Minnesota

Whitewater River Watershed
Section 319
National Monitoring Program Project

Figure 23: Whitewater River (Minnesota) Watershed Project Location

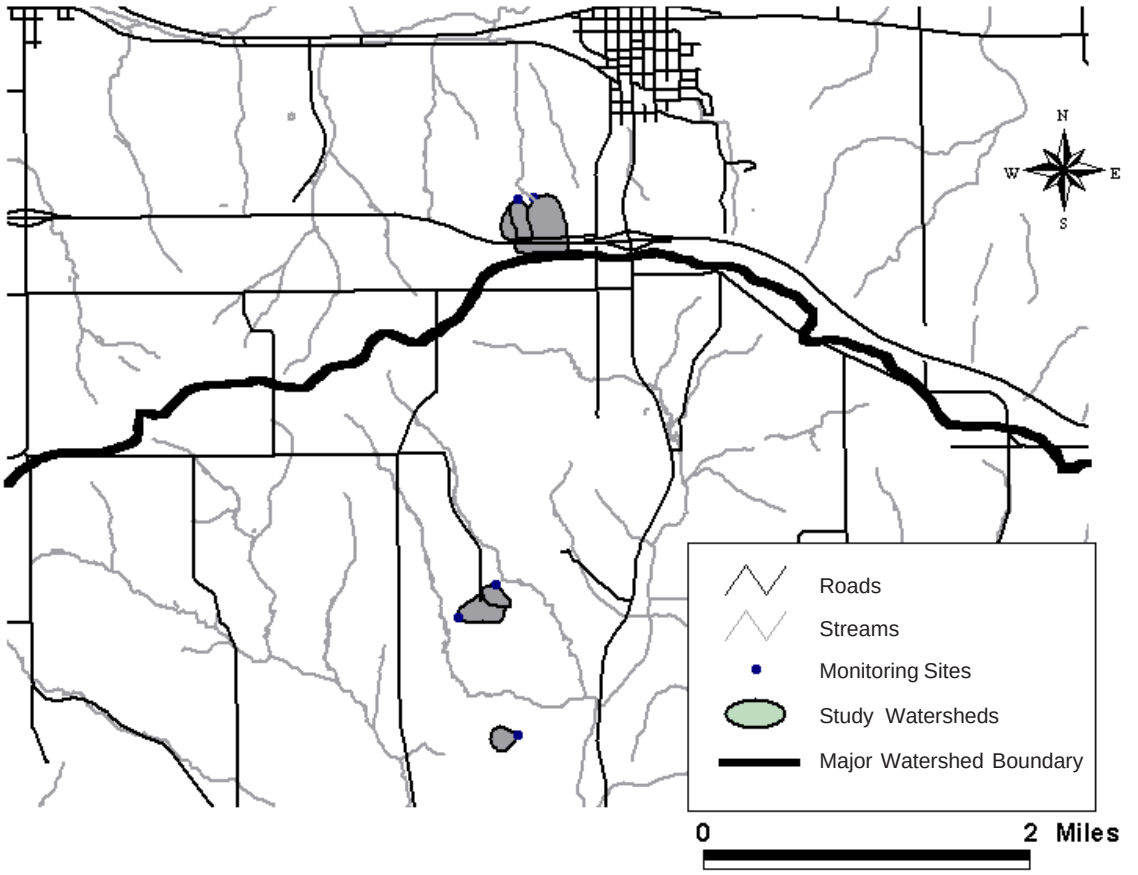

Figure 24: Watersheds monitored for physical and chemical variables as part of the paired-watershed monitoring component of the NMP project.

