

# Using Monitoring Data to Promote Local Water Quality Improvements: The FM River Project and Related Volunteer Monitoring

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## **Biographical Sketch of Authors**

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Tom Williams, Ph.D., Counselor and Professor Emeritus, Minnesota State University–Moorhead is an unapologetic tree hugger who has always loved forests, lakes, and rivers. Currently, Dr. Williams serves on the Board of Directors for Minnesota's Clean Water Action Alliance and is a member of the Red River Basin Water Quality Implementation Team. Dr. Williams was instrumental in establishing River Keeper's River Watch program in the Fargo–Moorhead area, which is now providing volunteer monitoring assistance to the FM River Project.

## **Abstract**

Two separate, but interrelated water quality-monitoring activities have been initiated in the Fargo, North Dakota–Moorhead, Minnesota (F–M) metropolitan area. A volunteer River Watch program was begun in 1999 to help evaluate the impact of the community on the Red River of the North on several parameters, including nutrients and fecal coliforms. The 1999 River Watch monitoring consisted of monthly sampling from two sites. Because of high fecal findings, the River Watch monitoring program was expanded in 2000 to weekly sampling from four sites, with one of the sites situated well upstream of the metro reach to serve as a reference. Funding was received from the U.S. Environmental Protection Agency in 2001 to initiate FM River, a 2-year water quality-monitoring and community outreach project. FM River monitoring is being conducted on a biweekly basis from three sites roughly equivalent to the 2000 River Watch sites.

The water quality information generated by River Watch and FM River is proving to be invaluable to the community in relation to two federally mandated regulatory activities. Several reaches of the Red River within the F–M metro area have been listed as impaired for one or more constituents, including fecal coliform, and are subject to the development of total maximum daily loads (TMDLs) for each listed impairment. Additionally, entities within the urbanized F–M area must soon receive permit coverage under the new Phase II storm water regulations, which will require the commitment of considerable municipal resources. Data generated by both monitoring programs have been used to complete the initial phase of a fecal coliform TMDL and will likely be used for future planning and modeling activities. Several components of the FM River Project have been identified for use in complying with future storm water permit requirements which will provide significant benefits to the community.

## **FM River Background and Objectives**

FM River is one of a wide number of EMPACT (Environmental Monitoring Program for Access and Community Tracking) projects funded through the U.S. Environmental Protection Agency (EPA) in over 86 major U.S. metropolitan areas. FM River is designed to provide the citizens of the Fargo, North Dakota–Moorhead, Minnesota, (F–M) metropolitan area with accurate, timely information on the quality of the Red River of the North—the main source of drinking water for some 150,000 area citizens. Water quality is the focus of the project since the Red River not only provides drinking water for the community, but is also a significant source of industrial water supply, a critical element in the health of the local ecosystem, and an emerging recreational resource. The need for this information is acute because of the vulnerability of the Red River, the continued growth of the area, and the direct impact of the community on water quality. FM River will meet these goals by satisfying the following objectives:

- Establish a coordinated water quality-monitoring network for the Red River in the FM area.
- Collect and assemble timely data on water quality parameters and conditions for the Red River.
- Develop tools for disseminating the information, including the FM River Web site ([www.fmriver.org](http://www.fmriver.org)).
- Use the information to educate the community on water quality issues.
- Provide a forum for community participation and interaction in the program.
- Develop a sustainability plan for the program.

Activities are focused on collecting and disseminating water quality data for the Red River as developed by local agencies, citizen and student volunteers, and dedicated, regular water quality monitoring. Field efforts will also include the development of applicable biological monitoring protocols for the Red River which are not currently available. The program seeks to increase the educational opportunities for students and citizen volunteers to understand watershed processes in order to protect and improve ambient water quality. Information generated by FM River will be made available to the entire community to increase the awareness and understanding of this critically important regional resource.

FM River is built on a local partnership of government, education, and community groups. The Energy & Environmental Research Center (EERC) is overseeing the water quality-monitoring activities and data management and is assisting in developing outreach materials. Prairie Public Television (PPTV) is responsible for the production of a 30-minute telecast to introduce the project to the F–M community (aired in September 2001) and eighteen 30-second television spots on various water-related issues and is developing and hosting the FM River Web site. River Keepers, a local grassroots environmental group, is overseeing community monitoring and educational activities and is taking the lead in developing outreach materials. Other partners include the cities of Fargo and Moorhead, state and federal agencies, and local universities.

