

Introduction

Description of the Study Area

The Blue Earth River Watershed is one of twelve major watersheds located within the Minnesota River Basin. The Blue Earth River Watershed is located in south central Minnesota within Blue Earth, Cottonwood, Faribault, Freeborn, Jackson, Martin, and Watonwan counties and northern Iowa (Figure 1). The Blue Earth River Major Watershed area is a region of gently rolling ground moraine, with a total area of approximately 1,550 square miles or 992,034 acres. Of the 992,034 acres, 775,590 acres are located in Minnesota and 216,444 acres are located in Iowa. The Blue Earth River Watershed is located within the Western Corn Belt Plains Ecoregion, where agriculture is the predominate land use, including cultivation and feedlot operations. Urban land use areas include the cities of Blue Earth, Fairmont, Jackson, Mankato, Wells, and other smaller communities.

The watershed is subdivided using topography and drainage features into 115 minor watersheds ranging in size from 2,197 acres to 30,584 acres with a mean size of approximately 8,626 acres. The Blue Earth River Major Watershed drainage network is defined by the Blue Earth River and its major tributaries: the East Branch of Blue Earth River, the West Branch of Blue Earth River, the Middle Branch of the Blue Earth River, Elm Creek, and Center Creek. Other smaller streams, public and private drainage systems, lakes, and wetlands complete the drainage network. The lakes and other wetlands within the Blue Earth River Watershed comprise about 3% of the watershed. The total length of the stream network is 1,178 miles of which 414 miles are intermittent streams and 764 miles are perennial streams. A total of 505 miles of named streams exist within the Blue Earth River Watershed. Of the 505 miles of named streams, 482 miles are perennial and 22 miles are intermittent. Stream miles are calculated for Minnesota only. Table 1 reports the named streams of the Blue Earth River Major Watershed showing tributaries indented¹. (An asterisk denotes the streams that extend outside of the State of Minnesota).

Table 1. Named Streams and Stream Miles Within the Blue Earth River Major Watershed.

Stream Name	Total Perennial Miles	Total Intermittent Miles	Total Stream Miles
Blue Earth River	109.2	0.0	109.2
Willow Creek	9.2	0.0	9.2
Elm Creek	86.6	3.8	90.4
North Fork of Elm Creek	5.4	0.9	6.3
Cedar Creek	17.4	3.8	21.2
South Fork of Elm Creek	16.4	1.2	17.5
Center Creek	29.9	0.0	29.9
Lily Creek	10.0	4.4	14.4
Dutch Creek	8.8	4.1	13.0
South Creek	26.8	0.0	26.8
Badger Creek	13.7	1.7	15.4
Little Badger Creek	17.8	0.0	17.8
West Branch of Blue Earth River*	11.1	0.0	11.1
Middle Branch of Blue Earth River*	8.6	0.0	8.6
Coon Creek*	28.1	0.0	28.1
East Branch of Blue Earth River	58.4	0.0	58.4
Foster Creek	13.2	2.3	15.5
Brush Creek	11.8	0.0	11.8
Totals	482.4	22.2	504.6

Figure 1. Blue Earth River Major Watershed.

The mainstem of the Blue Earth River flows north-northeast toward its confluence with the Minnesota River near Mankato in Blue Earth County. The Blue Earth River is joined by the Watonwan River near Garden City, approximately one mile south of the Rapidan Reservoir in Blue Earth County. As the mainstem of the Blue Earth River flows north-northeast from its confluence with the Watonwan River, it is joined by the Le Sueur River, another major tributary, approximately 3.3 river miles from its confluence with the Minnesota River. The drainage network and watersheds of the Blue Earth, Le Sueur, and Watonwan Rivers define a sub-basin of the Minnesota River Basin referred to as the Greater Blue Earth River Watershed. Figure 1 illustrates the locations of the Blue Earth, Le Sueur, and Watonwan Rivers.

Historical Summary of the Blue Earth River and Its Tributaries

In the late 1600's Pierre Charles Le Sueur was among the earliest of the French explorers in Minnesota. A sample of bluish-green clay was obtained from a western river, where it was returned to France for assay. It was believed to be copper, therefore, in 1700 Le Sueur returned to ascend the Riviere St. Pierre (today's Minnesota River), a southern tributary named the Riviere Verte (Green River) to establish a copper mine. Fort L'huillier was established, which was named after the legendary assayer. Le Sueur left for France to return with copper and furs obtained from the Sioux. While away, the Fox Tribe attacked the fort, three Frenchmen were killed and the others fled down the Mississippi². The clay actually contained no copper, and the source of clay is not visible today.

Over a century later, Joseph Nicollet explored the abandoned location³. Nicollet named the Le Sueur River after the early explorer where he believed to have had his mine, rather than the Blue Earth. Nicollet named the area the "Undine Region" after a beautiful water sprite in German Folklore. A few of Nicollet's descriptions of his journeys along the Blue Earth River are as follows³.

Wednesday, August 15, 1838

Approximately 10 miles from the mouth of the Blue Earth River, "Here the river is very interesting, we found in the stratified bank, stone coal, and there is no doubt that the whole vegetation belongs to that formation. The current of the river is very swift and the bed was about 10-15 feet, the width of 60 feet."

The Blue Earth at a different location was described as 80 feet wide, "The waters are troubled and yellowish, as if yellow clay were in suspension; strong current."

Thursday, August 16, 1838

Observations at the junction of the Watonwan and Mankato Rivers, "The river banks are from 20 to 80 feet high. The country is still more beautiful-we proceeded on about 5-8 miles more and encamped on the Mankato (from which rocky banks we could see above the Woods and the windings of the river). This scenery is beautiful; the river is often interrupted by Rocks and Rapids. The banks are about 100 feet high and there is Sandstone with Limestone in perpendicular direction."