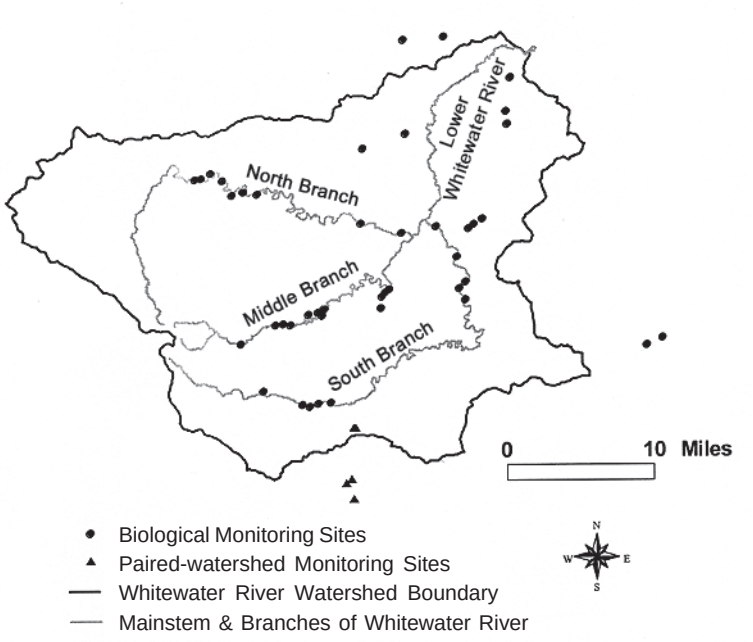

Figure 25: Monitoring site locations in and around the Whitewater River NMP project.

PROJECT OVERVIEW

The Whitewater River Watershed Section 319 National Monitoring Program (NMP) project is located in southeastern Minnesota (Figure 23). The NMP project is a small component of an overall watershed project involving several local, state, and federal agencies and organizations with various sources of funding for the Whitewater River and its tributaries.

The Whitewater River is a tributary to the Mississippi River at Weaver Bottoms, a nationally significant waterfowl staging area that is threatened by the pollutants delivered in the river. The Whitewater River watershed is 205,000 acres in size. Three main subwatersheds (South, Middle, and North Branches) drain gently rolling to steeply sloped karst topography. Land use in the watershed consists of approximately 58 percent cropland, 8 percent pastureland, 13 percent woodland, 14 percent wetland and designated wildlife management areas, and 7 percent other land. Significant portions of the river are classified as wild or semi-wild trout waters. The overall project evolved from a pilot project on the Middle Branch that identified intensively cultivated fields, long unprotected slopes, and inadequate feedlot, pasture, and forestry management as significant problems. These problems have resulted in impairments of the aquatic life (cold and warm water fisheries) and recreation designated uses of the river and its tributaries.

The Whitewater River NMP project was established to evaluate the effectiveness of various best management practices (BMPs) using NMP guidance that encouraged the use of paired-watershed monitoring designs and biological monitoring in streams. There are two components to the project. One component involves a multiple paired-watershed monitoring design incorporating physical and chemical monitoring of five small watersheds (Figures 24 and 25). The second component involves a biological monitoring effort at several sites throughout the watershed (Figure 25). The monitoring design for the biological monitoring involved the development of a cold-water Index of Biotic Integrity and an overall assessment of stream conditions to be followed with a before-and-after treatment comparison. Efforts will be made to add a paired-watershed component to the biological monitoring.

The physical and chemical monitoring of the five small watersheds is conducted using various methods. Continuous recording equipment is being used at the five H-flume monitoring sites to measure stream flow, temperature, and specific conductivity. An automated weather station collects various climate data at one site. Water samples have been collected by hand and with automatic samplers during the previous six to nine years. Water samples are analyzed for a suite of cations and anions, total suspended solids, and total phosphorus.

The biological monitoring involves annual stream assessments at between 15 and 42 stream sites. The assessments include the use of physical habitat, benthic macroinvertebrate, and fish surveys to assess watershed condition, generate baseline data to evaluate changes in the watershed, and provide comparisons of BMPs with conventional agricultural practices. Sampling was initially conducted in the lower cold water portions of the three branches of the Whitewater River and their tributaries, along with cold water streams in nearby watersheds to gauge the relative condition of the watershed. Sampling has now been extended into the upper warm water portions of the watershed, where there is more agricultural and urban land uses, to examine BMP and conventional sites, as well as riparian buffer types.

