

**MCES Water Monitoring Programs
In Support of the
Interagency Water Monitoring Initiative,
2000 – 2001 Biennial Progress Report**

Interagency Water Monitoring Initiative (IWMI)

Background

In May 1997, the Minnesota Legislature provided \$575,000 to the Metropolitan Council, via the Interagency Water Monitoring Initiative (IWMI), for an expansion of Metropolitan Council Environmental Services (MCES) water quality monitoring efforts. The funding was provided to the Metropolitan Council via the Minnesota Pollution Control Agency (MPCA) budget. Monitoring efforts began in 1998 and focused on two programs: the “Metropolitan Area Watershed Outlet Monitoring Program” and “Mercury and PCB Inputs to the Minnesota River Program.” Both programs are being conducted in cooperation with local, state, and federal partners with a mutual interest in the monitoring information.

In May 1999, the Minnesota Legislature provided an additional \$600,000 to the Metropolitan Council for the 2000-2001 biennium, via the MPCA’s budget. This funding allowed for continuation of the “Metropolitan Area Watershed Outlet Monitoring” and “Mercury and PCB Inputs to the Minnesota River” programs through June 2001. A 2000-2001 work plan for both programs was prepared by MCES Water Quality staff and submitted to the MPCA in September 1999. In September 2000, a business item was approved by the Environment Committee of the Metropolitan Council authorizing the Metropolitan Council to enter into the joint powers agreement with the MPCA, and to accept and expend the state funding. In November 2000, the MPCA and Metropolitan Council executed the joint powers agreement for the 2000-2001 monitoring work and funding.

In June 2001, the Minnesota Legislature again appropriated \$600,000 to the Metropolitan Council (via the MPCA), for continuation of the “Metro Area Watershed Outlet Monitoring” and “Mercury and PCB Inputs to the Minnesota River” programs during the 2002-2003 biennium. MCES Water Quality staff have prepared a 2002-2003 work plan for both programs. MCES and MPCA staff have initiated the process for establishing a joint powers agreement for the 2002-2003 funding.

IWMI Progress in 2000-2001

A number of regional, state, and federal agencies participate in the Interagency Water Monitoring Initiative (IWMI), including MCES, MPCA, MDNR, MDH, MDA, BWSR, the Minnesota Office of Planning, USGS, USACE, USDA, and NOAA¹. As a long-term goal, the IWMI is working to achieve increased interagency coordination and cooperation for state-wide water monitoring programs, as well as increased capability for sharing water monitoring data and environmental information. The IWMI

¹ See Table 1 for complete agency names.

surface water and ground water committees, with active MCES participation, continue to meet regularly to achieve this goal. The combined group has updated the monitoring work plan for the MPCA’s Minnesota Non-Point Source Management Plan, with MCES input. The IWMI surface water committee is seeking funding sources to support continuation of a statewide stream flow-gauging network, in cooperation with the USGS. A MCES Water Quality staff member has been participating in this effort.

In August 2000, IWMI participants prepared a summary of monitoring accomplishments completed with the funding that the Minnesota Legislature provided in 1997. As part of the IWMI summary, MCES reported on the accomplishments of the two MCES monitoring programs cited above. This information was provided to legislators during the 2001 legislative session. IWMI participants also developed a legislative initiative for possible 2001 funding which included the following components: strengthening of existing monitoring efforts; technical assistance to local units of government; capacity to monitor emerging contaminant issues; and integrated data access.

In November 2000, IWMI participants prepared the 2000 Biennial Report to the Legislative Commission on Minnesota Resources (LCMR) on the “Status of Water Resource Monitoring Programs and Emerging Trends in Minnesota.”

Table 1. Acronyms of Agency Names

BWSR	Minnesota Board of Water and Soil Resources
MCES	Metropolitan Council Environmental Services
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
NOAA	National Oceanographic and Atmospheric Administration
USACE	United State Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey

MCES Water Monitoring Programs

The two water monitoring programs that comprise the MCES contribution to the Interagency Water Monitoring Initiative include the “Metropolitan Area Watershed Outlet Monitoring Program” and the “Mercury and PCB Inputs to the Minnesota River Program.” Both programs use the same monitoring technology and the same data format for reporting the monitoring results. However, each program has a slightly different objective.

Metropolitan Area Watershed Outlet Monitoring Program

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. A ninth site (Cottage Grove Ravine) is scheduled for construction in the fall of 2001. The physical and chemical data from these nine 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.

Local partners conduct the monitoring at these locations with guidance and oversight from the MCES project coordinator, Leigh Harrod. Local partners include the Science Museum of Minnesota (St. Croix Watershed Research Station), the Minneapolis Park and Recreation Board, the Wright County Soil and Water Conservation District (SWCD), the Dakota/Goodhue County SWCDs, the City of Savage, the Black Dog Watershed Management Organization (WMO), the Riley-Purgatory-Bluff Creek Watershed District (WD), and the South Washington County WD.

Mercury and PCB Inputs to the Minnesota River Monitoring Program

The “Mercury and PCB Inputs to the Minnesota River Monitoring Program,” implemented in the fall of 1998, expanded the existing MCES river and stream monitoring network in the Minnesota River Basin. The objective of this program is to investigate sources and measure loads of mercury, PCB, and other non-point source pollutants in the Minnesota River Basin. Sources of mercury and PCB are contributing to fish consumption advisories in the Minnesota River, and sources of sediment, nutrients, and bacteria are contributing to a general degradation of Minnesota River water quality. Six monitoring sites are now operating in the Mankato, MN area. Monitoring sites are located on the Minnesota River at Judson and St. Peter, and within the Blue Earth and Le Sueur River watersheds. The monitoring work for this program is being conducted in cooperation with the Minnesota Department of Agriculture (MDA), the U.S. Geological Survey (USGS), and the Minnesota Pollution Control Agency (MPCA).

Metropolitan Area Watershed Outlet Monitoring Program

Introduction

The “Metropolitan Area Watershed Outlet Monitoring Program,” implemented in early 1998, has significantly expanded the existing MCES stream monitoring network in the Metropolitan Area. In February 1998, MCES hired Leigh Harrod as a Senior Environmental Scientist to coordinate the program, including establishment of up to ten new stream monitoring stations in Metro Area watersheds. The objective of this program is to collect the water quality data needed to assess current watershed conditions and develop target pollutant loads. As the target loads are developed, the monitoring stations can measure progress toward achievement of the target loading goals as non-point source best management practices (BMPs) are implemented in these watersheds.

In 1998, continuous monitoring stations in seven different Metropolitan Area watersheds were constructed near the outlets of five streams and two rivers which are tributaries to the Mississippi, Minnesota, and St. Croix Rivers. Continuous, year-round monitoring began in 1999 and all stations are fully functional to date. These seven stations are located near the outlets of the Cannon River, Crow River, Eagle Creek, Minnehaha Creek, Riley Creek, Valley Creek, and Willow Creek. In 2000, an eighth station was established on Bassett Creek. By the end of 2001, a ninth station will be established on the Cottage Grove Ravine in the South Washington Watershed District. The field work for this program is provided by cooperative, cost-share grant agreements with a number of federal, state, and local units of government in the Metro Area.

This portion of the biennial report will describe the status of the “Metropolitan Area Watershed Outlet Monitoring Program (WOMP)” during the 2000-2001 biennium. Measures of monitoring success are described in terms of monitoring activity, number of samples obtained, number of analyses conducted, monitoring lessons learned, the continuation of cooperative partnerships, data reporting, and uses and requests for WOMP data. The budget and financial accounting of funds used to date for this program are included in the **Budget** section of this report, which provides budget and financial information for both MCES monitoring programs.

Monitoring Program Design

The streams enrolled in the “Metropolitan Area Watershed Outlet Monitoring Program” (WOMP) are characterized by a multitude of land uses within their watersheds. Metro Area watersheds have been altered into a heterogeneous mix, ranging from the high-density urban corridors of Bassett Creek, to the suburban environs of Willow Creek, to the agricultural landscape of the Crow River basin, to the predominantly native vegetation that provides habitat for trout in Valley and Eagle Creeks. The variation in water quality among watersheds is dramatic. The monitoring results from each WOMP watershed, as distinguished by its land use characteristics, can therefore serve as a base line for other watersheds that are not actively monitored but share similar characteristics.

Monitoring Site Locations and Descriptions

1. Bassett Creek in Minneapolis, MN

BS 1.9 Activated in March 2000. T118N R24W Sec.13, ¼ mile upstream of storm sewer flowing under downtown Minneapolis. Watershed area approximates 43 sq. mi. Land use is urban, with 60% residential, 18% commercial-industrial, 14% open space and 5% open water.

Continuous stage recording is measured by a digital sonic ranging sensor. Campbell data logger also logs precipitation from a tipping bucket rain gage, and temperature and conductivity from an in-stream probe. Station is currently configured for continuous oxygen monitoring beginning in 2002. An automatic sampler captures event-generated flow weighted composites to supplement monthly grab samples. The Cooperator during the 2000-2001 biennium has been the Bassett Creek Watershed Management Commission, which provides the rating curve through their technical consultant, Barr Engineering. Beginning in July 2001, the Minneapolis Park and Recreation Board will conduct the monitoring in conjunction with Barr Engineering.

2. Cannon River at Welch, MN

CN 11.9 Cannon River at Welch, MN located 11.9 miles above its outlet to the Mississippi River in T113N, R16W, Sec.27. Site is shared with the USGS station no. 05355200. Watershed area approximates 235 sq.mi.; land use is predominantly agricultural with some forest and scattered urbanized areas.

Instruments coupled to a Campbell datalogger include a digital shaft encoder installed in a stilling well to continuously measure stage, a tipping bucket rain gauge, an in-stream temperature and conductivity probe, and an automatic sampler. The cooperator is Dakota County SWCD, with assistance from Goodhue County SWCD. Rating curve is maintained by the USGS.

3. Crow River at Rockford, MN

CW 23.1 T119N, R24W, Sec.29 on the NW bank of the Hwy 55 bridge in Rockford, MN; 1 mile below the confluence of the North and South Branches of the Crow River. Land use is 87.4% agricultural with 7.6% open water and wetland areas. Urbanization is increasing in Wright and Hennepin Counties along the riparian corridor. Drainage area is approximately 2,620 sq. mi.

A digital dry-gas pressure system continuously measures stage logged by a Campbell data logger. Other monitoring equipment includes a tipping bucket rain gauge, an in-stream temperature and conductivity probe, a refrigerated automatic sampler, a staff gage mounted to the Hwy 55 bridge footing, and a wire weight gage. Cooperator is Wright County SWCD. The rating curve is derived from USGS rating curve table for station no. 05280000.

4. Eagle Creek at Savage, MN

EA 0.8 T118N, R21W, Sec.7 under the 126th Street Bridge in Savage, MN. Outlet is to the Minnesota River 0.8 miles downstream. A MDNR designated trout stream, base flow is supplied by artesian groundwater discharging at Boiling Springs. Drainage area approximates 0.6 sq. mi. Despite the small watershed area, monitoring at this location provides an ideal control site because land use is entirely native vegetation. Eagle Creek is a viable trout stream with its native habitat largely intact.

A Campbell data logger continuously captures stage readings from a digital dry-gas pressure system; other monitoring instruments include a tipping bucket rain gauge, an in-stream temperature and conductivity probe, an automatic sampler, and a staff gage. Cooperator is the City of Savage. The rating curve was initially developed by the MN DNR; maintenance of the rating curve is achieved by in-stream wading rod measurements conducted by the Cooperator and MCES personnel.

5. Minnehaha Creek in Minneapolis, MN

MH 1.7 T117N, R 24W, Sec.14. Located west of Hwy 55 in city park land at 32nd Ave S. Land use in the watershed is predominantly riparian urban with a network of upland lake and wetland storage. Drainage area of the entire watershed is 181 sq. mi., including Lake Minnetonka. Considering only the urbanized, lower watershed area without Lake Minnetonka, the contributing drainage area is 55 sq. mi., or 31% of the total watershed area. The lower watershed region contributes most of the stream's annual loading into the Mississippi River at the outlet near Ft. Snelling.

Stage and flow monitoring at this WOMP site are measured by digital dry-gas pressure system; there is no rain gauge at this site. Temperature and conductivity are also continuously monitored. Rating curve measurements are taken regularly by Wenck Engineering on behalf of the Minnehaha Creek Watershed District. Cooperator is the Minneapolis Park and Recreation Board.

