform bacteria for sites SN1 (Sny Magill) and BR1 (Bloody Run) for water years 1992-1994. Water years divided into four seasons: Oct, Nov, Dec; Jan, Feb, Mar; Apr, May, Jun; and Jul, Aug, Sep.

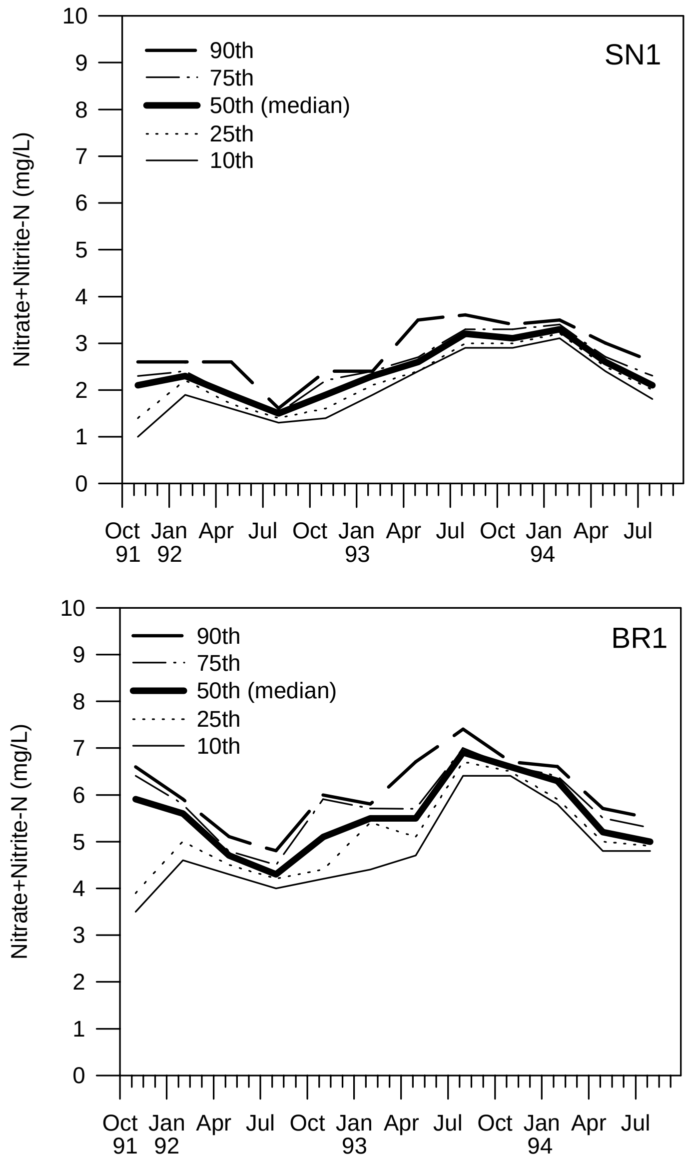
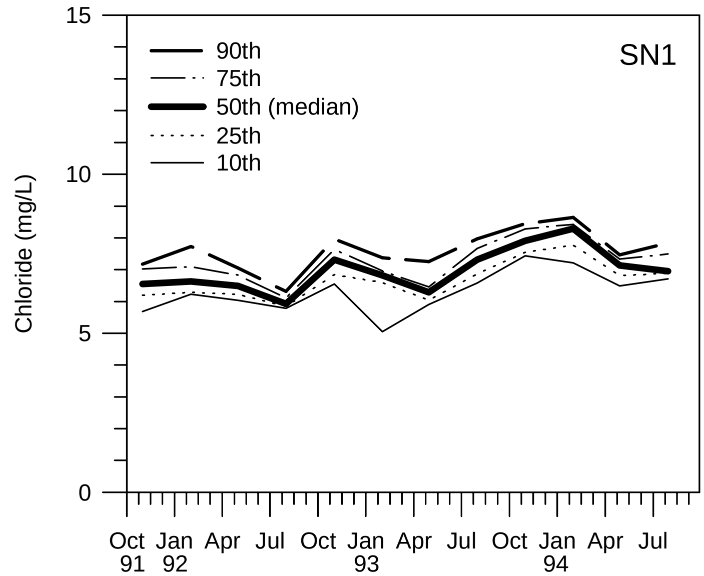


Figure 21. Percentiles, on a seasonal basis, for nitrate+nitrite-N for sites SN1 (Sny Magill) and BR1 (Bloody Run) for water years 1992-1994. Water years divided into four seasons: Oct, Nov, Dec; Jan, Feb, Mar; Apr, May, Jun; and Jul, Aug, Sep.



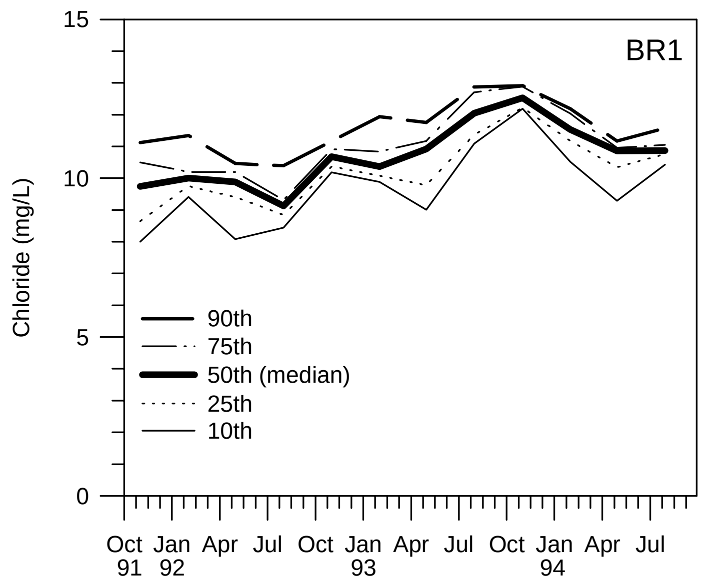


Figure 22. Percentiles, on a seasonal basis, for chloride for sites SN1 (Sny Magill) and BR1 (Bloody Run) for water years 1992-1994. Water years divided into four seasons: Oct, Nov, Dec; Jan, Feb, Mar; Apr, May, Jun; and Jul, Aug, Sep.

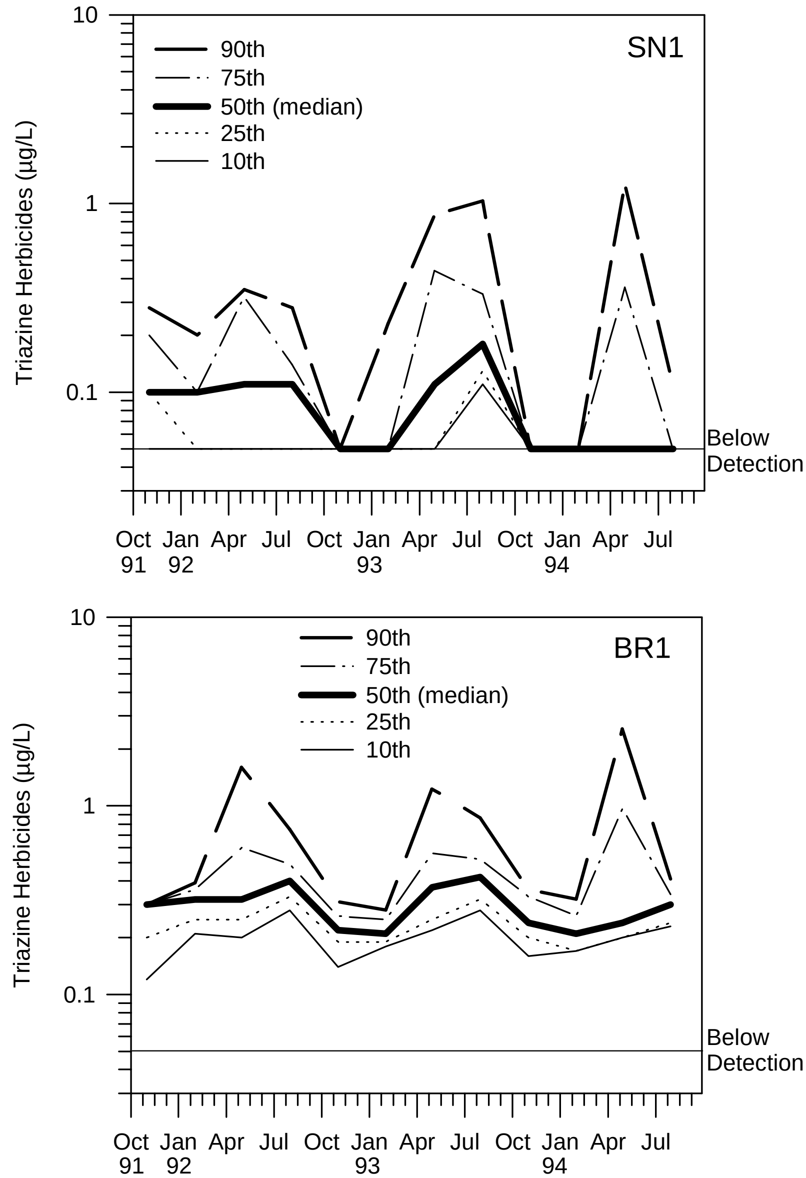


Figure 23. Percentiles, on a seasonal basis, for triazine herbicides for sites SN1 (Sny Magill) and BR1 (Bloody Run) for water years 1992-1994. Water years divided into four seasons: Oct, Nov, Dec; Jan, Feb, Mar; Apr, May, Jun; and Jul, Aug, Sep.