FM River was initiated July 2001 and will continue under EPA funding through June 2003. Subsequently, the program will be sustained by the groups in the F–M area.

## **Prior Volunteer Monitoring of the Red River in the F–M Metro Area**

Prior to initiation of the FM River Project, water quality monitoring of the Red River throughout the F–M metro area was conducted by adult and student volunteers over the 1999 and 2000 open-water seasons to help assess community's impact on local water quality. This monitoring was initially designed to collect samples on several physical, chemical and biological parameters in the metro reach of the river. During 1999, samples were collected on a roughly monthly basis at two monitoring sites. These sites consisted of a south (upstream) location designed to represent minimal impact from urban activities and a north (downstream) location situated below the effluent outfalls from the municipal wastewater treatment facilities.

To better investigate the 1999 high fecal levels, this monitoring effort was expanded considerably in 2000. A total of four sites were established to monitor Red River water quality. These sites included a reference site located well upstream (south) of Fargo's city limits, a midtown sampling site, a site approximately 5 river miles downstream of the midtown location in a strictly residential section of the community and immediately upstream of the discharge points from the two wastewater treatment plants, and the same downstream monitoring location established for 1999

sampling. Sample collection began on May 30, 2000, and continued on a weekly basis through October 3, 2000. In addition to sampling for fecal coliforms, each site was monitored for transparency, dissolved oxygen, water temperature, and flow. Local weekly precipitation totals were also compiled through the 2000 monitoring season.

### **FM River Project Description**

*Monitoring/Data Collection.* The FM River monitoring and data collection activities are designed to provide the physical, chemical, and biological data necessary to characterize and track the health of the Red River over time and to examine the ramifications of human actions on the river environment. Specific issues being addressed include identification and coordination of all ongoing monitoring activities and the development of strategies to address emerging water quality concerns, particularly total maximum daily load (TMDL) projects, source water protection, and Phase II storm water permit issues. The monitoring/data collection activities are divided into three subtasks: 1) development of an ongoing coordinated water quality-monitoring network, 2) chemical water quality sampling, and 3) biological sampling of macroinvertebrate communities.

A monitoring network is being established for the F–M metro area to identify all ongoing ambient and compliance monitoring, evaluate where additional monitoring is required, and develop and implement a strategy to link all existing monitoring efforts and needs. Currently, Red River water quality-monitoring efforts in the F–M area are being conducted by the U.S. Geological Survey (USGS); Minnesota Pollution Control Agency (MPCA); Minnesota Department of Natural Resources (MDNR); North Dakota Department of Health (NDDH); water and wastewater treatment facilities from the two cities; and several local universities, industries, and environmental organizations. Information on sampling locations, times of sampling, types of data collected, methods of analysis, quality assurance procedures, and the resulting data are being compiled by the EERC and River Keepers and stored on a database that is updated on a regular basis, e.g., bimonthly. This information will be reviewed by members of the FM River Project Advisory Group to evaluate monitoring practices and determine where overlap is occurring, how techniques and procedures can be improved, and where additional monitoring is necessary. Based on this evaluation, a strategy will be developed to better coordinate monitoring activities and enhance the value of the water quality data to the citizens of the F–M metro area.

Regular water quality monitoring has been implemented that supplements current ambient and regulatory monitoring. This monitoring is designed to evaluate changes in ambient water quality parameters over time via grab sampling and analysis and will provide citizen and student volunteers with hands-on experience in sampling procedures and analytical techniques as well as firsthand knowledge of the degree of variability in river water constituent levels. The monitoring will also add to the limited database of sound water quality information in the F–M metro area, including sampling of river water quality through the ice during winter months (usually December through March). River-monitoring activities will occur at three locations along an approximately 40 river-mile segment of the Red River in the F–M area. Site 1 is located at the Clay County 8 (Minnesota) bridge over the Red River at 46.7310 latitude and -96.7840 longitude. This site represents baseline conditions for the Red River upstream of the urban F–M metro area, as demonstrated by previous volunteer monitoring. Site 2 is located in the downtown area at the 1st Avenue North bridge. Site 2 represents a portion of the river that may show impacts via nonpoint source discharges from the city without the influence of major point sources, such as effluent from the two municipal wastewater treatment plants and discharges from a beet sugar refinery. The exact location of Site 2 is 46.8772 latitude and -96.7808 longitude. Site 3 is located at the Clay County Road 26 bridge over the Red River which is downstream of the F–M metro area and is also downstream of all permitted wastewater discharges. The exact location of Site 3 is 46.9768 latitude and -96.8197 longitude.

