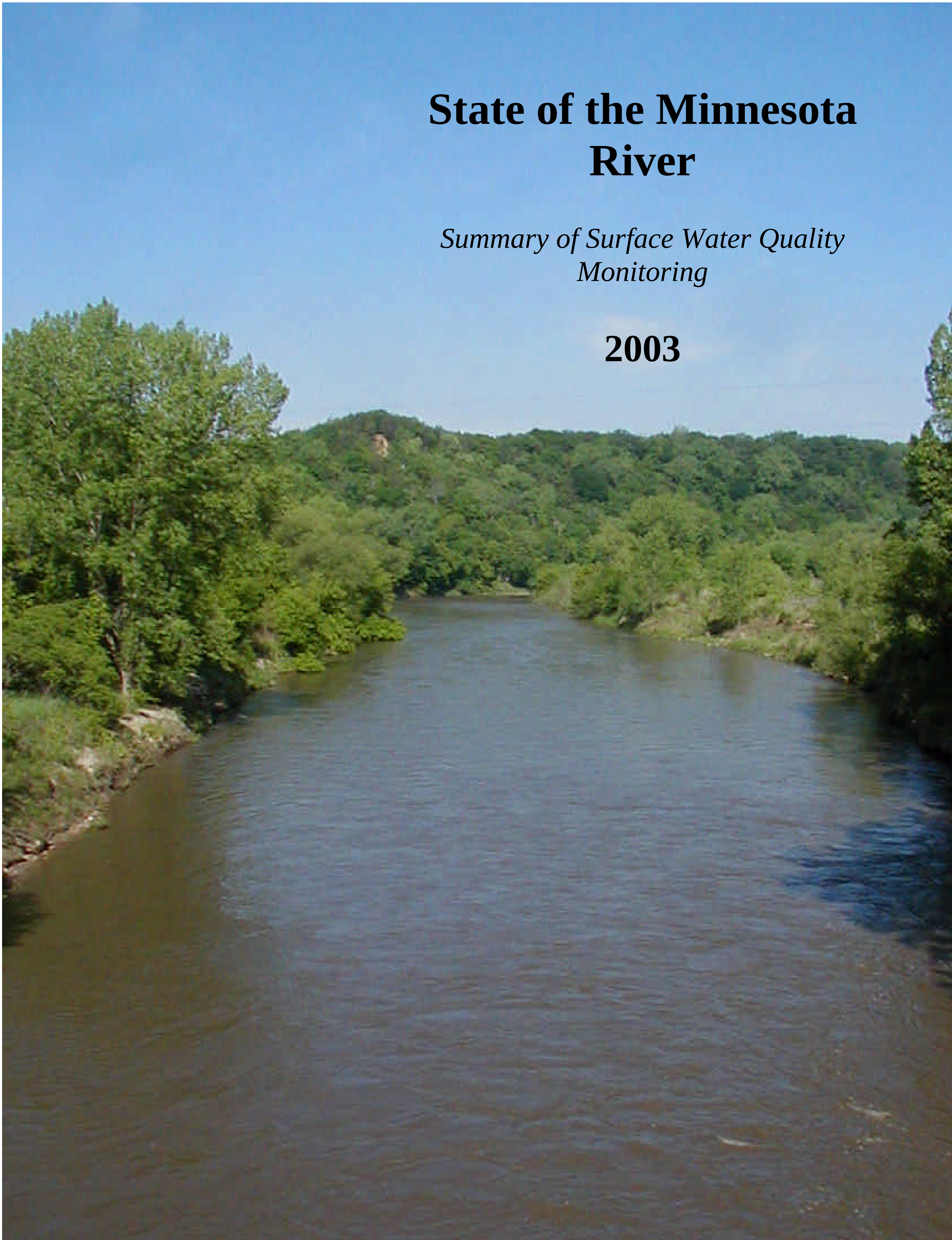
State of the Minnesota River

Summary of Surface Water Quality Monitoring

2003



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Abstract

Water-quality and streamflow data collected in the Minnesota River Basin during 2000 - 03 were examined and evaluated to determine the condition of 28 tributary streams and the Minnesota River mainstem with respect to concentrations, loads and yields of total suspended solids, total phosphorus, orthophosphorus, nitrate-nitrogen, pesticides, and bacteria. The data show widely varying water-quality conditions in most streams during a relatively short four-year monitoring period, underscoring the need for longer-term data gathering to gain an accurate perspective of water quality across a broad spectrum of hydrologic conditions. Results show that watershed yields of water-quality constituents follow a general pattern of increasing yield, often accompanied by increasing flow-weighted mean concentrations, from west-to-east across the Minnesota River Basin. The data indicate regional differences in the magnitude of constituent load response to water runoff. The difference in response is related to watershed soils, geology, topography, and stream morphology, but land use, cropping practices, drainage practices, and conservation practices also may be affecting the load response. Concentrations of total suspended solids, total phosphorus, orthophosphorus and nitrate-nitrogen in several of the monitored streams, despite reductions during 2003, frequently are at problematic levels, exceeding thresholds associated with reasonable expectations for water quality in their respective ecoregions. Affected streams range in size from minor tributaries to the Minnesota River mainstem. Impaired conditions were documented during widely varying hydrologic conditions ranging from near drought to flood. The data gathering, using consistent and technically-sound methodology at all sites across the Minnesota River Basin, serves to document present stream condition and provides a basis for directing resources to impaired streams. Such data, collected longer term, will form a solid body of evidence that accurately portrays stream water quality over time. These data will enhance the impaired waters listing process by providing an improved perspective of stream water quality during normal, above normal, and below normal runoff periods. During the four-year period, the monitoring data have served to identify impaired streams and have provided indications of source areas, but questions remain about specific contaminant sources, source mobilization, and transport mechanisms. The more complex mechanisms may require in-depth focused research studies beyond the scope of the present monitoring program and suggestions for research projects are presented in this report.

State of the Minnesota River
Summary of Surface Water Quality Monitoring
2003

Chapter 1

Purpose

The purpose of the 2003 State of the Minnesota River Report is to consolidate surface water quality monitoring information collected in the Minnesota River Basin for calendar years 2000 - 2003. This summary report assembles data collected by multiple agencies and organizations and presents the data in a fashion that allows for relative water quality comparisons between the mainstem Minnesota River sites, as well as between the major and minor tributaries in the Minnesota River Basin.

To date, three prior reports have been published in State of the Minnesota River Report series (2000, 2001 and 2002). The 2003 report presents 2003 monitoring data, and compares it with much of the 2000 - 2002 data along with a few additions and some minor corrections. The data and information presented in this report was gathered at 32 surface water quality monitoring stations located throughout the Minnesota River Basin.

Preparation of this report is a joint venture of the Minnesota Department of Agriculture (MDA) Minnesota Pollution Control Agency (MPCA), and the Water Resources Center at Minnesota State University, Mankato. Greg Payne, hydrologist, joined the group for a second year and examined the data, provided in-depth analysis, and wrote major sections of the report. This report helps fulfill the overall mission of the Minnesota River Basin Data Center, which is to inventory, develop, retrieve, interpret, and disseminate information on topics that impact the environment, economy and communities within the Minnesota River Basin. This mission was articulated first by the Minnesota River Citizens Advisory Committee (CAC) in a series of recommendations to the MPCA (MPCA, 1994), and later by the Minnesota River Basin Joint Powers Board (MRBJPB). This report demonstrates that good coordination exists between state and local water quality monitoring agencies in the Minnesota River Basin. The information provided in this report is also consistent with and helps fulfill the “Monitoring Action Strategy” identified in the Minnesota River Basin Plan (MPCA, 2001). The plan was developed with extensive input from researchers and citizens and charts a course for the continued restoration of the Minnesota River. The goal of the Minnesota River Basin Plan is “To restore, protect and maintain the water quality, bio-diversity and the natural beauty of the Minnesota River or to make the Minnesota River fishable and swimmable once again” (MPCA, 2001).

Background

The Minnesota River originates at the Minnesota-South Dakota border, flows for 335 miles through some of the richest agricultural land in Minnesota, and joins the Mississippi River at Minneapolis/St. Paul. The river drains a basin of 16,770 square miles: 14,840 square miles in Minnesota, including all or parts of 37 counties; 1,610 square miles in South Dakota; and 320 square miles in North Dakota and Iowa combined. Minnesota's portion of the Basin is primarily used for agriculture and represents 18.5% of the state's land mass and 29% of its cultivated land. As the state's largest tributary of the Mississippi River, the Minnesota River's volume increases the Mississippi's flow by 57% and adds disproportionately to its pollutant load (MPCA, 1997).

The 1994 Minnesota River Assessment Project (MRAP), at the time the most comprehensive study of water quality in the Minnesota River Basin, concluded that the Minnesota River is impaired by excessive nutrient and sediment concentrations (MPCA, 1994). Since the publication of the MRAP report, several organizations throughout the Basin have taken responsibility for collecting additional data to better define tributary characteristics and learn more about how these tributaries affect the condition of the Minnesota River. In many parts of the Basin, this information is used to target implementation practices that reduce point and non-point source pollution, thereby improving the overall health of the Minnesota River. Local watershed projects are supported mainly by Federal 319 funds and Clean Water Partnership grants administered by the MPCA. Much of the remaining data presented in this summary report is provided through monitoring programs of the MDA and Metropolitan Council Environmental Services (MCES), with contributions from the United States Geological Survey (USGS), Minnesota Department of Natural Resources (MDNR) and the Minnesota State Climatology Office.

In recent years, there have been significant improvements in point source pollution control as well as continued adoption of conservation and non-point source best management practices within the Minnesota River Basin. With these changes has come an increasing expectation that the monitoring data being collected will not only be used to identify potential problem areas but can also be used to document and quantify water quality improvements as best management practices are implemented. Recent publications have questioned the costs of implementation activities if the benefits cannot be readily quantified. As such, efforts like this to coordinate and standardize monitoring activities and information are becoming increasingly important to provide a scientifically defensible assessment of water quality responses to changes in land use throughout the Basin.

This report is available on the Minnesota River Basin Data Center web site at http://mrbdc.mnsu.edu/, to allow wide access and an opportunity to review and comment on its content.

Contributors

Data included in this report were submitted and reviewed by representatives of several organizations, including:

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Chapter 2: Monitoring and Data Assessment Methods

Monitoring Sites

For the 2003 monitoring season, data is presented for thirty-two (32) water quality monitoring stations operated throughout the Minnesota River Basin. The number and location of sites has changed slightly over the four year period, with some sites having four years of data and others only having one. In 2003, four monitoring stations are located along the mainstem of the Minnesota River, fourteen stations are located near the outlets of major Minnesota River tributaries (those with watersheds greater than 100,000 acres), and fourteen stations are located near the outlets of minor Minnesota River tributaries (those with watersheds less than 100,000 acres). It is important to note that there are over 40 over minor tributary sites located throughout the Basin. For the scope of this report, it was decided to include only a few representative minor sites. The 32 monitoring stations are listed in Table 2.01. Figure 2.01 depicts the locations of these monitoring stations throughout the Basin.

Table 2.01. Mainstem, Major Tributary, and Minor Tributary Monitoring Sites in the Minnesota River Basin

Mainstem	**Major Tributaries >100,000 acres**	**Minor Tributaries <100,000 acres**
MN River at Judson	Yellow Bank River	Dry Weather Creek
MN River at St. Peter	Lac qui Parle River	WF Beaver Creek
MN River at Jordan	Chippewa River	Clear Creek
MN River at Fort Snelling	Yellow Medicine River	Dutch Creek
	Hawk Creek	Seven Mile Creek
	Redwood River	Bevens Creek
	Cottonwood River	Chaska Creek
	Little Cottonwood R.	Carver Creek
	Watonwan River	Bluff Creek
	Blue Earth River	Riley Creek
	Le Sueur River	Eagle River
	Rush River	Credit Creek
	High Island Creek	Willow Creek
	Sand Creek	Nine Mile Creek

Additional details on each individual monitoring station are presented in Chapter 3 and Appendix D.

Map here

Monitoring Season

Monitoring season length is an important variable to consider when characterizing water quality and evaluating temporal and spatial trends throughout the Minnesota River Basin. The targeted time period for the 2000 monitoring season was April 1 through October 31. To allow additional time for the Clean Water Partnership Projects to analyze water quality data prior to the required reporting deadlines, the 2001 monitoring season was shortened by one month, extending from April 1 through September 30. While October runoff and river flows can be substantial during some years, the April 1 (approximate ice-out date) through September 30 period typically represents the months when nutrient and sediment loads are expected to be the highest, and when the majority of river flow occurs. At monitoring stations where year-round USGS or agency flow gauging occurs, year-round monitoring is also encouraged. The 2003 monitoring season length was very similar to that of 2001 and 2002. Table 2.02 presents the 2003 monitoring season length at each of the 32 monitoring stations in the Minnesota River Basin.

Storm Event Sampling Methodology

Two primary methods of storm event sampling are used in the Minnesota River Basin. Grab sampling is the collection of a discrete, instantaneous sample, either by manual means or with an automatic sampler (autosampler). Flow-based composite sampling is the collection of a composite sample during the time period when the river is responding to the increased runoff associated with a storm event. Flow-based composite samples are collected using an autosampler. The objective of flow-based composite sampling is to determine the pollutant characteristics of the entire stormflow volume, using either equal-time increment (ETI) or equal-flow increment (EFI) sampling. Generally, with ETI sampling, the automatic sampler is used to collect discrete grab samples at pre-specified time intervals (every hour, for example) during a storm event. These discrete grab samples can then be composited based upon time and flow, or analyzed as discrete samples. With EFI sampling, the autosampler is used to obtain a composite sample throughout a storm event by collecting discrete sub-samples representing equal volumes of flow. For example, 200 mL of river water may be collected for every 10,000 cubic feet of river flow, resulting in one composite sample that can represent several days of runoff. In theory, EFI composite sampling provides better pollutant characterization, as all flow conditions are equally represented in one sample.

Table 2.03 presents the 2003 storm event monitoring methodology used at each of the 32 monitoring stations in the Minnesota River Basin.

Table 2.02. 2003 Monitoring Season Length in the Minnesota River Basin

River	Acreage	Time Interval	Years of Operation
Dry Weather	67,759	4/1 – 9/30	5
West Fork Beaver Creek	61,326	4/1 – 9/30	4
Yellow Bank River	281,456	4/1 – 9/30	3
Lac qui Parle River	615,244	3/25 – 9/30	3
Chippewa River	1,203,200	4/1 – 9/30	6
Yellow Medicine River	424,958	3/26 – 9/30	5
Hawk Creek	323,199	4/1 – 9/30	5
Clear Creek	49,280	4/1 – 9/30	14
Redwood River	402,560	3/29 – 9/30	15
Cottonwood River	840,000	4/1 – 9/30	8
Little Cottonwood River	108,760	4/1 – 9/30	6
MN River at Judson	7,186,921	3/15 - 9/30	5
Dutch Creek	8,653	4/1 – 9/30	5
Watonwan River	544,533	4/1 – 9/30	4
Blue Earth River	1,555,270	3/15 - 9/30	5
Le Sueur River	710,400	3/15 - 9/30	5
MN River at St. Peter	9,634,760	3/15 - 9/30	5
Seven Mile Creek	23,551	4/1 – 9/30	5
Rush River	257,775	4/1– 9/30	1
High Island Creek	152,150	4/1 – 9/30	4
Bevens Creek	83,776	3/15 - 9/30	15
Sand Creek	163,071	3/15 - 9/30	15
MN River at Jordan	10,389,757	3/15 - 9/30	15
Chaska Creek	9,640	3/15 - 9/30	6
Carver Creek	53,440	3/15 - 9/30	15
Bluff Creek	5,724	3/15 - 9/30	15
Riley Creek	8,366	3/15 - 9/30	5
Eagle Creek	2,158	3/15 - 9/30	5
Credit River	32,896	3/15 - 9/30	15
Willow Creek	6,558	3/15 - 9/30	5
Nine Mile Creek	24,512	3/15 - 9/30	15
MN River at Fort Snelling	10,849,467	3/15 - 9/30	28

Table 2.03. 2003 Storm Event Sampling Methods in the Minnesota River Basin

Equal Time Increment Auto-sampling	Equal Flow Increment Auto-sampling	Grab Sampling
Redwood River	MN River at Judson	Yellow Bank River
Cottonwood River	Dutch Creek	Lac qui Parle River
Little Cottonwood River	Blue Earth River	Chippewa River
Seven Mile Creek	Le Sueur River	Yellow Medicine River
Clear Creek	MN River at St. Peter	Hawk Creek
	Bevens Creek	Watonwan River
	Sand Creek	Dry Creek
	Chaska Creek	West Fork Beaver Creek
	Carver Creek	Rush River
	Bluff Creek	High Island Creek
	Riley Creek	MN River at Jordan
	Eagle Creek	MN River at Fort Snelling
	Credit River	
	Willow Creek	
	Nine Mile Creek	

Grab or composite sample collection during storm events is typically supplemented by grab sample collection during non-event (baseflow) periods.

Compilation of Water Quality Data

Most of the data used for the 2000 - 2003 State of the Minnesota River Reports were compiled and submitted by the organizations conducting the water quality monitoring work.

Criteria for Data Inclusion

As the 2001 State of the Minnesota River Report was being prepared, it became clear that water quality comparisons between monitoring stations and watersheds are not possible when monitoring season lengths are inconsistent and/or when inadequate sampling has been conducted. Consequently, a multi-agency group established monitoring criteria that are intended to ensure more accurate comparisons of water quality data between monitoring stations and watersheds. These criteria will be used to determine which data are included in these annual reports, and have also proven to be beneficial for guiding monitoring program improvements. These criteria include:

1. Representation of a complete monitoring season (April 1 (or ice-out date) to September 30).
2. Sufficient water quality sampling to accurately characterize all flow periods.
3. A well-defined stage/discharge relationship.
4. Frequent site visits to ensure the integrity of the monitoring equipment.

5. Similar monitoring and analytical methodologies.
6. Implementation of field quality-assurance measures.

Refer to Appendix A for the document: "Criteria for Inclusion of Monitoring Data in the 2001, 2002 and 2003 State of the Minnesota River Reports."

Calculation of Loads and Flow-Weighted Mean Concentrations

FLUX is an interactive software program that allows the user to estimate loads and flow-weighted mean concentrations (FWMCs) of water quality constituents at a monitoring location. The FLUX program combines flow and water chemistry data from the monitoring location to make these estimates. Loads and FWMCs can be determined for any time period, but for the purpose of this report, loads and FWMCs were all calculated for the April 1 – September 30 monitoring season. FLUX was the primary tool used by all monitoring partners for assessment of the 2000 – 2003 data. For a more detailed explanation of FLUX, see Appendix B.

Because FLUX is designed to use daily average flow data coupled with water chemistry data from discrete grab samples, flow-composited samples that are collected over a time period greater than one day require an estimate of the daily average flow. To estimate the daily average flow for a composite sample, the middle day of the composite sampling period or the day during which the majority of the flow occurred is selected. An average flow for that day is then derived by dividing the total flow volume (cubic feet) for the composite sample collection period by the total number of seconds elapsed during that period, to give an average composite flow in cubic feet per second (cfs).

High water at a ditch site in the Le Sueur Watershed.

Chapter 3: 2003 Monitoring Data

2003 Precipitation and Runoff

State-wide 2003 total precipitation amounts and precipitation departure from normal (MN State Climatology Office, 2003) are presented in Figures 3.01 and 3.02, respectively. Figure 3.01 indicates that the greatest precipitation occurred in the downstream (eastern) part of the Minnesota River Basin. Total precipitation amounts decreased slightly as one moves westward through the Basin. Total precipitation amounts in 2003 ranged from 16 inches in the western part of the Basin to 24 inches in the eastern portion of the Basin. As shown in Figure 3.02, these annual totals represent an approximate 2 - 6 inch decrease from normal in the throughout the whole Basin.

Figure 3.01.

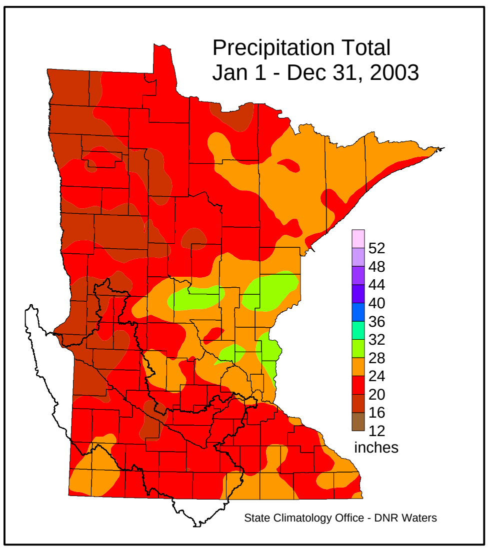
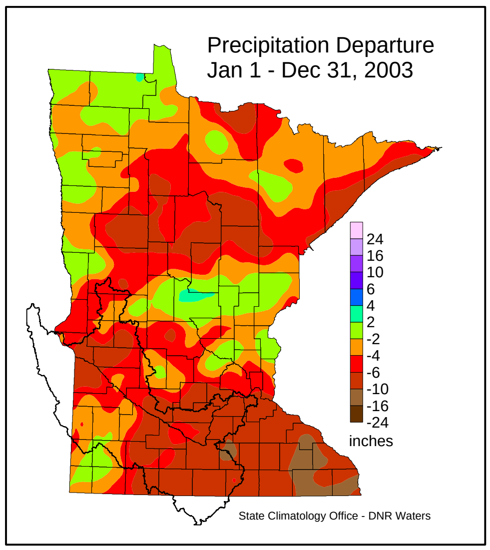


Figure 3.02.



Runoff is the part of precipitation that appears in rivers and streams, including baseflow, stormflow, flow from ground water, and flow from point sources (see Appendix C: Glossary of Terms). Typically, the more precipitation that occurs in a watershed, the more runoff there will be. However, the timing and intensity of precipitation, antecedent soil moisture conditions, soil types, land slopes, land use, as well as other factors, can dramatically influence the seasonal or annual final runoff number. In the Minnesota River Basin, runoff tends to increase from the western portion of the Basin to the eastern portion due to geographical differences in precipitation. By normalizing constituent loading data for runoff, watersheds from different parts of the Basin can be compared on a more relative basis.

Conservation Reserve Enhancement Program Easements

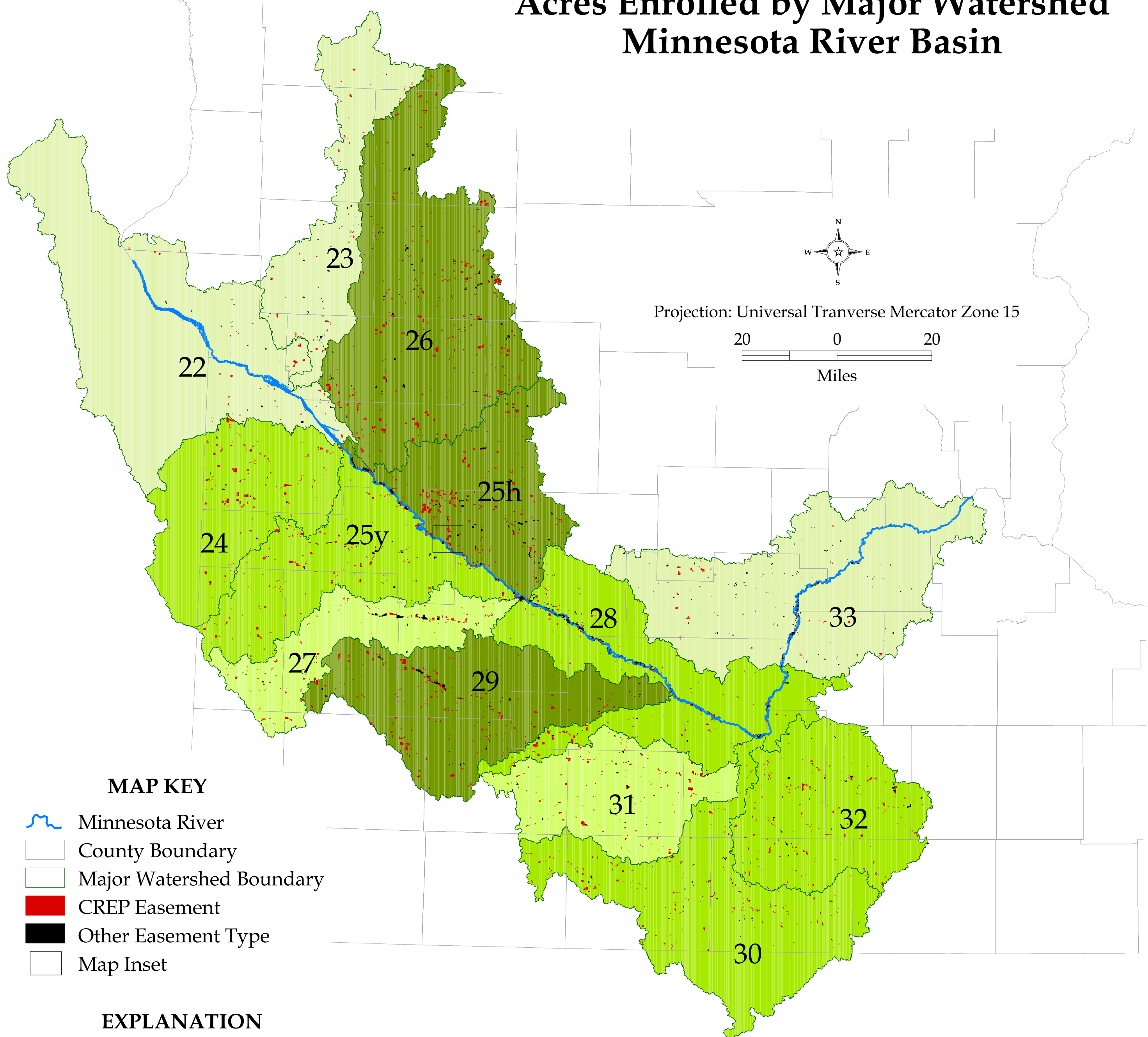
Figure 3.03 depicts acres enrolled in the Conservation Reserve Enhancement Program (CREP) by major watershed in the Minnesota River Basin. The inset table describes by major watershed how many CREP acres there are, followed by the total number of acres of easements throughout the watershed.

2003 Information for Individual Monitoring Stations

Information on each of the 32 individual monitoring stations in the Minnesota River Basin is presented in Appendix D. This information includes a project summary, details regarding site location, a short synopsis of 2003 monitoring season results, numbers and types of water chemistry samples, and a hydrograph for the 2003 monitoring season. Project contact information also is provided.

The 2003 water chemistry data for each of the 32 Minnesota River Basin monitoring sites are presented in Appendix E. The 2000 - 2003 total suspended solids, total phosphorus, orthophosphorus, and nitrate-N loads, yields, runoff-adjusted yields, and FWMCs for each of the 32 Minnesota River Basin monitoring sites are presented in Appendix F. Fecal coliform information are presented in Appendix G.

CREP EASEMENTS
Acres Enrolled by Major Watershed
Minnesota River Basin



MAP KEY

- Minnesota River
- County Boundary
- Major Watershed Boundary
- CREP Easement
- Other Easement Type
- Map Inset

EXPLANATION

The map displays CREP and other easement locations relative to major watershed areas in the Minnesota River Basin. The data analysis classifies each watershed by acres of CREP enrollments in place by May 2004 and does not include final CREP enrollment acres. Total conservation easements include CREP, RIM, PWP, and other easement such as riparian and marginal cropland but may not include other easement data available in programs such as CRP. The acres and percent of CREP and total easements are based on the Minnesota portion of the Minnesota River Basin.

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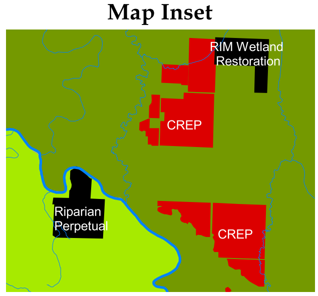
May 31, 2005
ARCINFO 8.2 and ArcView 3.3

Data Sources: BWSR Rimactive file 05-10-04; Minnesota River Basin Data Center GIS files. Data analysis of rimactive file is approximate due to overlapping polygons in source data.

Major Watershed Classified by CREP Enrollment Acres

- 2,427 - 2,694 acres
- 4,675 - 5,710 acres
- 6,507 - 8,051 acres
- 11,404 - 16,570 acres

Map Inset



CREP and Total Easements by Major Watershed
Easement Acres and Percent of Major Watershed

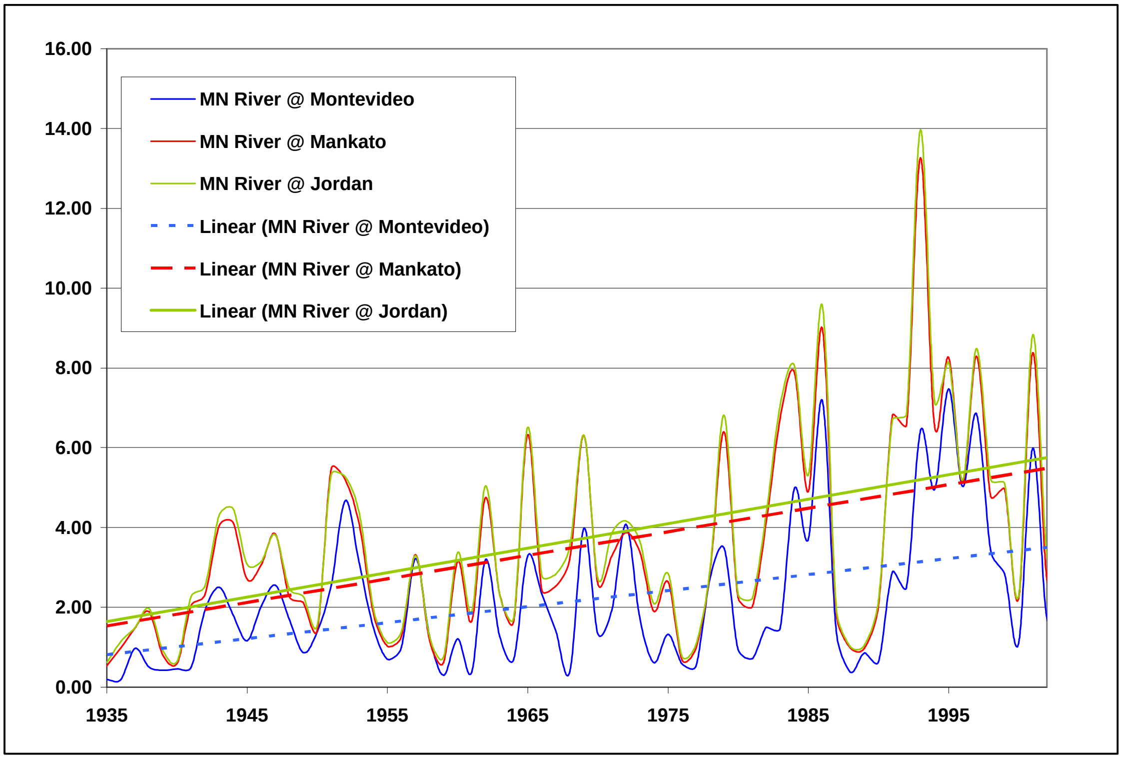
Major Watershed ID	Name	CREP Acres	CREP %	Total Easements Acres	Total Easements %
30	Blue Earth	6,507	0.8	7,715	1.0
26	Chippewa	16,570	1.2	20,859	1.6
29	Cottonwood	11,404	1.4	14,123	1.7
25h	Hawk Creek	12,715	2.0	17,368	2.8
24	Lac qui Parle	8,051	1.7	8,652	1.8
32	Le Sueur	6,936	1.0	8,512	1.2
33	Lower Minnesota	2,653	0.2	6,674	0.6
28	Middle Minnesota	6,727	0.8	12,398	1.4
23	Pomme de Terre	2,427	0.4	3,977	0.7
27	Redwood	4,675	1.0	7,307	1.6
22	Upper Minnesota	2,694	0.6	3,296	0.7
31	Watonwan	5,710	1.0	7,131	1.3
25y	Yellow Medicine	7,971	1.1	10,785	1.5
	Total Acres	95,039	1.0	128,797	1.3

Chapter 4: A Comparison of 2000 - 2003 Monitoring Results

Runoff

Figure 4.01 presents annual runoff amounts at three Minnesota River mainstem locations during the 1935 through 2003 period, as determined by the USGS. Data are presented for the Minnesota River at Montevideo, Mankato, and Jordan, located in the Upper, Middle and Lower Minnesota River Watersheds, respectively.

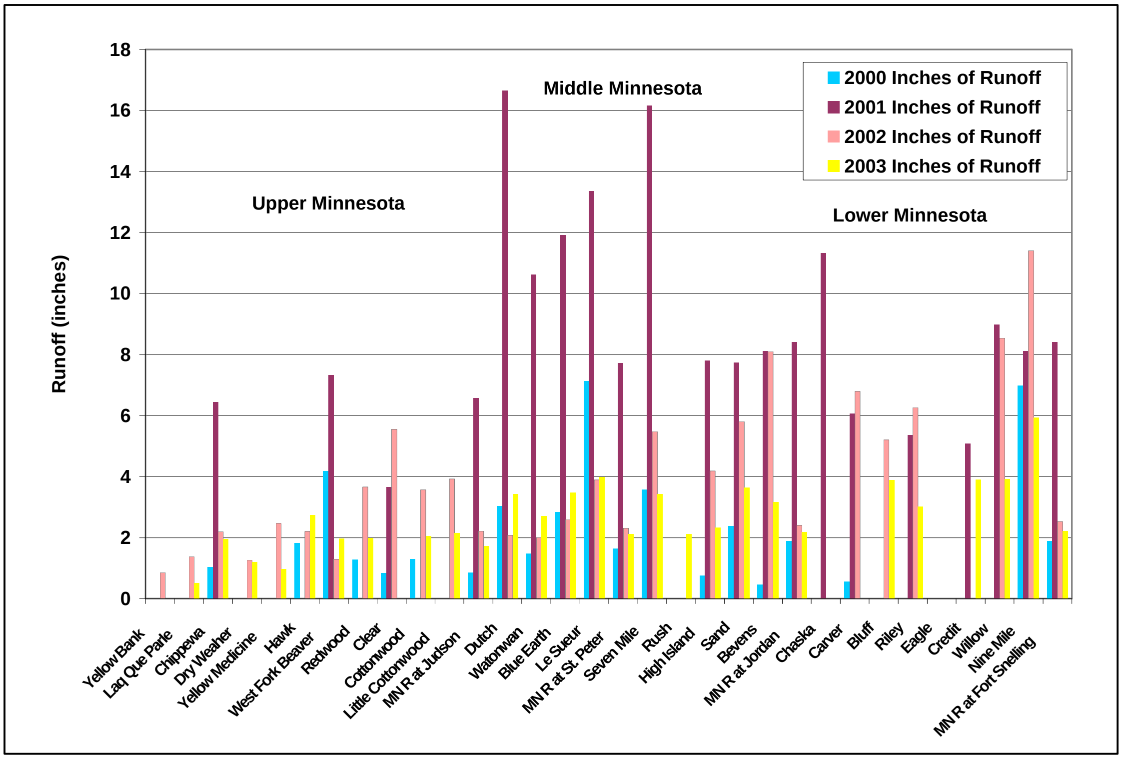
Figure 4.01. Annual Runoff at Minnesota River Mainstem Locations, 1935 - 2003



A clear trend of increasing runoff is apparent in Figure 4.01. During the most recent 13-year period (1991-2003), seven of the top ten runoff years have occurred at Mankato, and six of the top ten runoff years have occurred at Montevideo and Jordan. The increases in runoff indicated in Figure 4.01 are the result of a combination of factors, including increasing precipitation, changes in agricultural and urban drainage, and other landscape and land use modifications. Mallawatantri and Mulla (1998) analyzed long-term flow trends for the Minnesota River and found that 70% of the increased flow was due to climatic changes, with the rest due to non-climatic effects.

Figure 4.02 presents 2000 - 2003 monitoring season runoff amounts at all 32 Minnesota River Basin sites, in an upstream to downstream sequence. This figure shows a substantial difference between the four years with respect to runoff in the Basin. The 2000 monitoring season was relatively dry in most of the Basin, while the 2001 season was relatively wet. In 2002, the runoff amounts were less than 2001 but greater than 2000 in the upper and middle part of the Basin. However, in the Lower Minnesota River Basin tributaries, 2002 runoff exceeded all of the corresponding runoff numbers in 2000, and in some instances, exceeded the runoff in 2001. In 2003, runoff totals were for the generally greater than 2000, but less than 2002 results.

Figure 4.02. 2000 - 2003 Monitoring Season Runoff at Minnesota River Basin Sites



Water Quality

The discussion and graphics presented on the following pages evaluate spatial and temporal differences in 2000 - 2003 monitoring results, and in some instances also evaluate the methodologies used to collect or compile these results. The loading, yield, runoff-adjusted yield, and FWMC data for each of four key water quality constituents (total suspended solids, total phosphorus, orthophosphorus, and nitrate-N) have been grouped into the Minnesota River mainstem, major tributaries, and minor tributaries (See Table 2.01 and Figure 2.01). For each of the three Minnesota Basin groups, the graphics are organized in an upstream to downstream sequence, from left to right.

A glossary of some of the key terms used in the following comparison of 2000 - 2003 monitoring results is presented in Appendix C.

Mainstem Total Suspended Solids

Figure 4.03 presents the 2000 - 2003 monitoring season total suspended solids (TSS) loads for Minnesota River mainstem sites and the Greater Blue Earth River Watershed (including the Blue Earth, Watonwan, and Le Sueur Rivers). Runoff at mainstem sites decreased during 2003 compared to 2002, while runoff in the Greater Blue Earth Watershed during 2003 increased compared to 2002. Total suspended solids load response corresponded to runoff conditions in that TSS loads at mainstem sites were less than loads measured during 2002 and TSS load in the Greater Blue Earth increased slightly compared to 2002 (Figure 4.03). The relation between annual runoff and annual sediment yield is not linear because the magnitude and timing of the individual runoff events that comprise total annual runoff also greatly affect the amount of sediment delivered. For example, runoff in the Greater Blue Earth increased 21 percent during 2003 compared to 2002, but TSS load increased only 8 percent compared to 2002.

In general, TSS loads at mainstem sites during 2003 were among the lowest measured since reporting began in 2000. Three of the mainstem sites, St. Peter, Jordan, and Ft. Snelling recorded the smallest TSS loads of the four-year period. The 2003 TSS load at Judson (184,000 tons) exceeded the previous low of 131,000 tons measured during 2000, but runoff at Judson in 2003 was 1.72 inches, an amount that was more than double the 0.85 inches of runoff recorded at Judson in 2000. Overall, water quality in the mainstem and the Greater Blue Earth River appears to have benefited (TSS loads decreased) from two consecutive years of low to moderate rainfall (with localized exceptions) across most of the Basin. Reduced TSS loads during 2003 are reflected in the FWMC values (Figure 4.04). The FWMC values (85-166 mg/L) have diminished compared to values in 2000, but exceed the impaired waters thresholds of 58 mg/L (Western Corn Belt Plains) and 66 mg/L (Northern Glaciated Plains).

Figure 4.03. 2000 - 2003 Monitoring Season Total Suspended Solids Loads in Thousands of Tons at Minnesota River Mainstem and Greater Blue Earth River Sites

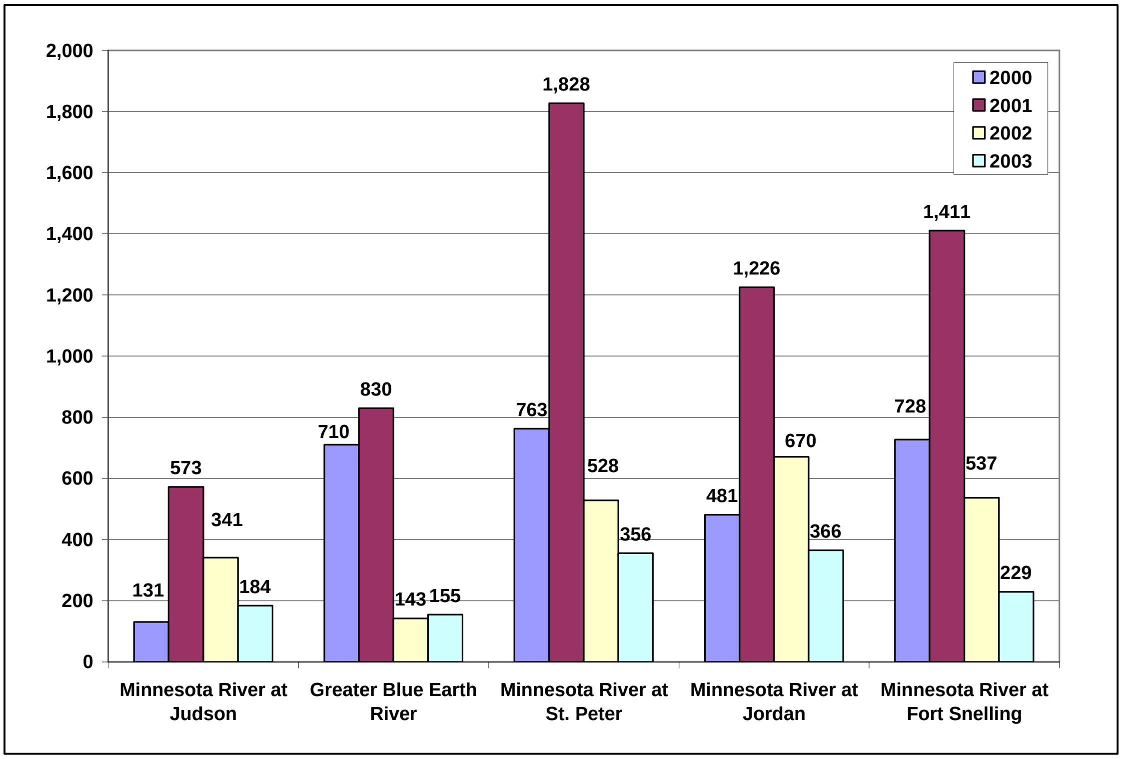
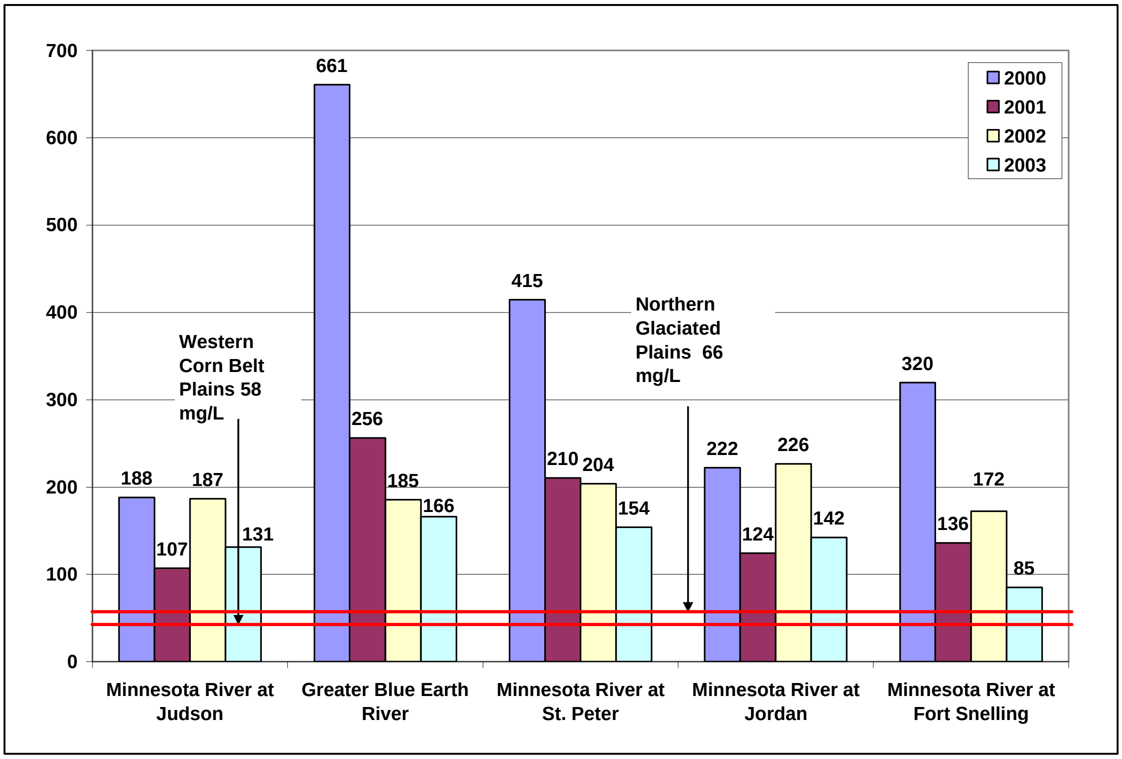


Figure 4.04. 2000 - 2003 Monitoring Season Total Suspended Solids FWMC at Minnesota River Mainstem and Greater Blue Earth River Sites



Major Tributaries Total Suspended Solids

Figure 4.05 shows major-tributary TSS loads in thousands of tons during the past four years. Taken as a whole, major tributaries in the Middle and Lower part of the Minnesota River Basin have contributed the greatest TSS load, most notably the Le Sueur and Blue Earth Rivers, and to a lesser extent, the Cottonwood River. These tributaries drain large watersheds that receive greater than average precipitation, and they have greater than average runoff as compared to tributaries in the upstream part of the Basin. This difference was particularly notable during 2000 and 2001, when loads in the Le Sueur and Blue Earth Rivers greatly exceeded loads in the other major-tributary streams (Figure 4.05).

While TSS loads are useful for assessing the relative sediment contribution from each of the major tributaries to the total sediment burden of the Minnesota River, TSS yields and FWMC's are better indicators of water-quality condition among the tributaries. Yields (Figure 4.06), in general, were moderate during 2003 compared to 2000 and 2001, especially in the Lower part of the Basin. A notable exception is Sand Creek where yields during both 2002 and 2003 were highest among the major tributaries. Examining the yield data from all four years shows that tributaries upstream of the Redwood River have not exceeded 100 lbs/ac, whereas the tributaries downstream of the Redwood River often have exceeded 200 lbs/ac.

As discussed in the 2002 State of the Minnesota River Report, annual precipitation increases from west to east (downstream) across the Basin. The amount of precipitation and associated runoff is a major factor affecting the amount of erosion within a watershed and thus its TSS yield. The data collected during the last four years, however, show that total seasonal runoff amounts are only approximate predictors of watershed yields. The seasonal timing of precipitation (spring, summer, or fall) along with rainstorm intensity (inches of rain per hour) greatly affects the amount of erosion. Spring and early summer rains, in general, result in more erosion and the greater the intensity of rainfall the greater the amount of erosion. Furthermore, the amount of rainfall that has preceded a major precipitation event (antecedent precipitation) may increase the amount of erosion. Data collected over the last four years have shown that some of the greatest storm loads and yields occur when heavy rainfall (generally 2" or greater) falls on watersheds that have soils already moistened by rain that has fallen within the previous 3-7 days. Runoff and erosion can be high during these events, even when the antecedent rains were moderate and produced little erosion of their own.

Given the dynamic response of watersheds to precipitation variables, it often is difficult to determine to what extent a watershed's response (yield) is influenced by other factors such as terrain, land use, and management practices. Separating the effects of these influences remains an important objective of resource managers and policy makers because of the continuing need to properly allocate resources between; (1) mitigating the effects of natural forces (primarily climate and weather), and (2) management of human activities (land use practices). As each year's data is collected and evaluated, more is learned about the response of each watershed to precipitation variables. After four years

Figure 4.05. 2000 - 2003 Monitoring Season Total Suspended Solids Loads in Thousands of Tons at Major Minnesota River Tributary Sites

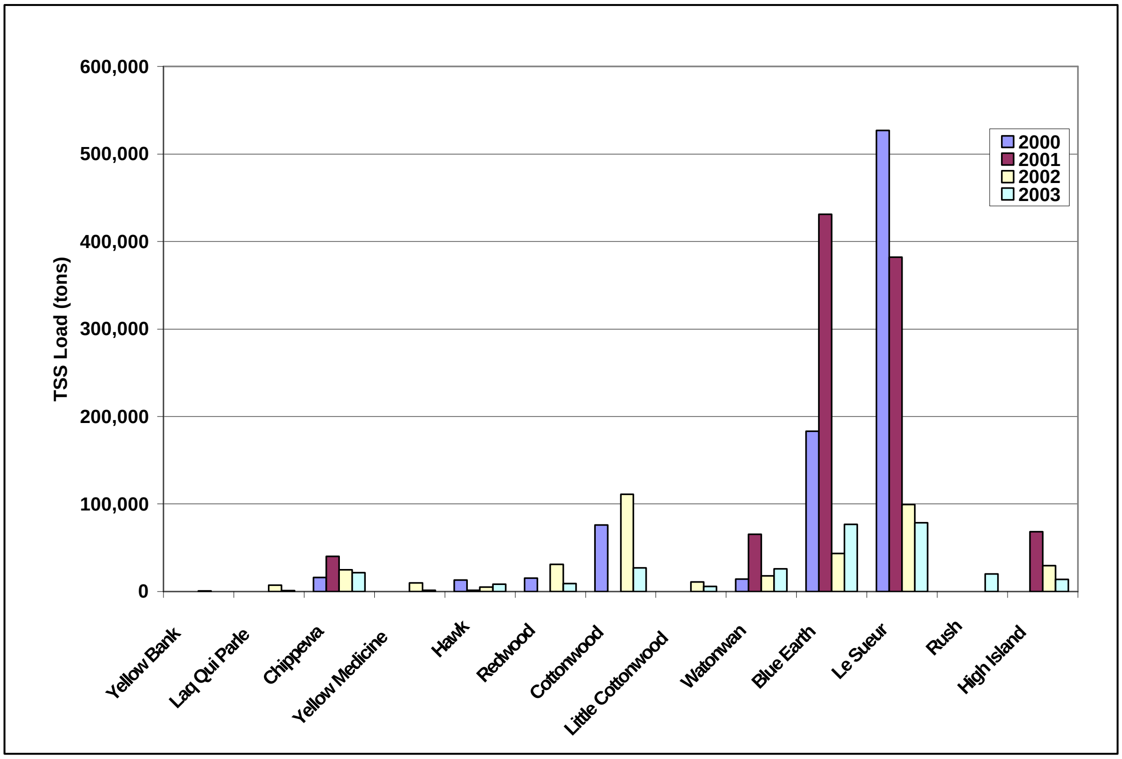
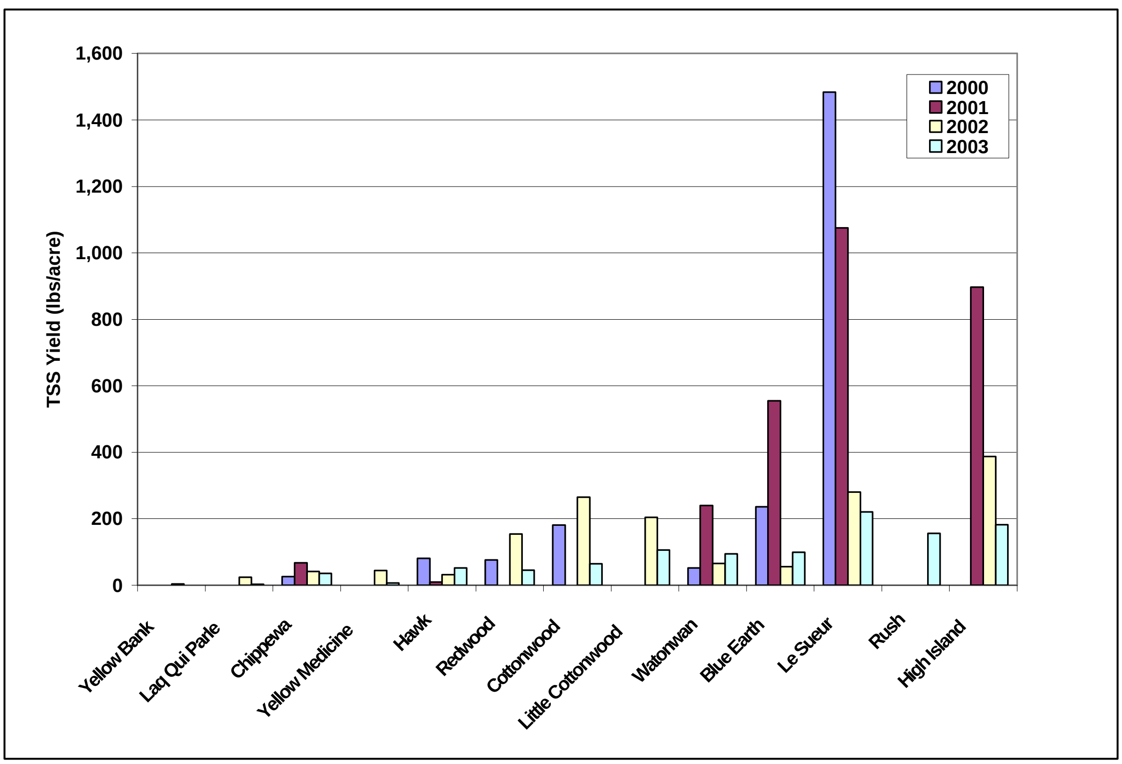


Figure 4.06. 2000 - 2003 Monitoring Season Total Suspended Solids Yields at Major Minnesota River Tributary Sites



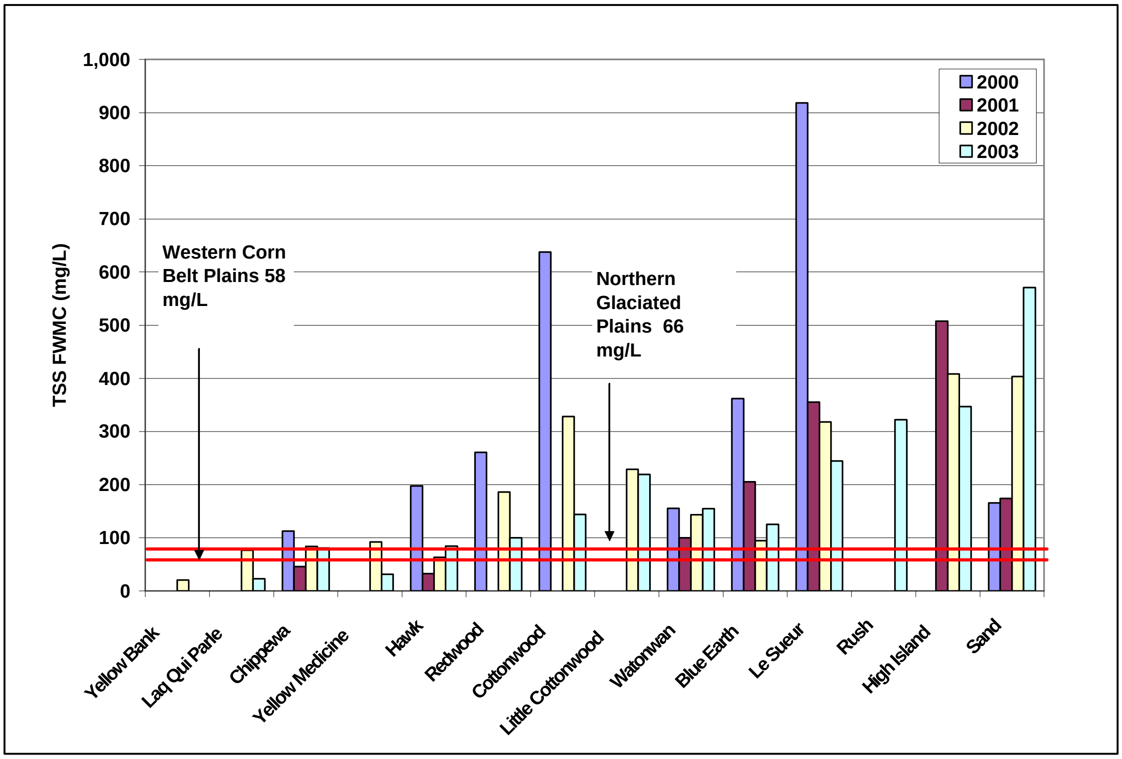
of monitoring, some fairly consistent patterns seem to be emerging from the data, among them the aforementioned lower TSS yields from tributaries in the upstream, western part of the Basin.

When comparing runoff responses among the major tributaries, it is notable that equivalent runoff amounts result in strikingly dissimilar amounts of TSS delivery (yield). As mentioned previously, differences in rainfall intensity, timing, and antecedent rainfall need to be considered when runoff amounts are compared among major watersheds. Comparisons based on total seasonal runoff amounts, nonetheless, provide a starting point for evaluation and may be a useful tool for discovery of other factors (non-precipitation factors) that may be affecting watershed yields. The following discussion examines these comparisons.

The Chippewa River and Cottonwood River Watersheds had nearly equivalent total seasonal runoff during 2003 (1.94 and 2.05 inches, respectively). Both watersheds rank in size among the larger of the major tributaries (1,880 and 1,312 mi^2, respectively). Despite similar runoff amounts, the Cottonwood yielded 65 tons/ac of TSS, an amount nearly double the yield of the Chippewa (35 tons/ac). The higher yield in the Cottonwood resulted in a greater FWMC as well, 144 mg/L, compared to 80 mg/L in the Chippewa River (Figure 4.07). The precipitation and hydrographs in Figures D.02 and D.08 show that total precipitation was, in fact, somewhat greater in the Cottonwood River Watershed. Perhaps of greater significance, antecedent rainfall during two significant runoff events in mid-May and late June was greater in the Cottonwood River Watershed. Seasonal differences are clearly shown by the meager runoff response to rainfall that occurred in September in both watersheds, a time period when crop canopies are generally fully developed and antecedent soil moisture conditions are low. The September rain events, the largest of the 2003 season, resulted in a very small amount of runoff compared to runoff amounts that occurred following smaller rainfalls during May and June. A significant part of the Chippewa Watershed (upstream part) is characterized by less intensive agricultural land use interspersed with lakes and woodlands (land use is 68% agriculture, 62% row crop). This is in contrast to the Cottonwood River Watershed, which supports intensive agriculture, primarily row cropping, across nearly all of its drainage area (land use is 84% agriculture, 92% row crop). These differences in land use may explain some of the differences in TSS yields and FWMC's.

The Rush River and Little Cottonwood River also had similar runoff amounts during 2003, registering seasonal totals of 2.12 and 2.14 inches respectively. Here again, very similar runoff amounts produced dissimilar TSS yields and FWMC's. Yield from the Rush River Watershed was 155 tons/ac, while the Little Cottonwood River Watershed yielded 106 tons/ac (Figure 4.06). The FWMC in the Rush River was 322 mg/L, while the FWMC in the Little Cottonwood River was 219 mg/L. An examination of Figures D.09 and D.17 shows that rainfall totals for the major runoff events were greater in the Little Cottonwood River, opposite of what would be expected given its yield and FWMC values. In this comparison, neither storm precipitation totals nor seasonal runoff totals are good predictors of water quality outcomes.

Figure 4.07. 2000 - 2003 Monitoring Season Total Suspended Solids Flow Weighted Mean Concentrations at Major Minnesota River Tributary Sites



A third comparison can be made using data from the Redwood and Cottonwood River watersheds. Runoff amounts were similar during each of the 2000, 2002, and 2003 monitoring seasons. This might be expected as the two watersheds adjoin each other, and therefore both would tend to be exposed to similar weather patterns and storm tracks. In each of the years, TSS yields were greater in the Cottonwood River Watershed (Figure 4.06). The Cottonwood River also had greater FWMC values during all three years. Examining data from 2000, yields from the Cottonwood River Watershed were about 2.4 times greater than yields from the Redwood River Watershed. The yield difference between these two watersheds diminished somewhat during 2002 and diminished again during 2003. Nonetheless, yields in the Cottonwood were 44 percent greater than yields in the Redwood even during 2003.

Although differences in precipitation variables partly explain TSS yield differences in some of the preceding watershed comparisons, the poor correlation between precipitation, runoff, and water quality in two of the examples points to the need to consider other factors. The primary factor other than precipitation is watershed geomorphology, along with the influence of local land use and land management practices. One aspect of geomorphology, channel slope, has attracted attention as monitoring of the watersheds has progressed. Channel slopes do not differ greatly in the relatively level till-plains that comprise a major part of the watersheds in the Minnesota River Basin. Channel slopes, however, increase as the streams approach the Minnesota River Valley where the tributary channels become incised near their confluence with the Minnesota River mainstem.

The elevation difference between the till-plain portions and the Minnesota River Valley floor varies across the Minnesota River Basin, and the extent (stream miles) of incised channels differs among the tributaries. The more steeply-sloped and incised channel reaches have greater potential for erosion, thereby contributing to greater TSS loads and yields. Channel incision (down cutting) can lead to bank instability and collapse. Another consequence of deeply incised channels is the formation of lateral gullies that head cut into adjacent upland fields. These gully streams tend to form during high-intensity precipitation events, at times forming sizeable ravines and thereby contributing significant amounts of sediment to the major-tributary channels. At times, the gullies extend well into upland areas, intersecting agricultural fields where they receive overland flow and tile discharge resulting in sediment and nutrient transport from the field. The areal extent of these gully-prone areas differs among the major tributaries and may partially explain differences in TSS yields from their respective watersheds. Monitoring in at least one of the major tributaries, High Island Creek, has documented greater TSS yields from the incised-channel areas through use of multiple monitoring stations that bracketed the steeply sloped, incised reaches of that stream.[1]

Terrain features in the steeper channel reaches bear closer scrutiny. In the previous comparison of TSS yields in the Redwood and Cottonwood River Watersheds, the terrain differences are plainly evident. The Redwood River encounters a bedrock outcrop as it approaches the rim of the Minnesota River Valley at Redwood Falls. The bedrock, a series of falls and rapids, has prevented the Redwood River from incising (head cutting) an extensive river valley upstream of Redwood Falls, and much of the lower reach of the Redwood River below the falls is boulder strewn, thereby partially armoring the river channel and reducing channel incision. In contrast, the Cottonwood River flows mostly over unconsolidated material along its course from the upland till plains to its mouth, forming several miles of incised river valley in its downstream reaches. Conditions along that downstream reach of the Cottonwood River may contribute to its higher TSS yields compared to the Redwood River, at least in part. Differences in terrain features among the other major watersheds may be more subtle, but investigating them may lead to a better understanding of the relative significance of the various sediment sources and delivery mechanisms throughout the Minnesota River Basin.

Overall, 2003 marked a year in which TSS yield and FWMC's were moderate compared to values recorded at many sites during 2000 and 2001. The Le Sueur and High Island Watersheds in particular show substantial reductions. Sand Creek, however, has not followed this trend, and values during 2002 and 2003 were substantially greater than they were during 2000 and 2001. Sand Creek Watershed had the greatest TSS yield among all the major tributaries during both 2002 and 2003.

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[1] Two samplesheds in the High Island Creek outlet area represent 26% of the watershed area, but 96% of the TSS load in 2001, and 92% of the TSS load in 2002 (HICWAP, 2002).

Minor Tributaries

Most of the minor tributaries presented in this report discharge directly into the Minnesota River, and are located within the Lower Minnesota River Watershed. Three tributaries were added to this year's report to provide information about streams in the western part of the Minnesota River Basin. Table 2.01 presents the relative size of the minor tributaries listed in this report. Watershed land use for Minnesota River minor tributaries is presented in Table 4.01.

Most of these minor watersheds lie fully or partly within the Twin Cities Metropolitan Area (TCMA). As Table 4.01 indicates, there are significant differences in land use between these watersheds. Land use in Carver, Chaska, and Bevens Watersheds is predominantly agricultural, while land use in the other watersheds tends to be more mixed use. The land use data presented for Chaska Creek and Bevens Creek were obtained during the early 1990's and are presented in the MPCA's Basin Information Document (MPCA, 1997). Land use from Dry Weather, West Fork Beaver, Clear, Dutch, and Seven Mile Creeks was obtained from their respective watershed projects. Land use for the remaining watersheds is from the Metropolitan Council, and is more current.

Table 4.01. Watershed Land Use for Minor Minnesota River Tributaries Sites

	Agriculture	Residential	Commercial	Industrial	Public Semi-Public	Parks and Rec.	Transprt	Undev.	Water
Dry Weather	94%	1%						4%	1%
WFBC	92%	3%						4%	<1%
Clear	94%	<1%	<1%					3%	1%
Dutch	92%	1%						5%	
Seven Mile	86%	3%						8%	3%
Bevens	85%	2%						5%	8%
Chaska	73%	4%						12%	11%
Carver	58%	4%	0%	1%	0%	1%	0%	25%	9%
Bluff	19%	15%	<1%	3%	1%	21%	<1%	33%	6%
Riley	7%	20%	2%	3%	1%	17%	5%	31%	13%
Eagle	<1%	13%	2%	7%	20%	0%	6%	45%	7%
Credit	26%	17%	1%	1%	1%	14%	0%	37%	4%
Willow	0%	36%	11%	14%	2%	8%	3%	22%	4%
Nine Mile	0%	44%	6%	8%	4%	19%	5%	9%	6%

Minor Tributaries Total Suspended Solids

Figure 4.08 presents 2000 - 2003 runoff for the minor tributaries. Runoff for all minor tributaries was below normal during 2003, except for Nine Mile Creek where runoff was about normal. Normal runoff ranges from about 2 inches near Dry Weather Creek to about six inches in the TCMA.

The 2000 - 2003 monitoring season TSS loads at the Minnesota River minor tributary sites are presented in Figure 4.09. Loads in Bevens Creek were substantially reduced from amounts recorded during 2002, reflecting the absence of intensive late-summer runoff events that drove TSS loads to very high levels during 2002. Loads in Bevens Creek remain the highest among the minor tributaries, as might be expected owing to its large watershed. Bevens Creek loads' equal or exceed loads in some of the major tributaries. Overall, the minor tributaries show reduced loading compared to 2002, following the general trend seen in the major tributaries across most of the Minnesota River Basin.

Total suspended solids yields for the 2000 - 2003 monitoring seasons are presented in Figure 4.10. Yields for two of the agricultural watersheds, Seven Mile Creek and Bevens Creek, were substantially reduced compared to 2002, but they are much greater than yields in the other agricultural watersheds (Dry Weather Creek, West Fork Beaver Creek, and Dutch Creek). Smaller TSS yields might be expected in the Dry Weather and West Fork Beaver Creek Watersheds, as they had less runoff during 2003. A comparison of runoff from the Dutch and Seven Mile Creek Watersheds revealed that their runoffs were equal (3.42 inches), but Dutch yielded only 12 lbs/ac of TSS compared to 186 lbs/ac from Seven Mile. Bevens Creek, which has a predominantly agricultural watershed, yielded 147 lbs/ac of TSS from slightly less runoff (3.16 inches).