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APPENDIX I.

SUMMARY OF AQUATIC HABITAT EVALUATIONS FOR BLOODY RUN AND SNY MAGILL WATERSHEDS FOR 1991 THROUGH 1994

	SN1 '91	'92	'93	'94
STREAM REACH DIMENSIONS:				
Area: square feet	33226.3	31309.2	32947.5	34433
(square meters)	(3086.8)	(2908.7)	(3060.9)	(3198.9)
Length: feet	951.4	951.4	951.4	952.1
(meters)	(290.0)	(290.0)	(290.0)	(290.2)
Flow: cubic feet per second	10.95	9.53	25.42	15.89
(cubic meters per second)	(0.31)	(0.27)	(0.72)	(0.45)
Average width: feet	35.1	32.8	34.8	36.1
(meters)	(10.7)	(10.0)	(10.6)	(11.0)
Maximum depth: feet	6.20	5.18	6.49	4.9+
(meters)	(1.89)	(1.58)	(1.98)	(1.5+)
Average transect maximum depth: feet	3.05	2.72	3.28	2.79
(meters)	(0.93)	(0.83)	(1.00)	(0.85)
Average depth: feet	2.13	1.83	2.19	1.80
(meters)	(0.65)	(0.56)	(0.67)	(0.55)
INSTREAM HABITAT:				
Dominant habitat type	POOL	POOL	POOL	POOL
Riffle repeat frequency (X average width)	14	10	27	13
% reach with instream cover	70	70	50	40
Dominant cover type	POOL	POOL	POOL	POOL
% reach with pool habitat	60	85	75	80
Dominant pool size class *	1	1	1	1
% reach with silt deposition	65	80	65	75
% reach with scoured substrate	10	5	<5	<5
% reach with vascular aquatic vegetation	-	10	5	15
Dominant vascular aquatic vegetation type	-	SUBMERG	SUBMERG	SUBMERG
SUBSTRATE COMPOSITION				
% clay	2	2	4	4
% silt	48	68	52	52
% sand	8	2	0	8
% gravel	10	20	29	18
% cobble	22	6	10	14
% boulder	10	2	5	0
% wood	0	0	0	2
% other	0	0	0	2
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:				
Periphyton colonization amount	-	HVY	LGHT	HVY/MOD
Dominant periphyton form	-	FLMNT	NONFLMNT	FLMNT
Average embeddedness rating **	-	2.1	3.0	3.5
STREAMSIDE OBSERVATIONS:				
Average stream shading rating	-	1.7	1.5	2.3
Average streambank tree coverage rating	1.9	1.9	1.1	1.8
Average streambank shrub coverage rating	1.0	1.0	1.2	1.0
Average streambank herbaceous coverage rating	4.3	3.8	4.0	3.8
Average streambank instability rating	1.2	1.6	2.9	2

* Pool class rating: 1=large and deep pools; 2=pools of moderate size and depth; 3=small and shallow pools.

** 1-5 rating scale: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.

	'91	SN2 '92	'93	'94
STREAM REACH DIMENSIONS:				
Area: square feet	8986.9	8962.1	11599.3	10857.7
(square meters)	(834.9)	(832.6)	(1077.6)	(1008.8)
Length: feet	482.3	482.3	482.3	482.3
(meters)	(147.0)	(147.0)	(147.0)	(147.0)
Flow: cubic feet per second	8.12	9.89	20.83	9.89
(cubic meters per second)	(0.23)	(0.28)	(0.59)	(0.28)
Average width: feet	18.7	18.7	23.9	22.3
(meters)	(5.7)	(5.7)	(7.3)	(6.8)
Maximum depth: feet	5.93	5.57	4.9+	4.9+
(meters)	(1.81)	(1.7)	(1.5+)	(1.5+)
Average transect maximum depth: feet	1.67	1.34	1.96	1.57
(meters)	(0.51)	(0.41)	(0.60)	(0.48)
Average depth: feet	1.01	0.82	1.24	0.85
(meters)	(0.31)	(0.25)	(0.38)	(0.26)
INSTREAM HABITAT:				
Dominant habitat type	RUN	POOL	RUN	RUN
Riffle repeat frequency (X average width)	6	9	10	7
% reach with instream cover	30	25	25	10
Dominant cover type	POOL	POOL	POOL	POOL/OV
% reach with pool habitat	30	55	20	25
Dominant pool size class *	1	1	1	1
% reach with silt deposition	30	45	50	30
% reach with scoured substrate	<5	10	5	<5
% reach with vascular aquatic vegetation	-	15	0	5
Dominant vascular aquatic vegetation type	-	SUBMERG	NA	SUBMERG
SUBSTRATE COMPOSITION				
% clay	0	0	2	0
% silt	18	44	42	18
% sand	10	4	2	11
% gravel	36	32	48	35
% cobble	34	20	6	27
% boulder	0	0	0	2
% wood	0	0	0	2
% other	0	0	0	5
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:				
Periphyton colonization amount	-	MOD	MOD	MOD/LGHT
Dominant periphyton form	-	FLMNT	NONFLMNT	FLMNT
Average embeddedness rating **	-	2.0	3.4	2.5
STREAMSIDE OBSERVATIONS:				
Average stream shading rating	-	2.4	2.8	3.1
Average streambank tree coverage rating	2.1	1.6	1.5	2.6
Average streambank shrub coverage rating	1.2	2.0	1.0	1.3
Average streambank herbaceous coverage rating	4.2	4.1	3.4	3.8
Average streambank instability rating	1.3	2.0	2.0	1.8

* Pool class rating: 1=large and deep pools; 2=pools of moderate size and depth; 3=small and shallow pools.

** 1-5 rating scale: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.

	SN3			
	'91	'92	'93	'94
STREAM REACH DIMENSIONS:				
Area: square feet	3647.9	4918.1	4344.4	3647.9
(square meters)	(338.9)	(456.9)	(403.6)	(358.2)
Length: feet	315.6	311.7	311.7	311.7
(meters)	(96.2)	(95.0)	(95.0)	(95.0)
Flow: cubic feet per second	1.76	1.76	5.65	3.18
(cubic meters per second)	(0.05)	(0.05)	(0.16)	(0.09)
Average width: feet	11.8	15.7	13.7	12.46
(meters)	(3.6)	(4.8)	(4.2)	(3.8)
Maximum depth: feet	2.16	2.03	2.49	2.1
(meters)	(0.66)	(0.62)	(0.76)	(0.64)
Average transect maximum depth: feet	0.95	0.59	1.18	0.82
(meters)	(0.29)	(0.18)	(0.36)	(0.25)
Average depth: feet	0.45	0.26	0.59	0.46
(meters)	(0.14)	(0.08)	(0.18)	(0.14)
INSTREAM HABITAT:				
Dominant habitat type	RUN	RN/RFFL	RUN	RFFL
Riffle repeat frequency (X average width)	5	6	10	6
% reach with instream cover	15	<5	5	<5
Dominant cover type	POOL	POOL	OVRVEG	UBNK
% reach with pool habitat	30	10	10	15
Dominant pool size class *	3	3	3	3
% reach with silt deposition	10	30	20	20
% reach with scoured substrate	5	5	<5	<5
% reach with vascular aquatic vegetation	-	15	0	<5
Dominant vascular aquatic vegetation type	-	EMERG	NA	EMERG/SUBMERG
SUBSTRATE COMPOSITION				
% clay	1	0	2	0
% silt	0	21	16	14
% sand	3	5	1	4
% gravel	33	42	45	44
% cobble	54	32	31	36
% boulder	7	0	3	0
% wood	0	0	0	0
% other	1	0	2	2
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:				
Periphyton colonization amount	-	HVY	MOD	MOD
Dominant periphyton form	-	FLMNT	FLMNT	FLMNT
Average embeddedness rating **	-	2.5	2.2	2.2
STREAMSIDE OBSERVATIONS:				
Average stream shading rating	-	2.0	2.3	2.6
Average streambank tree coverage rating	2.0	1.6	1.3	1.3
Average streambank shrub coverage rating	1.6	1.4	1.6	1.4
Average streambank herbaceous coverage rating	2.7	3.4	2.5	2.8
Average streambank instability rating	1.9	1.3	2.3	1.8

* Pool class rating: 1=large and deep pools; 2=pools of moderate size and depth; 3=small and shallow pools.