"At a very interesting and romantic place on the Mankato River, the banks are intervelled by the Sandstone Rocks and the River is divided by an island and is foaming over the Rapids. This country around Mankato increases in beauty and fertility the more we approach there junctions with the Minnesota. I was unable to ascertain the variety of timber on the other side of the river, on account of high water and not being provided with a canoe. It is said that Black Walnut and Butternut is abundant. I saw none on the left bank."

Friday, August 17, 1838

"The place of the Blue Earth is an almost perpendicular rock (sandstone carboniferous), the very banks of the River rise about 200 feet above. We got some of it (the Blue Earth) with great difficulty ascending and descending the heights. Red cedar and oaks dress these rocks, at some distances they appeared almost naked. There is a large sandbar island in the river, which is as rapid as above."

Historically, prior to regional settlement and agricultural development in the Blue Earth River Watershed, the area's rivers were described as high wooded banks with a network of deeply incised small streams². The landscape was divided into "The Big Woods" and the grasslands. A large reach of virgin hardwoods covered much of east central Minnesota. These hardwoods extended into the northern portion of the Blue Earth drainage. The southern portion of the Blue Earth drainage consisted of flat plains with natural grassland in which the streams cut deeply through. The Big Woods from the north extended along these steep riverbank hillsides. Located in the downstream reaches of the Blue Earth River Watershed, the streams have cut through glacial drift to expose sedimentary bedrock with channels up to 200 feet deep in certain areas.

Historical Summary of Research Related to the Blue Earth River Watershed

The Blue Earth River is a tributary to the Minnesota River. The Minnesota River has been studied extensively during the past fifteen years. The Phase I Diagnostic Study, which began in 1996, is the most recent study of the Blue Earth River and its tributaries within a watershed context. This study was not the beginning of watershed research in this region. Previously, many studies and projects have contributed to the collection of data and knowledge. The focus of this summary is to review a few of the historical milestones related to watershed management in the Blue Earth River Watershed.

Since the 1930's, there has been an increased interest in land conservation practices with the assistance of local, state and federal conservation groups. The passage of the Water Pollution Control Act in 1948 has dramatically controlled point source discharges from industrial and wastewater treatment plants. Into the 1960's, with the growth of the environmental movement, surface water and ground water were targeted areas of pollution.

The Corps of Engineers initiated "The Upper Mississippi River Comprehensive Basin Study", in response to a resolution adopted in 1962 by the Committee on Public Works of the United States Senate⁴. Approval of the "Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources," was an important federal statement. The policies and standards were utilized to investigate, create and recommend a structure for future resource planning at the basin level. The Upper Mississippi River Comprehensive Basin Study gave a brief summary of problem areas and ranked them accordingly. A summary of the results can be found in Appendix A.

The region was subdivided to identify areas with significant needs and problems according to time period. The time periods were divided into the following: short-range (to 1980), intermediate-range (1981 to 2000), and long-range (2001 to 2020). The Upper Mississippi River Comprehensive Basin Study ranked the Minnesota River Basin as a priority area for investigating the problems and needs of water and land resources in the short-range time period. The Upper Minnesota River ranked eighth, and the Lower Minnesota River ranked tenth out of nineteen areas⁴. The Lower Minnesota River includes the Blue Earth River Subbasin (currently referred to as the Greater Blue Earth River Watershed, which is comprised of the Blue Earth, Le Sueur, and Watonwan Rivers). The needs and problems identified included: water supply; water quality; flood and sediment damage; commercial navigation; recreational opportunity, and environmental preservation⁴. These items were then incorporated into priority action items.

In 1970, the United States Department of Agriculture (USDA) approved a request made by the Minnesota State Soil and Water Conservation Commission to study rivers in the Southern Minnesota River Basin⁵ (Appendix B). Participating agencies included the Soil Conservation Service, United States Forest Service, and the United States Economic Research Service. These agencies were to complete an inventory collecting and interpreting data, information, and results in the Blue Earth River Subbasin.

In 1971, the Minnesota State Legislature established the Southern Minnesota Rivers Basin Commission⁵. The commission utilized information from local citizens, local, state, and federal agencies to investigate and survey watersheds in the Blue Earth River Subbasin to create an Inventory Report. These coordination efforts were the initial advances towards the development of a comprehensive plan for environmental conservation regarding land and water resources. The Phase I Study included an inventory of natural

resources and identification of problems and needs. The Phase II Study involved a detailed investigation for the development of strategies, analysis of strategies and the recommendation of feasible solutions.

In January 1972, the above agencies prepared the Inventory Report of the Greater Blue Earth River Basin. A summary of the water and land resource problems identified in the inventory included⁵:

1. Flood damage to agricultural crops on approximately 28,000 acres of land.
2. Drainage improvements would benefit 600,000 acres of agricultural cropland.
3. Reduced soil fertility due to erosion and sedimentation. Roadside, streambank, and lake shore erosion cause sedimentation problems.
4. Continuous study is needed to determine actual and potential effects of pollution on the quality of resources, natural and man made. Accelerated pollution of many subbasin lakes and streams.
5. Water supply shortages were not apparent in the basin. Further study is needed to define future water needs in the basin.
6. Approximately 30,000 acres of agricultural land were characteristically dry.
7. Deterioration of the natural environment. Environmental planning involves everyone.

Selected priority areas for Watershed Investigation Reports and Watershed Evaluation Reports in the Blue Earth River Subbasin are located in Table 2, which included Dutch Creek, the East Fork of the Blue Earth River, Elm Creek, and Union Slough.

Table 2. Selected Priority Areas for Watershed Investigation Reports and Watershed Evaluation Reports in the Greater Blue Earth River Basin in 1971.