Total suspended solids yields in four of the urban land use watersheds (Bluff Creek, Riley Creek, Willow Creek, and Nine Mile Creek) were substantially lower during 2003 compared to 2002, probably because of less runoff during 2003. Despite the yield reduction from 2002, TSS yield in Riley Creek was 313 lbs/ac, a value that is more than double yields from the other minor watersheds. Willow Creek Watershed, in contrast, yielded only 27 lbs/ac, even though runoff amounts in Riley Creek and Willow Creek were nearly equivalent at 3.88 and 3.94 inches, respectively. The occurrence of substantial yield differences among watersheds that have similar land use and runoff amounts suggests that the watersheds may differ in geomorphic characteristics or that BMP implementation is lacking in the higher-yielding watersheds. More investigation, in the form of aerial photo interpretation, field reconnaissance, and short-term synoptic sampling during runoff events, may be warranted to identify high-yielding source areas in some of the watersheds. Synoptic sampling, for example, could be used to identify stream subreaches that have elevated turbidity, and then follow up work could be undertaken to identify actively eroding ravines, unbuffered stream reaches, construction sites, and other potential high-yielding areas within the turbid subreaches.

Total suspended solids FWMC values for three streams draining agricultural watersheds (Dry Weather Creek, West Fork Beaver Creek, and Dutch Creek) were within the

Figure 4.08. 2000 - 2003 Monitoring Season Runoff at Minor Minnesota River Tributary Sites

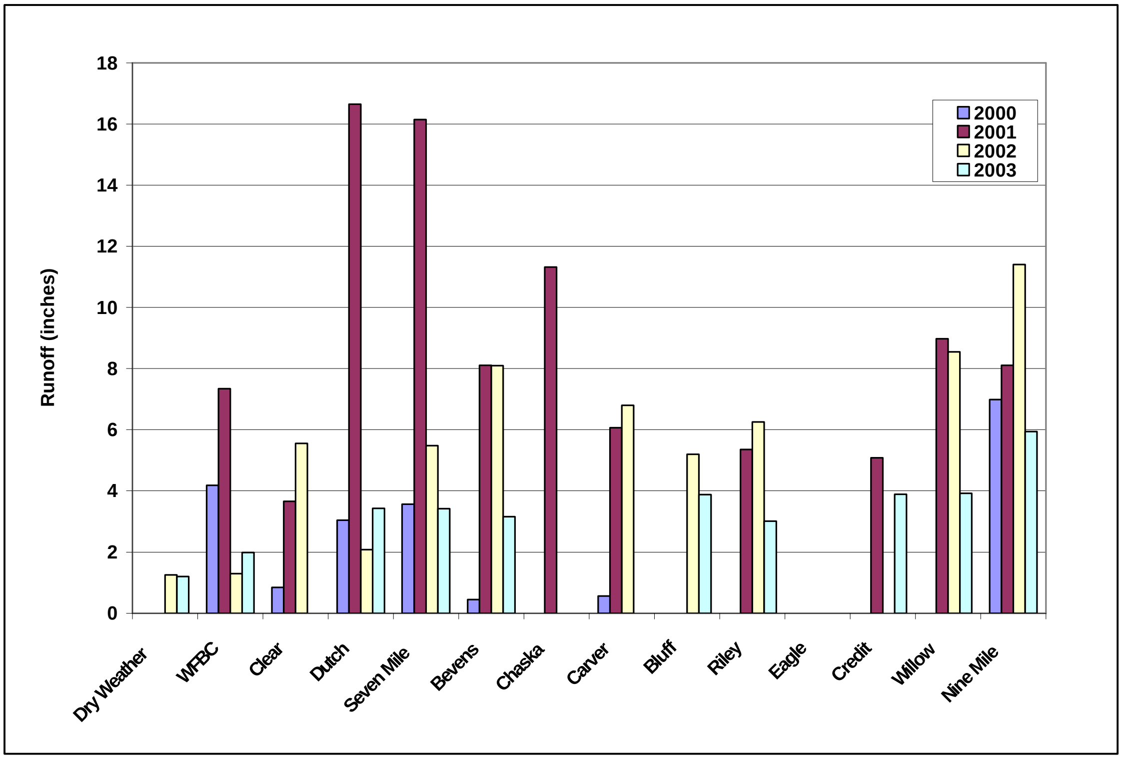
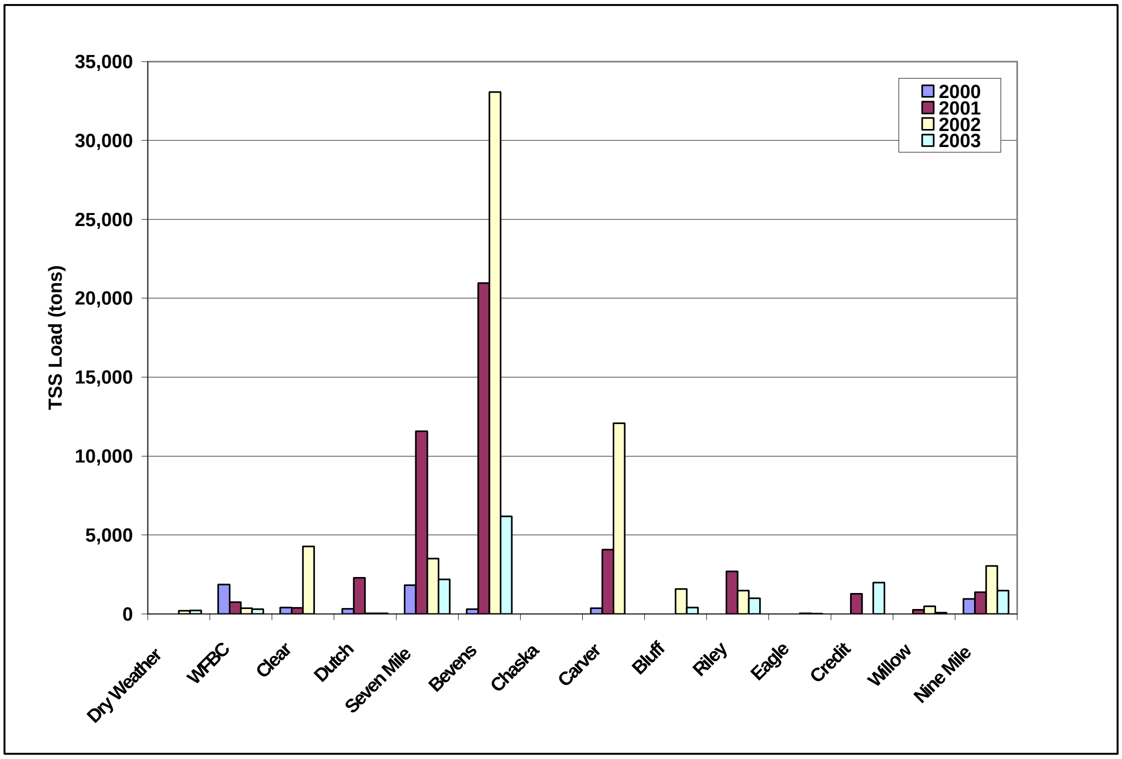


Figure 4.09. 2000 - 2003 Monitoring Season Total Suspended Solids Loads at Minor Minnesota River Tributary Site



threshold values of 58 mg/L and 66 mg/L for the Western Corn Belt Plains and Northern Glaciated Plains ecoregions, respectively, during 2003 (MPCA, 1993). Values for two other agricultural streams, Seven Mile Creek and Bevens Creek were 254 mg/L and 206 mg/L, respectively, exceeding the threshold values. Among the urban watersheds, the TSS FWMC for Riley Creek greatly surpassed its urban counterparts at 516 mg/L (Figure 4.11). Although 2003 runoff, TSS load, and TSS yield values for Riley Creek were reduced compared to 2002, its 2003 TSS FWMC values increased substantially compared to 2002. The increase in TSS FWMC values indicates that runoff from its watershed during 2003, while reduced in total volume, was more concentrated with respect to TSS than it was during 2002. In contrast, the TSS FWMC value for Bluff Creek, which drains a watershed adjacent to Riley Creek Watershed, decreased substantially compared to 2002, dropping from 472 mg/L (2002) to 160 mg/L (2003).

Figure 4.10. 2000 - 2003 Monitoring Season Total Suspended Solids Yields at Minor Minnesota River Tributary Sites

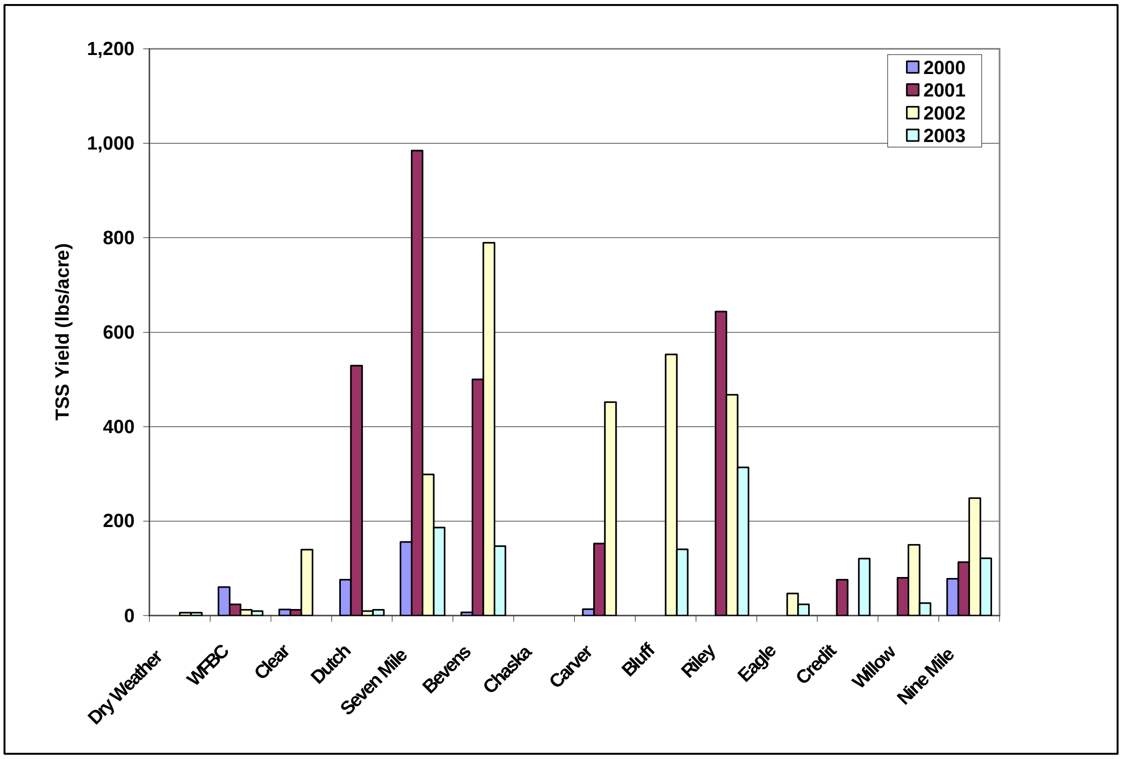
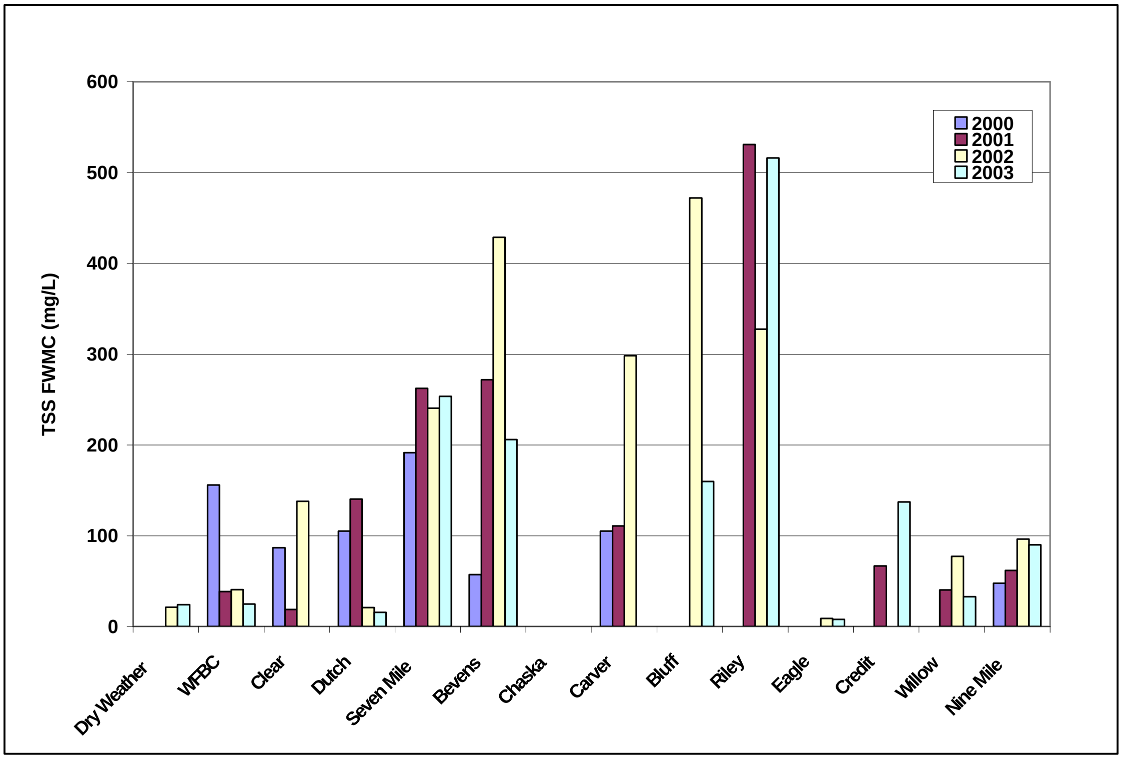


Figure 4.11. 2000 - 2003 Monitoring Season Total Suspended Solids Flow Weighted Mean Concentrations at Minor Minnesota River Tributary Sites



Total Phosphorus

Phosphorus originates from many sources in the Minnesota River Basin and is the primary cause of algal growth, a leading contributor to low dissolved oxygen concentrations in the lower twenty-two mile reach of the Minnesota River during low flow conditions. Point sources of phosphorus are mostly related to municipal and industrial discharges; whereas non-point sources are distributed among agricultural areas, urban areas, construction sites, feedlots, and direct discharge of sewage. Currently, there are no statewide standards for total phosphorus in rivers or streams.

Phosphorus that is in a soluble form (orthophosphorus) is readily available to algae (bio-available), and under certain conditions exerts an immediate impact on the growth of algae and subsequent dissolved oxygen depletion. Generally, a larger proportion of the phosphorus in runoff from cropland is attached to sediment particles, and may not be immediately available to support algae growth. Particulate phosphorus, however, can be transformed to a dissolved bio-available form after runoff discharges to streams. A study of storm runoff in the Redwood River showed that 44% of the particulate phosphorus load was bio-available (James, 2002). Studies in other regions have shown that 20-70% of particulate phosphorus is bio-available (Barr, 2003) Although bio-available phosphorus entering the river has more immediate impact than particulate phosphorus, both sources over time contribute to the total amount of algae producing phosphorus in the Minnesota River (MPCA, 1997).

Mainstem Phosphorus

The load of total phosphorus (TP) transported through the lower reach of the mainstem (St. Peter to Ft. Snelling) during 2003 was reduced from 2002 levels, and was the lowest amount recorded during the four-year reporting period (See Figure 4.12). This load reduction followed reductions seen in 2002 when loads decreased substantially from the relatively high amounts transported during 2001. Total phosphorus loading often strongly correlates with stream flow, and much of the load reduction can be attributed to below-normal runoff across most of the Minnesota River Basin during 2002 and 2003 (Figure 4.02).

Total seasonal runoff amounts, however, are not always straightforward predictors of TP loading, as shown by data collected in the Greater Blue Earth Watershed. During 2003, runoff in the Greater Blue Earth River was 3.63 inches, an amount 20 percent greater than the 3.00 inches of runoff measured during 2002. Total phosphorus load, however, was essentially unchanged during 2003, increasing to only 245 tons from the 244-ton load measured during 2002. Seasonal timing, rainfall intensity, and antecedent moisture conditions for each precipitation event along with watershed terrain determine the characteristics of each watershed's total annual runoff. These often variable characteristics, in turn, affect the amount of nutrient leaching, water runoff, and soil erosion which, in combination, move phosphorus into streams. Land use and management decisions related to urbanization, tillage methods, fertilizer applications,

Figure 4.12. 2000 - 2003 Monitoring Season Total Phosphorus Loads at Minnesota River Mainstem and Greater Blue Earth River Sites

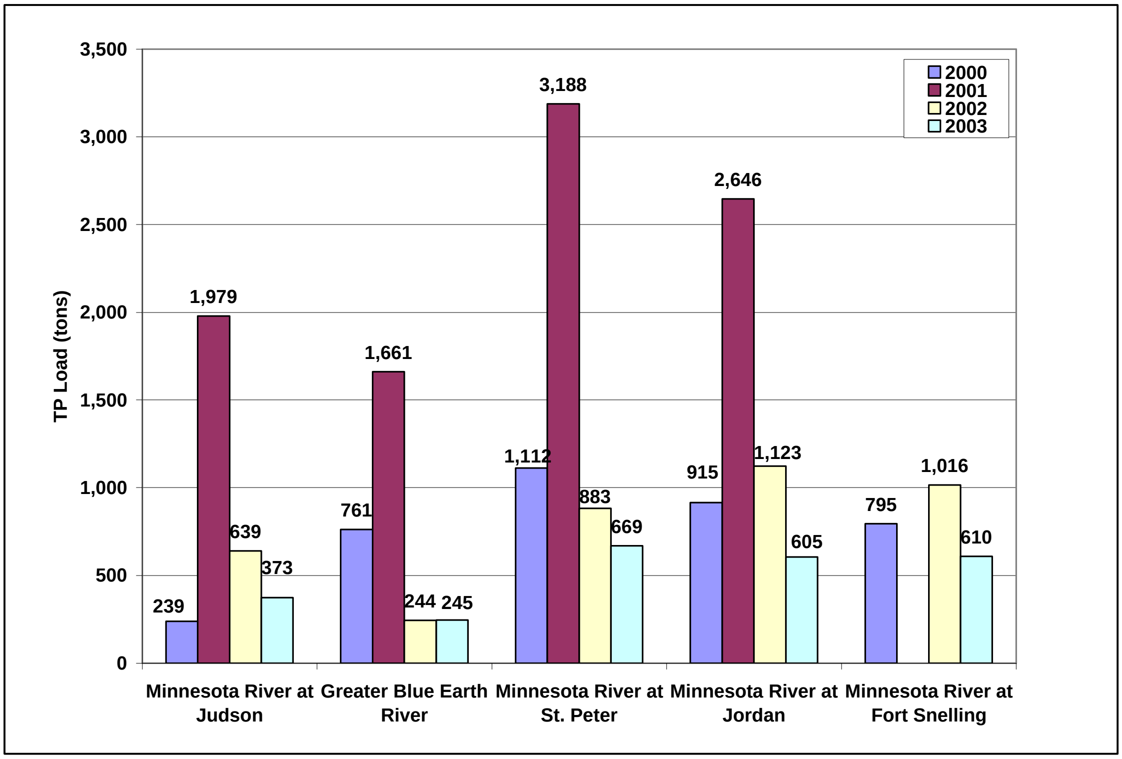
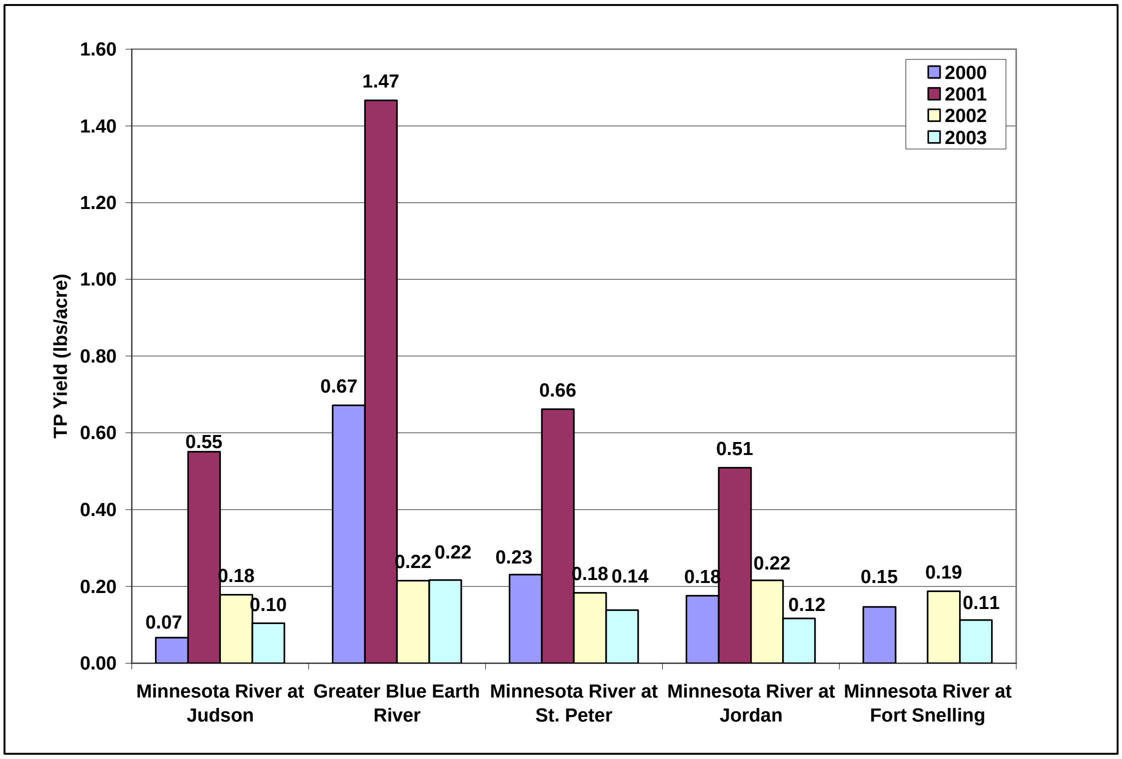


Figure 4.13. 2000 - 2003 Monitoring Season Total Phosphorus Yields at Minnesota River Mainstem and Greater Blue Earth River Sites

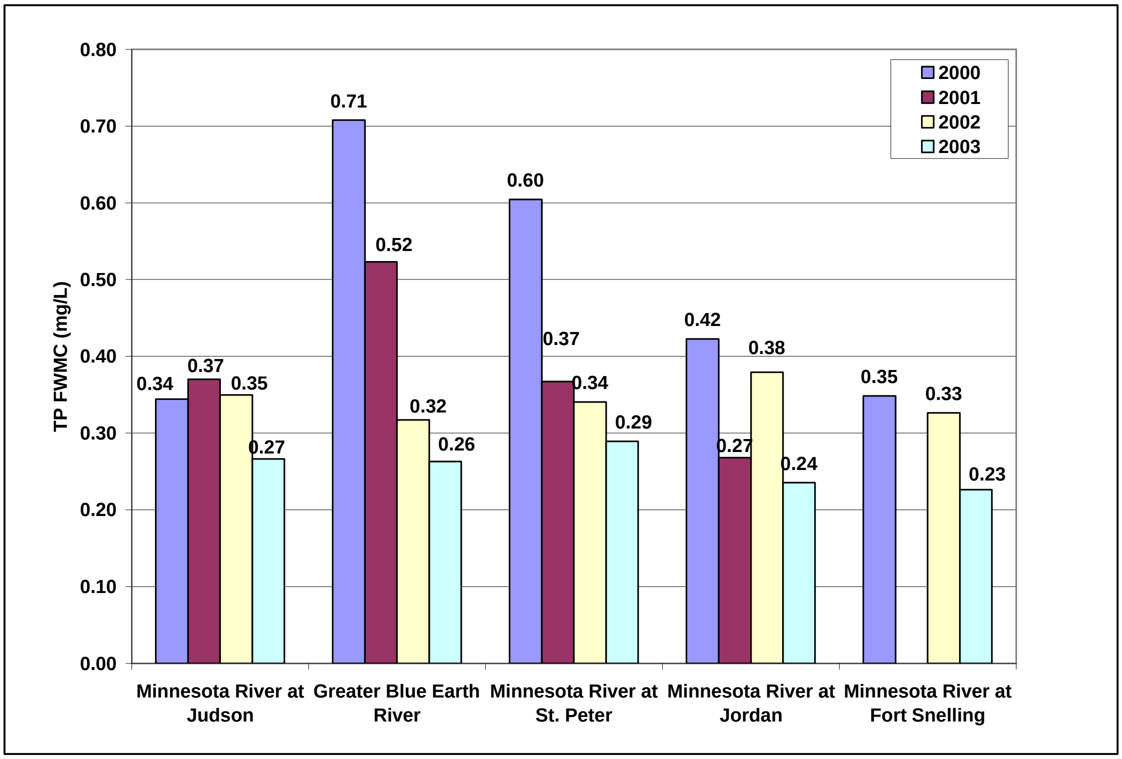


conservation buffers, and many others modify the natural affects of climate, weather, and geomorphic variables. The TP load data for the mainstem sites necessarily represent the combined affects of all these variables spread across very large watersheds that have varied landscapes. Because of these many factors, it is particularly difficult at this large scale to ascribe water quality changes to specific events or actions, whether natural or human influenced.

The TP yield data (Figure 4.13) like the TP load data, show the overall reduction in the amount of phosphorus transported to the Minnesota River during 2002 and 2003. The most marked change is seen in the Greater Blue Earth River Watershed where yield values are now much more closely aligned with yields from the western part of the Basin as represented by data from the Minnesota River at Judson site. Below normal runoff in the Greater Blue Earth River during the past two years likely accounts for much of the yield reduction, but as with load reductions, it is difficult to assign the change to specific factors

The TP FWMC data shown in Figure 4.14 may provide the most useful diagnostic appraisal of the Minnesota River mainstem condition thus far. Researchers generally agree that the Minnesota River is over enriched with respect to phosphorus and that a reduction in phosphorus concentrations could result in reduced algal growth and lower biochemical oxygen demand, thereby enhancing water quality. The 2002 State of the Minnesota River report (State, 2002) described TP concentration thresholds that are sought for the Minnesota River. For example, an analysis by MPCA (MPCA, 1997) showed that a reduction in algal productivity cannot be expected unless TP concentrations in the Minnesota River are brought below 0.26 mg/L. During 2002 and 2003, TP FWMC's in the Greater Blue Earth River and the mainstem at Judson were diminished relative to 2001 levels and presently are at or near the threshold value (Figure 4.14). Fewer high-intensity rainfall events during 2003 and generally reduced runoff throughout the Basin during both 2002 and 2003 probably account for most of the reduction in TP concentrations, but the data also may reflect basin wide efforts to reduce both point and non-point phosphorus inputs. The data from the Jordan and Ft. Snelling sites (Figure 4.14) show that the reductions extend into the Lower reaches of the Minnesota River to its mouth, where TP FWMC's dropped below the 0.26 mg/L threshold during 2003.

Figure 4.14. 2000 - 2003 Monitoring Season Total Phosphorus Flow Weighted Mean Concentrations at Minnesota River Mainstem and Greater Blue Earth River Sites



Mouth of the Le Sueur River flowing into the Blue Earth River (middle left corner)

Major Tributaries Total Phosphorus

Figure 4.15 presents 2000 - 2003 TP loads for the monitoring season. The principal value of major-tributary load data lies in identifying which parts of the Minnesota River Basin are transporting the most TP load to the mainstem. The major tributary monitoring sites are distributed throughout the Minnesota River Basin from the Upper Minnesota River Basin to the Lower Minnesota River Basin. As such, a look at Figure 4.15 gives us an overview of the geographical distribution of TP loading to the mainstem. Strict load comparisons, however, need to be tempered by considering the amount of tributary load relative to average streamflow in the mainstem channel at the point of confluence. Tributaries that deliver a total seasonal TP load of 50 tons to the mainstem near its headwaters, for example, are likely to have a greater affect on mainstem water quality than tributaries that deliver an equivalent load near the mouth of the mainstem.

Total phosphorus yield data (Figure 4.16) show which major tributaries are contributing the most TP to the mainstem on a per-acre basis. The yield data can be thought of as a seasonal loading rate. Total phosphorus yields that are consistently elevated relative to yields in other major tributary watersheds are an indication of problems such as excessive soil erosion or large point-source inputs. During 2003, yields for most of the major tributaries were less than they were during 2002, with large reductions noted for High Island Creek and Sand Creek. Despite appreciable reductions in yields during the past two monitoring seasons, the higher-yielding watersheds are still delivering 4-8 times more TP per acre than the lower-yielding watersheds (compare Le Sueur River, High Island Creek, and Sand Creek with Yellow Bank River, Lac qui Parle River, and Chippewa River in Figure 4.16).

Elevated TP yields from watershed landscapes, augmented by point source inputs in some of the watersheds, usually result in elevated TP FWMC values (Figure 4.17). The TP FWMC values, arguably, may offer the best appraisal of the state of the Minnesota River with regard to phosphorus enrichment. While TP loads and yields are useful diagnostic parameters, it is the resulting stream concentration that drives overproduction of algae that in turn reduces water clarity and often causes undesirable levels of oxygen demand. During 2003, TP FWMC values in eight of the major tributaries were reduced from levels measured during 2002, reflecting the reduced loads and yields discussed previously. The 2002 State of the Minnesota River Report stated that none of the major tributary streams had FWMC’s that met the goal of 0.1 mg/L TP set by the EPA for protection of aquatic life. One stream, the Yellow Medicine River, met that criterion during 2003 (Figure 4.16). Furthermore, the MPCA threshold level of 0.26 mg/L TP was met in seven streams, three of which exceeded the threshold during 2002. The 0.26 mg/L TP threshold is considered to be the point at which algal production will start to decline because of phosphorus limitation. It is important to note that the FWMC is a seasonal average, and the streams probably exceeded the threshold on some days during the season.

Figure 4.15. 2000 - 2003 Monitoring Season Total Phosphorus Loads at Major Minnesota River Tributary Sites

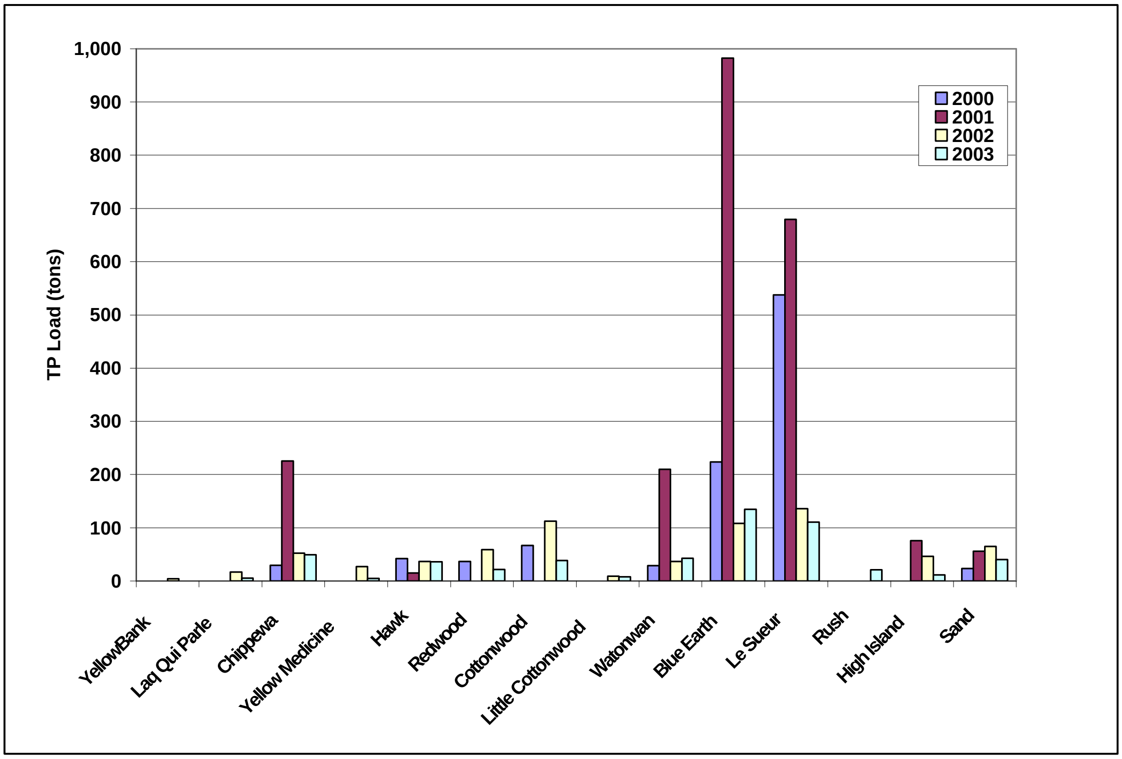
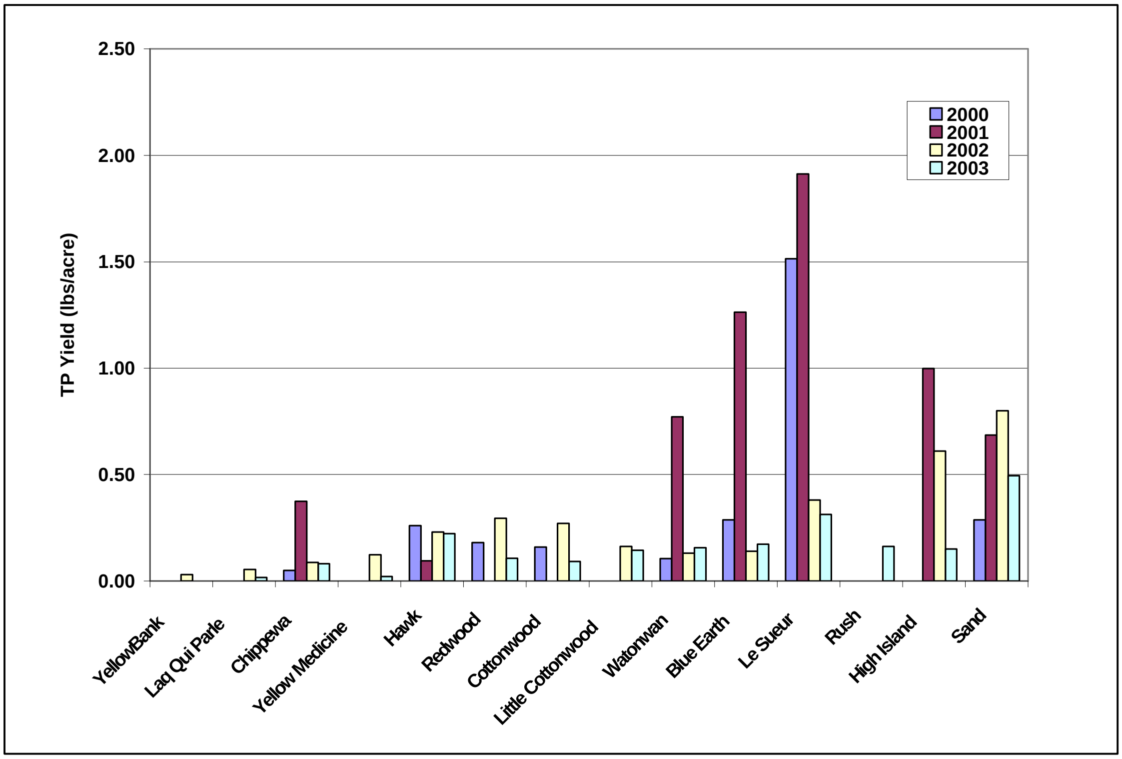


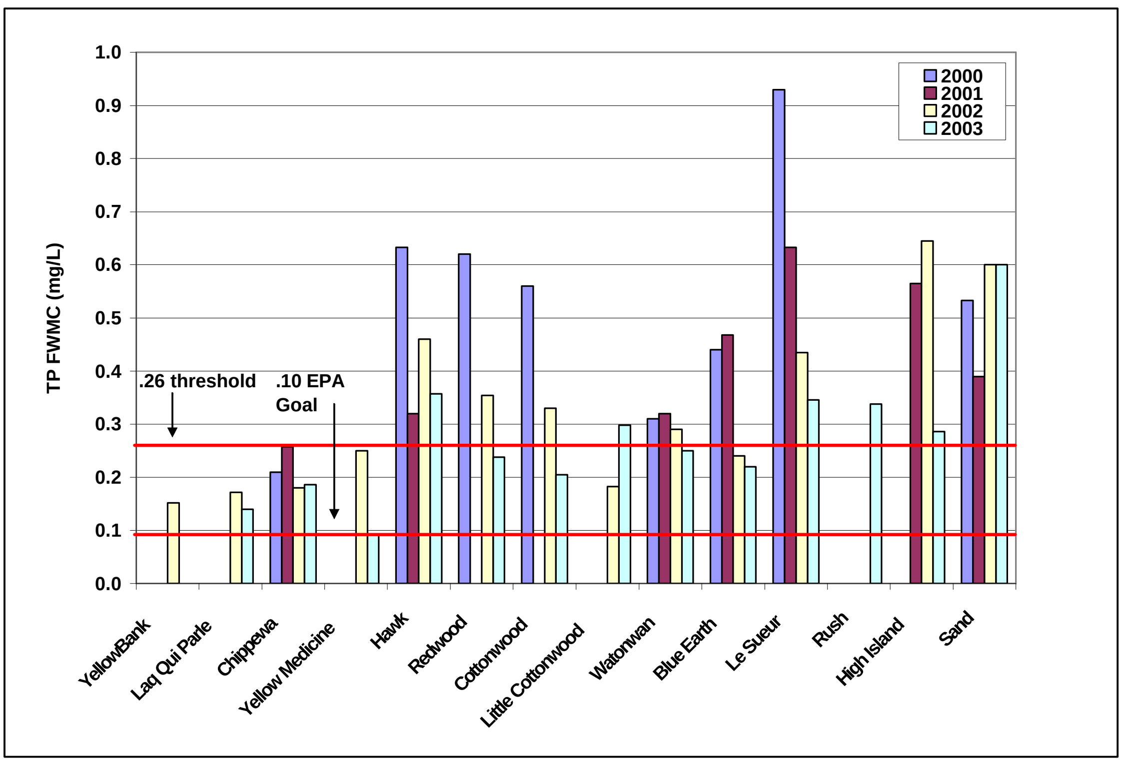
Figure 4.16. 2000 - 2003 Monitoring Season Total Phosphorus Yields at Major Minnesota River Tributary Sites



Reductions in TP FWMC's were not seen at all major tributary sites during 2003. The TP FWMC for Sand Creek was unchanged from 2002 and remains at a very high level (0.60 mg/L) relative to concentrations in the other major tributaries (Figure 4.17). The Chippewa River also was relatively unchanged during 2003, rising slightly to 0.19 mg/L, but it remains within the 0.26 mg/L threshold.

Assessing results from the past four years, there appears to be a general reduction in TP FWMC's in Hawk Creek, the Redwood River, and the Cottonwood River (Figure 4.17). Concentrations are now substantially reduced from the relatively high concentrations present in these streams during 2000, and are now more closely aligned with the relatively low concentrations that typify major tributaries in the headwaters of the Minnesota River Basin (Yellow Bank to Chippewa). The Le Sueur River has undergone three consecutive and substantial reductions in seasonal FWMC values that started in 2001, but the present value, 0.35 mg/L TP for the 2003 season, remains well above the 0.26 mg/L threshold. Further perspective can be gained by observing that TP FWMC values for the Minnesota River mainstem ranged from 0.23-0.29 mg/L during the 2003 season. These results place the mainstem approximately at the threshold value. If phosphorus loading can be further reduced, it is expected that levels of algal productivity will decline and thereby the River's condition will improve. The major tributaries that presently discharge flows containing TP in excess of the threshold concentration threaten the Minnesota River's recovery because their relatively large watersheds can deliver flow volumes that are sufficient to raise the average TP concentration in the mainstem.

Figure 4.17. 2000 - 2003 Monitoring Season Total Phosphorus FWMC at Major Minnesota River Tributary Sites



Minor Tributaries Total Phosphorus

Figure 4.18 presents the TP loads for the 2000 - 2003 monitoring season for the minor tributaries. Loads decreased at all sites compared to 2002 levels. Loads in Bevens Creek were greatly reduced relative to the very high loads recorded at that site during 2001 and 2002. At most of the sites the load reductions correspond to decreases in runoff, but in West Fork Beaver Creek and Dutch Creek runoff increased about 50 percent compared to 2002 while their TP loads decreased.

Total phosphorus yields for 2000 - 2003 are shown in Figure 4.19. Minor watershed yields during 2003 were relatively modest compared to the very high yields recorded during 2001 and 2002. Yields also were more uniform across the Basin, lacking the very large site-to-site variations present during 2001 - 2002. Despite greater overall uniformity, three of the agricultural land use watersheds, Dry Weather, West Fork Beaver, and Dutch Creeks, have relatively low yields that contrast markedly with yields from Seven Mile Creek and Bevens Creek, which also have agricultural watersheds.

The TP FWMC results, unlike the yield data, show little cross-basin uniformity and site-to-site differences are readily apparent in Figure 4.20. During 2003, TP FWMC values ranged from 0.05 mg/L in Eagle Creek to 0.42 mg/L in Riley Creek. Eleven minor tributaries were monitored during 2003, and TP FWMC values in seven of them were equal to or less than the 0.26 mg/L threshold and three of the streams had FWMC's equal to or less than the EPA goal of 0.10 mg/L. Comparing 2003 data with results from 2002, only one stream, Riley Creek, showed an increase it its TP FWMC value during 2003. Runoff in Riley Creek for 2003 decreased more than 50 percent compared to runoff during 2002 and its TP load and TP yield also decreased. This indicates that the runoff in Riley Creek during 2003, although reduced from 2002 runoff amounts, probably was highly concentrated with respect to TP. These results suggest that Riley Creek, an urbanizing watershed, may be receiving intermittent, but highly concentrated, wash loads from construction sites.

Figure 4.18. 2000 - 2003 Monitoring Season Total Phosphorus Loads at Minor Minnesota River Tributary Sites

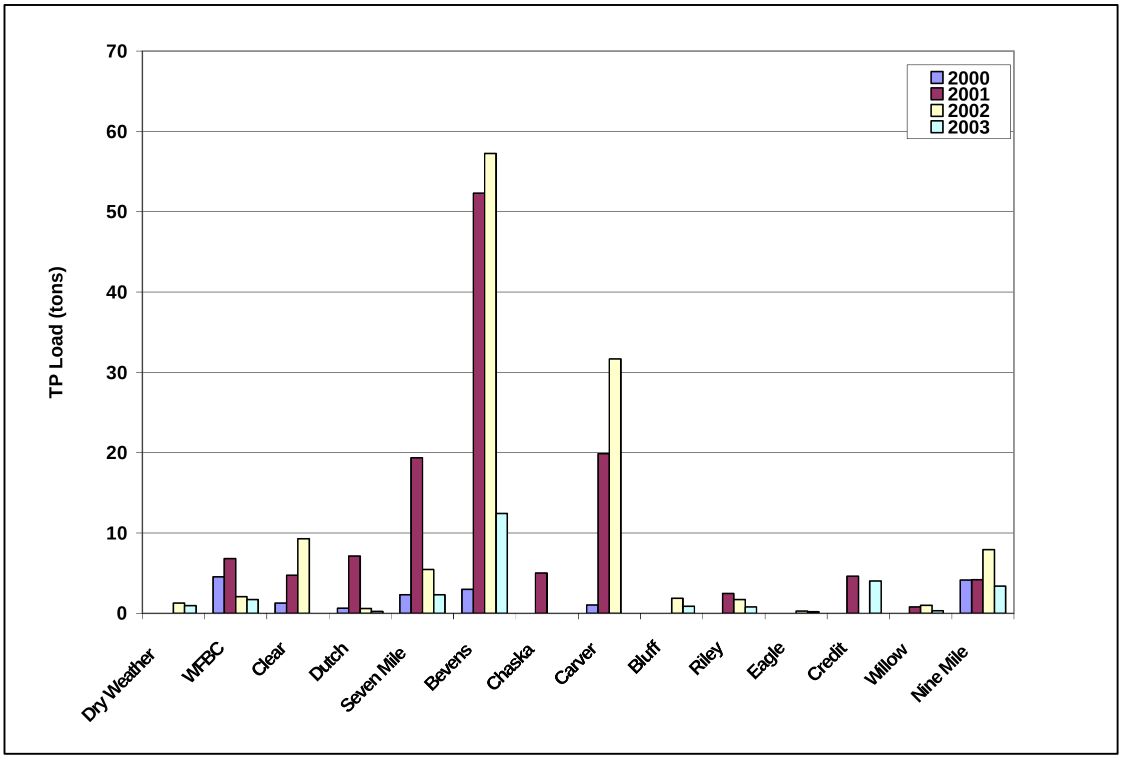


Figure 4.19. 2000 - 2003 Monitoring Season Total Phosphorus Yields at Minor Minnesota River Tributary Sites

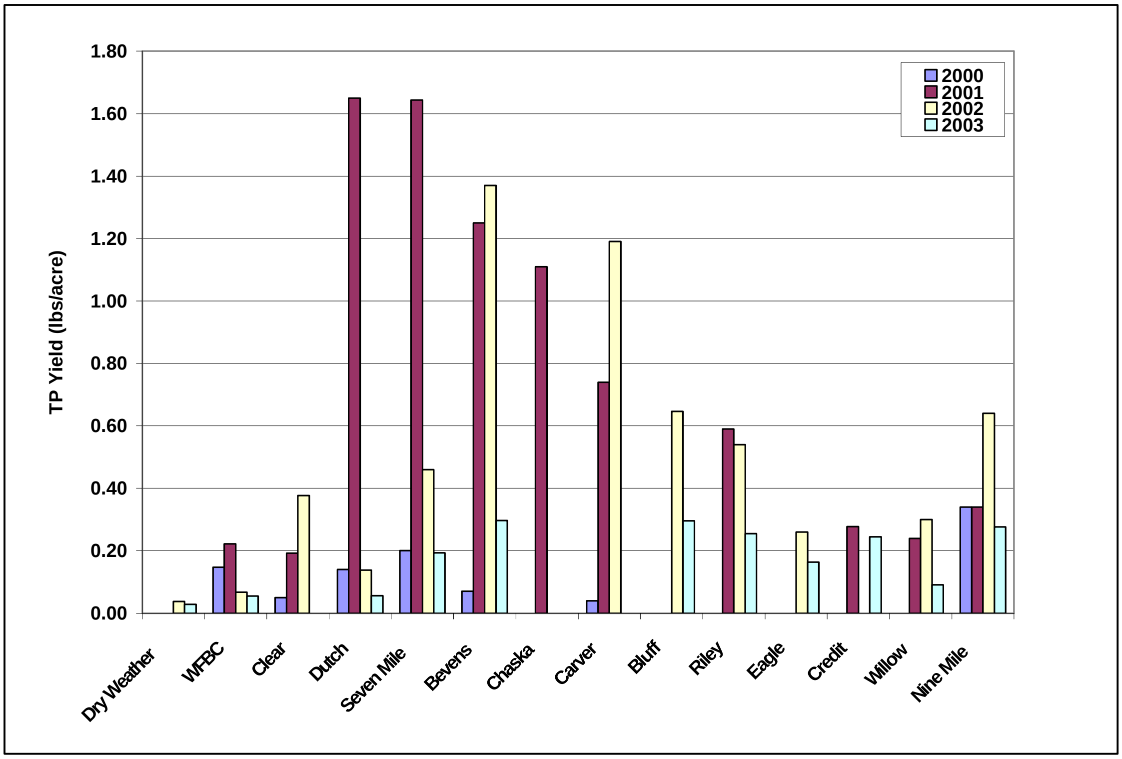
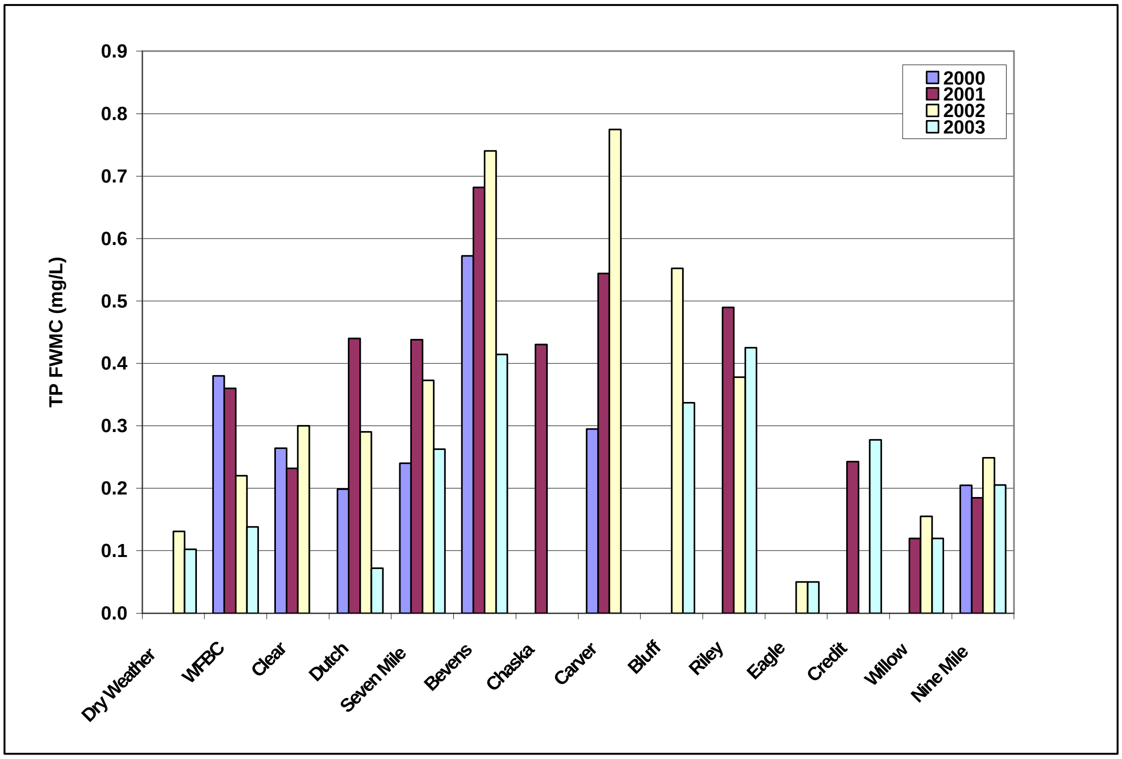


Figure 4.20. 2000 - 2003 Monitoring Season Total Phosphorous FWMC at Minor Minnesota River Tributary Sites



Nine Mile Creek

Mainstem Orthophosphorus

Orthophosphorus (OP) loads at mainstem sites (Figure 4.21) declined during 2003 compared to 2002 loads. The OP loads at mainstem sites were the lowest measured during the four year period with the exception of the Minnesota River at Judson site. The OP load at Judson reflects an increase in OP loading from the Chippewa River during 2003, and relatively high loads from Hawk Creek, Redwood River and Cottonwood River (Figure 4.24). Because of its greater size, the watershed upstream of Judson delivered more OP load than the Greater Blue Earth Watershed. The Greater Blue Earth River Watershed, however, delivered more OP per acre, yielding 0.05 lbs/ac compared to 0.03 lbs/ac from the part of the Minnesota River Basin upstream of Judson (See Figure 4.22).

The OP FWMC data (Figure 4.23) show that the present condition (2003) of the Greater Blue Earth River and the Lower Minnesota River, with respect to OP concentrations, is the best recorded during the four year period. Lower concentrations of OP are expected to result in reduced algal productivity, greater water clarity, and less oxygen demand in the lower mainstem.

The OP data for 2000, 2002, and 2003 stand in marked contrast to the very high OP loads, yields, and FWMC's seen in 2001. The elevated OP values in 2001 occurred in conjunction with ponding of large volumes of water during the snowmelt period. The 2001 snowmelt runoff period was prolonged by a heavy snow pack and ice that blocked many drainage channels and small streams. It is probable that the increased contact time enhanced desorption of OP from vegetation and soils, leading to elevated OP loads in the ponded water which eventually ran off when ditch and stream channels became ice-free.

Figure 4.21. 2000 - 2003 Monitoring Season Orthophosphorus Loads at Minnesota River Mainstem and Greater Blue Earth River Sites

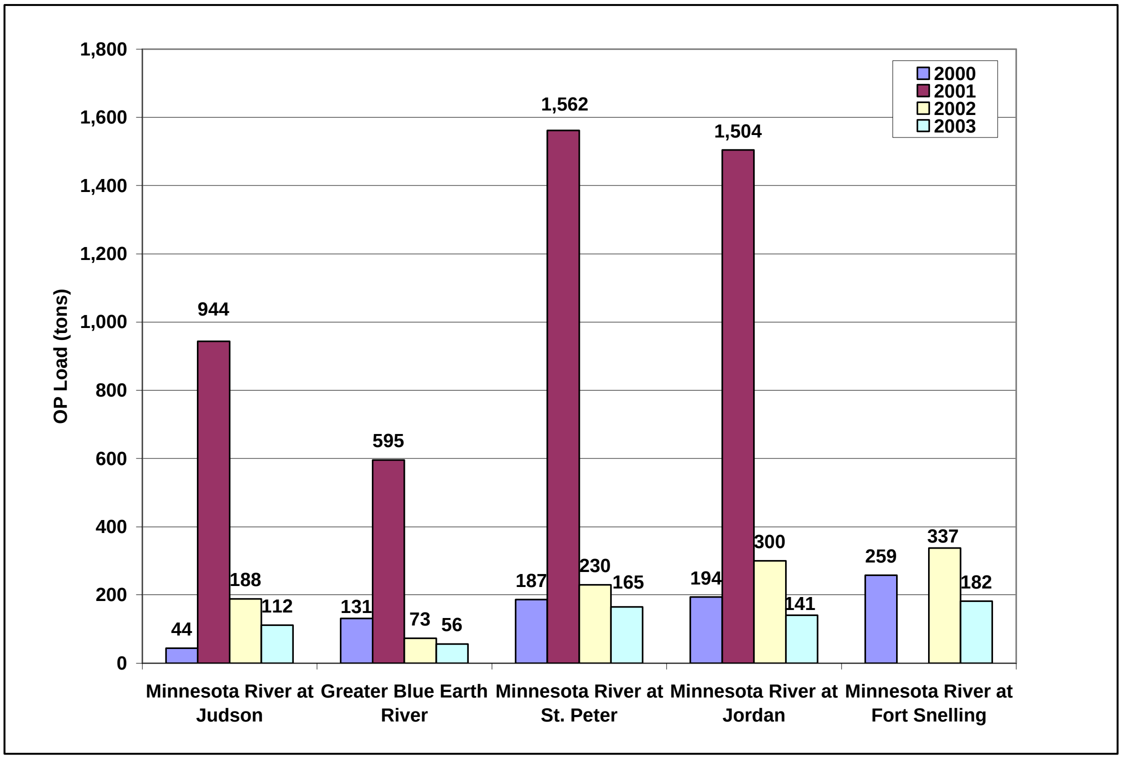


Figure 4.22. 2000 – 2003 Monitoring Season Orthophosphorus Yields at Minnesota River Mainstem and Greater Blue Earth River Sites

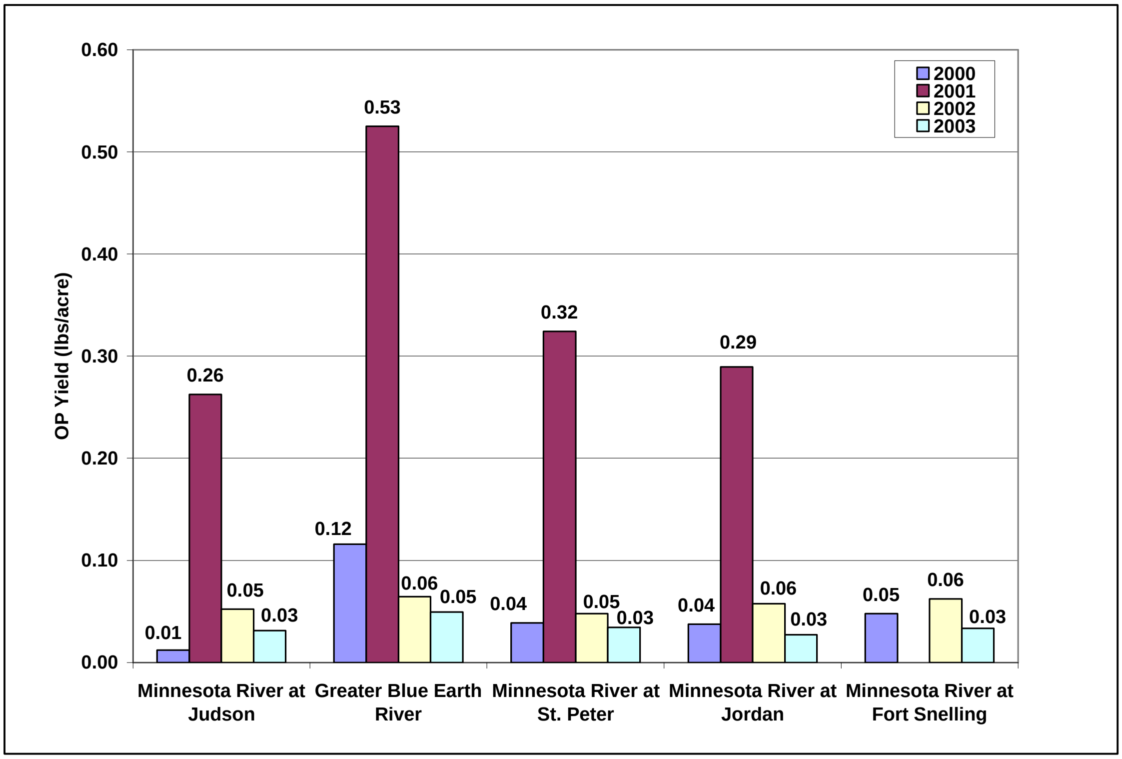
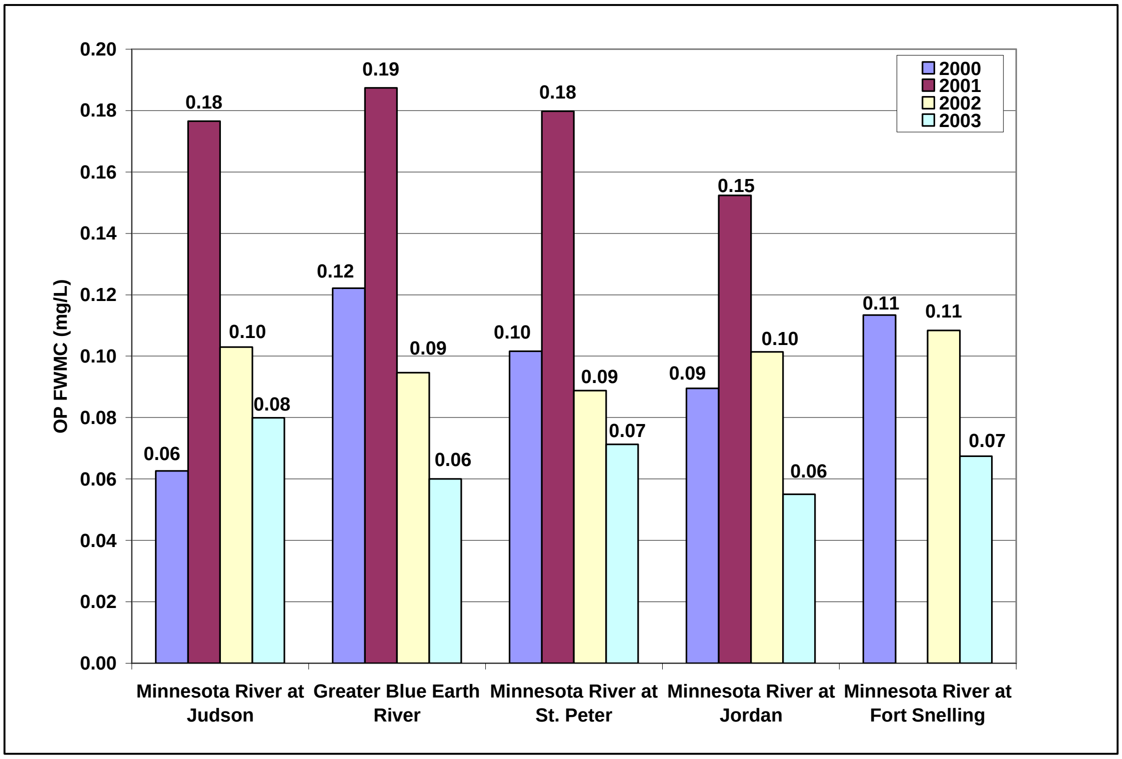


Figure 4.23. 2000 - 2003 Monitoring Season Orthophosphorus FWMC at Minnesota River Mainstem and Greater Blue Earth River Sites



Major Tributaries Orthophosphorus

Figure 4.24 presents OP loads for the major tributaries. Loads and yields (Figure 4.24 and Figure 4.25) for the 2003 season declined at all sites compared to 2002 values except in the Chippewa River and Watonwan River. The yield data show substantial differences in seasonal loading rates among the major tributaries. In the upper part of the Minnesota River Basin, 2003 yields for Hawk Creek and the Redwood River, although reduced from the relatively high yields recorded during 2002, remain at higher levels than yields for the Lac qui Parle, Chippewa, Yellow Medicine, and Cottonwood Watersheds. In the lower part of the Basin, from the Little Cottonwood River to the Rush River, yields during 2003 were more uniform, ranging from 0.04-0.07 lbs/ac, with the exception of Sand Creek, which yielded 0.11 lbs/ac.

The OP:TP ratio, shown as percent OP in Figure 4.26, is a measure of the portion of total phosphorus that is readily available for algal uptake, and the ratios serve to further characterize and differentiate OP loads in the major tributaries. Orthophosphorus comprises about 20-30 percent of total phosphorus in most of the major tributaries. In three of the tributaries, Watonwan River, High Island Creek, and Rush River, OP is greater than 40 percent of TP. In Hawk Creek and the Redwood River, OP is greater than 50 percent of TP. These differences in the proportion of OP may be indicators of differences in the source of the phosphorus loading. Wastewater from municipalities and septic systems, for example, usually has a high OP:TP ratio.

The OP FWMC data (Figure 4.27) also show substantial differences among the major tributaries, with values that ranged from 0.02-0.20 mg/L during 2003, a ten-fold difference. Mainstem FWMC's, in comparison, were less variable with concentrations ranging from 0.06-0.08 mg/L during 2003 (See Figure 4.23). Six of the major tributaries, Hawk Creek, Redwood River, Watonwan River, Rush River, High Island Creek, and Sand Creek, had OP FWMC's that exceeded the mainstem levels. As such, they have potential to elevate OP concentrations in the mainstem. Orthophosphorus is a readily assimilated form of phosphorus that triggers excessive algal growth when it is present at elevated concentrations. More evaluation of these data and special studies may be needed to learn why some of the major tributaries have OP present in higher proportions and at greater concentrations compared to what is present in other major tributaries.