Grab samples are collected from the Red River monitoring sites for water quality analysis using EPA-approved methods. Students and community volunteers working through River Keepers under the guidance of water quality specialists from the EERC collect samples via nonmetallic Beta bottle samplers (Figure 1). Each of the grab samples are split between the student/community volunteers and an EERC representative. The EERC sample split is analyzed by the EPA-certified laboratory at the Fargo Water Treatment Plant (FWTP), while the student/citizen split is analyzed separately by the volunteers themselves under the supervision of River Keepers. The citizen/student volunteer sampling may not be held on a regular basis, depending on availability of volunteers and time constraints. However, EERC

monitoring will follow the schedule outlined below. A monitoring training session or workshop for volunteers will be offered each year of the project before spring monitoring begins. The training sessions will be organized by River Keepers and include participation by project partners from the EERC, NDDH, and MPCA.

Field parameters including dissolved oxygen, temperature, electrical conductivity, and pH are measured at each site at the time of sampling. All sample splits are analyzed for pH, turbidity, conductivity, total phosphorus, and nitrate–nitrogen. Samples delivered to the FWTP are also analyzed for water column chlorophyll *a*, fecal coliform, ammonia–nitrogen, total suspended solids, and total dissolved solids. Grab sampling and analysis will continue year-round. Monitoring will be performed on a biweekly basis from May through October and on a monthly basis during periods of ice cover (i.e., December through March) or potentially unstable river conditions (e.g., April flooding, November thin ice). Because of liability issues, water quality monitoring from November through April will be by EERC personnel only during the project period of performance. Subjective observations of general water quality will also be recorded by sampling personnel to develop a record of water quality conditions in terms of human versus natural debris, floatables, etc. This activity will be directed at helping to raise community awareness of the Red River, environmental protection, and recreational opportunities.

Biomonitoring goes beyond physical and chemical parameters to provide an indication of the overall health of the riverine system and reflects the effects of both short- and long-term perturbations in that system. Because existing EPA-approved protocols for biomonitoring apply to swift sand- or rocky-bottomed streams, studies are currently under way through other programs to establish new protocols to support biological monitoring for low-gradient, mud-bottomed streams, as are characteristic of the Red River Basin. Experimental biomonitoring techniques derived from other monitoring projects conducted on low-gradient rivers in North America are being used to sample the Red River macroinvertebrate diversity. Because of this, specific biomonitoring protocols have not been completely defined. However, typical sampling protocols and general procedures are outlined below.

Microbiological (i.e., macroinvertebrate) sampling is being conducted, at a minimum, twice per year during ice-free conditions, by River Keepers and undergraduate college students under the direction of Dr. D. Bryan Bishop, Assistant Professor of Biology, Concordia College, Moorhead, Minnesota. Sampling assistance and advice will be provided by the EERC and regulatory agency personnel. All monitoring sites will be colocated with the three water quality-sampling sites, samples will be collected within a 1-week period from all sites, no sampling will occur within 5 days of any rainfall event greater than 1 inch, and consecutive annual sampling dates will not vary by more than 2 weeks. At each sampling point, two monitoring protocols will be established. One of the protocols will most likely involve the placement of artificial substrates in the river to mimic natural submergent vegetation and woody debris typical of the Red River. Figure 2 shows a variety of artificial substrates that were used for macroinvertebrate monitoring in 2001. Sampling will occur following a minimum 30-day colonization period. Another protocol that has met with some success in the Red River Basin is the jab sample method, where a composite of 20 jab samples has been collected at each site. The use of two distinct sampling protocols will help to establish more accurate biological monitoring techniques for the Red River Basin. Once the protocols are proven, results of the biomonitoring can be used to assess sites and to provide a picture of river health over the long term.