6. Riley Creek in Eden Prairie, MN

RI 1.3 T116N, R22W, Sec.33. Under Flying Cloud Drive in Eden Prairie, MN. Drainage area approximates 10 sq.mi. Land use is 53% agricultural, 18% open space and water bodies. The remainder of the watershed is a mix of residential and commercial areas which over time may entirely replace the agricultural activity.

Stage is measured by digital sonic ranging sensor mounted under a box culvert. Campbell data logger records precipitation from a tipping bucket rain gage, as well as temperature and conductivity from an in-stream probe. Barr Engineering manages the station and maintains the rating curve on behalf of the Riley-Purgatory-Bluff Creek Watershed District.

7. Valley Creek in Afton, MN

VA 1.0 T28N, R20W, Sec.15. Located at the Putnam Blvd. Bridge in Afton, MN. Drainage area approximates 16.8 sq.mi. A MDNR designated trout stream, Valley Creek is located in a groundwater discharge zone. Land use is largely a mix of agriculture and rural residential development, although large tracts have been set aside in land trusts and restored to prairie. In addition, much of the riparian corridor is re-developing into floodplain forest following cessation of agriculture in the stream valley 30-40 years ago.

A Campbell data logger continuously captures stage readings from a digital dry-gas pressure system; other monitoring instruments include an in-stream temperature and conductivity probe, an automatic sampler, and a staff gage. Precipitation data is collected by a tipping bucket rain gauge on the Belwin property west of the station. The WOMP cooperator is the Science Museum of Minnesota. Field monitoring and rating curve work is conducted regularly by personnel from the St. Croix Watershed Research Station.

8. Willow Creek in Burnsville, MN

WI 1.0 T115N, R21W, Sec.14 behind the Cub Food store on Hwy 13, Burnsville, MN. Monitoring one mile from the outlet to the Minnesota River captures approximately 9 square miles of the Black Dog watershed. Land use is predominantly residential with 20% open space and agricultural remaining.

Monitoring instruments are mounted in the underground box culvert; the automatic sampler and datalogger are housed in an above-ground shelter. Stage is measured with a digital sonic ranging sensor. Other monitoring instruments include a tipping bucket rain gage and in-stream temperature and conductivity probe. The cooperator is the Black Dog WMO with technical assistance provided by Barr Engineering. The rating curve is based upon a Mannings equation, because it is too hazardous to enter the culvert with a wading rod during high flows. This site is particularly flashy due to the predominance of impervious cover in the watershed.

9. Proposed Site: Cottage Grove Ravine in Cottage Grove, MN

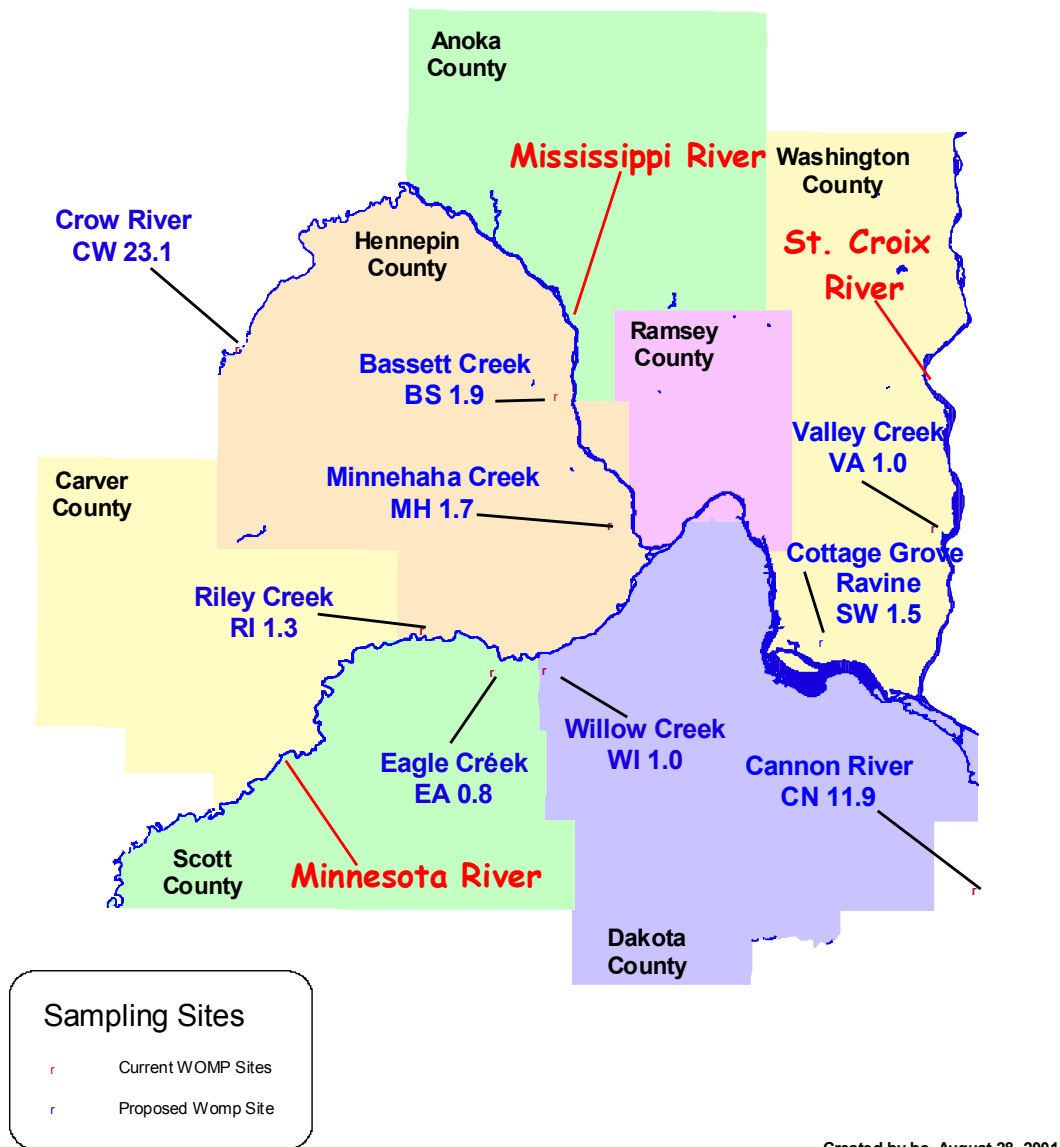
SW 1.5 Proposed site to be located in T27N, R21W, Sec.28 at 100th Street. Property access agreement with 3M Company was recently completed after 18 months of negotiation. The tributary drainage area to the WOMP site is approximately 18 sq. mi. Land use is estimated to be 30% residential/commercial, 30% undeveloped/large lot residential, and 30% agriculture. The Cottage Grove Ravine is a conduit for storm water discharges from the City of Woodbury.

The station is designed to measure and calculate flows directly by coupling an in-stream velocity meter with a digital dry-gas pressure system for stage. A staff gage was installed and grab sampling was initiated during the biennium. The cooperator will be the South Washington Watershed District with technical assistance provided by the

Washington County SWCD. Shelter design and monitoring protocols will conform to other WOMP stations in the program. Construction will begin in the fall of 2001, with fully automated monitoring commencing in January 2002.

Additional information on the nine MCES WOMP sites is presented in Appendix A. Locations of all nine WOMP sites are indicated in Figure 1.

Figure 1
Watershed Outlet Monitoring Program Station Locations



Monitoring Activity and Analyses

Since July 1999, seven WOMP stations continuously logged stream flow, temperature and conductivity, with 15-minute average values reported. Bassett Creek was activated in March 2000. All stations captured both water quality samples and continuous discharge data for snowmelt and storm-generated runoff during the 2000-2001 biennium. In addition, monthly base flow samples were collected at all sites. Six of the eight stations are equipped with rain gauges.

Table 2 below shows the number of both composite and grab samples taken at each site during the 2000-2001 biennium. Lab costs for the biennium are also presented in Table 2. Lab costs increased during the 2000-2001 biennium due to two factors: 1) two additional sampling analytes, total chlorides and fecal coliform bacteria, were added to the program; and 2) the 2001 spring flood event generated more sampling activity than originally anticipated.

Table 2. Number of Samples and Lab Costs for WOMP Sites, 2000-2001 Biennium

Station	no. of samples: COMPOSITES	no. of samples: GRABS	SPENT ON COMPOSITES	SPENT ON GRABS	TOTAL SPENT
BASSETT CREEK	35	13	\$ 3,397.10	\$ 2,322.58	\$ 5,719.68
CANNON RIVER	18	22	\$ 3,930.52	\$ 3,930.52	\$ 7,861.04
CROW RIVER	21	24	\$ 2,038.26	\$ 4,287.84	\$ 6,326.10
EAGLE CREEK	16	6	\$ 1,552.96	\$ 1,071.96	\$ 2,624.92
MINNEHAHA CREEK	44	22	\$ 4,270.64	\$ 3,930.52	\$ 8,201.16
RILEY CREEK	23	16	\$ 2,232.38	\$ 2,858.56	\$ 5,090.94
COTTAGE GROVE		17		\$ 3,037.22	\$ 3,037.22
VALLEY CREEK	36	23	\$ 3,494.16	\$ 4,109.18	\$ 7,603.34
WILLOW CREEK	30	13	\$ 2,911.80	\$ 2,322.58	\$ 5,234.38
TOTALS	223	156	\$ 23,827.82	\$ 27,870.96	\$ 51,698.78

The duration and intensity of the 2001 spring runoff season dramatically increased the number of samples taken. However, the cooperators were well prepared and did an excellent job. Figure 2 below shows the sampling interval at the Crow River site at Rockford during the 2001 flood. This is a textbook example of how to capture composite flow samples over many days of a rising hydrograph.

Figure 2. Crow River Hydrograph, Spring 2001

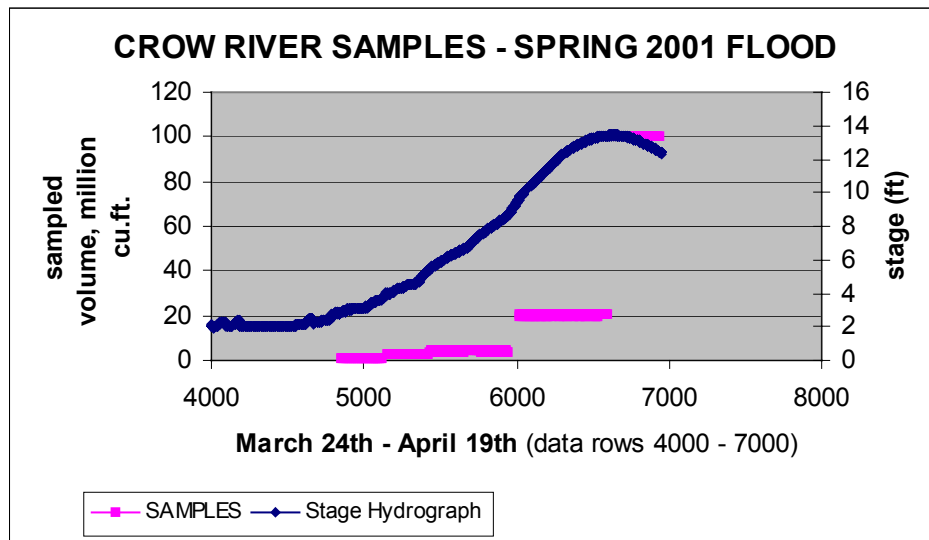


Table 3 summarizes the number of conventional pollutant analyses conducted for each WOMP site during the 2000-2001 biennium. All laboratory analyses are being conducted by the MCES Laboratory Services Section in St. Paul, MN.