Figure 4.24. 2000 - 2003 Monitoring Season Orthophosphorus Loads at Major Minnesota River Tributary Sites

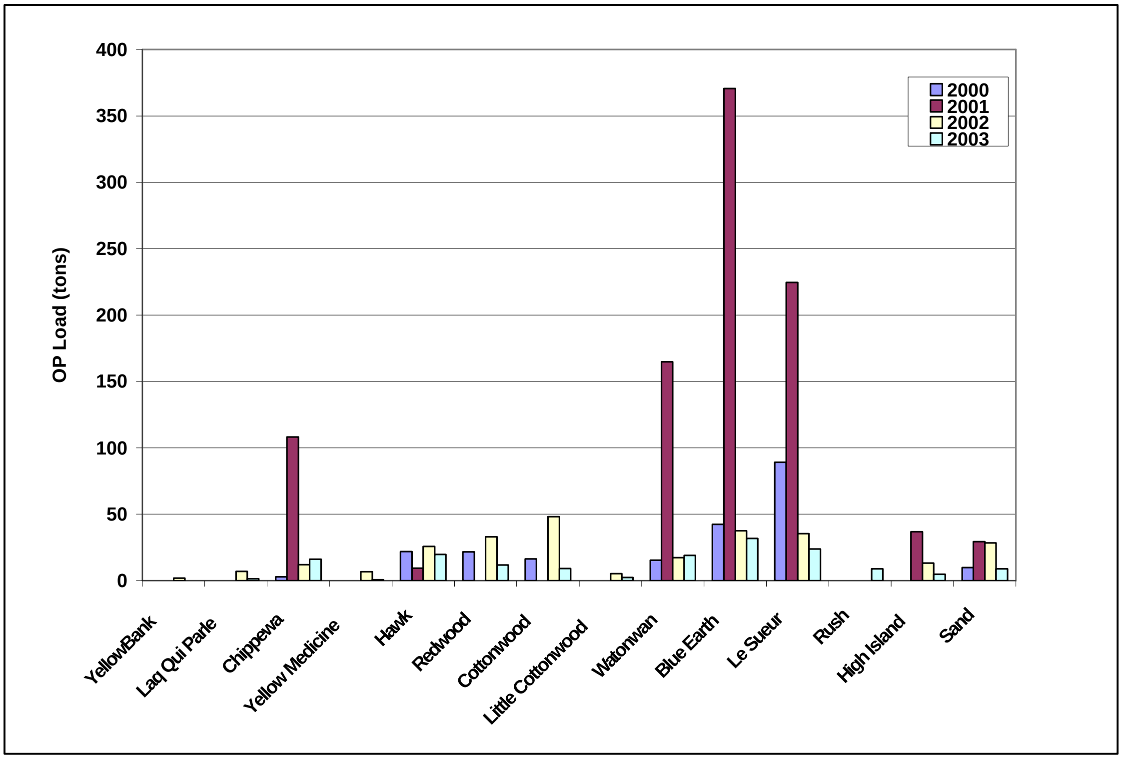


Figure 4.25. 2000 - 2003 Monitoring Season Orthophosphorus Yields at Major Minnesota River Tributary Sites

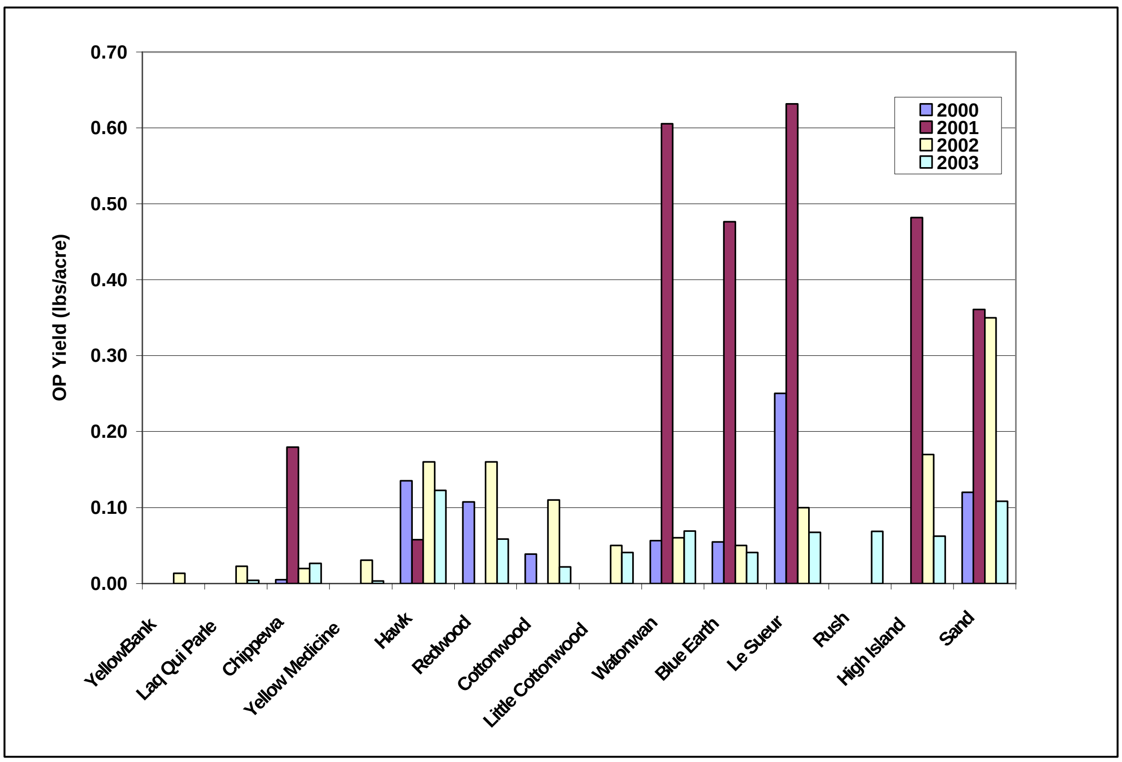


Figure 4.26. 2000 - 2003Monitoring Season Orthophosphorus/Total Phosphorus Ratio at Major Minnesota River Tributary Sites

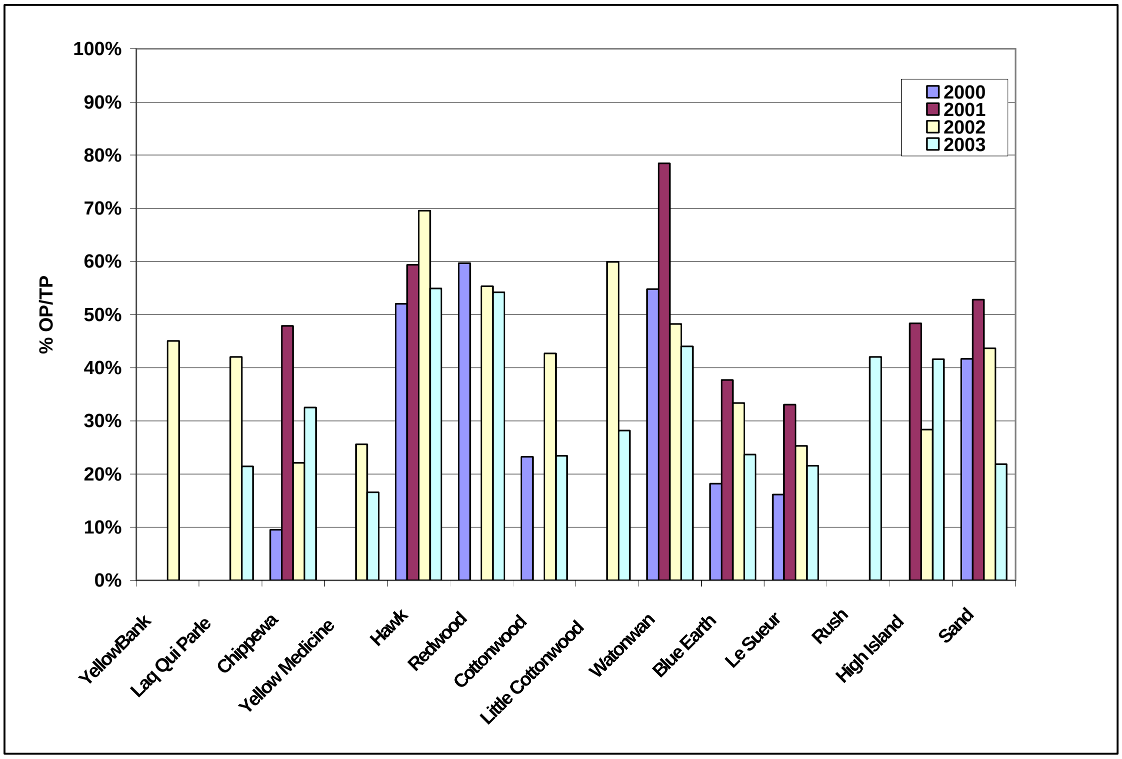
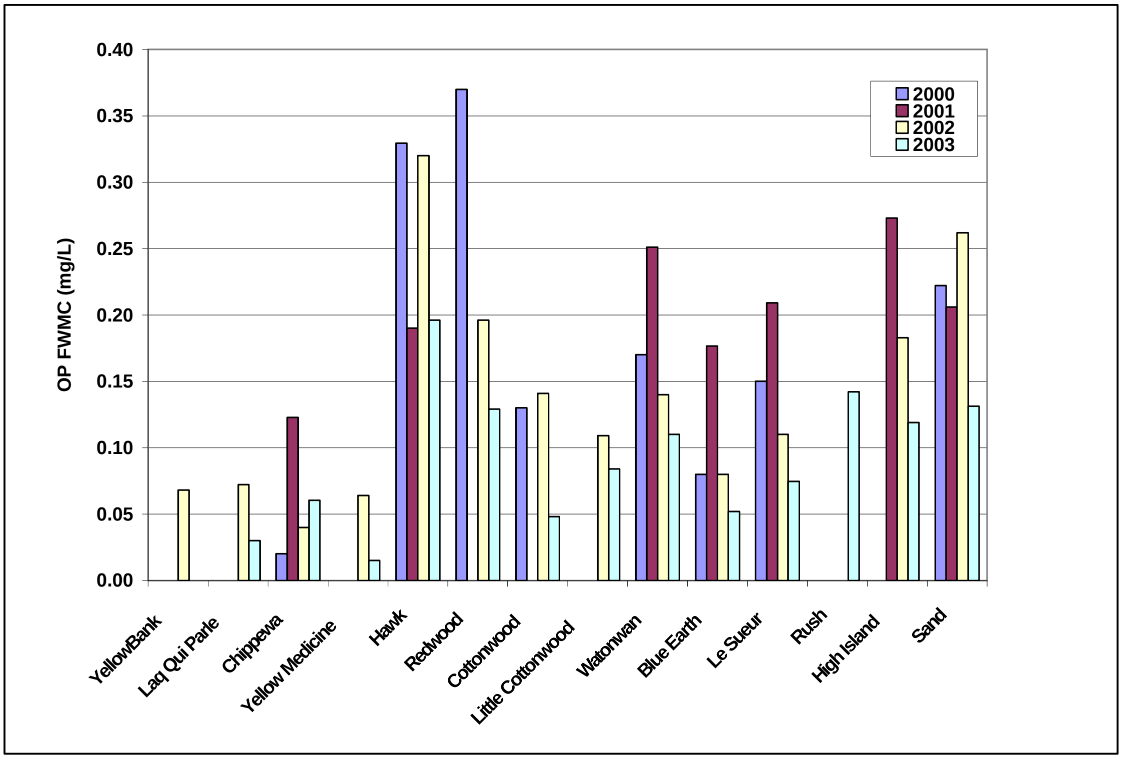


Figure 4.27. 2000 - 2003 Monitoring Season Orthophosphorus FWMC at Major Minnesota River Tributary Sites



Minor Tributaries Orthophosphorus

Figure 4.28 shows orthophosphorus loads in minor tributaries for the 2000 - 2003 monitoring seasons. Comparing 2003 data with results from 2002, loads and yields of OP decreased at all minor tributary sites during 2003. Most notable is the substantial decrease in load and yield for Bevens Creek. Although greatly reduced from 2001-2002 levels, the OP load in Bevens Creek during 2003 greatly exceeds loads in the other minor tributaries and also exceeded the loads in four of the major tributaries.

Minor-tributary OP yields fluctuated widely during the 2000 - 2002 period, showing large site-to-site and year-to-year differences at most sites (Figure 4.29). During 2003, OP yields were comparatively more uniform among sites and lower in magnitude overall, ranging from 0.01 to 0.14 lbs/ac, compared to a range of 0.01 to 0.74 lbs/ac during 2002. Substantial differences are still evident, however, as seen in the Bevens Creek, Bluff Creek, and Credit River Watersheds which yielded about twice as much OP per acre compared to the other minor watersheds.

The OP FWMC data further illustrate differences between the minor tributaries (Figure 4.30). The Dutch Creek, Seven Mile Creek, and Bevens Creek Watersheds have similar land use and had nearly equal runoff amounts (3.42, 3.42, and 3.16 inches, respectively) during 2003. Despite these similarities, the OP FWMC for Bevens Creek was 0.19 mg/L, a value nearly two times greater than the FWMC for Seven Mile Creek (0.10 mg/L) and more than three times greater than the FWMC for Dutch Creek (0.06 mg/L). These differences point to the need for further research into OP sources and the transport processes that deliver OP to streams.

Figure 4.28. 2000 - 2003 Monitoring Season Orthophosphorus Loads at Minor Minnesota River Tributary Sites

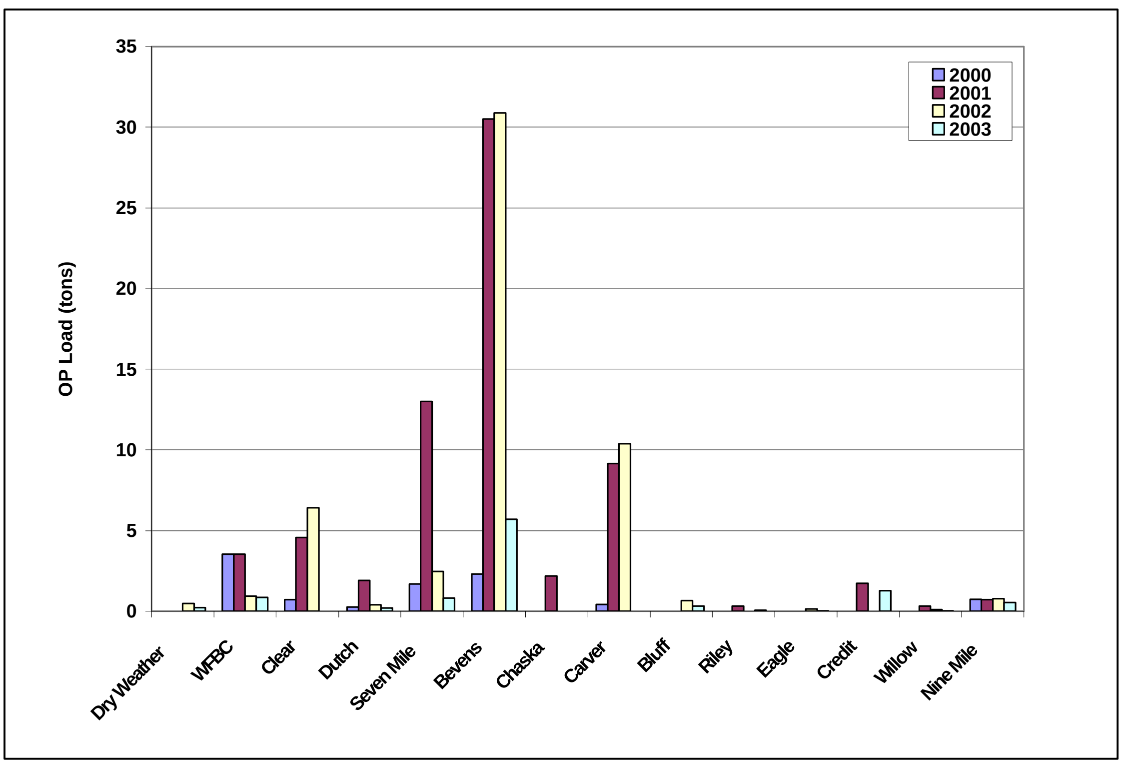


Figure 4.29. 2000 - 2003 Monitoring Season Orthophosphorus Yields at Minor Minnesota River Tributary Sites

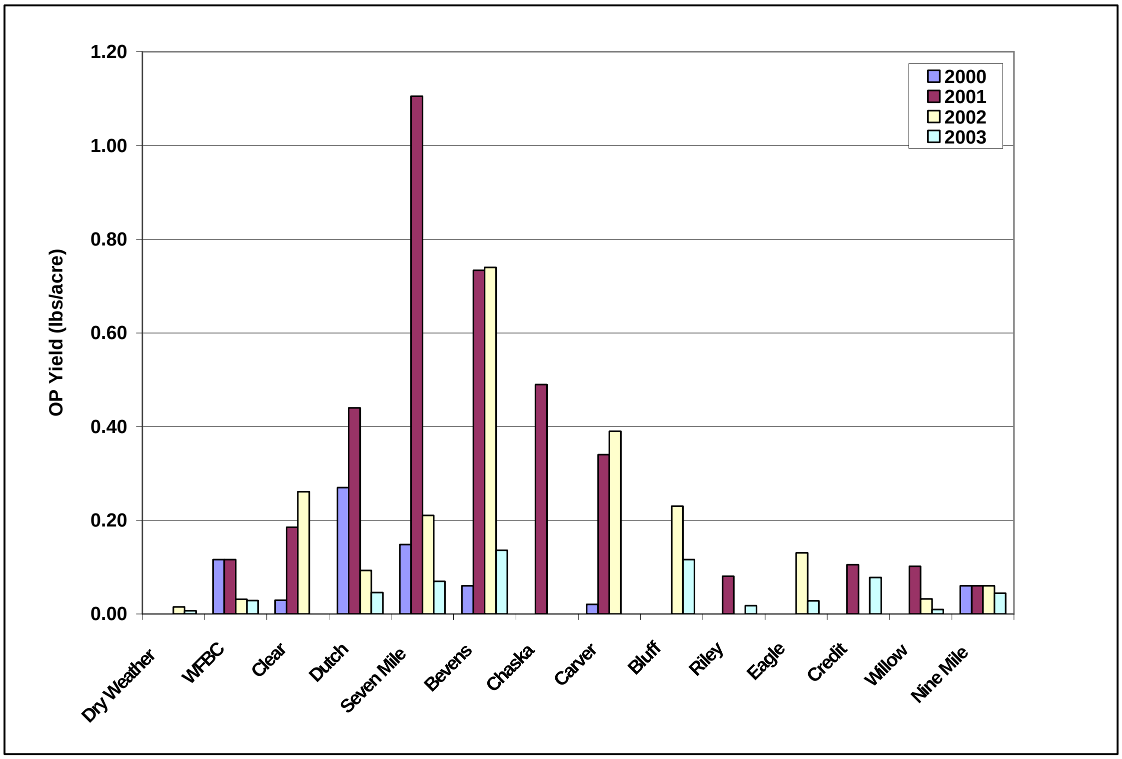
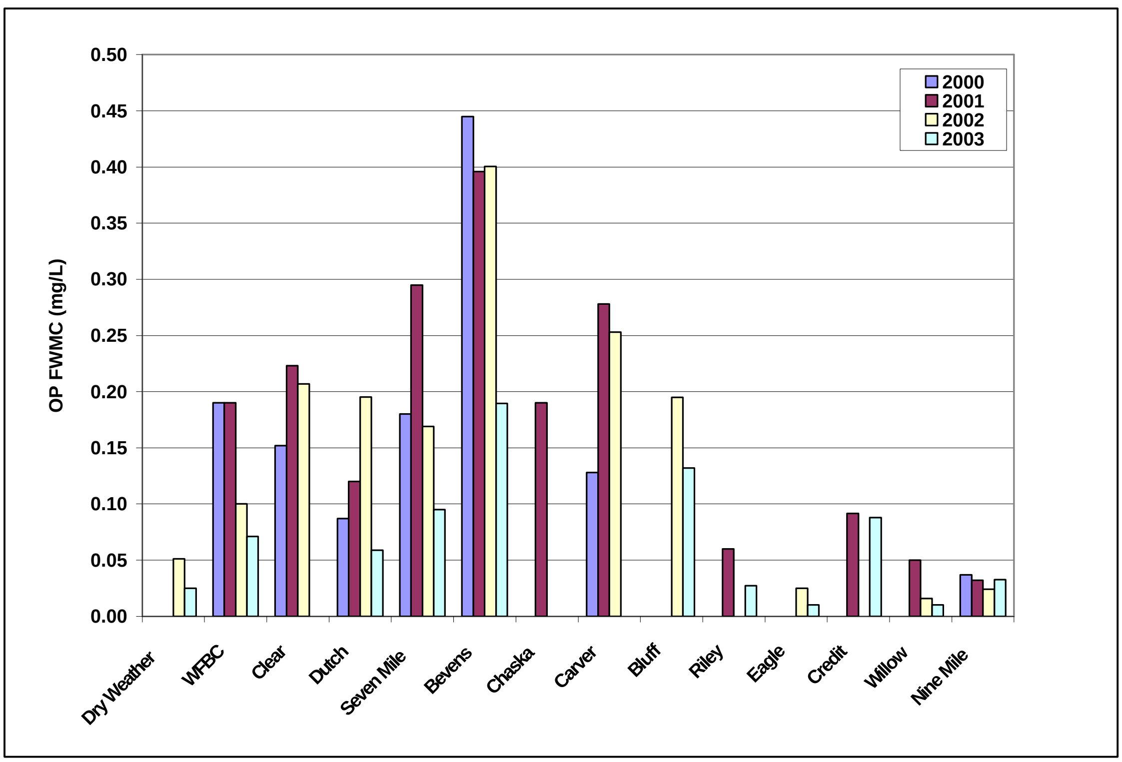


Figure 4.30. 2000 - 2003 Monitoring Season Orthophosphorus FWMC at Minor Minnesota River Tributary Sites



Nitrate-Nitrogen

The primary form of nitrogen monitored in the Minnesota River Basin is nitrate-nitrogen (nitrate-N). Typically the nitrate-N concentration includes nitrite plus nitrate when reported from the laboratory. Ammonia also is monitored at many of the stations for which data are presented, and a few organizations also monitor for Total Kjehldahl Nitrogen (organic nitrogen plus ammonia). However, only nitrate-N data are presented in this report. Nitrate-N is important because it is biologically available to aquatic plants and it is the primary and most abundant nitrogen species with respect to loading and nutrient enrichment of surface waters. Nitrate loading from the Minnesota River Basin has national implications as it is the primary chemical contributing to the hypoxia zone at the mouth of the Mississippi River in the Gulf of Mexico.

Mainstem Nitrate-N

Nitrate-N loads for 2000 - 2003 are presented in Figure 4.31 for the Minnesota River mainstem sites and the Greater Blue Earth River. The Greater Blue Earth River (Upper Blue Earth, Watonwan and Le Sueur Rivers) is included in the mainstem analysis because of the substantial nitrate load contribution from the Blue Earth River Watershed.

Nitrate-N loads declined during 2003 in the Minnesota River at Judson when compared to 2002 levels, but nitrate-N loads increased in the Greater Blue Earth River. Research in recent years (EPA, 2000) has shown that the amount of nitrate reaching streams is strongly associated with the amount of water that infiltrates and percolates through the soil profile. Wet years (such as 2001) are often periods of increased nitrate-N loading, particularly when they are preceded by one or more dry years. Nitrate-N tends to accumulate in soil profiles during dry periods when crops are not able to fully utilize available nitrate. Other factors, such as the type of crop, crop rotation, and nitrogen application rates, also affect the amount of nitrate build up in the soil profile. When this is followed by abnormally high precipitation, the nitrate-N becomes mobilized. In tiled fields, the drainage network collects excess nitrate-laden water from the soil profile and delivers it to ditches and streams. Greatly elevated (> 20 mg/L) nitrate-N concentrations are often found in tile drainage water (Randall et al., 2003 and Randall et al., 2001). The high runoff during the 2001 snowmelt period was followed by a return to dryer conditions that continued through 2002 and 2003 in the western part of the Basin. The lower runoff amounts during 2002-03 were accompanied by reduced nitrate-N loads in that part of the Basin as indicated by data collected in the Minnesota River at Judson (Figure 4.31). In contrast, runoff in the Greater Blue Earth River increased 21 percent during 2003 compared to 2002 while nitrate-N loading increased 54 percent, demonstrating how nitrate-N loading can respond to a moderate increase in runoff.

The Greater Blue Earth comprises 22 percent of the total drainage area of the Minnesota River at Jordan but contributed 68-, 48-, 36-, and 55 percent of the total nitrate-N load at Jordan during 2000, 2001, 2002, and 2003, respectively. For comparison, the Minnesota River upstream of Judson comprises 69 percent of the total drainage area at Jordan but contributed only 23-, 28-, 41-, and 26- percent of the total nitrate-N load at Jordan during those years.

Figure 4.31. 2000 – 2003 Monitoring Season Nitrate-N Loads at Minnesota River Mainstem and Greater Blue Earth River Sites

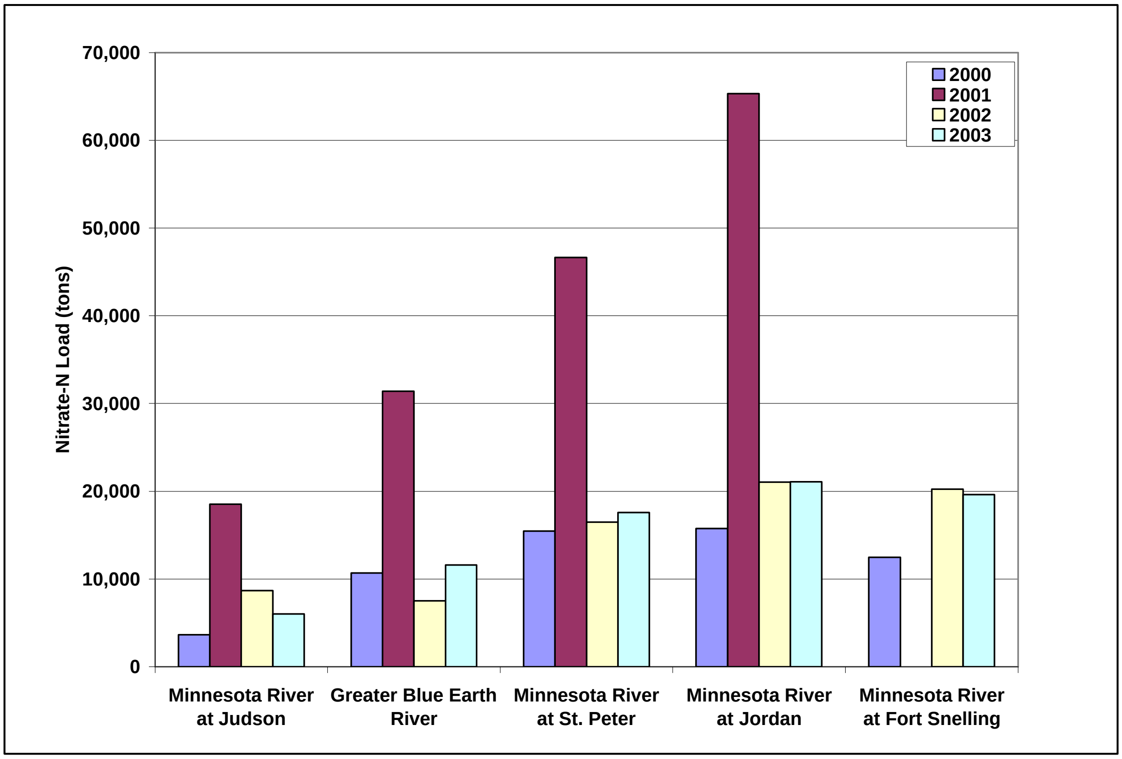
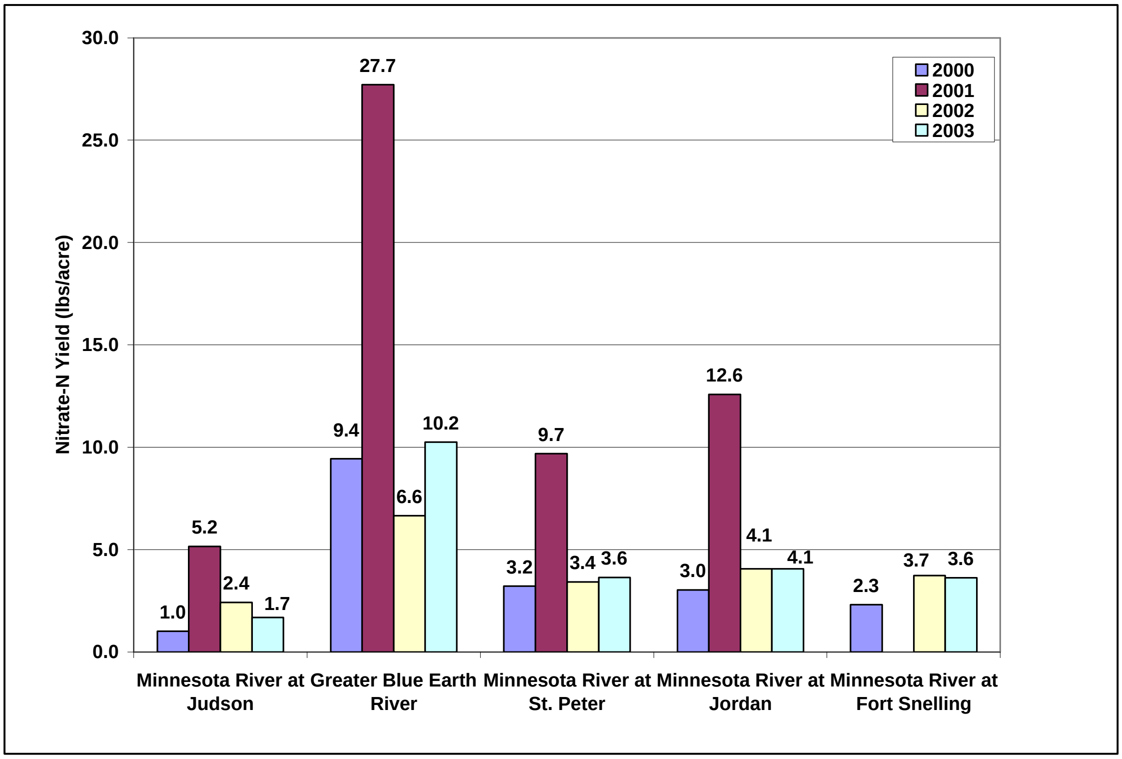


Figure 4.32. 2000 - 2003 Monitoring Season Nitrate-N Yields at Minnesota River Mainstem and Greater Blue Earth River Sites



The yield data (Figure 4.32) illustrate the effect of a wet year (2001) on nitrate-N delivery. An examination of yields during the drier years (2000, 2002, and 2003) shows that the Greater Blue Earth River yields more nitrate-N than the Upper Minnesota River (Judson) even when runoff is below normal levels. The lower yields at Judson reflect inputs of relatively small loads from the lower-yielding tributaries upstream of the Redwood River (Figure 4.36), as well as probable denitrification and assimilation in the 160 mile reach from Lac qui Parle Reservoir to Judson.

When nitrate-N yields are adjusted for runoff (Figure 4.33), the Greater Blue Earth yields are approximately two times greater than the adjusted yields at Judson. This suggests that the yield differences between the Upper Minnesota River and the Greater Blue Earth River may not be strictly a result of greater precipitation and runoff in the Greater Blue Earth River. Differences in fertilizer application rates, crop rotations, the extent of tile drainage, soil types, conservation practices and other sources may be factors. Research into understanding which factors influence the relatively low nitrate-N yields in the Upper Minnesota River Basin may lead to ways to reduce yield from the Greater Blue Earth River and other streams in the Lower Minnesota River Watershed.

Nitrate-N FWMC values for 2000 - 2003 are shown in Figure 4.34. As with nitrate-N loads and yields, the Greater Blue Earth River has the greatest values. The FWMC values for the Greater Blue Earth River were nearly constant during the 2000-03 period (9.78-9.95 mg/L), but increased substantially to 12.44 mg/L during 2003. The 2003 results place the Greater Blue Earth River above the 10 mg/L drinking water standard. The 12.44 mg/L FWMC is a seasonal average, but it indicates that water from Greater Blue Earth was not suitable as a source of drinking water during at least part of the 2003 monitoring period. This may have implications for the City of Mankato, which draws its drinking water from an aquifer that is connected to and partially recharged by the Blue Earth River.

The nitrate-N laden water of the Greater Blue Earth River joins the Minnesota River at their confluence at Mankato. As shown in Figure 4.34, the addition of the Greater Blue Earth River to the flow from the Upper Minnesota River (Minnesota River at Judson) increases the nitrate-N FWMC of the Minnesota River, as indicated by data from the Minnesota River at St. Peter. During three of the last four years, there were further increases in nitrate-N FWMC's between St. Peter and Jordan as major and minor tributaries in the Lower Minnesota River Watershed added their nitrate-N contributions. Despite these increases, nitrate-N FWMC's at the St Peter and Jordan monitoring sites have not exceeded the drinking water standard. There is some reduction in nitrate-N FWMC's between Jordan and Ft. Snelling (Figure 4.34), possibly brought about by denitrification or algal uptake within that relatively low velocity reach. While the nitrate-N FWMC's at Ft. Snelling do not exceed the drinking water standard, they indicate substantial nitrate enrichment that may contribute to hypoxia in the Gulf of Mexico (EPA, 2000).

Figure 4.33. 2000 - 2003 Monitoring Season Nitrate-N Runoff-Adjusted Yields at Minnesota River Mainstem and Greater Blue Earth River Sites

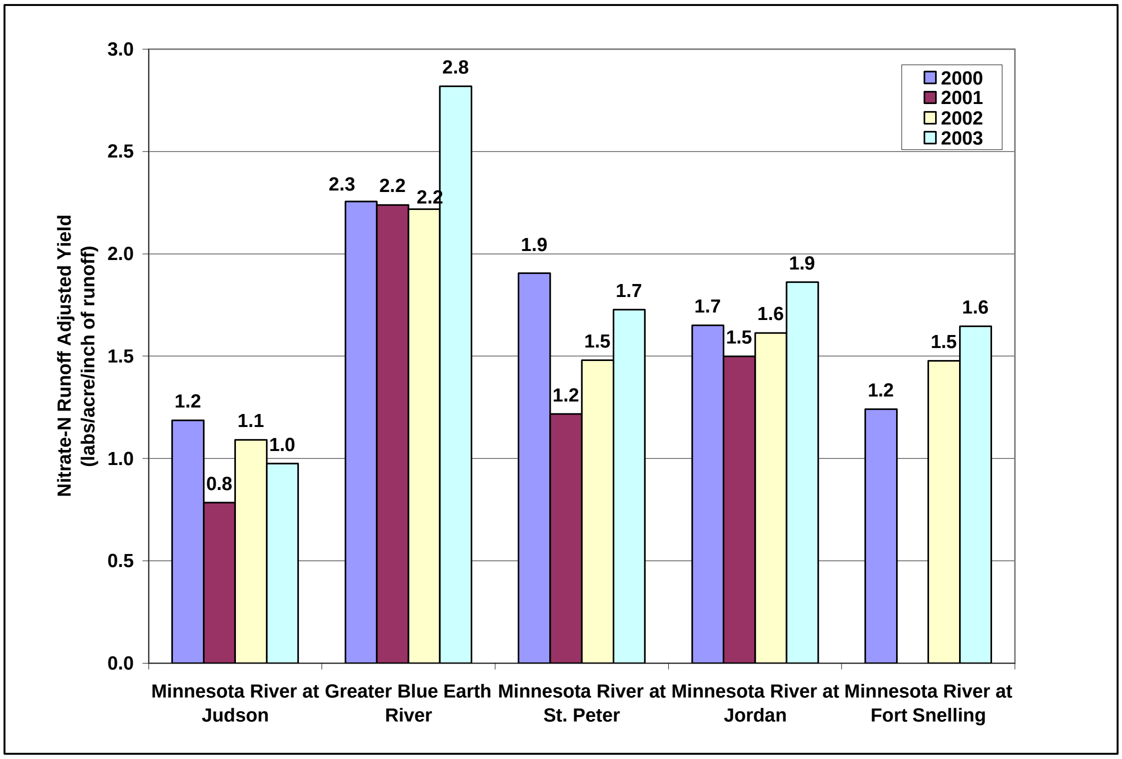
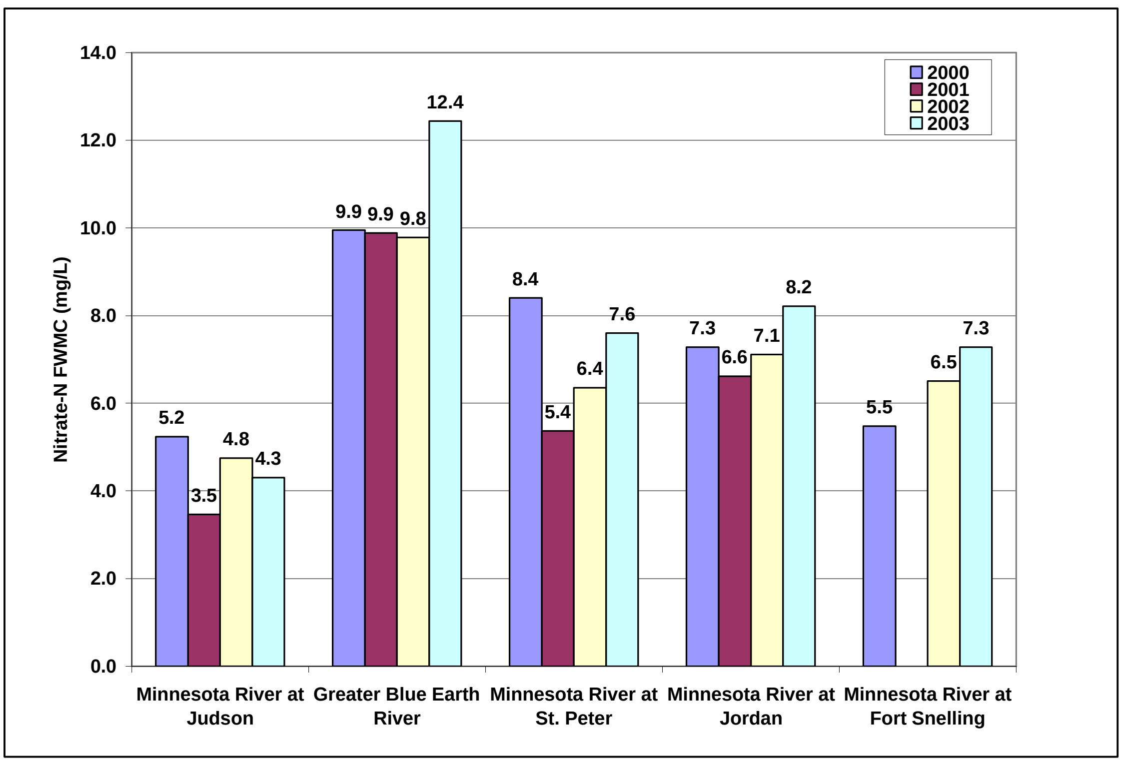


Figure 4.34. 2000 - 2003 Monitoring Season Nitrate-N FWMC at Minnesota River Mainstem and Greater Blue Earth River Sites



Major Tributaries Nitrate-N

Figure 4.35 presents nitrate-N loads for the 2000 – 2003. The data show that major tributaries in the Greater Blue Earth River system delivered a major portion of the total load during 2003, particularly the Blue Earth River and the Le Sueur River. The 2003 results continue to exhibit a pattern of relatively small loads in the western, upstream part of the Minnesota River Basin (Yellow Bank River to Yellow Medicine River Watersheds).

Nitrate-N yield data are shown in Figure 4.36. Yields for tributaries upstream of Hawk Creek have, thus far, been less than 3 lbs/ac, while streams in the Greater Blue Earth and Lower Minnesota River Watersheds have typically ranged from 5-10 lbs/ac, and were much higher during 2001, ranging from 12.4-31.4 lbs/ac. Hawk Creek yields, which were less than 3 lbs/ac during the first 3 years of monitoring, increased about 100 percent to 6.0 lbs/ac during 2003. Nitrate-N yields in the Redwood and Cottonwood Rivers decreased substantially compared to the moderately high yields recorded during 2002 (Figure 4.36). Yield decreases also were recorded for the Yellow Medicine, Little Cottonwood, and Sand Creek Watersheds. In each of those, the yield decrease was approximately proportional to the decrease in runoff from their watersheds. Runoff from the High Island Creek Watershed also decreased compared to 2002 (about 45%), but its nitrate-N yield only decreased about 8 percent.

Runoff-adjusted yields are shown in Figure 4.37. The values indicate the amount of nitrate-N each watershed delivers per inch of water runoff. As discussed in the mainstem section, nitrate-N tends to accumulate in soil profiles during dry periods. Runoff-adjusted yield values may prove useful as a combined surrogate measuring of two important watershed variables; 1) the soil-profile nitrate-N potential, and 2) the delivery efficiency with respect to nitrate. Nitrate-N potential is influenced by soil organic matter, application rates, and crop history. Watershed delivery efficiency is determined by several variables, among them soil type and texture, density of natural and man-made drainage pathways, and contact with denitrifying substrates along those pathways, e.g. stream-bottom materials and wetlands. Comparing the 2003 data for the Le Sueur River with Rush River, the Le Sueur River has a greater yield (Figure 4.36), 11.8 lbs/ac compared to 8.2 lbs/ac for the Rush River, but Rush River has a greater runoff-adjusted yield (Figure 4.37), at 3.9 lbs/ac/in compared to 3.0 lbs/ac for the Le Sueur. This may be an indication that the Rush River Watershed has accumulated more nitrate-N in its soil profiles or that it has a more efficient delivery system, or a combination of both. As can be seen in Figure 4.37, the Yellow Bank, Lac qui Parle, and Chippewa Watersheds have much smaller runoff-adjusted yields than the other major tributaries. The reason for the lower values is uncertain at present, but additional investigation may show that these watersheds have less soil nitrate potential because of differences in such factors as soil type, fertilizer use, and cropping practices or that their nitrate-N delivery pathways are less efficient.

Nitrate-N FWMC values for the major tributaries are shown in Figure 4.38. Flow-weighted mean concentrations increased during 2003 in most of the tributaries that comprise the Greater Blue Earth and Lower Minnesota River Watersheds, and reached

Figure 4.35. 2000 - 2003 Monitoring Season Nitrate-N Loads at Major Minnesota River

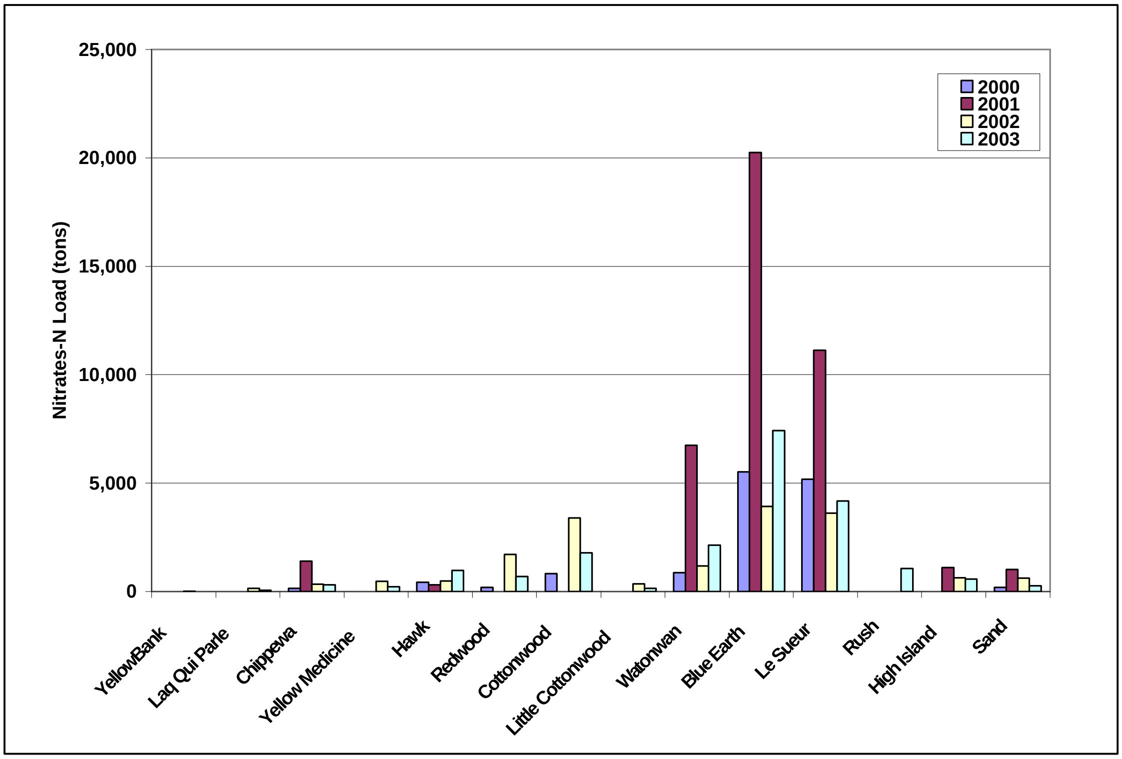
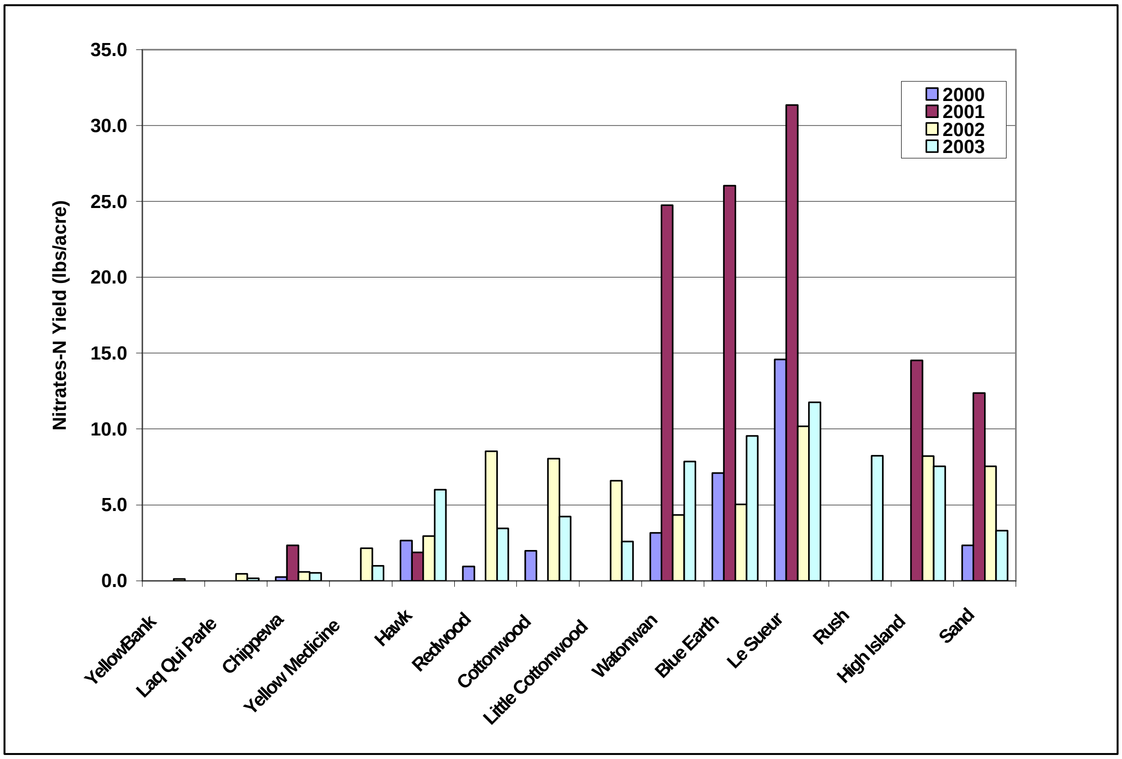


Figure 4.36. 2000 - 2003 Monitoring Season Nitrate-N Yields at Major Minnesota River Tributary Sites



levels that exceed the drinking water standard at five of six sites. Farther upstream in the Basin, the nitrate-N FWMC in Hawk Creek increased from its 2002 level to 9.67 mg/L, a value that places it near the drinking water standard of 10 mg/L. Concentrations in the Redwood River and Cottonwood River, which reached or exceeded the standard during 2002, were reduced during 2003, dropping to 7.7 mg/L in the Redwood River and 9.4 mg/L in the Cottonwood River. In sharp contrast to the other major tributaries, 2003 nitrate-N FWMC's in the Lac qui Parle and Chippewa Rivers remained at levels less than 2.0 mg/L, as they have during previous monitoring seasons.

Figure 4.37. 2000 - 2003 Monitoring Season Nitrate-N Runoff-Adjusted Yields at Major Minnesota River Tributary Sites

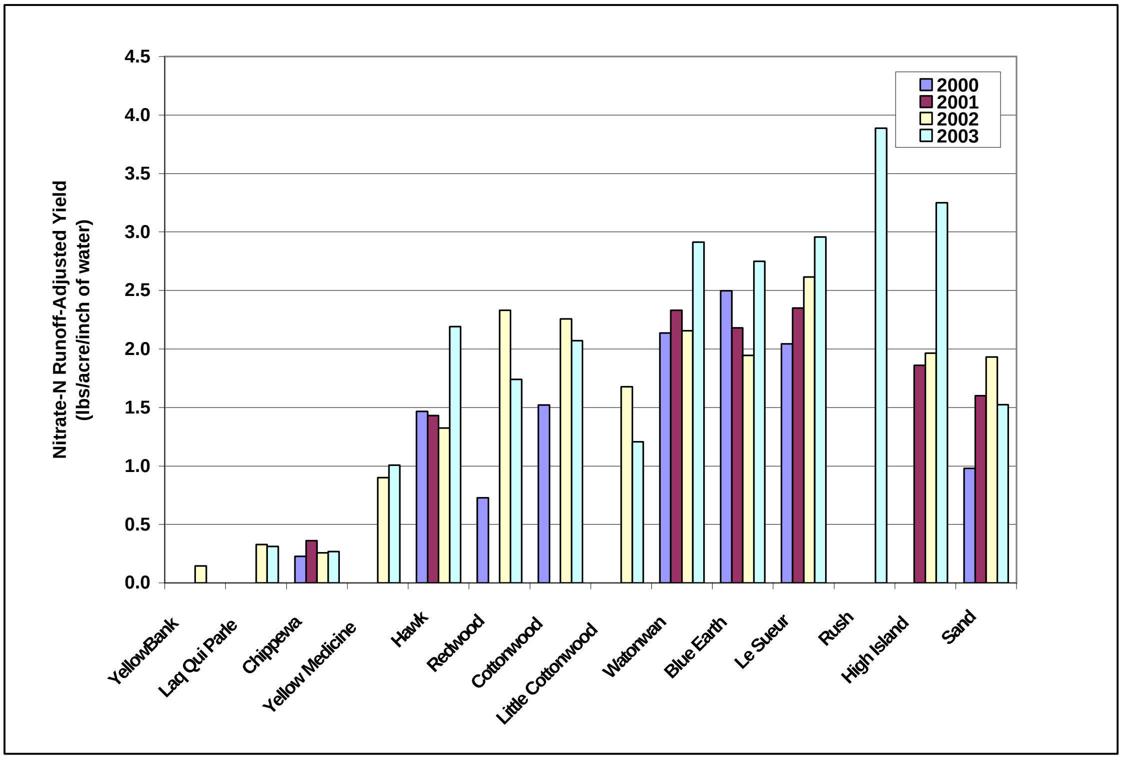
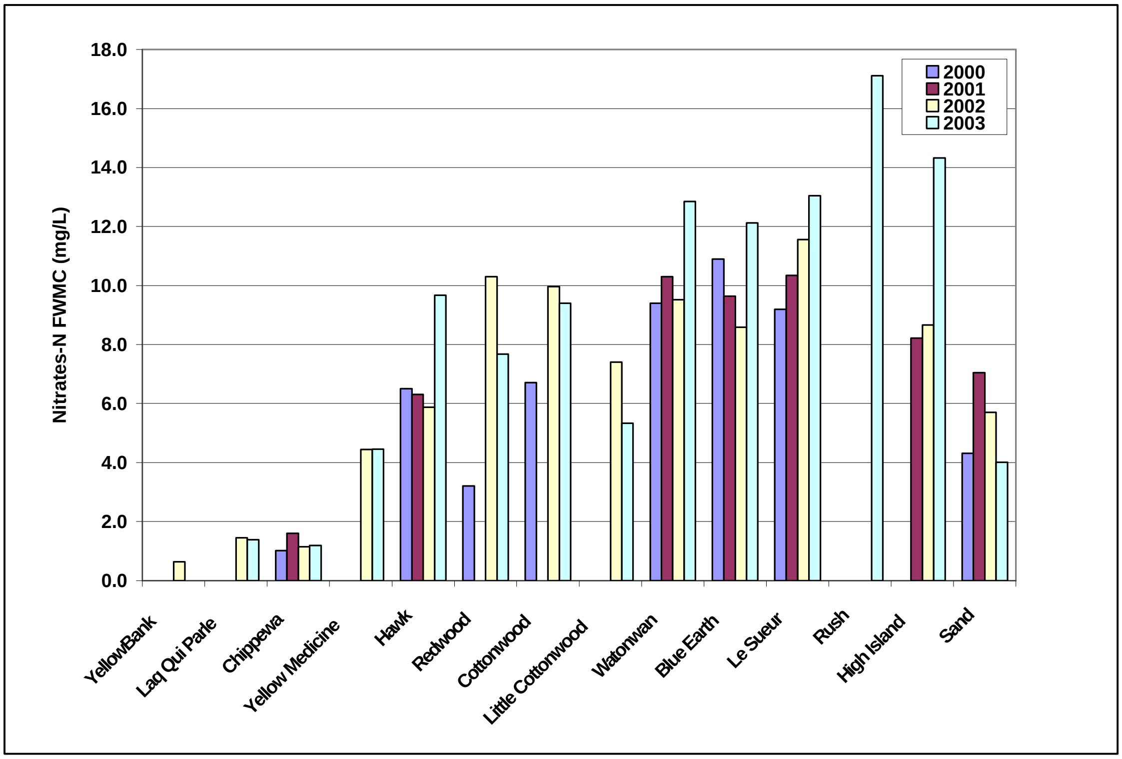


Figure 4.38. 2000 - 2003 Monitoring Season Nitrate-N FWMC at Major Minnesota River Tributary Sites



Minor Tributaries Nitrate-N

Figure 4.39 presents the nitrate-N loads for the 2000 - 2003 monitoring season for the minor tributaries. Nitrate-N loads and yields (Figure 4.40) show an increase from west to east , with relatively low values in Dry Weather Creek and West Fork Beaver Creek that transition to higher values farther east in the Basin followed by diminished yields in the urban and mixed urban land use areas (Bluff Creek to Nine Mile Creek) in the Twin Cities Metropolitan Area. The runoff-adjusted yields (Figure 4.41) show the same general pattern. Clear Creek, which is a tributary to the Redwood River in the western part of the Basin, had a very high runoff adjusted yield during 2002 and is an exception to the general pattern.

The nitrate-N FWMC values generally reflect the same east to west patterns as loads and yields (Figure 4.42). Dry Weather Creek is a tributary to the Chippewa River and has the lowest FWMC value among the minor tributaries that have agricultural land use. Nonetheless, its FWMC value, 8.08 mg/L, places its concentration well above levels in the Chippewa River and other major tributaries in that region, which typically are less than 2 mg/L. These results, and those from West Fork Beaver Creek and Clear Creek, indicate that small streams, even those in the western part of the Basin, can deliver water that is relatively concentrated with respect to nitrate-N. Two of the minor tributaries, Dutch Creek and Seven Mile Creek, had nitrate-N FWMC's that exceeded the drinking water standard during 2003. Dutch Creek flows to a chain of lakes that supplies water to Fairmont, Minnesota. In the Twin City Metropolitan Area, nitrate-N FWMC's were low in comparison, at 1.0 mg/L or less.

Figure 4.39. 2000 - 2003 Monitoring Season Nitrate-N Loads at Minor Minnesota River Tributary Sites

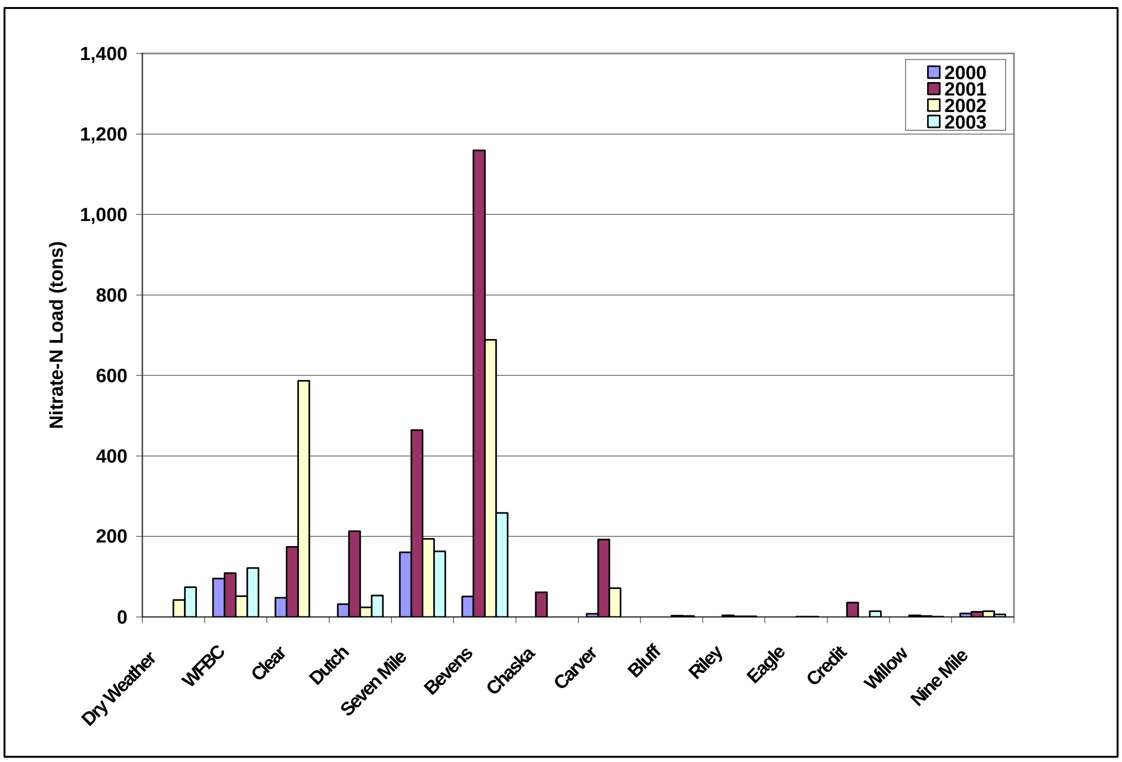


Figure 4.40. 2000 - 2003 Monitoring Season Nitrate-N Yields at Minor Minnesota River Tributary Sites

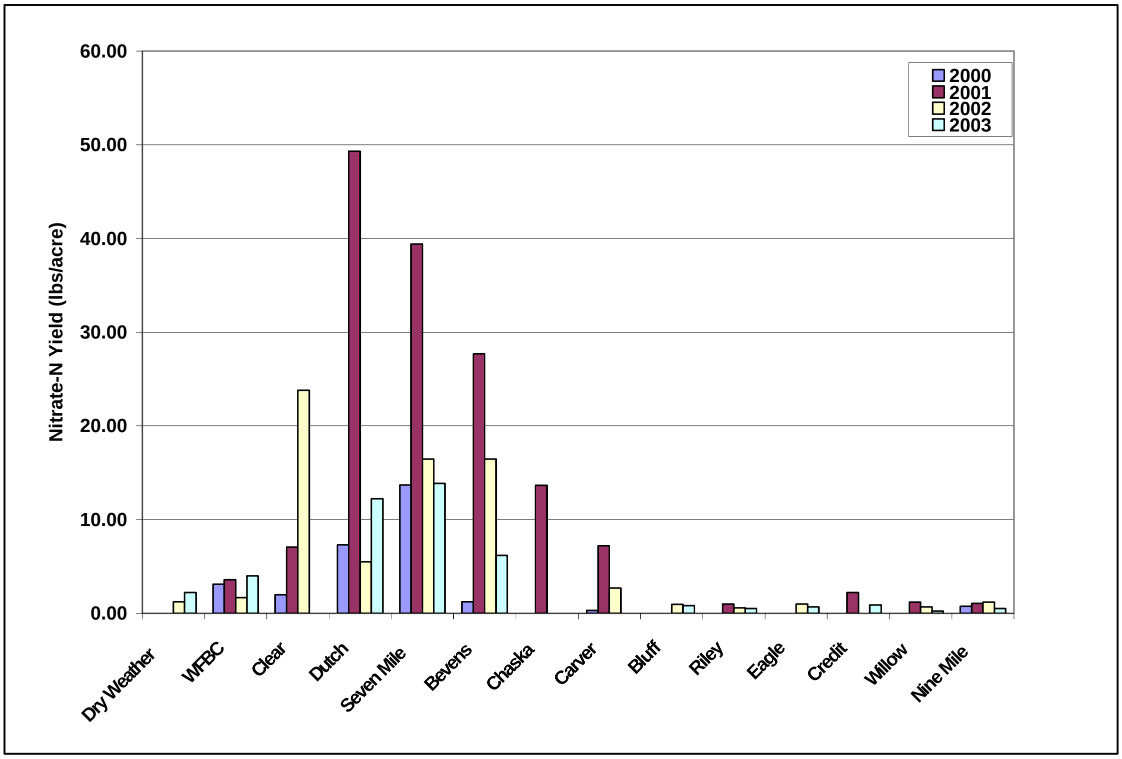


Figure 4.41. 2000 - 2003 Monitoring Season Nitrate-N Runoff-Adjusted Yields at Minor Minnesota River Tributary Sites

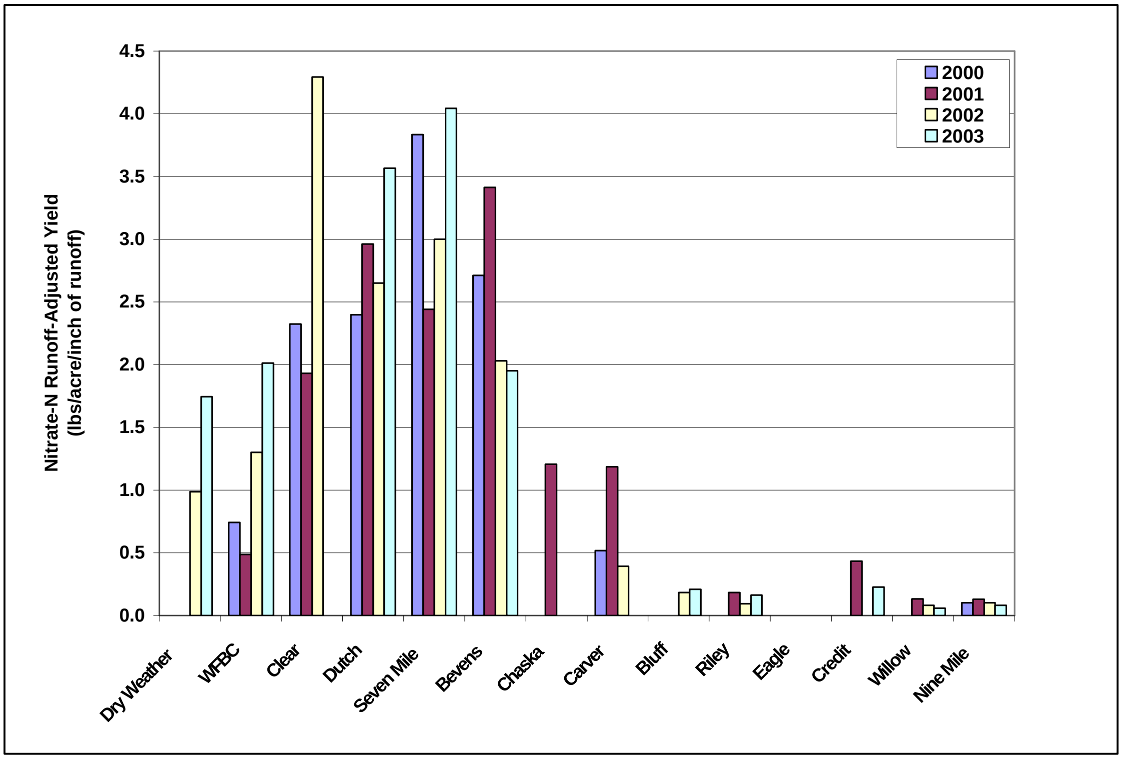
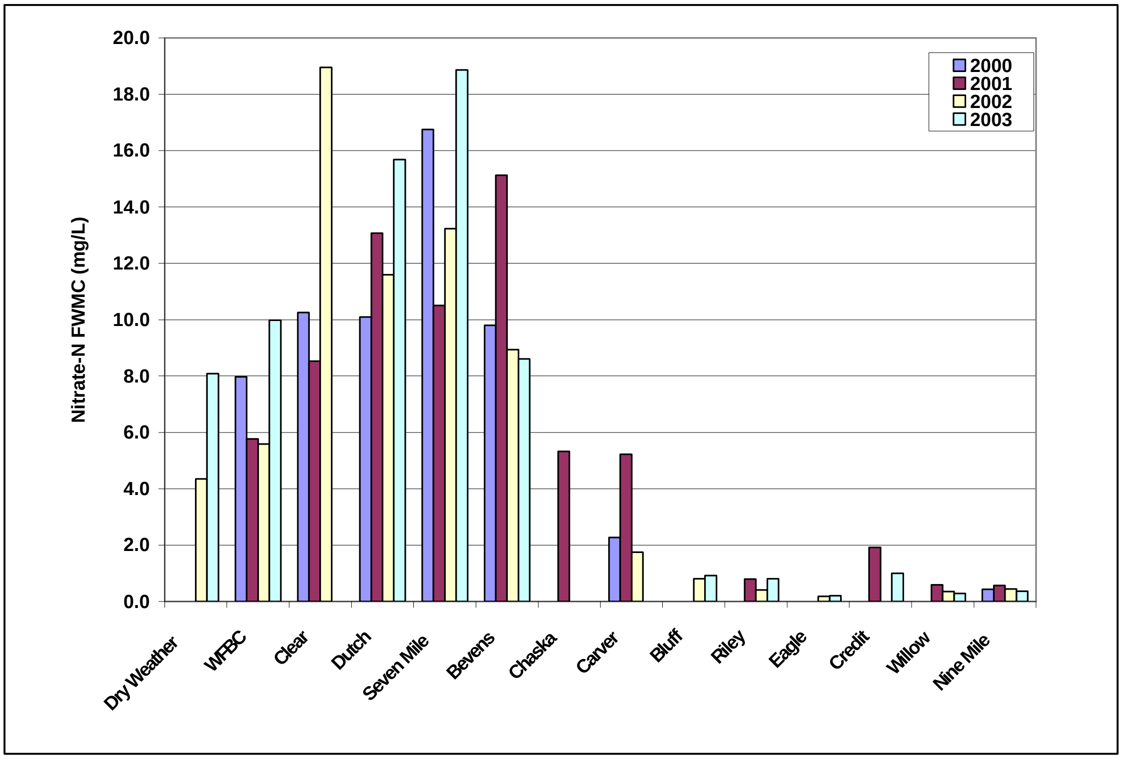


Figure 4.42. 2000 - 2003 Monitoring Season Nitrate-N FWMC at Minor Minnesota River Tributary Sites



Pesticide Monitoring

The Minnesota Department of Agriculture (MDA) Monitoring and Assessment Unit collected pesticide samples from the Le Sueur River at Highway 66, the Blue Earth River below the Rapidan Dam, and the Minnesota River at Judson. Table 4.02 presents a summary of all pesticide samples collected during 2000 - 2003. During this four year period, the herbicides metolachlor, atrazine and acetochlor were the most frequently detected compounds in these rivers. Of these, metolachlor was the most frequently detected pesticide, with detections in approximately 80 percent of the samples collected. During this same four year period, atrazine and acetochlor were detected in 72 and 62 percent of the samples, respectively. The maximum concentration detected during each year as well as the annual flow-weighted mean concentration for each of the detected pesticides are presented in Table 4.02. Compounds qualified as "Present" by the MDA laboratory were quantified at one half the method reporting limit (MRL). The complete pesticide analytical list and corresponding method reporting limits (MRLs) are presented in Table D.02 of the Methods section of this Report. In an effort to reduce costs, analysis for acid herbicides was discontinued by MDA for the 2003 monitoring season. This resulted in a reduction in cumulative pesticide load since no detections of 2,4-D and dicamba, the two most commonly detected acid herbicides, were recorded.

Pesticide concentration for most compounds typically peak in May and June in the rivers of south central Minnesota, although it is not unusual to see peak metolachlor concentrations earlier in the year (March or April) because the product is commonly applied in the fall. Peak concentration periods for the most compounds generally occur with the first significant post-application runoff event.

Annual pesticide loads were calculated for the Le Sueur and Blue Earth Rivers and Minnesota River at Judson for 2000 - 2003. At all three locations, total pesticide load for the four most frequently detected base neutral compounds were down significantly in 2003. However, loads for individual compounds were not consistently lower in 2003. For instance, the Blue Earth and Le Sueur Rivers delivered slightly higher acetochlor and metolachlor loads during 2003 as compared to 2002. Atrazine and dimethenamid loads for all three locations were down considerably from 2002, representing the lowest loads measured in these rivers during the four years of monitoring. The reduction in load is in part a result of pesticide application timing with respect to rainfall events and/or product use patterns which may shift slightly from year to year. The loss of 2,4-D and dicamba from the analytical list also reduced cumulative pesticide load presented in Figure 4.43.

The total pesticide load for these four compounds were divided by the number of square miles of agricultural land in row crops in the given watershed to estimate the yield of pesticide in pounds per square mile. Figure 4.44 presents 2000 through 2003 pesticide yields for each of the watersheds for the four pesticides most frequently detected. The percent landuse in agricultural row crop for the Judson, Le Sueur and Blue Earth watersheds were estimated at 60, 82, and 85 percent respectively (MPCA BID, 1997). As in the previous three years the Le Sueur River Watershed, displayed the highest cumulative pesticide yield, at over 0.72 pounds per square mile.