Priority Group I	Priority Group II
South Fork of the Watonwan River Watershed	Butterfield Creek Watershed
Maple River Watershed	Elm Creek Watershed
Dutch Creek Watershed	East Fork of the Blue Earth River
Cobb and Little Cobb Watersheds	
Union Slough Watershed	

In June 1972, the Upper Mississippi River Basin Coordinating Committee submitted the completed Upper Mississippi River Comprehensive Basin Study to the United States Water Resources Council⁶. The study provided a structure for the development and management of water and related land resources in the Upper Mississippi River Basin. A summary of the water and land resource problems identified in the Greater Blue Earth River Basin was included in the Minnesota River Basin section. The proposal suggested the development of a regional or river basin plan, coordinated by a river basin commission or other federal-state interagency organization. The focus was to concentrate on needs and desires within the next 10-15 years, following the guidelines established by the Water Resources Council.

The Southern Minnesota River Basin Commission in 1977 submitted the Minnesota River Basin Report (Appendix C). The Minnesota River Basin Report was to be used by the state of Minnesota to⁶:

1. Help formulate the Minnesota River Basin portion of the State Land and Water Resource Plan.
2. Assist the USDA in making the most effective use of the Land and Water Conservation Development Program.
3. Serve as a guide in coordinating water and related land resource development programs and projects of local, state, and federal agencies, and private groups and individuals.
4. Aid in setting priorities for water resources development within the Minnesota River Basin.

Local County Water Planning efforts were initiated in 1985. The purpose of such plans was to provide a guide for individuals and groups who are involved in water planning. The third generation of local water plans is under revision for most counties. Watershed management will be incorporated into these plans.

In 1985 a Waste Load Allocation (WLA) study was completed on the lower 25 miles of the Minnesota River. This WLA called for a 40 percent reduction in Biochemical Oxygen Demanding (BOD) material in the Minnesota River. A reduction in BOD has been linked to phosphorus. Subsequently, a phosphorus reduction strategy has been proposed for the Minnesota River Basin.

The Minnesota River Assessment Project (MRAP) began in 1989, which involved more than 30 local, state, and federal government agencies. The study was a comprehensive biological, chemical, and physical watershed assessment of the Minnesota River Basin. Flow monitoring data and water quality data were collected on the mainstem of the Minnesota River including its main tributaries. Table 3 indicates approximate water quality data collected on the Blue Earth River Watershed near its outlet at Mankato (Site 24)⁷.

Table 3. MRAP Results Indicating the Average Concentrations and Approximate Ranges of Select Water Quality Parameters for the Blue Earth River Watershed at Mankato.

Parameter	Average	Approximate Range
Total Suspended Sediment Concentration	150 mg/l	>0 - 900 mg/l
Total Phosphorus Concentration	0.3 mg/l	>0 - 1.1 mg/l
Nitrite-Nitrate Nitrogen Concentration	12 mg/l	0 - 25 mg/l
BOD	2.5 mg/l	0.25 - 13 mg/l

The Greater Blue Earth River Watershed has a large impact on the Minnesota River, which contributes to the pollution of the Mississippi River. The results of this study indicated that the Blue Earth River contributes 46% of the flow to the Minnesota River at Mankato, while delivering 55% of the suspended sediment load, and 69% of the nitrate-nitrogen load⁸. Sediment yields from the Blue Earth River Watershed were three to four times higher compared to the yields upstream at the confluence of the Blue Earth River from 1990 to 1992⁸. The nitrate concentrations in the Blue Earth River and its major tributaries frequently exceeded the Federal Drinking Standard of 10mg/l, with peak concentrations exceeding 20mg/l⁸. The fecal coliform bacteria results exceeded the standard in 32% of the samples collected from the Blue Earth River. Total phosphorous concentrations were highly elevated (200-500ug/l) during runoff periods resulting in the load deliveries of up to 15 tons/day to the Minnesota River⁸. Seventy-four percent of the samples exceeded 100ug/l in total phosphorous and 30% of the samples exceeded 100 ug/l in ortho-phosphorous⁸. A more detailed section of the results is located in Appendix D.

The study concluded that in order to attain a 40 percent reduction in BOD levels in the Minnesota River, an aggressive broad-based implementation program would be needed. The major areas of pollution to be addressed were identified as the following: bacterial contamination, sedimentation, nutrient enrichment, toxic substances, and watershed hydrologic alterations. MRAP made general recommendations on each of these pollutant areas and a final report was published in 1994.

The 40 percent biochemical oxygen demanding substance (BOD) and total suspended solids (TSS) reduction goals for the Minnesota River will be partitioned between each of the Minnesota River tributaries. A reduction goal for the Blue Earth River will be refined through this modeling process, but until that time, the 40 percent reduction goal is an appropriate target.

MRAP also called for the measurement and ranking of the most significant sources of pollution according to each sub watershed for implementation activities. These monitoring results indicate that the suspended sediment concentration of the Blue Earth River is higher than many of the other major watersheds. The Blue Earth River's average nitrate concentration is one of the highest in the Minnesota River Basin. This

Blue Earth Phase I Clean Water Partnership study was designed based on MRAP and other previous studies.

The Minnesota River Basin Water Quality Overview reports data from 1968 to 1994 by various federal and state agencies that collected water quality monitoring data to provide a comprehensive framework to understand watersheds with the largest regional effects (Appendix E). Sampling locations were located mostly at the mouth of major tributaries near the point where they enter the Minnesota River. Results indicated that the Blue Earth River Watershed contributed 19.0 percent of the sediment, 14.6 percent of the phosphorous, and 25.6 percent of the nitrates in the Minnesota River⁹.