Macroinvertebrate identification is being conducted to the family level and includes family richness and total abundance, which is used to indicate population size and diversity. An appropriate biotic index, that weighs the relative abundance of each taxon in terms of its pollution tolerance and produces a community score, will be used to rate the river's health. The index will require calibration over several sampling periods. Existing data from the headwaters of a tributary to the Red River at Fargo–Moorhead (Buffalo River in Minnesota) and results from the USGS National Water Quality Assessment Program Study will be used to calibrate the index. The NDDH also has existing biomonitoring data from the Sheyenne River and the Red River near Wahpeton, North Dakota, that will be included in developing an Index of Biotic Integrity (IBI) for the Red River Basin. The IBI will be strongly considered for use in the FM River Project.

Through FM River, citizens and students will be directly involved in the biomonitoring research activities planned for the F–M area. Specifically, the citizens and students will be given the opportunity to take part in macroinvertebrate sampling/analysis events. Activities may include aiding in the emplacement and retrieval of sampling devices, the

assessment of samples, and organization of data for dissemination via the FM River Web site or other means.

*FM River Data Interpretation and Dissemination.* A data management system is being developed that will handle the data from the grab sample analyses, the results of the biomonitoring activity, and select data from other monitoring activities outside of the project. The EERC is responsible for collecting, compiling, and interpreting the water quality-related data, while communication of data results is the responsibility of all project partners. Figure 3 illustrates a conceptual flowchart that is being followed by the EERC for management of FM River-related data. Interpretation of biomonitoring data is being handled by Dr. Bishop, with input from the EERC through the Red River Biological Monitoring Workgroup. River Keepers is the lead in communication efforts, directing the release of information to media outlets, the FM River Web site, and coordinating local river-related events. PPTV is also playing a significant role in communicating project information and results to the community through project-specific programming and its involvement with Web site development.

The raw water quality data generated through FM River will be made available to anyone with access to the Internet, along with basic information on water quality concepts, the impact of the constituents of interest on surface water resources, the trend of these constituents over the recent past in the Red River at Fargo–Moorhead (e.g., the last 10 years), and the impact of each constituent on the local resource and the general public. In this way, the community has the opportunity to develop a better understanding of water resource concepts in general and the Red River specifically and can make their own decisions and assessments of the river, in terms of its health and overall value in their lives. Provisions are being provided for public input on all aspects of FM River through e-mail and via telephone, coordinated by River Keepers.

### **Water Quality-Monitoring Activities and Recent Regulatory Developments**

Local developments related to regulatory requirements associated with the 1972 Clean Water Act have demonstrated the usefulness of the water quality-monitoring activities described above. One of these is related to the recent push by EPA for states to accelerate the development of TMDLs for water bodies included on the Section 303(d) list of impaired waters of the state. The other water quality-related regulatory development which will impact the F–M area, along with a large number of communities across the United States, is the Phase II storm water regulations.

*Monitoring Activities Related to TMDL Issues.* The federal Clean Water Act requires states to adopt water quality standards to protect the nation's waters. These standards define how much of a pollutant can be in a surface and/or groundwater while still allowing it to meet its designated uses, such as for drinking water, fishing, swimming, irrigation, or industrial purposes. Many water resources cannot currently meet their designated uses because of pollution problems from a combination of point and nonpoint sources. For each pollutant that causes a water body to fail to meet state water quality standards, the federal Clean Water Act requires the applicable regulatory body to conduct a TMDL study. A TMDL study identifies both point and nonpoint sources of each pollutant that fails to meet water quality standards. Water quality sampling and computer modeling determine how much each pollutant source must reduce its contribution to assure the water quality standard is met. Rivers and streams may have several TMDLs, each one determining the limit for a different pollutant. The Clean Water Act requires states to publish, every two years, an updated list of streams and lakes that are not meeting their designated uses because of excess pollutants. The list, known as the 303(d) list, is based on violations of water quality standards and is organized by river basin.