Land use and management information will be obtained with the assistance of the landowners, county soil and water conservation district staff, and/or Whitewater River Joint Powers Board staff. The identification and selection of management practices to be used on the paired-watershed treatment watersheds will also be made with the assistance of these people. The watershed assessment needs for the biological monitoring portion of the project will be more extensive than the assessment needs for the small automated monitoring sites. Analysis of the data collected will be completed with a geographic information system (GIS).

BMPs will be implemented in two ways. The automated monitoring site paired watersheds selected as treatment sites will have BMPs implemented using individual landowner interest and 319 project

funds, as needed. The study design had to be adapted with the introduction of a small grazing-based dairy in place of the row crops present previously. Implementation for the biological component of the monitoring project will rely on the watershed implementation plan of the overall watershed project.

PROJECT BACKGROUND

Project Area

The Whitewater River watershed is located between the cities of Rochester and Winona, Minnesota, and is 205,000 acres in size. The drainage areas of the five paired-watershed monitoring sites range from 12 to 60 acres. The drainage areas of the biological monitoring sites range in size from about 2,500 to 50,000 acres.

Relevant Hydrological, Geological, and Meteorological Factors

The Whitewater River Watershed consists of four major subwatersheds: the South Branch, Middle Branch, North Branch, and Lower (mainstem) Whitewater River. The landscape ranges from gently rolling hills to steep bluffs with rock outcrops. The predominant soils are silt loams, which overlay bedrock formations of sedimentary sandstones, shales, and dolomites. Given the dolomite (limestone) formations, the terrain is largely characterized as incipient (poorly developed) karst.

The average annual precipitation in the watershed is between 30 and 32 inches. Approximately 60 percent of this precipitation falls during the growing season. The average growing season is 150 days. The average daily minimum and maximum temperatures of 2 and 82 degrees Fahrenheit occur in January and July, respectively.

Land Use

Land use in the watershed consists of 58 percent cropland, 13 percent woodland, 8 percent pasture land, 14 percent wetland and 7 percent other land. Dairy and beef farms were predominate in the past; however, recent trends in the farm economy have shown a shift from dairy to cash crop production. The watershed also includes 2 state parks, a state wildlife management area, and a trout hatchery.

Water Resource Type and Size

The Whitewater River and its tributaries range from first- to third-order streams. Stream flows are largely influenced by springs originating from the various bedrock aquifers that are intersected by the river and its tributaries. The Whitewater River outlets to the Mississippi River at Weaver Bottoms, a nationally significant waterfowl staging area that is threatened by the pollutants delivered in the river.

The five paired-watershed monitoring sites are located on first-order streams that originate from springs and/or seeps from the Galena Dolomite aquifer. The presence of the springs (and the geologic formations causing the springs) was a primary factor in selecting the sites for the project.

Water Uses and Impairments

The designated uses identified by Minnesota's water quality standards for the Whitewater River and its tributaries are for aquatic life and recreation. Specifically, eight segments of these streams are classified as cold water fisheries. The remaining segments of the river and its tributaries are classified as cool and warm water fisheries. All of the waters are classified for all recreational uses, including

swimming. Three reaches in the watershed were listed as impaired for turbidity and/or fecal coliform bacteria in Minnesota's 1998 303(d) List. Four other reaches were added to the 2002 303(d) List.

In addition to the impairments associated with water quality standards, the primary water quality problems of concern in the Whitewater River watershed include elevated water temperatures, sediment, low dissolved oxygen concentrations, flow, and habitat. Water temperatures, sedimentation and turbidity, dissolved oxygen, and habitat are primary issues of concern for the river's trout fishery. Sediment transport through the watershed is a major concern for the Weaver Bottoms area of the Mississippi River. Other pollutants of concern include nutrients and pesticides.

The paired-watershed component of the project is focusing on water temperature, flow, total suspended solids, and several cations and anions (including nutrients) to evaluate changes in water quality with the implementation of BMPs. Fecal coliform bacteria will also be measured, with the addition of the dairy cows to the farm. The biological monitoring component of the project is focusing on fish, invertebrate, and habitat variables to evaluate changes in water quality.