Table 3. Number of Water Analyses for WOMP Sites, 2000-2001 Biennium

	Basset Creek	Cannon River	Crow River	Eagle Creek	Minnehaha Creek	Riley Creek	Valley Creek	S. Washington Creek	Willow Creek	Total Analyses
Total Submissions	53	56	61	34	79	53	83	20	52	
Analytes										
Alkalinity	41	55	55	32	76	51	79	2	51	442
5-day CBOD	17	29	26	14	53	17	18		16	190
5-day BOD	17	35	39	22	59	23	31		20	246
Chloride	14	9	17	7	24	13	22		11	117
Chemical Oxygen Demand (COD)	41	54	45	31	75	51	79	19	51	446
Dissolved COD	40	41	42	22	65	40	62	1	46	359
Coliform count	12	8	16	4	9	2	2	4	1	58
Hardness	42	55	56	31	76	52	79	2	50	443
Copper	39	49	48	25	72	49	59	3	50	394
Nickel	39	49	48	25	72	49	59	3	50	394
Lead	39	49	48	25	72	49	59	3	50	394
Zinc	39	49	48	25	72	49	59	3	50	394
Cadmium	39	49	48	24	72	49	59	3	50	393
Chromium	39	49	48	25	72	49	59	3	50	394
Ammonia (NH3)	41	53	55	30	75	51	76	11	52	444
Nitrite N	41	55	56	29	76	51	78	16	51	453
Nitrate N	41	55	56	29	76	51	78	16	51	453
Total Kjeldahl Nitrogen	37	52	52	29	72	47	72	18	48	427
Dissolved TKN	4	3	3	6	11	4	6	1	5	43
Total Phosphorus	37	52	52	29	72	47	72	18	48	427
Dissolved Phosphorus	38	51	53	29	76	49	75	14	48	433
Dissolved Ortho Phosphorus	23	39	39	24	65	30	31	7	23	281
Total Suspended Solids	41	54	55	32	74	51	71	18	50	446
Volatile Suspended Solids	41	54	55	32	74	51	71	18	50	446
Turbidity	18	39	37	22	62	32	39	11	28	288
Total Analyses	820	1087	1097	603	1602	1007	1395	194	1000	8805

Monitoring Lessons Learned

In addition to the same lessons learned in the “Mercury and PCB Inputs to the Minnesota River Program” (pg. 28), the added experience gained since establishment of the WOMP stations in 1998 has been equally valuable to both programs. Lessons learned in hindsight frequently lead to changes in procedures and station design. Had the lessons learned by this hindsight initially been discernable when the program started, they would have been incorporated from the outset. Lessons learned are as follows:

- **Cooperator coordination.** Even after initial training, regular on-going communication with WOMP cooperators is essential to a successful program. Sometimes winter grab samples were not collected when the cooperator assumed this was not necessary and the WOMP coordinator assumed they were being collected. The solution has been to email cooperators when potential storm events approach the Metro Area, actively inquire about site maintenance needs, and remind cooperators to grab sample on a monthly basis. All cooperators are now following the same sampling protocol.
- **Conductivity probe drift.** The in-stream conductivity probes at each site are bolted to a steel stake pounded into the stream bed. As such, they are difficult to access for cleaning, especially during high flows. These probes invariably clog with algae and silt, which causes “drift” in the readings. This problem was addressed by giving each cooperator a hand-held conductivity probe that can be easily calibrated in the field using a solution of known value. Computer code for the Campbell data logger was developed and added to each station’s program. The new code allows the field personnel to input the calibrated conductivity reading from the hand-held probe by using the portable keypad that comes with each data logger. The code then automatically calculates and applies the appropriate offset when reporting the data.
- **Artificial spikes in stage readings.** All digital instruments are sensitive to fluctuations in electrical current or power supply. Initially, the dry-gas bubbler systems were notorious for stage spikes, which would needlessly start the sampling process and cause field personnel to travel to the site simply to empty a single sample triggered by the false spike. This problem was addressed by powering the bubblers through the 12-volt port of the datalogger, which has turned out to be a more stable power source instead of using a separate, stand-alone battery with trickling recharger dedicated solely to the bubbler. Another improvement was to modify the data logger code to compute the 15-minute average stage by using a different averaging routine, Running Average. The Running Average routine automatically ignores statistically anomalous spikes when applying the rating curve polynomial to stage readings generated over a 15 minute period.
- **Hundred year floods occur more frequently than every 100 years.** The locations of the monitoring stations were thoroughly researched in 1997 and 1998.. The goal was to locate stations as close to the watershed outlet as possible while avoiding backwater effects, thereby monitoring as much of the watershed discharge as possible without losing any stations to floods. The flood stages encountered in the 2001 spring runoff event, even in these secondary watersheds, taxed this design to the maximum. While all stations experienced backwater effects to some degree, most backwater signatures were easily identifiable in the hydrograph data. The Riley Creek station was in danger of flooding by the Minnesota River, so MCES personnel waded out to the station and successfully removed the instruments before the water rose further. At Willow Creek, an ultrasonic range

sensor was destroyed when water levels inundated the sensor. The location of that sensor in an underground storm sewer made access far too dangerous to remove the sensor in advance.

As flood levels rose beyond the range of previous rating curve measurements, the rating curves began to fail. At the Crow River monitoring site, the data logger program was quickly revised to incorporate additional rating curve data from USGS to calculate the higher flows. The rating curves would fail at stations whenever the stream flooded outside of its banks or control structure. This occurred during the 2001 spring flood event at the Cannon River in Welch, MN; Minnehaha Creek in Minneapolis, MN; Willow Creek in Burnsville, MN; Eagle Creek in Savage, MN; and Riley Creek in Eden Prairie, MN.

- **Contract Negotiation.** The process of issuing and approving grant contracts with WOMP cooperators was not in sync with the timetable MPCA and MCES needed to finalize a Joint Powers Agreement that allowed transfer of the Legislative funds from the MPCA to MCES. Cooperator contracts and payments were delayed for over a year while awaiting approval of the MCES-MPCA joint powers agreement, which underwent several revisions. MCES subsequently has revised its internal procedures by designating a grant manager in addition to the project manager for WOMP contracts. The grant manager works directly with the legal department to expedite all contract approvals and issue payments to cooperators for all WOMP contracts.

Cooperative Monitoring Partnerships

Local Monitoring Partners

With direction and oversight provided by MCES staff, local cooperators are conducting WOMP monitoring. Watershed districts, Soil and Water Conservation Districts, cities and non-profit organizations participate as WOMP cooperators through cost-share grant agreements with MCES. To achieve greater benefit from the legislative funding, the local cooperators provide 25% of the lab, labor, mileage, and new equipment costs for the WOMP stations, while MCES provides the remaining 75%. MCES pays 100% of maintenance costs for both stations and equipment, and pays all the utility bills.

Cooperators have been participating in a WOMP “user group” forum, which serves as a network for coordinating stream monitoring efforts and for facilitating training when new sampling protocols are introduced. MCES staff facilitate the meetings, which inform cooperators about any changes in data management, monitoring equipment and technology. MCES will continue to conduct these meetings in response to cooperators’ requests for FLUX training to calculate watershed pollutant loads.

Appendix A is a list of all WOMP cooperators and their contact information.

Data Management and Reporting

Every six months, the continuous monitoring data from the WOMP sites are compiled by the cooperators in a specified format and reported to MCES personnel. The grant manager works closely with the cooperator to check the data.

Excel is currently the easiest tool for the WOMP cooperators to use for reporting the data obtained from their respective monitoring stations. All the cooperators have been trained to download data in an identical manner, and a pre-formatted Excel template has been developed for storage of their data. Data from the individual cooperators will be imported into a MCES Oracle database.

From the MCES Oracle database, the WOMP data can be exported to the MPCA in a variety of formats, or provided directly in the original Excel templates submitted by the cooperators. Each year two data sets are delivered to the MPCA: one data set consists of daily averages for stage, flow, rainfall, conductivity and temperature; and the second data set consists of the laboratory results from sampling. Both data sets currently are provided to the MPCA in an Excel spreadsheet.

Two monitoring reports, including the results of all MCES monitoring conducted during the July - December 1999 and January - December 2000 periods, have already been provided to the MPCA. A third monitoring report, which will include the results of all MCES monitoring conducted during the January - June 2001 period, will be provided to the MPCA by September 30, 2001.

It is recognized that the current format for data submittal is an interim solution that may be modified in the future to reflect the needs of both MCES and the MPCA. MCES is in the process of designing and implementing an Environmental Information Management System ("EIMS") for data management. As this tool evolves, decisions regarding data format, data retrieval and data delivery to MPCA can be incorporated into the final output.

Use of WOMP Monitoring Data

WOMP monitoring data continue to be requested and used by a number of agencies. During the 2000-2001 biennium, the USGS requested the entire flow record for all WOMP sites to use in a two-year study that is estimating groundwater recharge in the seven-county Metropolitan Area.² Dakota County used WOMP data for their Hastings Area Nitrate Study. WOMP data were used to refine the MPCA's Metro Groundwater Model in the area around the Savage Fen in Scott County. Both the Minnesota Department of Transportation and the Minnehaha Creek Watershed District requested stream flow data for use in assessing the impacts of the Highway 55 construction project.

In addition to external agency use, the local cooperators apply the data to their own watershed projects. Riley Creek and Willow Creek data are being catalogued by Barr Engineering in anticipation of MCES development of target pollutant loads.

The City of Savage (Eagle Creek) uses the data to look at the effects of construction projects or development within the city. They also pass the monitoring information along to the Middle Minnesota Watershed District and Scott County for their information.

² "Recharge to Shallow Aquifers and Leakage to Deep Aquifers in the Seven-County Metropolitan Area of Minneapolis-St. Paul, Minnesota," James F. Ruhl, Project Chief.

The Minneapolis Park and Recreation Board publishes the Minnehaha Creek monitoring and lab results in the "Minneapolis Park and Recreation Board 2000 Water Resources Report." This report was subsequently placed in the public libraries. When a sewer discharge occurred recently near Minnehaha Creek, the station was used to automatically collect samples every 4 hours in response to the situation.

The Crow River Organization of Water (a 10-county JPO) used the data from the Rockford WOMP station in their initial Crow River Diagnostic Study. The Wright SWCD submits news articles and information about the WOMP station to 11 local newspapers in Wright County. The SWCD plans to use the data in the next five-year revision of the Wright County Water Plan, and is currently using the data to compare three methodologies used for measuring turbidity at the station (lab analysis, T-Tube, and Hach kit).

Valley Creek WOMP data were used by the St. Croix Watershed Research Station to calibrate both a surface-water model and a groundwater model of the area. At present, the data are being used to establish baseline conditions of the creek, should development alter the watershed hydrology in the future. The cooperators are using the data to establish the present base flow of the creek, which may become the critical benchmark against which any future reduction in base flow -- caused, e.g., by nearby water-supply well fields capturing water from the Prairie Du Chien aquifer -- will be measured. The nitrate data are being closely watched to see if nitrate concentrations will decrease in the future, as agriculture gradually becomes phased out in the watershed.

Contact Information for Metropolitan Area Watershed Outlet Monitoring Program

Questions or comments about this report or the Metropolitan Area Watershed Outlet Monitoring Program may be directed to:

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Mercury and PCB Inputs to the Minnesota River Monitoring Program

Introduction

The “Mercury and PCB Inputs to the Minnesota River Program” began in the fall of 1998, with the establishment of six monitoring sites in the vicinity of Mankato, MN. The program’s objective is to investigate sources and measure loads of mercury, PCB, and other nonpoint source pollutants in the Middle Minnesota River, Blue Earth River, and Le Sueur River Watersheds of the Minnesota River Basin. The six monitoring sites have been fully functional for over two years. Two monitoring sites are located on the Minnesota River at Judson and St. Peter in the Middle Minnesota River Watershed. One monitoring site is located near the mouth of the Blue Earth River in the Blue Earth River Watershed. The three remaining monitoring sites are all located in the Le Sueur River Watershed. One site is located near the mouth of the Le Sueur River, and two sites are located on smaller tributaries (Little Cobb River and Little Beauford Ditch) in the Le Sueur River Watershed. Refer to Figure 3 for all Mankato monitoring site locations.

MCES Research and Development staff in St. Paul are providing support for the mercury and PCB monitoring components of the program, and Heather Offerman in the MCES Mankato Field Office is providing support for the conventional pollutant monitoring component of the program.

This portion of the biennial report will describe the status of the Mercury and PCB Inputs to the Minnesota River Monitoring Program during the 2000-2001 biennium. Initial results are reported for the Hg and PCB monitoring components of the program. For the conventional pollutant monitoring component, information is provided about the monitoring site locations, monitoring equipment, rating curve development, initial results, monitoring lessons learned, cooperative monitoring partnerships, and data reporting.³ The budget and financial accounting of funds used to date for this program are included in the **Budget** section of this report, which provides budget and financial information for both MCES monitoring programs.