The numerous tall, steep, and bare stream banks are of considerable interest along the Blue Earth River. Mulla, Bell and Peterson conducted a study to directly estimate the amount of sediment delivered to the Minnesota River by the Blue Earth River from slumping stream banks. Aerial photographs from 1938 and 1964, and digital ortho-photographs from 1994 were utilized to locate streambank sites with significant upper bank slumping and lower bank undercutting along the Blue Earth River. The results of this study indicated that the total amount of sediment lost from 1964 to 1994 along 136 slumping stream bank locations was 82,208 metric tons¹⁰. It was determined that approximately 60% were from 70 moderately active sites, 32% from 18 severe sites, and 8% from 48 minor sites¹⁰. Soil particle size, river flow rates, channel morphology, and riparian vegetation contribute to the varying amounts of sediment transported from the Blue Earth River to the Minnesota River. Soil particle size analysis led to the assumption that 34-40% of the slumping soil from the upper stream bank slopes could be transported by the Blue Earth River as suspended sediment to the Minnesota River¹⁰. Using these rates, the Blue Earth River was calculated as contributing 28-33% of the sediment load carried to the Minnesota River¹⁰. These figures can be compared to the amount of sediment load carried to the Blue Earth River by Highly Erodible Land (HEL) which is approximately 38%⁹. Further details of this study are located in Appendix F.

Currently, the entire Minnesota River is being modeled using the Hydrologic Simulation Program - FORTTRAN (HSPF), by the Minnesota Pollution Control Agency. HSPF is a watershed delivery/instream-processing model. The purpose for running HSPF is to partition the 40 percent reduction in BOD called for by the Waste Load Allocation (WLA) on the lower Minnesota River. Once completed, the model will be used in developing load reduction to target levels for each major tributary. The sampling sub watersheds for this Blue Earth project were sited to correspond with the watershed partitioning used in the HSPF modeling.

It is obvious that there has been a considerable amount of assessment, research and implementation in the region since the 1930's. However, the approach to watershed management in the past utilized the top-down approach, which has proven itself unsuccessful. The perspective of today's approach to watershed management is from the bottom-up, generating local interest and ownership within the watershed. Local citizens have been engaging in these activities for a number of years. The Minnesota River Citizens Advisory Committee was formed in 1992 to provide local input from a diverse group of citizens about the Minnesota River. In 1998, the Blue Earth River watershed team (Blue Earth Watershed Implementation from the Local Level or WILL) was formed to specifically target efforts within a smaller geographical area. In addition, the re-organization, communication, and flexibility of local, state and federal agencies and government in watershed management will contribute, establish and maintain the necessary technical support for the citizens. Continuous efforts involving local citizens, local, state, and federal governments and agencies will advance watershed management.

Summary of Information for the Blue Earth River Watershed

Introduction

The Minnesota River and its tributaries are waters of concern for the state of Minnesota. The Minnesota River currently does not meet federal water quality standards and is a major source of pollution to the Mississippi River. The overriding public policy goal of the state of Minnesota, enunciated by former

Governor Arne Carlson in September of 1992, is to restore the Minnesota River to fishable and swimmable conditions in 10 years (2002).

Local development throughout the Blue Earth River Watershed places a high priority on water quality issues. County Comprehensive Local Water Plans have indicated that area residents rank water quality as a top priority for their local communities. County water issues in the Blue Earth River Major Watershed are ranked by priority. The ranking of each County's water issues is included in the summaries of the County Comprehensive Local Water Plan Goals and Objectives (Appendix G).

Water Resources Integrity

"We need to see the rivers in their entirety."¹¹ Watersheds are dynamic, continually changing towards a relatively stable equilibrium. This balance may be interrupted by natural or unnatural conditions. Watershed management requires careful, flexible planning and implementation to fit the physical, chemical and biological characteristics of the waters of concern. The environmental movement has placed a demand on "ecosystem management" to be an integral component of natural resources management in urban and rural settings. Ecosystem management provides an appropriate link between the natural unit of the hydrosphere, the watershed, and the need for environmentally sensitive management of the nation's land and water resources.¹²

Population

Throughout recent years rural Minnesota has been impacted by emigration. According to the 1990 Census, the total population of the Blue Earth River Watershed is 35,350¹. Table 4 indicates an estimate by decade of the population in the Blue Earth River Watershed from 1940 to 1990 (United States Census Bureau). Over the past fifty years, the population of the Blue Earth River Watershed has fluctuated (Table 5). A percent change of the population in the Blue Earth River Watershed was also calculated. From 1940 to 1960 the population increased slightly, however, from 1960 to 1990 the population has continued to decrease. Overall, the watershed has experienced a decline in population with an aging population. A detailed description of the cities and townships within the Blue Earth River Watershed is located within each sub watershed description. Population data are located in Appendix H.

Table 4. Total Estimated Population from 1940-1990 in the Blue Earth River Watershed, Including Cities and Townships.

Year	Population
1940	42,205
1950	43,258
1960	45,774
1970	39,037
1980	38,552
1990	35,350

Table 5. Estimated Percent Change in Population within the Blue Earth River Watershed by Decade.

Time Frame	Percent Change
1940-1950	+ 2.49
1950-1960	+ 5.82
1960-1970	-14.72
1970-1980	- 1.24
1980-1990	- 8.31

Urban Economics

Improving water quality in the Blue Earth River Watershed is associated with urban economics and improving the quality of life. An increase in local commitment towards improved water quality can attract and enhance local businesses and development for residents and nonresidents throughout the area. Local residents may be more inclined to spend their time and resources in their local urban sector versus traveling outside their home area. However, there is an increased aging population, located in smaller rural communities within the Blue Earth River Watershed. This aging population survives on fixed incomes, making changes such as septic upgrades an economic challenge. In addition, the economics of this region is tied closely to sustainable agriculture, companies and communities relying on the agricultural sector. An overall collection of local efforts can enhance the development and sense of pride and ownership linked to regional economics and environmental quality in the Blue Earth River Watershed.