Table 4.02. Pesticides Detected in the Minnesota River at Judson, Blue Earth and Le Sueur Rivers, 2000 through 2003 by the Minnesota Department of Agriculture

Data		4 Year Detection	Max (ug/l)	Max (ug/l)	Max (ug/l)	Max (ug/l)	FWMC (ug/l)	FWMC (ug/l)	FWMC (ug/l)	FWMC (ug/l)
River	**Compound**	**Frequency**	**2000**	**2001**	**2002**	**2003**	**2000**	**2001**	**2002**	**2003**
Minnesota	Acetochlor	50%	0.66	0.42	1.09	0.43	0.10	0.10	0.18	0.07
Minnesota	Atrazine	68%	0.77	0.98	2.24	0.55	0.17	0.16	0.37	0.12
Minnesota	Metolachlor	66%	6.65	3.36	0.65	0.37	0.51	0.49	0.14	0.1
Minnesota	Dimethenamid	46%	2.05	0.38	0.44	0.14	0.13	0.13	0.08	0.03
Minnesota	2,4-D	*44%	7.10	0.22	3.00	na	0.37	0.02	0.29	na
Minnesota	Dicamba	*40%	0.49	0.61	0.70	na	0.02	0.03	0.08	na
Blue Earth	Acetochlor	68%	3.80	6.50	1.50	0.86	0.60	0.54	0.21	0.22
Blue Earth	Atrazine	73%	1.38	2.20	2.87	0.98	0.55	0.32	0.44	0.14
Blue Earth	Metolachlor	91%	1.13	2.52	0.52	0.46	0.36	0.48	0.12	0.14
Blue Earth	Dimethenamid	46%	0.61	0.89	0.25	0.09	0.12	0.11	0.04	0.02
Blue Earth	2,4-D	*27%	nd	0.10	0.49	na	nd	0.01	0.05	na
Blue Earth	Dicamba	*31%	0.28	1.07	0.52	na	0.02	0.11	0.05	na
Le Sueur	Acetochlor	67%	3.55	9.00	7.10	2.38	0.75	0.84	0.34	0.49
Le Sueur	Atrazine	75%	2.80	3.80	2.97	0.43	0.92	0.65	0.60	0.14
Le Sueur	Metolachlor	83%	1.41	1.44	0.65	0.68	0.31	0.44	0.13	0.20
Le Sueur	Dimethenamid	55%	1.13	2.10	1.80	0.36	0.22	0.28	0.11	0.07
Le Sueur	2,4-D	*44%	0.65	0.97	1.38	na	0.09	0.11	0.16	na
Le Sueur	Dicamba	*37%	0.70	1.27	1.35	na	0.07	0.20	0.11	na

NOTE: nd = not detected
na = not analyzed
* = 3 year detection frequency (not analyzed in 2003)

Annual flow-weighted mean concentrations for each of the sites are presented in Figure 4.45. As was the case for total pesticide load, there was a notable reduction in pesticide concentration for most compounds during 2003. Maximum concentrations presented in Table 4.02 were also down in 2003. The cumulative flow-weighted mean pesticide concentrations presented in Figure 4.45 indicate that for the first time in the four years of monitoring all sites were at levels below 1.0 part per billion (ug/L). The loss of 2,4-D and dicamba from the analytical list also likely contributed to the reduction in cumulative pesticide concentration during 2003.

Figure 4.43. Minnesota River at Judson, Blue Earth and Le Sueur Rivers Cumulative Pesticide Load for 2000 through 2003

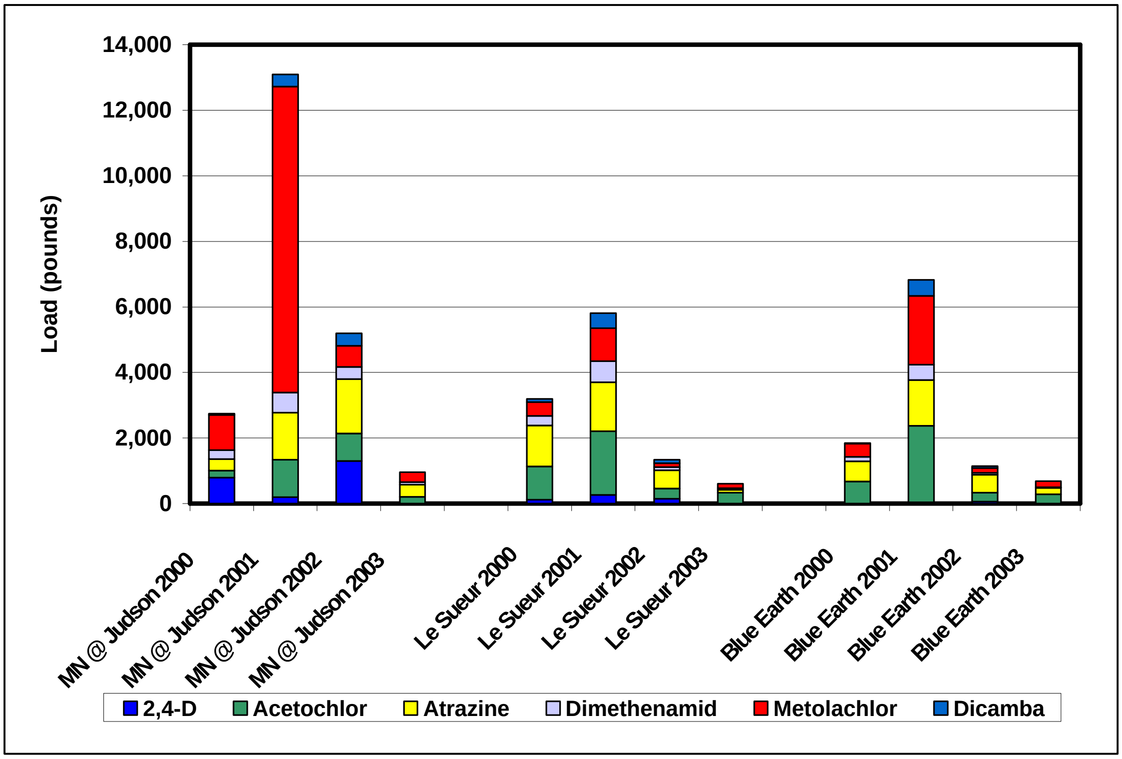


Figure 4.44. Minnesota River at Judson, Blue Earth and Le Sueur Rivers Pesticide Yield for 2000 through 2003

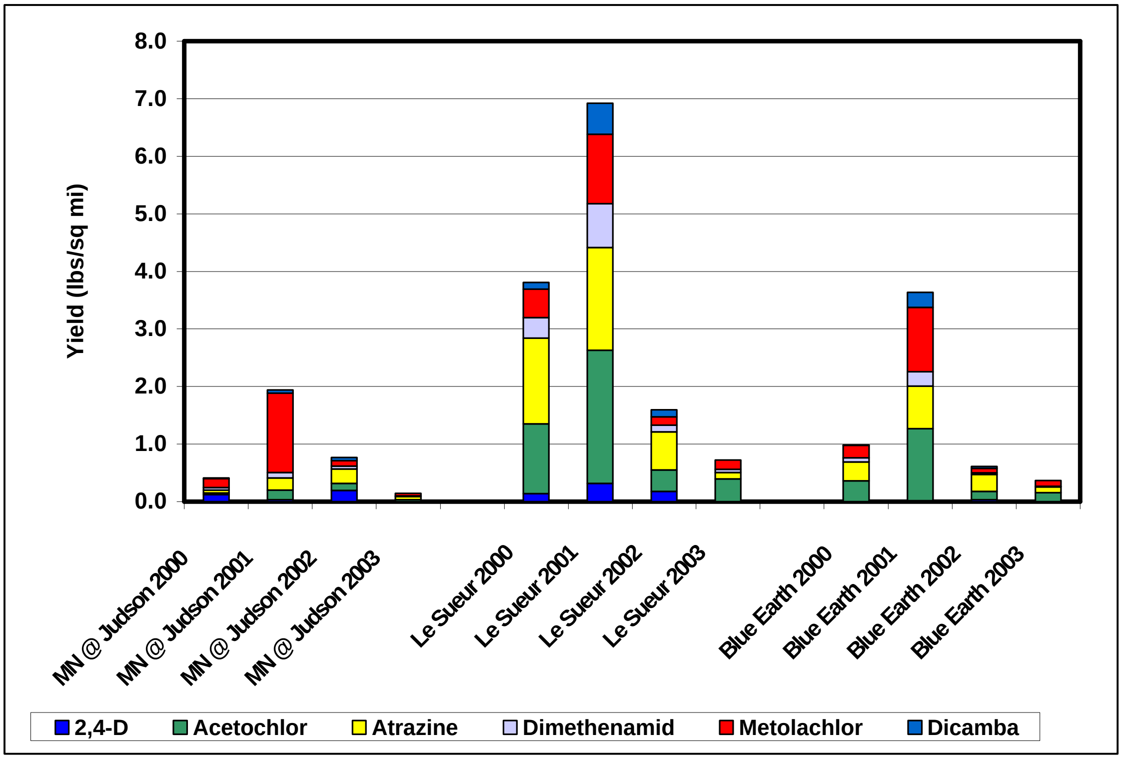
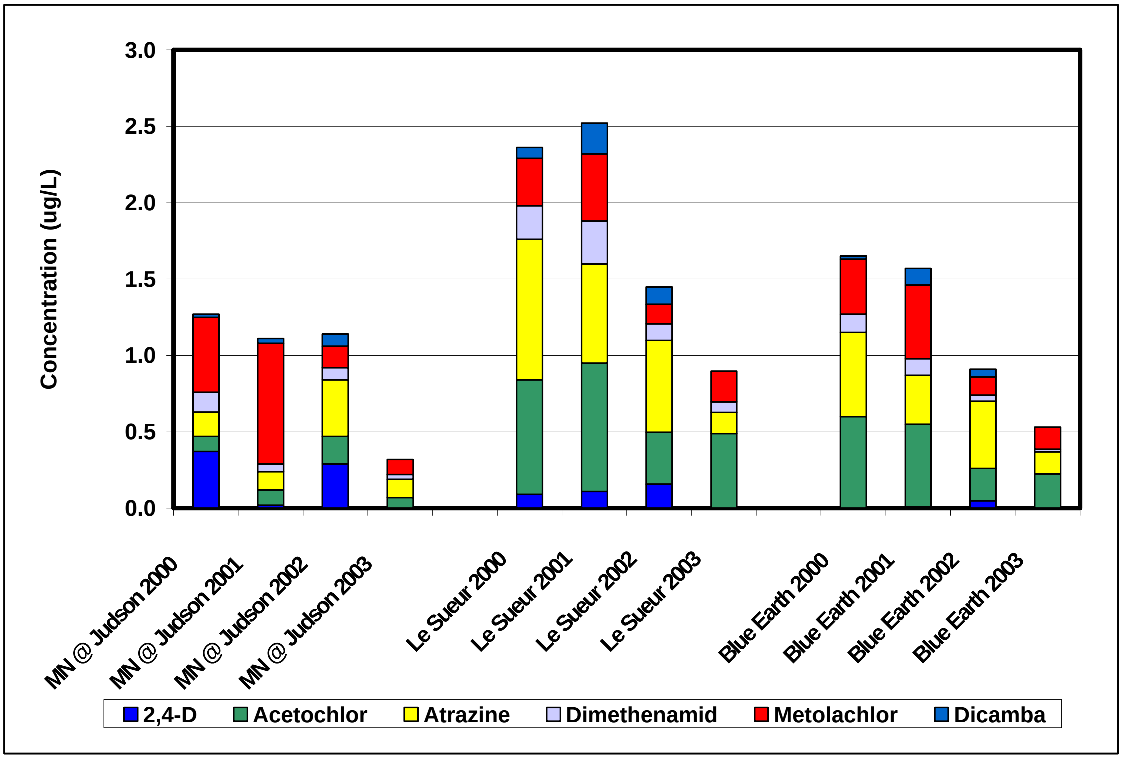


Figure 4.45. Minnesota River at Judson, Blue Earth and Le Sueur Rivers Annual Pesticide Flow-Weighted Mean Concentrations for 2000 through 2003



Fecal Coliform Bacteria

Fecal coliform bacteria are bacteria that are found in the intestines of warm blooded animals. Fecal coliform bacteria are usually not harmful, but do indicate that disease causing pathogens or disease-producing bacteria could be present.

Fecal coliform bacteria are passed through the fecal excrement of humans, livestock and wildlife. These bacteria can enter streams and ditches through direct discharge of waste from mammals and birds, from agricultural and urban stormwater runoff and from poorly or untreated human sewage. Current estimates suggest that more than half of all individual sewage treatments systems (septic systems) in the Minnesota River Basin are not functioning properly, in many cases allowing untreated human waste to enter ditches and streams. Agricultural practices such as spreading manure during wet periods and allowing livestock uncontrolled access to streams can contribute to high levels of fecal coliform bacteria. Wildlife can also be a contributor of fecal coliform bacteria, especially during low flow conditions.

In addition to bacteria and other pathogens, human and animal waste contains high levels of other pollutants such as phosphorus, nitrogen, and oxygen demanding organic material. Additionally, some of the same process (e.g. storm event runoff) and pathways (e.g. gullies) that lead to high suspended sediment concentrations in streams and rivers also contribute to human and animal waste entering the water.

The applicable Minnesota water quality standards for fecal coliform bacteria are listed below (these criteria apply to class 2b and 2 c waters, the classification of almost all streams and ditches in the MN River basin):

1. The geometric mean based on not less than five samples within a 30-day period shall not exceed 200 fecal coliform organisms per 100 milliters of water; and
2. Not more than ten percent of all samples taken in any calendar month can exceed 2,000 organisms per 100 milliters.

The fecal coliform surface water standard applies only between April 1st and October 31st. The criteria are based on an assumed illness rate of 8 per 1000 swimmers (MPCA, 2004).

In the Minnesota River Basin streams monitored for fecal coliform bacteria are often found to exceed water quality standards. Figure 4.46 presents 4/1-10/31 geometric mean fecal coliform for sites that had 10 or more samples for the years 2000 - 2003. These values should not be compared directly to the water quality standards, but do provide an indication of spatial and year-to-year variability.

Figure 4.46. 2000 – 2003, 4/1-10/31 Geometric Means at Minnesota River Sites

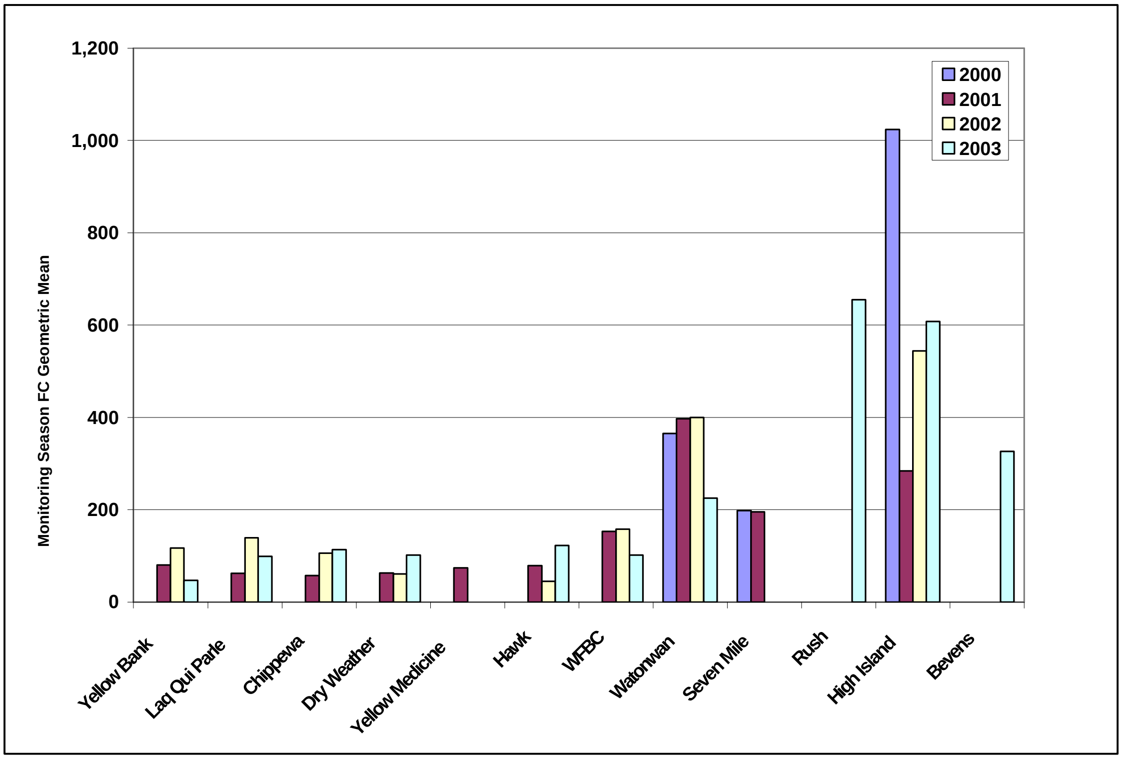


Table 4.03 presents the monthly geometric calculated for each sites based on 2000 - 2003 data sets. In general, the majority of sites with adequate monitoring data were impaired for fecal coliform bacteria. However, several of the eastern watersheds have significantly higher bacterial concentrations than watersheds to the west. Review of individual stream data from streams located in the Blue Earth, Watonwan, Le Sueur and Lower Minnesota Watersheds show fecal coliform bacteria levels that were a magnitude of 2 to 4 times higher than western watersheds.

Table 4.03 Monthly Calculated Fecal Coliform Geometric Means using 2000 – 2003 at Minnesota River Sites

Site	April	May	June	July	August	September
Yellow Bank		27	289	154	60	65
Laq Qui Parle		28	208	253	111	87
Chippewa	11	49	169	119	169	151
Dry Weather	8	17	92	143	236	368
Hawk Creek	27	37	129	109	205	123
WFBC	37	54	440	620	226	174
Watonwan	85	368	839	668	213	257
Dutch		570	1780	1854		
Seven Mile		194				
High Island	93	431	2339	1350	95	10
Bevens		637				

(green)	Equal or less than 200 org/100 ml
(orange)	Greater than 200 org/100 ml. Potentially qualifies for listing as impaired water.

Figure 4.47 presents the percentage of samples that exceeded 2000 org/100 ml for each monitoring site. This analysis uses 2000 - 2003 data, with a minimum sample set of 20. According to MPCA guidelines, a sample set (taken over previous ten year period) with more than 10% of samples exceeding 2000 org/100ml would qualify as an impaired water. This data indicates that water quality samples collected in the eastern portion often have severe bacterial concentrations.

Review of monitoring data throughout the Basin also revealed seasonal differences in bacterial concentrations. Figure 4.48 presents the average monthly geometric mean for 11 of the monitoring sites shown in Table 4.03 (all except Dutch). Plotting of the monthly geometric mean values indicate that on average bacterial concentrations are highest during the months of June and July.

Figure 4.47. 2000 - 2003 Monitoring Data at Minnesota River Sites, Percentage of Samples that Exceeded 2000 org/100 ml

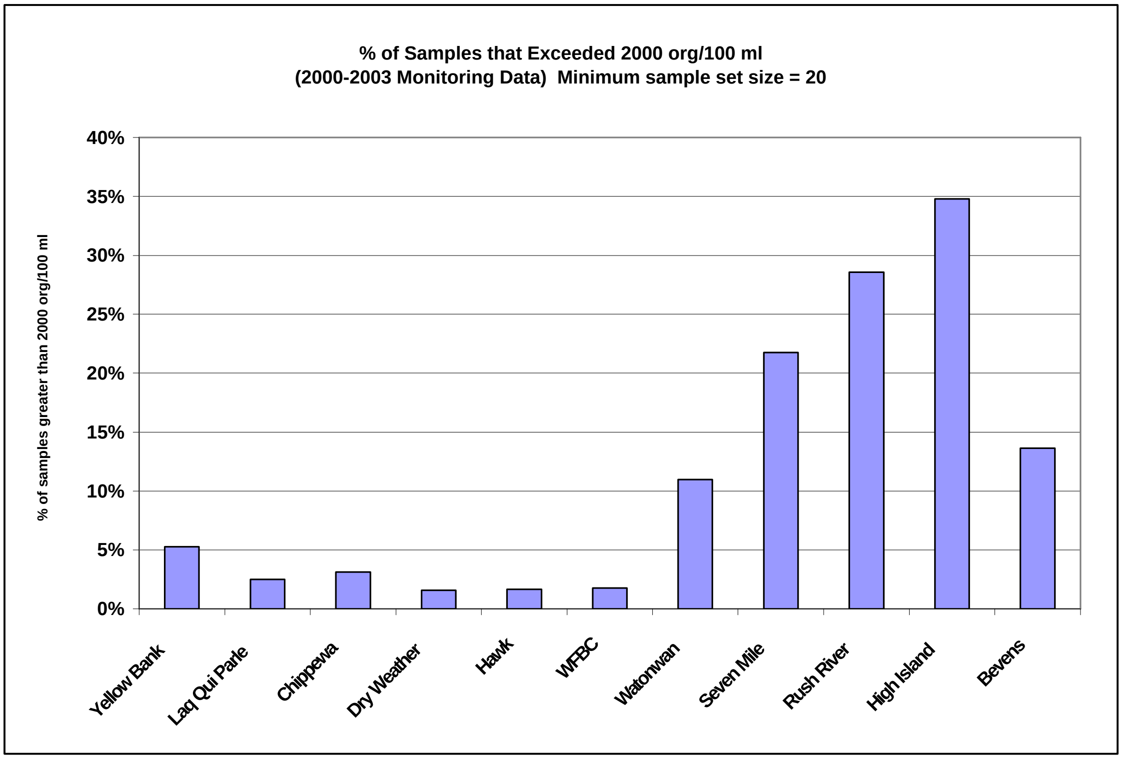
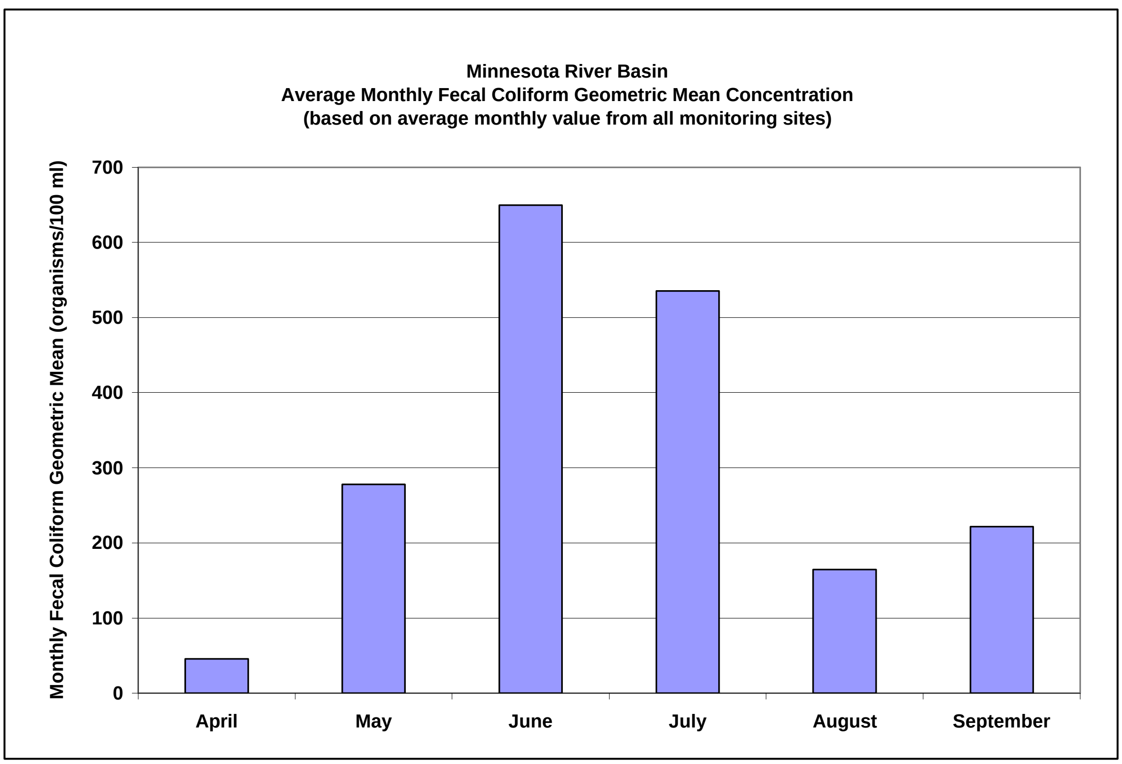


Figure 4.48. Minnesota River Sites Average Monthly Fecal Coliform Geometric Mean Concentration



Stream order (or size) also appears correlated to fecal coliform concentrations. As stream order increases, fecal coliform concentrations on average decrease. Suggested possibilities for this correlation are dieoff of bacteria, deposition of sediment (of which bacteria is often associated) and dilution with downstream water that may have lower concentrations of fecal coliform.

Other observations related to fecal coliform bacteria monitoring:

- The majority of monitoring sites in the basin are impaired for fecal coliform bacteria (2000 - 2003 data). However, in general, moving from the western watersheds to the eastern watersheds, the number of months when impairment occurs and severity of the impairment increases.
- Analysis of fecal coliform bacteria concentrations in the Minnesota River (2000 - 2003 data) indicate geometric means at or near surface water standards.
- Impairments most often occur in June and July.
- Bacterial concentrations in streams are typically highest after high intensity precipitation events.
- In general, when total suspended solids concentrations are high, so are bacterial concentrations.
- Deposition of bacteria in sediments and resuspension during storm runoff, may be a contributor of elevated bacterial concentrations during higher flows.
- Bacterial concentrations in water are influenced by several seasonal and weather related factors, such as precipitation, streamflow, temperature and vegetative cover.

New Bacterial Surface Water Standard

The MPCA is estimating that by December of 2005, the bacterial surface water standard will change from fecal coliform bacteria to E. coli bacteria. E. coli is a better indicator of the risk of contracting gastroenteritis than fecal coliform. The proposed surface water standard for E. coli is 126 coliform forming units (cfu) per 100 ml for a monthly geometric mean or 1260 cfu/100 ml for the 10% maximum standard. The surface water standard for E. coli is also based on an assumed illness rate of 8 per 1000 individual swimmers.

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Chapter 5: Summary and Conclusions

Runoff

Substantial annual and regional differences in runoff were observed across the Minnesota River Basin during the monitoring period 2000 – 2003. While 2000 was relatively dry in most of the Basin, 2001, a flood year, showed runoff values two to ten times greater than 2000. In 2002, runoff amounts were greater than those measured in 2000 and, with the exception of a few watersheds in the lower portion of the Basin, less than those recorded in 2001. 2003 was another dry year, and further reductions in runoff were recorded at most of the monitoring sites. Regional differences in runoff are generally consistent with long-term rainfall distribution patterns in the Minnesota River Basin, with the upper portion of the Basin recording lower rainfall and runoff than the lower portion of the Basin. Year to year differences in pollutant loads often are closely related to annual variations in runoff amounts.

Total Suspended Solids

During the course of four monitoring seasons, 2000 - 2003, flow-weighted mean concentrations of total suspended solids (TSS) for the Minnesota River mainstem sites ranged from a low of 85 mg/L at the Minnesota River at Ft. Snelling during 2003 to a high of 415 mg/L at the Minnesota River at St. Peter during 2000. These values are greater than the turbidity-based TSS threshold of 58 mg/L for the Western Corn Belt Plains ecoregion.

For major tributaries, the 2000 - 2003 results show substantial differences in TSS flow-weighted mean concentrations across the Minnesota River Basin. Concentrations seldom exceed 100 mg/L in major tributaries in the upper part of the Basin. In contrast, concentrations in major tributaries in the lower part of the Basin frequently are much greater than 100 mg/L.

Results obtained over the past four years of monitoring continue to illustrate the strong influence that runoff exerts on the amount of sediment delivered to the Minnesota River. Yields in the Greater Blue Earth River, for example, ranged from 126 lbs/acre during 2002 to 718 lbs/acre during 2001. Magnitude and timing of the individual runoff events also greatly affect the amount of sediment delivered. Whereas precipitation amounts and timing cannot be controlled, management alternatives that maximize water infiltration and retention in upland areas to minimize soil erosion and surface runoff can minimize impacts. Particular attention is needed in the watersheds that have deeply incised stream channels with areas of ravines and unstable stream banks. Given the magnitude of the TSS loads in the Middle and Lower Minnesota Watersheds, widespread implementation of these types of measures may be necessary to have a significant impact on TSS loads.

Total Phosphorus

The load of total phosphorus (TP) transported through the lower reach of the mainstem (St. Peter to Ft. Snelling) during 2003 was reduced from 2002 levels, and was the lowest amount recorded during the four-year reporting period. This load reduction followed reductions seen in 2002 when loads decreased substantially from the relatively high amounts transported during 2001. Total phosphorus loading often strongly correlates with stream flow, and much of the load reduction can be attributed to below-normal runoff across most of the Minnesota River Basin during 2002 and 2003. Seasonal timing, rainfall intensity, and antecedent moisture conditions for each precipitation event along with watershed terrain determine the characteristics of each watershed's total annual runoff. These often variable characteristics, in turn, affect the amount of nutrient leaching, water runoff, and soil erosion which, in combination, move phosphorus into streams. Land use and management decisions related to urbanization, tillage methods, fertilizer applications, conservation buffers, and many others modify the natural affects of climate, weather, and geomorphic variables. The TP load data for the mainstem sites necessarily represent the combined affects of all these variables spread across very large watersheds that have varied landscapes.

The TP FWMC data collected in the past four years provide a useful diagnostic appraisal of the Minnesota River mainstem condition. Researchers generally agree that the Minnesota River is over enriched with respect to phosphorus and that a reduction in phosphorus concentrations could result in reduced algal growth and lower biochemical oxygen demand, thereby enhancing water quality. The 2002 State of the Minnesota River report (State, 2002) described TP concentration thresholds that are sought for the Minnesota River. For example, an analysis by MPCA (MPCA, 1997) showed that a reduction in algal productivity cannot be expected unless TP concentrations in the Minnesota River are brought below 0.26 mg/L. Throughout 2002 and 2003, TP FWMC's in the Greater Blue Earth River and the mainstem at Judson were diminished relative to 2001 levels and presently are at or near the threshold value (Figure 4.14). Fewer high-intensity rainfall events during 2003 and generally reduced runoff throughout the Basin during both 2002 and 2003 probably account for most of the reduction in TP concentrations, but the data also may reflect Basin wide efforts to reduce both point and non-point phosphorus inputs. The data from the Jordan and Ft. Snelling sites (Figure 4.14) show that the reductions extend into the downstream reaches of the Minnesota River to its mouth, where TP FWMC's dropped below the 0.26 mg/L threshold in 2003.

In 2003, the bulk of TP loading from major tributaries occurred in watersheds located in the middle and lower Minnesota River Basin (i.e. downstream of Morton). Load comparisons, however, need to be tempered by considering the amount of tributary load relative to average streamflow in the mainstem channel at the point of confluence. During 2003, TP yields for most of the major tributaries were less than they were throughout 2002, with very large reductions noted for High Island Creek and Sand Creek. Despite appreciable reductions in yields during the past two monitoring seasons, the higher-yielding watersheds are still delivering 4-8 times more TP per acre than the lower-yielding watersheds.

While TP loads and yields are useful diagnostic parameters, it is the resulting stream concentration that drives overproduction of algae that in turn reduces water clarity and often causes undesirable levels of oxygen demand. During 2003, TP FWMC values in eight of the major tributaries were reduced from levels measured during 2002, reflecting the reduced loads and yields. The 2002 State of the Minnesota River Report stated that none of the major tributary streams had FWMC's that met the goal of 0.1 mg/L TP set by the EPA for protection of aquatic life. One stream, the Yellow Medicine River, met that criterion during 2003. Furthermore, the MPCA threshold level of 0.26 mg/L TP was met in seven major tributaries, three of which exceeded the threshold during 2002. Reductions in TP FWMC's were not seen at all major tributary sites during 2003. The Little Cottonwood River FWMC increased from 0.18 mg/L during 2002 to 0.30 mg/L during 2003. The TP FWMC for Sand Creek was unchanged from 2002 and remains at a high level (0.60 mg/L) relative to concentrations in the other major tributaries (Figure 4.17). The Chippewa River also was relatively unchanged during 2003, rising slightly to 0.19 mg/L, but it remains within the 0.26 mg/L threshold.

Assessing results from the past four years, there appears to be a general reduction in TP FWMC's in Hawk Creek, the Redwood River, and the Cottonwood River (Figure 4.17). Concentrations are now substantially reduced from the relatively high concentrations present in these streams during 2000, and are now more closely aligned with the relatively low concentrations that typify major tributaries in the headwaters of the Minnesota River Basin (Yellow Bank to Chippewa). The Le Sueur River has undergone three consecutive and substantial reductions in seasonal FWMC values that started in 2001, but the present value, 0.35 mg/L TP for the 2003 season, remains well above the 0.26 mg/L threshold. Further perspective can be gained by observing that TP FWMC values for the Minnesota River mainstem ranged from 0.23-0.29 mg/L during the 2003 season. These results place the mainstem approximately at the threshold value. If phosphorus loading can be further reduced, it is expected that levels of algal productivity will decline and the River's condition will improve. The major tributaries that presently discharge flows containing TP in excess of the threshold concentration threaten the Minnesota River's recovery because their relatively large watersheds can deliver flow volumes that are sufficient to raise the average TP concentration in the mainstem.

Total phosphorus loads decreased at all minor-tributary sites during 2003 compared to 2002 levels. Loads in Bevens Creek were greatly reduced relative to the very high loads recorded at that site during 2001 and 2002. At most of the sites, the load reductions correspond to decreases in runoff, but TP loads in West Fork Beaver Creek and Dutch Creek decreased despite a runoff increase of about 50 percent compared to 2002 levels.

Total phosphorus yields from the minor-tributary watersheds during 2003 were relatively modest compared to the very high yields recorded during 2001 and 2002. Yields also were more uniform across the basin, lacking the very large site-to-site variations present during 2001 - 2002. Despite greater overall uniformity, three of the agricultural land use watersheds, Dry Weather Creek, West Fork Beaver Creek, and Dutch Creek, have relatively low yields that contrast markedly with yields from Seven Mile Creek and Bevens Creek, which also have agricultural watersheds.

The TP FWMC results, unlike the yield data, show little cross-basin uniformity and site-to-site differences are readily apparent. During 2003, TP FWMC values ranged from 0.05 mg/L in Eagle Creek to 0.42 mg/L in Riley Creek. Eleven minor tributaries were monitored during 2003, and TP FWMC values in seven of them were equal to or less than the 0.26 mg/L threshold and three of the streams had FWMC's equal to or less than the EPA goal of 0.10 mg/L. Comparing 2003 data with results from 2002, only one minor-tributary stream, Riley Creek, showed an increase it its TP FWMC value despite reductions in its annual runoff, TP load, and TP yield during 2003. These results suggest that Riley Creek, an urbanizing watershed, may be receiving intermittent, but highly concentrated, wash loads from construction sites.

Orthophosphorus

Orthophosphorus (OP) loads at mainstem sites during 2003 were reduced compared to loads during 2001, a year of spring flooding, and 2002, which was a relatively low-runoff year. The OP loads at mainstem sites were the lowest measured during the four year period, with the exception of the Minnesota River at Judson site, where the data reflects an increase in OP loading from the Chippewa River during 2003 and relatively high loads from Hawk Creek, Redwood River and Cottonwood River. Because of its greater area, the watershed upstream of Judson delivered more OP load than the Greater Blue Earth Watershed. However, the Blue Earth River Watershed delivered more OP per acre, yielding 0.05 lbs/ac compared to 0.03 lbs/ac from the part of the Minnesota River Basin upstream of Judson. The OP FWMC data show that the present condition (2003) of the Greater Blue Earth River and the Lower Minnesota River, with respect to OP concentrations, is the best recorded during the four year period. Lower concentrations of OP, if sustained, are expected to result in reduced algal productivity, greater water clarity, and less oxygen demand in the lower mainstem.

Orthophosphorus comprises about 20-30 percent of TP in most of the major tributaries. In three of the tributaries, Watonwan River, High Island Creek, and Rush River, OP is greater than 40 percent of TP. In Hawk Creek and the Redwood River, OP is greater than 50 percent of TP. These differences in the proportion of OP may be indicators of differences in the source of the phosphorus loading. Orthophosphorus loads and yields in the major tributaries declined at all sites during 2003 compared to 2002 values except in the Chippewa River and Watonwan River. The OP yield data indicate substantial differences in loading rates among the major tributaries. Focused attention and evaluation of the major-tributary watersheds may be warranted to determine why some yield more OP than others.

The OP FWMC data (Figure 4.27) also show substantial differences among the major tributaries, with values that ranged from 0.02-0.20 mg/L during 2003, a ten-fold difference. Six of the major tributaries, Hawk Creek, Redwood River, Watonwan River, Rush River, High Island Creek, and Sand Creek, had OP FWMC's that exceeded OP levels in the mainstem. As such, their discharges have potential to elevate OP concentrations in the mainstem. More evaluation of these data and special studies may be needed to learn why some of the major tributaries have OP present in higher proportions and at greater concentrations compared to the other major tributaries.

Loads and yields of OP decreased at all minor tributary sites during 2003 compared to 2002. Most notable is the substantial decrease in load and yield for Bevens Creek. Although greatly reduced from 2001 - 2002 levels, the OP load in Bevens Creek during 2003 greatly exceeds loads in the other minor tributaries and also exceeded the loads in three of the major tributaries.

Minor-tributary OP yields fluctuated widely during the 2000 - 2002 period, showing large site-to-site and year-to-year differences at most sites. During 2003, OP yields were comparatively more uniform among sites and lower in magnitude overall, ranging from 0.01 to 0.14 lbs/ac, compared to a range of 0.01 to 0.74 lbs/ac during 2002. Substantial differences are still evident, however, as seen in the Bevens Creek, Bluff Creek, and Credit River Watersheds which yielded about twice as much OP per acre compared to the other minor watersheds.

The OP FWMC data further illustrate differences between the minor tributaries. The Dutch Creek, Seven Mile Creek, and Bevens Creek Watersheds have similar land use and had nearly equal runoff amounts during 2003. Despite these similarities, the OP FWMC for Bevens Creek was 0.19 mg/L, a value nearly two times greater than the FWMC for Seven Mile Creek (0.10 mg/L) and more than three times greater than the FWMC for Dutch Creek (0.06 mg/L). These differences point to the need for further research into OP sources and the transport processes that deliver OP to streams.

Nitrate-N

Results from the past four years of monitoring at Minnesota River mainstem sites continue to show that nitrate-N loads, yields and FWMC's are greatest in the eastern part of the Minnesota River Basin that contains the Greater Blue Earth River Watershed and the Lower Minnesota River Watershed. The nitrate-N FWMC values for the Greater Blue Earth River were nearly constant during the 2000 - 02 period (9.95-9.78 mg/L), but increased substantially to 12.44 mg/L during 2003. The 2003 nitrate-N FWMC for the Greater Blue Earth River exceeds the 10 mg/L drinking water standard.

Results for major-tributary streams also show that nitrate-N loads, yields, and FWMC's generally increase from west to east across the Basin. Nitrate-N FWMC's in the Yellow Bank, Lac qui Parle and Chippewa Rivers (western part of Basin) were less than 2.0 mg/L during 2003, as they have been during previous monitoring seasons. Farther east in the Basin, in the Yellow Medicine River, Hawk Creek, Redwood River, Cottonwood River, and Little Cottonwood River, FWMC's are somewhat greater, generally ranging from 4 to 10 mg/L. The greatest FWMC's are seen in the Watonwan, Blue Earth, and Le Sueur Rivers in the Greater Blue Earth River Watershed, and also in Rush River and High Island Creek, which are part of the Lower Minnesota River Watershed. Nitrate-N FWMC's in these streams have been greater than 8 mg/L during all four monitoring seasons, and have exceeded 10 mg/L at times, reaching a maximum of more than 16 mg/L in the Rush River during 2003.

Nitrate-N loads and yields for minor tributaries show an increase from west to east, with relatively low values in Dry Weather Creek and West Fork Beaver Creek that transition to higher values farther east in the Basin followed by diminished yields in the urban and mixed urban land use areas (Bluff Creek to Nine Mile Creek) in the Twin Cities Metropolitan Area. Clear Creek, which is a tributary to the Redwood River in the western part of the Basin, had a relatively high nitrate-N yield during 2002, and is an exception to the general pattern. Research has shown that the amount of nitrate reaching streams is strongly associated with the amount of water that infiltrates and percolates through the soil profile. Wet years (such as 2001) are often periods of increased nitrate-N loading, particularly when they are preceded by one or more dry years. Nitrate-N tends to accumulate in soil profiles during dry periods when crops are not able to fully utilize available nitrate. The increase in stream nitrate-N from west to east across the Basin generally corresponds to the rainfall and runoff gradient across the Basin. The occurrence of elevated nitrate-N in some streams in the drier, western, part of the Basin (Dry Weather, West Fork Beaver, and Clear Creeks) suggests that fertilizer application rates, crop rotations, drainage density, the extent of tile drainage, soil types, and other nitrate sources also may be factors. Research into understanding which factors influence nitrate-N watershed yields may lead to ways to reduce nitrate-N concentrations in streams.

Pesticides

Pesticide samples were collected from the Le Sueur, Blue Earth and Minnesota Rivers from 2000 - 2003. Over the four-year period, the herbicides metolachlor, atrazine and acetochlor were the most frequently detected compounds in these rivers. Of these, metolachlor was the most frequently detected pesticide, with detections in approximately 80 percent of the samples collected. During this same four year period, atrazine and acetochlor were detected in 72 and 62 percent of the samples, respectively.

Fecal Coliform Bacteria

In the Minnesota River Basin, bacterial monitored streams are often found to exceed the Minnesota surface water standard.

Conclusions

Data in this report illustrate widely varying water-quality conditions in most streams during a relatively short four-year monitoring period. These year-to-year fluctuations underscore the value of long-term data gathering using consistent and technically sound methodology at all sites across the Minnesota River Basin. Such data, collected longer term, will form a solid body of evidence that more accurately portrays stream water quality. These data will enhance the impaired waters listing process by providing an improved perspective of stream water quality during normal, above normal, and below normal runoff periods.

Data in this report show that watershed yields of key water-quality constituents (TSS, TP, OP, and nitrate-N) follow a general pattern of increasing yield, often accompanied by increasing FWMC values, from west-to-east across the Minnesota River Basin. A corresponding west-to-east precipitation and runoff gradient has long been recognized and documented. The magnitude of the constituent yield response, however, appears to be greater than what would be expected from the differences in annual runoff alone. The frequency, intensity, duration, and seasonal timing of precipitation events can greatly affect constituent yield, but other factors also may shape the observed responses. These factors may include differences in watershed geomorphology, vegetative cover, and alluvial progression and adjustment to climate and land-use variables. In addition, direct human influences such as cropping, urbanization, extent and coverage of conservation practices, fertilizer usage (amount and timing), and point source inputs affect constituent yield. The relative importance of these, and perhaps other factors, needs to be better understood as we chart a course of action to reduce pollutant levels in streams, large and small, across the Minnesota River Basin.

Concentrations of TSS, TP, OP and nitrate-N in several of the monitored streams, despite reductions during 2003, are frequently at problematic levels. Affected streams range in size from minor tributaries to the Minnesota River mainstem. Concentrations of these constituents are often at, or well above, thresholds associated with reasonable expectations for water quality in their respective ecoregions. The data clearly show that these impaired conditions develop during various hydrologic cycles ranging from near drought to floods. The data do not make clear the source mobilization and transport mechanisms that deliver pollutants to streams. However, several of the organizations that contributed data for this report are collecting additional data from smaller watersheds and are using that information to identify and target specific sources and areas within their respective watersheds. Inclusion of data from some of these smaller watersheds in this year's State of the Minnesota River Reports is providing a more comprehensive assessment and will improve our understanding of pollutant source and transport mechanisms. Some of the more complex pollutant source mobilization and transport mechanisms will likely need in-depth focused research studies beyond the scope of the present monitoring program. Some research of this type currently is in progress and more research is proposed. Better communication between researchers and continued coordination of the monitoring effort will improve our understanding of the processes and enhance our ability to reduce pollutant loading.

The present monitoring network has no Minnesota River mainstem sites upstream of Judson. Two additional mainstem monitoring sites are needed, one near Morton and one near Montevideo. Sites near these locations could take advantage of USGS streamflow gaging stations already in place, document conditions in the mainstem, and assist in differentiating effects of the relatively low-yielding major watersheds in the upstream part of the Basin from the moderate-to-high yielding watersheds in the mainstem reach between Morton and Judson.

Questions and Concerns for Further Research:

- More research is needed on potential water-quality and aquatic-ecosystem improvements in streams located in watersheds that have extensive participation in CREP and other BMP programs. Furthermore, there needs to be continued research that will lead to new innovations for managing surface and subsurface runoff and erosion, particularly methods that can be effective during the critical May-July period.

- Monitoring data indicate regional differences in the magnitude of constituent load response to water runoff. Differences are related to watershed soils, geology, and stream morphology, but land use, cropping practices, drainage practices, and conservation practices also may be affecting load response. A better understanding of these processes could help allocate BMP resources more effectively.

- Assessments are needed in major tributaries to determine the nature of the phosphorus sources and the location of source areas. Particular attention should be placed on identifying 1) highly-erodible land that is not presently treated with conservation practices, 2) land adjacent to stream and ditches, 3) actively eroding streambanks, ravines and gullies, 4) municipal and industrial point sources, 5) non-compliant animal-waste systems, and 6) other potential sources.

- More evaluation of the monitoring data and special studies may be needed to learn why some of the major tributaries have greater OP/TP ratios and greater OP concentrations compared to other major tributaries. Investigation of phosphorus sources, phase partitioning, and transport mechanisms may reveal new information about these processes that could, in turn, lead to new approaches for reducing phosphorus loading to streams. Research projects directed at non-point source processes at both field and small-watershed scale may be needed to determine how and why the major tributaries differ in these important aspects of phosphorus dynamics.

- Elevated nitrate-N loads, yields, and FWMC values are present in most of the major tributaries starting with the Redwood River and continuing downstream. The elevated numbers underscore the need for BMPs that reduce nitrate in streams. Source reduction, through effective nutrient management, is an important first step. More research is needed at the minor watershed scale to evaluate why some agricultural watersheds deliver more nitrate-N and what can be done to mitigate this problem.

Appendix A

Suggested Criteria for Inclusion for 2001 -2003 State of the Minnesota River Reports

Criteria for Inclusion of Monitoring Data in the 2001 - 2003 State of the Minnesota River Reports

PURPOSE

The purpose of the criteria proposed below is to ensure that water quality monitoring data from critical locations in the Minnesota River Basin is collected and analyzed in a consistent fashion by all participating organizations. This effort is being undertaken to enhance the comparability of data collected from different locations and from year to year (spatial and temporal comparability). These criteria were established by a multi-agency team. All monitoring organizations are encouraged to follow these criteria whenever practical with all of their monitoring locations. Only if data collection efforts are coordinated and standardized, will there be a detailed, scientifically defensible assessment of the long-term trends in the Minnesota River Basin. As such, only data collected and analyzed in a fashion generally consistent with the criteria established below will be eligible for inclusion in future Minnesota River Monitoring Reports.

CRITERIA

1. **Monitor for the complete season**: A monitoring season is defined as April 1st (or ice out) to September 30th. For stations located at the mouths of major tributaries, a longer monitoring season is encouraged when possible. If this is a non-USGS site, start monitoring and collecting samples as soon as the channel bed is clear of ice. If the station is located at a USGS site, year round sampling is encouraged. The USGS will compute the shift in stage due to the ice in the channel and adjust the flows accordingly. Safety is paramount in late and early season sampling but there is value in samples collected during these periods if reasonable estimates of flow can be made. Samples collected during the middle of winter can be valuable for assessing true baseflow water quality conditions.

2. **Accurately characterize all flow periods**: During most years, an absolute minimum of 15 samples is necessary to begin characterizing all flow periods. In general, 15 to 25 samples should be collected during the monitoring season. In years with significant snow pack (spring floods), at least 3 grab samples should be collected on the rising limb of the snowmelt hydrograph in order to capture the initial sediment flush, followed by at least two samples weekly until the flood waters recede (up to 75% or more of the total seasonal volume of water may move through during a flood). During spring through midsummer baseflow periods, at least one sample every ten days should be collected. During late summer/early fall baseflow periods (after the crop canopy has closed), one sample every fourteen days should be collected if there are no rain events that result in changes to stage. During the major spring and summer storm events, projects should strive for a minimum of 3 samples collected over each hydrograph (rising limb, peak and recession limb). Extreme events should be sampled more to

correctly characterize the flow/concentration dynamics. For lesser events that result in little change in stage, collect one or two samples over the event, use your discretion.

3. **The stage/discharge relationship must be defined and maintained**: The existing rating curves must be verified with monthly flow measurements. Any stage shifts that have occurred must be computed and data adjusted accordingly. Data will not be allowed for inclusion in the report when the maximum seasonal stage level has exceeded the stage level of the highest flow measurement used in constructing the sites rating curve.

4. **Site visits**: Site visits to download data and verify the monitoring equipment are important. Visits should be no less frequent than once a week during periods of moderate to high flows and once every two weeks during baseflow periods. During floods, site visits should be more frequent to make sure debris is not piling up on (submerged transducers or bubblers) or under your transducer (ultrasonic transducers).

5. **Sampling Methods:** All organizations must utilize a State Certified laboratory. On larger river systems, it is generally best to collect grab samples from a bridge deck using an approved sampling vessel whenever possible. Ideally, sampling will occur on the downstream side of the bridge so the person sampling can see the sampling vessel to assess its condition. However, safety should be the primary consideration when working on or around traffic and bridges. Sample collection should occur near the center of flow in a well-mixed or turbulent portion of the river and should be depth integrated (represent water from the surface to the bottom of the water column) if possible.

   Wading sample collection may be possible on smaller streams. In these instances, sample collection should again occur near the center of flow in a turbulent stretch of the river and should be depth integrated if possible. Sample collection should occur upstream of the person sampling to avoid disturbance caused by wading. Again, safety should be the primary consideration when evaluating how best to collect the sample.

   In some instances sample collection from the bank may be the only safe collection option. In these instances, the person sampling should seek a turbulent or well-mixed portion of the river within reach of the bank. Use a dipper to extend the sampling reach if necessary. Sample collection from pools or backwater areas of the river should be avoided.

   Organizations utilizing automatic samplers for the collection of storm event samples must pay close attention to sample tube intake location. Specifically, sample tube intakes should always be located a minimum of 12 inches from the stream channel bottom and as close to the center of flow as possible. In addition, samples collected by automatic samplers during warm weather should not be allowed to sit in the sampler for an extended period of time unless ice is added to the sampler base to cool the samples.

6. **Field Quality Control (QC):** Quality Control is an extremely important process when collecting any type of environmental sample. In addition to water quality samples, it is recommended that replicate samples be collected for approximately 5 to10 percent of the samples and that field and equipment blanks also be collected at a rate of approximately 5 to 10 percent.

Appendix B

FLUX

FLUX

FLUX is an interactive program developed by the U.S. Army Corps of Engineers that allows the user to estimate loadings from grab sample concentration data and continuous flow records. All participating organizations in the Summary Report used the Flux program, except where noted. Water quality data was derived from either composite or continuous sampling with sampling equipment, or grab sampling. These samples were paired with the flow data for that specific time period. Flow records for monitored sites were derived from continuous stage measurements.

Six alternative calculations methods are provided in the FLUX program. These calculations determine the flow/concentration relationship developed from the sample record onto the entire flow record to calculate total mass discharge and associated error statistics. The user selects the most appropriate method based on sampling design and flow dynamics for the specified time period.

For a complete discussion of FLUX, see U.S. Department of the Army, Corps of Engineers, Empirical Methods for Predicting Eutrophication in Impoundments, Report 4, Phase III: Application Manual, 1999.

Download the FLUX program free at http://www.wes.army.mil/el/elmodels/index.html

Appendix C

Glossary of Terms

Glossary of Terms

- **Load:** An estimate of pollutant or constituent mass, passing a specific location on a river during a specified interval of time.

- **Yield**: One way to assess pollutant contributions from watersheds of different sizes is to determine the **“yield”** or the mass per unit area (such as lbs./acre) of a constituent coming out of a watershed during a given time period (monitoring season in this report). Yield normalizes mass on the basis of area, and allows for more relative comparisons of pollutant contributions to be made between watersheds. Yield is calculated by dividing the total mass or load of a constituent by the area (acres) of the watershed.

- **Runoff-adjusted yield:** For many pollutants, the more precipitation that falls in a given watershed, the higher the pollutant loads and yields. To account for spatial differences in precipitation and resulting increases in runoff, the yield can be further divided by the number of inches of runoff for the watershed, giving a **“runoff-adjusted yield”** or yield per inch of runoff.

- **Flow-Weighted Mean Concentration:** Proportionately equivalent to runoff-adjusted yield, the **“flow-weighted mean concentration”** (FWMC) is calculated by dividing the total mass or load for the given time period by the total flow volume. The FWMC is mass for flow. Conceptually, a FWMC would be the same as routing all the flow that passed a monitoring site during a specific timeframe into a big, well-mixed pool, and collecting and analyzing one sample from the pool to give the average concentration.

- **Runoff:** Runoff is the part of precipitation which appears in rivers and streams, including baseflow, storm flow, flow from ground water, and flow from point sources. Essentially, runoff is all the flow passing a particular location on the river. To calculate monitoring season runoff, the total flow volume or the amount of water which passes by the station during the monitoring period is calculated and converted to acre-inches of water. This number is then divided by the total number of watershed acres to determine inches of runoff. Conceptually, this is equivalent to redistributing all the river flow equally over the watershed, then measuring that water depth in inches.

Appendix D

2003 Monitoring Project Methods

The following pages contain the methodologies for each watershed organization that contributed to the "2003 State of the Minnesota River Report." Each project submitted data based off of a provided outline.

Project summaries and 2003 monitoring season results were written by each individual project.

Yellow Bank River

Lac qui Parle-Yellow Bank Clean Water Partnership Diagnostic Studies
600 6th St,
Madison, MN 56265
Phone: (320) 598-3319
Contacts: Mary Homan
mahoman@mail.co.lac-qui-parle.mn.us

Monitoring Began: 2001

Project Summary

This is a cooperative partnership partially funded through a Clean Water Partnership Grant from the Minnesota Pollution Control Agency. There is assessment of the watershed through water quality monitoring and land use analysis. Major components include water quality monitoring, a citizen monitoring network and education/information components.

There are a total of thirteen sites between the Lac qui Parle and Yellow Bank partnership. Water quality monitoring occurs April through September. Sampling happens twice a month for baseline grabs and during rain events as needed. Samples are analyzed for pH, temperature, specific conductivity, dissolved oxygen, transparency, nitrate-nitrite nitrogen, total kjeldahl nitrogen, orthophosphorus, total phosphorus, suspended volatile solids, total suspended solids and turbidity.

Site Location

The Yellow Bank River Site #8 is located at County Highway 40, 2 and ¾ miles south of Odessa, MN. The drainage area is 440 square miles or 281,456 acres.

2003 Monitoring Season Results

Results for 2003 are not included in the report.

Lac qui Parle River

Lac qui Parle-Yellow Bank Clean Water Partnership Diagnostic Studies
600 6th St,
Madison, MN 56265
Phone: (320) 598-3319
Contacts: Mary Homan
mahoman@mail.co.lac-qui-parle.mn.us

Monitoring Began: 2001

Project Summary
This is a cooperative partnership partially funded through a Clean Water Partnership Grant from the Minnesota Pollution Control Agency. There is assessment of the watershed through water quality monitoring and land use analysis. Major components include water quality monitoring, a citizen monitoring network and education/information components.

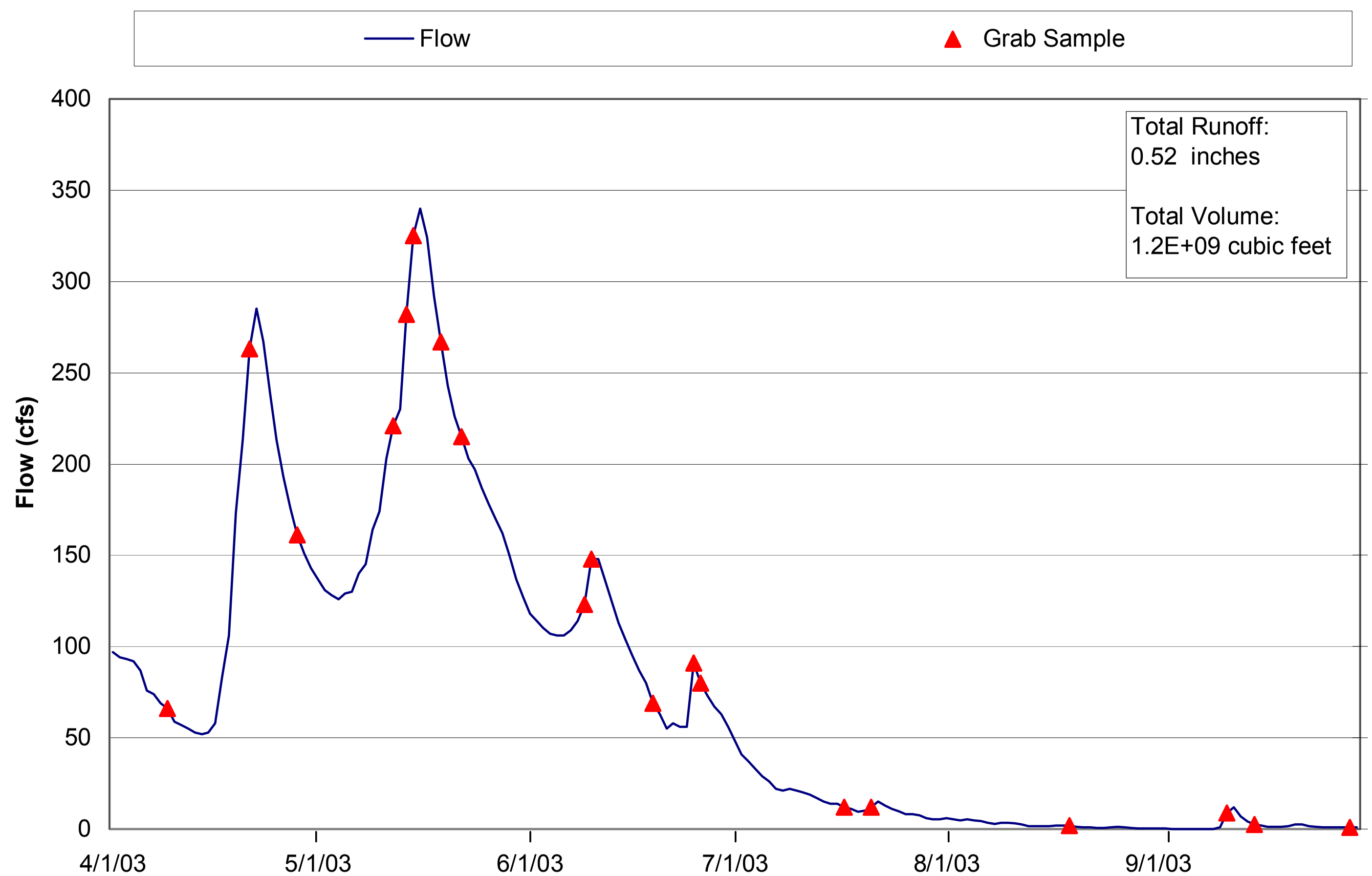
There are a total of thirteen sites between the Lac qui Parle and Yellow Bank partnership. Water quality monitoring occurs April through September. Sampling happens twice a month for baseline grabs and during rain events as needed. Samples are analyzed for pH, temperature, specific conductivity, dissolved oxygen, transparency, nitrate-nitrite nitrogen, total kjeldahl nitrogen, ortho-phosphorus, total phosphorus, suspended volatile solids, total suspended solids and turbidity.

Site Location
The Lac qui Parle River Site #9 is located at County Highway 31, 1 mile southwest of Lac qui Parle Village, MN. The drainage area is 961 square miles or 615,244 acres.

2003 Monitoring Season Results
This is the third year that the Lac qui Parle-Yellow Bank Clean Water Partnership collected samples in the watershed. All samples taken are grab samples and sent to ERA Laboratories in Duluth, MN. Both rising and falling limbs of the hydrograph are represented in the samples with good baseline samples. This monitoring site is the last site we monitor before the Lac qui Parle drains into Lac qui Parle Lake and the Minnesota River.

Sampling and Loading Results for the Lac qui Parle River
There were nineteen grab samples collected at the Lac qui Parle River Site #9 in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2003 can be found at Appendix E. Figure D.01 presents the Lac qui Parle River hydrograph for 2003.

Figure D.01 Lac qui Parle River 2003 Hydrograph with Sampling Information



Chippewa River

Chippewa River Watershed Project
629 N. 11th Street
Montevideo, MN 56265
Phone: 320-269-2139 x116
Fax: 320-269-8593
Contacts: Kylene Olson, Watershed Project Coordinator
Kylene.Olson@mn.usda.gov
Paul Wymar, Watershed Technician
Paul.Wymar@mn.usda.gov

Monitoring Began: 1998

Project Summary

In 1998 CRWP began to monitor the Chippewa River. The overall goal of the CRWP was to improve the water quality and flooding problems in the Chippewa River Watershed Project while also promoting a healthy agricultural, industrial and recreation-based economy for the region.

The objective of the monitoring is to monitor and evaluate the variability of water quality and flow volume within the basin. The monitoring and assessment are used to identify which problems are present in each subregion, prioritize them, and then appropriate suits of best management practices are developed. To help achieve this objective, sampling is done using a three-pronged approach designated as Level 1, Level 2 and Level 3. Level 1 sampling involves the collection of continuous streamflow data and intensive collection of water-quality samples during runoff events. Level 2 sampling is designed to be synoptic and consists of sampling stream segments in a downstream order over a short period of time to collect baseline data that can document changes in water quality along a stream's course. Level 3 sites are those initiated through the Citizen Monitoring Network. These sites were mostly monitored for transparency tube readings and rainfall, but these readings are useful for isolating source areas in more detail than the widespread, costly Level 1 and Level 2 efforts.

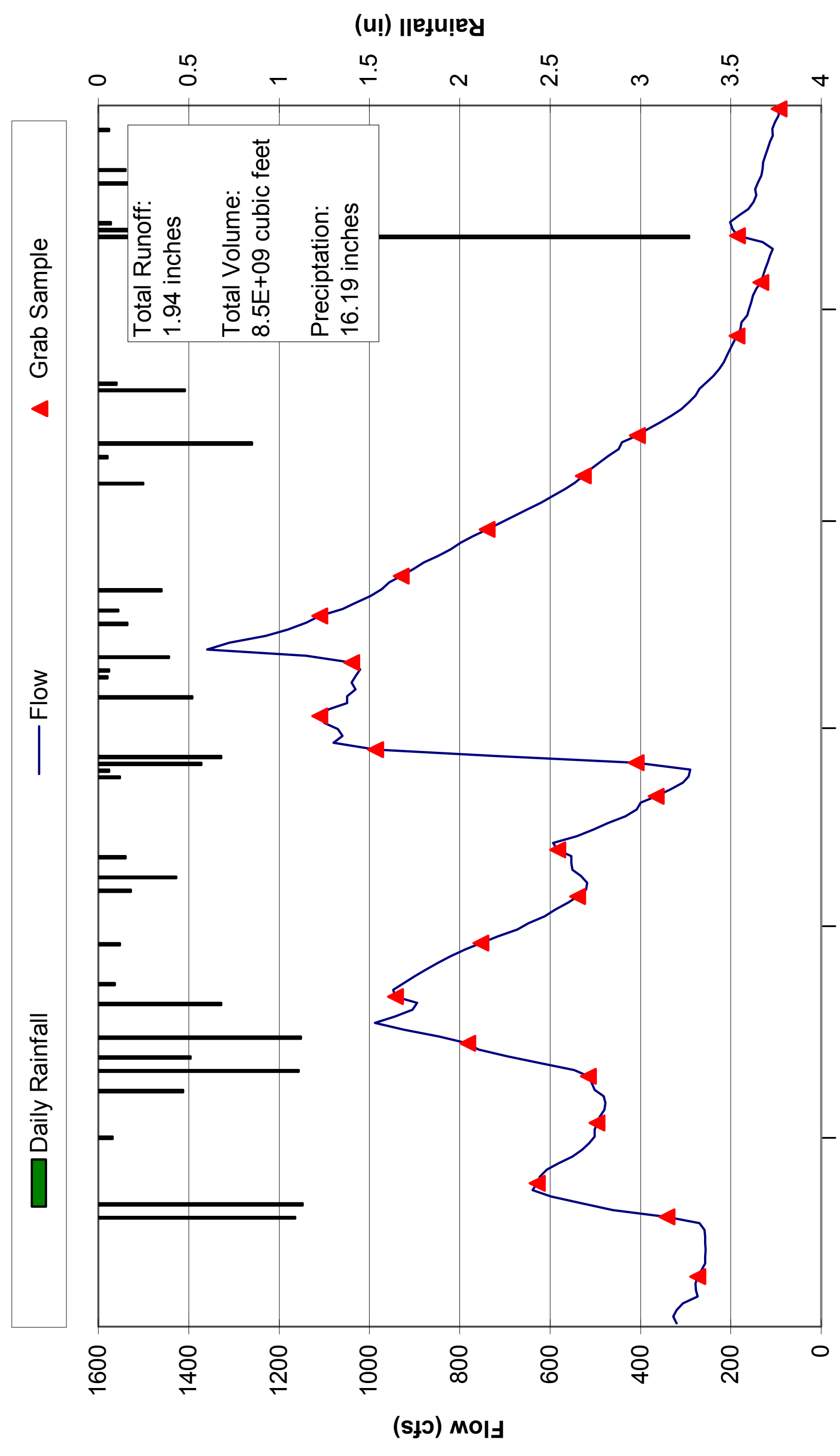
Site Location

The Chippewa River Site #18, at Hwy 40 Bridge near Milan, MN, is located in SE¼, SE¼, Sec.16, T.119 N., R.41 W., Chippewa County. This is also a USGS stream gaging site, station 05304500. This site is located on the right bank, 20 ft. downstream from State Highway 40 bridge, 2.0 miles upstream from small tributary, and 5.5 miles east of Milan. The drainage area is 1,880 square miles or 1,203,200 acres.

Sampling and Loading Results for the Chippewa River

There were twenty-four grab samples collected at the CRWP site18 station in 2003. Only samples collected during the defined monitoring season (4/1 – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000 to 2003 can be found at Appendix E. Figure D.02 presents the Chippewa River hydrograph for 2003.