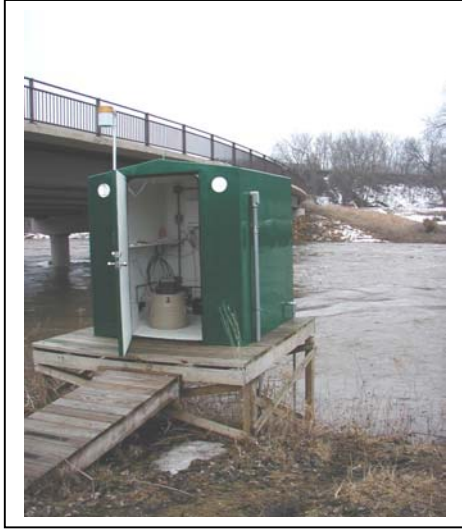
Monitoring Site Locations and Descriptions

Land use in the Middle Minnesota River, Blue Earth River, and Le Sueur River Watersheds, in which the six monitoring stations are located, is dominated by row crop agriculture, primarily corn and soybeans. This section provides a brief description of each monitoring station.

Middle Minnesota River Watershed

MN 120.0 Minnesota River monitoring site near Judson, MN, T109, R28, S33, at the Minnesota Department of Natural Resources boat landing near Nicollet County Road 23, Nicollet County, Nicollet Township. Drainage area is approximately 11,400 sq. mi.

³ Details of the procedures used for specific operation of the monitoring equipment were previously described in the 1998-1999 Biennial Progress Report.



The Le Sueur River monitoring station. Even during the high flow conditions of Spring 2001, this site stayed safely above the turbulent water.

MN 89.7 Minnesota River monitoring site in St. Peter, MN, T110, R26, S21, Nicollet County, Oshawa Township. 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 about 15, 500 sq. mi., and encompasses 11 of the 12 major watersheds in the Minnesota River Basin.

Blue Earth River Watershed

BU 12.0 Blue Earth River monitoring site is on left bank 0.2 mi. downstream from power plant, 2 mi. west of Rapidan, T107, R 27, S6, Rapidan Township, Blue Earth County. Drainage area is approximately 2,430 sq. mi.

Le Sueur River Watershed

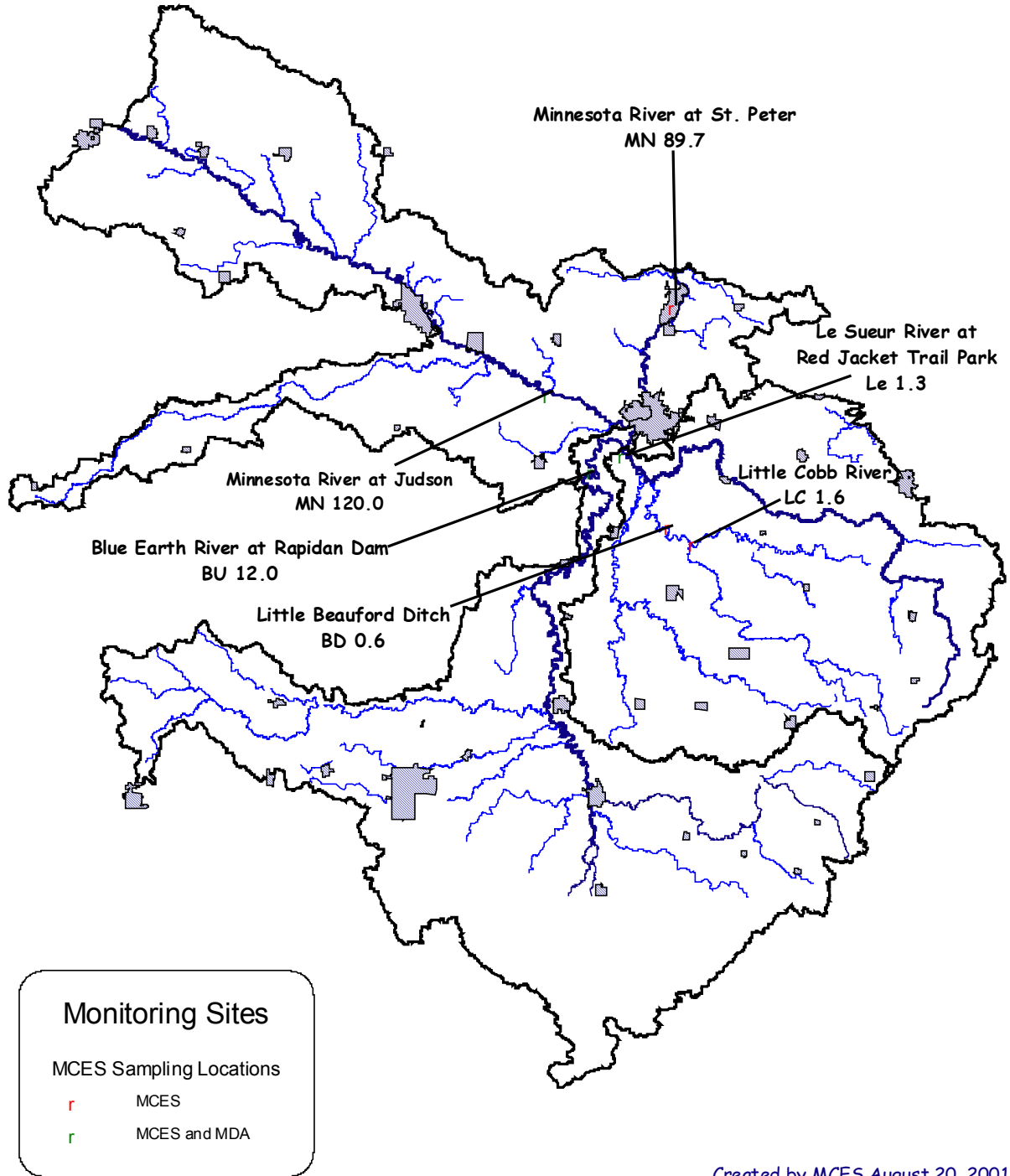
BD 0.6 Little Beauford Ditch monitoring site, T106, R26, S4 of Beauford Township, Blue Earth County, MN. Approximately ½ mile north of the town of Beauford on MN Highway 22. Drainage area is approximately 7 sq. mi.

LC 1.6 Little Cobb River monitoring site, T106, R26, between S11 and 12 of Beauford Township, Blue Earth County, MN. Located adjacent to bridge on County Road 16. Drainage area is approximately 130 sq. mi.

LE 1.3 Le Sueur River monitoring site is located in the Red Jacket Trail County Park, 20 feet downstream from the MN Hwy 66 bridge, T108, R27, S34, South Bend Township, Blue Earth County. Drainage area is approximately 1,100 sq. mi.

FIGURE 3

MCES Mankato Area Monitoring Sites Blue Earth, Le Sueur, and Middle Minnesota Watersheds



Created by MCES August 20, 2001

Monitoring Equipment

The following is a general description of the monitoring equipment at each site, with exceptions noted.

All six monitoring sites have AC power and phone line connections to the shelter. Power is converted to DC with a Campbell Scientific Inc. (CSI) CH12R regulator charger. The data collection platform consists of a CSI CR10X datalogger with extended memory. The system operates with a 60-second execution interval and data are averaged and saved as output on a 15-minute basis. Stage is measured using a Design Analysis (DA) H350 Pressure Transducer and H355 dry gas bubbler system. The orifice for the bubbler is typically located in the stream except at the Blue Earth River site below the Rapidan Dam, where the bubbler orifice is located in a USGS stilling well below the USGS building. Adjustments are made to the bubbler when readings deviate from actual stage by more than 0.05 foot. At several sites, stage measurements are also recorded as a backup on a PCMCIA flash memory card in the H350 instrument. Continuous in-stream temperature and conductivity are also recorded at most sites. Rainfall data is collected using a TE525 tipping bucket rain gage at all sites. Sigma 900 autosamplers are used to collect storm runoff samples on an Equal Flow Increment (EFI) basis.

At the Judson and St. Peter sites on the Minnesota River, and at the Blue Earth River site below the Rapidan Dam, in-stream pumps are used to transfer water from the river to the monitoring shelter because of the large lift between the river and the shelters. The water is pumped into a reservoir in the shelter and the autosamplers sample from the reservoir (see photo below). The in-stream pump is activated by the datalogger several minutes ahead of the actual sample collection, allowing the system to effectively purge prior to sample collection. Sample tubing connecting the shelter to the stream consists of both polypropylene and Teflon lined polypropylene. All sites are equipped with heat tape to keep sample lines from freezing during cold weather.



The Minnesota River at Judson station. This is a site that houses both MCEs and MDA equipment. Located in the corner of the shelter is the reservoir. Each sampler is programmed to take a pulse of water from this reservoir, based on specific flow intervals during storm events.

Mercury Monitoring

Sampling and analysis of total mercury (THg) continued at all six monitoring sites during the period July 1, 1999 through June 30, 2001 period. This monitoring, conducted by the Research and Development Section of MCES, is an extension of previous MCES mercury monitoring of the Minnesota, Mississippi, and St. Croix Rivers in the Twin Cities Metropolitan Area. Steve Balogh is directing the mercury monitoring component of the program, with support from Yabing Huang. Grab samples were collected weekly during 2000 and 2001 when waterways were open and ice free. Total mercury sampling and analysis was sharply reduced in 1999 due to a lack of adequate staffing. In addition to monitoring THg concentrations, a substantial effort was directed at characterizing methyl mercury (MeHg) concentrations in the target streams in 2000 and 2001. The collected data constitute the most comprehensive MeHg data sets yet produced for streams in Minnesota. The total number of THg and MeHg samples collected at each site for the two-year period is shown in Table 4.

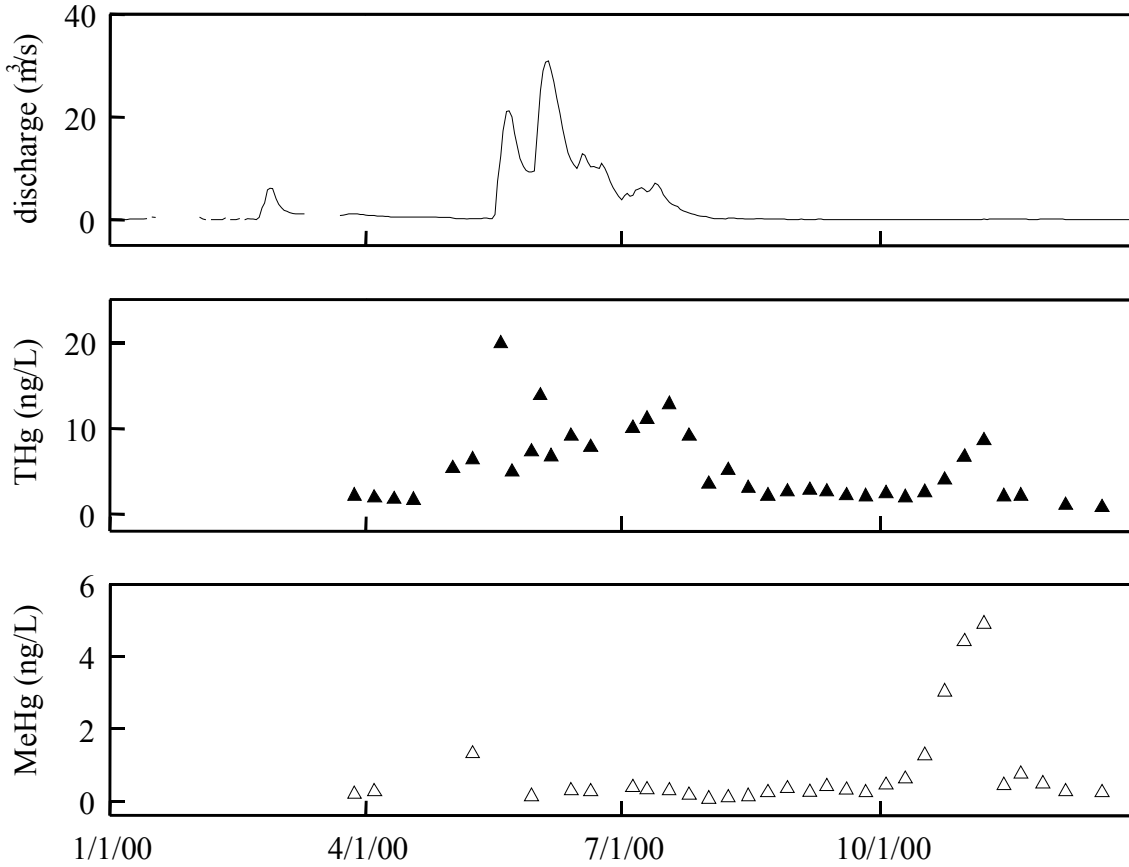
Over the reporting period, THg concentrations at all sites continued to respond to climatic influences, with precipitation and snowmelt runoff events producing increased in-stream THg loads. Total Hg concentrations showed strong positive correlation with total suspended solids (TSS) concentrations at the Minnesota River, Blue Earth River, Le Sueur River, and Cobb River Tributary sites throughout the reporting period. Total Hg and TSS concentrations were strongly correlated in the Little Cobb River for most of the year, but transient conditions created by drought and fallen leaf litter in October 2000 resulted in a more complex relationship between THg and TSS at that time. Methyl Hg inputs from leaf litter entering the Little Cobb River and mercury methylation under anoxic, low-flow conditions resulted in highly elevated MeHg concentrations in October 2000 (see Figure 4).