Pollutant Sources

Pollutant sources include both point and nonpoint sources. Several small wastewater treatment facilities are located in the watershed; however, the primary sources of concern are nonpoint sources. The nonpoint sources include streambank erosion, degraded riparian areas, runoff and erosion from crop land, feedlot runoff, animal waste on crop land and pastures, and livestock access to streams.

Pre-Project Water Quality

No historical data exists for the paired-watershed and the biological monitoring sites of the NMP project.

Data collected in various watershed monitoring efforts has shown elevated sediment and nutrient concentrations, degraded stream habitats, increased water temperatures, potential low dissolved oxygen conditions, and turbidity and fecal coliform bacteria levels that often exceed water quality standards. Commonly used pesticides have been detected frequently at the two Minnesota Department of Agriculture surface water monitoring program sites in the watershed.

Water Quality Objectives

The overall goals of the Whitewater River Watershed NMP project are:

1. To provide the information needed for use in evaluating the effectiveness of best management practices (BMPs) implementation, and
2. To provide long-term monitoring for continuing evaluation of the pollution problems and solutions in the Whitewater River Watershed Project.

Specific objectives for the project are:

1. To evaluate surface and ground water interactions present in the five small paired-watershed study areas.
2. To detect improvement in the quality of water from a treatment watershed as compared to the quality of water from a control watershed using a paired-watershed monitoring design in the five H-flume sites. Variables to be evaluated include amount of runoff; peak flows; base flows; and total suspended solids, nitrate-nitrogen, phosphorus, and chloride concentrations and loads.
3. To characterize and evaluate the biological conditions of the Whitewater River and its tributaries as they relate to watershed hydrology, land use, land cover, geology, and location.

4. To evaluate the effect of BMP implementation on water quality using biological monitoring at a watershed scale larger than the paired-watershed study. Efforts will involve a reference stream monitoring design and a paired-watershed monitoring design. Variables to be evaluated include macroinvertebrate, fish, and stream habitat indices.
5. To evaluate the degree to which BMPs are implemented in treatment watersheds versus control watersheds.

Project Time Frame

Biological monitoring and the small paired-watershed monitoring following NMP guidelines began in 1994 and 1996, respectively. The project was approved as a NMP project in 2001. The project will end in 2006.

PROJECT DESIGN

Nonpoint Source Control Strategy

The project is designed to evaluate the effectiveness of various BMPs in two settings.

The first setting involves five small watersheds in which cropland management practices will be compared using a paired-watershed design. BMPs will be or were selected by the landowners. One watershed was enrolled in the Conservation Reserve Program (CRP) until fall, 1997, when it was tilled for conversion back to a corn-soybean rotation with a small portion seeded to alfalfa. Three watersheds contain a grass buffer between the crop land and the springs and streams. A series of paired-watershed control and treatment evaluations will be made. The first will involve a "reverse" treatment given the conversion of CRP back to cropland in one watershed. Other treatments to be evaluated include use of no-till planting, adding small grain to a corn-soybean rotation, and the use of managed intensive grazing.

The second setting involves the biological monitoring of several sites in and around the Whitewater River watershed. Implementation of nonpoint source BMPs will occur through the overall watershed project's implementation efforts utilizing P.L. 566 and Minnesota Clean Water Partnership funds. Practices targeted for use include several land treatment practices (i.e., conservation tillage, use of cover crops, critical area plantings, diversions, field borders, grade stabilization structures, livestock exclusion, contour farming, etc.), planned grazing systems, nutrient and pesticide management plans, forestry BMPs, waste management systems, and stream filters and buffers.

Water Quality Monitoring

Water quality monitoring consists of two components. One component involves a paired-watershed monitoring design incorporating physical and chemical monitoring of five small watersheds. The second component involves a biological monitoring effort at several sites throughout the watershed.