** 1-5 rating scale: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.

	SNWF			
	'91	'92	'93	'94
STREAM REACH DIMENSIONS:				
Area: square feet	1871.8	2061.3	2549.9	2146.3
(square meters)	(173.9)	(191.5)	(236.9)	(199.4)
Length: feet	232.3	236.2	236.2	236.2
(meters)	(70.8)	(72.0)	(72.0)	(72.0)
Flow: cubic feet per second	1.76	2.12	5.65	2.12
(cubic meters per second)	(0.05)	(0.06)	(0.16)	(0.06)
Average width: feet	7.8	8.5	10.8	8.86
(meters)	(2.4)	(2.6)	(3.3)	(2.7)
Maximum depth: feet	1.44	1.51	2.19	2.00
(meters)	(0.44)	(0.46)	(0.67)	(0.61)
Average transect maximum depth: feet	0.78	0.78	0.95	0.79
(meters)	(0.24)	(0.24)	(0.29)	(0.24)
Average depth: feet	0.49	0.39	0.52	0.39
(meters)	(0.15)	(0.12)	(0.16)	(0.12)
INSTREAM HABITAT:				
Dominant habitat type	RUN	RUN	RUN	RUN
Riffle repeat frequency (X average width)	5	7	11	9
% reach with instream cover	5	5	<5	5
Dominant cover type	UCUTBNK	WDDEBR	UCUTBNK	WDDEBR
% reach with pool habitat	10	20	5	15
Dominant pool size class *	3	3	3	3
% reach with silt deposition	25	35	5	10
% reach with scoured substrate	5	5	5	5
% reach with vascular aquatic vegetation	-	0	0	0
Dominant vascular aquatic vegetation type	-	NA	NA	NA
SUBSTRATE COMPOSITION				
% clay	6	5	6	8
% silt	5	16	2	6
% sand	5	4	4	6
% gravel	49	50	54	52
% cobble	31	22	28	16
% boulder	4	0	0	2
% wood	0	3	6	2
% other	0	0	0	8
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:				
Periphyton colonization amount	-	MOD	MOD	MOD
Dominant periphyton form	-	FLMNT	NONFLMNT	FLMNT
Average embeddedness rating **	-	2.2	1.6	1.9
STREAMSIDE OBSERVATIONS:				
Average stream shading rating	-	4.0	3.6	4.2
Average streambank tree coverage rating	2.2	2.0	1.5	1.6
Average streambank shrub coverage rating	1.1	1.2	2.0	1.4
Average streambank herbaceous coverage rating	3.9	2.9	2.4	2.6
Average streambank instability rating	1.8	2.6	3.5	2.4

* Pool class rating: 1=large and deep pools; 2=pools of moderate size and depth; 3=small and shallow pools.

** 1-5 rating scale: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.

	NCC			
	'91	'92	'93	'94
STREAM REACH DIMENSIONS:				
Area: square feet	3281.9	3298.1	3970.8	3635
(square meters)	(304.9)	(306.4)	(368.9)	(337.7)
Length: feet	324.7	324.7	323.1	325.1
(meters)	(99.0)	(99.0)	(98.5)	(99.1)
Flow: cubic feet per second	1.05	2.11	4.94	1.41
(cubic meters per second)	(0.03)	(0.06)	(0.14)	(0.04)
Average width: feet	10.1	10.1	12.5	11.15
(meters)	(3.1)	(3.1)	(3.8)	(3.4)
Maximum depth: feet	3.41	3.21	3.15	2.79
(meters)	(1.04)	(0.98)	(0.96)	(0.85)
Average transect maximum depth: feet	0.78	0.75	1.11	0.92
(meters)	(0.24)	(0.23)	(0.34)	(0.28)
Average depth: feet	0.52	0.42	0.65	0.49
(meters)	(0.16)	(0.13)	(0.20)	(0.15)
INSTREAM HABITAT:				
Dominant habitat type	RUN	RUN	RUN	RUN
Riffle repeat frequency (X average width)	6	8	10	10
% reach with instream cover	20	10	<5	<5
Dominant cover type	WDDEBR	OVRVEG	WDDEBR	OV/UBNK
% reach with pool habitat	15	20	15	20
Dominant pool size class *	2	2	2	2
% reach with silt deposition	15	35	10	30
% reach with scoured substrate	5	<5	<5	<5
% reach with vascular aquatic vegetation	-	<5	<5	0
Dominant vascular aquatic vegetation type	-	SUBMERG	EMERG	NA
SUBSTRATE COMPOSITION				
% clay	8	0	7	2
% silt	2	12	12	6
% sand	0	10	2	0
% gravel	56	46	55	54
% cobble	34	28	22	36
% boulder	0	4	1	2
% wood	0	0	0	0
% other	0	0	1	0
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:				
Periphyton colonization amount	-	HVY	MOD	HVY
Dominant periphyton form	-	FLMNT	FLMNT	FLMNT
Average embeddedness rating **	-	2.7	2.1	2
STREAMSIDE OBSERVATIONS:				
Average stream shading rating	-	3.3	2.9	3.8
Average streambank tree coverage rating	1.8	2.3	1.2	3.6
Average streambank shrub coverage rating	1.0	1.6	1.3	1.1
Average streambank herbaceous coverage rating	3.6	4.1	3.2	4.3
Average streambank instability rating	1.2	1.8	2.4	1.8

* Pool class rating: 1=large and deep pools; 2=pools of moderate size and depth; 3=small and shallow pools.
** 1-5 rating scale: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.

	SNT '91	'92	'93	'94
STREAM REACH DIMENSIONS:				
Area: square feet	976.2	975.2	1133.4	1068.9
(square meters)	(90.7)	(90.6)	(105.3)	(99.3)
Length: feet	149.9	150.9	150.9	150.9
(meters)	(45.7)	(46.0)	(46.0)	(46.0)
Flow: cubic feet per second	0.35	0.35	1.41	1.06
(cubic meters per second)	(0.01)	(0.01)	(0.04)	(0.03)
Average width: feet	6.5	6.5	7.5	7.22
(meters)	(2.0)	(2.0)	(2.3)	(2.2)
Maximum depth: feet	0.78	0.78	0.85	1.08
(meters)	(0.24)	(0.24)	(0.26)	(0.33)
Average transect maximum depth: feet	0.45	0.45	0.59	0.59
(meters)	(0.14)	(0.14)	(0.18)	(0.18)
Average depth: feet	0.26	0.29	0.39	0.3
(meters)	(0.08)	(0.09)	(0.12)	(0.09)
INSTREAM HABITAT:				
Dominant habitat type	RUN	RUN	RUN	RUN
Riffle repeat frequency (X average width)	6	12	7	7
% reach with instream cover	0	5	<5	<5
Dominant cover type	NA	OVRVEG	BOULD	OVRVEG
% reach with pool habitat	<5	20	<5	<5
Dominant pool size class *	3	3	3	3
% reach with silt deposition	25	15	10	10
% reach with scoured substrate	30	<5	<5	<5
% reach with vascular aquatic vegetation	-	5	<5	<5
Dominant vascular aquatic vegetation type	-	EMERG	EMERG	EMERG
SUBSTRATE COMPOSITION				
% clay	3	0	0	0
% silt	3	10	0	7
% sand	3	7	17	3
% gravel	17	43	47	53
% cobble	57	33	30	33
% boulder	17	7	6	3
% wood	0	0	0	0
% other	0	0	0	0
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:				
Periphyton colonization amount	-	MOD	MOD/HVY	LGHT
Dominant periphyton form	-	NONFLMNT	NONFLMNT	NONFLMNT
Average embeddedness rating **	-	2.3	1.9	1.6
STREAMSIDE OBSERVATIONS:				
Average stream shading rating	-	4.7	2.6	3.3
Average streambank tree coverage rating	2.5	1.2	1.2	2.8
Average streambank shrub coverage rating	1.0	1.8	2.2	1.6
Average streambank herbaceous coverage rating	4.9	4.2	3.5	4.8
Average streambank instability rating	1.0	1.0	1.0	1.1

* Pool class rating: 1=large and deep pools; 2=pools of moderate size and depth; 3=small and shallow pools.

** 1-5 rating scale: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.

	BR1 '91	'92	'93	'94
STREAM REACH DIMENSIONS:				
Area: square feet	35821.5	38990.4	40010.8	39103.5
(square meters)	(3327.9)	(3622.3)	(3717.1)	(3632.8)
Length: feet	1149.9	1151.5	1151.5	1151.6
(meters)	(350.5)	(351.0)	(351.0)	(351.0)
Flow: cubic feet per second	10.95	16.95	32.84	22.95
(cubic meters per second)	(0.31)	(0.48)	(0.93)	(0.65)
Average width: feet	28.8	33.8	34.7	34.12
(meters)	(8.8)	(10.3)	(10.6)	(10.4)
Maximum depth: feet	6.00	5.90	4.9+	4.9+
(meters)	(1.83)	(1.80)	(1.5+)	(1.5+)
Average transect maximum depth: feet	3.21	2.98	2.91	2.79
(meters)	(0.98)	(0.91)	(0.89)	(0.85)
Average depth: feet	1.93	1.74	1.77	1.61
(meters)	(0.59)	(0.53)	(0.54)	(0.49)
INSTREAM HABITAT:				
Dominant habitat type	POOL	POOL	POOL	POOL
Riffle repeat frequency (X average width)	13	17	17	17
% reach with instream cover	50	35	10	15
Dominant cover type	POOL	POOL	WDDEB	WDDEB
% reach with pool habitat	50	60	55	55
Dominant pool size class *	1	1	1	1
% reach with silt deposition	80	40	35	80
% reach with scoured substrate	<5	<5	<5	<5
% reach with vascular aquatic vegetation	-	15	5	50
Dominant vascular aquatic vegetation type	-	SUBMERG	SUBMERG	SUBMERG
SUBSTRATE COMPOSITION				
% clay	4	2	8	4
% silt	34	30	16	48
% sand	8	20	24	18
% gravel	14	24	28	18
% cobble	34	20	14	4
% boulder	6	2	6	4
% wood	0	0	2	4
% other	0	2	2	0
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:				
Periphyton colonization amount	-	HVY	MOD	HVY
Dominant periphyton form	-	FLMNT	FLMNT	FLMNT
Average embeddedness rating **	-	2.1	2.7	4
STREAMSIDE OBSERVATIONS:				
Average stream shading rating	-	1.7	2.0	2.2
Average streambank tree coverage rating	1.9	1.7	1.3	1.4
Average streambank shrub coverage rating	1.0	1.2	2.0	1.0
Average streambank herbaceous coverage rating	3.2	3.9	3.4	3.6
Average streambank instability rating	2.1	2.0	2.4	2.3

* Pool class rating: 1=large and deep pools; 2=pools of moderate size and depth; 3=small and shallow pools.