In the streams and rivers under study, the slope of the line describing the correlation of THg and TSS concentrations generally represents the concentration of THg per unit mass of TSS. Data for the period 1998 through June 2001 show an increasing slope of this plot each year at every site, suggesting that the concentration of THg per unit mass of TSS is increasing from year to year. In the Minnesota River at St. Peter, for example, this parameter has increased from 41.2 ng/g in 1998, to 52.3 ng/g in 2000, to 53.7 ng/g in the first half of 2001. These observations suggest that THg monitoring in these streams should continue in order to verify whether this is a short-term variation or a long-term phenomenon, and to determine causative factors. For this purpose, we expect to collect and analyze 15-20 THg samples per year at each site in 2002 and 2003, subject to available funding.

Table 4. Number of Mercury Samples Collected and Analyzed, July 1999-June 2001

Monitoring Site	River mile	Total Hg	Methyl Hg
Minnesota River at St. Peter	MI 89.7	54	36
Minnesota River at Judson	MI 120	54	36
Blue Earth R. near Rapidan	BU 12	54	36
Le Sueur River in Blue Earth County	LE 1.3	54	36
Little Cobb R. near Beauford (Hwy 16)	LC 1.6	54	36
Cobb River Tributary near Beauford (Hwy 22)	BD 0.6	54	36

Figure 4. Little Cobb River's Average Daily Flow, Total Hg Concentrations, and MeHg Concentrations for 2000.



PCB Monitoring

Polychlorinated biphenyl (PCB) monitoring efforts have continued in the Middle and Lower Minnesota River, Blue Earth River and Le Sueur River Watersheds throughout 1999, 2000 and 2001. A routine analytical method has been developed for the congener specific analysis of both dissolved and particulate phases of PCBs. A brief description of the analytical scheme can be found in the 1998-99 Biennial Progress Report, although some modifications have subsequently been made. A more complete documentation of field protocols and laboratory procedures will be available in a MCES report by the end of 2001.

In September 1999, MCES hired Angella Craft-Reardon to work in the Research and Development Section of MCES, with a specific focus of providing additional PCB monitoring and analytical support for Tom Franz, who is directing the PCB monitoring component of the program. Since that time, the number of PCB grab samples collected in 2000 (103) and 2001 (70 to date) has increased dramatically over that collected in 1999 (31). Approximately 60% of all samples were collected during the spring

season, when stream flow conditions are most variable due to snowmelt and rain events which create near-saturated soil conditions.

Additional PCB samples beyond the official scope of this monitoring effort were collected during the spring of 2001 because of this winter's extensive regional snow cover and record flooding. Three snow cores were taken at the Little Cobb, Le Sueur and Judson sites; and two from Fort Snelling and a residential St. Paul location. These samples were used to estimate the snow pack burden of PCBs in both rural and urban areas of the Minnesota River watershed. It is felt that this suite of samples will help to characterize the regional interaction between winter atmospheric deposition, as revealed in the snowpack, and river loadings during spring snowmelt. A number of water samples were also collected from Nine Mile Creek in Bloomington, Valley Creek in Afton, and the Mississippi River near downtown St. Paul. These supplementary samples were taken to estimate river loadings from urban non-point sources and to characterize the relative impact of the Minnesota River on Mississippi River PCB burdens under record flood conditions.

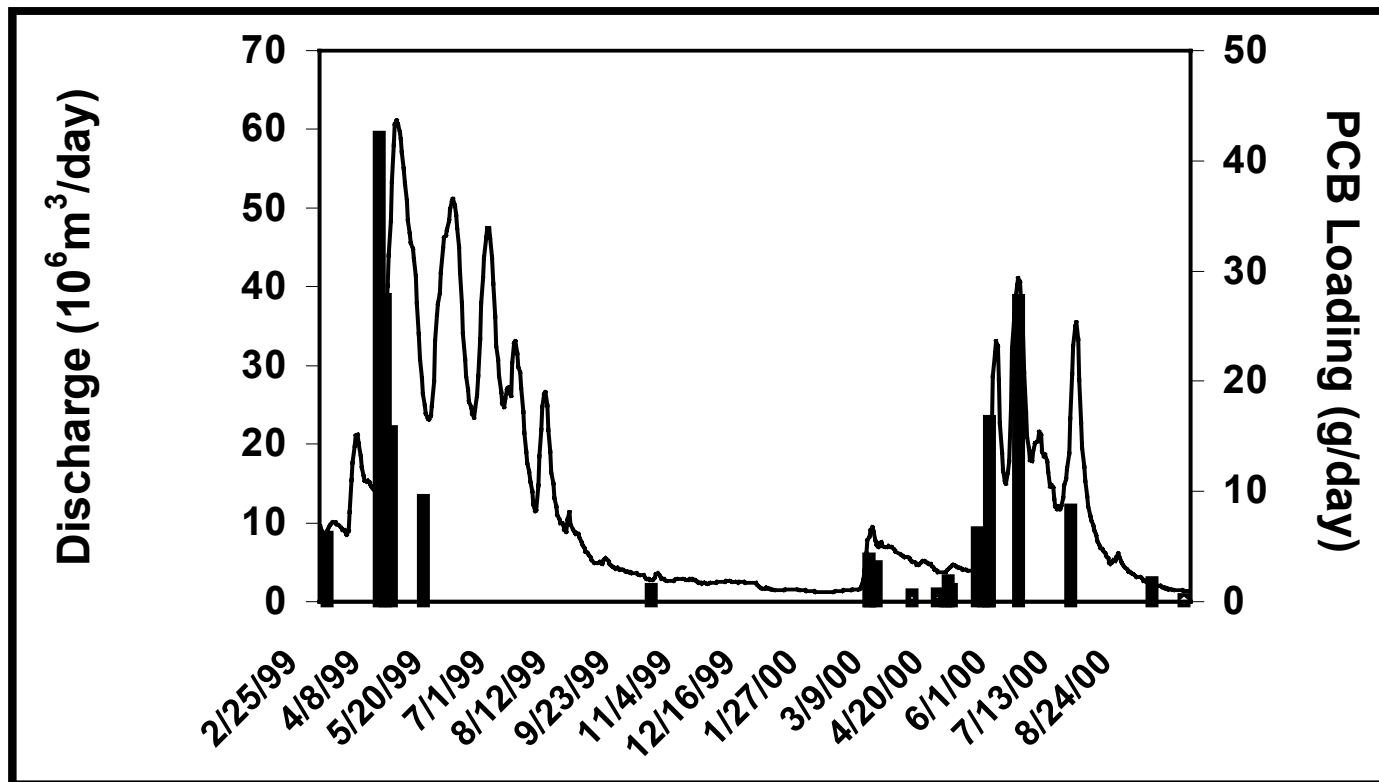
Table 5 summarizes 1999-2000 PCB data for each monitoring site. Generally, PCB concentrations are <2 ng/L at all locations, although higher concentrations are occasionally observed. The particulate fraction is highly variable accounting for $\sim 60 \pm 30$ % of total PCBs. No spatial variability is evident from the table. However, a more rigorous temporal evaluation may indicate differences in PCB loads and transport within the Minnesota River watershed. For example, Figure 5 illustrates the relationship between daily PCB loads in the Minnesota River at Jordan and river discharge. Loadings at this site result from point and non-point source inputs from the agricultural region of the watershed prior to entering the Minneapolis-St. Paul Metropolitan Area. As shown, total PCB loads at Jordan ranged from ~ 0.3 to 40 g/day during 1999-2000. High loads are especially evident on the leading edge of the annual spring hydrograph as snowmelt and spring rains cause both sediment re-suspension and surface runoff of atmospherically deposited PCBs. A thorough evaluation and interpretation of the 1998-2000 data will be available in a MCES report by December, 2001.

The strategy for the remainder of 2001 is to collect approximately 5 more sets of samples under ambient flow conditions from eight sites (Beauford Ditch, the Little Cobb, Le Sueur, and Blue Earth Rivers; and the Minnesota River at Judson, St. Peter, Jordan, and Ft. Snelling). Thus, approximately 100 samples will be collected in 2001, corresponding to a total of 200 particulate and dissolved fractions, plus requisite quality assurance/quality control monitors. Unfortunately, PCB monitoring will end with the 2001 water year due to a lack of funds for staff (Tom Franz, Angella Craft-Reardon). However, analysis and interpretation of the 2001 samples will continue into 2002. Additional efforts will include the writing of MCES reports documenting the PCB analytical method and a summary of the 1998-2000 data as mentioned above. Efforts will also be made to prepare manuscripts from these reports and from the 2001 data for peer review and publication in the scientific literature.

Table 5. 1999-2000 Concentrations of Total PCB (Dissolved + Particulate) by Site

SITE	Range (ng/L)	GeoMean (ng/L)	Median (ng/L)	Number
Beauford Ditch	0.16 - 1.2	0.44	0.43	9
Little Cobb R.	0.10 - 1.0	0.37	0.37	9
LeSueur R.	0.08 - 2.4	0.42	0.43	11
Blue Earth R.	0.11 - 4.5	0.55	0.44	4
Minnesota R. at Judson	0.19 - 9.8	0.65	0.53	14
Minnesota R. at St. Peter	0.19 - 16	0.57	0.52	15
Minnesota R. at Jordan	0.14 - 2.6	0.48	0.47	21
Minnesota R. at Ft. Snelling	0.09 - 2.0	0.56	0.60	23
			Total	106

Figure 5. 1999-2000 PCB Loads and Discharge of the Minnesota River near Jordan, MN



Conventional Pollutant Monitoring

The conventional pollutant monitoring component of the program has been successfully operating for the past three and one-half years (1998-2001). A unique aspect of this program is the joint partnership between the Minnesota Department of Agriculture (MDA) and Metropolitan Council Environmental Services (MCES). MCES and MDA share office space in Mankato, as well as three out of the six monitoring locations. MDA shares monitoring duties and collects samples at the Le Sueur River, Blue Earth River and Minnesota River at Judson, in order to quantify the long-term trends and impacts of normal pesticide use on surface water quality. This partnership is a functional template that illustrates the effectiveness of different government agencies working together toward a common goal, and how resources can be used in the most beneficial manner, with minimal duplication.

All six monitoring sites are fully operational. Data are logged continuously for water stage and flow, temperature, conductivity, and precipitation. Flow-composited samples are generated automatically during runoff events, and a bi-weekly grab sampling routine has been established at all sites. Grab samples characterize water quality under baseflow conditions and supplement the automated composite samples taken during runoff events. Grab sampling is conducted year round as conditions permit, while composite sampling is typically conducted during the open-water season (March – October).

The monitoring record for the six Mankato sites has grown each year, beginning in 1999. In 1999 only a partial monitoring record is available for all sites, since the flow equipment was not installed until the summer months. Due to high water conditions at the two Minnesota River sites, monitoring equipment was not installed until October 1999. The 2000 monitoring season marked the first complete year of water quality monitoring at all six sites. Table 6 reports the number of grab, composite, and replicate samples taken at each site in 2000. Table 7 reports the number of grab, composite and replicate samples taken from January 1 – June 30, 2001. As of June 30, 2001, approximately 445 grab and composite samples have been collected from the six monitoring locations since the program began in 1999.