Groundwater and recharge areas are of concern in the Blue Earth River Watershed. In Freeborn County, there are geological sensitive areas located along the East Branch of the Blue Earth River and the western boundary of this watershed. Faribault County has been using local criteria to identify highly sensitive areas where interconnections between surface and ground water conditions exist within the major watersheds. Monitoring and an inventory of wells require attention to prevent contamination of groundwater throughout the Blue Earth River Watershed.

Agricultural Economics¹³

The natural resources and climate in south central Minnesota is favorable for crop production. Corn and soybeans make up the majority of agricultural crops, generating the highest average yields in the state. The relatively flat landscape is conducive to large farms. Therefore, farmers in the area have been able to take advantage of modern machinery and weed control methods to substantially increase the acreage farmed, spreading fixed assets over more bushels produced, resulting in lower unit costs of production. Recent advances in planting equipment with high residue tolerance, especially drills compared to 30 inch rows, offer a 10-15% yield boost for soybeans. Also, new weed control technologies have made it possible to plant soybeans in high residue without sacrificing yield. However, it is still common to fall-till soybean stubble intended for corn, which greatly increases erosion potential.

Farmers are succeeding in reducing unit cost of production, which helps to maintain net income in a period of sustained low prices caused by global competition. Farmers have little or no influence on the market price of their output. It is by reducing prices that they can achieve higher net income. Corn and soybean production provides the base of which the regional economy is devoted to converting these basic foodstuffs into higher value products. This includes feed mills, corn/soy processing and the livestock and meat processing industry.

Poultry and hogs are the predominant types of livestock in this region. Poultry has become fully industrialized, and vertically integrated with producers tied to feed manufacturers and/or meat processors by specific contracts at a large scale. The hog sector is rapidly going the same way, with more vertical integration among feed suppliers, producers, and meat packers. This is resulting in a more uniform and regular supply of hogs and poultry to the processor, and production efficiencies throughout the marketing chain resulting from better coordination and economies of scale. Recently, prices for hogs have plummeted, and recovered somewhat, which may be due to the new industrial structure where production is less responsive to market price signals because more is marketed through contracts instead of through open market.

Agriculture impacts the environment in a number of ways. First, farms with larger equipment increase soil compaction, often using deep tillage to break up compaction, potentially increasing erosion. Second, large livestock operations concentrate the production of manure, and odors. However, they also have a greater capability to use modern technology to design runoff controls, and test and apply manure. Third, food processors can be the main sources of point source phosphorous in the basin. Phosphorous management plans and/or pretreatment will be required to meet phosphorous goals for the basin. The Mankato Waste

Water Treatment Plant (WWTP) has been involved in this process with future efforts to continue throughout the watershed.

The greatest challenge is to develop and implement pollutant-reduction best management practices (BMPs) that are consistent with the global environment in which agriculture competes. Natural resource use can be efficiently enhanced, according to the University of Minnesota recommendations. Pollutant loads generated at the primary and secondary (crop and livestock) stages of agricultural production can be reduced. Pollution prevention and improved industrial resource utilization at the tertiary stage (food processing) can also be developed.

Indications are that agriculture will continue to develop from a mass commodity industry driven by production economics to a producer of differentiated products in a demand-driven sector. Biotechnology will result in the ability to customize crops such as corn and soybeans for specific end-uses. Retailers will demand such products, and the food industry will respond. Groups of farmers, as individuals or co-op members will produce to specifications, receiving a price premium for the quality of their product.

Biotechnology is also likely to enable producers worldwide to produce food more efficiently in challenging environments, therefore, export markets for traditional commodities may gradually be depleted as more countries become self-sufficient in basic foodstuffs. This would keep a lid on prices, including land prices. The niche markets will generate some opportunities for farm production that can capture higher prices. However, improving technology will reduce overseas demand for basic foodstuffs. As a result, different types of foods are substitutes for each other, so competition will put an upper bound on premium available to farmers.

Agricultural Drainage

When the first settlers arrived, much of the Blue Earth River Watershed was covered with water year-round, in the form of small, shallow, weedy lakes called sloughs or potholes. The land in this condition was unsatisfactory for fishing, aesthetic purposes, and cultivation. These lakes and sloughs were useful in water retention, which helps to prevent flooding, but many of these areas have been drained with only a few of the larger lakes remaining. Rich, easily cultivated soil needs warmth, moisture and an ample growing season to produce first-class farm crops. Overall, farmland drainage can improve farm profits, aid local economies and increase property tax bases¹⁴. Fortunately, well-coordinated climatic conditions make this possible and help to justify the characterization of the Blue Earth Watershed as one of the most fortuitously endowed agricultural regions of the world.

Since the 1900s, the majority of wetlands in this geographic region were drained and tiled for agricultural purposes. The first drainage work consisted of small shallow ditches designed to remove surface water for pasture lands. Initially this was completed by hand digging. The "bull-ditchers" followed using a very large plow, with the power supplied by oxen to open ditches from one to four feet in depth. It was common that 50 to 75 yoke of oxen would be utilized to open such ditches. County Ditch No. 1, located in Clark and Foster Townships of Faribault County, was laid in 1905 and completed in 1906. Many other such ditches were built between 1905 and 1920. These were open ditches, which opened and deepened natural streams, by conveying water to the Blue Earth River and its tributaries. Many of these were designed with large amounts of tile construction; the tile lines drained into the ditches.