** 1-5 rating scale: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.

	'91	BR2 '92	'93	'94
STREAM REACH DIMENSIONS:				
Area: square feet		15535.6	14930.74	15544.3
(square meters)	N	(1443.3)	(1387.1)	(144.1)
Length: feet		757.8	757.8	758.8
(meters)	O	(231.0)	(231.0)	(231.3)
Flow: cubic feet per second		7.06	19.06	7.42
(cubic meters per second)	T	(0.2)	(0.54)	(0.21)
Average width: feet		20.6	19.7	20.34
(meters)		(6.3)	(6.0)	(6.2)
Maximum depth: feet		4.9	4.9+	4.9+
(meters)		(1.5)	(1.5+)	(1.5+)
Average transect maximum depth: feet		2.16	1.80	2.03
(meters)		(0.66)	(0.55)	(0.62)
Average depth: feet		1.37	1.08	1.12
(meters)		(0.42)	(0.33)	(0.34)
INSTREAM HABITAT:				
Dominant habitat type	E	POOL	POOL	POOL
Riffle repeat frequency (X average width)	V	9	10	12
% reach with instream cover	L	50	15	15
Dominant cover type	U	POOL	POOL	POOL
% reach with pool habitat	A	75	50	45
Dominant pool size class *	T	2	2	2
% reach with silt deposition	E	65	35	40
% reach with scoured substrate	D	10	<5	<5
% reach with vascular aquatic vegetation		0	0	<5
Dominant vascular aquatic vegetation type		NA	NA	EMERG
SUBSTRATE COMPOSITION				
% clay	N	2	0	4
% silt	O	30	24	24
% sand	T	10	8	2
% gravel		34	40	30
% cobble		18	24	38
% boulder		6	4	2
% wood		0	0	0
% other		0	0	0
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:				
Periphyton colonization amount	E	MOD	MOD	MOD
Dominant periphyton form	V	FLMNT	FLMNT	FLMNT
Average embeddedness rating **	A	2.8	3.3	2.8
	L			
STREAMSIDE OBSERVATIONS:	U			
Average stream shading rating	A	2.1	2.0	2.8
Average streambank tree coverage rating	T	1.4	1.2	2.9
Average streambank shrub coverage rating	E	1.2	1.6	1.4
Average streambank herbaceous coverage rating	D	3.6	3.8	3.8
Average streambank instability rating		3.6	2.2	1.8

* Pool class rating: 1=large and deep pools; 2=pools of moderate size and depth; 3=small and shallow pools.

** 1-5 rating scale: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.

APPENDIX II.

SUMMARY OF WATER QUALITY DATA ON AN ANNUAL AND QUARTERLY BASIS; WATER YEAR 1994

Site SN1
Annual

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	52	0-21	5	11	17	6.74	10
Specific Conductance	uS/cm	50	375-685	606	615	646	56.66	611
Dissolved Oxygen	mg/L	52	3-14	10	11	13	2.39	11
Turbidity	NTU	51	2.7-23.0	4.8	6.6	9.0	4.35	7.8
NO2+NO3-N	mg/L	51	1.8-3.7	2.5	3.0	3.3	0.51	2.8
Ammonia-N	mg/L	52	<0.1-0.8	<0.1	0.1	0.2	0.18	0.2
Organic-N	mg/L	52	<0.1-1.2	<0.1	0.1	0.2	0.22	0.2
Fecal Bacteria	count 100 ml.	52	<10-4800	10	43	210	829.64	320
Total P	mg/L	51	<0.1-0.2	<0.10	<0.1	0.1	0.06	<0.1
BOD	mg/L	51	<1-3	<1	<1	1	0.53	<1
IMA	ug/L	52	<0.10-1.47	<0.10	<0.10	<0.10	0.29	0.14
Nitrate-N	mg/L	51	1.33-4.98	2.24	2.77	3.11	2.82	2.75
Nitrite-N	mg/L	51	<0.01-0.11	<0.01	0.01	0.02	0.08	0.02
Phosphorus	mg/L	51	<0.03-<0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	51	21.97-30.08	24.67	25.42	26.27	1.41	25.51
Fluoride	mg/L	51	<0.04-0.60	<0.04	0.06	0.11	0.09	0.08
Chloride	mg/L	51	6.30-9.51	6.99	7.49	8.25	0.72	7.59
Bromide	mg/L	51	<0.06-<0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN1
Oct-Nov-Dec

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0-13	5	7	9	3.68	7
Specific Conductance	uS/cm	13	520-685	644	658	661	40.21	645
Dissolved Oxygen	mg/L	13	6-14	10	11	13	2.39	11
Turbidity	NTU	13	3.3-7.8	4.4	4.7	6.6	1.46	5.4
NO2+NO3-N	mg/L	13	2.8-3.7	3.0	3.1	3.3	0.25	3.2
Ammonia-N	mg/L	13	<0.1-0.8	<0.1	0.1	0.4	0.23	0.2
Organic-N	mg/L	13	<0.1-1.2	<0.1	0.2	0.3	0.38	0.3
Fecal Bacteria	count 100 ml.	13	<10-160	10	20	50	44.94	43
Total P	mg/L	13	<0.1-0.2	<0.1	<0.1	0.1	0.04	<0.1
BOD	mg/L	12	<1-3	<1	<1	<1	0.72	<1
IMA	ug/L	13	<0.10-0.11	<0.10	<0.10	<0.10	0.02	<0.10
Nitrate-N	mg/L	13	2.63-4.98	2.84	3.10	3.29	2.74	3.23
Nitrite-N	mg/L	13	<0.01-0.02	<0.01	0.01	0.01	0.02	0.01
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	24.47-26.87	24.73	25.14	25.82	0.84	25.39
Fluoride	mg/L	13	<0.04-0.24	0.05	0.08	0.14	0.07	0.10
Chloride	mg/L	13	7.24-8.79	7.54	7.91	8.28	0.46	7.98
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SN1
Jan-Feb-Mar

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0-10	0	2	4	3.33	3
Specific Conductance	uS/cm	13	375-668	490	611	646	92.6	580
Dissolved Oxygen	mg/L	13	3-14	7	12	13	3.4	10
Turbidity	NTU	13	2.7-9.0	4.8	5.0	7.0	1.87	5.6
NO2+NO3-N	mg/L	13	3.1-3.6	3.2	3.3	3.4	0.16	3.3
Ammonia-N	mg/L	13	<0.1-0.8	0.1	0.2	0.4	0.24	0.3
Organic-N	mg/L	13	<0.1-0.2	<0.1	<0.1	0.1	0.06	<0.1
Fecal Bacteria	count 100 ml.	13	<10-50	<10	<10	10	12.56	11
Total P	mg/L	13	<0.1-0.2	<0.1	0.1	0.1	<0.1	<0.1
BOD	mg/L	13	<1-1	<1	1	1	0.26	<1
IMA	ug/L	13	<0.10-<0.10	<0.10	<0.10	<0.10	0	<0.10
Nitrate-N	mg/L	13	0.59-3.74	3.03	3.26	3.41	1.21	3.22
Nitrite-N	mg/L	13	<0.01-0.05	0.01	0.01	0.03	0.06	0.02
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	23.64-30.08	24.45	26.31	27.10	1.96	26.18
Fluoride	mg/L	13	0.05-0.16	0.07	0.10	0.13	0.04	0.10
Chloride	mg/L	13	7.11-9.51	7.77	8.29	8.42	0.67	8.11
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SN1
Apr-May-June

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	8-21	12	17	18	4.11	15
Specific Conductance	uS/cm	11	586-618	604	608	611	8.71	607
Dissolved Oxygen	mg/L	13	9-14	10	10	13	1.74	11
Turbidity	NTU	12	3.5-23.0	6.3	8.6	9.6	4.99	9.2
NO2+NO3-N	mg/L	13	2.4-3.0	2.5	2.6	2.7	0.23	2.6
Ammonia-N	mg/L	13	<0.1-0.3	0.1	0.2	0.2	0.08	0.2
Organic-N	mg/L	13	<0.1-0.3	<0.1	0.1	0.2	0.09	0.1
Fecal Bacteria	count 100 ml.	13	<10-4800	30	60	390	1448.40	696
Total P	mg/L	13	<0.1-0.2	<0.1	0.1	0.2	0.07	0.1
BOD	mg/L	13	<1-2	<1	<1	<1	0.43	<1
IMA	ug/L	13	<0.10-1.47	<0.10	<0.10	0.36	0.54	0.35
Nitrate-N	mg/L	12	2.11-2.77	2.27	2.39	2.62	1.02	2.44
Nitrite-N	mg/L	12	<0.01-0.04	<0.01	<0.01	<0.01	0.05	0.01
Phosphorus	mg/L	12	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	12	23.15-26.66	25.24	25.79	26.22	1.10	25.50
Fluoride	mg/L	12	<0.04-0.13	<0.04	<0.04	0.09	0.05	0.05
Chloride	mg/L	12	6.30-7.77	6.81	7.13	7.32	0.44	7.05
Bromide	mg/L	12	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SN1