Table 6. Grab and Composite Samples at MCES Mankato Monitoring Sites, 2000

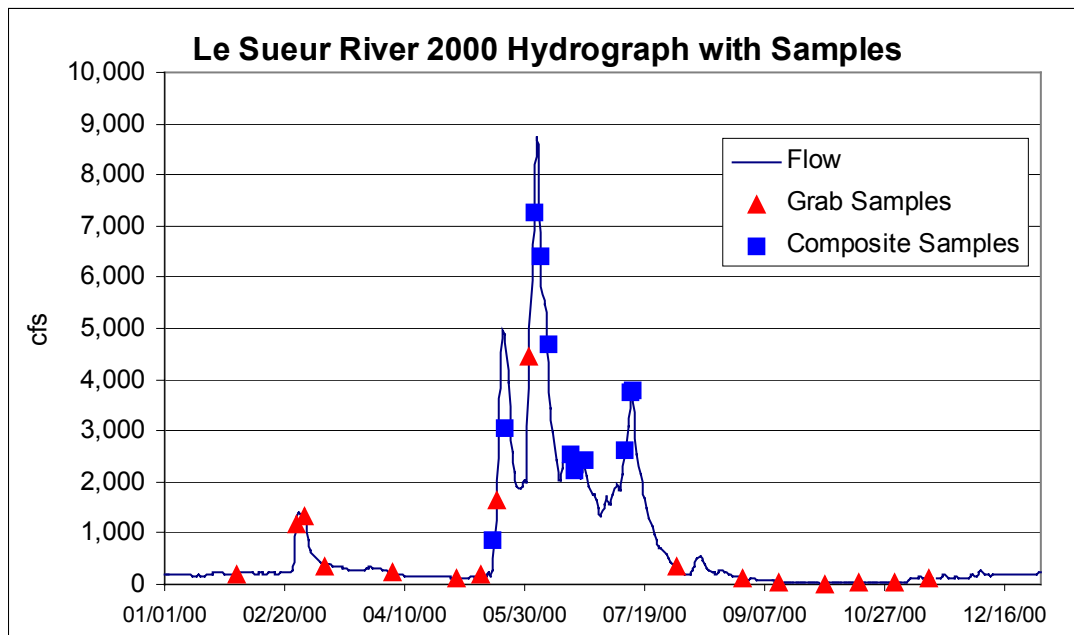
	Grab Samples	Composite Samples	Replicates
BD 0.6	15	2	
LC 1.6	14	5	
LE 2.3	17	13	1
BU 12.0	13	12	
MN 120.0	13	9	1
MN 89.7	12	9	

Table 7. Grab and Composite Samples at MCES Mankato Monitoring Sites, January 2001 – June 2001

	Grab Samples	Composite Samples	Replicates
BD 0.6	7	11	1
LC 1.6	7	17	
LE 2.3	10	18	
BU 12.0	9	17	1
MN 120.0	13	16	1
MN 89.7	12	21	1

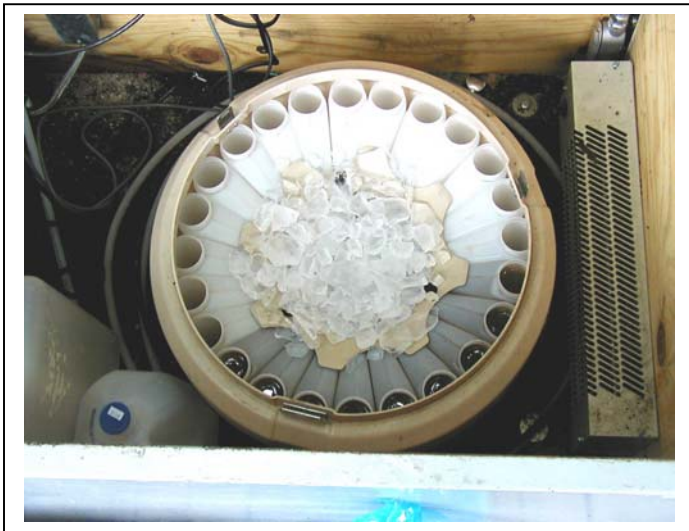
Figure 6 shows the Le Sueur River annual hydrograph for 2000. Historic precedence was set in 2000 when, for the first time since the USGS flow records were initiated in the late 1930's, the total annual flow in the Le Sueur River exceeded the total annual flow in the Blue Earth River. This figure also illustrates the typical sampling regime for all the monitoring sites, with base flow grab samples obtained during low flow conditions and composite sampling occurring during storm events. In 2001, the number of grab samples taken during storm events was increased to help characterize and strengthen the sampling record. Through June 30, 2001, 162 samples have been collected. Many samples were collected during the April through June period, due to the extremely high flow conditions that existed at most of the sites.

Figure 6. Le Sueur River 2000 Average Daily Flows with Samples





The picture on the left portrays the flow-composited sample collected during the snowmelt and runoff event in April 2001 at the Le Sueur River station. The picture on the right shows the Le Sueur River flowing at its peak this spring, during the time period when this sample was collected.



This is a typical sight during a storm event at Beauford Ditch. These samples are being iced to prolong sample longevity and insure sample integrity. By doing this, one flow-composite sample can be collected for a complete storm hydrograph.

The grab and composite samples are transported by project personnel to the MCES Laboratory Services Section in St. Paul, MN. Each sample is analyzed for water transparency, total and volatile suspended solids, turbidity, alkalinity, hardness, metals, chlorides and sulfides, nitrogen, phosphorus, chlorophyll-a, total organic carbon (TOC), chemical oxygen demand (COD), and biochemical oxygen demand (BOD). Table 8 shows the numbers of chemical analyses that have been conducted on water samples from the six monitoring sites, during the 2000 – 2001 biennium period.

Table 8. Number of Analyses for the Mankato Sites, 2000-2001 Biennium

	Beauford Ditch	Blue Earth River	Le Sueur River	Little Cobb River	Minnesota River at Judson	Minnesota River at St. Peter	Total Analyses
Total Submissions	58	79	84	68	77	79	
Alkalinity	47	67	76	61	69	75	395
5-day CBOD	3	3	3	3	3	3	18
5-day BOD	47	60	65	55	65	61	353
Total Chlorophyll a	43	50	48	45	52	50	288
Chloride	49	62	71	59	66	71	378
COD	47	70	72	60	72	73	394
Hardness	50	62	69	58	67	67	373
Copper	32	36	40	35	35	37	215
Nickel	32	36	40	35	35	37	215
Lead	32	36	40	35	35	37	215
Zinc	32	36	40	35	35	37	215
Cadmium	32	36	40	35	35	37	215
Chromium	32	36	40	35	35	37	215
Total Organic Carbon	43	65	69	57	65	66	365
Sulfide	43	62	68	56	62	68	359
Ammonia NH3	55	76	80	67	76	75	429
Nitrite N	51	79	82	68	77	78	435
Nitrate N	51	79	82	68	77	78	435
Dissolved Kjeldahl N	4	8	10	8	10	13	53
TKN	53	78	83	67	77	77	435
Total Phosphorus	54	78	83	67	77	77	436
Dissolved Phosphorus	48	77	79	66	76	76	422
Dissolved OTP	46	61	64	55	64	62	352
Suspended Solids	50	76	81	65	74	76	422
Volatile Solids	50	76	81	65	74	76	422
Turbidity	50	76	79	66	74	78	423
Total Analyses	1076	1481	1585	1326	1487	1522	8477

Rating Curve Development

To insure the ongoing collection of good stream flow information, rating curves have been developed for all sites during the past two years, and are continually being refined. Some of the rating curves are based upon historical USGS data or other historical data, such as measurements made by the National Weather Service. Rating curves have also been developed based upon field stage measurements and interpolated flow measurements.

Flow measurements are obtained by a variety of methods. In 1999, the flow and stage at the two Minnesota River sites (Judson and St. Peter) were measured with an Acoustic Doppler Current Profiler (ADCP), which gives a complete picture of the channel geometry and flow velocity across a transect. In 2000, when the streams were wadeable, a USGS price meter with the Aqua Calc 5000 was used to calculate the discharge. Because important high flow measurements were being missed, a USGS bridge board with accompanying sounding reel was acquired in 2001. This allowed MCES and MDA field personnel to take measurements during higher flow conditions.

During the spring of 2001, historic stage levels were recorded at the Minnesota River sites. Due to this extreme high flow event, accurate flow measurements were infeasible to collect because of safety reasons. After the flood stage peaked, and began to subside, the ADCP was utilized again to measure flow. Manual flow measurements will continue to be made as time and resources permit. Special emphasis will be placed upon collecting high flow measurements, which are needed at all sites to help better refine rating curves.

Initial Results: Conventional Pollutant Monitoring

Loading estimates for four MCES monitoring sites in 2000 were computed and can be found in Table 9. Beauford Ditch and Little Cobb River had incomplete monitoring records, and loading estimates could not be generated. For the sake of comparison, MDA manual loading estimates are included in Table 9. FLUX software was used by MCES to calculate loads of various chemical parameters, including total suspended solids, nitrate-nitrogen, total phosphorus, and ortho-phosphorus. FLUX is an interactive program that allows a user to estimate loads and flow-weighted mean concentrations by combining grab sample concentration data and continuous flow records over the sampling period.

Because FLUX is designed to utilize daily flow averages coupled with grab sample chemistry data, flow composited samples that were collected over a period of greater than one day required slight adjustments when the FLUX input files were prepared. This adjustment consisted of selecting a day to represent the sample (generally the last full day of the composite) and calculating an instantaneous flow. Instantaneous sample flows were derived by dividing the total flow volume in cubic feet for the composite by the total number of seconds elapsed during the composite collection period to give an average composite flow in cubic feet per second (cfs). A potential complication of this methodology is that the concentration range from low to high is theoretically smaller with composite samples than with grab samples. As such, automated composite samples, while better at characterizing total flow concentrations, do not represent either the maximum or minimum concentration at one point in time on an event hydrograph.

Table 9. 2000 Annual and Growing Season Loads in Tons at 4 MCES Monitoring Sites

Watershed	Source	Method	Period	TSS	NO3-N	Total P	Ortho P
MN @ Judson	MCES	Flux	Grow Season	130,597	3,636	239	44
MN @ Judson	MDA	Manual	Grow Season	NA	2,663	215	36
MN @ Judson	MCES	Flux	Annual	161,340	4,181	359	120
MN @ Judson	MDA	Manual	Annual	NA	3,499	323	85
Le Sueur	MCES	Flux	Grow Season	530,981	4,627	546	111
Le Sueur	MDA	Manual	Grow Season	NA	7,240	339	83
Le Sueur	MCES	Flux	Annual	548,882	6,012	608	96
Le Sueur	MDA	Manual	Annual	NA	7,705	352	88
Blue Earth	MCES	Flux	Grow Season	183,422	4,588	223	42
Blue Earth	MDA	Manual	Grow Season	NA	5,372	209	37
Blue Earth	MCES	Flux	Annual	190,405	4,517	188	51
Blue Earth	MDA	Flux	Annual	NA	5,900	187	40
Blue Earth	MDA	Manual	Annual	NA	5,562	220	42
MN @ St. Peter	MCES	Flux	Grow Season	762,712	15,470	1,112	187
MN @ St. Peter	MCES	Flux	Annual	842,969	14,949	1,348	274

NA – Not Available

The table indicates a wide range of variability between growing season and annual loading estimates. In some instances, FLUX predicts higher growing season loads than annual loads. Physically this is impossible because annual loads will always be greater than or equal to growing season loads. The variability with FLUX generated results makes it difficult to assess the growing season's percentage of the annual load. It is possible that the variability is in part related to the use of composite samples as input for FLUX, which was designed for use with grab sample data.

A much more in-depth analysis of the MCES monitoring site loading information can be found in the "State of the Minnesota River, Summary of Surface Water Quality Monitoring Report, 2000," jointly prepared by MCES, MDA, MPCA, and the Minnesota State University Water Resources Center in Mankato.

Monitoring Lessons Learned

Any time a program of this magnitude is undertaken, there will be some unforeseen problems that arise. Frequently these problems created opportunities to learn valuable lessons. Below are several important lessons that have been learned, which in the end have strengthened the program.

- **Dual sampling efforts.** In 2000, MCES and MDA personnel attempted to collect simultaneous grab samples for comparison purposes. Unfortunately this did not always occur. As a result, it is difficult to tell whether differences in monitoring results are due to river conditions, differences in monitoring and laboratory protocols, or other unknown factors. To improve on this, almost every 2001 grab sample has been taken by MCES and MDA at approximately the same time.
- **Rain gages.** Erroneous rain gage readings were evident in the May and June 2000 sampling record. At first, it was thought to be a coding error in the datalogger program. It turned out that the gages were simply clogged from leaf debris and accumulated dust particles. To solve this, rain gages are checked and cleaned every month to prevent this problem from reoccurring.
- **Equipment failure.** Equipment will invariably have glitches, and this has happened at almost every site. It is very important to have at least one back up of each data collection system. There have been problems ranging from broken check valves, jammed samplers, and stalled programs to defective equipment. It is imperative to check equipment and field test every aspect of the station before each sampling season. Case in point: at Beauford Ditch in 2001, the beginning of the snowmelt event was missed because of an error in programming. A trial run would have pointed out this problem and averted this mistake. A grab sample was taken as a back up for this system failure.