In the early 1900s, the concept of public work to provide drainage came into its own. Laws were so designed to use the power of eminent domain upon the benefits concerned and payment would have to be made from the benefits accrued by the improvement of the land. While the public laws and construction were necessary to provide channels and outlets, contractors and individuals constructed the larger portion of public drainage systems in the watershed. Modern agriculture usually requires tile drains at intervals of 75 to 100 feet apart. The effects of such drainage have naturally increased the productivity of the lands in this watershed.

The need for further drainage was still extensive in 1976. The design of the many original systems became insufficient as outlets for modern drainage. Additional drainage will be costly, and extensive. However, in

view of increased land valuation, it is reasonable to suppose that the work can be done and paid for without undue hardship on landowners. It appears that the drainage systems, both public and privately constructed in this county, have been both necessary and profitable. A large share in the increase in farm productivity is demonstrated to have been the result of proper drainage.

Drainage maintenance throughout the Blue Earth River Watershed has been costly. A collection of drainage information for each county within the Blue Earth River Watershed is located in the County Water Plans (Appendix G). For example, the maintenance cost of repairs related to drainage ditches cost Faribault County \$174,716 in 1995, and Martin County \$530,205 in 1985. The collection of drainage maintenance data, including cost and frequency of repairs is critical within the watershed to determine priority sites and utilize alternative methods to prevent future problems. Advances in tiling technology have allowed landowners to improve existing installations (tiling at closer distances) and drain new lands at an accelerating pace¹⁴. In some cases, these new installations are overwhelming the capacity of existing ditch systems to handle the flow of water during peak periods.

The political environment of drainage varies throughout the watershed. The local County Commissioners have different views on what to do with existing systems. Now that some drainage systems are approaching an age of 70 to 100 years, they are not functioning efficiently due to the design or system exhaustion. Some decision makers believe that water storage to the landscape is important both for the environment and the functioning of the existing drainage system. Others believe our deteriorating tile should be replaced and even increased in capacity. Surface tile intakes present another problem. These intakes can provide relatively direct conduits for the movement of sediment and other pollutants into surface waters. Amendments to existing laws could allow alternative drainage systems to develop, thereby helping drainage and environmental protection become more compatible in the Blue Earth river Watershed.

Public Drainage

There are a total of 1,724 miles of public drainage ditch systems in the Blue Earth River Watershed in Minnesota. Of this total, 333 miles are open ditches and 1,391 miles are tiled. The asterisk (*) in Table 6 denotes those sub watersheds partially located in Iowa. Public drainage is augmented by extensive private tiling, which contributes to the increased movement of water throughout the watershed.

Table 6. Public Drainage in the Blue Earth River Watershed.

Sub Watershed	Stream Name	Miles Public Ditch Open	Miles Public Tile	Total Miles Public Ditch System
BP1	Blue Earth River	0	0	0
BP2	Blue Earth River	0	60	60
BS1	Elm Creek	22	144	165
BS2	Blue Earth River	5	71	76
BS3	East Branch of the Blue Earth River	82	260	342
BS4*	Blue Earth River	25	82	107
BT1	Lily Creek	9	26	35
BT2	Lake George	10	62	73
BT3*	South Creek	21	127	148
BT4	Center Creek	8	69	77
BT5	Willow Creek	30	92	122
BT6	Cedar Creek	4	54	58
BT7*	West Branch of the Blue Earth River	0	6	6
BT8*	Blue Earth River	0	0	0
BT9*	Coon Creek	45	74	119
BT10	Badger Creek	58	141	199
BT11	Elm Creek	14	123	138
Unsampled Area		0	0	0
Total		333	1,391	1,724

Crop Residue Survey Results

Crop Residue Management is an effective approach to reduce and prevent erosion. Crop residue from the previous year protects soil from the impact of raindrops and allows the soil to capture water thus reducing and preventing runoff. Each county conducts a crop residue survey in the spring to estimate the percentage of corn planted into greater than 15 percent residue and soybeans planted into greater than 30 percent residue. The results are used to determine the percent of cropland meeting the residue targets. Table 7 indicates crop residue survey results for the counties located in the Blue Earth River Watershed from 1995-1999 from the transect survey results collected by the Soil and Water Conservation Districts and analyzed by the Board of Water and Soil Resources (BWSR)¹⁵.

According to Table 7, Blue Earth County has decreased notably in the percentage of cropland meeting residue targets in the past few years, with the lowest value of all counties within the Blue Earth River Watershed. Watonwan County's crop residue survey results have slightly decreased over the past five years. Cottonwood, Jackson, and Martin Counties have shown fluctuating increases in the percentage of cropland meeting the target residue. Results were only available for Faribault County in 1995 and 1996, indicating an increase that is limited to minimal data collected. Freeborn County did not participate in the crop residue transect survey. A summary table of all participating counties in the crop residue survey is located in Appendix I.

Table 7. Crop Residue Survey Results for the Counties Located in the Blue Earth River Watershed from 1995-1999.

County	1995 % of Cropland Meeting Residue Targets	1996 % of Cropland Meeting Residue Targets	1997 % of Cropland Meeting Residue Targets	1998 % of Cropland Meeting Residue Targets	1999 % of Cropland Meeting Residue Targets
Blue Earth	41	59	51	11	6
Cottonwood	59	67	73	62	70
Faribault	34	45	NA	NA	NA
Freeborn	NP	NP	NP	NP	NP
Jackson	21	38	61	57	66
Martin	56	66	78	63	76
Watonwan	40	46	NA	38	29

NA – Non-Applicable NP – Non-Participating

Fertilizer and Pesticide Use

The use of chemicals by the agricultural and urban sector can affect surface water and groundwater from the runoff that occurs. The 1999 Minnesota Agricultural Statistics published by the U.S. Department of Agriculture contains data related to fertilizer and pesticide use for corn and soybeans, which are the major crops in the Blue Earth River Watershed¹⁶. A summary of this information is located in Appendix J.