July-Aug-Sept

Parameters	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Temperature	degree C	13	12-19	16	17	18	1.89	17
Specific Conductance	uS/cm	13	540-646	610	613	617	24.11	611
Dissolved Oxygen	mg/L	13	6-14	10	11	11	1.80	11
Turbidity	NTU	13	5.4-20.0	6.7	10.0	12.0	5.06	11.0
NO2+NO3-N	mg/L	12	1.8-2.6	2.0	2.1	2.3	0.27	2.1
Ammonia-N	mg/L	13	<0.1-0.2	<0.1	0.1	0.1	0.04	<0.1
Organic-N	mg/L	13	<0.1-0.3	<0.1	0.1	0.2	0.08	0.1
Fecal Bacteria	count 100 ml.	13	36-2600	200	400	600	661.12	530
Total P	mg/L	12	<0.1-0.2	<0.1	<0.1	<0.1	0.06	<0.1
BOD	mg/L	13	<1-2	<1	<1	1	0.64	<1
IMA	ug/L	13	<0.10-0.38	<0.10	<0.10	<0.10	0.09	<0.10
Nitrate-N	mg/L	13	1.33-2.46	2.11	2.18	2.22	1.35	2.09
Nitrite-N	mg/L	13	<0.01-0.11	<0.01	0.02	0.02	0.13	0.02
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	21.97-26.93	24.61	25.16	25.70	1.34	24.98
Fluoride	mg/L	13	<0.04-0.6	<0.04	<0.04	<0.04	0.16	0.06
Chloride	mg/L	13	6.32-8.79	6.88	6.95	7.49	0.64	7.17
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site BR1

ANNUAL

Parameters	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Temperature	degree C	51	0-22	6	11	16	5.88	11
Specific Conductance	uS/cm	49	346-795	594	613	635	65.83	610
Dissolved Oxygen	mg/L	51	5-16	11	12	13	2.43	12
Turbidity	NTU	51	2.9-27.0	4.7	6.1	8.6	4.48	7.4
NO2+NO3-N	mg/L	51	4.6-6.8	5.1	5.8	6.5	0.69	5.8
Ammonia-N	mg/L	52	<0.1-1.1	<0.1	0.1	0.2	0.21	0.2
Organic-N	mg/L	52	<0.1-1.4	<0.1	0.1	0.2	0.26	0.2
Fecal Bacteria	count 100 ml.	52	<10-26000	<10	60	215	3613.74	751
Total P	mg/L	51	<0.1-0.7	<0.1	<0.1	0.1	0.12	0.1
BOD	mg/L	51	<1-5	<1	<1	1	0.75	<1
IMA	ug/L	52	0.11-4.89	0.20	0.25	0.34	0.75	0.44
Nitrate-N	mg/L	50	1.91-7.49	4.99	5.62	6.45	4.43	5.66
Nitrite-N	mg/L	50	<0.01-0.11	<0.01	0.01	0.02	0.09	0.02
Phosphorus	mg/L	50	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	50	15.39-23.68	19.67	20.43	20.75	1.28	20.25
Fluoride	mg/L	50	<0.04-0.60	<0.04	0.07	0.11	0.10	0.08
Chloride	mg/L	50	8.99-13.65	10.77	11.20	12.17	0.97	11.39
Bromide	mg/L	50	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site BR1
Oct-Nov-Dec

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	1-12	6	7	9	3.22	7
Specific Conductance	uS/cm	13	510-763	629	650	661	64.9	639
Dissolved Oxygen	mg/L	13	6-14	9	13	13	2.57	11
Turbidity	NTU	13	2.9-8.6	3.2	4.9	6.5	1.80	5.0
NO2+NO3-N	mg/L	13	6.4-6.8	6.5	6.6	6.6	0.12	6.6
Ammonia-N	mg/L	13	<0.1-0.7	<0.1	<0.1	0.2	0.20	0.2
Organic-N	mg/L	13	<0.1-1.4	0.1	0.1	0.2	0.38	0.3
Fecal Bacteria	count 100 ml.	13	<10-210	<10	10	30	57.07	32
Total P	mg/L	13	<0.1-0.3	<0.1	<0.1	<0.1	0.08	<0.1
BOD	mg/L	12	<1-1	<1	<1	<1	0.19	<1
IMA	ug/L	13	0.14-0.36	0.20	0.24	0.33	0.08	0.25
Nitrate-N	mg/L	13	6.22-7.49	6.50	6.70	6.82	1.53	6.71
Nitrite-N	mg/L	13	<0.01-0.02	<0.01	<0.01	0.01	0.03	0.01
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	20.47-21.51	20.66	20.71	21.32	0.39	20.93
Fluoride	mg/L	13	<0.04-0.25	0.07	0.09	0.14	0.07	0.11
Chloride	mg/L	13	12.04-13.65	12.21	12.53	12.88	0.44	12.58
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site BR1
Jan-Feb-Mar

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0-12	3	4	6	3.6	5
Specific Conductance	uS/cm	12	346-795	538	600	644	109.86	590
Dissolved Oxygen	mg/L	12	5-15	12	13	13	2.87	12
Turbidity	NTU	13	4.1-16.0	6.1	7.5	11.0	3.73	8.8
NO2+NO3-N	mg/L	13	4.9-6.6	5.9	6.3	6.4	0.47	6.1
Ammonia-N	mg/L	13	<0.1-0.6	0.1	0.2	0.5	0.2	0.3
Organic-N	mg/L	13	<0.1-1.2	<0.1	<0.1	0.2	0.32	0.2
Fecal Bacteria	count 100 ml.	13	<10-490	<10	<10	10	134.79	58
Total P	mg/L	13	<0.1-0.7	<0.1	0.1	0.1	0.2	0.2
BOD	mg/L	13	<1-5	<1	<1	1	1.24	1
IMA	ug/L	13	0.14-0.38	0.17	0.21	0.26	0.06	0.22
Nitrate-N	mg/L	12	4.77-7.01	5.53	5.95	6.40	2.84	5.95
Nitrite-N	mg/L	12	<0.01-0.06	0.01	0.02	0.03	0.08	0.02
Phosphorus	mg/L	12	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	12	15.39-23.68	18.98	19.83	20.64	2.17	19.68
Fluoride	mg/L	12	<0.04-0.16	0.07	0.10	0.12	0.04	0.09
Chloride	mg/L	12	10.27-12.22	11.17	11.53	12.03	0.67	11.47
Bromide	mg/L	12	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site BR1

Apr-May-June

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	12	8-22	14	16	17	3.87	15
Specific Conductance	uS/cm	11	576-622	597	605	615	15.56	603
Dissolved Oxygen	mg/L	13	10-16	11	12	13	1.76	12
Turbidity	NTU	12	3.2-27.0	5.3	6.5	9.6	6.58	8.8
NO2+NO3-N	mg/L	13	4.6-5.9	5.0	5.2	5.5	0.38	5.2
Ammonia-N	mg/L	13	<0.1-1.1	0.1	0.2	0.2	0.27	0.2
Organic-N	mg/L	13	<0.1-0.6	<0.1	0.2	0.2	0.16	0.2
Fecal Bacteria	count 100 ml.	13	<10-26000	10	230	720	7115.94	2539
Total P	mg/L	13	<0.1-0.3	<0.1	0.1	0.2	0.08	0.1
BOD	mg/L	13	<1-2	<1	<1	1	0.64	<1
IMA	ug/L	13	0.19-4.89	0.20	0.24	0.97	1.40	0.98
Nitrate-N	mg/L	12	4.13-5.74	4.66	4.84	5.46	2.31	4.97
Nitrite-N	mg/L	12	<0.01-0.05	<0.01	0.01	0.02	0.07	0.02
Phosphorus	mg/L	12	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	12	18.98-21.20	19.47	20.14	20.51	0.73	20.07
Fluoride	mg/L	12	<0.04-0.19	<0.04	0.04	0.08	0.05	0.06
Chloride	mg/L	12	8.99-11.20	10.34	10.86	10.95	0.73	10.53
Bromide	mg/L	12	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site BR1

July-Aug-Sept

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	13	11-18	15	15	18	2.18	16
Specific Conductance	uS/cm	13	550-635	600	605	623	21.6	606
Dissolved Oxygen	mg/L	13	5-14	10	11	12	2.44	11
Turbidity	NTU	13	3.4-19.0	4.7	5.9	7.5	4.08	7.0
NO2+NO3-N	mg/L	12	4.8-5.9	4.9	5.0	5.3	0.34	5.1
Ammonia-N	mg/L	13	<0.1-0.2	<0.1	0.1	0.2	0.07	0.1
Organic-N	mg/L	13	<0.1-0.4	<0.1	0.1	0.2	0.12	0.2
Fecal Bacteria	count 100 ml.	13	60-1200	100	200	410	379.42	373
Total P	mg/L	12	<0.1-0.2	<0.1	<0.1	0.1	<0.1	<0.1
BOD	mg/L	13	<1-2	<1	<1	1	0.44	<1
IMA	ug/L	13	0.11-0.50	0.24	0.30	0.34	0.1	0.31
Nitrate-N	mg/L	13	1.91-5.70	4.91	5.14	5.57	4.42	4.97
Nitrite-N	mg/L	13	<0.01-0.11	<0.01	0.02	0.02	0.13	0.02
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	19.45-22.98	19.61	20.00	20.71	0.95	20.27
Fluoride	mg/L	13	<0.04-0.60	<0.04	<0.04	<0.04	0.16	0.06
Chloride	mg/L	13	10.24-12.00	10.76	10.87	11.05	0.48	10.94
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site NCC
ANNUAL