- **Check sites often for problems.** Having the capability to call the stations remotely does not decrease the likelihood for an unexpected problem to occur. There have been instances, to name a few, where beavers have felled trees close to the intake, ice has jammed up bubbler lines, and equipment has malfunctioned, all of which could have caused major error had the problems not been identified as early as they were. Because of this, sites are routinely inspected every two weeks during grab sample trips and more often during storm event sampling, with visits sometimes occurring daily during the events.
- **Rating curve development.** It has been difficult to create and maintain good rating curves for some of these sites. For example, in April 2001, during the high flow conditions on the Le Sueur River, the rating curve failed when stage exceeded the last known measurement. Because of the extremely high flow conditions, MCES was unable to safely get a flow measurement to add to the rating curve data set. Fortunately, there is a USGS gaging site one-mile upstream from this location. Because there is no additional inflow of water between these two sites, a correlation was used to obtain the necessary rating curve point. This experience showed the value of tracking each site's rating curves and measurements closely, and the value of always trying to make a manual rating curve measurement during high flow conditions, time and safety permitting.

Cooperative Monitoring Partnerships

Minnesota Department of Agriculture (MDA)

MCES has established an important monitoring partnership with the Minnesota Department of Agriculture (MDA). MCES and MDA cooperatively established a shared field office in Mankato, and the two agencies worked closely together to further develop the Le Sueur River, Blue Earth River, and the Minnesota River at Judson monitoring stations. The MDA shares these three stations for their pesticide monitoring program. Currently, MDA has a grab sampling routine similar to the MCES grab sampling routine. Composite sampling began in 2000.

United States Geological Survey (USGS)

The U.S. Geological Survey (USGS) is an invaluable source of historical stage, or water elevation, and flow information. All of the MCES monitoring stations are located at or near sites which are currently being gauged by the USGS, or which have been gauged by the USGS in the past. This USGS information is the basis for the preliminary rating curves for all six monitoring stations. At the Little Cobb River and the Blue Earth River sites, the MCES shelters are located next to the USGS shelters, where stream stage and flow are being monitored. Because of the close proximity, USGS is able to draw from the electrical power in the MCES stations to power their own equipment, eliminating the need for heavy, awkward marine batteries.

The USGS publishes its stage and flow information on the web. For the Little Cobb River site, information can be found at http://webdmnspl.cr.usgs.gov/rt-cgi/gen_stn_pg?station=05320270. For the Blue Earth River site, information can be found at http://wwwmn.cr.usgs.gov/rt-cgi/gen_stn_pg?station=05320000.

The MCES Le Sueur River monitoring site is located one mile downstream from USGS stream gaging station number 05320500. The USGS preliminary stage and real-time flow data for this USGS station are published on the USGS web page at http://www.mn.cr.usgs.gov/rt-cgi/gen_stn_pg?station=05320500. The data from the USGS station are used to help develop the rating curve for the MCES Le Sueur River monitoring station.

Minnesota Pollution Control Agency (MPCA)

MCES is supporting a monitoring study currently being conducted by Laurie Sovell from the MPCA office in Mankato. The study is determining the effectiveness of a new piece of monitoring equipment, the transparency tube. The tube is being used by volunteer citizen monitoring groups to assess water clarity. The MPCA is trying to establish a relationship between the tube, which measures water clarity in centimeters, to turbidity and total suspended solids concentrations measured in the lab. MCES has incorporated transparency tube measurements into the sampling routine, and will contribute all relevant data to the MPCA study.

Local Cooperators

MCES has established important monitoring partnerships with many local cooperators in the Mankato area. Among these are staff from the local MDNR, MPCA, and MNDOT offices, staff from the Blue Earth County Roads and Parks Departments, Blue Earth and Nicollet County water planners, and several private citizens. MCES has also formed a key partnership with the Water Resources Center at Minnesota State University in Mankato.

Data Management, Analysis and Reporting

All of the flow and water quality data collected by the dataloggers have been summarized in an Excel database, and have been made accessible to the MPCA and other water resource professionals. The Excel database for each site is organized into monthly worksheets. Data are reported as 15-minute average values for stage, flow, temperature, and conductivity, and as 15-minute total values for precipitation. In addition, a special line of data is written each time the autosampler collects a water sample. This detailed information is summarized into daily, monthly, and annual averages.

All of the analytical chemistry results from the MCES lab are currently stored in a MCES Oracle database. This information will also be summarized in an Excel spreadsheet and made accessible to the MPCA and other water resource professionals. Annual load estimates have been calculated for 2000 by the use of the program FLUX. Loading estimates thus far have been calculated only for the calendar year 2000, with plans to calculate for each subsequent year.

Two monitoring reports, including the results of all MCES monitoring conducted during the July – December 1999 and January – December 2000 periods, have already been provided to the MPCA. A third monitoring report, including the results of all MCES monitoring conducted during the January – June 2001 period, will be provided to the MPCA by September 30, 2001

A further analysis of MCES monitoring information, along with information from other agency monitoring sites in the Minnesota River Basin, can be found in the “State of the Minnesota River, Summary of Surface Water Quality Monitoring Report, 2000.” This report was prepared jointly by MCES, MDA, MPCA, and the Minnesota State University Water Resources Center in Mankato.

Contact Information for the Mercury and PCB Inputs to the Minnesota River Monitoring Program

Questions or comments about this report or the Mercury and PCB Inputs to the Minnesota River Monitoring Program may be directed to:

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Environmental Monitoring and Assessment
Metropolitan Council Environmental Services
209 South Second Street, Suite 203
Mankato, MN 56001
Phone: 507-344-0145
E-mail: heather.offerman@metc.state.mn.us
Mces@mctcnet.net

Kent Johnson
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Budget

Combined Programs - Costs for the 2000 – 2001 Biennium

Cost accounting for both the “Metropolitan Area Watershed Outlet Monitoring Program (WOMP)” and the “Mercury and PCB Inputs to the Minnesota River Monitoring Program” has been continuously tracked by MCES program staff and the Metropolitan Council’s internal accounting department. The \$600,000 grant from the MPCA for the 2000 – 2001 biennium is being disbursed to MCES in three installments, as specified by the Joint Powers Agreement. The first two installments of \$270,000 each were received by MCES in December 2000 and February 2001. The remaining \$60,000 is being withheld by the MPCA until MCES submits this 2000-2001 biennial progress report in August 2001. As indicated in the work plans accompanying the grant agreement, the estimated budget for the Metropolitan Area Watershed Outlet Monitoring Program during the 2000-2001 biennium was \$355,000, while the estimated budget for the Mercury and PCB Inputs to the Minnesota River Monitoring Program was \$245,000. The expenditures in Table 10 below reflect the actual costs for both programs during the period from July 1, 1999 through June 30, 2001.

Table 10. Program Expenditures from July 1, 1999 through June 30, 2001

Program	WOMP \$355,000	Hg/PCB \$245,000	Total \$600,000
MCES Staff Labor	87,764.45	115,084.40	202,848.85
Staff Fringe Costs	39,510.04	45,400.46	84,910.50
Contracted Services	67,668.79	350.00	68,018.79
New Monitoring Stations	14,134.44	0	14,134.44
Materials and Supplies	7,772.01	17,009.35	24,781.36
Monitoring Utilities	12,150.46	5,646.61	17,797.07
Office Expenses	33.00	7,750.85	7,783.85
Laboratory Expenses	36,281.12	47,058.80	83,339.92
Travel Expenses	935.91	468.66	1,404.57
Fuel and Vehicle Expense	194.70	160.42	355.12
Professional Development	970.00	1,075.00	2,045.00
TOTAL	267,414.92	240,004.55	507,419.47
Surplus			92,580.53

The accounting figures in Table 10 indicate that as of June 30, 2001 a surplus existed in the approximate amount of \$92,580.53. These figures, although based upon information provided by the Metropolitan Council's accounting department, should be regarded as preliminary. The majority of the surplus amount will be used for continuation of mercury and PCB monitoring work through the end of 2001, in support of the "Mercury and PCB Inputs to the Minnesota River Program."

For more detailed accounting information on these two programs, please contact Mary Elverum (651-602-1084) in the Metropolitan Council's accounting department.

Public Education Efforts

MCES personnel continue public education efforts in support of both monitoring programs and the Interagency Water Monitoring Initiative. Leigh Harrod gave a presentation about WOMP stations at the Minnesota Ground Water Association Spring Conference. Heather Offerman worked with the MDA, MPCA, Minnesota State University Water Resources Center and other local partners to prepare a "State of the Minnesota River 2000" report, which will help identify strengths and weaknesses in the Minnesota River Basin surface water quality monitoring efforts, and begin to build partnerships. She also continues to meet with local water planners to talk about the MCES monitoring program in Mankato, and to offer information to suit their specific county needs. In March 2001, Offerman also presented "Chemical Water Quality: Thoughts from the Field," a power point discussion, at the Minnesota River Basin Water Quality and Watershed Technical Workshop in Redwood Falls, MN. MCES personnel are scheduled to give a presentation in October 2001 at the national annual meeting of the American Institute of Hydrology. The title of the presentation is "*Enlisting Local Governments: A Model for a Regional Stream and River Monitoring Network.*"

Goals for the 2002 – 2003 Biennium

The first biennium (1998-1999) of the Interagency Water Monitoring Initiative focused on implementation of the two MCES water monitoring programs. Monitoring stations were built, personnel were hired, and contracts with cooperators were established. The monitoring was in a start-up phase.

The second biennium (2000-2001), as described throughout this report, reflects the emphasis placed upon coordination and operation of what is now a sizeable monitoring network.

In June 2001, the Minnesota Legislature appropriated an additional \$600,000 to the Metropolitan Council (via the MPCA), for continuation of the "Metropolitan Area Watershed Outlet Monitoring Program" and the "Mercury and PCB Inputs to the Minnesota River Monitoring Program" during the 2002-2003 biennium. MCES staff have prepared program work plans and budgets for the 2002-2003 biennium. MCES and MPCA staff have initiated the process for establishing a grant agreement for the 2002-2003 funding.

During the third biennium, program managers and participants have the benefit of being fully operational, as well as the advantage of experience. New tools and activities for the MCES monitoring programs are scheduled for the current biennium. These enhancements reach beyond the standard monitoring tasks outlined in the MCES program work plans. Implementation of these goals in the third biennium will not only enhance the monitoring effort, but will also increase public awareness of the program's uniqueness and importance of these programs for characterizing the quality of Minnesota's water environment.

Monitoring Enhancements

Some of the monitoring enhancements anticipated during the 2002-2003 biennium include:

- Surveying the elevation reference points at all stations so that stages can be converted to mean sea level.
- Enlisting the Metro Area Volunteer Stream Monitoring Partnership program to collect macroinvertebrate data in WOMP and Mankato area watersheds, thereby providing valuable biological data to complement physical and chemical data.
- Implementing the use of hand-held PDAs⁴ for collection and automation of field notes.
- Implementing continuous oxygen monitoring at two sites (Crow River and Bassett Creek).
- Increasing the use of transparency-tubes and Hach kits in the field.
- Training the WOMP cooperators in the use of FLUX, and developing protocols for calculation of pollutant loads.
- Assessing and interpreting the data from both programs to characterize water quality conditions and impacts.
- Providing recommendations, where appropriate, for watershed best management practices that will protect and improve water quality.

Public Education Efforts

Some of the public education efforts anticipated during the 2002-2003 biennium include:

- Creating and maintaining web pages about the two MCES monitoring programs on the Metropolitan Council's internet web site.⁵
- Increasing the frequency of group meetings of the WOMP cooperators.

⁴ PDA = Personal Digital Assistants, commonly known as Palm Pilots. Because field notes currently are hand-written on paper, it is both labor intensive and difficult to transcribe field comments into a data base so they can be viewed electronically when the data are displayed or manipulated. PDAs will automate the process of writing field notes in a digital format common to all monitoring stations in the MCES and IWMI network.

⁵ A page describing the Mankato area monitoring network is already established on the MCES intranet.