Figure D.02 Chippewa River 2003 Hydrograph with Rainfall and Sampling Information



Dry Weather Creek

Chippewa River Watershed Project
629 N. 11th Street
Montevideo, MN 56265
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Fax: 320-269-8593
Contacts: Kylene Olson, Watershed Project Coordinator
Kylene.Olson@mn.usda.gov
Paul Wymar, Watershed Technician
Paul.Wymar@mn.usda.gov

Monitoring Began: 1998

Project Summary

See the Chippewa River section on the previous two pages for a complete project summary.

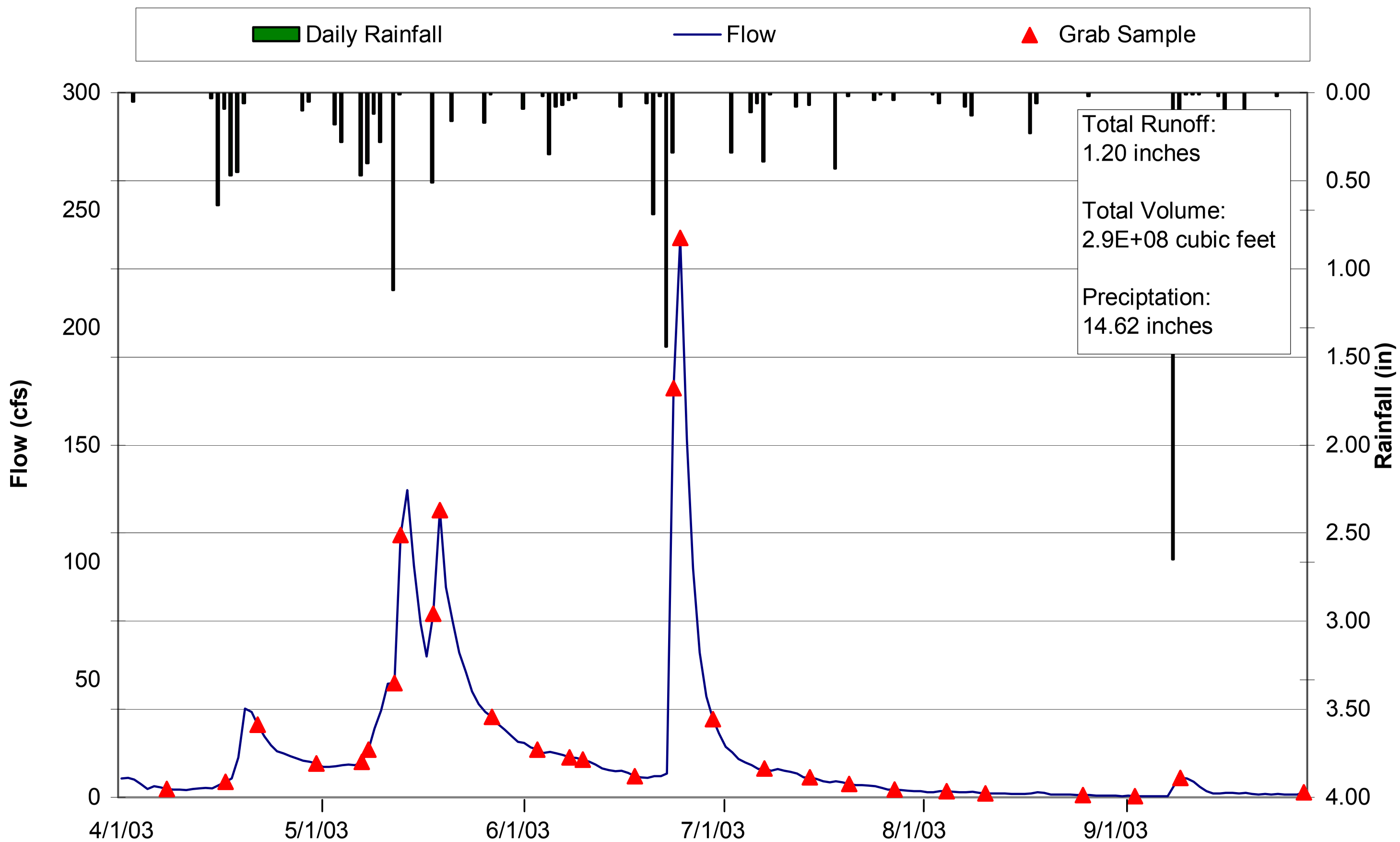
Site Location

The Dry Weather Creek Site #19, is about 4 miles NE of Watson on 85th Ave. NW, is located in Sec.11, T.118 N., R.41 W., Chippewa County. The drainage area is 106 square miles or 67,759 acres.

Sampling and Loading Results for the Dry Weather Creek

There were twenty-eight grab samples collected at the Dry Weather Creek Station in 2003. Only samples collected during the defined monitoring season (4/1 – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2002 to 2003 can be found at Appendix E. Figure D.03 presents the Dry Weather Creek hydrograph for 2003.

Figure D.03 Dry Weather Creek 2003 Hydrograph with Rainfall and Sampling Information



Yellow Medicine River

Yellow Medicine River Watershed
122 North Jefferson Street P.O. Box 267
Minneota, MN 56262
Phone: (507)-872-6720
Contacts: Terry Renken and Cindy Potz
ymrw@starpoint.net
Website: www.ymrw.com/YMRW.html

Monitoring Began: 1999

Project Summary

The Yellow Medicine River Watershed District is involved in a Phase II Implementation Phase of a Clean Water Partnership, with Project Partners being Minnesota Pollution Control Agency, Lincoln, Lyon and Yellow Medicine Soil and Water Conservation Districts, Lincoln, Lyon and Yellow Medicine NRCS agencies, Area II MN River Basin Projects, and MN BSWR. The project was designed to determine the nutrient loads of the water in the Yellow Medicine River and its tributaries. Through the three-year Phase I diagnostic study, specific areas were chosen in the Yellow Medicine River Watershed to have extremely high or moderately high levels of nitrate-nitrites, phosphorus, and total suspended solids. These areas became our priority sites.

The Implementation Phase began in March of 2001, with a focused plan of action, that being to address the priority sites diagnosed in the previous diagnostic study. Several best management practice options were discussed at our technical committee meetings, along with comments and suggestions from the committee as to what practices would most likely be accepted and what programs were offered to financially assist the landowners in becoming involved in the best management practices. Funds were requested and received through the CWP MPCA grant, in order for the Yellow Medicine River Watershed GYMR Phase II project to allocate an incentive payment to the involved landowners, based on the number of acres signed into the best management practices project.

In the initial Phase I project, 15 sites were periodically monitored through each season, with grab samples taken every two weeks, and storm event sampling taken after significant storms.

In the Implementation Program, Phase II, monitoring began in April of 2001, beginning with a spring runoff grab sampling event. The spring runoff monitoring is a valuable tool in assessing the erosion sediments, and assessing snow melt effects on the river, including the nutrient loads carried from the soil into the river. Monitoring continued throughout the season, from April until October, on a more scaled down level, at the eight primary sites, 1-8 in central locations throughout the watershed. Site 1 is designates as a USGS site, and data relating to that site was taken from the USGS online water data information system in addition to the watersheds monitoring teams' grab sampling events and storm events. All other sites 2-8 were monitored for water quality through grab sample events, and quantity through flow rating measurements and CR10X datalogger systems recordings with the use of Instrumentation Northwest pressure transducers.

As we progress into the implementation phase, we anticipate that the monitoring results will reflect the effects of the best management practices now being put into place. Numerous filter strips, basins and waterways have been and continue to be funded, as well as the utilization of a nutrient management specialist, employed by the Yellow Medicine River Watershed District, through the Clean Water Partnership grant program. These projects should have a positive effect on the quantity and quality of the water in the Yellow Medicine River. As the Yellow Medicine River Watershed District has submitted results of their programs to MPCA and the Minnesota River Basin Data Center in Mankato, various information about our Clean Water Partnership Program can be found on their websites. See http://www.mrbdc.mankato.msus.edu and http://www.pca.state.mn.us for more information.

The Yellow Medicine River Watershed District also has available on their website a 130 page final report of the Phase I diagnostic study which will cover in great detail the results of our Phase I Clean Water Partnership, and upon its approval by MCPA, brought us into the application for a grant for the Implementation Phase. See www.ymrw.com/YMRW.html for more information.

The Yellow Medicine River Watershed District follows closely the efforts of all local watershed districts in their clean water partnerships, and has met with their staff at various times, to share methods of data collection and reporting. We are all working towards the same end results, of restoring and maintaining the quality of our rivers and streams in our watershed districts. These projects in return should benefit the efforts of those working towards the goal of restoring the quality of the water in the Minnesota River. Our specific goal is that in the next six years, we intend to ascertain that the quality of the Yellow Medicine River becomes improved by at least 25%. We hope to ensure that the Yellow Medicine River water entering the Minnesota River will be better in fact than that of the Minnesota River. We are proud to be involved with everyone working towards the goal of cleaner lakes and rivers in Minnesota.

Site Location

The Yellow Medicine River Site #1 is located between sections 34 and 35 of Minnesota Falls Township, Yellow Medicine County. This is a USGS station 05313500 near Granite Falls, MN. The drainage area is 664 square miles or 424,958 acres.

Sampling and Loading Results for the Yellow Medicine River

There were nine grab samples collected at the Yellow Medicine River Site#1 in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000 to 2003 can be found at Appendix E. Figure D.04 presents the Yellow Medicine River hydrograph for 2003.

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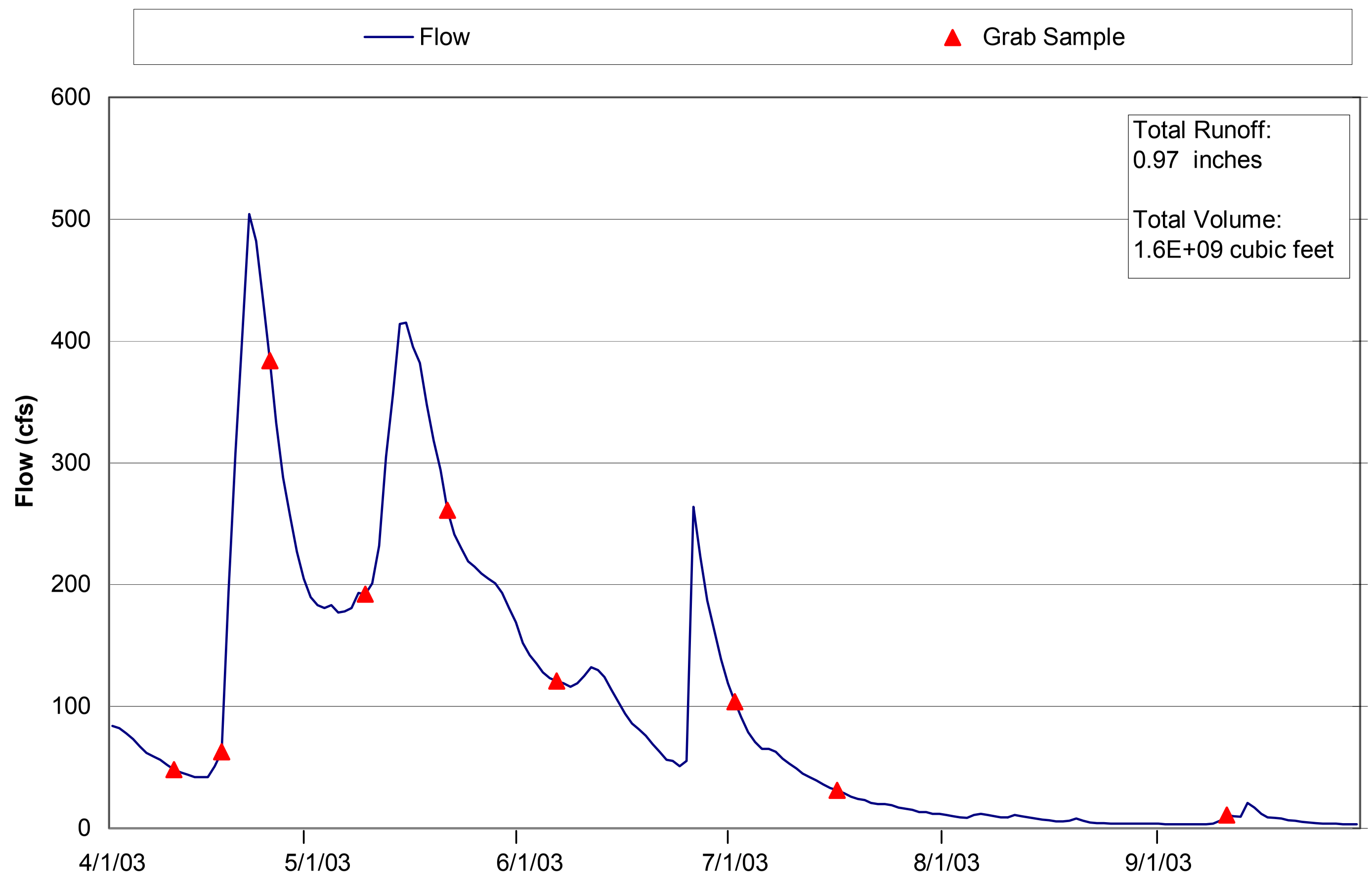
Figure D.04 Yellow Medicine River 2003 Hydrograph with Rainfall and Sampling Information



Hawk Creek

Hawk Creek Watershed Project
Renville County Courthouse, Lower Level
500 East DePue Avenue
Olivia, MN 56277
Fax: 320-523-3668
Contact: Loren Engelby, Project Coordinator
Phone: 320-523-3672
loren_e@co.renville.mn.us

Monitoring Began: 1999

Project Summary

Prompted by concern over suspected and known water quality and quantity issues in the Hawk Creek Watershed, a group of concerned citizens and local, state and federal representatives from the three counties in the watershed began meeting in February of 1997 to work together to address these issues. Known as the Hawk Creek Watershed Committee, the group determined their long-term goal to be improving the water quality and quantity issues in watershed while also promoting a healthy agricultural, industrial and recreation-based economy for the region.

A Phase I Diagnostic Study was established in 1999 to determine present water quality conditions and identify stream segments that were not supporting designated uses. This study had 27 sites throughout the watershed, six of which had CR10 sampling stations. Phase II Diagnostic Study began in 2001 and will end in 2004. This study only monitored the water quality and quantity at the six primary sites that had sampling stations. During Phase I and Phase II, the project monitored for fecal coliform, ammonia nitrogen, nitrate + nitrite nitrogen, total kjeldahl nitrogen, ortho phosphorus, total phosphorus, total suspended solids, and transparency. The Phase II 2002 sampling season added dissolved oxygen, conductivity, and pH to the monitoring routine.

Site Location

Site 19 is located near the mouth of the Hawk Creek in Renville County at a bridge on County Road 52. The drainage area is 505 square miles or 323,199 acres.

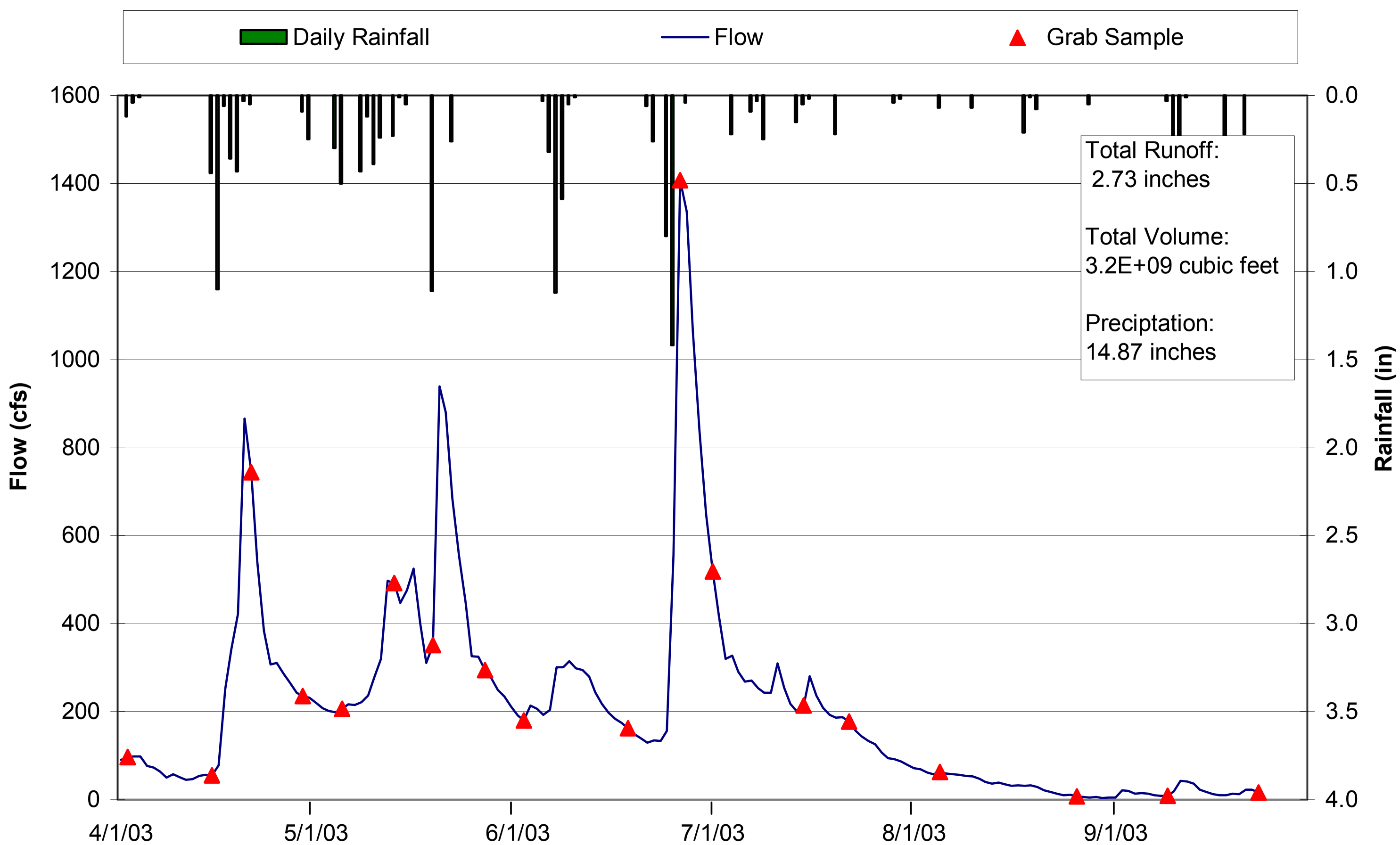
2003 Monitoring Season Results

There was very little snow melt runoff in the spring of 2003. There was an occasional “timely” rain during April and May but for the most part flows remained relatively low. One big event occurred on 6/25/03. After that, it was one of the driest summers on record, very little rain during the late summer and fall

Sampling and Loading Results for Hawk Creek

There were eighteen grab samples collected at the Hawk Creek site #19 in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000 to 2003 can be found at Appendix E. Figure D.05 presents the Hawk Creek hydrograph for 2003.

Figure D.05 Hawk Creek 2003 Hydrograph with Rainfall and Sampling Information



West Fork Beaver Creek

Hawk Creek Watershed Project
Renville County Courthouse, Lower Level
500 East DePue Avenue
Olivia, MN 56277
Fax: 320-523-3668
Contact: Loren Engelby, Project Coordinator
Phone: 320-523-3672
loren_e@co.renville.mn.us

Stephanie Klamm, Water Quality & Education/Outreach Technician
Phone: 320-523-3673
hawkcreeksteph@redred.com

Monitoring Began: 1999

Project Summary

See Hawk Creek section on the previous three pages for complete project summary.

Site Location

Site 25 is located in Henryville township in Renville County, approximately 8 miles north of Redwood Falls on MN Hwy 71 and then approximately 1.3 miles west on Renville Cty Rd 4. The drainage area is 96 square miles or 61,326 acres.

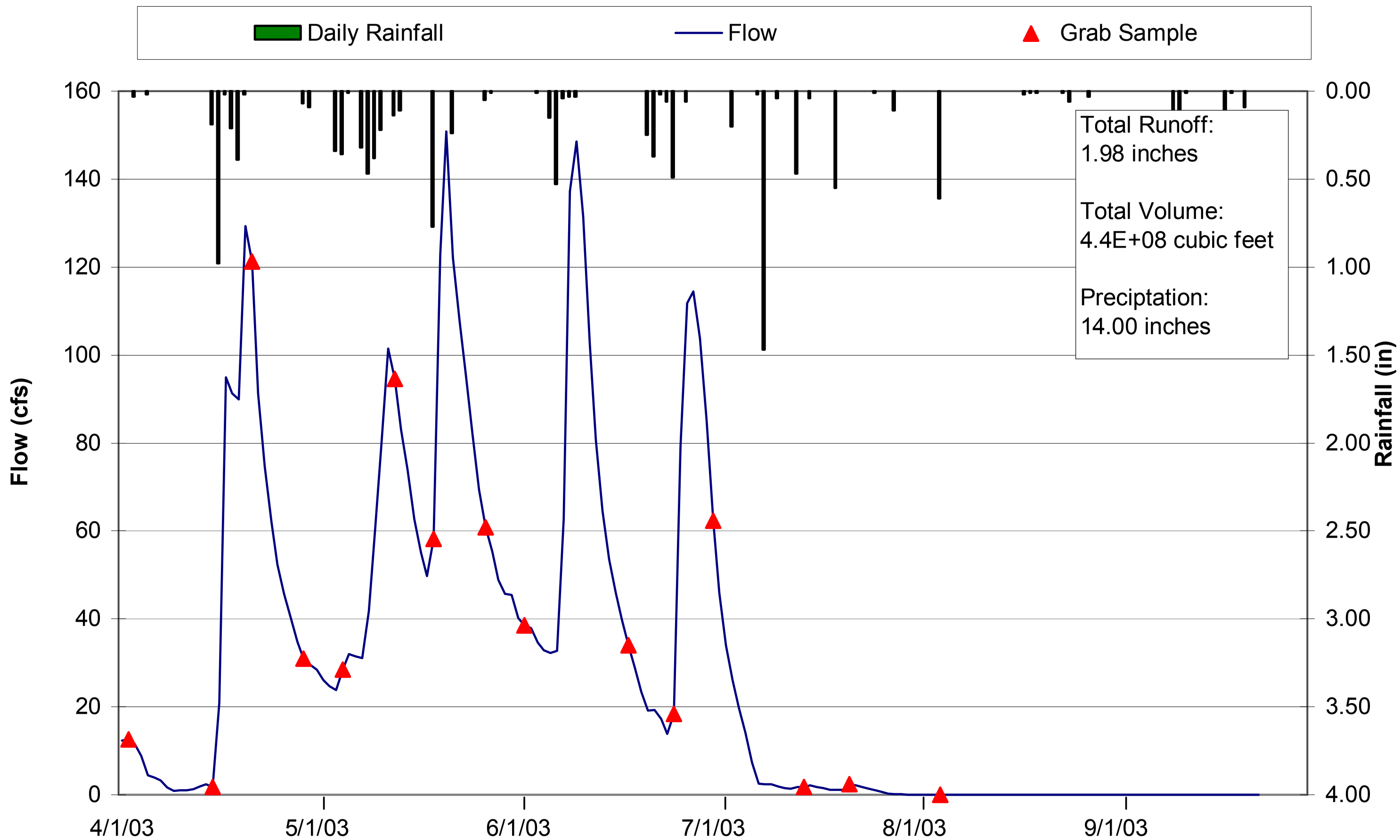
2003 Monitoring Season Results

There was very little snow melt runoff in the spring of 2003. There was an occasional "timely" rain during April and May but for the most part flows remained relatively low. One big event occurred on 6/25/03. After that, it was one of the driest summers on record, very little rain during the late summer and fall

Sampling and Loading Results for West Fork Beaver Creek

There were fifteen grab samples collected at the West Fork Beaver Creek site #25 in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2003 can be found at Appendix E. Figure D.06 presents the West Fork Beaver Creek hydrograph for 2003.

Figure D.06 West Fork Beaver Creek 2003 Hydrograph with Rainfall and Sampling Information



Redwood River

Redwood River Clean Water Project
Redwood-Cottonwood Rivers Control Area (RCRCA)
1241 E. Bridge St.
Redwood Falls, MN 56283
Phone: (507) 637-2142 ext. 4
www.rcrca.com
Contacts: Jim Doering, Executive Director
Jim.doering@mn.usda.gov
Douglas A. Goodrich
douglas.goodrich@mn.usda.gov

Monitoring Began: 1989 (exception is 1993)

Project Summary

The monitoring program is designed to be a continuation of water quality data collection procedures initiated during the diagnostic study phase of the Redwood River Clean Water Project. Information gathered through the program improves loading estimate accuracy, and also helps to assess water quality trends within the watershed as wells as communicate project activities to the general public.

Monthly base flow samples are collected at each station between May and September. At least two storm events equal to a five-year frequency will be sampled at each location. At the main stem location, monthly base flow samples are carried on throughout the year. Retrieving samples each month will help with the Flux estimation of loading and will allow the Project to accurately predict annual loading.

Each monthly base flow sample is analyzed for total suspended solids, nitrate/nitrite, total phosphorus, orthophosphate and fecal coliform. Storm samples are analyzed for the same with exception of fecal coliform. Field analysis includes monthly testing on temperature, conductivity, dissolved oxygen, pH and both storm and monthly with the transparency tube.

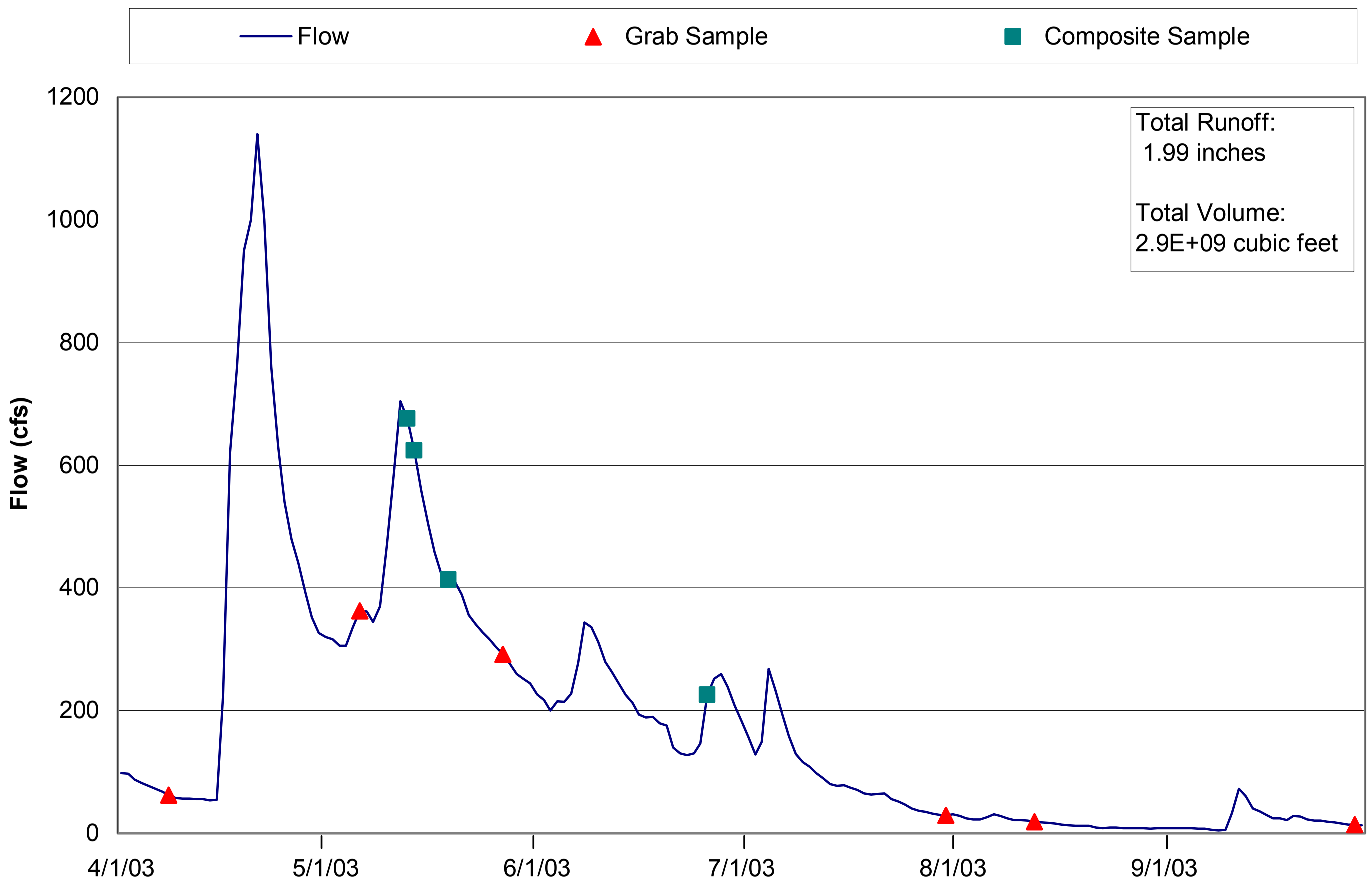
Site Location

The Redwood River site, RR1, is located at Sec. 9, T112N, R36W, on CSAH 17, 3 miles south west of Redwood Falls, MN. This is also a USGS stream gaging site, station 05316500. The drainage area is 629 square miles or 402,560 acres.

Sampling and Loading Results for the Redwood River

There were ten samples collected at the Redwood River site RR1 in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000, 2002 and 2003 can be found at Appendix E. Figure D.07 presents the Redwood River hydrograph for 2003.

Figure D.07 Redwood River 2003 Hydrograph with Sampling Information



Clear Creek

Redwood River Clean Water Project
Redwood-Cottonwood Rivers Control Area (RCRCA)
1241 E. Bridge St.
Redwood Falls, MN 56283
Phone: (507) 637-2142 ext. 4
www.rcrca.com
Contacts: Jim Doering, Executive Director
Jim.doering@mn.usda.gov
Douglas A. Goodrich
douglas.goodrich@mn.usda.gov

Monitoring Began: 1990

Project Summary
See Redwood River section on the previous two pages for complete project summary.

Site Location
The Clear Creek Site, RWR003, is located at SE ¼, NW ¼, section 29, T112N, R37W , on CR-56, 1/3 mile from the confluence with the Redwood River on the NE edge of Seaforth. The drainage area is 77 square miles or 49,280 acres.

Sampling and Loading Results for Clear Creek
There were nine samples collected at Clear Creek Site RWR003 in 2003. However, the datalogger was not working properly and no flow data were available to calculate loads. Loading results for 2000 - 2002 can be found at Appendix E.

Cottonwood River

Cottonwood River Restoration Project
Redwood-Cottonwood Rivers Control Area (RCRCA)
1241 E. Bridge St.
Redwood Falls, MN 56283
Phone: (507) 637-2142 ext. 4
www.rcrca.com
Contacts: Jim Doering, Executive Director
jrd@mnredwoodf.fsc.usda.gov
Douglas A. Goodrich
douglas.goodrich@mn.usda.gov

Monitoring Began: 1997

Project Summary

The monitoring program is designed to be a continuation of water quality data collection procedures initiated during the diagnostic study phase of the Cottonwood River Restoration Project. Information gathered through the program improves loading estimate accuracy, and also helps to assess water quality trends within the watershed as wells as communicate project activities to the general public.

Monthly base flow samples are collected at each station between May and September. At least two storm events equal to a five-year frequency will be sampled at each location. At the main stem location, Cottonwood River at New Ulm monthly base flow samples will be carried on throughout the year. Retrieving samples each month will help with the Flux estimation of loading and will allow the Project to accurately predict annual loading.

Each monthly base flow sample is analyzed for total suspended solids, nitrate/nitrite, total phosphorus, orthophosphate and fecal coliform. Storm samples are analyzed for the same with exception of fecal coliform. Field analysis includes monthly testing on temperature, conductivity, dissolved oxygen, pH and both storm and monthly with the Transparency Tube.

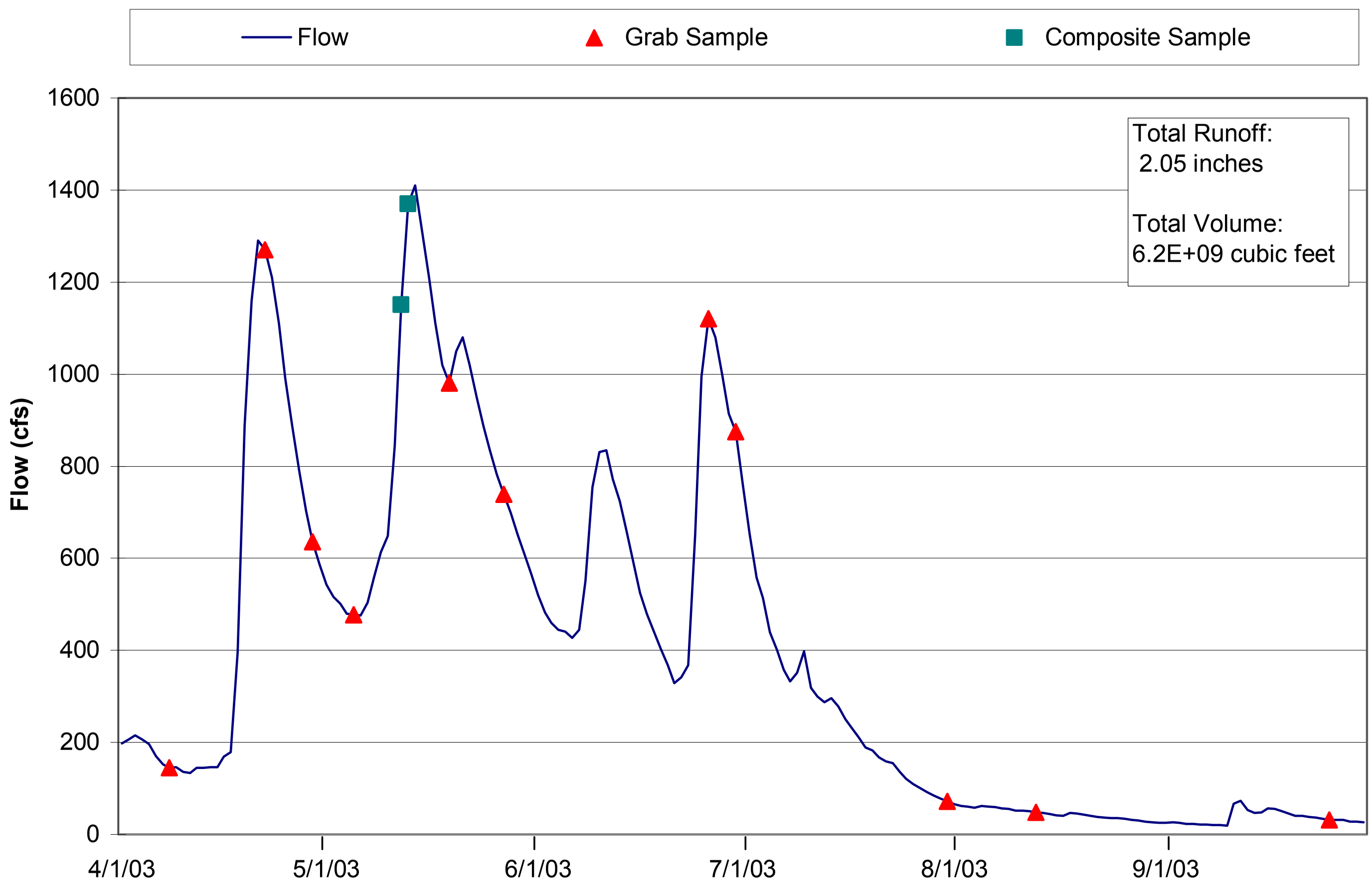
Site Location

The Cottonwood River site, PLC001, is located in SW ¼, NE ¼ Section 33 T. 110N, R. 30W, Brown County, within the city of New Ulm, MN. This site is approximately 500 yards downstream from the USGS stream gaging station 05317000. The drainage area is 1,312 square miles or 840,000 acres.

Sampling and Loading Results for the Cottonwood River

There were thirteen samples collected at the Cottonwood site PLC001 in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000, 2002 and 2003 can be found at Appendix E. Figure D.08 presents the Cottonwood River hydrograph for 2003.

Figure D.08 Cottonwood River 2003 Hydrograph with Sampling Information



Little Cottonwood River

Little Cottonwood River Watershed Project
Brown Nicollet Cottonwood Water Board
322 So. Minnesota Ave.
St Peter, MN 56082
Phone: 507-934-4140
Fax: 507-934-8958
Contact: Kevin Kuehner, Program Director
kuehnbnc@mnic.net
Scott MacLean
maclebnc@mnic.net

Monitoring Began: 1998

Project Summary

Three water quality monitoring sites were established on the Little Cottonwood River in 1989 as part of the Brown-Nicollet-Cottonwood Groundwater Quality Analysis Project. These sites were monitored until 1994. In 1996, monitoring efforts intensified as part of a resource investigation project titled Middle/Lower Minnesota Assessment Project. Four monitoring sites were established. The Little Cottonwood River Restoration Project received Clean Water Partnership funds from the MNPCA in 1997 to perform a diagnostic study. Following completion of the four year diagnostic study, the LCR project received Phase II funding in 2001 from the MNPCA. For the implementation phase of the project, water quality samples are still taken at two of the four monitoring sites.

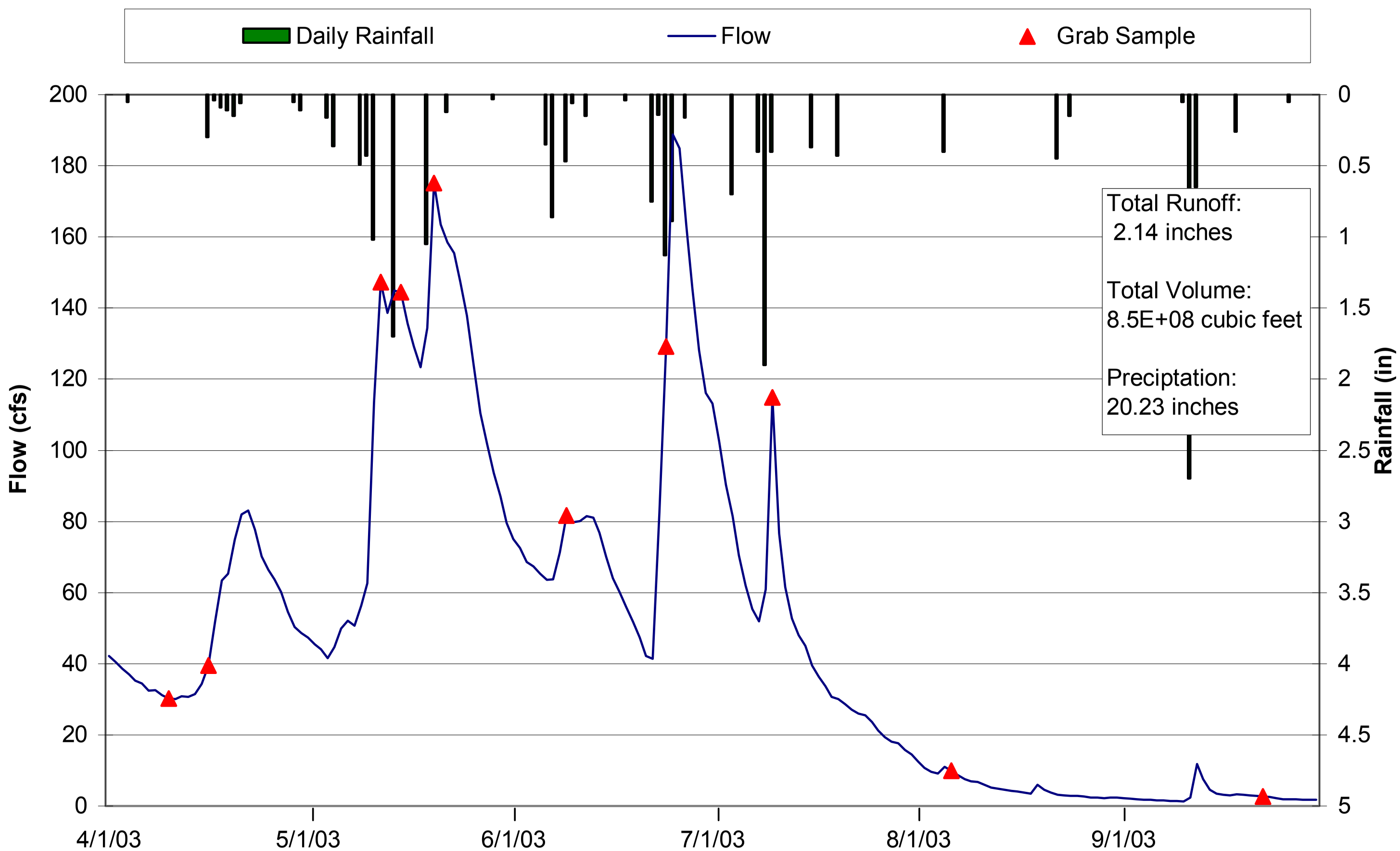
Site Location

Site 4 is located in SW ¼, NE ¼, Sec 17 T.109N, R. 29W, which is two miles south of Courtland, MN on unnamed Blue Earth County gravel road, just off of MN Highway 68. This is a USGS stream gaging station 05317200 that is slated for discontinuation on Oct. 1, 2003. This site has a drainage area of 170 square miles or 108,760 acres.

Sampling and Loading Results for the Little Cottonwood River

There were ten samples collected at the Little Cottonwood Site 4 in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2002 and 2003 can be found at Appendix E. Figure D.09 presents the Little Cottonwood River hydrograph for 2003.

Figure D.09 Little Cottonwood River 2003 Hydrograph with Rainfall and Sampling Information



Watonwan River

Watonwan River Phase II CWP
1230 South Victory Drive
Mankato, MN 56001
Phone: 507-389-1648
Fax: 507-389-5422
Contact: Pat Baskfield, Minnesota Pollution Control Agency
Pat.baskfield@pca.state.mn.us

Monitoring Began: 2000

Project Summary

During 2000, the Watonwan River entered the second phase of the Clean Water Partnership. Five sites were re-established along the Watonwan River to monitor the North Fork of the Watonwan, the western Mainstem, Butterfield and St. James Creeks, the South Fork and the Outlet by Garden City. Electronic monitoring equipment was installed to measure stage, several flow measurements were taken to update or verify existing rating curves and many grab samples were collected throughout the season so nutrient loads and concentrations could be computed. The additional information collected is being used to gain additional knowledge and gain a better understanding of the long term water quality and quantity trends of the Watonwan River.

The spring of 2003 marked the fourth year of the second phase of the Watonwan River Clean Water Partnership.

Site Location

The Watonwan Outlet (WO) is located in SW¼ NE¼ Sec.28, T.107 N., R.28 W, Blue Earth County. This site was previously referred to as WP1 during the Phase I CWP. This site is located on the left bank 25 ft downstream from bridge on Blue Earth County Rd 13, 1.5 miles west of Garden City, 7.3 miles upstream from mouth, and 9.2 miles downstream from Perch Creek. This is also a USGS stream gaging station 05319500. Drainage area for the entire watershed is approximately 812 square miles or 544,533 acres.

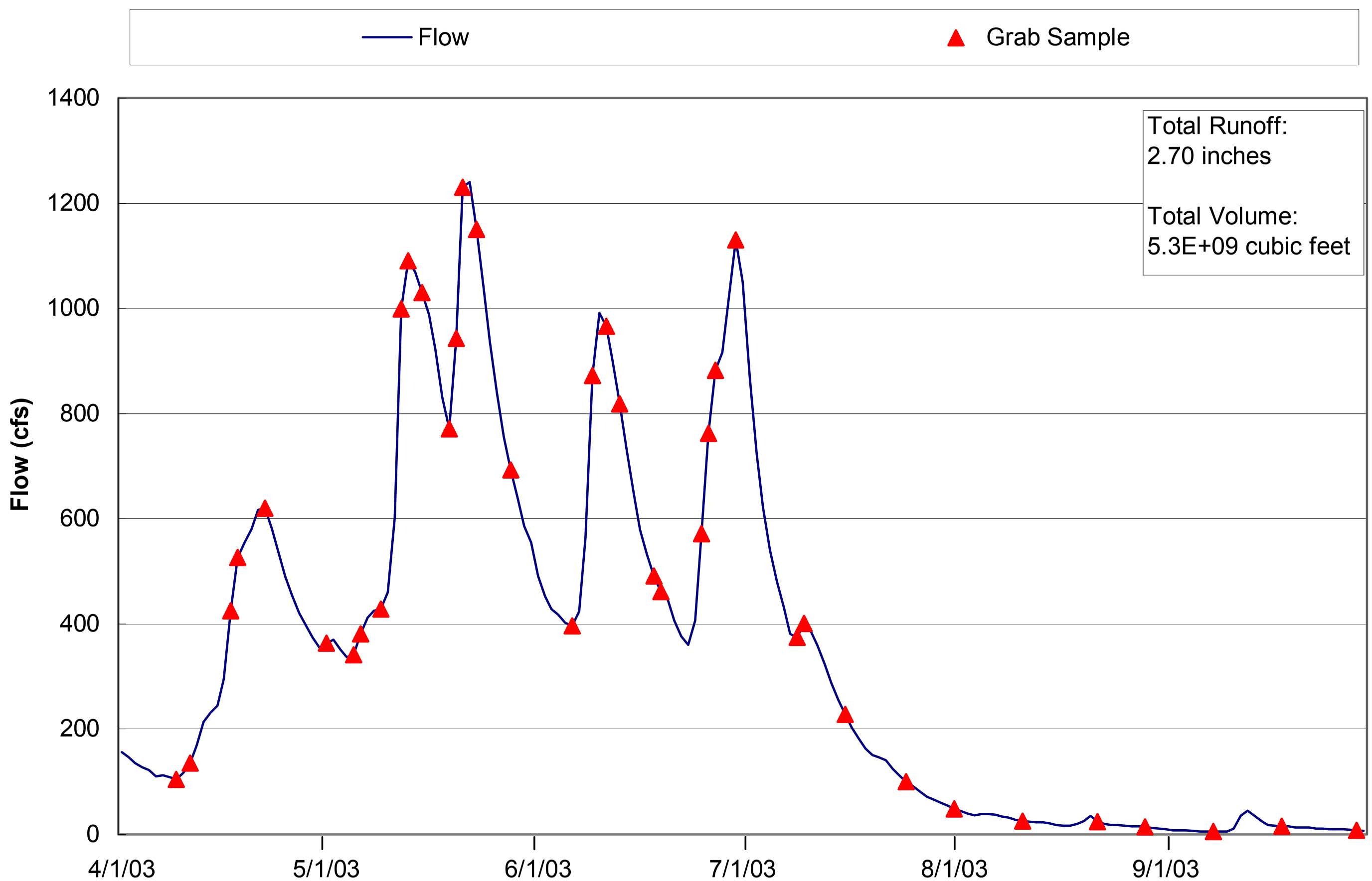
2003 Monitoring Season Results

The sampling regime was fairly complete. The falling limb of a major flow event, which occurred in late June and early July, was missed. Snowpack for the 2003 monitoring season was well below average. As a result snowmelt runoff was minimal.

Sampling Results for Watonwan River

There were thirty-eight grab samples collected at the Watonwan outlet site WO in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000 - 2003 can be found at Appendix E. Figure D.10 presents the Watonwan River hydrograph for 2003.

Figure D.10 Watonwan River 2003 Hydrograph with Sampling Information



Dutch Creek

Martin County Environmental Services Department
Martin County Courthouse
201 Lake Avenue
Room 100
Fairmont, MN 56031
Phone: 507-238-3227
Fax: 507-238-3136

Contact: Darren Newville

Monitoring Began: 1999

Project Summary

Purpose:

To evaluate and make targeted improvements to water quality within the watershed.

Goals:

- To determine the nutrient and sediment loads coming from the Dutch Creek Watershed into the Fairmont Chain of Lakes. (The City of Fairmont obtains their drinking water from Budd Lake located in the Chain of Lakes and experiences taste and odor problems associated with algal blooms.)
- To determine the possible sources of the loading and implement practices to reduce the loads.
- To continue monitoring efforts and evaluate the success of implementation measures.

Project monitoring began in 1999 with grab sampling. In 2000, the sampling location changed, and an automatic sampling station was used.

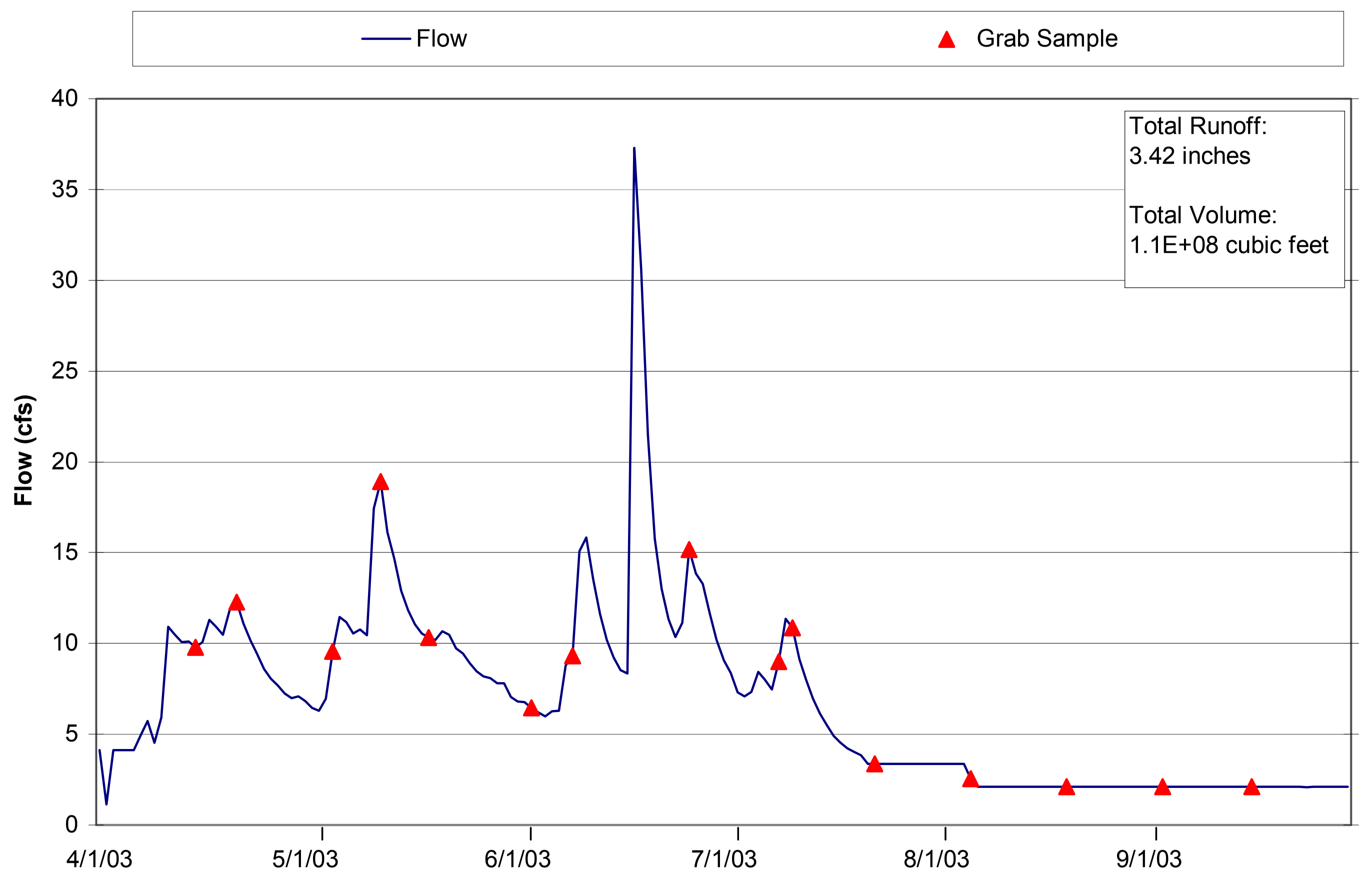
Site Location

The Dutch Creek site is located in NW¼ Sec. 24, 102N R31W, Martin County. The Dutch Creek Watershed (30072) is located in the Blue Earth River Watershed. It is located west of Fairmont and is part of the watershed that feeds the Fairmont Chain of Lakes, and eventually Center Creek. Drainage area for the entire watershed is approximately 13.52 square miles or 8,653 acres.

Sampling and Loading Results for Dutch Creek

There were fifteen grab samples collected at the Dutch Creek site in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000 - 2003 can be found at Appendix E. Figure D.11 presents the Dutch Creek hydrograph for 2003.

Figure D.11 Dutch Creek 2003 Hydrograph with Rainfall and Sampling Information



Blue Earth, Le Sueur, and MN River at Judson and St. Peter

Water Resources Center at Minnesota State University, Mankato
Minnesota Department of Agriculture, Monitoring and Assessment
Mankato Field Office
184 Trafton Science Center South
Mankato, MN 56001
Contact: Zachary Pagel
zachary.pagel@mnsu.edu
Bill Van Ryswyk, MDA, Hydrologist
Phone: 507-389-5772
Fax: 507-389-5712
Bill.Vanryswyk@state.mn.us

Monitoring Began: 1999

Project Summary

In February 1999, the Minnesota Department of Agriculture (MDA) and the Metropolitan Council Environmental Services (MCES) established a surface water quality monitoring field office in Mankato. The office serves as a central location for the operation and maintenance of long-term monitoring stations located on the main stem of the Minnesota River, and near the Blue Earth and Le Sueur River Watershed outlets as well as on several other smaller tributaries. This effort is part of the "Interagency Water Monitoring Initiative" funded by the Minnesota legislature in 1997.

The MCES monitoring initiative is known as the "Minnesota River Watershed Monitoring Program" with the Mankato office focusing on the collection of hydraulic, sediment and nutrient data. The objective of this program is to focus on conventional water quality pollutants contributing to exceedances of water quality standards/criteria and impairment of designated uses in the Minnesota River Basin.

The primary goal of MDA Surface Water Monitoring Program is to quantify the long-term trends associated with normal pesticide use on surface water quality in the Minnesota, Blue Earth and Le Sueur Rivers. In 2003 the MDA monitored for 26 different pesticides (including herbicides, insecticides and breakdown products) commonly used in agriculture and on lawns and gardens as well as selected nutrients. Understanding how the routine use of pesticides impacts water quality is critical in determining how to best manage pesticides and pesticide application to minimize surface water impact. An MDA standard analyte list is presented under the Water Sample Analysis Section.

Effective January 1, 2005, the Minnesota River Watershed Monitoring Program was transferred from MCES to the Water Resources Center at Minnesota State University, Mankato. The WRC will be taking over the responsibility for running the program. MCES will continue to provide laboratory support for the project.

Water Sample Analysis
Metropolitan Council Environmental Services (MCES) samples were transported by project personal to the MCES Laboratory Services Section in St. Paul, MN. Each sample was analyzed for water transparency, total and volatile suspended solids, turbidity, alkalinity, hardness, metals, chlorides, nitrogen, phosphorus, chlorophyll-a, total organic carbon (TOC), chemical oxygen demand (COD), and biochemical oxygen demand (BOD). For a complete list, see Table D.01.

Table D.01. MCES Analyte list

Alkalinity
Chloride
Total Chlorophyll a
Total Chromium
Total Copper
Hardness
Total Lead
Total Nickel
Nitrate + Nitrite
Dissolved Othro-phosphorus
Sulfide
Total Suspended Solids
Biological Oxygen Demand
Total Kjehldahl Nitrogen
Total Organic Carbon
Dissolved Phosphorus
Total Phosphorus
Volatile Suspended Solids
Total Zinc

MDA samples were typically hand delivered or next day shipped to the MDA laboratory in St. Paul. Analysis at the MDA laboratory includes pesticides, nitrate-N, ammonia, total phosphorus and ortho-phosphorus. Pesticide analysis consists of base neutral pesticide analysis for all samples collected throughout the year and acid herbicides are run from early May through October. Acid herbicide analysis is discontinued during the winter and early spring months because the concentration of these compounds typically drops below detection levels. For a complete list of analytes, see Table D.02.

Table D.02. MDA's analyte list

PESTICIDE	METHOD	REPORTING LIMIT (ug/l)
ACETOCHLOR	BASE NEUTRAL	0.05
ALACHLOR	BASE NEUTRAL	0.05
ATRAZINE	BASE NEUTRAL	0.05
CHLOROTHALONIL	BASE NEUTRAL	0.12
CHLORPYRIFOS	BASE NEUTRAL	0.10
CYANAZINE	BASE NEUTRAL	0.20
DEETHYLATRAZINE	BASE NEUTRAL	0.05
DEISOPROPYLATRAZINE	BASE NEUTRAL	0.20
DIAZINON	BASE NEUTRAL	0.12
DIMETHENAMID	BASE NEUTRAL	0.05
DIMETHOATE	BASE NEUTRAL	0.22
EPTC	BASE NEUTRAL	0.23
FONOFOS	BASE NEUTRAL	0.10
MALATHION	BASE NEUTRAL	0.09
METHYL PARATHION	BASE NEUTRAL	0.12
METOLACHLOR	BASE NEUTRAL	0.07
METRIBUZIN	BASE NEUTRAL	0.10
PENDIMETHALIN	BASE NEUTRAL	0.08
PHORATE	BASE NEUTRAL	0.12
TERBUFOS	BASE NEUTRAL	0.19
TRIFLURALIN	BASE NEUTRAL	0.17

Le Sueur River

Site Location

The Le Sueur River monitoring site (LE 1.3) is located in T108, R27, S34, within the Red Jacket Trail County Park, 20 feet downstream from the MN Hwy 66 bridge, South Bend Township, Blue Earth County. This station is 1 mile downstream from the USGS stream gaging station 05320500. The drainage area is 1,100 square miles or 710,400 acres. Both MDA and MCES maintain this station.

2003 Monitoring Year Results

Snowmelt began during the second week of March 2003. Like 2002, spring runoff was again minimal in 2003. The peak daily average flow during the 2003 snowmelt period was 920 cfs. Only 1.91 inches of rainfall were recorded at the monitoring station in April 2003, but 3.85 inches were recorded in May. The peak daily average flow of 3,829 cfs occurred on May 15, 2003. After the last runoff event in early August, the river receded slowly and remained at baseflow for the remainder of the year. Runoff event-based composite sampling began in late March 2003 and continued into mid-July. A composite sample collected on May 15, at the peak of the hydrograph for the largest runoff event of the year, had the highest total suspended solids (TSS) concentration (958 mg/L) of all 2003 samples. After the last runoff event in early August, grab samples were obtained for the remainder of the year.

Sampling and Loading Results for Le Sueur River

MCES colleted 18 grab samples and 13 composite samples collected at the Le Sueur River station in 2003. MDA collected 29 samples of which 14 were composites.

Although some of the analysis (nitrate-N and phosphorus) completed by these two agencies seems redundant, the resulting data has allowed for evaluation of variability between laboratories, sampling methods and data analysis protocols that would not have been possible without the duplicate sampling. These efforts have resulted in better basin-wide communication, coordination and evaluation on field and laboratory methodologies and an overall improvement in data consistency across the Basin.

Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000 - 2003 can be found at Appendix E. Figure D.12 presents the Le Sueur River hydrograph for 2003.

Blue Earth River

Site Location

The Blue Earth River (BU 12.0) monitoring site is located in T107, R 27, Sec 6, Rapidan Township, on the left bank 0.2 miles downstream from Rapidan Dam, 2 miles west of Rapidan, MN, Blue Earth County. This is also a USGS stream gaging station 05320000. The drainage area is approximately 2,430 square miles or 1,555,270 acres. Both MDA and MCES maintain this station.

2003 Monitoring Year Results

Snowmelt began during the second week of March 2003. The peak daily average flow of 4,700 cfs, with a stage of 6.14 feet, occurred on May 15, 2003. After the last runoff event in early August, the river receded slowly and remained at baseflow for the remainder of the year.

Event-based composite sampling began at the end of March 2003 and continued until mid-July. A composite sample collected on the rising hydrograph of an extended May runoff event had the highest total suspended solids (TSS) concentration (488 mg/L) of all 2003 samples. After the last runoff event in early August, grab samples were obtained for the remainder of the year.

Sampling and Loading Results for Blue Earth River

There were 14 grab samples and 13 composite samples were collected at the Blue Earth station in 2003 by MCES. MDA collected 26 samples of which 16 were composites. Although some of the analysis (nitrate-N and phosphorus) completed by these two agencies seems redundant, the resulting data has allowed for evaluation of variability between laboratories, sampling methods and data analysis protocols that would not have been possible without the duplicate sampling. These efforts have resulted in better basin-wide communication, coordination and evaluation on field and laboratory methodologies and an overall improvement in data consistency across the Basin.

Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Figure D.13 presents the Blue Earth River hydrograph for 2003.

Minnesota River at Judson

Site Location

The Minnesota River monitoring site near Judson, MN (MI 120.0), is located at T109, R28, S33, at the Minnesota Department of Natural Resources boat landing near Nicollet County Road 23, Nicollet Township, Nicollet County. The drainage area is approximately 11,230 square miles or 7,186,921 acres. Both MDA and MCES maintain this station.

2003 Monitoring Year Results

Snowmelt began during the second week of March 2003. The peak daily average flow of 6,600 cfs occurred on May 21, 2003. After the last runoff event in late July, the river receded slowly and remained at baseflow for the remainder of the year.

Due to a sampler pump problem, there were only grab samples collected at this location. A grab sample collected on the rising hydrograph of an April runoff event had the highest total suspended solids (TSS) concentration (191 mg/L) of all 2003 samples. After the last runoff event in early August, grab samples were obtained for the remainder of the year.

Sampling and Loading Results for the Minnesota River at Judson

MCES collected 23 grab samples at the Minnesota River at Judson in 2003. MDA collected 20 grab samples. Although some of the analysis (nitrate-N and phosphorus) completed by these two agencies seems redundant, the resulting data has allowed for evaluation of variability between laboratories, sampling methods and data analysis protocols that would not have been possible without the duplicate sampling. These efforts have resulted in better basin-wide communication, coordination and evaluation on field and laboratory methodologies and an overall improvement in data consistency across the Basin.

Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000 - 2003 can be found at Appendix E. Figure D.14 presents the Minnesota River at Judson hydrograph for 2003.

Minnesota River at St. Peter

Site Location

The Minnesota River monitoring site in St. Peter, MN (MI 89.7) is located at T110, R26, Sec21, Oshawa Township, Nicollet County. This site in St. Peter is located behind the Chamber of Commerce building near the MN Highway 99 bridge. The drainage area represented by this site is approximately 15,054 square miles or 9,634,760 acres. It encompasses 11 of the 12 major watersheds in the Minnesota River Basin. MCES maintains this station.

2003 Monitoring Year Results
Snowmelt began during the second week of March 2003. The peak daily average flow of 14,100 cfs occurred on May 15, 2003. After the last runoff event in late July, the river receded slowly and remained at baseflow for the remainder of the year.

There were five different composite events collected in 2003. A composite sample collected on the rising hydrograph of a May runoff event had the highest total suspended solids (TSS) concentration (498 mg/L) of all 2003 samples. This sample also had the highest nitrate-N concentration for the season (13.28 mg/L) and the second highest total phosphorus concentration (.54 mg/L). After the last runoff event in early August, grab samples were obtained for the remainder of the year.

Sampling and Loading Results for the Minnesota River at St. Peter
There were 15 grab samples and 12 composite samples collected at the Minnesota River at St. Peter station in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000 - 2003 can be found at Appendix E. Figure D.15 presents the Minnesota River at St. Peter hydrograph for 2003.