Several reaches of the Red River within the F–M metro area have been identified as impaired by both MPCA and NDDH. The primary parameters of concern are fecal coliform and turbidity as reported by MPCA (see Table 1). MPCA and NDDH have recently begun to meet, along with local nongovernmental water management entities, to begin the TMDL process related to these impairments. The first step taken in the process was to compile existing data to determine data gaps and additional monitoring needs so that sufficient data would be available for future resource assessment and modeling activities related to the TMDL. Table 2 shows data sources, periods of records and number of samples compiled for fecal coliform monitoring since 1990. Most of these data represent monthly sampling, with the exception of the volunteer monitoring accomplished in 2000 by River Keepers' River Watch (weekly samples) and the most recent monitoring data collected for FM River (biweekly during open-water season). Additionally, the samples collected by the regulatory agencies through the 1990s were limited to not more than two sites per sampling

event and did not include a reference sample from upstream of the metro area, so there is no baseline data for comparison. The data generated by the River Keepers and FM River monitoring provide a better picture of constituent variability in the river through the community and the impact of different portions of the metro area. This is especially true of River Keeper's 2000 monitoring results. Not only were there four monitoring sites sampled concurrently, but weekly sampling allowed for statistical analysis of the data as defined by the water quality standard. The fecal coliform standard for the Red River has been established to apply during the recreation season (i.e., May 1 – September 30) at a geometric monthly mean of not more than 200 CFU/100 mL and no single sample above 400 CFU/100 mL. Figure 4 illustrates variability in fecal coliform concentrations within the Red River from upstream to downstream of the F–M community during the 2000 recreation season including the prior week's rainfall total. Figure 5 shows these same data in terms of monthly geometric mean along with the average rainfall reported for Fargo for the period June through September 2000.

Both Figures 4 and 5 illustrate that the fecal coliform standards were frequently exceeded during the spring and summer of 2000 in the Red River at Fargo. It is interesting to note that fecal coliform concentrations in samples from the reference site consistently met the established standards, with the exception of the 400-CFU/100-mL maximum instantaneous standard on June 20, 2000. Subsequent sampling for the FM River Project has shown the same general trends.

Inspection of Figure 4 reveals that there was an extreme precipitation event during the third week of June 2000, which resulted in huge spikes in fecal coliform at each monitoring site. This storm, which produced in excess of 7 inches of rain in Fargo, created considerable sewer backup problems in the F–M area because of the intensity of the event. In general, fecal coliform fluctuations tend to correspond directly with rainfall events. However, the 2000 River Keepers data show that there are other factors contributing to increased fecals concentrations. Additional monitoring may be warranted to determine the reason(s) for these anomalies.

The detail and completeness of the 2000 River Keepers monitoring data are providing an excellent starting point for fecal coliform TMDLs required for the mainstem Red River at Fargo. Also, the monitoring data being generated by the FM River Project will help to fill existing data gaps and identify specific areas that should be monitored more rigorously.

*Activities Related to New Storm Water Rules.* The larger communities in the Red River Valley will soon require permit coverage in compliance with the federally mandated Phase II Storm Water regulations developed by EPA. These regulations require entities that own and maintain storm sewer conveyance systems within urbanized areas, as defined by the 2000 U.S. census, to develop a storm water management plan (SWMP) which will address 6 minimum control measures. These minimum control measures include Public Education and Outreach, Public Participation/Involvement, Illicit Discharge Detection/Elimination, Construction Site Runoff Control, Postconstruction Runoff Control, and Pollution Prevention/Good Housekeeping related to Municipal Operations. Under each of the six minimum control measures, each storm water permittee must identify best management practices (BMPs) and measurable goals for each which will reduce the impact of storm water runoff to the maximum extent practicable. Each permittee is responsible for implementing its approved SWMP over the course of the first 5-year permit term and, as such, must commit considerable resources to cover the cost of the program, share program expenses with neighboring permit holders, utilize the assistance and expertise of local volunteer organizations, or a combination of these factors. Considering that one-third of the new storm water regulations pertain to the public, it is clear that EPA is placing significant emphasis on public notification and involvement in the program.

The cities of Fargo and Moorhead, along with other potential permittees in the Red River Valley, have been working cooperatively over the past several months to develop strategies to deal with the new storm water regulations. Personnel from both Fargo and Moorhead responsible for storm water permitting have identified the FM River Project and related volunteer monitoring programs as a key component of their future SWMPs. Each community recognizes the utility of the local water quality-monitoring effort and educational outreach network that has already been developed by the project and its potential to conserve limited municipal resources. Fargo and Moorhead plan on using components of the existing programs as BMPs for permit compliance. Some of the components under consideration

include River Keepers' existing storm water inlet stenciling program and annual F–M water festival; support of the development of storm water-related curricula for area schools through FM River; extensive use of the FM River Web site, water quality network, and display materials for general public outreach; and use of FM River and volunteer water quality monitoring as baseline information and as a gauge of the effectiveness of future storm water control procedures (BMPs).