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	52	0-21	5	11	16	6.56	10
Specific Conductance	uS/cm	52	329-690	594	620	640	62.09	603
Dissolved Oxygen	mg/L	52	3-16	10	12	13	3.36	11
Turbidity	NTU	51	1.5-14.0	3.4	4.4	6.0	2.38	5.0
NO2+NO3-N	mg/L	51	1.5-4.4	2.0	2.3	2.6	0.56	2.4
Ammonia-N	mg/L	52	<0.1-0.6	<0.1	0.1	0.2	0.16	0.2
Fecal Bacteria	count 100 ml.	52	<10-1100	<10	15	115	193.73	103
Nitrate-N	mg/L	51	1.38-5.43	1.92	2.20	2.40	3.27	2.35
Nitrite-N	mg/L	51	<0.01-0.11	<0.01	0.01	0.01	0.08	0.01
Phosphorus	mg/L	51	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	51	22.85-31.48	26.58	27.42	28.16	1.44	27.32
Fluoride	mg/L	51	<0.04-0.60	<0.04	0.07	0.13	0.10	0.09
Chloride	mg/L	51	5.30-8.77	6.43	6.82	7.18	0.63	6.84
Bromide	mg/L	51	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site NCC
Oct-Nov-Dec

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	1-12	5	7	8	3.45	7
Specific Conductance	uS/cm	13	510-690	625	641	650	43	635
Dissolved Oxygen	mg/L	13	6-16	11	13	14	2.87	12
Turbidity	NTU	13	1.5-7.8	3.0	3.6	3.9	1.53	3.8
NO2+NO3-N	mg/L	13	2.0-3.0	2.2	2.5	2.6	0.30	2.4
Ammonia-N	mg/L	13	<0.1-0.6	<0.1	<0.1	<0.1	0.16	0.1
Fecal Bacteria	count 100 ml.	13	<10-50	<10	<10	10	13.48	13
Nitrate-N	mg/L	13	2.14-5.43	2.21	2.26	2.36	4.03	2.59
Nitrite-N	mg/L	13	<0.01-0.01	<0.01	<0.01	0.01	0.02	0.01
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	26.14-29.28	26.58	27.32	27.80	0.98	27.46
Fluoride	mg/L	13	<0.04-0.24	<0.04	0.05	0.13	0.08	0.10
Chloride	mg/L	13	6.49-7.68	6.82	6.96	7.20	0.31	7.02
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site NCC
Jan-Feb-Mar

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0-10	1	1	3	3.16	2
Specific Conductance	uS/cm	13	329-671	500	599	650	97.95	569
Dissolved Oxygen	mg/L	13	3-15	5	11	13	4.59	9

	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Turbidity	NTU	13	2.9-6.2	3.1	3.9	4.6	1.23	4.1
NO2+NO3-N	mg/L	13	2.3-3.9	2.4	2.6	2.9	0.48	2.7
Ammonia-N	mg/L	13	<0.1-0.6	0.2	0.2	0.4	0.18	0.3
Fecal Bacteria	count 100 ml.	13	<10-490	<10	10	10	133.13	48
Nitrate-N	mg/L	13	1.98-3.84	2.28	2.56	3.02	2.68	2.69
Nitrite-N	mg/L	13	<0.01-0.05	0.01	0.01	0.03	0.06	0.02
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	22.85-31.48	25.24	27.86	28.87	2.36	27.38
Fluoride	mg/L	13	<0.04-0.19	0.08	0.10	0.13	0.05	0.11
Chloride	mg/L	13	6.21-8.77	6.90	7.35	7.54	0.68	7.29
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site NCC

Apr-May-June

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	6-21	12	15	17	4.27	15
Specific Conductance	uS/cm	13	587-627	594	598	607	11.21	602
Dissolved Oxygen	mg/L	13	9-16	11	12	13	1.91	12
Turbidity	NTU	12	2.3-11.0	4.6	5.3	6.8	2.53	5.9
NO2+NO3-N	mg/L	13	1.7-4.4	1.8	2.0	2.2	0.7	2.2
Ammonia-N	mg/L	13	<0.1-0.6	<0.1	0.2	0.3	0.16	0.2
Fecal Bacteria	count 100 ml.	13	<10-1100	10	45	110	303.01	155
Nitrate-N	mg/L	12	1.54-4.27	1.75	1.86	2.08	3.22	2.07
Nitrite-N	mg/L	12	<0.01-0.01	<0.01	<0.01	<0.01	0.01	<0.01
Phosphorus	mg/L	12	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	12	25.17-28.78	26.72	27.52	28.11	1.06	27.39
Fluoride	mg/L	12	<0.04-0.18	<0.04	0.08	0.14	0.06	0.08
Chloride	mg/L	12	5.30-7.14	5.89	6.19	6.59	0.51	6.23
Bromide	mg/L	12	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site NCC

July-Aug-Sept

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	11-19	15	17	17	2.09	16
Specific Conductance	uS/cm	13	470-650	612	624	630	48.99	607
Dissolved Oxygen	mg/L	13	3-13	9	11	11	2.74	10
Turbidity	NTU	13	3.1-14.0	4.8	6.0	7.5	2.92	6.4
NO2+NO3-N	mg/L	12	1.5-3.1	1.6	2.0	2.2	0.48	2.0
Ammonia-N	mg/L	13	<0.1-0.3	<0.1	<0.1	0.1	0.07	0.1
Fecal Bacteria	count 100 ml.	13	<10-520	50	180	310	159.71	195
Nitrate-N	mg/L	13	1.38-3.06	1.77	1.92	2.20	1.89	2.00
Nitrite-N	mg/L	13	<0.01-0.11	<0.01	0.01	0.02	0.13	0.02

Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	25.20-28.56	26.63	27.00	27.70	0.99	27.08
Fluoride	mg/L	13	<0.04-0.60	<0.04	<0.04	<0.04	0.16	0.06
Chloride	mg/L	13	6.23-7.80	6.40	6.71	7.01	0.46	6.79
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SNWF
ANNUAL

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	52	0-21	5	11	16	6.47	10
Specific Conductance	uS/cm	52	300-708	642	655	668	72.78	636
Dissolved Oxygen	mg/L	52	3-15	10	11	12	2.54	11
Turbidity	NTU	50	2.2-13.0	4.0	4.7	6.0	2.12	5.1
NO2+NO3-N	mg/L	51	2.6-4.0	3.4	3.6	3.8	0.29	3.6
Ammonia-N	mg/L	52	<0.1-0.6	<0.1	0.1	0.2	0.14	0.2
Fecal Bacteria	count 100 ml.	52	<10-3400	50	185	785	836.27	598
Nitrate-N	mg/L	51	3.05-5.79	3.29	3.46	3.73	2.08	3.57
Nitrite-N	mg/L	51	<0.01-0.11	<0.01	<0.01	0.02	0.08	0.01
Phosphorus	mg/L	51	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	51	24.86-37.62	32.76	33.94	34.45	1.95	33.57
Fluoride	mg/L	51	<0.04-0.70	<0.04	0.11	0.18	0.11	0.11
Chloride	mg/L	51	7.58-11.58	8.03	8.55	9.03	0.72	8.59
Bromide	mg/L	51	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SNWF
Oct-Nov-Dec

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0-12	5	7	9	3.49	7
Specific Conductance	uS/cm	13	300-708	660	671	675	108.54	636
Dissolved Oxygen	mg/L	13	6-15	10	11	12	2.46	11
Turbidity	NTU	13	2.2-8.8	3.9	4.6	6.2	2.15	5.1
NO2+NO3-N	mg/L	13	2.6-4.0	3.4	3.6	3.7	0.36	3.5
Ammonia-N	mg/L	13	<0.1-0.5	<0.1	0.1	0.2	0.17	0.2
Fecal Bacteria	count 100 ml.	13	10-430	70	130	160	130.61	161
Nitrate-N	mg/L	13	3.15-4.29	3.37	3.47	3.62	1.66	3.59
Nitrite-N	mg/L	13	<0.01-0.02	<0.01	<0.01	0.01	0.02	<0.01
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	31.33-34.19	31.68	32.45	33.13	0.99	32.51
Fluoride	mg/L	13	<0.04-0.24	0.05	0.15	0.17	0.07	0.12
Chloride	mg/L	13	7.69-9.48	8.05	8.23	8.55	0.54	8.41
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SNWF
Jan-Feb-Mar

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0-11	1	2	4	3.28	3
Specific Conductance	uS/cm	13	375-692	590	647	665	95.20	609
Dissolved Oxygen	mg/L	13	4-14	8	12	13	3.45	10
Turbidity	NTU	13	2.4-7.5	3.0	4.0	4.7	1.36	4.1
NO2+NO3-N	mg/L	13	3.5-4.0	3.8	3.9	3.9	0.13	3.9
Ammonia-N	mg/L	13	<0.1-0.4	0.1	0.2	0.3	0.13	0.2
Fecal Bacteria	count 100 ml.	13	10-110	20	30	50	34.49	43
Nitrate-N	mg/L	13	3.38-5.79	3.69	3.82	3.91	2.74	3.91
Nitrite-N	mg/L	13	<0.01-0.05	0.01	0.01	0.03	0.06	0.02
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	24.86-37.62	32.47	33.45	34.04	3.01	32.94
Fluoride	mg/L	13	0.04-0.17	0.08	0.12	0.13	0.04	0.11
Chloride	mg/L	13	7.78-11.58	8.63	8.94	9.21	0.98	8.94
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SNWF
Apr-May-June