Figure D.12 Le Sueur River 2003 Hydrograph with Sampling Information

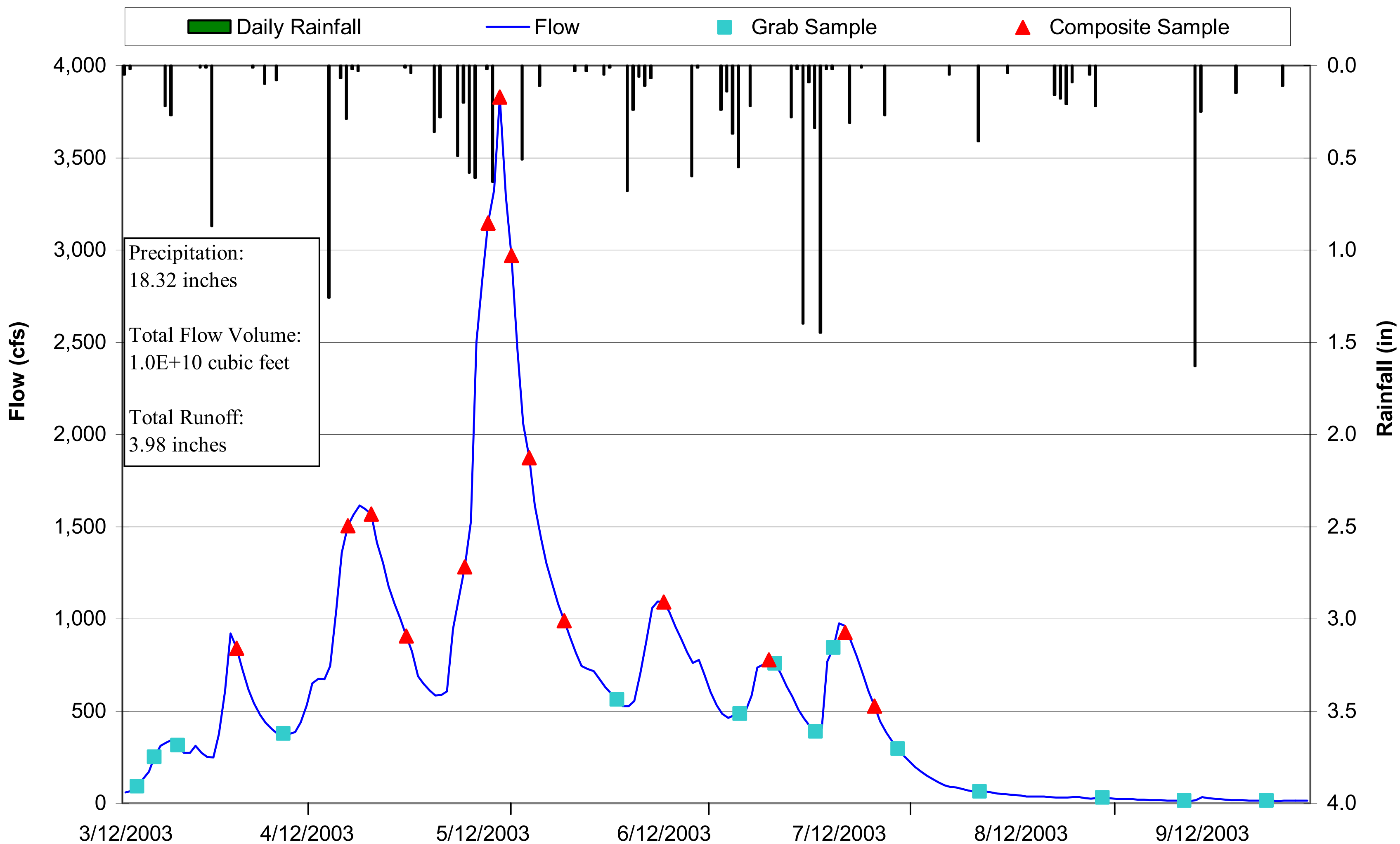


Figure D.13 Blue Earth River 2003 Hydrograph with Sampling Information

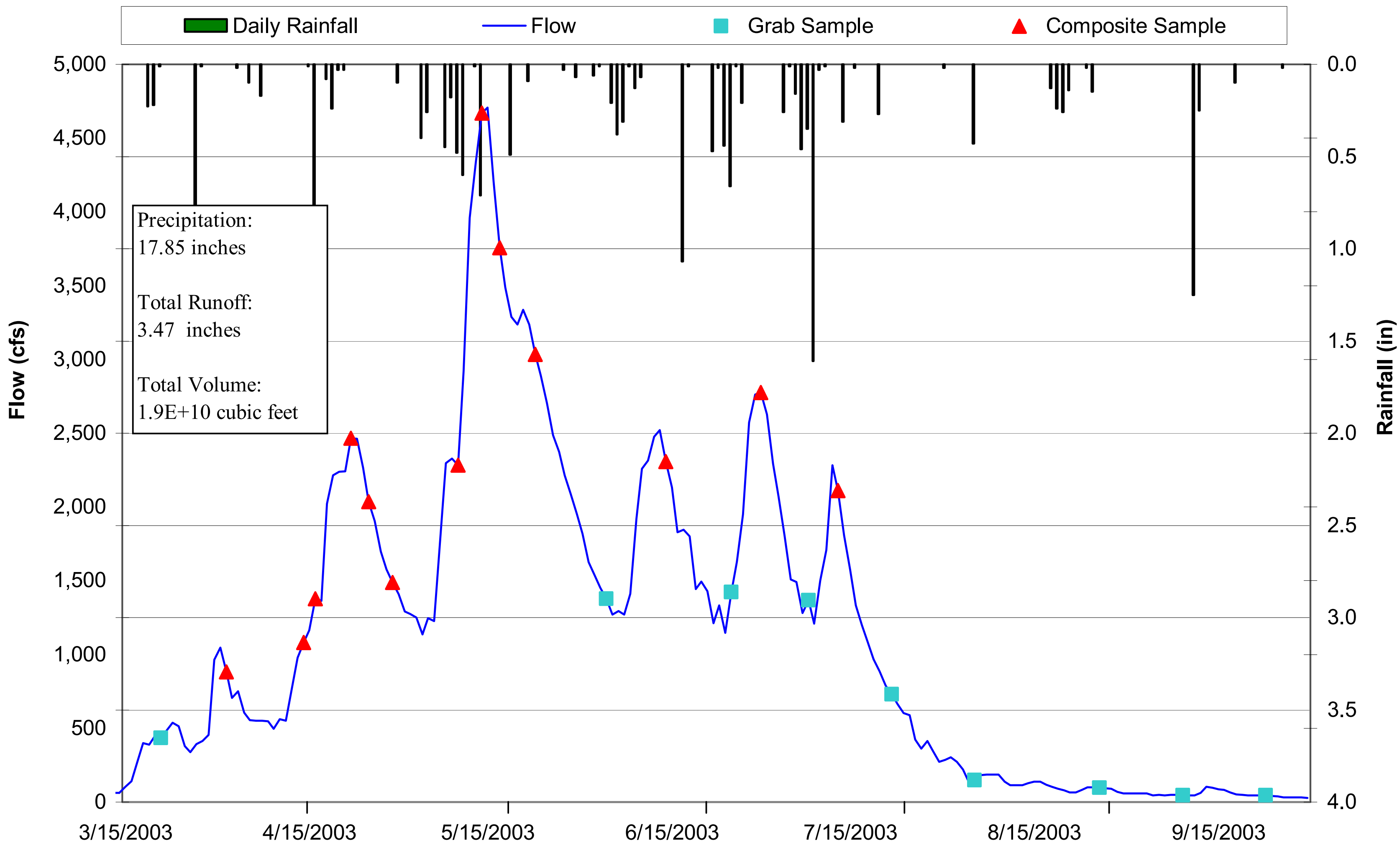


Figure D.14 MN River at Judson 2003 Hydrograph with Sampling Information

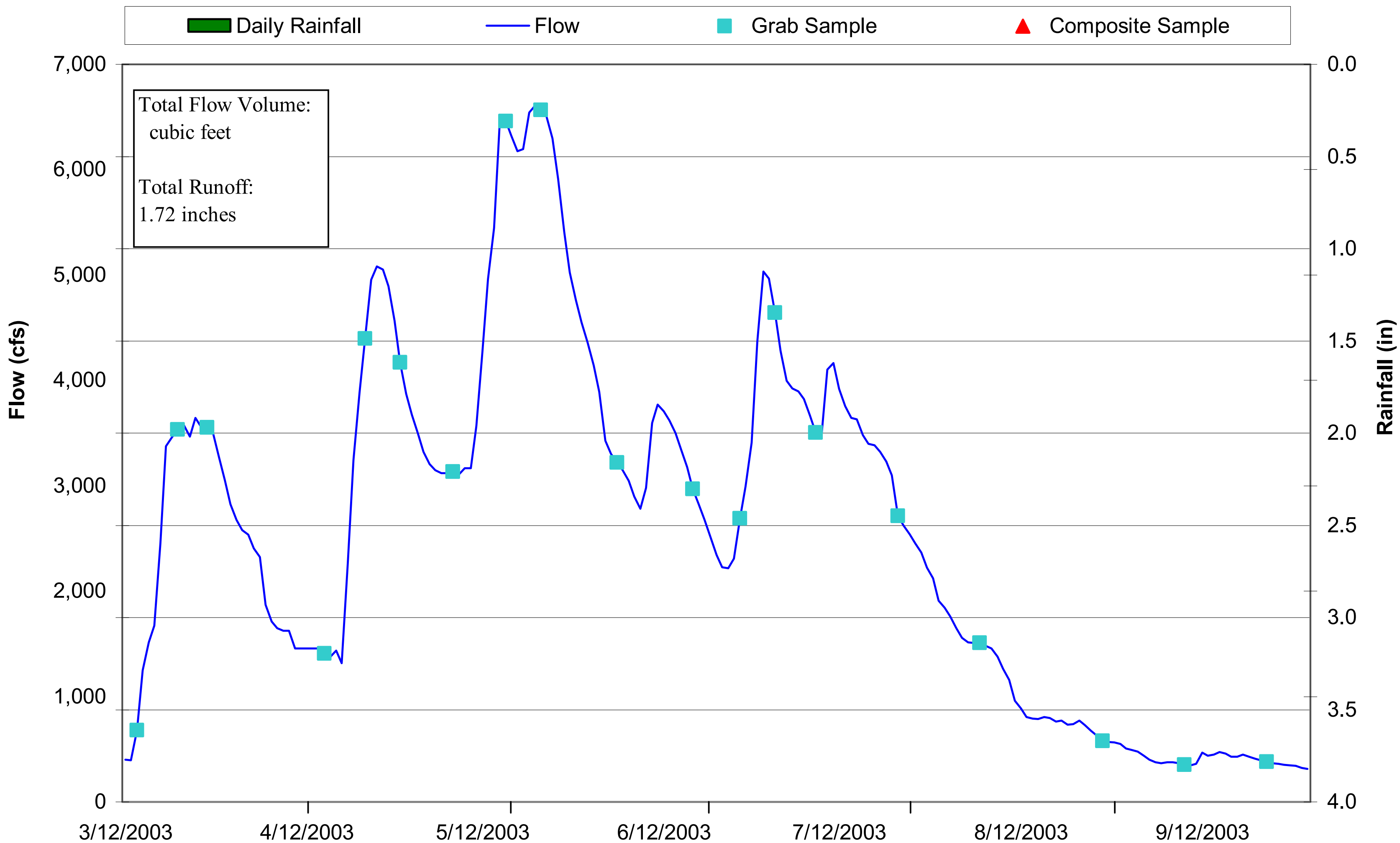
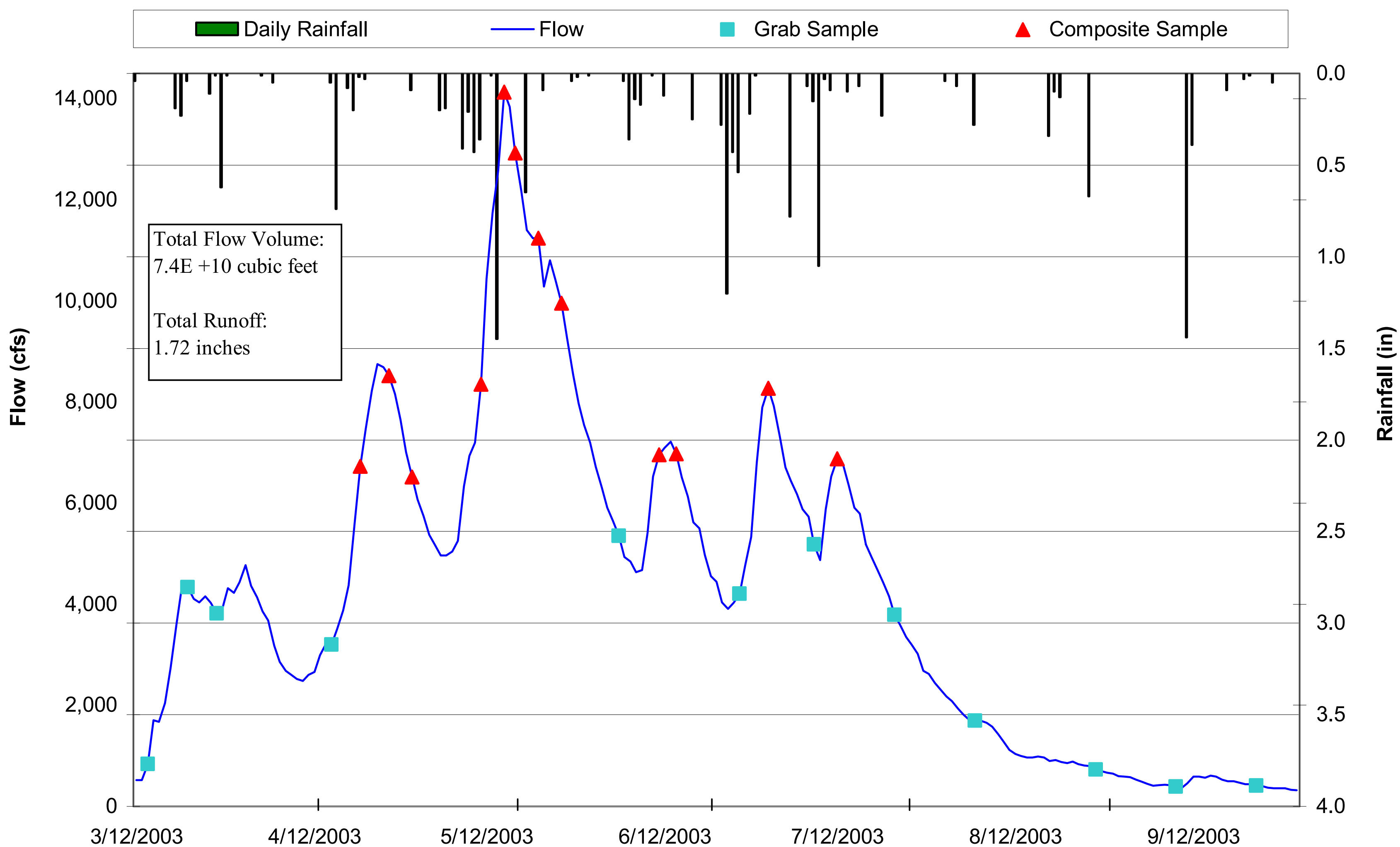


Figure D.15 MN River at St. Peter 2003 Hydrograph with Sampling Information



Seven Mile Creek

Seven Mile Creek Assessment Project
Brown Nicollet Cottonwood Water Board
322 So. Minnesota Ave.
St Peter, MN 56082
Phone: 507-934-4140
Fax: 507-934-8958
bnccwp@mnic.net
Contact: Kevin Kuehner, Program Director
kuehnbnc@mnic.net
To take a virtual tour of the watershed visit:
http://mrbdc.mankato.msus.edu/major/midminn/subshed/sevenmi/vtour/smvt_1.html

Monitoring Began: 1999

Project Summary

The Seven Mile Creek Watershed was chosen for a Water Quality Resource Investigation Grant following the 1990 Middle Lower Assessment Project funded through the Minnesota Pollution Control Agency. Monitoring was postponed in 1998 because of the tornado that struck St. Peter but resumed in earnest in 1999. The Seven Mile Creek project received Phase II CWP funding from the MPCA in 2002 which will allow for water quality monitoring for several more seasons.

The watershed is 23,551 acres in size and comprises about 3% of the Middle Minnesota Major watershed and covers 8% of Nicollet County. Monitoring in this watershed has taken place since the early 1990's. Since 1985, the ecological classification of the stream has been Class 1-D or a marginal trout fishery. With the start of the Middle Minnesota project in 2000, monitoring sites were established at the mouth of the watershed and the tow upper reaches to estimate loads within the Seven Mile Creek Watershed and its effect on the Minnesota River.

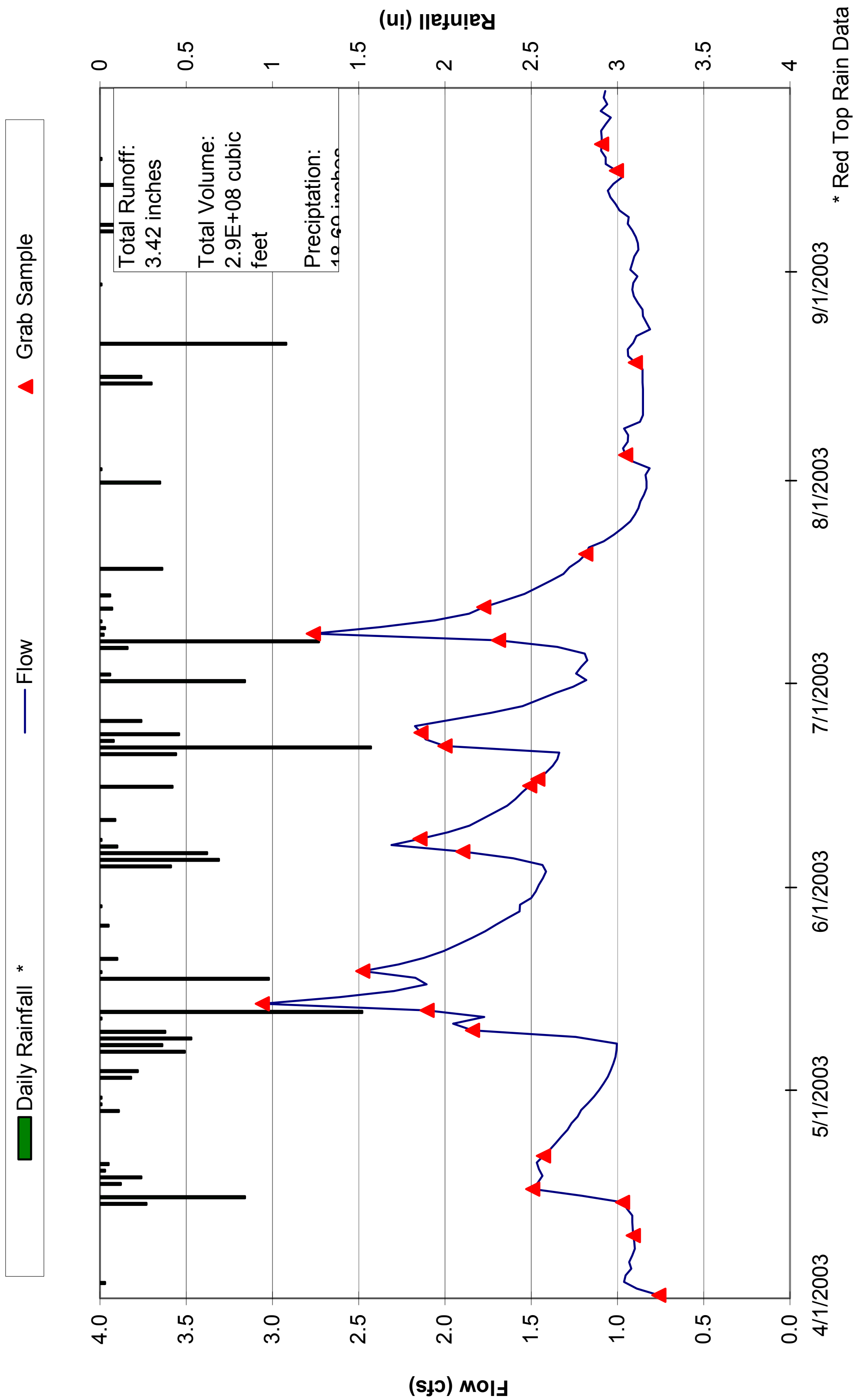
Site Location

The Seven Mile Creek monitoring site (Site 3) is located in T109, R27 Sec 12, NW1/4, SW1/4, Belgrade Township, Nicollet County, which is within the Seven Mile Creek County Park near the first footbridge. This is a mouth site, upstream of the first footbridge in the County Park. Stream flows are taken upstream of bridge about 50 yards. The drainage area is 37 square miles or 23, 551 acres.

Sampling Results for Seven Mile Creek

There were twenty-three samples collected at the Seven Mile Creek Site 3 in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000 to 2003 can be found at Appendix E. Figure D.16 presents the Seven Mile Creek hydrograph for 2003.

D.16 Seven Mile Creek 2003 Hydrograph with Rainfall and Sampling Information



Rush River

Rush River Assessment Project
111 6th Street, Gaylord, MN 55334
Phone 507-237-5435 ext. 105
Fax 507-237-5249
Contact: Scott Kudelka, Project Coordinator
scott.kudelka@mn.nacd.net
To take a virtual tour of the watershed, visit:
http://mrbdc.mnsu.edu/major/lowminn/subshed/rush/rr_index.html

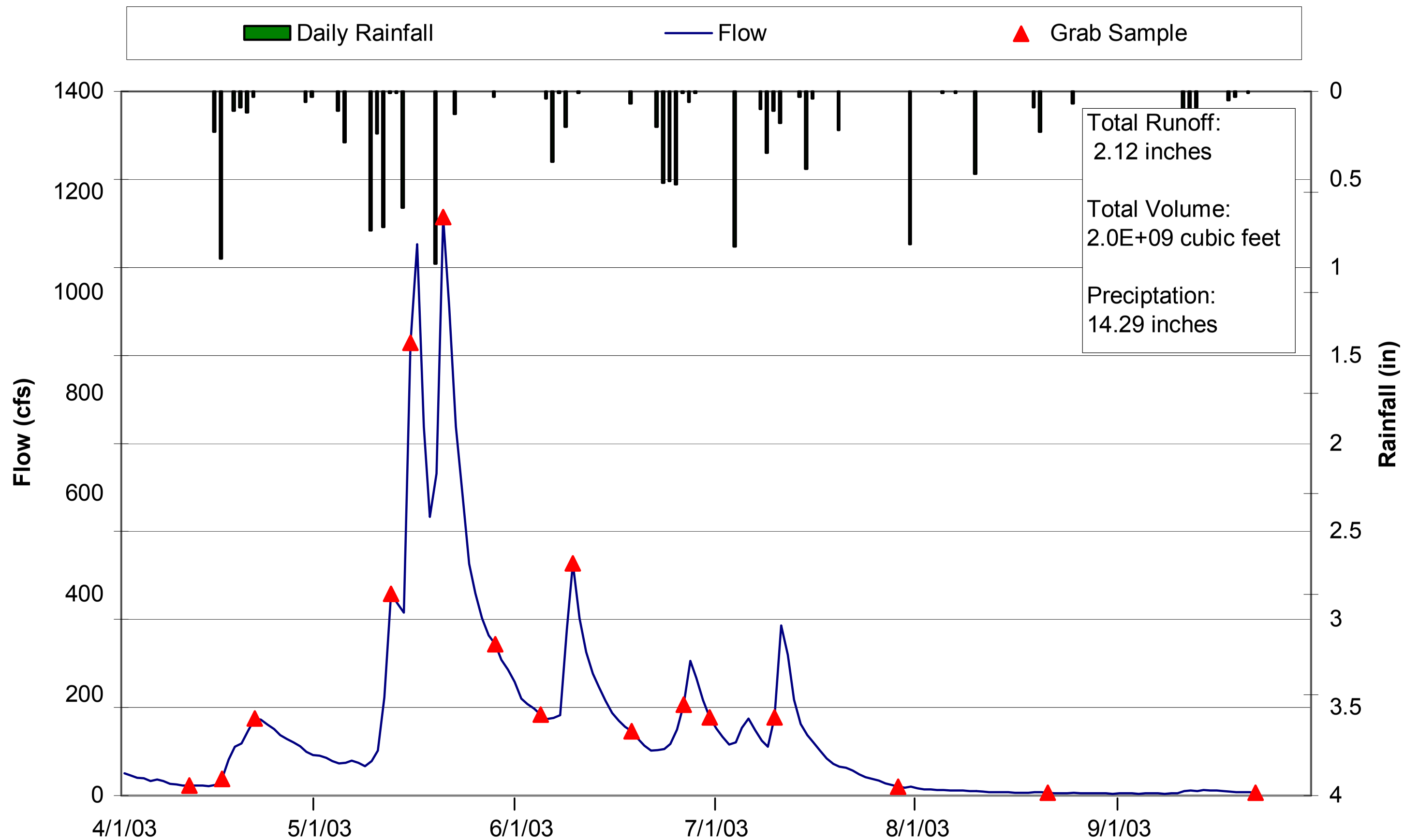
Monitoring Began: 2003

Project Summary
The goal of the Rush River Assessment Project (RRAP) is to monitor the river to determine the amounts of sediments, nutrients and fecal coliform bacteria entering the river. It will also explore where these sediments and nutrients are coming from and how to reduce the amounts in the river to reach water quality standards by changing land use practices. A total of eight sites will be monitored for water quality three years, beginning in 2003. Five of the sites will also be monitored for flow for the duration of the project.

Site Location
The Rush River monitoring site (Site 1RP) is located in Sec. 24, T.112 N., R.26 W, two miles south of Henderson, on Hwy 93. It is also a USGS gaging station; site number 05326400. The equipment is placed on the downstream side of bridge.The drainage area is 403 square miles or 257,775 acres.

Sampling Results for the Rush River Watershed
There were sixteen grab samples collected at the Rush River Site 1RP in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2001 to 2003 can be found at Appendix E. Figure D.17 presents the Rush River hydrograph for 2003.

Figure D.17 Rush River 2003 Hydrograph with Rainfall and Sampling Information



High Island Creek

High Island Creek Watershed Assessment Project
PO Box 161
111 6th Street
Gaylord, MN 55334
Phone: (507) 237-5435 ext. 103
Fax: (507) 237-5249
http://cgee.hamline.edu/rivers/MRN/HIWAP/
Contact: Scott Matteson, Project Coordinator
scott.matteson@mn.usda.gov

Monitoring Began: 1999

Project Summary

The overall purpose of the diagnostic phase of the project is to obtain water quality data that will be used to implement land use changes to improve water quality. Flow data will be used in correlation with water quality data to determine loading at the five primary sampling sites. Quantity and quality data will also be used for future management of water quantity issues. The collected data will be used to determine priority areas to implement best management practices that will reduce sediment and nutrient loading to the High Island Creek. The data will also be used to create a plan that will work toward a reduction of fecal coliform bacteria in High Island Creek and its tributary, Buffalo Creek.

The goal of the Phase I Diagnostic Study is to assess the quality and quantity of water in the High Island Creek Watershed through a cooperative effort between local governments, state agencies, local residents/landowners and operators while promoting a viable economy for agriculture, industry and recreation.

Water Quality Characterization Goals

- Characterize sediment, phosphorus, nitrogen and bacteria concentrations and loading for the High Island Creek and its tributary, Buffalo Creek, during periods of baseflow and storm events.
- Identify land use and land use practices of the watershed, and correlate their relationship to observed water quality results.
- Identify the pathways of fecal coliform and nutrient loading into High Island Creek and Buffalo Creek.
- Develop load/concentration reduction goals for each parameter in the watershed.

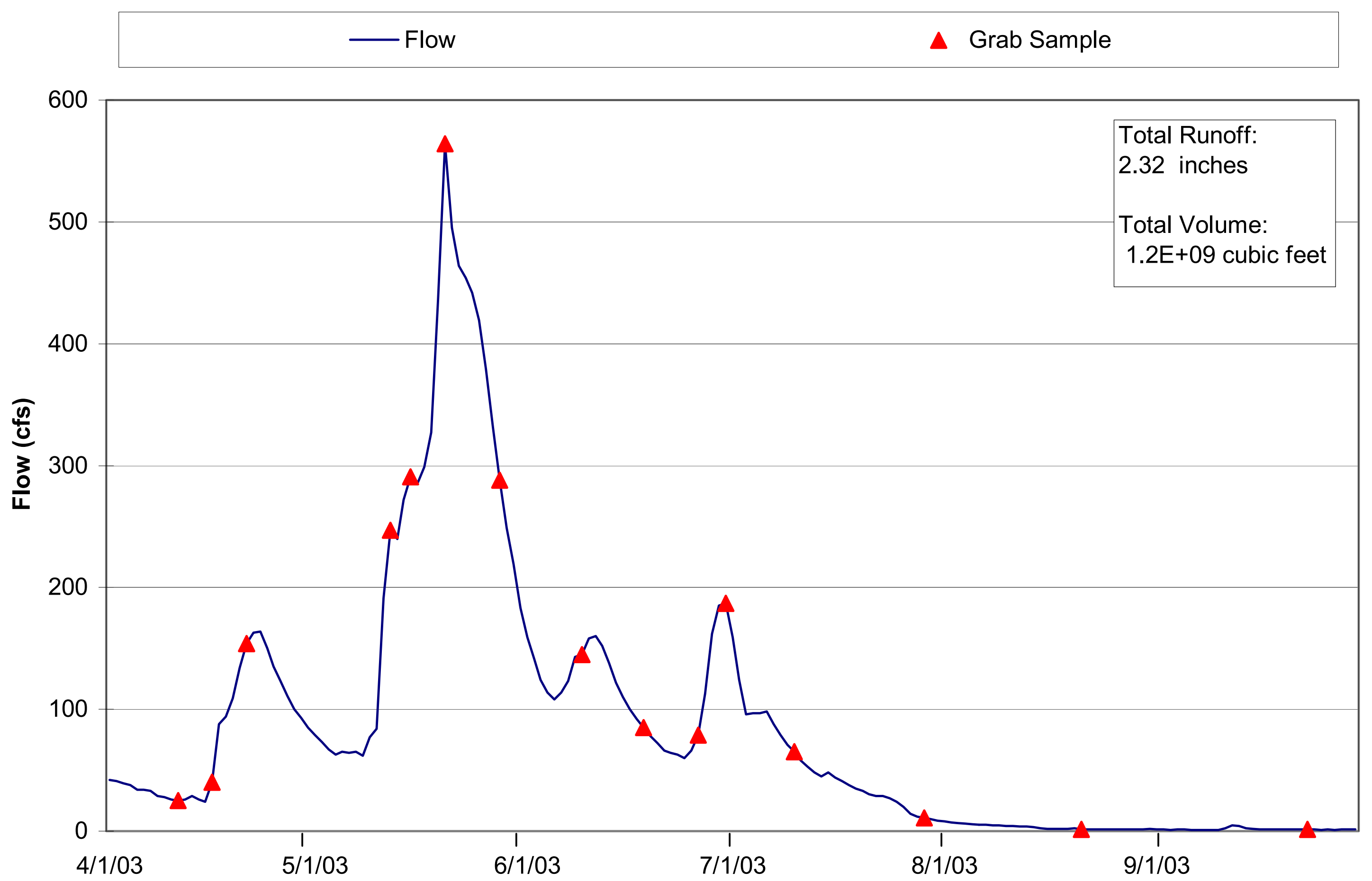
Site Location

The High Island Creek monitoring site (Site 10P) is located in T.113 N., R.26 W., Sec. 26, NE1/4, NW1/4, Sibley County, on left bank 20 ft downstream from bridge on County Road 6, 1.6 miles upstream from mouth, and 3.1 miles north of Henderson. The drainage area is 237 square miles or 152,150 acres.

Sampling Results for High Island Creek Watershed

There were twenty-one grab samples collected at the High Island Creek Site 10P in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2001 to 2003 can be found at Appendix E. Figure D.18 presents High Island Creek hydrograph for 2003.

Figure D.18 High Island Creek 2003 Hydrograph with Rainfall and Sampling Information



Lower Minnesota River Watershed monitored by MCES

Metropolitan Council Environmental Services
2400 Childs Road
St. Paul, MN 55106
http://www.metrocouncil.org/environment/RiversLakes/
Contact: Timothy Pattock
Phone: 651-602-8084
timothy.pattock@metc.state.mn.us or
Mike Ahlf
Phone: 651-602-8082
mike.ahlf@metc.state.mn.us

Monitoring Began: See Table 2.02

Project Summary

The MCES Stream Monitoring Program was initiated in the late 1980's. It was recognized at that time that point source pollution controls alone would be insufficient to attain the water quality goals of the Federal Clean Water Act, as amended through 1987, in the lower Minnesota River. To monitor the volume and water quality of major tributaries flowing to the lower Minnesota River in the TCMA, the first automonitoring sites were established in 1988 and 1989 on six tributaries (Bevens, Bluff, Carver, Credit, Nine Mile, and Sand) and at one mainstem location (Minnesota River at Jordan).

Site Locations

The Lower Bevens Creek monitoring site (BE 2.0) is located at the County Highway 40 Bridge, San Francisco Township, Carver County. The drainage area is approximately 131 square miles or 83,776 acres.

The Upper Bevens Creek monitoring site (BE 5.0) is located by Maplewood Road, Cologne, MN, Carver County. The drainage area is approximately 90.2 square miles or 57,727 acres.

The Sand Creek monitoring site (SA 8.2) is located at the Hwy 282 Bridge, Scott County, Jordan, MN. The drainage area is approximately 255 square miles or 163,071 acres.

The Carver Creek monitoring site (CA 1.7) is located ¾ of a mile west of Carver, MN, 50 ft. south of Carver County Highway 40. The drainage area is approximately 85 square miles or 54,440 acres.

The Bluff Creek monitoring site (BL 3.5) is located at 781 Flying Cloud Drive, Chanhassen, MN. The drainage area is approximately 8.9 square miles, or 5,724 acres.

The Credit Creek monitoring site (CR 0.9) is located at the 123rd St. Bridge in Savage, MN, Scott County. The drainage area is approximately 52 square miles or 32,896 acres.

The Nine Mile Creek monitoring site (NM 1.8) is located 1400 ft S of 106th St. at Central Park, Bloomington, MN, Hennepin County. The drainage area is approximately 38.3 square miles or 24,512 acres.

The Minnesota River at Jordan monitoring site (MI 39.4) is located at the bridge which intersects Hwy 9 in Scott County and Hwy 45 in Carver County, near Jordan, MN. This is a USGS station with hydrologic code 05330000. The drainage area is approximately 16,200 square miles or 10,389,757 acres.

2003 Monitoring Year for Lower Bevens Creek

Spring snowmelt and ice-free stream conditions occurred in mid-March 2003. Runoff event-based sampling began in mid-March and continued into July; then baseflow conditions persisted until the end of the year. The peak daily average flow of 452 cfs occurred on May 20, 2003.

Thirty-four samples were collected for water quality analysis during 2003, including 14 composite samples and 18 grab samples. Samples were obtained throughout the year during varying stream flow conditions, to most accurately characterize Lower Bevens Creek water quality. The MCES annual water quality monitoring plan includes 12 monthly baseflow ("non-event") grab samples and approximately 10 to 15 flow-weighted composite samples collected during all runoff events in the open water season (March-November). The 2003 sampling scheme met the goals of the MCES monitoring work plan.

2003 Monitoring Year for Upper Bevens Creek

Spring snowmelt and ice-free stream conditions occurred in mid-March 2003. Runoff event-based sampling began in mid-March and continued into July. From mid-August until the end of the year, no flow existed in the stream at this monitoring station. The remaining water pooled and eventually dried up completely.

The peak daily average flow of 249 cfs occurred on May 20, 2003. This runoff event also produced the highest total suspended solids (TSS) concentration (720 mg/l) measured at this station in 2003.

Twenty samples were collected for water quality analysis during 2003, including 13 composite samples and 7 grab samples. Until mid-August, when stream flow ceased, samples were obtained during varying flow conditions, to most accurately characterize Upper Bevens Creek water quality. The MCES annual water quality monitoring plan includes 12 monthly baseflow ("non-event") grab samples and approximately 10 to 15 flow-weighted composite samples collected during all runoff events in the open water season (March-November). During the portion of year when stream flow existed, the 2003 sampling scheme met the goals of the MCES monitoring work plan. Baseflow grab samples could not be obtained from September through December, due to the lack of flow at the Upper Bevens Creek monitoring station.

2003 Monitoring Year for Carver Creek

Spring snowmelt began in mid-March, and the stream was ice free on March 17, 2003. Runoff event-based composite sampling began in mid-March and continued into late May, when the monitoring station was removed. A runoff event on May 23 produced a peak daily average flow of 171 cfs.

Despite the shortened monitoring season, twenty-two samples were collected for water quality analysis during 2003, including 11 composite samples and 11 grab samples. To the extent that road and bridge construction allowed access to the monitoring site, samples were obtained throughout most of the year during varying stream flow conditions, to most accurately characterize Carver Creek water quality. The MCES annual water quality monitoring plan includes 12 monthly baseflow ("non-event") grab samples and approximately 10 to 15 flow-weighted composite samples collected during all runoff events in the open water season (March-November). Due to road and bridge construction, the 2003 sampling scheme did not meet the goals of the MCES monitoring work plan.

2003 Monitoring Year for Bluff Creek

Spring snowmelt and ice-free stream conditions occurred in mid-March 2003. Runoff event-based sampling began in mid-March and continued through mid-July; then baseflow conditions persisted until the end of the year. A runoff event on May 11 produced a peak daily average flow of 36 cfs. This event generated the highest total suspended solids (TSS) concentration (2,430 mg/l) and the highest total phosphorus (TP) concentration (0.87 mg/l) measured at this station in 2003.

Sixteen samples were collected for water quality analysis during 2003, including 1 composite sample and 15 grab samples. Samples were obtained throughout the year during varying stream flow conditions, to most accurately characterize Bluff Creek water quality. Due to equipment problems caused by shifting gravel in the streambed, which occurred during periods of increased stream flow, only one composite sample was successfully collected. While composite sampling was not successful, grab samples were collected during runoff events whenever possible. The MCES annual water quality monitoring plan includes 12 monthly baseflow ("non-event") grab samples and approximately 10 to 15 flow-weighted composite samples collected during all runoff events in the open water season (March-November). The 2003 sampling scheme did not fully meet the goals of the MCES monitoring work plan, based on the very limited number of composite samples obtained.

2003 Monitoring Year for Credit River

Spring snowmelt and ice-free stream conditions occurred in mid-March 2003. Runoff event-based sampling began in mid-March and continued through mid-September. A runoff event on May 11 produced a peak daily average flow of 169 cfs. This event generated the highest total suspended solids (TSS) concentration (634 mg/l) measured at this station in 2003.

Twenty-three samples were collected for water quality analysis during 2003, including 3 composite samples and 20 grab samples. Due to continuing problems with flow monitoring equipment at the Credit River station during the first half of 2003, flow weighted composite samples were not collected during all runoff events, as stipulated by the MCES monitoring work plan. However, when composite sampling was not possible, grab samples were collected instead. Samples were obtained throughout the year during varying stream flow conditions, to most accurately characterize Credit River water quality. The MCES annual water quality monitoring plan includes 12 monthly baseflow ("non-event") grab samples and approximately 10 to 15 flow-weighted composite samples collected during all runoff events in the open water season (March-November). The 2003 sampling scheme did not fully meet the goals of the MCES monitoring work plan, based on the very limited number of composite samples obtained.

2003 Monitoring Year for Sand Creek

Spring snowmelt and ice-free stream conditions occurred in mid-March 2003. Runoff event-based sampling began in mid-March and continued through mid-July; then baseflow conditions persisted until the end of the year. The peak daily average flow of 992 cfs occurred on May 12, 2003. This runoff event also produced the highest total suspended solids (TSS) concentration (4,380 mg/l) and the highest total phosphorus (TP) concentration (1.14 mg/l) measured at this station in 2003.

Thirty-three samples were collected for water quality analysis during 2003, including 12 composite samples and 21 grab samples. Samples were obtained throughout the year during varying stream flow conditions, to most accurately characterize Sand Creek water quality. The MCES annual water quality monitoring plan includes 12 monthly baseflow ("non-event") grab samples and approximately 10 to 15 flow-weighted composite samples collected during all runoff events in the open water season (March-November). The 2003 sampling scheme met the goals of the MCES monitoring work plan.

2003 Monitoring Year for Nine Mile Creek

Spring snowmelt and ice-free stream conditions occurred in mid-March 2003. Runoff event-based sampling began in mid-March and continued through mid-September. The peak daily average flow of 171 cfs occurred on June 28, 2003. Due to the large amount of impervious surface in the Nine Mile Creek Watershed, including storm drainage from the Interstate Highway 35W corridor, the stream hydrograph responds rapidly to rain events and is characterized by numerous sharp peaks.

Thirty-one samples were collected for water quality analysis during 2003, including 12 composite samples and 19 grab samples. Samples were obtained throughout the year during varying stream flow conditions, to most accurately characterize Nine Mile Creek water quality. The MCES annual water quality monitoring plan includes 12 monthly baseflow ("non-event") grab samples and approximately 10 to 15 flow-weighted composite samples collected during all runoff events in the open water season (March-November). The 2003 sampling scheme met the goals of the MCES monitoring work plan.

2003 Monitoring Year for Minnesota River at Jordan
Spring snowmelt and ice-free stream conditions occurred in mid-March 2003. The peak daily average flow of 15,800 cfs occurred on May 17, 2003.

Fourteen grab samples were collected for water quality analysis during the monitoring season of 2003. There were no composite samples collected at this location, as bridge construction was being completed and the station was being constructed. The peak total suspended solids concentration came (278 mg/l) during a minor rainfall event in July. Samples were collected roughly every two weeks throughout the season.

Sampling and Loading Results for Bevens 2.0 and 5.0
There were 14 grab samples and 18 composite samples collected at Bevens 2.0 in 2003. There were seven grab samples and 13 composite samples collected at Bevens 5.0 in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. For yearly results, please refer to MCES Annual Stream Monitoring Report 2003. Loading results for 2000 -2003 can be found at Appendix E. Figure D.19 and Figure D.20 presents the Bevens Creeks hydrograph for 2003.

Sampling and Loading Results for Sand Creek
There were 21 grab samples and 12 composite samples collected at Sand Creek in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. For yearly results, please refer to MCES Annual Stream Monitoring Report 2003. Loading results for 2000 - 2003 can be found at Appendix E. Figure D.21 presents the Sand Creek hydrograph for 2003.

Sampling and Loading Results for Carver Creek
Loading results for 2000 - 2002 can be found at Appendix E. .

Sampling and Loading Results for Bluff Creek
There were 15 grab samples and one composite samples collected at Bluff Creek in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. For yearly results, please refer to MCES Annual Stream Monitoring Report 2003. Loading results for 2000 – 2003 can be found at Appendix E. Figure D.22 presents the Bluff Creek hydrograph for 2003.

Sampling and Loading Results for Credit Creek
There were 20 grab samples and three composite samples collected at Credit Creek in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. For yearly results, please refer to MCES Annual Stream Monitoring Report 2003. Loading results for 2000, 2001 and 2003 can be found at Appendix E. Figure D.23 presents the Credit Creek hydrograph for 2003.

Sampling and Loading Results for Nine Mile Creek
There were 19 grab samples and 12 composite samples collected at Nine Mile Creek in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were

used to calculate the monitoring load estimates for this report. For yearly results, please refer to MCES Annual Stream Monitoring Report 2003. Loading results for 2000 - 2003 can be found at Appendix E. Figure D.24 presents the Nine Mile Creek hydrograph for 2003.

Sampling and Loading Results for the Minnesota River at Jordan

There were fourteen grab samples collected at the Minnesota River at Jordan. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000 to 2003 can be found at Appendix E. Figure D.25 presents the Minnesota River at Jordan hydrograph for 2003.

Figure D.19 Upper Bevens Creek 2003 Hydrograph with Sampling Information

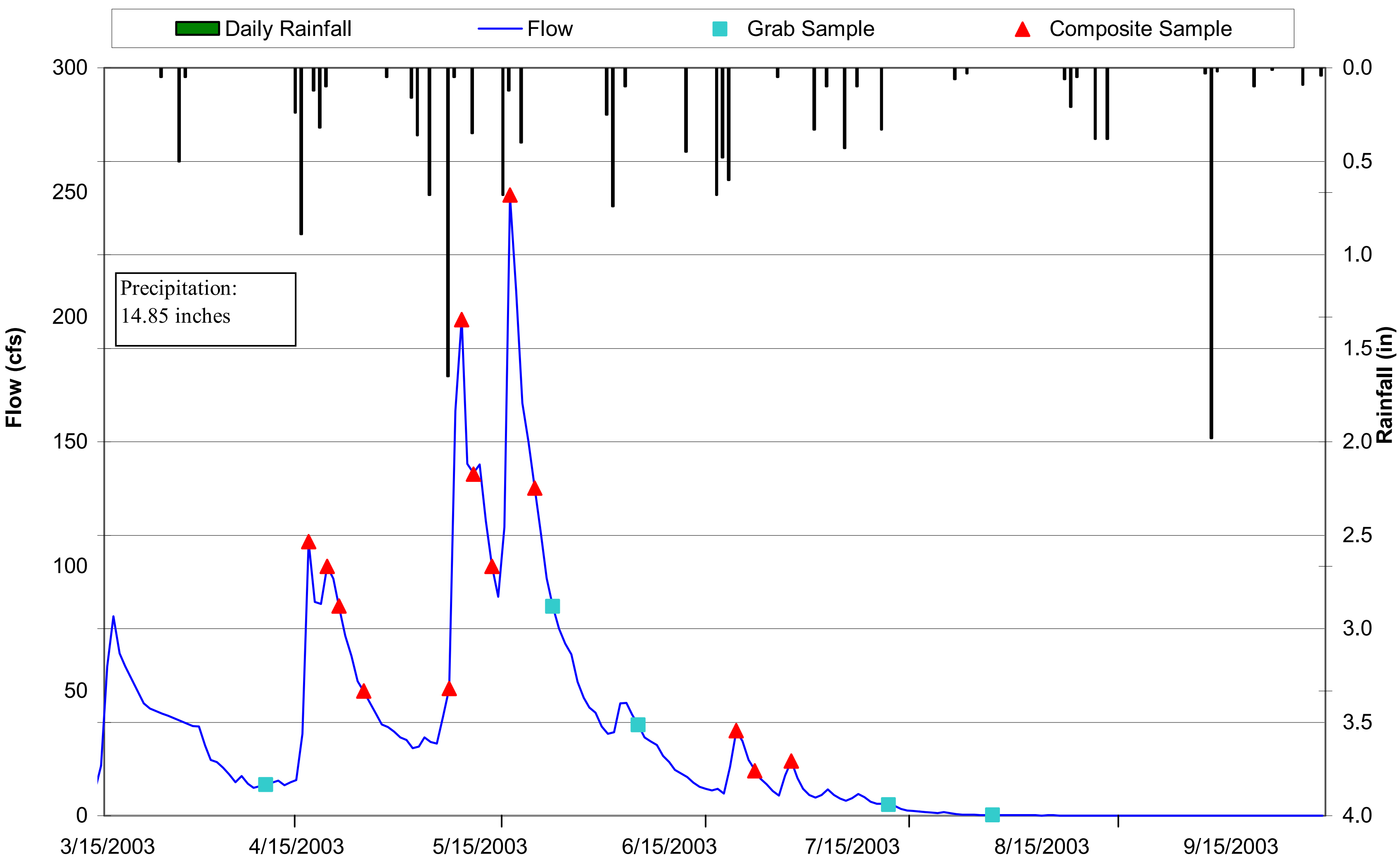


Figure D.20 Lower Bevens Creek 2003 Hydrograph with Sampling Information

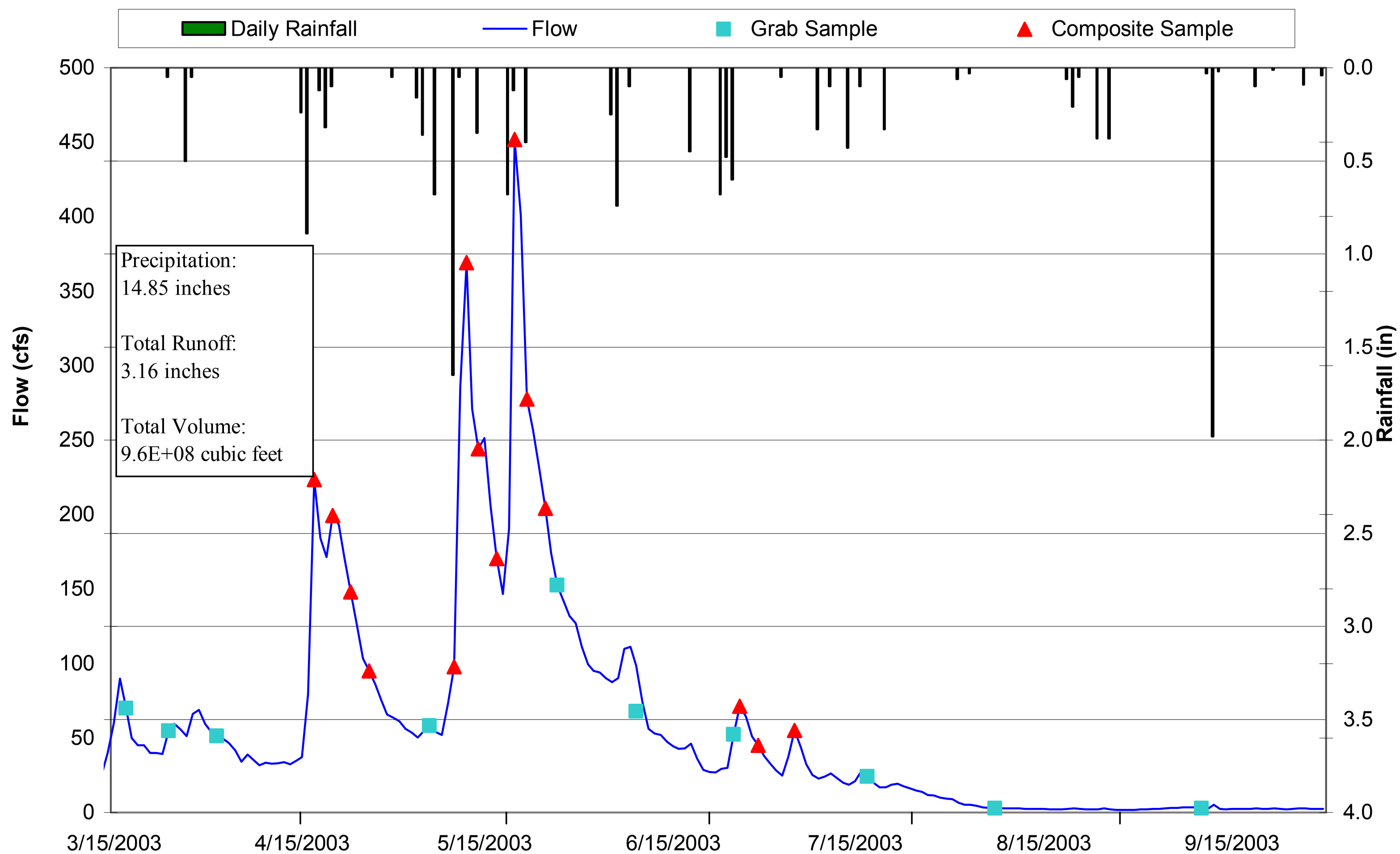


Figure D.21 Sand Creek 2003 Hydrograph with Sampling Information

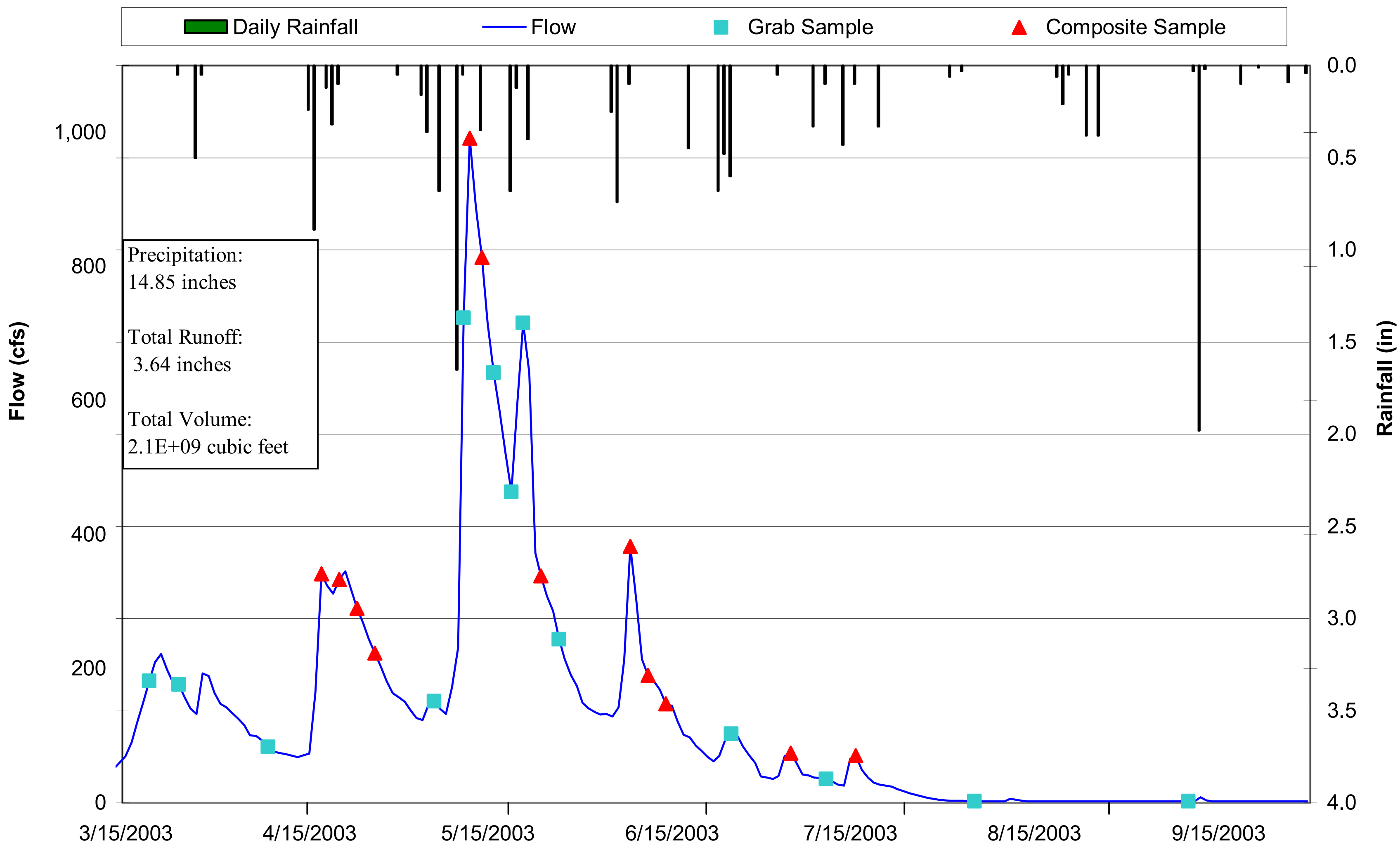


Figure D.22 Bluff Creek 2003 Hydrograph with Sampling Information

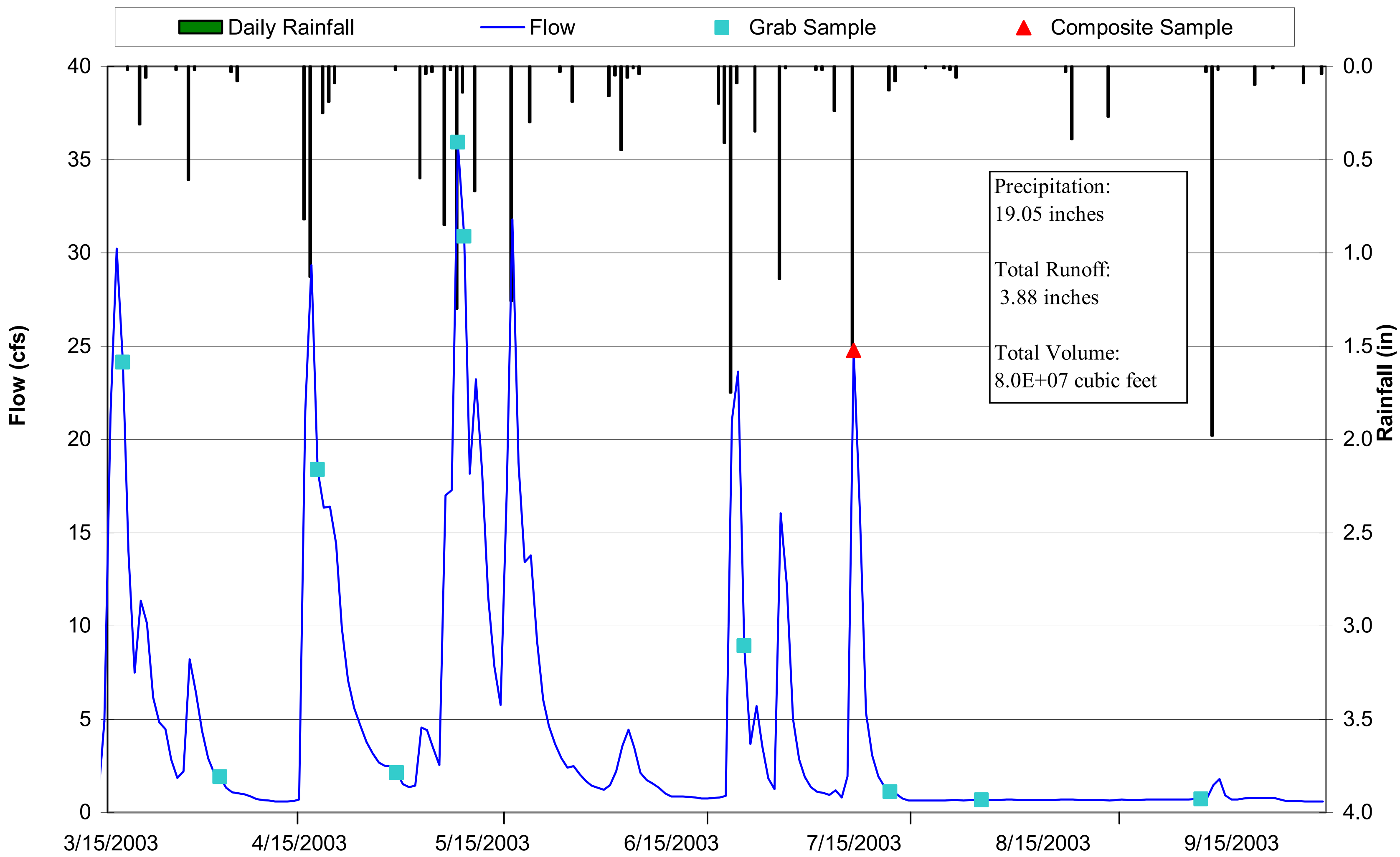


Figure D.23 Credit River 2003 Hydrograph with Sampling Information

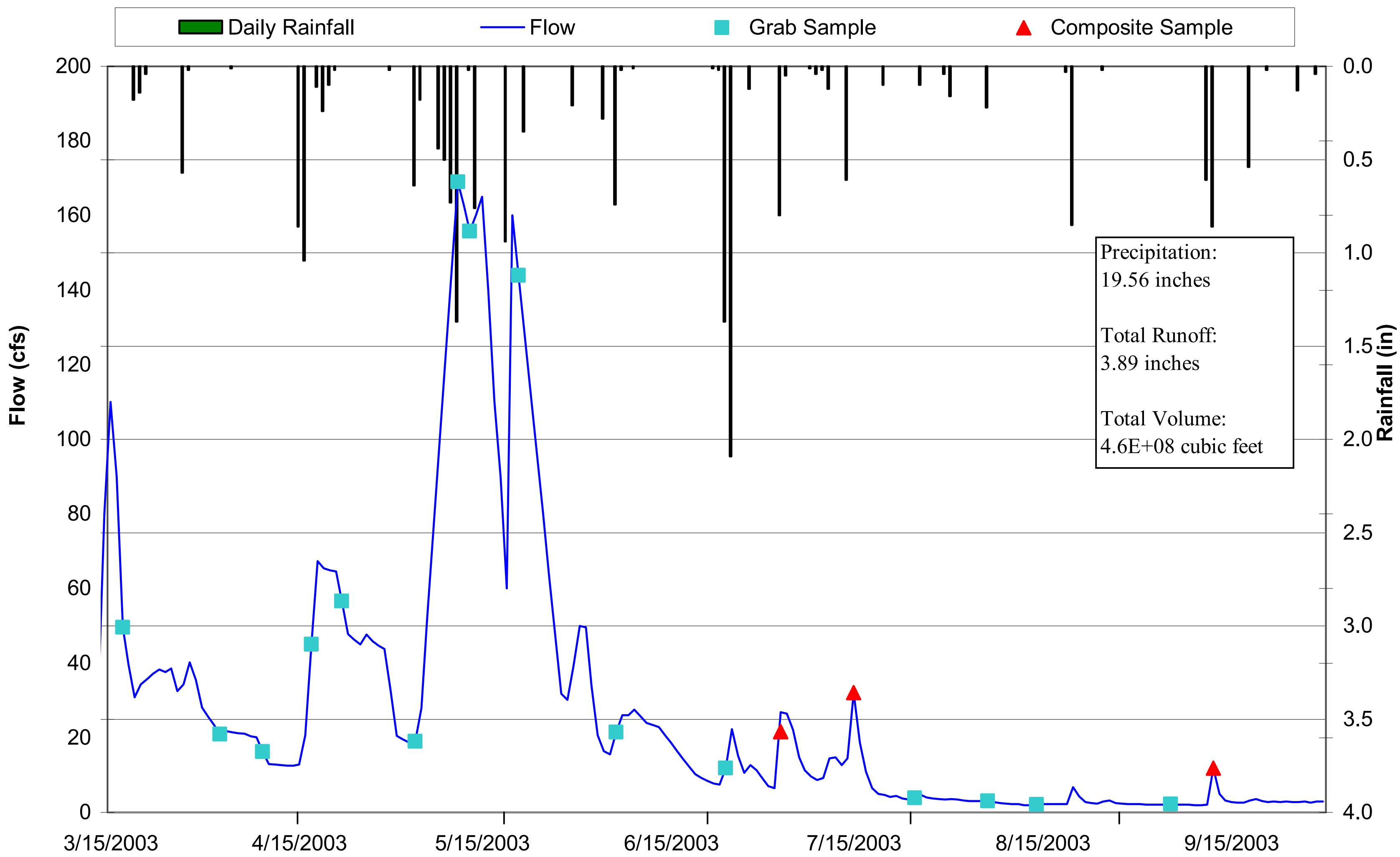


Figure D.24 Nine Mile Creek 2003 Hydrograph with Sampling Information

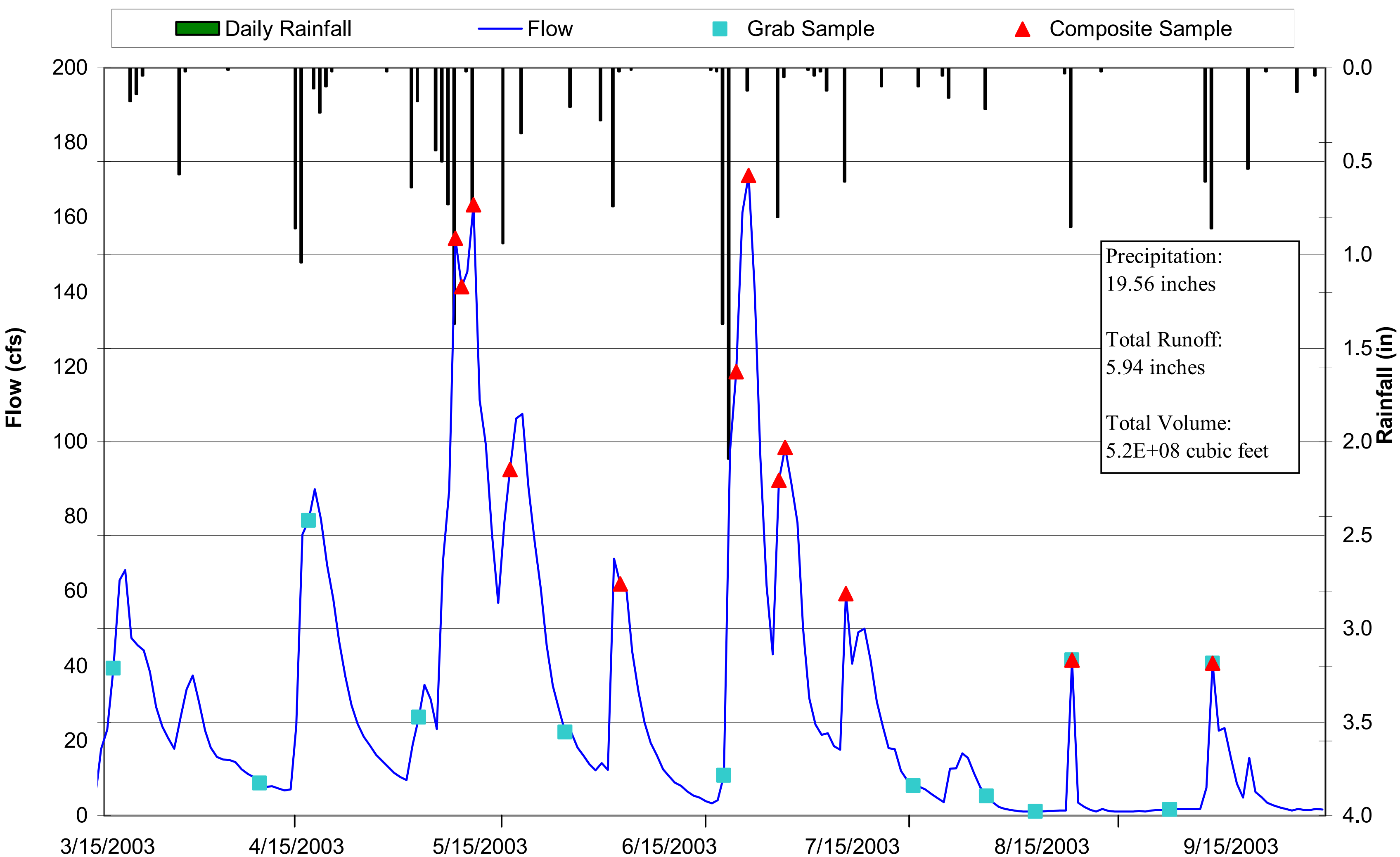
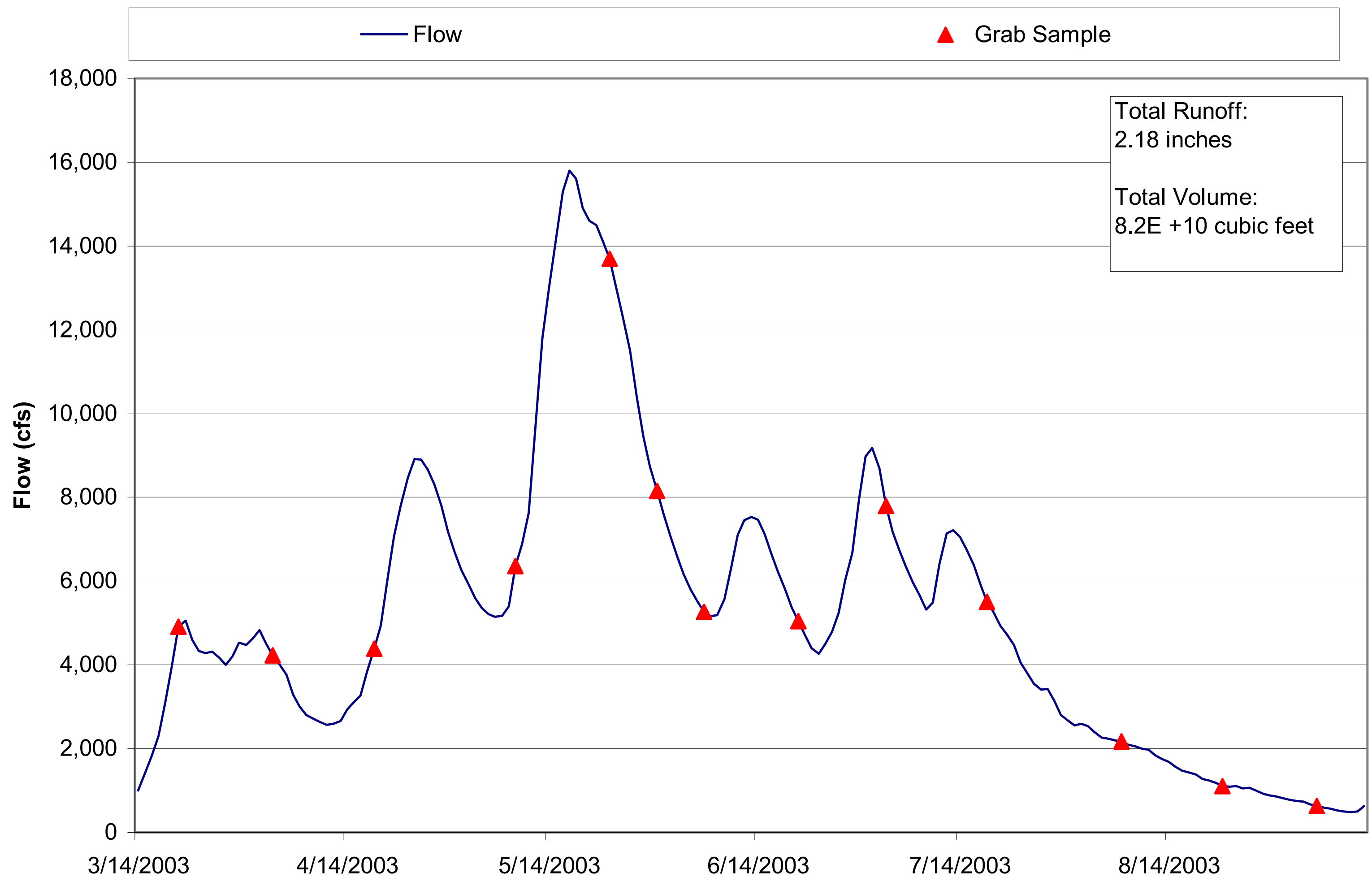


Figure D.25 Minnesota River at Jordan 2003 Hydrograph with Sampling Information



Chaska Creek

Minnesota Department of Agriculture
90 West Plato Blvd.
St. Paul, MN 55107
Contact: Marie Juenemann
Phone: 952-707-6413
Mjuenema@mda.state.mn.us

Monitoring Began: 1999 Chaska Creek

Project Summary for Chaska Creek

In 1997, the Minnesota Department of Agriculture (MDA) in cooperation with Carver County Environmental Services began long-term non-point surface water monitoring efforts in the Lower Minnesota River Watershed, focusing on agriculture and urban development patterns. The surface water monitoring stations are located in two minor watersheds of the Lower Minnesota River watershed. Both watersheds have a mix of agriculture and older and newer urban land use.