Variables Measured

Biological
Fish
Macroinvertebrates
Habitat
Fecal coliform bacteria

Chemical
Temperature
Total suspended solids
Nitrate-nitrogen
Nitrite-nitrogen
Total phosphorus
Conductivity
pH
Chloride
Oxygen-18
Deuterium

Covariates
Precipitation (continuous)
Discharge (continuous)

Sampling Scheme

A multiple paired-watershed monitoring design is being used for physical and chemical variables in five small. Continuous recording equipment is being used at the five H-flume monitoring sites to measure stream flow, temperature, and specific conductivity. An automated weather station collects various climate data at one site. Water samples have been collected by hand and with automatic samplers. The sampling frequency was increased in 1999 in an effort to better characterize the hydrology of the watersheds (source(s) and pathways of the water).

Biological monitoring has been conducted for several years at 15 to 42 stream sites within the project area since 1994. The assessments include the use of physical habitat, benthic macroinvertebrate, and fish surveys. Sampling was initially conducted in the lower cold water portions of the three branches of the Whitewater River and their tributaries, along with cold water streams in nearby watersheds to gauge the relative condition of the watershed. Sampling has now been extended into the upper warm water portions of the watershed. Physical habitat measurements include water depth, mean water column velocity, substrate type, substrate embeddedness, and cover with a quantitative measurement of bank erosion along each bank. Fish habitat ratings are calculated using the procedures of Simonson et al. (1994). Macroinvertebrates are sampled using the Rapid Bioassessment Protocol III as described by Plafkin et al. (1989). Fish sampling is conducted with a backpack electrofisher. The fish assemblage at all sites are assessed with the Index of Biotic Integrity (IBI) recommended by Plafkin et al. (1989), using regional modifications for cold water (Mundahl and Simon, 1998) and warm water (Lyons, 1992) streams.

Monitoring Scheme for the Whitewater River Watershed Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Multiple paired-watershed	Finley East Finley West	Temperature Nitrate-N TP TSS Conductivity Cations Anions Fecal coliform bacteria	Precipitations Discharge (both continuous)	Continuous temperature & conductivity Weekly and flow-interval event sampling or other variables		Variable-depending on treatment: 1 - 5 yrs pre-BMP 1 yr BMP 3 - 4 yrs post-BMP
Biological-Reference & Before/After (potential paired-watershed design, if possible)	Within watershed: North Br. (9) Middle Br. (9) South Br. (9) Trout Run (2) Trout Run trib. (1) South Br. trib. (1) Trout Valley Cr. (3) Beaver Cr. (2) Outside watershed: Garvin Brook (2) East Indian Cr. (2) (#) - number of sites	Fish Macro-invertebrates Habitat			Once per year	1994-2005

Land Treatment Monitoring

Land use and management information will be obtained with the assistance of the landowners, county soil and water conservation district staff, and/or Whitewater River Joint Powers Board staff. The identification and selection of management practices to be used on the paired-watershed treatment watersheds will also be made with the assistance of these people. The watershed assessment needs for the biological monitoring portion of the project will be more extensive than the assessment needs for the small automated monitoring sites. Analysis of the data collected will be completed with a geographic information system (GIS).

Modifications Since Project Start

Significant delays occurred in initiating the paired-watershed monitoring component of this project. The initial plan to conduct paired-watershed monitoring on two perennial streams with watersheds greater than 5,000 acres to allow biological, physical, and chemical monitoring at the same sites proved to be too difficult. The reasons for this difficulty were two-fold. One, the proposed paired-watershed sites were determined to not be representative of each other given that extensive habitat restoration work had been completed in the control watershed stream. Two, the likelihood of detecting significant changes in water quality as a result of BMP implementation was determined to be low given the large watersheds and the large amount of BMPs that would have to be implemented in a relatively short time.

The next plan for paired-watershed monitoring focused on two watersheds in the one thousand- acre size range to increase the likelihood of obtaining sufficient BMP implementation in the treatment

watershed to detect a water quality change. Monitoring at these sites would have been limited to runoff event sampling due to the ephemeral nature of the streams at these locations. Biological sampling was proposed on two streams below the proposed control watershed. A miscommunication between project staff resulted in initial monitoring site work prior to the landowner giving his permission to establish the monitoring site. This mistake resulted in the need to change monitoring sites again.