The following results reflect fertilizer and pesticide use for corn. In Minnesota, 96 percent of the cropland had nitrogen applied. Nitrogen was applied at 125 pounds per acre. Phosphate was applied to 91 percent of the cropland, which was applied at 52 pounds per acre.

The following results reflect pesticide use for corn. Herbicides were applied to 97 percent of the cropland throughout the state of Minnesota, and insecticides were applied to 10 percent of the land. Dicamba and Atrazine were two of the most common types of herbicides applied to the land. Dicamba was applied at a rate of 0.37 pounds per year, and Atrazine was applied at 0.65 pounds per year.

The following results reflect fertilizer use for soybeans. In Minnesota, 18 percent of the cropland had nitrogen applied. Nitrogen was applied at 23 pounds per acre. Phosphate was applied to 17 percent of the cropland at 33 pounds per acre.

The following results reflect pesticide use for soybeans. Herbicides were applied to 97 percent of the cropland throughout the state of Minnesota, and insecticides were negligible. Glyphosate, Imazamox, Imazethapyr, Pendimethalin, and Trifluralin were the most common types of herbicides applied at 0.96, 0.03, 0.03, 1.23, and 0.88 pounds per year, respectively.

Streambank Erosion/Stream Blockades

The Blue Earth River is deeply entrenched, and additional monitoring is needed to quantify streambank erosion in order for the counties within the Blue Earth River Watershed to develop a streambank erosion control program to correct existing problems and prevent future complications. An inventory of river blockades throughout the Blue Earth River Watershed is needed for the removal and relocation of selected blockades to control streambank erosion. These monitoring results, along with additional water quality parameters, can provide direction and a focus of efforts to address critical water quality issues in the Blue Earth River Watershed.

Stream Use Classification

The Minnesota Pollution Control Agency (MPCA), Water Quality Division classifies the waters of the state to designate appropriate water uses¹⁷. Specific stream classifications in the Blue Earth River Watershed are shown in Table 8. All other creeks, streams, and rivers in the watershed are classified for all uses except domestic consumption. The following is a listing of the classification of the waters by use:

Class 1	Domestic Consumption
Class 2	Aquatic Life and Recreation
Class 3	Industrial Consumption
Class 4	Agriculture and Wildlife
Class 5	Aesthetic Enjoyment and Navigation
Class 6	Other Uses
Class 7	Limited Resource Value

Table 8. Stream Use Classification in the Blue Earth River Watershed

Stream Name	Location	Classification
Badger Creek	T101, 102, R28	2C
East Fork of the Blue Earth River	Brush Creek to mouth	2C, 3B
West Fork of the Blue Earth River	Iowa border to mouth	2C, 3B
Brush Creek	Iowa border to mouth	2C
Cedar Run Creek	T103, 104, R32, 33	2C
County Ditch No. 45, Bricelyn, Owatonna Canning, Co.	T101, R25, S7, 8, 16, 17 T101, R26, S1, 12 T102, R26, S36	7
North Fork of Elm Creek	T104, R34	2C
South Fork of Elm Creek	T103, R34	2C
South Creek	T102, 103, R28, 29, 30	2C, 3B
Foster Creek (excluding Class 7 segment)	T102, 103, R24	2C
Foster Creek, Alden	T103, R23, S31, 32 T103, R24, S25, 36	7
Unnamed Ditch, Bricelyn, Owatonna Canning Co.	T101, R25, S10 T102, R23, S4, 5	7
Unnamed Ditch, Alden	T102, R23, S4, 5 T103, R23, S31, 32	7

Protected Flow

The United States Geological Survey (USGS) monitors the water level on the Blue Earth River near Rapidan Dam. The Minnesota Department of Natural Resources (MN DNR) has established a protected interim flow of 21 cfs (cubic feet per second) on the Blue Earth River at this site. Historically, the Blue Earth River has been sampled since 1949 in Section 6 of Rapidan Township. In 1965 the river reached its flood record flow of 43,100 cfs at this site.

Rapidan Dam

The Rapidan Dam, located at river mile 11.8, is a permanent fish barrier on the Blue Earth River. The dam has been in place since 1903, which has resulted in a large accumulation of silt in the reservoir. There has been discussion concerning the fate of this historic structure. Removal of the dam would cause the massive amount of silt to flow down the Blue Earth River, reaching the Minnesota River. However, repairing the dam would be less expensive than dam removal, which would allow the generation of hydroelectric power to continue. There is further discussion concerning the dam located in the recreation section and the implementation plan for the Blue Earth River Watershed.

Shoreland Classification and Protected Waters

The Shoreland Management Zoning Classification of lakes is based on current DNR approved shoreland ordinances.

Natural Environment – This classification is intended for those waters needing a significant amount of protection because of their unique natural characteristics or their unsuitability for development and sustained recreational use. They are usually shallower lakes, with marginal soil that can be eroded easily. They are also assigned the more restrictive development standards.

Recreational Environment – This classification is intended for those waters that are larger in size than natural environment lakes, but still need protection. Development can occur on these lakes, but special considerations have to be used to help achieve minimal impact for the lake.

General Development – This classification is intended for those bodies of water which are at the present highly developed or which, due to their location, may be needed for high density development in the future. The lakes are able to withstand high levels of activity because of the type of soil or other features inherent to the lake. These lakes are assigned the least restrictive development standards.