Interestingly, in the case of the F–M area, compliance with near-future TMDLs and storm water regulations is interrelated, as fecal coliform contamination of the metro reach of the Red River is a prime water quality concern. As suggested by Figure 4, the F–M community has a significant impact on fecal coliform concentrations in the river, particularly following precipitation events. It is quite likely that the TMDL process will identify specific sources of fecal contamination from within the cities that will require mitigation via some type of structural or, possibly, nonstructural BMP. Continued water quality monitoring of the F–M metro reach of the Red River will be an important component of both programs and will continue to provide valuable information for future municipal and regional policy decisions.

Table 1. Impaired Reaches of the Red River of the North in the Fargo–Moorhead area from 1998 Minnesota and North Dakota Section 303(d) Lists.

<b>Reach</b>	<b>Affected Use</b>	<b>Pollutant</b>	<b>Listing State</b>	<b>Target Completion</b>
Wild Rice River (ND) to F–M Dam	Swimming	Fecal coliform	MN	2007
Wild Rice River (ND) to F–M Dam	Aquatic life	Turbidity	MN	2004
F–M 12th Ave. Bridge to Buffalo River	Aquatic life	Ammonia <sup>1</sup> , low DO <sup>2</sup>	ND	High priority
F–M Dam A to Sheyenne River	Aquatic life	Ammonia <sup>1</sup>	MN	1999
F–M Dam A to Sheyenne River	Swimming	Fecal coliform	MN	2004
Buffalo River to Elm River	Swimming	Fecal coliform	MN	2004
Buffalo River to Elm River	Aquatic life	Turbidity	MN	2008

<sup>1</sup>The wastewater facility in this reach has been upgraded to meet permitted ammonia effluent limits. If subsequent in-stream data are collected that demonstrate the reach is no longer impaired for ammonia, the reach will be deleted from this list.

<sup>2</sup>Low-oxygen TMDL scheduling is dependent upon low flow conditions. The draft schedule may be changed accordingly.

Table 2. Compilation of Fecal Coliform Data for the Red River at Fargo, North Dakota, since 1990.

<b>Data Source</b>	<b>Site ID</b>	<b>Monitoring Location</b>	<b>Period of Record</b>	<b>Number of Samples</b>
MPCA	RE-452	Main Ave., Moorhead	Jan 1990–Sept 1994	44
NDDH	380084	Cass County 22	Jan 1990–Sept 1996	51
NDDH	380154	Not available	Jun 1994–Sept 1996	10
NDDH	385040	Not available	Mar 2000–Sept 2001	6
River Keepers	South	52nd Ave. So., Fargo	Jun 1999–Nov 1999	6
River Keepers	North	Clay County 22	Jun 1999–Nov 1999	6
River Keepers	Site A	Clay County 8	Jun 2000–Sept 2000	18
River Keepers	Site B	1st Ave. N., Moorhead	Jun 2000–Sept 2000	18
River Keepers	Site C	15th Ave. N., Moorhead	Jun 2000–Sept 2000	18
River Keepers	Site D	Clay County 22	Jun 2000–Sept 2000	18
FM River	1-RR	Clay County 8	Aug 2001–Feb 2002	11
FM River	2-RR	1st Ave. N., Moorhead	Aug 2001–Feb 2002	10
FM River	3-RR	Clay County 26	Aug 2001–Feb 2002	10

*MOE6B Figure 1.jpg*

Figure 1. Citizen volunteers and EERC personnel sampling the Red River in September 2001 for the FM River Project.

*MOE6B figure 2.jpg*

Figure 2. Various forms of artificial substrates used for macroinvertebrate monitoring of the Red River during 2001.

*MOE6B figure 3.jpg*

Figure 3. Conceptual FM River data management flowchart.

*MOE6B figure 4.jpg*

Figure 4. 2000 River Keepers fecal coliform monitoring results and the prior week's total rainfall for Fargo, North Dakota.

*MOE6B figure 5.jpg*

Figure 5. Geometric mean monthly Red River fecal coliform data and monthly average rainfall for Fargo, North Dakota.