The third plan for paired-watershed monitoring involved the selection of the second plan's biological monitoring sites as the primary paired-watershed monitoring sites. These sites, again, presented an opportunity to conduct biological, physical, and chemical monitoring at the same sites. The problem that developed at these sites, in terms of not being suitable for paired-watershed monitoring, resulted from the findings of the first round of biological sampling conducted on the two streams. The findings indicated that not only were the two streams very similar to each other in terms of fisheries, benthic macroinvertebrates, and habitat, but that the streams ranked among the best trout streams in the whole Whitewater River watershed. With both streams being in such good condition, the ability to detect a significant change in water quality would, again, be difficult. So, new paired-watersheds needed to be located one more time.

Following these project delays, two small watersheds were selected for physical and chemical monitoring using a paired-watershed approach. Monitoring sites were constructed in 1996 with full monitoring beginning in April 1997. Monitoring is also being completed at three previously established sites in an adjacent watershed given their proximity and similarities to the Whitewater sites. The paired-watershed monitoring sites in the Whitewater River watershed were selected for the project given their small size, proximity and similar land use (pasture and crop land) combined with the farmer's interest in expanding his use of rotational grazing. Initial paired-watershed treatment plans involved the expansion of rotational grazing onto the crop land acreage in the treatment watershed; however, these plans were altered when the farmer sold his dairy herd and the management of the land reverted to his father. Treatment plans have been delayed given that the landowner uses good conservation tillage practices. The addition of small grain (oats) and alfalfa to the crop rotation in the treatment watershed in 2002 was an initial treatment BMP; however, management of the farm again changed with the reintroduction of a dairy herd to the farm by the landowner's granddaughter. Efforts are being made to compare grazing management techniques.

Efforts were made to adapt the monitoring sites to allow monitoring through the winter, but these efforts were not successful.

Progress to Date

Water quality data has been collected for several years through the Whitewater 319 Monitoring Project. The physical and chemical data collected from the paired-watershed monitoring sites is sufficient to provide adequate calibration period relationships between the following pairings of the study sites: Finley East and Finley West and CRP and Corn-Soybean sites. Pairing the Organic Site with either the CRP or Corn-Soybean Sites may be more difficult. The ability to pair the Finley sites with the other three sites has not been explored yet. Data is also available to evaluate the effects of a reverse treatment given a change in land use from CRP enrollment to annual cropping in 1998.

The initiation of BMP treatment practices in the small paired-watersheds has been delayed due to landowner issues. While these delays have limited the progress toward completing the project, they have also resulted in a longer calibration period. The implementation of BMPs in the treatment watersheds began in 2001 and 2002. Monitoring will continue through 2005 to obtain the necessary treatment period data.

The biological monitoring data base that has been developed through this project is quite extensive. In addition to characterizing the biological quality of the streams in the Whitewater River watershed, it has been used to develop and refine the biological metrics used in assessing the quality of cold water streams throughout Minnesota. Use of the data to evaluate the effectiveness of BMPs in the water-

shed is just beginning. Detailed land use data is present and will be incorporated into the data analyses. It is likely that a paired-watershed design can be established for both a warm water and a cold water set of streams. The existing data will provide the calibration period data needed. Data will continue to be collected as BMP implementation activities are accelerated via USDA P.L. 566 and Minnesota Clean Water Partnership funding. An implementation effectiveness project using special project funds received from USEPA Region V will also assist in accelerating BMP installation. Following a transition period of implementation, a formal treatment period is targeted to begin in 2004.

Additional information will also be available as a TMDL study of turbidity and fecal coliform bacteria is completed for three reaches of the Whitewater River. The data gathered via both projects will be used to better characterize and quantify the water quality impairments due to turbidity and/or sediment and fecal coliform bacteria.