The Chaska Creek monitoring station, established in 1999, is situated at Chaska Creek and located in the Chaska Creek watershed which covers an area of 3520 acres and drains into the Minnesota River. The Chaska Creek watershed also takes the outlet from an adjacent unnamed watershed covering an area of 5,800 acres. Delineated from the point of sample location, this monitoring station covers 9000 acres of watershed area.
The goals and objectives of MDA are to define long-term trends associated with the non-point concentrations of pesticides and nutrients in surface waters of the state. This information aids in assessing the impacts of pesticide and nutrient use in agricultural and urban environments and is needed in determining how to best manage pesticides and nutrients to minimize their impact on surface water. The MDA monitors for 21 Base Neutral pesticides (including breakdown products), 6 Acid Herbicides, and selected nutrients.

Site Location

The Chaska Creek (Site CHA) in T115N, R23W, Sec. 8 in Carver County off old County Road 10 in Chaska. This station is located up stream from open Ogee Spillway and Inlet on levee at the VFW parking lot. The drainage area is 9,640 acres.

Riley Creek

Barr Engineering Co.
4700 West 77th St.
Edina, MN 55435
Contact: Chris Bonick
Phone: 952-832-2760
cbonick@barr.com
Station Operator: Riley-Purgatory-Bluff Creek Watershed District / Barr Engineering, Inc.
Monitoring Began: 1999

Project Summary
The "Metropolitan Area Watershed Outlet Monitoring Program," implemented in early 1998, significantly expanded the existing stream monitoring network in the Metropolitan Area. Eight new monitoring sites (Bassett Creek, Cannon River, Crow River, Eagle Creek, Minnehaha Creek, Riley Creek, Valley Creek, and Willow Creek) were established in eight Metro Area watersheds. Three of these watersheds are in the Minnesota River Basin, Riley being one of them. The physical and chemical data from these eight monitoring sites will be used by MCES to develop target pollutant loads for these watersheds, and to measure water quality improvements as best management practices are implemented.

Site Location
The Riley Creek monitoring site (RI 1.3) is located in T116N, R22W, Sec. 33, in Hennepin County. The drainage area is approximately 13 square miles or 8,366 acres.

2003 Monitoring Year
Riley Creek flow was perennial in 2003 due to groundwater discharge from Quaternary terrace deposits. Spring snowmelt began in mid-March. Numerous rainfall events occurred throughout the spring and early summer of 2003. The peak daily average flow of 19.7 cfs, with a stage of 0.43 feet, occurred on May 11, 2003, when 0.85 inch of rain was recorded by the station's rain gauge. The largest rain event (1.53 inches) occurred on June 25. This wet pattern tapered off dramatically after mid- July, when drought conditions became prevalent. Daily average flows were estimated during the August-September period, since the ultrasonic sensor at this site cannot accurately measure stage during prolonged drought conditions.

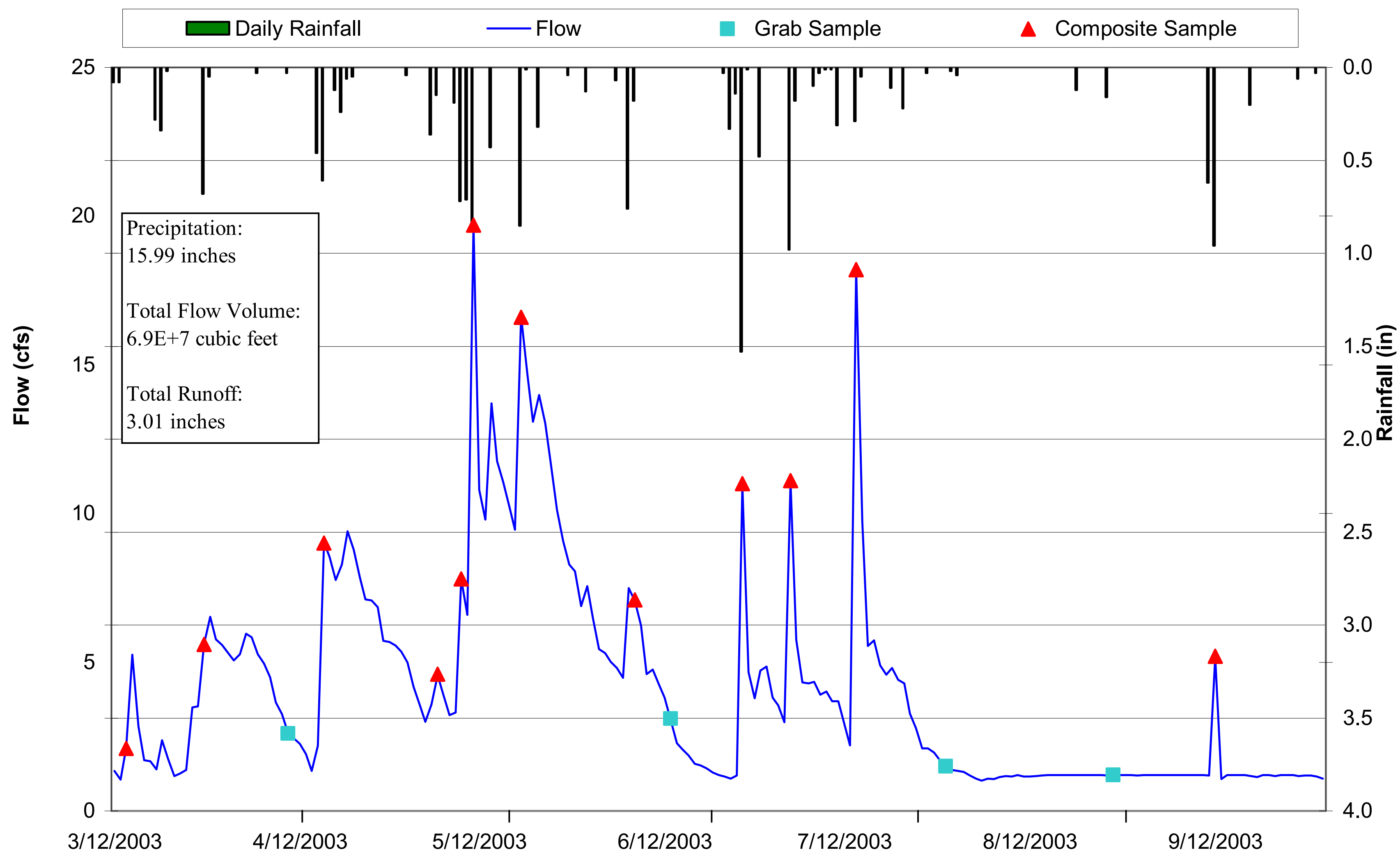
Despite extremely cold air temperatures, baseflow grab samples were successfully collected during the winter months of 2003. Runoff event-based composite sampling began in mid-March 2003 and continued through mid-October. The highest total suspended solids (TSS) concentration (2,970 mg/l) observed in 2003 was measured in a composite sample collected during the July 14, 2003 storm event, after a series of rain events during the preceding 3 weeks had created saturated soil conditions in the watershed.

Twenty-two samples were collected for water quality analysis during 2003, including 13 composite samples and nine grab samples. The MCES annual water quality monitoring plan includes 12 monthly baseflow ("non-event") grab samples and approximately 10 to 15 flow-weighted composite samples collected during all runoff events in the open-water season (March-November). The 2003 sampling scheme did not quite meet the goals of the MCES monitoring work plan, as monthly baseflow grab samples were not obtained in February, May, and September. However, all runoff events in 2003 were well characterized by flow-weighted composite samples. A limited number of composite samples were obtained during the last half of 2003 due to drought conditions.

Sampling and Loading Results for Riley Creek

There were nine grab samples and 22 composite samples collected at Riley Creek in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. For yearly results, please refer to MCES Annual Stream Monitoring Report 2003. Loading results for 2001 - 2003 can be found at Appendix E. Figure D.26 presents the Riley Creek hydrograph for 2003.

Figure D.26 Riley Creek 2003 Hydrograph with Sampling Information



Eagle Creek

Metropolitan Council Environmental Services
2400 Childs Road
St. Paul, MN 55106
http://www.metrocouncil.org/environment/RiversLakes/
Contact: Leigh Harrod
651-602-8085
leigh.harrod@metc.state.mn.us
Station Operator: City of Savage, MN
Monitoring Began: 1999

Project Summary

The "Metropolitan Area Watershed Outlet Monitoring Program," implemented in early 1998, significantly expanded the existing stream monitoring network in the Metropolitan Area. Eight new monitoring sites (Bassett Creek, Cannon River, Crow River, Eagle Creek, Minnehaha Creek, Riley Creek, Valley Creek, and Willow Creek) were established in eight Metro Area watersheds. Three of these watersheds are in the Minnesota River Basin, Eagle being one of them. The physical and chemical data from these eight monitoring sites will be used by MCES to develop target pollutant loads for these watersheds, and to measure water quality improvements as best management practices are implemented.

Site Location

The Eagle Creek monitoring site (Ea 0.8) is located at the 126th St. Bridge in Savage MN, at T118N, R21W, Sec. 7, Scott County. The drainage area is 3.4 square miles or 2,176 acres.

2003 Monitoring Year

Spring snowmelt occurred in late March 2003. The peak daily average flow of 16.2 cfs, with a stage of 1.43 feet, occurred on March 31. The 2003 monitoring year was marked by normal to heavy precipitation during the first half of the year, followed by intermittent drought conditions during the second half of the year. Rain was recorded on 71 days at this location in 2003. The largest rain event (1.67 inches) occurred on June 25. Runoff event-based composite sampling began in mid- March 2003 and continued through early September.

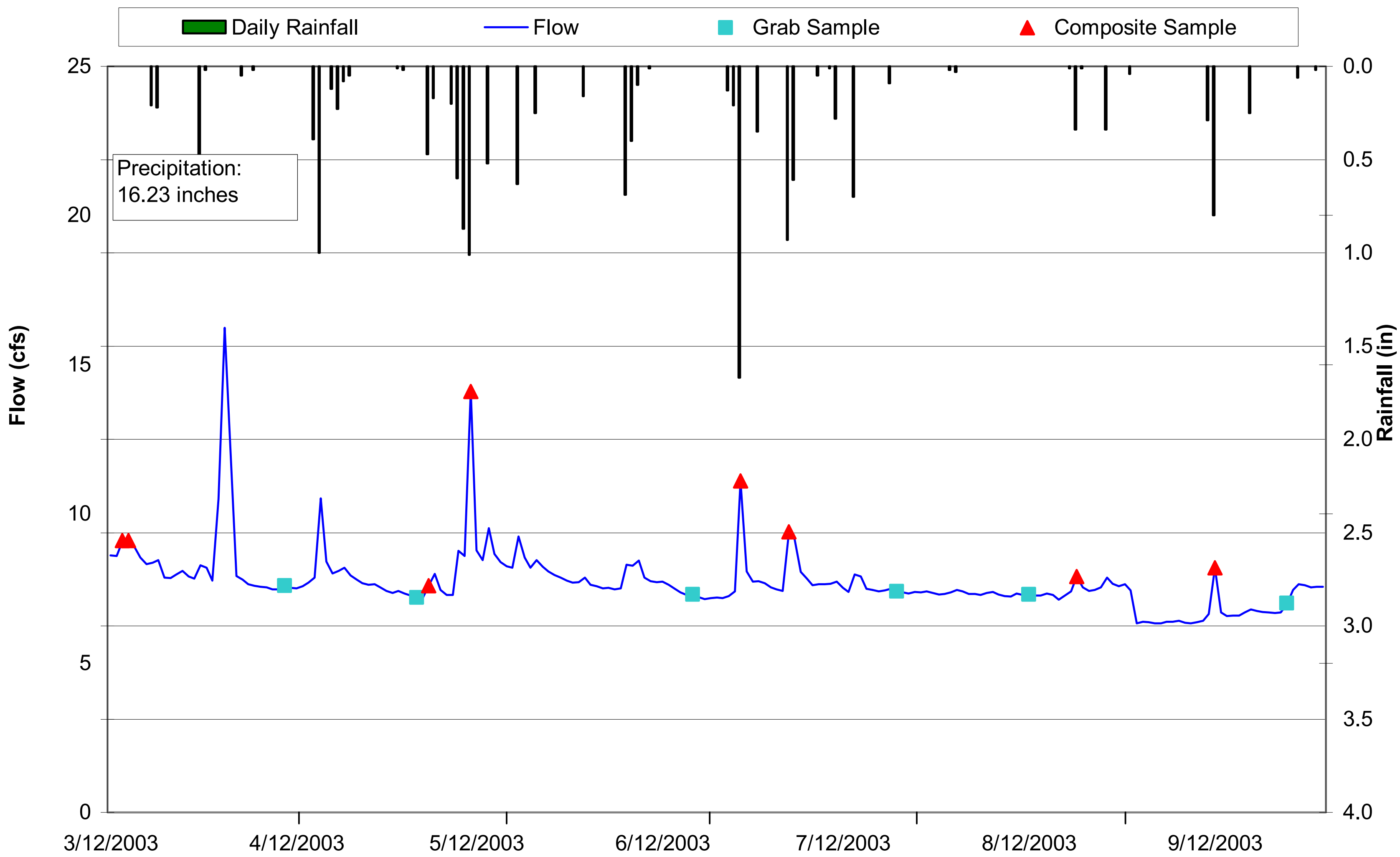
Field observations indicate that a large population of waterfowl congregates in this small watershed during the winter months, because of the warmer water and ice-free conditions. Thousands of birds have been observed churning the waters of Eagle Creek on random days between December and March. When the birds are present in large numbers, field notes typically report the appearance of the creek as cloudy. Winter field measurements taken under these conditions register some of the highest turbidity and lowest transparency levels of the year. When the birds are present in large numbers, total suspended solids (TSS) concentrations and fecal coliform bacteria levels in winter baseflow grab samples register as high as the concentrations in composite samples generated by intense summer thunderstorm events.

Twenty-one samples were collected for water chemistry analysis during 2003, including eight composite samples and thirteen grab samples. The MCES annual water quality monitoring plan includes 12 monthly baseflow ("non-event") grab samples and approximately 10 to 15 flow-weighted composite samples collected during all runoff events in the open water season (March-November). In 2003, baseflow conditions were well characterized by monthly grab samples. However, several runoff events during the late March to mid- April period were not characterized by composite samples. A limited number of composite samples were obtained during the last half of 2003 due to drought conditions.

<u>Sampling and Loading Results for Eagle Creek</u>

There were thirteen grab samples and eight composite samples collected at Eagle Creek in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. For yearly results, please refer to MCES Annual Stream Monitoring Report 2003. Loading results for 2002 to 2003 can be found at Appendix E. Figure D.27 presents the Eagle Creek hydrograph for 2003.

Figure D.27 Eagle Creek 2003 Hydrograph with Sampling Information



Willow Creek

Barr Engineering Co.
4700 West 77th St.
Edina, MN 55435
Contact: Chris Bonick
Phone: 952-832-2760
cbonick@barr.com
Station Operator: Riley-Purgatory-Bluff Creek Watershed District / Barr Engineering, Inc.
Monitoring Began: 1999

Project Summary
The "Metropolitan Area Watershed Outlet Monitoring Program," implemented in early 1998, significantly expanded the existing stream monitoring network in the Metropolitan Area. Eight new monitoring sites (Bassett Creek, Cannon River, Crow River, Eagle Creek, Minnehaha Creek, Riley Creek, Valley Creek, and Willow Creek) were established in eight Metro Area watersheds. Three of these watersheds are in the Minnesota River Basin, Willow Creek being one of them. The physical and chemical data from these eight monitoring sites will be used by MCES to develop target pollutant loads for these watersheds, and to measure water quality improvements as best management practices are implemented.

Site Location
The Willow Creek monitoring site (WI 1.0) is located at Hwy 13, in Burnsville, MN, T115N, R21W, Sec. 14, Dakota County. The drainage area is approximately 10.25 square miles or 6,558 acres.

2003 Monitoring Year:
Because the underground box culvert prevents Willow Creek from freezing, direct measurements of stage and flow were possible throughout the 2003 monitoring year. Spring snowmelt occurred throughout March 2003. The highest conductivity measurements of the year occurred during this period. During a rain event, Willow Creek flow typically exhibits a rapid increase followed by a rapid subsidence after the storm. At all other times, the creek is usually characterized by low-flow conditions. In 2003, the peak daily average flow for Willow Creek was 36.6 cfs, with a daily average stage of 0.87 feet. This occurred on May 11 in response to a 1.38-inch rainfall in the watershed, when soil conditions were already saturated after a series of precipitation events. The peak instantaneous flow of 97 cfs, with a stage of 1.71 feet, occurred three days later during a storm event on May 14. A total of 5.6 inches of rain fell in the watershed during the month of May.

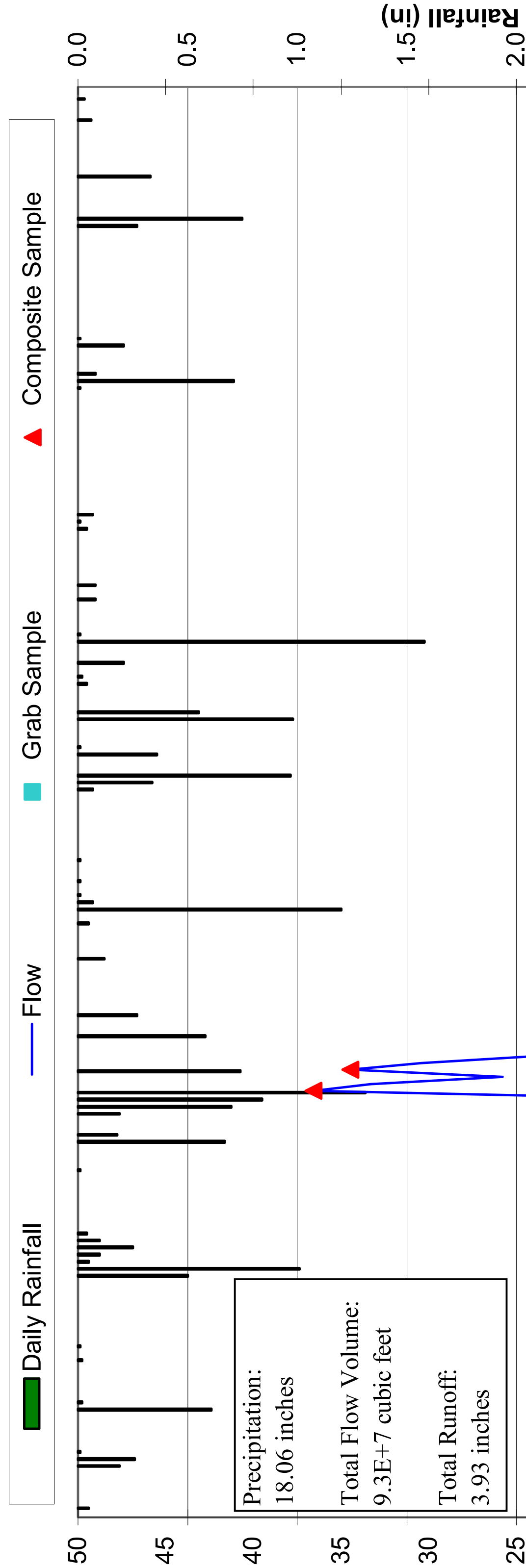
Runoff event-based composite sampling began in late March 2003 and continued through mid-September. The highest total suspended solids (TSS) concentration (216 mg/l) observed in 2003 was measured in a composite sample obtained during a mid-April rainfall event.

Twenty samples were collected for water quality analysis during 2003, including 12 composite samples and 8 grab samples. The MCES annual water quality monitoring plan includes 12 monthly baseflow (“non-event”) grab samples and approximately 10 to 15 flow-weighted composite samples collected during all runoff events in the open-water season (March-November). The 2003 sampling scheme did not quite meet the goals of the MCES monitoring work plan. Due to low-flow conditions, monthly baseflow samples could not be obtained in January and February. When higher flow conditions precluded baseflow sampling in May and July, additional composite samples were obtained. Overall, the 2003 sampling scheme adequately characterized Willow Creek water quality for the monitoring year.

Sampling and Loading Results for Willow Creek

There were eight grab samples and twelve composite samples collected at Willow Creek in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. For yearly results, please refer to MCES Annual Stream Monitoring Report 2003. Loading results for 2001 - 2003 can be found at Appendix E. Figure D.28 presents the Willow Creek hydrograph for 2003.

Figure D.28 Willow River 2003 Hydrograph with Sampling Information



Minnesota River at Fort Snelling

Metropolitan Council Environmental Services
2400 Childs Road
St. Paul, MN 55106
http://www.metrocouncil.org/environment/RiversLakes/Rivers/index.htm
Contact: Scott Schellhaass
Phone: 651-602-3841
Scott.schellhaass@metc.state.mn.us

Monitoring Began: 1976

Project Summary

MCES operates an automatic monitoring network that was initiated in 1973 as a cooperative program with the United States Geological Survey (USGS). The network consists of six monitors which continuously measure dissolved oxygen, temperature, pH and specific conductance of the river water. I n addition to the previously listed variables, turbidity is continuously measured at the Fort Snelling site. These variables are good indicators of river water quality and the effectiveness of MCES wastewater treatment plant operations. The data are reported to the Minnesota Pollution Control Agency via monthly monitoring reports, as required by NPDES permits.

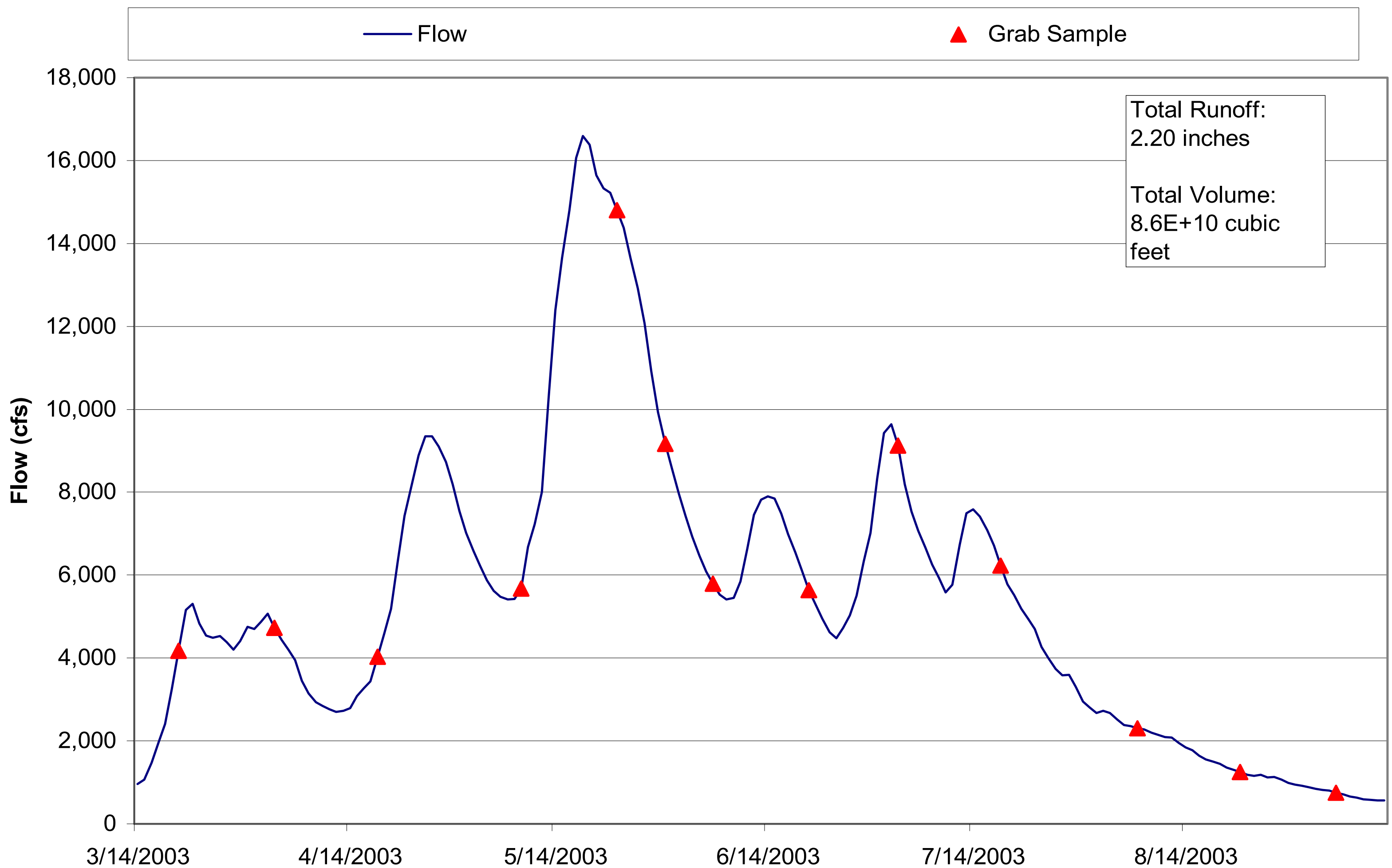
Extensive conventional pollutant monitoring is also conducted to complement automatic monitoring. Samples are manually collected at numerous sites in addition to the automatic monitoring stations, and are analyzed for a wide variety of variables not measurable by the automatic monitors. Sample collection takes place on a weekly (March-October) or semi-monthly (November-February) basis at most sites. This sampling schedule may be reduced depending on the variable being monitored. Sample analyses are conducted in the field as well as in the MCES laboratory in St. Paul, MN. The river monitoring results are used to more fully characterize water quality and to help determine specific sources of pollution, as well as the extent and nature of problems that may exist.

Site Location

The Minnesota River at Fort Snelling monitoring site (MI 3.5) is a sampling point located southeast of the Postroad and Highway 5 overpass. Samples are collected in the main channel from the pier extending off the North bank of the Minnesota River. The drainage area is approximately 16,988 square miles or 10,849,467 acres.

There were fifteen samples collected at the Minnesota River at Fort Snelling in 2003. Only samples collected during the defined monitoring season (ice out – 9/30) were used to calculate the monitoring load estimates for this report. Loading results for 2000 - 2003 can be found at Appendix E. Figure D.29 presents the Minnesota River at Fort Snelling hydrograph for 2003.

Figure D.29 Minnesota River at Fort Snelling 2003 Hydrograph with Sampling Information



Appendix E

Water Quality Concentrations for Monitoring Sites

The concentrations provided on the following pages are the lab results from samples submitted by each project or program. This is the data which was used to calculated the loads for 2003. Grab or composite samples are not identified. For further information on a specific sample, please contact the data owner.

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Yellow Bank River	01/08/03		1			0.03	0.03	0.00	
Yellow Bank River	03/17/03		14			0.9	0.91	0.51	
Yellow Bank River	04/09/03		1			<0.01	0.04	0.00	
Yellow Bank River	04/21/03		3			0.17	0.07	0.02	
Yellow Bank River	04/28/03		2			<0.01	0.05	0.01	
Yellow Bank River	05/12/03		2			<0.01	0.06	0.02	
Yellow Bank River	05/14/03		2			<0.01	0.07	0.02	
Yellow Bank River	05/19/03		2			<0.01	0.06	0.02	
Yellow Bank River	05/22/03		1			<0.01	0.06	0.02	
Yellow Bank River	06/19/03		3			0.05	0.13	0.07	
Yellow Bank River	06/25/03		3			0.11	0.10	0.06	
Yellow Bank River	06/25/03		3			0.13	0.10	0.06	
Yellow Bank River	06/26/03		3			0.13	0.11	0.06	
Yellow Bank River	07/17/03		3			0.09	0.10	0.04	
Yellow Bank River	07/21/03		2			0.13	0.12	0.05	
Yellow Bank River	08/19/03		3			0.03	0.09	0.02	
Yellow Bank River	09/11/03		3			0.01	0.07		
Yellow Bank River	09/15/03		4			<0.01	0.07	0.01	
Yellow Bank River	09/29/03		3			<0.01	0.05	0.01	
Lac qui Parle River	01/08/03		9			1.1	0.05	0.05	
Lac qui Parle River	03/17/03		142			1.4	0.84	0.84	
Lac qui Parle River	04/09/03		9			0.01	0.07	0.07	
Lac qui Parle River	04/21/03		29			1.9	0.12	0.12	
Lac qui Parle River	04/28/03		14			0.6	0.06	0.06	
Lac qui Parle River	05/12/03		11			1.6	0.23	0.23	
Lac qui Parle River	05/14/03		23			1.5	0.21	0.21	
Lac qui Parle River	05/15/03		16			2.8	0.21	0.21	
Lac qui Parle River	05/19/03		27			1.8	0.14	0.14	
Lac qui Parle River	05/22/03		20			1.7	0.10	0.10	
Lac qui Parle River	06/09/03		37			1.6	0.10	0.10	
Lac qui Parle River	06/10/03		43			1.7	0.13	0.13	
Lac qui Parle River	06/19/03		23			0.63	0.13	0.13	
Lac qui Parle River	06/25/03		63			1.1	0.15	0.15	
Lac qui Parle River	06/25/03		84			1.4	0.21	0.21	
Lac qui Parle River	06/26/03		57			1.3	0.22	0.22	
Lac qui Parle River	07/17/03		17			0.1	0.13	0.13	
Lac qui Parle River	07/21/03		30			< 0.01	0.16	0.16	
Lac qui Parle River	08/19/03		8			0.07	0.10	0.10	
Lac qui Parle River	09/11/03		9			0.09	0.09	0.09	
Lac qui Parle River	09/15/03		10			0.05	0.08	0.08	
Lac qui Parle River	09/29/03		6			0.05	0.06	0.06	

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Chippewa River	03/27/03	546	35			0.4	0.14	0.05	
Chippewa River	04/08/03	273	9			0.4	0.07	0.00	
Chippewa River	04/17/03	342	22			0.11	0.11	0.01	
Chippewa River	04/22/03	629	64			2.7	0.18	0.02	
Chippewa River	05/01/03	496	56			0.8	0.12	0.00	
Chippewa River	05/08/03	515	66			0.7	0.13	0.01	
Chippewa River	05/13/03	782	68			1.9	0.13	0.00	
Chippewa River	05/20/03	942	75			2.2	0.14	0.00	
Chippewa River	05/28/03	754	69			1.5	0.13	0.00	
Chippewa River	06/04/03	539	97			1.2	0.17	0.01	
Chippewa River	06/11/03	583	107			1.5	0.17	0.02	
Chippewa River	06/19/03	365							
Chippewa River	06/24/03	410	92			0.8	0.19	0.03	
Chippewa River	06/26/03	986	190			5.3	0.29	0.07	
Chippewa River	07/01/03	1110	83			2.1	0.19	0.05	
Chippewa River	07/09/03	1040	64			0.4	0.24	0.13	
Chippewa River	07/16/03	1110	75			0.67	0.20	0.11	
Chippewa River	07/22/03	930	68			0.4	0.23	0.13	
Chippewa River	07/29/03	740	68			0.28	0.23	0.12	
Chippewa River	08/06/03	527							
Chippewa River	08/12/03	407	86			0.17	0.22	0.07	
Chippewa River	08/27/03	187	80			0.01	0.21	0.03	
Chippewa River	09/04/03	133							
Chippewa River	09/11/03	185	120			0.01	0.26	0.06	
Chippewa River	09/30/03	93	13			0.01	0.08	0.00	
Dry Weather	03/17/03	76	9			2	0.66	0.49	
Dry Weather	03/27/03	18	6			0.8	0.12	0.04	
Dry Weather	04/08/03	3	5			0.5	0.05	0.00	
Dry Weather	04/17/03	7	3			0.03	0.06	0.01	
Dry Weather	04/22/03	31	4			11	0.06	0.02	
Dry Weather	05/01/03	14	4			6	0.03	0.00	
Dry Weather	05/08/03	15	4			5	0.03	0.00	
Dry Weather	05/09/03	20	5			5.2	0.04	0.00	
Dry Weather	05/13/03	49	9			9.7	0.04	0.00	
Dry Weather	05/14/03	112	62			10	0.20	0.04	
Dry Weather	05/19/03	78	11						
Dry Weather	05/20/03	122	17			11	0.11	0.04	
Dry Weather	05/28/03	34	8			8.8	0.05	0.00	
Dry Weather	06/04/03	20	6			6.8	0.04	0.01	
Dry Weather	06/09/03	17	4						
Dry Weather	06/11/03	16	6			5	0.06	0.02	

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Dry Weather	06/19/03	9	4						
Dry Weather	06/25/03	10	142						
Dry Weather	06/26/03	174	65			11	0.21	0.12	
Dry Weather	07/01/03	238	21			10	0.11	0.05	
Dry Weather	07/09/03	33	11			3	0.07	0.03	
Dry Weather	07/16/03	12	9			1	0.07	0.04	
Dry Weather	07/22/03	8	7			0.29	0.09	0.05	
Dry Weather	07/29/03	6	8			0.27	0.13	0.09	
Dry Weather	08/06/03	3	24						
Dry Weather	08/12/03	3	22			0.01	0.19	0.07	
Dry Weather	08/27/03	2	13			0.17	0.22	0.05	
Dry Weather	09/04/03	1							
Dry Weather	09/11/03	8	21			0.08	0.17	0.08	
Dry Weather	09/30/03	2	5			0.02	0.04	0.03	
Yellow Medicine River	03/15/03								
Yellow Medicine River	04/10/03	48	9			0.23	0.07	0.01	
Yellow Medicine River	04/17/03	63	11			0.01	0.09	0.00	
Yellow Medicine River	04/24/03	384	60			7	0.14	0.05	
Yellow Medicine River	05/08/03	192	11			3	0.05	0.00	
Yellow Medicine River	05/20/03	261	11			4.9	0.05	0.00	
Yellow Medicine River	06/05/03	121	17			3	0.05	0.01	
Yellow Medicine River	07/01/03	104	39			5.3	0.19	0.02	
Yellow Medicine River	07/16/03	31	64			0.005	0.23	0.00	
Yellow Medicine River	09/11/03	11	25			0.06	0.10	0.01	
Hawk Creek	04/02/03	98	5			1.9	0.61	0.52	2.01
Hawk Creek	04/15/03	56	19			2.2	0.66	0.45	<0.02
Hawk Creek	04/21/03	744	48			16	0.33	0.21	0.15
Hawk Creek	04/29/03	235	19			10	0.21	0.11	
Hawk Creek	05/05/03	206	17			7.7	0.27	0.16	
Hawk Creek	05/13/03	493	31			12	0.17	0.07	
Hawk Creek	05/19/03	351	26			10	0.18	0.08	0.02
Hawk Creek	05/27/03	294	19			11	0.15	0.08	
Hawk Creek	06/02/03	180	27			10	0.28	0.17	<0.02
Hawk Creek	06/18/03	162	46			8.1	0.30	0.22	0.04
Hawk Creek	06/26/03	1407	410			9.8	0.61	0.22	0.13
Hawk Creek	07/01/03	519	78			8.8	0.40	0.20	<0.02
Hawk Creek	07/15/03	215	65			5.9	0.45	0.24	
Hawk Creek	07/22/03	177	71			3.8	0.49	0.27	<0.02
Hawk Creek	08/05/03	63	43			0.6	0.63	0.33	<0.02
Hawk Creek	08/26/03	8	54			<0.1	0.55	0.30	<0.02
Hawk Creek	09/09/03	9	64			<0.1	0.74	0.30	<0.02

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Hawk Creek	09/23/03	17	63			<0.1	0.46	0.10	0.07
West Fork Beaver Creek	04/02/03	13	8			1.2	0.14	0.06	0.38
West Fork Beaver Creek	04/15/03	2	22			0.01	0.11	0.02	<0.02
West Fork Beaver Creek	04/21/03	121	14			15	0.24	0.18	0.09
West Fork Beaver Creek	04/29/03	31	13			8	0.06	0.01	
West Fork Beaver Creek	05/05/03	29	6			5.4	0.05	0.00	
West Fork Beaver Creek	05/13/03	95	5			12	0.05	0.01	
West Fork Beaver Creek	05/19/03	58	9			8	0.07	0.01	0.07
West Fork Beaver Creek	05/27/03	61	13			11	0.07	0.01	
West Fork Beaver Creek	06/02/03	39	14			8	0.08	0.02	0.1
West Fork Beaver Creek	06/18/03	34	49			7.2	0.17	0.11	0.25
West Fork Beaver Creek	06/26/03	79	51			5	0.19	0.11	0.19
West Fork Beaver Creek	07/01/03	62	42			7	0.25	0.14	0.09
West Fork Beaver Creek	07/15/03	2	93			0.9	0.25	0.20	
West Fork Beaver Creek	07/22/03	2	72			0.57	0.37	0.29	0.2
West Fork Beaver Creek	08/05/03	0							
Redwood River	05/14/03		100			11.2	0.20	0.12	
Redwood River	05/19/03		90			9.05	0.22	0.12	
Redwood River	05/27/03								
Redwood River	06/26/03		192			5.79	0.32	0.05	
Redwood River	07/31/03		35			<0.2	0.23	0.03	
Redwood River	08/13/03		64			<0.2	0.33	0.02	
Redwood River	09/29/03		74			<0.2	0.53	0.20	
Redwood River	10/22/03		49			<0.2	0.64	0.52	
Redwood River	11/13/03		5			3.18	1.01	0.93	
Redwood River	12/22/03		28			3.08	1.32	1.30	
Cottonwood River	01/07/03		7			5.3	0.10	0.02	
Cottonwood River	02/20/03		6			3	0.32	0.03	
Cottonwood River	03/19/03		113			1.78	0.53	0.41	
Cottonwood River	04/08/03	145	14			1.79	0.08	0.02	
Cottonwood River	04/22/03	1270	348			11.00	0.28	0.08	
Cottonwood River	04/29/03	636	88			9.14	0.16	0.04	
Cottonwood River	05/05/03	477	66			7.41	0.09	0.02	
Cottonwood River	05/12/03	1150	260			8.71	0.21	0.02	
Cottonwood River	05/14/03	1409	178			11.8	0.18	0.05	
Cottonwood River	05/19/03	981	100			11.00	0.15	0.04	
Cottonwood River	05/27/03	1120							
Cottonwood River	06/26/03	875	460			11.90	0.64	0.18	
Cottonwood River	06/30/03	72	263			15.10	0.27	0.06	
Cottonwood River	07/31/03	48	40			<0.2	0.10	0.02	
Cottonwood River	08/13/03	32	43			<0.2	0.11	0.01	

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Cottonwood River	09/25/03	32	13			<0.2	0.12	0.01	
Cottonwood River	10/22/03	41	12			<0.2	0.04	0.02	
Cottonwood River	11/13/03		9			0.64	0.04	0.02	
Cottonwood River	12/22/03		21			1.55	0.02		
Little Cottonwood River	03/20/03	80	82			1.8	0.38	0.19	
Little Cottonwood River	04/10/03	30	5			1.5	0.09	0.02	
Little Cottonwood River	04/16/03	40	17			0.5	0.10	0.00	
Little Cottonwood River	05/12/03	147	334			13	0.42	0.01	
Little Cottonwood River	05/15/03	144	213			12	0.16	0.07	
Little Cottonwood River	05/20/03	175	341			9.4	0.17	0.06	
Little Cottonwood River	06/09/03	82	156			8.1	0.22	0.14	
Little Cottonwood River	06/24/03	129	250			8.7	0.49	0.09	
Little Cottonwood River	07/10/03	115	532			6.9	0.65	0.13	
Little Cottonwood River	08/06/03	10	27			1.04	0.11	0.05	
Little Cottonwood River	09/22/03	3	6			0.5	0.09	0.03	
Watonwan River	04/09/03	105	6			4.09	0.21	0.15	
Watonwan River	04/11/03	136	12			3.82	0.21	0.14	
Watonwan River	04/17/03	425	98			9.23	0.25	0.08	
Watonwan River	04/18/03	526	130			11.1	0.22	0.10	
Watonwan River	04/22/03	620	78			13.4	0.20	0.08	
Watonwan River	5/1/2003-1	364							
Watonwan River	5/1/2003-2	364							
Watonwan River	05/05/03	342	34			7.88	0.13	0.04	
Watonwan River	05/06/03	381	42			8.21	0.14	0.05	
Watonwan River	05/09/03	429	48			10.1	0.12	0.12	
Watonwan River	05/12/03	999	304			12.4	0.32	0.08	
Watonwan River	05/13/03	1090							
Watonwan River	05/15/03	1030							
Watonwan River	05/19/03	771							
Watonwan River	05/20/03	943							
Watonwan River	05/21/03	1230							
Watonwan River	05/23/03	1150							
Watonwan River	05/28/03	693							
Watonwan River	06/06/03	397	104			11.6	0.19	0.10	
Watonwan River	06/09/03	872							
Watonwan River	06/11/03	966							
Watonwan River	06/13/03	818							
Watonwan River	06/18/03	491							
Watonwan River	06/19/03	462							
Watonwan River	06/25/03	572	228			12.8	0.34	0.21	
Watonwan River	06/26/03	762	91			16.0	0.32	0.21	

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Watonwan River	06/27/03	882	168			16.5	0.27	0.17	
Watonwan River	06/30/03	1130	142			17.9	0.29	0.12	
Watonwan River	07/09/03	375	136			11.4	0.27	0.17	
Watonwan River	07/10/03	401	128			11.1	0.27	0.15	
Watonwan River	07/16/03	228	86			10.8	0.16	0.16	
Watonwan River	07/25/03	100	28			5.78	0.18	0.21	
Watonwan River	08/01/03	49	20			2.18	0.17	0.14	
Watonwan River	08/11/03	25	54			1.04	0.26	0.21	
Watonwan River	08/22/03	24	53			0.86	0.25	0.10	
Watonwan River	08/29/03	14	42			<0.2	0.20	0.09	
Watonwan River	09/08/03	6	48			<0.2	0.22	0.02	
Watonwan River	09/18/03	15	41			1.51	0.53	0.43	
Watonwan River	09/29/03	8	6			0.24	0.27	0.20	
Dutch Creek	04/15/03	10	13			17.8	0.04	0.02	
Dutch Creek	04/21/03	12	10			19.0	0.05	0.04	
Dutch Creek	05/05/03	10	5			16.4	0.02	0.01	
Dutch Creek	05/12/03	19	26			19.0	0.06	0.04	
Dutch Creek	05/19/03	10	9			16.3	0.03	0.01	
Dutch Creek	06/03/03	6	6			16.3	0.04	0.03	
Dutch Creek	06/09/03	9	7			17.5	0.03	0.03	
Dutch Creek	06/26/03	15	15			21.1	0.10	0.09	
Dutch Creek	07/09/03	9	13			15.6	0.01	0.01	
Dutch Creek	07/11/03	11	9			20.4	0.09	0.07	
Dutch Creek	07/23/03	3	12			9.3	0.13	0.10	
Dutch Creek	08/06/03	3	17			2.6	0.19	0.20	
Dutch Creek	08/20/03	2	12			0.9	0.27	0.26	
Dutch Creek	09/03/03	2	11			0.5	0.15	0.12	
Dutch Creek	09/16/03	2	189			1.1	0.28	0.29	
Le Sueur River	01/30/03	41	1	8.16	0.05	8.21	0.04	0.02	0.2
Le Sueur River	03/14/03	90	3	2.88	0.06	2.94	0.41	0.30	0.38
Le Sueur River	03/17/03	250	52	3.7	0.03	3.73	0.11	0.09	0.2
Le Sueur River	03/21/03	338	33	2.34	0.06	2.4	0.27	0.15	0.44
Le Sueur River	03/31/03	812	205	12.2	0.15	12.35	0.66	0.13	0.27
Le Sueur River	04/08/03	377	21	9.23	0.05	9.28	0.11	0.03	0.02
Le Sueur River	04/19/03	1344	308	10.9	0.05	10.95	0.12	0.01	0.06
Le Sueur River	04/23/03	1540	158	14.6	0.03	14.63	0.18	0.03	0.1
Le Sueur River	04/28/03	1003	137	12.5	0.03	12.53	0.15	0.01	0.02
Le Sueur River	05/10/03	1648	324	15	0.06	15.06	0.59	0.05	0.03
Le Sueur River	05/13/03	3161	514	18.5	0.09	18.59	0.71	0.10	0.02
Le Sueur River	05/15/03	3739	958	16.3	0.12	16.42	1.07	0.13	0.09
Le Sueur River	05/17/03	3049	340	16.7	0.09	16.79	0.55	0.11	0.03

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Le Sueur River	05/20/03	1854	216	15	0.05	15.05	0.25	0.07	0.02
Le Sueur River	05/25/03	1098	125	12.7	0.03	12.73	0.23	0.06	0.02
Le Sueur River	06/04/03	571	56	10.9	0.04	10.94	0.15	0.01	0.02
Le Sueur River	06/12/03	1063	284	15.9	0.04	15.94	0.31	0.07	0.02
Le Sueur River	06/25/03	495	143	12.2	0.03	12.23	0.21	0.06	0.02
Le Sueur River	06/30/03	762	143	14.1	0.03	14.13	0.33	0.08	0.02
Le Sueur River	07/01/03	744	172	14.9	0.03	14.93	0.23	0.09	0.02
Le Sueur River	07/08/03	395	107	10.3	0.03	10.33	0.18	0.09	0.02
Le Sueur River	07/13/03	899	390	13.7	0.03	13.73	0.46	0.11	0.02
Le Sueur River	07/11/03	839	316	13.2	0.04	13.24	0.45	0.13	0.02
Le Sueur River	07/17/03	545	224	12.1	0.05	12.15	0.27	0.07	0.02
Le Sueur River	07/22/03	296	98	10.5	0.13	10.63	0.05	0.03	0.02
Le Sueur River	08/05/03	65	10	2.84	0.04	2.88	0.05	0.01	0.02
Le Sueur River	08/26/03	31	26	0.19	0.03	0.22	0.07	0.01	0.02
Le Sueur River	09/09/03	13	12	0.1	0.03	0.13	0.04	0.01	0.02
Le Sueur River	09/23/03	13	3	0.33	0.03	0.36	0.21	0.05	0.02
Le Sueur River	10/14/03	16	3	0.55	0.03	0.58	0.04	0.01	0.02
Le Sueur River	10/28/03	18	3	0.83	0.03	0.86	0.72	0.01	0.02
Le Sueur River	11/19/03	20	3	0.5	0.03	0.53	0.01	0.01	0.02
Blue Earth River	01/30/03	75	2	7.38	0.06	7.44	0.11	0.08	0.17
Blue Earth River	03/13/03	62	2	4.1	0.04	4.14	0.16	0.13	0.17
Blue Earth River	03/21/03	627	7	1.49	0.04	1.53	0.14	0.11	0.39
Blue Earth River	04/01/03	995	25	8.13	0.15	8.28	0.19	0.10	0.18
Blue Earth River	04/14/03	1106	54	8.18	0.04	8.22	0.14	0.01	0.12
Blue Earth River	04/16/03	1632	50	13.5	0.04	13.54	0.31	0.04	0.03
Blue Earth River	04/22/03	2362	59	13.1	0.04	13.14	0.18	0.04	0.04
Blue Earth River	04/25/03	2087	66	13.5	0.03	13.53	0.12	0.02	0.02
Blue Earth River	04/26/03	1507	54	11.4	0.03	11.43	0.14	0.01	0.02
Blue Earth River	05/10/03	2436	101	12.6	0.04	12.64	0.16	0.02	0.02
Blue Earth River	05/14/03	4567	488	15.7	0.07	15.77	0.55	0.06	0.09
Blue Earth River	05/17/03	3805	234	15.2	0.05	15.25	0.27	0.06	0.02
Blue Earth River	05/23/03	3055	133	14.1	0.03	14.13	0.23	0.04	0.02
Blue Earth River	06/04/03	1408	51	11.6	0.03	11.63	0.13	0.01	0.02
Blue Earth River	06/14/03	2299	94	13.9	0.04	13.94	0.14	0.05	0.02
Blue Earth River	06/25/03	1446	80	12.1	0.03	12.13	0.17	0.05	0.02
Blue Earth River	06/30/03	2726	185	15.5	0.04	15.54	0.26	0.09	0.02
Blue Earth River	07/01/03	2484	137	14.9	0.04	14.94	0.21	0.08	0.02
Blue Earth River	07/08/03	1484	85	10.7	0.03	10.73	0.19	0.07	0.02
Blue Earth River	07/13/03	2068	103	14.4	0.03	14.43	0.31	0.09	0.02
Blue Earth River	07/22/03	765	65	10.3	0.04	10.34	0.17	0.07	0.02
Blue Earth River	08/05/03	169	63	1.74	0.05	1.79	0.11	0.01	0.13

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Blue Earth River	08/26/03	95	61	0.24	0.03	0.27	0.15	0.02	0.08
Blue Earth River	09/09/03	45	40	0.35	0.03	0.38	0.13	0.01	0.02
Blue Earth River	09/23/03	42	39	0.49	0.03	0.52	0.12	0.01	0.03
Blue Earth River	10/14/03	35	42	0.56	0.03	0.59	0.10	0.01	0.13
Blue Earth River	11/19/03	53	15	0.72	0.03	0.75	0.12	0.01	0.02
Seven Mile Creek	03/18/03		11			3.6	0.46	0.26	
Seven Mile Creek	03/20/03		81			3.6	0.42	0.28	
Seven Mile Creek	04/01/03	0				6.08	0.12	0.06	
Seven Mile Creek	04/10/03	1	3			4.3	0.08	0.00	
Seven Mile Creek	04/15/03	1	7			2.6	0.08	0.01	
Seven Mile Creek	04/17/03	20				11.7	0.15	0.09	
Seven Mile Creek	04/22/03	16				14	0.04	0.01	
Seven Mile Creek	05/11/03	42	38			15	0.25	0.01	
Seven Mile Creek	05/11/03	33				18.7	0.38	0.04	
Seven Mile Creek	05/14/03	158	2849			11	0.54	0.26	
Seven Mile Creek	05/15/03	209	644			7.9	0.51	0.20	
Seven Mile Creek	05/15/03	191				29	0.53	0.10	
Seven Mile Creek	05/20/03	108	142			24	0.19	0.17	
Seven Mile Creek	05/20/03	105				24	0.19	0.04	
Seven Mile Creek	06/07/03	84				22.5	0.26	0.03	
Seven Mile Creek	06/09/03	67	49			29	0.15	0.15	
Seven Mile Creek	06/09/03	84	237			22	0.20	0.14	
Seven Mile Creek	06/17/03	15				18.4	0.03	0.01	
Seven Mile Creek	06/18/03	16	6			20	0.06	0.05	
Seven Mile Creek	06/23/03	78				18	0.43	0.15	
Seven Mile Creek	06/25/03	66				21.4			
Seven Mile Creek	06/25/03	66	84			22	0.25	0.06	
Seven Mile Creek	06/25/03	67	338			21	0.45	0.12	
Seven Mile Creek	06/25/03	68				24.6	0.13	0.02	
Seven Mile Creek	07/09/03	13				14.9	0.04	0.02	
Seven Mile Creek	07/09/03	156				14.5	1.06	0.12	
Seven Mile Creek	07/09/03	156				16.4	1.30	0.16	
Seven Mile Creek	07/10/03	158	399			20	0.49	0.06	
Seven Mile Creek	07/10/03	156	1770			15	1.64	0.19	
Seven Mile Creek	07/10/03	100	308			22.2	0.25	0.04	
Seven Mile Creek	07/14/03	100	184			25			
Seven Mile Creek	07/22/03	6	93			14	0.04	0.01	
Seven Mile Creek	08/06/03	1				6.39	0.01		
Seven Mile Creek	08/20/03	2	14			6.9	0.12	0.02	
Seven Mile Creek	09/18/03	2				5.5	0.01		
Seven Mile Creek	09/22/03	2	2			5.6	0.69	0.11	

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
High Island Creek	03/25/03	59	109			2.79	0.28	0.18	
High Island Creek	04/11/03	25	12			1.59	0.11	0.02	
High Island Creek	04/16/03	35	48			0.71	0.15	0.02	
High Island Creek	04/21/03	97	308			11.30	0.24	0.08	
High Island Creek	05/12/03	148	408			13.70	0.31	0.08	
High Island Creek	05/15/03	183	456			18.20	0.28	0.08	
High Island Creek	05/20/03	450	1090			19.00	0.55	0.25	
High Island Creek	05/28/03	284	212			14.60	0.19	0.05	
High Island Creek	06/09/03	138	146			13.90	0.14	0.02	
High Island Creek	06/18/03	77	56			12.10	0.10	0.04	
High Island Creek	06/26/03	66	71			8.69	0.17	0.12	
High Island Creek	06/30/03	177	224			19.00	0.21	0.12	
High Island Creek	07/10/03	NA	62			9.32	0.18	0.13	
High Island Creek	07/29/03	13	10			1.49	0.04	0.01	
High Island Creek	08/21/03	2	6			<.2	0.10	0.03	
High Island Creek	09/23/03	2	2			<.2	0.04	0.04	
Rush River	03/25/03	45	63			4.03	0.33	0.25	
Rush River	04/11/03	22	12			3.01	0.19	0.10	
Rush River	04/16/03	29	50			1.06	0.20	0.03	
Rush River	04/21/03	147	220			12.3	0.27	0.09	
Rush River	05/12/03	388	1030			16.4	0.69	0.11	
Rush River	05/15/03	901	2350			19.7	1.66	0.25	
Rush River	05/20/03	1024	900			23.0	0.58	0.33	
Rush River	05/28/03	286	106			18.9	0.14	0.09	
Rush River	06/04/03	159	-			20.0	-	-	
Rush River	06/09/03	465	190			22.0	0.24	0.14	
Rush River	06/09/03	465	230			21.6	0.24	0.13	
Rush River	06/18/03	120	46			18.7	0.07	0.05	
Rush River	06/26/03	169	100			16.2	0.22	0.12	
Rush River	06/30/03	149	96			20.7	0.15	0.08	
Rush River	07/10/03	94	60			11.9	0.14	0.09	
Rush River	07/29/03	16	8			6.5	0.03	<.005	
Rush River	08/21/03	4	2			0.2	0.03	0.03	
Rush River	09/23/03	7	5			<.2	0.02	0.01	
Sand Creek	04/17/03	304	493	4.11	0.04	4.15	1.03	0.10	
Sand Creek	04/20/03	332	613	5.14	0.04	5.18	0.74	0.10	
Sand Creek	04/23/03	310	1190	4.08	0.02	4.10	0.80	0.08	
Sand Creek	04/26/03	228	126	2.58	0.02	2.60	0.22	0.05	
Sand Creek	05/12/03	979	2240	8.48	0.09	8.57	1.14	0.17	
Sand Creek	05/14/03	887	1250	7.60	0.06	7.66	0.90	0.12	
Sand Creek	05/24/03	344	1490	1.94	0.02	1.96	0.95		

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Sand Creek	06/08/03	299	712	4.42	0.05	4.47	0.76	0.13	
Sand Creek	06/11/03	200	524	3.78	0.02	3.80	0.62	0.12	
Sand Creek	06/14/03	151	528	2.04	0.02	2.06	0.72	0.10	
Sand Creek	07/05/03	83		1.11	0.02	1.13	0.90	0.15	
Sand Creek	07/16/03	77		0.63	0.04	0.67	0.45	0.08	
Sand Creek	01/07/03	45	2	2.60	0.04	2.64	0.17	0.11	
Sand Creek	02/13/03	37	5	3.32	0.04	3.36	0.34	0.30	
Sand Creek	03/19/03	179	36	2.06	0.10	2.16	0.56	0.31	
Sand Creek	03/24/03	184	105	2.06	0.25	2.31	0.36	0.13	
Sand Creek	04/08/03	81	19	1.56	0.02	1.58	0.19	0.01	
Sand Creek	05/06/03	149	20	2.12	0.02	2.14	0.19	0.08	
Sand Creek	05/11/03	800	4380	5.04	0.07	5.11	1.00	0.16	
Sand Creek	05/16/03	648	195	4.34	0.05	4.39	0.28	0.10	
Sand Creek	05/19/03	464	153	2.56	0.02	2.58	0.24	0.07	
Sand Creek	05/21/03	410	106	2.71	0.02	2.73	0.26	0.10	
Sand Creek	05/27/03	225	64	2.32	0.03	2.35	0.28	0.10	
Sand Creek	06/25/03	103	84	6.57	0.07	6.64	0.38	0.24	
Sand Creek	07/11/03	41	28	2.65	0.02	2.67	0.35	0.28	
Sand Creek	08/05/03	2	6	0.30	0.02	0.32	0.21	0.19	
Sand Creek	09/10/03	2	5	0.09	0.02	0.11	0.08	0.05	
Sand Creek	10/07/03	2	3	0.51	0.02	0.53	0.09	0.06	
Sand Creek	10/22/03	1	1	0.60	0.02	0.62	0.25	0.17	
Sand Creek	11/12/03	3	2	1.54	0.02	1.56	0.40	0.34	
Sand Creek	11/25/03	1	2	3.44	0.04	3.48	0.72	0.66	
Sand Creek	12/11/03	1	2	3.56	0.04	3.60	0.65	0.56	
Sand Creek	12/22/03	1	1	3.68	0.05	3.73	0.67	0.55	
Lower Bevens Creek	04/17/03	194	622	7.99	0.07	8.06	1.00	0.21	
Lower Bevens Creek	04/20/03	188	219	9.97	0.05	10.02	0.36	0.16	
Lower Bevens Creek	04/23/03	165	117	9.57	0.03	9.60	0.21	0.12	
Lower Bevens Creek	04/26/03	99	58	7.77	0.04	7.81	0.18	0.10	
Lower Bevens Creek	05/10/03	308	520	6.28	0.05	6.33	0.56	0.15	
Lower Bevens Creek	05/12/03	368	820	15.90	0.09	15.99	0.86	0.23	
Lower Bevens Creek	05/14/03	263	300	12.60	0.05	12.65	0.34		
Lower Bevens Creek	05/17/03	183	170	10.00	0.03	10.03	0.28	0.14	
Lower Bevens Creek	05/20/03	415	592	14.40	0.08	14.48	0.66	0.23	
Lower Bevens Creek	05/22/03	311	302	14.80	0.05	14.85	0.57	0.15	
Lower Bevens Creek	05/25/03	221	171	10.80	0.02	10.82	0.33		
Lower Bevens Creek	06/26/03	70	159	6.62	0.08	6.70	0.50	0.35	
Lower Bevens Creek	06/29/03	44	68				0.30		
Lower Bevens Creek	07/05/03	52	102	7.02	0.07	7.09	0.46	0.34	
Lower Bevens Creek	01/07/03	29	2	4.26	0.04	4.30	0.35	0.32	

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Lower Bevens Creek	02/20/03	24	2	2.95	0.03	2.98	0.40	0.36	
Lower Bevens Creek	03/17/03	70	67	5.07	0.18	5.25	0.90	0.71	
Lower Bevens Creek	03/24/03	67	52	4.88	0.23	5.11	0.35	0.20	
Lower Bevens Creek	04/10/03	31	5	3.00	0.03	3.03	0.19	0.12	
Lower Bevens Creek	05/06/03	58	6	5.32	0.03	5.35	0.18	0.11	
Lower Bevens Creek	05/27/03	152	99	8.87	0.03	8.90	0.35	0.11	
Lower Bevens Creek	06/09/03	68	10	6.89	0.04	6.93	0.19	0.17	
Lower Bevens Creek	06/25/03	52	144	5.35	0.08	5.43	0.40	0.28	
Lower Bevens Creek	07/17/03	21	26	3.71	0.04	3.75	0.39	0.36	
Lower Bevens Creek	08/07/03	3	3	0.29	0.03	0.32	0.13	0.12	
Lower Bevens Creek	09/10/03	2	2	0.56	0.03	0.59	0.04	0.01	
Lower Bevens Creek	10/07/03	2	2	1.17	0.03	1.20	0.03	0.01	
Lower Bevens Creek	10/22/03	2	2	1.14	0.03	1.17	0.02	0.02	
Lower Bevens Creek	11/12/03	2	1	1.13	0.03	1.16	0.02	0.01	
Lower Bevens Creek	11/25/03	2	1	1.12	0.03	1.15	0.01	0.01	
Lower Bevens Creek	12/11/03	2	2	1.25	0.03	1.28	0.02	0.00	
Lower Bevens Creek	12/22/03	2	4	1.12	0.03	1.15	0.01	0.01	
Bluff Creek	07/15/03	20	337	0.12	0.015	0.135	0.46	0.18	
Bluff Creek	01/07/03	1	5	0.24	0.02	0.26	0.05	0.02	
Bluff Creek	02/13/03	0	1	0.40	0.02	0.42	0.01	0.01	
Bluff Creek	03/17/03	23	155	1.24	0.07	1.31	0.69	0.44	
Bluff Creek	04/02/03	2	3	0.73	0.02	0.75	0.10		
Bluff Creek	04/18/03	18	40	1.13	0.04	1.17	0.16	0.05	
Bluff Creek	05/01/03	2	2	0.36	0.02	0.38	0.07	0.02	
Bluff Creek	05/11/03	61	2430	1.63	0.05	1.68	0.87	0.13	
Bluff Creek	05/12/03	30	272	0.81	0.02	0.83	0.21	0.09	
Bluff Creek	06/27/03	9	24	0.41	0.02	0.43	0.16	0.10	
Bluff Creek	07/21/03	1	4	0.38	0.02	0.40	0.10	0.06	
Bluff Creek	08/05/03	1	5	0.28	0.02	0.30	0.04	0.02	
Bluff Creek	09/10/03	1	9	0.22	0.02	0.24	0.05	0.02	
Bluff Creek	10/29/03	1	1	0.85	0.02	0.87	0.02	0.02	
Bluff Creek	11/25/03	0	4	0.70	0.02	0.72	0.04	0.02	
Bluff Creek	12/17/03	1	1	0.75	0.02	0.77	0.04	0.02	
Nine Mile Creek	05/11/03	165	152	0.21	0.02	0.23	0.20	0.01	
Nine Mile Creek	05/12/03	142	54	0.19	0.02	0.21	0.12	0.01	
Nine Mile Creek	05/14/03	236	456	0.23	0.02	0.25	0.26		
Nine Mile Creek	05/20/03	94	74	0.13	0.02	0.15	0.12	0.04	
Nine Mile Creek	06/07/03	66	48	0.24	0.02	0.26	0.18		
Nine Mile Creek	06/26/03	120	114	0.24	0.02	0.26	0.15	0.05	
Nine Mile Creek	06/28/03	225					0.26		
Nine Mile Creek	07/03/03	161	372	0.38	0.02	0.40	0.24		

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Nine Mile Creek	07/04/03	96	47	0.26	0.04	0.30	0.19	0.07	
Nine Mile Creek	07/14/03	189		0.49	0.02	0.51	0.42		
Nine Mile Creek	08/20/03	85	306	0.61	0.04	0.65	0.44		
Nine Mile Creek	09/12/03	83		0.28	0.02	0.30	0.31		
Nine Mile Creek	01/02/03	5	2	0.36	0.02	0.38	0.01	0.01	
Nine Mile Creek	02/06/03	3	2	0.88	0.02	0.90	0.04	0.01	
Nine Mile Creek	03/04/03	3	1	1.11	0.02	1.13	0.02	0.01	
Nine Mile Creek	03/14/03	45	304	0.87	0.09	0.96	0.83		
Nine Mile Creek	03/16/03	49	36	0.63	0.02	0.65	0.29	0.14	
Nine Mile Creek	04/09/03	7	3	0.45	0.02	0.47	0.04	0.00	
Nine Mile Creek	04/17/03	80	30	0.17	0.02	0.19	0.15	0.00	
Nine Mile Creek	05/05/03	24	10	0.34	0.03	0.37	0.11	0.01	
Nine Mile Creek	05/29/03	21	4	0.23	0.04	0.27	0.08		
Nine Mile Creek	06/24/03	8	5	0.69	0.05	0.74	0.16	0.07	
Nine Mile Creek	07/25/03	8	5	0.29	0.02	0.31	0.08		
Nine Mile Creek	08/06/03	5	3	0.31	0.02	0.33	0.08	0.03	
Nine Mile Creek	08/14/03	1	1	0.72	0.02	0.74	0.05	0.03	
Nine Mile Creek	08/20/03	10						0.04	
Nine Mile Creek	09/05/03	2	1	0.90	0.02	0.92	0.06	0.02	
Nine Mile Creek	09/12/03	8	38					0.00	
Nine Mile Creek	10/21/03	2	1	0.87	0.02	0.89	0.03	0.01	
Nine Mile Creek	11/14/03	2	1	0.68	0.02	0.70	0.03	0.01	
Nine Mile Creek	12/03/03	2	2	0.99	0.02	1.01	0.01	0.01	
Riley Creek	01/30/03	2	2	2.03	0.04	2.07	0.03	0.03	0.07
Riley Creek	03/05/03	2	3	2.2	0.03	2.23	0.03	0.02	0.02
Riley Creek	03/15/03	8	512	1.04	0.07	1.11	1.98		0.02
Riley Creek	03/27/03	7	534	0.71	0.03	0.74	0.55	0.04	0.21
Riley Creek	04/10/03	2	59	0.76	0.03	0.79	0.12	0.02	0.09
Riley Creek	04/16/03	7	205	0.58	0.03	0.61	1.23	0.02	0.09
Riley Creek	05/05/03	4	61	0.63	0.03	0.66	0.09		0.06
Riley Creek	05/09/03	8	535	0.55	0.04	0.59	0.88		0.05
Riley Creek	05/11/03	17	1130	0.44	0.04	0.48	0.73		0.07
Riley Creek	05/19/03	19	415	0.49	0.03	0.52	0.44		0.02
Riley Creek	06/07/03	8	263	0.47	0.08	0.55	0.26		0.06
Riley Creek	06/13/03	4	89	0.66	0.05	0.71	0.04	0.03	0.02
Riley Creek	06/25/03	11	1370	0.54	0.08	0.62	1.28		0.09
Riley Creek	07/03/03	11	835	0.48	0.04	0.52	0.82		0.05
Riley Creek	07/14/03	38	2970	0.32	0.1	0.42	2.89		0.12
Riley Creek	07/29/03	2	30	0.75	0.04	0.79	0.10	0.03	0.06
Riley Creek	08/26/03	1	3	1.6	0.03	1.63	0.05	0.04	0.02
Riley Creek	09/12/03	7	800	0.37	0.05	0.42	1.00	0.06	0.04