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	6-21	14	16	17	4.30	15
Specific Conductance	uS/cm	13	625-669	642	648	658	11.9	648
Dissolved Oxygen	mg/L	13	9-13	10	10	12	1.36	11
Turbidity	NTU	11	4.5-9.5	5.2	6.0	7.4	1.58	6.3
NO2+NO3-N	mg/L	13	3.3-3.7	3.4	3.4	3.6	0.13	3.5
Ammonia-N	mg/L	13	<0.1-0.6	0.1	0.1	0.2	0.15	0.2
Fecal Bacteria	count 100 ml.	13	<10-3400	210	420	1400	1038.69	937
Nitrate-N	mg/L	12	3.05-3.54	3.15	3.32	3.42	0.73	3.30
Nitrite-N	mg/L	12	<0.01-0.01	<0.01	<0.01	<0.01	0.01	<0.01
Phosphorus	mg/L	12	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	12	31.36-36.00	34.00	34.23	34.88	1.13	34.28
Fluoride	mg/L	12	<0.04-0.23	0.06	0.13	0.17	0.07	0.11
Chloride	mg/L	12	7.58-9.66	7.81	8.01	8.51	0.62	8.22
Bromide	mg/L	12	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SNWF
July-Aug-Sept

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	13-19	15	17	17	1.79	16
Specific Conductance	uS/cm	13	610-676	644	654	664	18.49	651
Dissolved Oxygen	mg/L	13	3-12	9	10	11	2.49	10

Turbidity	NTU	13	2.2-13.0	4.0	4.5	5.5	2.7	5.1
NO2+NO3-N	mg/L	12	3.2-3.6	3.2	3.3	3.4	0.15	3.3
Ammonia-N	mg/L	13	<0.1-0.1	<0.1	<0.1	0.10	0.03	<0.1
Fecal Bacteria	count 100 ml.	13	470-2900	580	900	1500	866.17	1249
Nitrate-N	mg/L	13	3.10-4.52	3.19	3.32	3.56	1.70	3.45
Nitrite-N	mg/L	13	<0.01-0.11	<0.01	0.01	0.02	0.13	0.02
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	33.00-36.62	33.66	34.26	35.48	1.14	34.59
Fluoride	mg/L	13	<0.04-0.7	<0.04	<0.04	<0.04	0.19	0.10
Chloride	mg/L	13	7.98-9.65	8.48	8.79	9.05	0.45	8.79
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SN3

ANNUAL

	Units	Number	Range	Quartile 25th	50th	75th	std	Mean
Parameters								
Temperature	degree C	52	0-23	5	13	18	7.16	11
Specific Conductance	uS/cm	52	380-732	633	652	684	58.53	651
Dissolved Oxygen	mg/L	52	3-15	10	11	12	2.68	11
Turbidity	NTU	51	1.1-7.0	3.3	4.1	5.0	1.3	4.2
NO2+NO3-N	mg/L	51	4.4-6.3	4.8	5.2	5.7	0.55	5.3
Ammonia-N	mg/L	52	<0.1-0.7	<0.1	0.1	0.2	0.15	0.2
Fecal Bacteria	count 100 ml.	52	<10-830	18	50	143	181.75	128
Nitrate-N	mg/L	51	3.64-7.01	4.70	5.12	5.59	3.02	5.20
Nitrite-N	mg/L	51	<0.01-0.11	<0.01	0.01	0.02	0.07	0.01
Phosphorus	mg/L	51	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	51	21.44-32.84	23.05	23.80	24.48	2.01	24.17
Fluoride	mg/L	51	<0.04-0.6	<0.04	0.06	0.14	0.1	0.10
Chloride	mg/L	51	9.19-12.00	10.13	10.68	11.17	0.72	10.63
Bromide	mg/L	51	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SN3

Oct-Nov-Dec

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0-13	5	7	8	3.72	7
Specific Conductance	uS/cm	13	540-730	681	690	703	46.74	684
Dissolved Oxygen	mg/L	13	8-15	10	12	13	2.18	12
Turbidity	NTU	13	1.1-6.8	3.3	4.0	5.5	1.72	4.2
NO2+NO3-N	mg/L	13	5.1-6.2	5.2	5.3	5.7	0.35	5.5
Ammonia-N	mg/L	13	<0.1-0.7	<0.1	<0.1	0.2	0.19	0.2
Fecal Bacteria	count 100 ml.	13	<10-460	20	30	90	121.39	73
Nitrate-N	mg/L	13	4.85-7.01	5.26	5.44	5.62	2.57	5.52
Nitrite-N	mg/L	13	<0.01-0.02	<0.01	<0.01	0.01	0.02	0.01

Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	22.29-25.79	22.87	23.16	23.65	0.89	23.39
Fluoride	mg/L	13	<0.04-0.31	0.05	0.09	0.19	0.09	0.12
Chloride	mg/L	13	9.41-11.63	10.44	10.98	11.23	0.61	10.82
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SN3
Jan-Feb-Mar

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0-13	0	2	5	3.92	3
Specific Conductance	uS/cm	13	380-732	630	645	692	95.13	635
Dissolved Oxygen	mg/L	13	3-15	7	12	13	4	10
Turbidity	NTU	13	3.0-5.5	3.4	4.0	4.5	0.79	4.1
NO2+NO3-N	mg/L	13	5.2-6.3	5.8	6.10	6.1	0.33	5.9
Ammonia-N	mg/L	13	<0.1-0.5	0.1	0.2	0.4	0.15	0.3
Fecal Bacteria	count 100 ml.	13	<10-190	<10	10	40	51.77	34
Nitrate-N	mg/L	13	3.64-6.53	5.30	6.02	6.14	3.44	5.69
Nitrite-N	mg/L	13	<0.01-0.03	<0.01	0.01	0.02	0.05	0.01
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	21.44-32.84	23.00	23.91	25.70	2.92	24.75
Fluoride	mg/L	13	0.06-0.18	0.09	0.13	0.15	0.04	0.12
Chloride	mg/L	13	9.37-11.97	9.89	11.04	11.52	0.83	10.79
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SN3
Apr-May-June

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	7-23	15	18	20	4.80	17
Specific Conductance	uS/cm	13	622-670	626	633	648	13.98	638
Dissolved Oxygen	mg/L	13	9-14	11	12	13	1.55	12
Turbidity	NTU	12	3.0-7.0	4.1	4.7	5.1	1.10	4.7
NO2+NO3-N	mg/L	13	4.4-5.5	4.9	5.0	5.2	0.29	5.0
Ammonia-N	mg/L	13	<0.1-0.5	0.1	0.1	0.2	0.12	0.2
Fecal Bacteria	count 100 ml.	13	<10-830	20	72	310	263.55	216
Nitrate-N	mg/L	12	4.14-5.21	4.54	4.77	5.04	1.54	4.76
Nitrite-N	mg/L	12	<0.01-0.04	<0.01	<0.01	0.01	0.04	0.01
Phosphorus	mg/L	12	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	12	22.39-31.92	23.43	23.82	24.21	2.48	24.30
Fluoride	mg/L	12	<0.04-0.14	<0.04	<0.04	0.09	0.05	0.05
Chloride	mg/L	12	9.19-10.88	9.60	10.08	10.27	0.54	10.01
Bromide	mg/L	12	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SN3
July-Aug-Sept

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	13-20	16	18	19	2.10	17
Specific Conductance	uS/cm	13	540-695	644	654	666	37.95	649
Dissolved Oxygen	mg/L	13	5-12	9	10	12	2.02	10
Turbidity	NTU	13	2.0-6.8	2.9	3.5	4.7	1.43	3.9
NO2+NO3-N	mg/L	12	4.4-5.4	4.6	4.7	4.8	0.26	4.7
Ammonia-N	mg/L	13	<0.1-0.1	<0.1	<0.1	0.1	0.03	<0.1
Fecal Bacteria	count 100 ml.	13	<10-600	82	140	270	168.15	188
Nitrate-N	mg/L	13	4.28-5.20	4.54	4.70	5.06	1.40	4.77
Nitrite-N	mg/L	13	<0.01-0.11	<0.01	0.01	0.02	0.13	0.02
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	22.46-25.71	23.73	24.30	24.90	0.91	24.23
Fluoride	mg/L	13	<0.04-0.60	<0.04	<0.04	<0.04	0.17	0.09
Chloride	mg/L	13	10.14-12.00	10.45	10.89	11.15	0.53	10.87
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site BR2
ANNUAL