DATA MANAGEMENT AND ANALYSIS

Data Management and Storage

Data management is completed using two spreadsheet systems. The small paired-watershed monitoring data is managed by the University of Minnesota Department of Biosystems and Agricultural Engineering. The biological monitoring data is managed by the Winona State University Department of Biology. The Nonpoint Source Management System (NPSMS) will be used to report data to EPA. Data will also be entered into STORET.

Data analysis will be performed using both parametric and nonparametric statistical methods.

NPSMS Data Summary

Data has not been entered into NPSMS as of July, 2004.

Findings to Date

The physical and chemical monitoring at the five paired-watershed sites has resulted in calibration-period regression relationships that appear to be significant for several variables. Figure 26 provides an example of the calibration period regression observed for the Finley East and West watersheds. Detailed analyses of the data began in 2004.

The biological monitoring has shown that most stream sites had fair to good fish habitat ratings. Fish assemblage assessment using two indices of biotic integrity (IBI) indicated that most cold water sites rated fair to good, but most warm water sites rated poor to very poor. Cold water IBI scores were more erratic from year to year at poorer-quality cold water sites than at better-quality cold water sites. Invertebrate assemblage assessments rated most sites throughout the watershed as having moderate impairment. Figure 27 provides a summary of the cold-water IBI scores recorded in the watershed.

To date, only a simple assessment of land use types versus the biological monitoring metrics has been made. Land use type was only identified by visual observation near the monitoring sites as conventional or BMP. There was no observable effect on the instream habitat variables due to these two land use types at the monitoring sites in the Whitewater watershed; however, the percent fines and embeddedness measures did show strong tendencies to be higher at stream sites adjacent to conventional land use than at sites adjacent to BMP land uses. Detailed land use information is available and will be incorporated into the data assessments in the coming year.

Based on similarities in land use and watershed size, there is a potential for the use of a paired-

watershed evaluation of BMP effectiveness via the biological monitoring data at selected sites. The drainage areas of these sites are approximately 10,000 acres and 10,000 to 30,000 for cold water and warm water sites, respectively.

INFORMATION, EDUCATION, AND PUBLICITY

Paired-watershed monitoring activities will be discussed informally with the three landowners in the five small watersheds. Information on the paired-watershed and biological monitoring activities will be presented to the Whitewater Watershed Joint Powers Board (WWJPB) and its overall project committees. WWJPB staff will coordinate information and education activities for landowners and local units of government in the overall watershed project.

Project papers have been presented at the National Nonpoint Source Monitoring workshops.

A fact sheet describing the NMP project was completed by the MPCA as part of its documentation of Section 319 and state Clean Water Partnership project successes.

PROJECT BUDGET

CWA Section 319 funds were first received for the monitoring project in federal fiscal year (FFY) 1993. Funds have subsequently been received each funding cycle, except FFY 2000, through FFY 2003 for a total grant amount of $513,425. All funds are used for monitoring-related project elements.

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

The overall watershed project has received diagnostic study and implementation project funding from the Minnesota Clean Water Partnership (CWP) Program and the USDA P.L. 566 Program. The project has worked hard to incorporate and integrate the project activities of these programs, as well as the activities of other local, state, and federal organizations. The implementation plan was developed by the Whitewater Joint Powers Board following extensive input from a citizens' advisory committee. Additional funding and support has been received from the Minnesota Board of Water and Soil Resources, the Legislative Commission on Natural Resources, the Minnesota Department of Natural Resources, the U.S. Fish and Wildlife Service, and private sources including Land O'Lakes and the McKnight Foundation.

A pilot turbidity TMDL project was initiated in the watershed in large part due to the extensive biological monitoring information available through this "long-term" monitoring project. While the TMDL program has placed increased attention on fecal coliform bacteria and turbidity given their presence on the 1998 303(d) List, the watershed data has been an important resource in the development of regional focused TMDLs. A regional TMDL titled, "Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota," was completed September 2002. A regional TMDL effort to address the turbidity listings in the Lower Mississippi River Basin has begun. Information from the Whitewater project will play an important role this effort.

OTHER PERTINENT INFORMATION

None.

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