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Riley Creek	10/03/03	1	1	1.97	0.03	2	0.04	0.04	0.02
Riley Creek	10/12/03	3	8	1.59	0.03	1.62	0.08		0.02
Riley Creek	10/31/03	1	3	2.3	0.03	2.33	0.04	0.03	0.03
Riley Creek	12/03/03	1	2	2.25	0.03	2.28	0.05	0.02	0.03
Eagle Creek	01/07/03	9	8	0.31	0.03	0.34	0.05	0.01	0.02
Eagle Creek	02/12/03	7	32	0.75	0.03	0.78	0.19	0.01	0.08
Eagle Creek	03/11/03	9	40	0.36	0.03	0.39	0.18	0.01	0.07
Eagle Creek	03/14/03	10	31	0.39	0.03	0.42	0.13		0.06
Eagle Creek	03/15/03	10	15	0.25	0.03	0.28	0.07		0.06
Eagle Creek	04/10/03	7	5	0.09	0.03	0.12	0.05	0.01	0.02
Eagle Creek	05/02/03	7	7	0.1	0.03	0.13	0.05	0.01	0.02
Eagle Creek	05/04/03	8		0.11	0.03	0.14	0.08	0.01	0.03
Eagle Creek	05/11/03	14	36	0.19	0.03	0.22	0.06	0.01	0.02
Eagle Creek	06/17/03	7	8	0.06	0.03	0.09	0.01	0.01	0.02
Eagle Creek	06/25/03	11	31	0.13	0.03	0.16	0.08	0.01	0.03
Eagle Creek	07/03/03	12	46	0.17	0.03	0.2	0.11	0.01	0.02
Eagle Creek	07/21/03	8	3	0.07	0.03	0.1	0.04	0.01	0.03
Eagle Creek	08/12/03	7	3	0.08	0.03	0.11	0.04	0.01	0.07
Eagle Creek	08/20/03	8	5	0.14	0.03	0.17	0.07	0.01	0.04
Eagle Creek	09/12/03	9	11	0.05	0.03	0.08	0.07	0.02	0.02
Eagle Creek	09/24/03	7	2	0.11	0.03	0.14	0.03	0.01	0.02
Eagle Creek	10/08/03	8	4	0.63	0.03	0.66	0.03	0.01	0.02
Eagle Creek	10/11/03	10		0.62	0.03	0.65	0.05		0.03
Eagle Creek	11/05/03	8	2	0.57	0.03	0.6	0.03	0.01	0.03
Eagle Creek	11/19/03	8	5	0.26	0.03	0.29	0.03	0.01	0.04
Eagle Creek	12/07/03	7	92	0.17	0.03	0.2	0.35	0.01	0.06
Credit Creek	01/07/03	9	1	0.88	0.02	0.90	0.02	0.01	
Credit Creek	02/06/03	8	1	1.36	0.02	1.38	0.03	0.02	
Credit Creek	03/17/03	58	66	1.60	0.04	1.64	0.75	0.43	
Credit Creek	04/02/03	23	8	1.13	0.02	1.15	0.12		
Credit Creek	04/09/03	13	4	0.70	0.02	0.72	0.06	0.01	
Credit Creek	04/17/03	66	52	1.58	0.05	1.63	0.24	0.09	
Credit Creek	04/22/03	49	15	1.54	0.02	1.56	0.16	0.04	
Credit Creek	05/05/03	32	32	0.45	0.02	0.47	0.08	0.01	
Credit Creek	05/11/03	169	634	0.62	0.02	0.64	0.32	0.07	
Credit Creek	05/13/03	156	180	1.54	0.02	1.56	0.23	0.11	
Credit Creek	05/21/03	52	26	0.70	0.02	0.72	0.17	0.08	
Credit Creek	06/06/03	26	32	0.59	0.02	0.61	0.20	0.05	
Credit Creek	06/24/03	11	8	0.77	0.02	0.79	0.11	0.08	
Credit Creek	07/03/03	25	38					0.05	
Credit Creek	07/03/03	22		0.65	0.03	0.68	0.80		

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
Credit Creek	07/15/03	37	78					0.08	
Credit Creek	07/15/03	20		0.50	0.02	0.52	0.63		
Credit Creek	07/25/03	4	2	0.55	0.02	0.57	0.07	0.05	
Credit Creek	08/06/03	3	1	0.36	0.02	0.38	0.05	0.03	
Credit Creek	08/14/03	3	2	0.56	0.02	0.58	0.05	0.04	
Credit Creek	09/05/03	2	1	0.73	0.02	0.75	0.07	0.04	
Credit Creek	09/12/03	10	19					0.06	
Credit Creek	09/12/03	17		0.70	0.02	0.72	0.52		
Credit Creek	10/21/03	3	1	0.78	0.02	0.80	0.58	0.01	
Credit Creek	11/18/03	6	2	0.73	0.02	0.75	0.04	0.03	
Credit Creek	12/15/03	3	3	1.04	0.02	1.06	0.05	0.02	
Willow Creek	03/07/03	0	28	1.12	0.07	1.19	0.11	0.02	0.57
Willow Creek	03/27/03	9	40	0.27	0.03	0.3	0.15	0.04	0.17
Willow Creek	04/10/03	1	4	0.12	0.03	0.15	0.06	0.01	0.02
Willow Creek	04/16/03	9	216	0.29	0.03	0.32	0.38	0.02	0.22
Willow Creek	04/21/03	9	8	0.41	0.03	0.44	0.07	0.01	0.05
Willow Creek	05/05/03	10	40	0.21	0.03	0.24	0.25		0.06
Willow Creek	05/09/03	13	52	0.15	0.03	0.18	0.24		0.07
Willow Creek	05/11/03	30	66	0.15	0.03	0.18	0.12		0.06
Willow Creek	05/14/03	35	31	0.19	0.03	0.22	0.06	0.01	0.07
Willow Creek	05/19/03	16	18	0.18	0.03	0.21	0.06		0.04
Willow Creek	06/07/03	12	29	0.14	0.03	0.17	0.10		0.11
Willow Creek	06/13/03	5	3	0.21	0.03	0.24	0.06	0.02	0.03
Willow Creek	06/24/03	12	49	0.22	0.03	0.25	0.14		0.09
Willow Creek	07/15/03	19	42	0.16	0.03	0.19	0.11		0.09
Willow Creek	07/29/03	1	2	0.42	0.03	0.45	0.03	0.01	0.05
Willow Creek	08/26/03	0	1	1.03	0.03	1.06	0.03	0.01	0.02
Willow Creek	09/12/03	14	56	0.14	0.03	0.17	0.17		0.03
Willow Creek	10/06/03	1	1	1.23	0.03	1.26	0.02	0.01	0.04
Willow Creek	10/31/03	0	1	0.97	0.03	1	0.01	0.01	0.02
Willow Creek	11/19/03	0	1	0.79	0.03	0.82	0.01	0.01	0.03
MN River at Judson	01/30/03	449	4	1.72	0.03	1.75	0.15	0.11	0.2
MN River at Judson	03/14/03	533	4	1.14	0.03	1.17	0.24	0.18	0.36
MN River at Judson	03/21/03	3411	168	1.89	0.12	2.01	0.65	0.44	0.86
MN River at Judson	03/26/03	3554	112	1.35	0.05	1.4	0.42	0.26	0.46
MN River at Judson	04/15/03	1456	87	0.05	0.03	0.08	0.22	0.01	0.02
MN River at Judson	04/22/03	4452	191	7.23	0.08	7.31	0.37	0.07	0.08
MN River at Judson	04/28/03	4202	138	4.57	0.03	4.6	0.22	0.03	0.06
MN River at Judson	05/07/03	3135	75	2.79	0.03	2.82	0.22	0.01	0.06
MN River at Judson	05/16/03	6454	174	9.16	0.04	9.2	0.24	0.05	0.03
MN River at Judson	05/22/03	6567	159	7.98	0.03	8.01	0.17	0.05	0.02

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
MN River at Judson	06/04/03	3214	88	4.28	0.03	4.31	0.15	0.01	0.02
MN River at Judson	06/17/03	2945	112	4.51	0.03	4.54	0.19	0.01	0.02
MN River at Judson	06/25/03	3037	117	4.65	0.03	4.68	0.21	0.01	0.02
MN River at Judson	07/01/03	4596	136	9.23	0.04	9.27	0.24	0.10	0.02
MN River at Judson	07/08/03	3503	140	3.43	0.03	3.46	0.25	0.05	0.02
MN River at Judson	07/22/03	2703	138	1.16	0.04	1.2	0.31	0.09	0.02
MN River at Judson	08/05/03	1517	114	0.05	0.03	0.08	0.29	0.09	0.03
MN River at Judson	08/26/03	569	132	0.11	0.03	0.14	0.31	0.12	0.02
MN River at Judson	09/09/03	352	60	0.05	0.03	0.08	0.25	0.07	0.02
MN River at Judson	09/23/03	378	45	0.33	0.03	0.36	0.01	0.01	0.02
MN River at Judson	10/14/03	201	60	0.54	0.03	0.57	0.25	0.08	0.02
MN River at Judson	10/28/03	226	71	0.72	0.03	0.75	0.19	0.06	0.02
MN River at Judson	11/19/03	258	30	0.42	0.03	0.45	0.19	0.01	0.03
MN River at St. Peter	01/30/03	540	2	3.3	0.04	3.34	0.13	0.10	0.15
MN River at St. Peter	03/14/03	840	13	1.78	0.07	1.85	0.22	0.18	0.28
MN River at St. Peter	03/21/03	4332	90	1.91	0.12	2.03	0.58	0.38	0.72
MN River at St. Peter	03/26/03	3811	103	1.62	0.08	1.7	0.50	0.24	0.45
MN River at St. Peter	04/15/03	3186	84	4.54	0.03	4.57	0.20	0.01	0.02
MN River at St. Peter	04/20/03	6274	151	8.38	0.04	8.42	0.25	0.04	0.02
MN River at St. Peter	04/25/03	8376	159	9.79	0.06	9.85	0.24	0.05	0.03
MN River at St. Peter	04/29/03	6369	80	7.57	0.03	7.6	0.16	0.01	0.02
MN River at St. Peter	05/11/03	8280	247	9.67	0.04	9.71	0.34	0.03	0.03
MN River at St. Peter	05/15/03	13518	498	13.2	0.08	13.28	0.54	0.07	0.08
MN River at St. Peter	05/17/03	12742	260	12.4	0.06	12.46	0.34	0.06	0.02
MN River at St. Peter	05/21/03	11103	150	10.6	0.05	10.65	0.29	0.06	0.02
MN River at St. Peter	05/25/03	9623	111	10.2	0.05	10.25	0.22	0.04	0.02
MN River at St. Peter	06/04/03	5378	126	7.44	0.03	7.47	0.21	0.01	0.02
MN River at St. Peter	06/11/03	7097	120	10.3	0.04	10.34	0.16	0.03	0.02
MN River at St. Peter	06/14/03	7129	126	11.2	0.05	11.25	0.17	0.04	0.02
MN River at St. Peter	06/25/03	4315	146	7.74	0.03	7.77	0.23	0.03	0.02
MN River at St. Peter	06/30/03	7923	190	10.7	0.05	10.75	0.25	0.09	0.02
MN River at St. Peter	07/08/03	5155	139	5.81	0.03	5.84	0.26	0.07	0.02
MN River at St. Peter	07/12/03	6703	169	7.61	0.03	7.64	0.30	0.07	0.02
MN River at St. Peter	07/22/03	3790	136	3.73	0.04	3.77	0.25	0.09	0.02
MN River at St. Peter	08/05/03	1690	104	0.26	0.03	0.29	0.23	0.06	0.02
MN River at St. Peter	08/26/03	729	75	0.13	0.03	0.16	0.23	0.07	0.02
MN River at St. Peter	09/09/03	390	46	0.08	0.03	0.11	0.20	0.03	0.02
MN River at St. Peter	09/23/03	411	36	0.25	0.03	0.28	0.42	0.06	0.02
MN River at St. Peter	10/14/03		26	0.7	0.03	0.73	0.15	0.05	0.02
MN River at St. Peter	11/19/03		42	0.5	0.03	0.53	0.21	0.01	0.02
MN River at Jordan	01/10/03	870	4	2.46	0.03	2.49	0.05	0.05	

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
MN River at Jordan	02/07/03	760	5	2.72	0.03	2.75	0.15	0.08	
MN River at Jordan	02/21/03	780	3	2.27	0.03	2.3	0.12	0.10	
MN River at Jordan	03/07/03	780	3	2.41	0.03	2.44	0.13	0.08	
MN River at Jordan	03/20/03	4910	84	1.7	0.07	1.77	0.42	0.23	
MN River at Jordan	04/03/03	4230	123	5.02	0.08	5.1	0.23	0.11	
MN River at Jordan	04/18/03	4380	106	5.75	0.03	5.78	0.22	0.01	
MN River at Jordan	05/09/03	6360	112	7	0.03	7.03	0.22	0.01	
MN River at Jordan	05/23/03	13700	165	12.8	0.03	12.83	0.23	0.06	
MN River at Jordan	05/30/03	8150	106	10.3	0.03	10.33	0.20	0.02	
MN River at Jordan	06/06/03	5270	100	6.73	0.03	6.76	0.15	0.01	
MN River at Jordan	06/20/03	5040	127	8.87	0.03	8.9	0.23	0.03	
MN River at Jordan	07/03/03	7800	208	12.7	0.03	12.73	0.32	0.09	
MN River at Jordan	07/18/03	5500	278	6.76	0.03	6.79	0.25	0.08	
MN River at Jordan	08/07/03	2170	94	0.13	0.03	0.16	0.18	0.03	
MN River at Jordan	08/22/03	1110	78	0.05	0.03	0.08		0.03	
MN River at Jordan	09/05/03	636	54	0.05	0.03	0.08	0.18	0.01	
MN River at Jordan	09/19/03	651	62	0.05	0.03	0.08	0.16	0.01	
MN River at Jordan	10/03/03		35	0.08	0.03	0.11	0.15	0.01	
MN River at Jordan	10/10/03		57	0.67	0.03	0.7	0.24	0.01	
MN River at Jordan	10/17/03		35	0.45	0.03	0.48	0.11	0.01	
MN River at Jordan	10/24/03		46	0.42	0.03	0.45	0.10	0.01	
MN River at Jordan	10/30/03		22	0.97	0.03	1	0.10	0.01	
MN River at Jordan	11/07/03		11	1.18	0.03	1.21	0.10	0.06	
MN River at Jordan	11/13/03		16	0.95	0.03	0.98	0.18	0.02	
MN River at Jordan	11/21/03		46	0.12	0.03	0.15	0.13	0.01	
MN River at Jordan	11/25/03		36	0.05	0.03	0.08	0.13	0.01	
MN River at Jordan	12/05/03		18	0.9	0.03	0.93	0.21	0.03	
MN River at Jordan	12/11/03		11	1.08	0.03	1.11	0.15	0.07	
MN River at Jordan	12/23/03		4	1.5	0.04	1.54	0.12	0.07	
MN River at Jordan	12/30/03		6	1.46	0.03	1.49	0.16	0.10	
MN River at F. Snelling	01/10/03	1040	11	2.59	0.03	2.62	0.15	0.08	
MN River at F. Snelling	01/24/03	860	10	3.96	0.03	3.99	0.18	0.11	
MN River at F. Snelling	02/07/03	820	9	3.15	0.03	3.18	0.11	0.07	
MN River at F. Snelling	02/21/03	850	7	2.8	0.04	2.84	0.14	0.08	
MN River at F. Snelling	03/07/03	850	10	3.17	0.04	3.21	0.12	0.08	
MN River at F. Snelling	03/20/03	4169	28	1.75	0.06	1.81	0.39	0.25	
MN River at F. Snelling	04/03/03	4725	71	3.26	0.05	3.31	0.22	0.11	
MN River at F. Snelling	04/18/03	4032	67	3.16	0.03	3.19	0.21	0.01	
MN River at F. Snelling	05/09/03	5670	45	3.96	0.03	3.99	0.01	0.01	
MN River at F. Snelling	05/23/03	14805	164	11.6	0.04	11.64	0.27	0.06	
MN River at F. Snelling	05/30/03	9167	96	8.96	0.03	8.99	0.21	0.03	

Water Quality Concentrations for Monitoring Sites 2003

Site	Date	Flow (cfs)	TSS (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	PO-4 (mg/L)	NH3 (mg/L)
MN River at F. Snelling	06/06/03	5796	85	7.04	0.03	7.07	0.17	0.01	
MN River at F. Snelling	06/20/03	5639	58	8.83	0.03	8.86	0.17	0.04	
MN River at F. Snelling	07/03/03	9125	70	11.8	0.04	11.84	0.19	0.10	
MN River at F. Snelling	07/18/03	6227	76	7.33	0.04	7.37	0.22	0.11	
MN River at F. Snelling	08/07/03	2310	54	0.66	0.03	0.69	0.18	0.09	
MN River at F. Snelling	08/22/03	1250	64	0.61	0.03	0.64	0.23	0.10	
MN River at F. Snelling	09/05/03	747	36	0.63	0.03	0.66	0.36	0.06	
MN River at F. Snelling	09/19/03	771	39	0.9	0.04	0.94	0.17	0.05	
MN River at F. Snelling	10/03/03		67	1.08	0.04	1.12	0.21	0.01	
MN River at F. Snelling	10/10/03		35	1.56	0.03	1.59	0.14	0.01	
MN River at F. Snelling	10/17/03		27	1.68	0.03	1.71	0.13	0.03	
MN River at F. Snelling	10/24/03		39	1.87	0.03	1.9	0.18	0.01	
MN River at F. Snelling	10/30/03		37	0.92	0.03	0.95	0.16	0.01	
MN River at F. Snelling	11/07/03		74	2.25	0.03	2.28	0.21	0.03	
MN River at F. Snelling	11/13/03		36	1.75	0.03	1.78	0.13	0.03	
MN River at F. Snelling	11/21/03		40	1.52	0.03	1.55	0.14	0.01	
MN River at F. Snelling	11/25/03		31	1.39	0.03	1.42	0.81	0.01	
MN River at F. Snelling	12/05/03		34	0.98	0.03	1.01	0.12	0.01	
MN River at F. Snelling	12/11/03		32	0.82	0.03	0.85	0.14	0.01	
MN River at F. Snelling	12/19/03		17	1.68	0.04	1.72	0.14	0.02	
MN River at F. Snelling	12/23/03		13	2.16	0.04	2.2	0.12	0.03	
MN River at F. Snelling	12/30/03		18	2.35	0.04	2.39	0.18	0.07	

Appendix F

Loads, Yields, Runoff-Adjusted Yields, and Flow-Weighted Mean Concentrations for Monitoring Sites, 2000-2003

2000 to 2003 Loads, Yields,
Runoff-Adjusted Yields and Flow-Weighted Mean Concentrations

Stream	2000 TSS (Thousands of Tons)	2001 TSS (Thousands of Tons)	2002 TSS (Thousands of Tons)	2003 TSS (Thousands of Tons)	2000 TSS Yield (lbs/acre)	2001 TSS Yield (lbs/acre)	2002 TSS Yield (lbs/acre)	2003 TSS Yield (lbs/acre)	2000 TSS Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2001 TSS Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2002 TSS Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2003 TSS Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2000 TSS FWMC (mg/l)	2001 TSS FWMC (mg/l)	2002 TSS FWMC (mg/l)	2003 TSS FWMC (mg/l)
Mainstem Sites																
MN R at Judson	131	573	341	184	36	159	95	51	43	24	43	30	188	107	187	131
Greater Blue Earth River	710	830	143	155	627	718	126	137	150	58	42	38	661	256	185	166
MN R at St. Peter	763	1,828	528	356	158	379	110	74	94	48	47	35	415	210	204	154
MN R at Jordan	481	1,226	670	366	93	236	129	70	50	28	51	32	222	124	226	142
MN R at Fort Snelling	728	1,411	537	229	134	260	99	42	72	31	39	19	320	136	172	85
Major Sites																
Yellow Bank			1				4				5				20	
Laq Que Parle			7	1			24	3			17	5			77	23
Chippewa	16	40	25	21	26	67	41	35	25	10	19	18	112	46	83	80
Yellow Medicine			10	2			46	7			19	7			92	31
Hawk	13	2	5	8	81	10	32	52	45	7	14	19	198	33	63	84
Redwood	15		31	9	76		155	45	59		42	23	261		186	100
Cottonwood	76		111	27	181		265	65	140		74	32	638		328	144
Little Cottonwood			11	6			204	106			52	50			229	219
Watonwan	14	65	18	26	52	241	66	95	35	23	33	35	155	100	144	155
Blue Earth	183	431	43	77	236	555	56	99	83	47	21	28	362	205	95	125
Le Sueur	527	382	99	78	1,483	1,076	280	221	208	81	72	55	918	355	318	245
Rush				20				155				73				322
High Island		68	29	14		897	387	182		115	92	79		508	408	347
Sand	7	25	44	38	90	305	534	471	37	39	92	129	166	174	404	571
Minor Sites																
Dry Weather			0.2	0.2			6	7			5	5			21	24
WFBC	2	1	0.4	0.3	61	24	12	10	15	3	9	5	156	39	41	25
Clear	0	0	4.3		13	13	139		16	3	25		87	19	138	
Dutch	0	2	0.0	0.1	76	529	10	12	25	32	5	4	105	140	21	16
Seven Mile	2	12	3.5	2.2	156	984	299	186	44	61	55	54	192	263	241	254
Bevens	0.3	21	33.1	6.2	7	500	789	147	16	62	97	47	57	272	429	206
Chaska																
Carver	0.4	4.1	12.1		14	153	452		24	25	66		105	111	298	
Bluff			1.6	0.4			553	140			106	36			472	160
Riley		2.7	1.5	1.0		644	468	313		120	75	104		531	327	516
Eagle			0.1	0.0			47	24							9	8
Credit		1.3	0.0	2.0		76		121		15		31		67		137
Willow		0.3	0.5	0.1		80	150	27		9	18	7		40	77	33
Nine Mile	1.0	1.4	3.0	1.5	78	114	248	121	11	14	22	20	48	62	96	90

2000 to 2003 Loads, Yields,
Runoff-Adjusted Yields and Flow-Weighted Mean Concentrations

Stream	2000 Nitrate-N (tons)	2001 Nitrate-N (tons)	2002 Nitrate-N (tons)	2003 Nitrate-N (tons)	2000 NO3-N Yield (lbs/acre)	2001 NO3-N Yield (lbs/acre)	2002 NO3-N Yield (lbs/acre)	2003 NO3-N Yield (lbs/acre)	2000 NO3-N Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2001 NO3-N Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2002 NO3-N Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2003 NO3-N Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2000 NO3-N FWMC (mg/l)	2001 NO3-N FWMC (mg/l)	2002 NO3-N FWMC (mg/l)	2003 NO3-N FWMC (mg/l)
Mainstem Sites																
MN R at Judson	3,636	18,512	8,687	6,028	1.01	5.15	2.42	1.68	1.19	0.78	1.09	0.98	5.24	3.46	4.75	4.31
Greater Blue Earth River	10,697	31,389	7,532	11,603	9.44	27.71	6.65	10.24	2.25	2.24	2.22	2.82	9.95	9.88	9.78	12.44
MN R at St. Peter	15,470	46,653	16,476	17,565	3.21	9.68	3.42	3.65	1.91	1.22	1.48	1.73	8.41	5.37	6.36	7.60
MN R at Jordan	15,762	65,308	21,062	21,093	3.03	12.57	4.05	4.06	1.65	1.50	1.61	1.86	7.28	6.62	7.12	8.22
MN R at Fort Snelling	12,480		20,267	19,642	2.30		3.74	3.62	1.24		1.48	1.65	5.48		6.51	7.28
Major Sites																
Yellow Bank			17				0.12				0.15				0.64	
Laq Que Parle			140	50			0.46	0.16			0.33	0.31			1.45	1.38
Chippewa	142	1,400	341	315	0.24	2.33	0.57	0.52	0.23	0.36	0.26	0.27	1.01	1.60	1.14	1.19
Yellow Medicine			470	215			2.21	0.98			0.90	1.01			4.44	4.45
Hawk	429	302	475	969	2.65	1.87	2.94	6.00	1.47	1.43	1.33	2.19	6.50	6.31	5.87	9.67
Redwood	188		1,718	696	0.93		8.53	3.46	0.73		2.33	1.74	3.21		10.30	7.68
Cottonwood	824		3,382	1,781	1.96		8.05	4.24	1.52		2.26	2.07	6.71		9.96	9.41
Little Cottonwood			359	141			6.59	2.59			1.68	1.21			7.40	5.33
Watonwan	861	6,744	1,184	2,141	3.16	24.77	4.35	7.86	2.14	2.33	2.16	2.91	9.40	10.30	9.52	12.85
Blue Earth	5,518	20,252	3,918	7,422	7.10	26.04	5.04	9.54	2.50	2.18	1.95	2.75	10.90	9.64	8.59	12.12
Le Sueur	5,179	11,136	3,614	4,181	14.58	31.35	10.17	11.77	2.04	2.35	2.62	2.96	9.20	10.35	11.56	13.04
Rush				1,063				8.25				3.89				17.12
High Island		1,105	626	574		14.53	8.22	7.54		1.86	1.96	3.25		8.22	8.66	14.33
Sand	191	1,008	616	269	2.34	12.36	7.55	3.30	0.98	1.60	1.30	1.52	4.32	7.05	5.70	4.00
Minor Sites																
Dry Weather			42	74			1.24	2.19			0.99	1.74			4.35	8.08
WFBC	95	109	52	122	3.11	3.57	1.68	3.98	0.74	0.49	1.30	2.01	7.97	5.77	5.59	9.98
Clear	48	174	587		1.95	7.08	23.82		2.32	1.93	4.29		10.26	8.53	18.95	
Dutch	32	213	24	53	7.29	49.33	5.51	12.21	2.40	2.96	2.65	3.57	10.10	13.07	11.60	15.68
Seven Mile	161	464	194	163	13.69	39.41	16.43	13.83	3.83	2.44	3.00	4.04	16.75	10.50	13.23	18.86
Bevens	51	1,159	689	258	1.22	27.68	16.45	6.17	2.71	3.41	2.03	1.95	9.80	15.12	8.93	8.61
Chaska		61				13.65				1.21				5.32		
Carver	8	192	71		0.29	7.20	2.67		0.52	1.19	0.39		2.27	5.23	1.75	
Bluff			3	2			0.95	0.81			0.18	0.21			0.81	0.92
Riley		4	2	2		0.98	0.59	0.49		0.18	0.09	0.16		0.80	0.41	0.81
Eagle			1	1			0.96	0.69							0.18	0.21
Credit		36		15		2.19		0.88		0.43		0.23		1.91		1.00
Willow		4	2	1		1.19	0.68	0.22		0.13	0.08	0.06		0.59	0.35	0.28
Nine Mile	9	13	14	6	0.72	1.05	1.16	0.49	0.10	0.13	0.10	0.08	0.44	0.57	0.45	0.36

2000 to 2003 Loads, Yields, Runoff-Adjusted Yields and Flow-Weighted Mean Concentrations

Stream	2000 TP (tons)	2001 TP (tons)	2002 TP (tons)	2003 TP (tons)	2000 TP Yield (lbs/acre)	2001 TP Yield (lbs/acre)	2002 TP Yield (lbs/acre)	2003 TP Yield (lbs/acre)	2000 TP Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2001 TP Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2002 TP Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2003 TP Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2000 TP FWMC (mg/l)	2001 TP FWMC (mg/l)	2002 TP FWMC (mg/l)	2003 TP FWMC (mg/l)
Mainstem Sites																
MN R at Judson	239	1,979	639	373	0.07	0.55	0.18	0.10	0.08	0.08	0.08	0.06	0.34	0.37	0.35	0.27
Greater Blue Earth River	761	1,661	244	245	0.67	1.47	0.22	0.22	0.16	0.12	0.07	0.06	0.71	0.52	0.32	0.26
MN R at St. Peter	1,112	3,188	883	669	0.23	0.66	0.18	0.14	0.14	0.08	0.08	0.07	0.60	0.37	0.34	0.29
MN R at Jordan	915	2,646	1,123	605	0.18	0.51	0.22	0.12	0.10	0.06	0.09	0.05	0.42	0.27	0.38	0.24
MN R at Fort Snelling	795		1,016	610	0.15		0.19	0.11	0.08		0.07	0.05	0.35		0.33	0.23
Major Sites																
Yellow Bank			4.13				0.03				0.03				0.15	
Laq Que Parle			16.52	5.22			0.05	0.02			0.04	0.03			0.17	0.14
Chippewa	29.50	225.52	52.30	49.25	0.05	0.37	0.09	0.08	0.05	0.06	0.04	0.04	0.21	0.26	0.18	0.19
Yellow Medicine			27.05	4.43			0.13	0.02			0.05	0.02			0.25	0.09
Hawk	41.84	15.24	36.98	35.82	0.26	0.09	0.23	0.22	0.14	0.07	0.10	0.08	0.63	0.32	0.46	0.36
Redwood	36.40		59.10	21.57	0.18		0.29	0.11	0.14		0.08	0.05	0.62		0.35	0.24
Cottonwood	66.50		112.11	38.73	0.16		0.27	0.09	0.12		0.08	0.05	0.56		0.33	0.21
Little Cottonwood			8.84	7.86			0.16	0.14			0.04	0.07			0.18	0.30
Watonwan	28.70	210.02	36.63	42.39	0.11	0.77	0.13	0.16	0.07	0.07	0.06	0.06	0.31	0.32	0.29	0.25
Blue Earth	223.30	982.29	107.97	134.55	0.29	1.26	0.14	0.17	0.10	0.11	0.05	0.05	0.44	0.47	0.24	0.22
Le Sueur	537.80	679.16	136.07	110.87	1.51	1.91	0.38	0.31	0.21	0.14	0.10	0.08	0.93	0.63	0.44	0.35
Rush				21.00				0.16				0.08				0.34
High Island		75.90	46.54	11.44		1.00	0.61	0.15		0.13	0.15	0.04		0.57	0.65	0.29
Sand	23.48	55.9	65.10	40.34	0.29	0.69	0.80	0.49	0.12	0.09	0.14	0.23	0.53	0.39	0.60	0.60
Minor Sites																
Dry Weather			1.26	0.94			0.04	0.03			0.03	0.02			0.13	0.10
WFBC	4.53	6.8	2.07	1.69	0.15	0.22	0.07	0.06	0.04	0.03	0.05	0.03	0.38	0.36	0.22	0.14
Clear	1.24	4.8	9.29		0.05	0.19	0.38		0.06	0.05	0.07		0.26	0.23	0.30	
Dutch	0.62	7.13	0.60	0.24	0.14	1.65	0.14	0.06	0.05	0.10	0.07	0.02	0.20	0.44	0.29	0.07
Seven Mile	2.30	19.36	5.45	2.27	0.20	1.64	0.46	0.19	0.06	0.10	0.08	0.06	0.24	0.44	0.37	0.26
Bevens	3.0	52.31	57.25	12.43	0.07	1.25	1.37	0.30	0.16	0.15	0.17	0.09	0.57	0.68	0.74	0.41
Chaska		5.01				1.11				0.10				0.43		
Carver	1.02	19.86	31.69		0.04	0.74	1.19		0.07	0.12	0.18		0.30	0.54	0.78	
Bluff			1.85	0.85			0.65	0.30			0.12	0.08			0.55	0.34
Riley		2.47	1.72	0.81		0.59	0.54	0.25		0.11	0.09	0.08		0.49	0.38	0.42
Eagle			0.28	0.18			0.26	0.16							0.05	0.05
Credit		4.60		4.02		0.28		0.24		0.05		0.06		0.24		0.28
Willow		0.77	0.98	0.30		0.24	0.30	0.09		0.03	0.04	0.02		0.12	0.16	0.12
Nine Mile	4.12	4.16	7.89	3.39	0.34	0.34	0.64	0.28	0.05	0.04	0.06	0.05	0.21	0.19	0.25	0.21

2000 to 2003 Loads, Yields, Runoff-Adjusted Yields and Flow-Weighted Mean Concentrations

Stream	2000 OP (tons)	2001 OP (tons)	2002 OP (tons)	2003 OP (tons)	2000 OP Yield (lbs/acre)	2001 OP Yield (lbs/acre)	2002 OP Yield (lbs/acre)	2003 OP Yield (lbs/acre)	2000 OP Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2001 OP Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2002 OP Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2003 OP Runoff-Adjusted Yield (lbs/acre/inch of runoff)	2000 OP FWMC (mg/l)	2001 OP FWMC (mg/l)	2002 OP FWMC (mg/l)	2003 OP FWMC (mg/l)
Mainstem Sites																
MN R at Judson	44	944	188	112	0.01	0.26	0.05	0.03	0.01	0.04	0.02	0.02	0.06	0.18	0.10	0.08
Greater Blue Earth River	131	595	73	56	0.12	0.53	0.06	0.05	0.03	0.04	0.02	0.01	0.12	0.19	0.09	0.06
MN R at St. Peter	187	1,562	230	165	0.04	0.324	0.05	0.03	0.02	0.04	0.02	0.02	0.10	0.18	0.09	0.07
MN R at Jordan	194	1,504	300	141	0.037	0.289	0.06	0.03	0.02	0.03	0.02	0.01	0.09	0.15	0.10	0.06
MN R at Fort Snelling	259		337	182	0.05		0.06	0.03	0.03		0.02	0.02	0.11		0.11	0.07
Major Sites																
Yellow Bank			1.86				0.01				0.02				0.07	
Laq Que Parle			6.95	1.30			0.02	0.004			0.02	0.01			0.07	0.03
Chippewa	2.80	107.99	11.88	16.02	0.00	0.18	0.02	0.03	0.004	0.03	0.01	0.01	0.02	0.12	0.04	0.06
Yellow Medicine			6.73	0.73			0.03	0.003			0.01	0.003			0.06	0.02
Hawk	21.73	9.00	25.55	19.70	0.14	0.06	0.16	0.12	0.07	0.04	0.07	0.04	0.33	0.19	0.32	0.20
Redwood	21.60		32.78	11.74	0.11		0.16	0.06	0.09		0.04	0.03	0.37		0.20	0.13
Cottonwood	16.30		48.18	9.08	0.04		0.11	0.02	0.03		0.03	0.01	0.13		0.14	0.05
Little Cottonwood			5.27	2.22			0.05	0.04			0.01	0.02			0.11	0.08
Watonwan	15.40	164.92	17.16	18.86	0.06	0.61	0.06	0.07	0.04	0.06	0.03	0.03	0.17	0.25	0.14	0.11
Blue Earth	42.30	370.61	37.52	31.82	0.05	0.48	0.05	0.04	0.02	0.04	0.02	0.01	0.08	0.18	0.08	0.05
Le Sueur	89.00	224.44	35.28	23.93	0.25	0.63	0.10	0.07	0.04	0.05	0.03	0.02	0.15	0.21	0.11	0.07
Rush				8.85				0.07				0.03				0.14
High Island		36.67	13.22	4.74		0.48	0.17	0.06		0.06	0.04	0.02		0.27	0.18	0.12
Sand	9.79	29.42	28.31	8.82	0.12	0.36	0.35	0.11	0.05	0.05	0.06	0.05	0.22	0.21	0.26	0.13
Minor Sites																
Dry Weather			0.49	0.23			0.01	0.01			0.01	0.01			0.05	0.03
WFBC	3.55	3.55	0.95	0.87	0.12	0.12	0.03	0.03	0.03	0.02	0.02	0.01	0.19	0.19	0.10	0.07
Clear	0.71	4.56	6.42		0.03	0.19	0.26		0.03	0.05	0.05		0.15	0.22	0.21	
Dutch	0.27	1.92	0.40	0.20	0.27	0.44	0.09	0.05	0.02	0.03	0.04	0.01	0.09	0.12	0.20	0.06
Seven Mile	1.70	13.02	2.47	0.82	0.15	1.11	0.21	0.07	0.04	0.07	0.04	0.02	0.18	0.30	0.17	0.10
Bevens	2.32	30.51	30.89	5.69	0.06	0.73	0.74	0.14	0.13	0.09	0.09	0.04	0.45	0.40	0.40	0.19
Chaska		2.20				0.49				0.04				0.19		
Carver	0.44	9.16	10.38		0.02	0.34	0.39		0.04	0.06	0.06		0.13	0.28	0.25	
Bluff			0.66	0.33			0.23	0.12			0.04	0.03			0.20	0.13
Riley		0.33		0.06		0.08		0.02		0.01	0.00	0.01		0.06		0.03
Eagle			0.14	0.03			0.13	0.03							0.03	0.01
Credit		1.73		1.27		0.10		0.08		0.02		0.02		0.09		0.09
Willow		0.33	0.10	0.03		0.10	0.03	0.01		0.01	0.00	0.00		0.05	0.02	0.01
Nine Mile	0.74	0.71	0.77	0.54	0.06	0.06	0.06	0.04	0.009	0.01	0.01	0.01	0.04	0.03	0.02	0.03

2000 to 2003 Loads, Yields,
Runoff-Adjusted Yields and Flow-Weighted Mean Concentrations

Stream	2000 Inches of Runoff (Water Yield)	2001 Inches of Runoff (Water Yield)	2002 Inches of Runoff (Water Yield)	2003 Inches of Runoff (Water Yield)
Mainstem Sites				
MN R at Judson	0.85	6.57	2.22	1.72
Greater Blue Earth River	4.19	12.37	3.00	3.63
MN R at St. Peter	1.69	7.96	2.31	2.12
MN R at Jordan	1.84	8.38	2.51	2.18
MN R at Fort Snelling	1.85	8.44	2.53	2.20
Major Sites				
Yellow Bank			0.85	
Laq Que Parle			1.38	0.52
Chippewa	1.04	6.44	2.20	1.94
Yellow Medicine			2.46	0.97
Hawk	1.81	1.31	2.21	2.75
Redwood	1.28		3.66	1.99
Cottonwood	1.29		3.57	2.05
Little Cottonwood			3.93	2.14
Watonwan	1.48	10.62	2.01	2.70
Blue Earth	2.84	11.92	2.59	3.47
Le Sueur	7.13	13.36	3.89	3.98
Rush				2.12
High Island	0.76	7.80	4.19	3.60
Sand	2.39	7.74	5.80	2.16
Minor Sites				
Dry Weather			1.25	1.20
WFBC	4.19	7.34	1.29	1.98
Clear	0.84	3.66	5.55	
Dutch	3.04	16.65	2.08	3.42
Seven Mile	3.57	16.15	5.48	3.42
Bevens	0.45	8.11	8.10	3.16
Chaska		11.32		
Carver	0.56	6.07	6.80	
Bluff			5.20	3.88
Riley		5.35	6.26	3.01
Eagle				0.00
Credit		5.08		3.89
Willow		8.98	8.55	3.93
Nine Mile	6.99	8.11	11.40	5.94

Appendix G

Fecal Coliform Bacteria

Fecal Coliform Bacteria Concentrations for Monitoring Sites 2000-2003

Site	Date	FC (org/100 ml)
Yellow Bank River	5/24/2001	50
Yellow Bank River	6/13/2001	3,800
Yellow Bank River	6/21/2001	130
Yellow Bank River	7/24/2001	2,500
Yellow Bank River	8/7/2001	25
Yellow Bank River	8/15/2001	25
Yellow Bank River	8/16/2001	25
Yellow Bank River	8/30/2001	25
Yellow Bank River	9/17/2001	90
Yellow Bank River	10/4/2001	5
Yellow Bank River	5/2/2002	28
Yellow Bank River	5/13/2002	25
Yellow Bank River	5/22/2002	14
Yellow Bank River	5/30/2002	80
Yellow Bank River	6/11/2002	300
Yellow Bank River	6/24/2002	58
Yellow Bank River	6/26/2002	1,300
Yellow Bank River	6/27/2002	1,300
Yellow Bank River	7/10/2002	153
Yellow Bank River	7/22/2002	155
Yellow Bank River	8/5/2002	75
Yellow Bank River	8/7/2002	70
Yellow Bank River	8/21/2002	163
Yellow Bank River	8/22/2002	210
Yellow Bank River	8/28/2002	323
Yellow Bank River	9/25/2002	40
Yellow Bank River	5/14/2003	65
Yellow Bank River	5/19/2003	16
Yellow Bank River	5/22/2003	8
Yellow Bank River	6/19/2003	54
Yellow Bank River	6/25/2003	150
Yellow Bank River	6/26/2003	120
Yellow Bank River	7/17/2003	12
Yellow Bank River	7/21/2003	122
Yellow Bank River	8/19/2003	33
Yellow Bank River	9/11/2003	260
Yellow Bank River	9/15/2003	44
Yellow Bank River	9/29/2003	28
Lac Qui Parle River	5/24/2001	35
Lac Qui Parle River	6/13/2001	2,000
Lac Qui Parle River	6/21/2001	50

Site	Date	FC (org/100 ml)
Lac Qui Parle River	7/24/2001	3,400
Lac Qui Parle River	8/7/2001	10
Lac Qui Parle River	8/16/2001	10
Lac Qui Parle River	8/30/2001	450
Lac Qui Parle River	9/24/2001	<5
Lac Qui Parle River	10/4/2001	<5
Lac Qui Parle River	5/13/2002	14
Lac Qui Parle River	5/22/2002	54
Lac Qui Parle River	5/30/2002	9
Lac Qui Parle River	6/11/2002	160
Lac Qui Parle River	6/24/2002	380
Lac Qui Parle River	6/26/2002	65
Lac Qui Parle River	6/27/2002	900
Lac Qui Parle River	7/10/2002	225
Lac Qui Parle River	7/22/2002	105
Lac Qui Parle River	8/5/2002	55
Lac Qui Parle River	8/7/2002	50
Lac Qui Parle River	8/12/2002	258
Lac Qui Parle River	8/21/2002	785
Lac Qui Parle River	8/22/2002	1,210
Lac Qui Parle River	8/28/2002	203
Lac Qui Parle River	9/10/2002	185
Lac Qui Parle River	9/25/2002	195
Lac Qui Parle River	5/14/2003	320
Lac Qui Parle River	5/19/2003	16
Lac Qui Parle River	5/22/2003	12
Lac Qui Parle River	6/9/2003	90
Lac Qui Parle River	6/10/2003	88
Lac Qui Parle River	6/19/2003	62
Lac Qui Parle River	6/25/2003	330
Lac Qui Parle River	6/26/2003	550
Lac Qui Parle River	7/17/2003	80
Lac Qui Parle River	7/21/2003	162
Lac Qui Parle River	8/19/2003	48
Lac Qui Parle River	9/11/2003	550
Lac Qui Parle River	9/15/2003	48
Lac Qui Parle River	9/29/2003	94
Chippewa River	4/10/2001	50
Chippewa River	4/19/2001	20
Chippewa River	4/24/2001	1
Chippewa River	5/1/2001	40

Fecal Coliform Bacteria Concentrations for Monitoring Sites 2000-2003

Site	Date	FC (org/100 ml)
Chippewa River	5/8/2001	60
Chippewa River	5/16/2001	60
Chippewa River	5/21/2001	320
Chippewa River	5/31/2001	40
Chippewa River	6/7/2001	100
Chippewa River	6/11/2001	80
Chippewa River	6/13/2001	580
Chippewa River	6/19/2001	60
Chippewa River	7/5/2001	180
Chippewa River	7/12/2001	140
Chippewa River	7/17/2001	60
Chippewa River	7/23/2001	280
Chippewa River	7/31/2001	1
Chippewa River	8/9/2001	120
Chippewa River	8/16/2001	60
Chippewa River	8/23/2001	20
Chippewa River	8/30/2001	180
Chippewa River	9/6/2001	80
Chippewa River	9/13/2001	180
Chippewa River	9/20/2001	260
Chippewa River	9/27/2001	200
Chippewa River	10/11/2001	1
Chippewa River	4/23/2002	20
Chippewa River	4/29/2002	20
Chippewa River	5/8/2002	220
Chippewa River	5/13/2002	20
Chippewa River	5/21/2002	1
Chippewa River	5/29/2002	20
Chippewa River	6/6/2002	100
Chippewa River	6/12/2002	180
Chippewa River	6/24/2002	1,360
Chippewa River	7/2/2002	320
Chippewa River	7/17/2002	50
Chippewa River	7/23/2002	150
Chippewa River	8/1/2002	180
Chippewa River	8/6/2002	700
Chippewa River	8/21/2002	10,800
Chippewa River	8/29/2002	60
Chippewa River	9/5/2002	150
Chippewa River	9/11/2002	80
Chippewa River	9/30/2002	140

Site	Date	FC (org/100 ml)
Chippewa River	4/8/2003	1
Chippewa River	4/22/2003	54
Chippewa River	5/13/2003	52
Chippewa River	5/20/2003	174
Chippewa River	5/28/2003	120
Chippewa River	6/4/2003	64
Chippewa River	6/11/2003	170
Chippewa River	6/19/2003	192
Chippewa River	6/24/2003	220
Chippewa River	7/1/2003	2,300
Chippewa River	7/9/2003	95
Chippewa River	7/16/2003	315
Chippewa River	7/22/2003	211
Chippewa River	7/29/2003	63
Chippewa River	8/6/2003	96
Chippewa River	8/12/2003	144
Chippewa River	8/27/2003	108
Chippewa River	9/4/2003	108
Chippewa River	9/11/2003	294
Dry Weather Creek	4/10/2001	50
Dry Weather Creek	4/19/2001	1
Dry Weather Creek	4/24/2001	140
Dry Weather Creek	5/1/2001	1
Dry Weather Creek	5/8/2001	40
Dry Weather Creek	5/16/2001	1
Dry Weather Creek	5/21/2001	740
Dry Weather Creek	5/31/2001	180
Dry Weather Creek	6/7/2001	200
Dry Weather Creek	6/11/2001	540
Dry Weather Creek	6/13/2001	540
Dry Weather Creek	6/19/2001	220
Dry Weather Creek	7/5/2001	40
Dry Weather Creek	7/12/2001	80
Dry Weather Creek	7/23/2001	100
Dry Weather Creek	8/9/2001	160
Dry Weather Creek	8/16/2001	40
Dry Weather Creek	8/23/2001	40
Dry Weather Creek	8/30/2001	1,220
Dry Weather Creek	9/6/2001	220
Dry Weather Creek	9/13/2001	700
Dry Weather Creek	9/20/2001	60

Fecal Coliform Bacteria Concentrations for Monitoring Sites 2000-2003

Site	Date	FC (org/100 ml)
Dry Weather Creek	9/27/2001	40
Dry Weather Creek	10/11/2001	1
Dry Weather Creek	4/23/2002	1
Dry Weather Creek	4/29/2002	20
Dry Weather Creek	5/8/2002	60
Dry Weather Creek	5/13/2002	1
Dry Weather Creek	5/21/2002	1
Dry Weather Creek	5/29/2002	1
Dry Weather Creek	6/6/2002	1
Dry Weather Creek	6/12/2002	120
Dry Weather Creek	6/24/2002	300
Dry Weather Creek	7/2/2002	120
Dry Weather Creek	7/17/2002	350
Dry Weather Creek	7/23/2002	250
Dry Weather Creek	8/1/2002	100
Dry Weather Creek	8/6/2002	480
Dry Weather Creek	8/21/2002	860
Dry Weather Creek	8/22/2002	620
Dry Weather Creek	8/29/2002	280
Dry Weather Creek	9/5/2002	400
Dry Weather Creek	9/11/2002	1,400
Dry Weather Creek	9/30/2002	240
Dry Weather Creek	4/8/2003	1
Dry Weather Creek	4/22/2003	11
Dry Weather Creek	5/8/2003	42
Dry Weather Creek	5/14/2003	48
Dry Weather Creek	5/20/2003	172
Dry Weather Creek	5/28/2003	82
Dry Weather Creek	6/4/2003	5
Dry Weather Creek	6/11/2003	200
Dry Weather Creek	6/19/2003	98
Dry Weather Creek	7/1/2003	170
Dry Weather Creek	7/9/2003	184
Dry Weather Creek	7/16/2003	132
Dry Weather Creek	7/22/2003	132
Dry Weather Creek	7/29/2003	279
Dry Weather Creek	8/6/2003	140
Dry Weather Creek	8/12/2003	321
Dry Weather Creek	8/27/2003	296
Dry Weather Creek	9/4/2003	252
Dry Weather Creek	9/11/2003	10,000

Site	Date	FC (org/100 ml)
Yellow Medicine River	9/19/2001	56
Yellow Medicine River	8/28/2001	50
Yellow Medicine River	7/11/2001	83
Yellow Medicine River	6/6/2001	17
Yellow Medicine River	5/15/2001	17
Yellow Medicine River	4/25/2001	2,500
Yellow Medicine River	10/24/2000	48
Hawk Creek	5/2/2000	5
Hawk Creek	5/12/2000	240
Hawk Creek	8/28/2000	280
Hawk Creek	4/9/2001	10
Hawk Creek	4/12/2001	300
Hawk Creek	4/19/2001	90
Hawk Creek	4/25/2001	260
Hawk Creek	5/2/2001	27
Hawk Creek	5/10/2001	60
Hawk Creek	5/22/2001	50
Hawk Creek	6/4/2001	5
Hawk Creek	6/13/2001	700
Hawk Creek	6/18/2001	180
Hawk Creek	6/21/2001	64
Hawk Creek	7/9/2001	200
Hawk Creek	7/17/2001	30
Hawk Creek	7/30/2001	90
Hawk Creek	8/14/2001	120
Hawk Creek	8/30/2001	330
Hawk Creek	9/19/2001	90
Hawk Creek	9/27/2001	30
Hawk Creek	4/9/2002	5
Hawk Creek	4/16/2002	5
Hawk Creek	4/23/2002	10
Hawk Creek	4/30/2002	7
Hawk Creek	5/7/2002	25
Hawk Creek	5/13/2002	20
Hawk Creek	5/21/2002	28
Hawk Creek	5/29/2002	10
Hawk Creek	6/4/2002	66
Hawk Creek	6/12/2002	410
Hawk Creek	6/18/2002	120
Hawk Creek	6/25/2002	140
Hawk Creek	7/1/2002	300

Fecal Coliform Bacteria Concentrations for Monitoring Sites 2000-2003

Site	Date	FC (org/100 ml)
Hawk Creek	7/9/2002	64
Hawk Creek	7/16/2002	30
Hawk Creek	7/24/2002	27
Hawk Creek	8/7/2002	100
Hawk Creek	8/19/2002	130
Hawk Creek	9/3/2002	320
Hawk Creek	9/16/2002	70
Hawk Creek	9/30/2002	82
Hawk Creek	4/2/2003	<10
Hawk Creek	4/15/2003	<10
Hawk Creek	4/21/2003	390
Hawk Creek	4/29/2003	27
Hawk Creek	5/5/2003	30
Hawk Creek	5/13/2003	70
Hawk Creek	5/19/2003	73
Hawk Creek	5/27/2003	110
Hawk Creek	6/2/2003	40
Hawk Creek	6/18/2003	91
Hawk Creek	6/26/2003	2,400
Hawk Creek	7/1/2003	190
Hawk Creek	7/15/2003	400
Hawk Creek	7/22/2003	370
Hawk Creek	8/5/2003	280
Hawk Creek	8/26/2003	380
Hawk Creek	9/9/2003	300
Hawk Creek	9/23/2003	290
West Fork Beaver Creek	5/10/2000	180
West Fork Beaver Creek	5/12/2000	140
West Fork Beaver Creek	6/30/2000	620
West Fork Beaver Creek	8/28/2000	310
West Fork Beaver Creek	4/9/2001	50
West Fork Beaver Creek	4/12/2001	110
West Fork Beaver Creek	4/19/2001	10
West Fork Beaver Creek	4/23/2001	1,000
West Fork Beaver Creek	4/25/2001	82
West Fork Beaver Creek	5/2/2001	20
West Fork Beaver Creek	5/10/2001	36
West Fork Beaver Creek	5/22/2001	140
West Fork Beaver Creek	6/4/2001	20
West Fork Beaver Creek	6/13/2001	1,700
West Fork Beaver Creek	6/18/2001	800

Site	Date	FC (org/100 ml)
West Fork Beaver Creek	6/21/2001	500
West Fork Beaver Creek	7/9/2001	1,000
West Fork Beaver Creek	7/17/2001	440
West Fork Beaver Creek	7/30/2001	380
West Fork Beaver Creek	8/14/2001	310
West Fork Beaver Creek	8/30/2001	170
West Fork Beaver Creek	9/19/2001	40
West Fork Beaver Creek	4/9/2002	30
West Fork Beaver Creek	4/16/2002	20
West Fork Beaver Creek	4/23/2002	55
West Fork Beaver Creek	4/30/2002	8
West Fork Beaver Creek	5/7/2002	15
West Fork Beaver Creek	5/13/2002	37
West Fork Beaver Creek	5/21/2002	30
West Fork Beaver Creek	5/29/2002	35
West Fork Beaver Creek	6/4/2002	1,400
West Fork Beaver Creek	6/12/2002	700
West Fork Beaver Creek	6/18/2002	460
West Fork Beaver Creek	6/25/2002	1,100
West Fork Beaver Creek	7/1/2002	540
West Fork Beaver Creek	7/9/2002	1,400
West Fork Beaver Creek	7/16/2002	600
West Fork Beaver Creek	7/24/2002	500
West Fork Beaver Creek	8/7/2002	600
West Fork Beaver Creek	8/19/2002	60
West Fork Beaver Creek	9/3/2002	450
West Fork Beaver Creek	9/16/2002	390
West Fork Beaver Creek	9/30/2002	130
West Fork Beaver Creek	4/2/2003	<10
West Fork Beaver Creek	4/15/2003	<10
West Fork Beaver Creek	4/21/2003	210
West Fork Beaver Creek	4/29/2003	10
West Fork Beaver Creek	5/5/2003	70
West Fork Beaver Creek	5/13/2003	10
West Fork Beaver Creek	5/19/2003	160
West Fork Beaver Creek	5/27/2003	210
West Fork Beaver Creek	6/2/2003	120
West Fork Beaver Creek	6/18/2003	300
West Fork Beaver Creek	6/26/2003	350
West Fork Beaver Creek	7/1/2003	380
West Fork Beaver Creek	7/15/2003	900

Fecal Coliform Bacteria Concentrations for Monitoring Sites 2000-2003

Site	Date	FC (org/100 ml)
West Fork Beaver Creek	7/22/2003	650
Watonwan River	5/18/2000	1,200
Watonwan River	5/19/2000	5,000
Watonwan River	5/22/2000	200
Watonwan River	5/26/2000	120
Watonwan River	5/30/2000	220
Watonwan River	6/1/2000	190
Watonwan River	6/5/2000	100
Watonwan River	6/13/2000	900
Watonwan River	6/16/2000	700
Watonwan River	6/21/2000	350
Watonwan River	6/26/2000	1,500
Watonwan River	7/5/2000	2,100
Watonwan River	7/10/2000	800
Watonwan River	7/14/2000	170
Watonwan River	7/21/2000	600
Watonwan River	7/31/2000	240
Watonwan River	8/9/2000	900
Watonwan River	8/18/2000	20
Watonwan River	9/26/2000	100
Watonwan River	10/29/2000	120
Watonwan River	4/6/2001	20
Watonwan River	4/13/2001	200
Watonwan River	4/17/2001	110
Watonwan River	4/22/2001	300
Watonwan River	4/25/2001	110
Watonwan River	5/4/2001	70
Watonwan River	5/15/2001	600
Watonwan River	5/23/2001	700
Watonwan River	5/29/2001	600
Watonwan River	6/3/2001	130
Watonwan River	6/7/2001	250
Watonwan River	6/14/2001	2,200
Watonwan River	6/20/2001	1,200
Watonwan River	6/26/2001	1,700
Watonwan River	7/2/2001	2,000
Watonwan River	7/16/2001	400
Watonwan River	7/24/2001	4,000
Watonwan River	7/25/2001	5,900
Watonwan River	7/30/2001	900
Watonwan River	8/6/2001	110
Watonwan River	8/20/2001	180
Watonwan River	9/13/2001	200
Watonwan River	9/25/2001	240
Watonwan River	4/10/2002	55
Watonwan River	4/17/2002	40
Watonwan River	4/23/2002	20
Watonwan River	4/30/2002	190
Watonwan River	5/9/2002	280
Watonwan River	5/16/2002	40
Watonwan River	5/22/2002	300
Watonwan River	5/30/2002	1,500
Watonwan River	6/4/2002	1,600
Watonwan River	6/7/2002	1,200
Watonwan River	6/11/2002	2,000
Watonwan River	6/14/2002	910
Watonwan River	6/20/2002	900
Watonwan River	6/26/2002	1,100
Watonwan River	7/8/2002	460
Watonwan River	7/12/2002	600
Watonwan River	7/26/2002	200
Watonwan River	8/8/2002	4,800
Watonwan River	8/19/2002	160
Watonwan River	8/27/2002	1,000
Watonwan River	8/30/2002	900
Watonwan River	9/20/2002	320
Watonwan River	4/9/2003	10
Watonwan River	4/11/2003	36
Watonwan River	4/17/2003	520
Watonwan River	4/18/2003	330
Watonwan River	4/22/2003	140
Watonwan River	5/6/2003	300
Watonwan River	5/9/2003	150
Watonwan River	5/12/2003	900
Watonwan River	6/6/2003	510
Watonwan River	6/25/2003	3,300
Watonwan River	6/26/2003	3,000
Watonwan River	6/27/2003	6,000
Watonwan River	6/30/2003	220
Watonwan River	7/9/2003	6,000
Watonwan River	7/10/2003	10
Watonwan River	7/16/2003	1,300

Fecal Coliform Bacteria Concentrations for Monitoring Sites 2000-2003

Site	Date	FC (org/100 ml)
Watonwan River	7/25/2003	350
Watonwan River	8/1/2003	170
Watonwan River	8/11/2003	40
Watonwan River	8/22/2003	520
Watonwan River	8/29/2003	10
Watonwan River	9/8/2003	500
Watonwan River	9/18/2003	600
Watonwan River	9/29/2003	160
Watonwan River	10/27/2003	18
Dutch Creek	7/11/2000	870
Dutch Creek	7/17/2000	1,100
Dutch Creek	7/24/2000	250
Dutch Creek	7/27/2000	280
Dutch Creek	7/31/2000	500
Dutch Creek	8/10/2000	290
Dutch Creek	8/17/2000	1,000
Dutch Creek	8/21/2000	500
Dutch Creek	8/24/2000	1,000
Dutch Creek	8/30/2000	780
Dutch Creek	6/5/2001	210
Dutch Creek	6/13/2001	140
Dutch Creek	6/19/2001	130
Dutch Creek	6/25/2001	1,400
Dutch Creek	6/27/2001	1,500
Dutch Creek	7/2/2001	8,000
Dutch Creek	7/9/2001	2,300
Dutch Creek	7/17/2001	5,000
Dutch Creek	7/1/2401	2,000
Dutch Creek	7/30/2001	2,300
Dutch Creek	8/1/2001	8,000
Dutch Creek	8/6/2001	8,000
Dutch Creek	8/14/2001	7,000
Dutch Creek	8/20/2001	200
Dutch Creek	8/27/2001	40
Dutch Creek	6/3/2002	280
Dutch Creek	6/10/2002	480
Dutch Creek	6/17/2002	900
Dutch Creek	6/19/2002	6,000
Dutch Creek	6/24/2002	620
Dutch Creek	7/1/2002	3,000
Dutch Creek	7/8/2002	2,800

Site	Date	FC (org/100 ml)
Dutch Creek	7/15/2002	560
Dutch Creek	7/22/2002	6,000
Dutch Creek	7/31/2002	14,300
Dutch Creek	8/5/2002	60,000
Dutch Creek	8/12/2002	5,900
Dutch Creek	8/19/2002	7,500
Dutch Creek	8/21/2002	2,800
Dutch Creek	8/26/2002	3,500
Seven Mile Creek	4/26/2000	<10
Seven Mile Creek	5/8/2000	10
Seven Mile Creek	5/11/2000	40
Seven Mile Creek	5/17/2000	5,000
Seven Mile Creek	5/18/2000	3,500
Seven Mile Creek	5/21/2000	300
Seven Mile Creek	5/24/2000	90
Seven Mile Creek	5/30/2000	290
Seven Mile Creek	6/12/2000	220
Seven Mile Creek	6/20/2000	100
Seven Mile Creek	7/11/2000	3,600
Seven Mile Creek	7/25/2000	10
Seven Mile Creek	8/8/2000	5,400
Seven Mile Creek	9/6/2000	60
Seven Mile Creek	4/23/2001	500
Seven Mile Creek	5/7/2001	100
Seven Mile Creek	5/14/2001	100
Seven Mile Creek	5/22/2001	140
Seven Mile Creek	6/13/2001	600
Seven Mile Creek	6/25/2001	80
Seven Mile Creek	7/23/2001	12,400
Seven Mile Creek	8/13/2001	10
Seven Mile Creek	9/24/2001	100
Rush River	3/25/2003	10
Rush River	4/11/2003	10
Rush River	4/16/2003	330
Rush River	4/21/2003	350
Rush River	5/12/2003	5,600
Rush River	5/15/2003	4,000
Rush River	5/20/2003	7,000
Rush River	5/28/2003	140
Rush River	6/9/2003	3,550
Rush River	6/18/2003	910

Fecal Coliform Bacteria Concentrations for Monitoring Sites 2000-2003

Site	Date	FC (org/100 ml)
Rush River	6/26/2003	1,700
Rush River	6/30/2003	1,300
Rush River	7/10/2003	730
Rush River	7/29/2003	1,200
Rush River	8/21/2003	1,100
High Island Creek	5/2/2000	52
High Island Creek	5/18/2000	16,600
High Island Creek	5/31/2000	400
High Island Creek	6/5/2000	8,600
High Island Creek	7/10/2000	5,000
High Island Creek	7/13/2000	2,650
High Island Creek	8/22/2000	30
High Island Creek	4/9/2001	300
High Island Creek	4/23/2001	1,000
High Island Creek	5/3/2001	10
High Island Creek	5/7/2001	80
High Island Creek	5/22/2001	400
High Island Creek	6/13/2001	1,800
High Island Creek	6/14/2001	3,300
High Island Creek	6/20/2001	100
High Island Creek	7/2/2001	100
High Island Creek	7/18/01	600
High Island Creek	4/3/02	10
High Island Creek	4/10/02	70
High Island Creek	4/24/02	20
High Island Creek	5/6/02	180
High Island Creek	5/15/02	80
High Island Creek	5/29/02	7,150
High Island Creek	6/3/02	6,000
High Island Creek	6/5/02	3,900
High Island Creek	6/12/02	1,000
High Island Creek	6/19/02	8,600
High Island Creek	6/20/02	1,400
High Island Creek	6/21/02	6,000
High Island Creek	6/25/02	3,400
High Island Creek	7/10/02	1,300
High Island Creek	9/17/02	10
High Island Creek	3/25/03	10
High Island Creek	4/11/03	10
High Island Creek	4/16/03	190
High Island Creek	4/21/03	700

Site	Date	FC (org/100 ml)
High Island Creek	5/12/2003	3,500
High Island Creek	5/15/2003	700
High Island Creek	5/20/2003	3,300
High Island Creek	5/28/2003	190
High Island Creek	6/9/2003	1,000
High Island Creek	6/18/2003	1,000
High Island Creek	6/26/2003	3,000
High Island Creek	6/30/2003	3,900
High Island Creek	7/10/2003	22,000
High Island Creek	7/29/2003	360
High Island Creek	8/21/2003	300
Lower Beven Creek	5/1/2000	290
Lower Beven Creek	5/16/2000	140
Lower Beven Creek	5/31/2000	14,050
Lower Beven Creek	6/14/2000	20
Lower Beven Creek	7/17/2000	1
Lower Beven Creek	7/28/2000	600
Lower Beven Creek	8/11/2000	100
Lower Beven Creek	8/22/2000	1
Lower Beven Creek	9/7/2000	200
Lower Beven Creek	4/9/2003	30
Lower Beven Creek	4/22/2003	250
Lower Beven Creek	5/5/2003	63
Lower Beven Creek	5/21/2003	2,900
Lower Beven Creek	6/4/2003	50
Lower Beven Creek	6/17/2003	640
Lower Beven Creek	6/30/2003	1,200
Lower Beven Creek	7/17/2003	15,000
Lower Beven Creek	7/29/2003	220
Lower Beven Creek	9/10/2003	2,000
Lower Beven Creek	9/22/2003	100
Lower Beven Creek	10/7/2003	150
Lower Beven Creek	10/22/2003	90
MN River at Dehli	10/24/2000	27
MN River at Dehli	4/25/2001	390
MN River at Dehli	5/15/2001	9
MN River at Dehli	6/6/2001	45
MN River at Dehli	6/11/2001	9
MN River at Dehli	8/28/01	66
MN River at Dehli	9/19/01	82
MN River at Dehli	10/22/03	9

Fecal Coliform Bacteria Concentrations for Monitoring Sites 2000-2003

Site	Date	FC (org/100 ml)
MN River at Morton	10/24/00	9
MN River at Morton	4/25/01	600
MN River at Morton	5/15/01	17
MN River at Morton	6/6/01	17
MN River at Morton	6/11/01	9
MN River at Morton	8/28/01	9
MN River at Morton	9/19/01	67
MN River at Morton	10/22/03	9
MN River at Courtland	10/29/00	32
MN River at Courtland	4/22/01	110
MN River at Courtland	5/23/01	120
MN River at Courtland	6/3/01	20
MN River at Courtland	8/6/01	91
MN River at Courtland	9/25/01	860
MN River at Courtland	10/26/03	24

Site	Date	FC (org/100 ml)
MN River at St. Peter	10/29/00	36
MN River at St. Peter	4/22/01	44
MN River at St. Peter	5/23/01	960
MN River at St. Peter	6/3/01	48
MN River at St. Peter	8/6/01	91
MN River at St. Peter	9/25/01	420
MN River at St. Peter	9/26/03	140
MN River at Henderson	10/29/00	9
MN River at Henderson	5/23/01	400
MN River at Henderson	6/3/01	82
MN River at Henderson	6/25/01	1,900
MN River at Henderson	8/6/01	55
MN River at Henderson	9/25/01	300
MN River at Henderson	10/26/03	20
MN River at Fort Snelling	10/18/00	320
MN River at Fort Snelling	4/3/01	78
MN River at Fort Snelling	5/29/01	85
MN River at Fort Snelling	6/12/01	9
MN River at Fort Snelling	6/24/01	180
MN River at Fort Snelling	8/7/01	120
MN River at Fort Snelling	9/4/01	55
MN River at Fort Snelling	10/1/03	12