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	52	0-22	4	11	16	6.65	10
Specific Conductance	uS/cm	50	363-772	656	690	716	70.64	673
Dissolved Oxygen	mg/L	52	5-17	10	12	13	3.07	11
Turbidity	NTU	51	0.6-79.0	4.6	6.4	10.0	11.11	9.2
NO2+NO3-N	mg/L	51	1.8-12.0	9.3	9.7	11.0	1.95	9.5
Ammonia-N	mg/L	52	<0.1-0.7	<0.1	0.1	0.3	0.17	0.2
Fecal Bacteria	count 100 ml.	52	<10-97000	40	220	813	13557.68	2898
Nitrate-N	mg/L	51	6.26-13.13	9.37	10.32	11.21	6.50	10.18
Nitrite-N	mg/L	51	<0.01-0.11	<0.01	<0.01	0.02	0.10	0.02
Phosphorus	mg/L	51	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	51	14.09-24.48	20.75	21.37	21.95	1.74	21.17
Fluoride	mg/L	51	<0.04-0.6	<0.04	0.10	0.16	0.11	0.12
Chloride	mg/L	51	12.78-19.87	16.43	17.58	18.58	1.77	17.28
Bromide	mg/L	51	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site BR2
Oct-Nov-Dec

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0-13	4	7	8	3.67	7
Specific Conductance	uS/cm	12	610-772	715	723	744	41	723
Dissolved Oxygen	mg/L	13	5-16	12	13	15	3.15	13

Turbidity	NTU	13	2.6-11.0	3.7	4.5	5.5	2.52	5.3
NO2+NO3-N	mg/L	13	5.0-12.0	11.0	11.0	11.0	1.60	10.6
Ammonia-N	mg/L	13	<0.1-0.4	<0.1	<0.1	0.2	0.12	0.1
Fecal Bacteria	count 100 ml.	13	10-960	40	140	450	295.48	253
Nitrate-N	mg/L	13	10.76-13.13	10.96	11.23	11.86	3.25	11.52
Nitrite-N	mg/L	13	<0.01-0.02	<0.01	0.01	0.01	0.03	0.01
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	20.72-23.33	21.14	21.68	22.39	0.86	21.76
Fluoride	mg/L	13	0.07-0.36	0.11	0.21	0.25	0.09	0.20
Chloride	mg/L	13	17.76-19.87	18.4	18.71	19.25	0.66	18.81
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site BR2
Jan-Feb-Mar

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0-11	1	2	4	3.44	3
Specific Conductance	uS/cm	12	363-753	551	620	706	113.99	618
Dissolved Oxygen	mg/L	13	5-14	8	11	13	3.44	10
Turbidity	NTU	13	0.6-20.0	4.6	7.6	13.4	5.49	8.5
NO2+NO3-N	mg/L	13	5.6-12.0	8.5	10.0	11.0	2.07	9.6
Ammonia-N	mg/L	13	<0.1-0.7	0.1	0.3	0.5	0.22	0.3
Fecal Bacteria	count 100 ml.	13	<10-550	20	40	50	168.14	109
Nitrate-N	mg/L	13	6.26-12.04	8.88	10.83	11.37	8.23	10.02
Nitrite-N	mg/L	13	<0.01-0.09	0.01	0.01	0.03	0.11	0.02
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	14.09-24.48	19.61	21.38	22.27	3.04	20.53
Fluoride	mg/L	13	0.08-0.19	0.10	0.14	0.15	0.04	0.13
Chloride	mg/L	13	12.78-19.60	15.98	17.89	19.00	2.45	17.03
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site BR2
Apr-May-June

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	7-22	13	16	18	4.35	16
Specific Conductance	uS/cm	13	613-702	655	660	674	24.35	661
Dissolved Oxygen	mg/L	13	9-17	11	12	14	2.43	12
Turbidity	NTU	12	3.6-79.0	5.3	8.9	14.3	20.87	16.1
NO2+NO3-N	mg/L	13	7.9-10.0	9.3	9.5	9.6	0.65	9.3
Ammonia-N	mg/L	13	<0.1-0.5	0.1	0.1	0.3	0.15	0.2
Fecal Bacteria	count 100 ml.	13	<10-97000	70	80	1200	26660.27	9604
Nitrate-N	mg/L	12	7.31-10.15	8.90	9.23	9.40	3.74	9.05
Nitrite-N	mg/L	12	<0.01-0.07	<0.01	<0.01	0.02	0.11	0.02

Phosphorus	mg/L	12	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	12	19.23-23.51	20.25	20.97	21.43	1.19	20.96
Fluoride	mg/L	12	<0.04-0.23	<0.04	0.11	0.16	0.08	0.11
Chloride	mg/L	12	13.31-18.04	15.16	15.58	16.41	1.28	15.80
Bromide	mg/L	12	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site BR2
July-Aug-Sept

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	10-21	15	16	17	2.74	16
Specific Conductance	uS/cm	13	650-717	681	690	702	19.71	688
Dissolved Oxygen	mg/L	13	5-13	10	11	12	2.56	10
Turbidity	NTU	13	2.1-15.0	6.2	6.5	8.2	3.36	7.6
NO2+NO3-N	mg/L	12	1.8-12.0	9.2	9.6	9.8	2.69	8.8
Ammonia-N	mg/L	13	<0.1-0.2	<0.1	<0.1	0.1	0.06	<0.1
Fecal Bacteria	count 100 ml.	13	440-7600	660	1000	1500	1958.26	1627
Nitrate-N	mg/L	13	8.00-11.36	9.49	9.85	11.05	4.32	10.05
Nitrite-N	mg/L	13	<0.01-0.11	0.01	0.02	0.02	0.13	0.02
Phosphorus	mg/L	13	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	13	20.52-22.37	20.94	21.42	21.77	0.62	21.41
Fluoride	mg/L	13	<0.04-0.60	<0.04	<0.04	<0.04	0.16	0.06
Chloride	mg/L	13	16.67-18.62	16.99	17.25	17.62	0.57	17.37
Bromide	mg/L	13	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site BRSC
ANNUAL

				Quartile				
	Units	Number	Range	25th	50th	75th	Std	Mean
Temperature	degree C	12	3-16	4	10	14	5.26	10
Specific Conductance	uS/cm	12	384-780	713	724	740	102.42	700
Dissolved Oxygen	mg/L	12	7-14	10	11	12	1.95	11
Turbidity	NTU	12	3.7-14.0	5.7	6.3	9.9	3.18	7.5
NO2+NO3-N	mg/L	11	9.2-12.0	9.8	10.0	11.5	1.11	10.5
Ammonia-N	mg/L	12	<0.1-0.6	<0.1	0.15	0.25	0.21	0.2
Fecal Bacteria	count 100 ml.	12	<10-6500	38	180	805	1820.44	897
Nitrate-N	mg/L	12	8.71-13.65	9.78	10.49	11.40	5.95	10.65
Nitrite-N	mg/L	12	<0.01-0.11	0.01	0.01	0.02	0.13	0.02
Phosphorus	mg/L	12	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	12	20.91-27.64	24.68	25.98	26.58	2.06	25.27
Fluoride	mg/L	12	<0.04-0.70	0.07	0.14	0.20	0.19	0.18
Chloride	mg/L	12	16.8-20.66	17.48	18.02	18.80	1.11	18.22
Bromide	mg/L	12	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SN2
OVERALL

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	12	1-17	2	11	16	6.59	9
Specific Conductance	uS/cm	12	371-710	635	645	668	86.06	633
Dissolved Oxygen	mg/L	12	10-15	10	11	13	1.82	12
Turbidity	NTU	12	2.0-9.2	4.7	5.0	6.2	2.11	5.5
NO2+NO3-N	mg/L	11	2.4-4.1	3.1	3.5	3.7	0.49	3.4
Ammonia-N	mg/L	12	<0.1-0.3	<0.1	0.1	0.2	0.08	0.1
Fecal Bacteria	count 100 ml.	12	<10-510	25	170	310	185.32	198
Nitrate-N	mg/L	12	2.24-4.90	3.12	3.30	3.49	2.85	3.35
Nitrite-N	mg/L	12	<0.01-0.11	<0.01	0.01	0.02	0.13	0.02
Phosphorus	mg/L	12	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	12	20.24-27.46	25.00	25.76	26.61	1.97	25.40
Fluoride	mg/L	12	<0.04-0.6	<0.04	0.04	0.13	0.16	0.11
Chloride	mg/L	12	6.94-8.86	7.45	8.20	8.62	0.69	8.02
Bromide	mg/L	12	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06

Site SNT
ANNUAL

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	12	2-16	4	11	14	5.39	9
Specific Conductance	uS/cm	12	378-660	613	622	644	74.93	609
Dissolved Oxygen	mg/L	12	6-13	10	11	12	1.96	11
Turbidity	NTU	12	3.2-11.0	4.5	5.8	8.1	2.47	6.4
NO2+NO3-N	mg/L	11	2.4-4.5	3.4	3.5	3.9	0.56	3.6
Ammonia-N	mg/L	12	<0.1-0.5	<0.1	0.2	0.2	0.13	0.1
Fecal Bacteria	count 100 ml.	12	<10-1500	10	80	278	431.78	263
Nitrate-N	mg/L	12	2.51-5.47	3.23	3.52	3.85	3.72	3.71
Nitrite-N	mg/L	12	<0.01-0.11	<0.01	0.01	0.02	0.13	0.02
Phosphorus	mg/L	12	<0.03-<0.03	<0.03	<0.03	<0.03	0	<0.03
Sulfate	mg/L	12	19.81-23.68	21.39	22.15	23.25	1.34	22.11
Fluoride	mg/L	12	<0.04-0.60	<0.04	0.09	0.18	0.16	0.14
Chloride	mg/L	12	7.39-10.81	8.40	9.27	9.37	0.99	8.98
Bromide	mg/L	12	<0.06-<0.06	<0.06	<0.06	<0.06	0	<0.06