- Publishing a semiannual newsletter and distributing it to local partners and other interested parties.
- Conducting field day education activities.
- Continuing and expanding partnerships with local groups and agencies.
- Promoting the use of data to outside agencies, participating in external hydrologic and watershed studies, and assuring easy access to the data through the MCES EIMS.

Recommendations for Continued Monitoring

The funding provided to MCES since 1998 by the Minnesota Legislature, as a part of the Interagency Water Monitoring Initiative, has been valuable for filling stream monitoring gaps in the Metropolitan Area, and for establishing an important monitoring presence in the Minnesota River Basin. The expanded monitoring work has provided insightful information on the condition of Minnesota waters, as well as current land use impacts on water quality. Since these land use impacts are largely a reflection of non-point sources of pollution that are heavily influenced by precipitation and runoff, long-term monitoring is critical for characterizing water quality conditions that occur as a result of considerable climatological variation from year to year. Long-term monitoring also provides crucial information for determining if changes in land use with application of best management practices are indeed achieving protection and improvement of water quality conditions, as desired.

A continuation of the “Metropolitan Area Watershed Outlet Monitoring Program” during the 2002-2003 biennium and beyond will help support the Metropolitan Council’s legislative mandate to develop management objectives and target pollution loads for watersheds in the Metropolitan Area. Long-term water quality monitoring information is needed for assessing current watershed and water quality conditions, developing target pollutant loads, and measuring progress toward achievement of target loads, as best management practices (BMPs) are implemented in these watersheds.

A continuation of the “Mercury and PCB Inputs to the Minnesota River Monitoring Program” during the 2002-2003 biennium and beyond will help achieve “fishable and swimmable conditions” in the Minnesota River, as mandated by the Federal Clean Water Act and Minnesota State Rules. Fish consumption advisories based on mercury and PCB (polychlorinated biphenyl) currently exist for the Minnesota River throughout the Metropolitan Area, as well as in outstate areas. Violations of water quality standards for turbidity and bacteria are also evident in the Minnesota River. Long-term water quality monitoring information is needed for assessing current watershed and water quality conditions, and measuring progress toward achievement of “fishable and swimmable conditions” in the Minnesota River, as best management practices (BMPs) are implemented in watersheds throughout the Minnesota River Basin.

MCES staff are currently analyzing and assessing the mercury and PCB data obtained for the Minnesota River during the 1998-2001 period. When this assessment is complete in late 2001 or early 2002, information will be available on the sources contributing to mercury and PCB contamination in the Minnesota River. Based on this information, recommendations can be made regarding best management practices that may help reduce mercury and PCB loads in the river. With intensive monitoring for mercury and PCB source identification nearing completion, and given the cost of mercury and PCB analytical work, it is likely that the mercury and PCB monitoring component of the program will be scaled back in 2002. However, the conventional pollutant monitoring component of the program is expected to continue as in the past, since annual loading information is needed for establishing target loads (TMDLs), and for measuring progress toward achievement of these target loads, as best management practices (BMPs) are implemented in Minnesota River watersheds.

MCES appreciates the support of the Minnesota Legislature and the Minnesota Pollution Control Agency for implementation and on-going maintenance of these important monitoring programs. An additional significant benefit of these monitoring programs are the partnerships that have been established with local, state, and federal governmental agencies and the public, as a collaborative effort is needed to protect and improve Minnesota's waters.

For more information about the MCES water monitoring network in the Metropolitan Area, or the two MCES programs that comprise a portion of the Interagency Water Monitoring Initiative, contact:

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Appendix A

MCES Watershed Outlet Monitoring Program Sites and Cooperators
(1999 – 2001)

MCES Watershed Outlet Monitoring Program Sites and Cooperators (1999 – 2001)

Grant funding provided to MCES by the Minnesota Legislature, via the MPCA, as a part of the “Interagency Water Monitoring Initiative”

Monitoring Sites and Cooperators, 1999-2001

Bassett Creek, Bassett Creek Watershed District

Cannon River, Dakota County SWCD

Cottage Grove Ravine, South Washington Watershed District*

Crow River, Wright County SWCD

Eagle Creek, City of Savage

Minnehaha Creek, Minneapolis Park and Recreation Board

Riley Creek, Riley-Purgatory Watershed District

Valley Creek, St. Croix Watershed Research Station, Science Museum of Minnesota

Willow Creek, Black Dog Watershed Management Commission

* approved and scheduled for construction, fall 2001

Addresses and Contact Information

Bassett Creek

Site Location: Bassett Creek at 100 Irving Ave N., Minneapolis, MN
Cooperator: Bassett Creek Watershed Management Organization
Field Services: MCES Environmental Services, Water Quality Section
Contact: Len Kramer, Barr Engineering
ph: 952-832-2781
Leigh Harrod, MCES
Ph: 651-602-8085
Leigh.harrod@metc.state.mn.us

Cannon River

Site Location: Housed inside the USGS gaging station in Welch, MN
Cooperator: Dakota SWCD
Field Services: Laura Jester, Dakota SWCD
Matt Jacobson, Goodhue SWCD
Contact: Laura Jester, Dakota SWCD
4100 220th St W #102, Farmington, MN 55024-8087
ph: 651-480-7784 fax: 651-480-7775
lora.jester@co.dakota.mn.us

Cottage Grove Ravine

Site Location: Public Wetland #82-0086-W, 100 St. South, Cottage Grove, MN.
Cooperator: South Washington Watershed District
Field Services: Washington County SWCD
Mark Doneaux, Washington County SWCD
Contact: Matthew Moore, Administrator, S. Washington Watershed District
8301 Valley Creek Road, Woodbury, MN
ph: 651-714-3729
Mmoore@ci.woodbury.mn.us

Crow River

Site Location: Hwy. 55 bridge at Rockford, MN
Cooperator: Wright County SWCD
Field Services: Brad Wozney, Wright County SWCD;
Greg Mitten, USGS, for rating curve
Contact: Kerry Saxton, Wright SWCD
ph: 763-682-1933 fax: 763-682-1970
bjw@mnbuffalo.fsc.usda.gov

Eagle Creek

Site Location: Eagle Creek @ Hwy. 101, Savage, MN
Cooperator: City of Savage
Field Services: Tina Carstens, City of Savage
Contact: Greg Kruse, MN DNR - rating curve
Tina Carstens, Jeff Sandberg; City of Savage
ph: 952-882-2686
TWarner@ci.savage.mn.us

Minnehaha Creek

Site Location: 32nd Ave and Minnehaha Creek, Minneapolis, MN
Cooperator: Minneapolis Park and Recreation Board
Field Services: Mike Perneil, Minneapolis Park and Recreation Board
Contact: Jeff Lee
Minneapolis Park and Recreation Board
ph: 370-4900 fax: 370-4831
jeffrey.t.lee@ci.minneapolis.mn.us

Riley Creek

Site Location: Riley Creek @ Hwy 212 in Eden Prairie
15995 Flying Cloud Drive
Cooperator: Barr Engineering, on behalf of Riley Creek Watershed District
Field Services: Chris Bonick, Barr Engineering
Contact: Hal Runke, Barr Engineering
ph: 832-2804 fax: 832-2601
hrunke@barr.com

Valley Creek

Site Location: Valley Creek at Putnam Rd, Afton, MN
Cooperator: St. Croix Watershed Research Station, Science Museum of
Minnesota; Valley Branch Watershed District
Field Services: Jim Almendinger, St. Croix Watershed Research Station
Contact: Jim Almendinger
ph: 433-5953, ext.19 fax: 433-5924
dinger@sci.mus.mn.us

Willow Creek

Site Location: Cub Foods parking lot at 2900 W. Hwy 13, Burnsville, MN
Cooperator: Black Dog Watershed Management Committee
Field Services: Barr Engineering
Contact: Mike Hudec, Hal Runke, Barr Engineering
ph: 832-2760 fax: 832-2601
cbonickc@barr.com

Appendix B

Location Coordinates for all MCES Automonitoring Stations

LOCATION COORDINATES FOR ALL MCES MONITORING STATIONS

HYDROLOGIC STREAM NAME	STREAM MILE	Topo sheet	MONITOR START	UTM-ZONE15 NORTH	UTM-ZONE15 EAST	COORD SOURCE
Existing MCES Monitoring Network						
WOMP 1 (300-399)						
VERMILLION RIVER	2.0	HASTINGS	1995	4952424.78	511864.58	trimble
SHINGLE CREEK	0.1	MINNEAPOLIS N.	1995	4987097.18	476864.45	GPS
RICE CREEK	3.7	NEW BRIGHTON	1995	4993377.68	480693.96	GPS
COON CREEK	1.9	COON RAPIDS	1995	4999689.80	476641.50	GPS
FISH CREEK	0.2	ST PAUL EAST	1995	4971586.36	499419.46	GPS
BATTLE CREEK	0.1	ST PAUL EAST	1995	4975987.00	497426.00	GPS
CARNELIAN-MARINE OUTLET	3.0	MARINE ON ST CROIX	1995-'98	4996183.92	516380.15	trimble
SILVER CREEK	0.7	STILLWATER	1998	4992297.55	514733.82	trimble
ELM CREEK	4.9	ANOKA	1995	5000970.90	465692.98	GIS ORTHO
PIONEER CREEK	10.6	ROCKFORD	1995	4983377.13	442692.91	GIS ORTHO
SARAH CREEK	1.8	ROCKFORD	1995	4991505.92	443544.73	GIS ORTHO
BELTLINE INTERCEPTOR	0.5	ST PAUL EAST	1995	4977134.66	496766.21	GPS
SPRINGBROOK	0.5	MINNEAPOLIS N.	1995	4996250.52	478160.82	GPS
LOWER RUM RIVER	0.5	ANOKA	1996	5004707.36	469159.35	GIS ORTHO
BROWNS CREEK	0.3	STILLWATER	1997	4991374.27	515023.98	GPS
WOMP 2 (100-199)						
VALLEY CREEK	1.0	HUDSON	1998	4973627.13	516894.73	trimble
MINNEHAHA CREEK	1.7	ST PAUL WEST	1998	4973800.64	482209.70	trimble
CROW RIVER	23.1	ROCKFORD	1998	4992848.44	442148.66	trimble
CANNON RIVER	11.9	WELCH	1999	4934596.45	521286.20	trimble
EAGLE CREEK	0.8	EDEN PRAIRIE	1999	4958073.03	496484.75	trimble
WILLOW CREEK	1.0	BLOOMINGTON	1999	4958291.02	475069.85	trimble
RILEY CREEK	1.3	EDEN PRAIRIE	1999	4962606.62	462058.41	GIS ORTHO
Existing MCES Monitoring Network						
NONPOINT (0 - 99)						
RILEY CREEK	1.3	EDEN PRAIRIE	1989	4962761.40	462030.81	trimble
LOWER BEVENS CREEK	2.0	JORDAN WEST	1989	4951134.75	445975.67	trimble
UPPER BEVINS CREEK	5.0	JORDAN WEST	1992	4953706.98	443954.51	trimble
BLUFF CREEK	3.5	SHAKOPEE	1989	4962181.92	457297.41	trimble
CARVER CREEK	1.7	VICTORIA	1989	4955415.85	448533.58	trimble
CREDIT RIVER	0.6	BLOOMINGTON	1988	4958447.65	472830.82	trimble
NINE MILE CREEK	1.8	BLOOMINGTON	1988	4961680.87	476185.24	trimble
SAND CREEK	1.6	JORDAN WEST	1988	4946330.32	449682.39	trimble
MINNESOTA RIVER at JORDAN	39.4	JORDAN WEST	1988	4949030.18	449114.55	trimble
MINNESOTA RIVER (200-299)						
LITTLE BEAUFORD DITCH	0.6	BEAUFORD	1999	4874284.07	423185.52	trimble
LITTLE COBB RIVER	1.6	BEAUFORD	1999	4871866.79	427114.98	trimble
LE SUEUR RIVER	2.3	GOOD THUNDER	1999	4885518.31	415940.56	trimble
BLUE EARTH RIVER	12.0	GOOD THUNDER	1999	4883146.90	411168.25	trimble
MINNESOTA RIVER at JUDSON	120.0	JUDSON	1999	4894885.00	404611.61	trimble
MINNESOTA RIVER at ST PETER	89.7	ST PETER	1999	4908399.82	423950.97	trimble

Code for COORD SOURCE field:
 "trimble: = read directly from instrument
 "GIS ORTHO" = coordinates read from DOQ
 "GPS" = coordinates captured by GPS and corrected