The Protected Water Inventory (PWI) Classification include:

P – Protected (Public-Water)

W – Protected (Public Waters) Wetland

N – Not Protected Water or Wetland

A – Protected Water or Wetland in Adjacent County; not protected in the indicated County

R – Renumbered; water has been assigned a legal Protected Waters Inventory number different from historic Bulletin 25 identification number.

Lakes

There are a total of 47 named lakes in the watershed covering 9,931 acres. Lake location can benefit the water quality of down gradient streams within a watershed by providing a sink for nutrients and sediment. However, lakes need to be protected from excessive pollutants as well. Information pertaining to the lakes in the Blue Earth River Watershed is located in Table 9.

Table 9. County, Acres, Shoreland Class and PWI Class for Lakes in the Blue Earth River Watershed.

Name	County	Acres	Shoreland Class	PWI Class
Amber Lake	Martin	182.06	General Development	P
Big Twin Lake	Martin	452.62	Natural Environment	P
Budd Lake	Martin	224.46	General Development	P
Buffalo Lake	Martin	248.94	Natural Environment	P
Buffalo Lake	Martin	100.34	Natural Environment	P
Canright Lake	Martin	39.52	Natural Environment	P
Cedar Lake	Martin	720.82	Natural Environment	P
Clam Lake	Martin	69.60	Natural Environment	P
Creek Lake	Martin	148.17	Natural Environment	P
Eagle Lake	Martin	132.63	Natural Environment	P
East Chain Lake	Martin	482.52	Natural Environment	P
Fish Lake	Martin	152.71	Natural Environment	P
Fox Lake	Martin	932.19	Recreational Development	P
George Lake	Martin	85.03	General Development	P
Hall Lake	Martin	551.09	General Development	P
High Lake	Martin	87.59	Natural Environment	P
Ida Lake	Blue Earth	111.72	Natural Environment	P
Iowa Lake	Martin	511.18	Natural Environment	P
Kiester Lake	Martin	45.60	Natural Environment	P
Lake Charlotte	Martin	121.17	Natural Environment	P
Lake Imogene	Martin	192.21	Natural Environment	P
Lake Independence	Jackson	97.08	Natural Environment	P
Lake Seymour	Martin	46.74	Natural Environment	P
Laurs Lake	Jackson	188.56	Natural Environment	P
Little Hall Lake	Martin	37.87	Natural Environment	P
Little Twin Lake	Martin	71.57	Natural Environment	P
Luedtke Slough	Martin	24.34	Not in shoreland program	N
Martin Lake	Martin	302.12	Natural Environment	P
Morin Lake	Freeborn	20.10	DNR Classified-RD	P
Mud Lake	Martin	114.71	Natural Environment	P
Murphy Lake	Martin	49.14	Natural Environment	P
North Lake	Martin	123.51	Natural Environment	P
North Silver Lake	Martin	200.68	Natural Environment	P
Porter Lake	Blue Earth	25.05	Not in shoreland program	W
Reinke Slough	Blue Earth	15.98	Not in shoreland program	W
Rice Lake	Faribault	257.03	Shoreland Residential	P
Rose Lake	Martin	391.34	Natural Environment	P
Round Lake	Martin	45.68	Natural Environment	W
Sager Lake	Martin	206.87	Natural Environment	P
Sisseton Lake	Martin	141.85	General Development	P
South Silver Lake	Martin	246.25	Recreational Development	P
South Walnut Lake	Faribault	345.75	Shoreland Agricultural	P
Swag Lake	Martin	70.47	Natural Environment	P
Twin Lake	Martin	8.95	Not in shoreland program	P
Walnut Lake	Faribault	686.12	Shoreland Agricultural	P
Watkins Lake	Martin	260.38	Natural Environment	P
Wilmert Lake	Martin	360.36	Natural Environment	P
Total Acres		9930.7		

Fishery Surveys

The Blue Earth River was once noted for smallmouth bass, walleye and other game fish. A special study conducted by the Minnesota Department of Conservation associated a decline in the smallmouth bass fishery with fluctuating water levels and turbidity, while discounting “high water temperature and pollution problems.”¹⁸. Anglers have also noted the decline of this popular species over time. Historically, the Blue Earth River has supported a variety of game fish including channel catfish, smallmouth bass, walleye, sauger, and northern pike. Currently the Blue Earth River provides good fishing in some areas, such as below the Rapidan Dam. Smallmouth bass and walleye are stocked in the river, and additional population assessments provide the opportunity to evaluate these stockings.

The MDNR has conducted stream surveys on the Mainstem of the Blue Earth River. The initial survey was conducted in 1980, which included 14 sampling stations covering the east, middle, and west branches of the Blue Earth River. Data collected from stations included: type and number of fish, physical stream characteristics, and general land use information. Fish were sampled using trap-nets or electroshocking equipment. The type and abundance of common invertebrates was assessed. Selected water quality data were also collected from sites. The initial survey also noted the importance to evaluate and document the impacts of the Rapidan Dam on the fishery above and below the dam.

Population assessments were also conducted on the Blue Earth River from 1983 to 1990, and 1992 at sampling locations above and below the Rapidan Dam. A creel survey was conducted from May through September 1984-1985, which determined that 16,234 angler hours were spent on the river in 1984 and 22,730 angler hours in 1985. Most fishing on the Blue Earth River occurs directly below the Rapidan Dam, where anglers are successful at catching channel catfish and walleye.

Previous studies indicate that fishing above the dam favors northern pike and walleye when strong year classes are present in the fishery. Walleye fry have been successfully stocked in the Blue Earth River and a number of tributaries, including the Watonwan River, Walnut Lake, and Lake Hanska, all of which drain into the Blue Earth River. The yearling walleyes are strongly correlated with successive fry stockings in the upper Blue Earth River and tributaries. Thus, management of the walleye is beneficial and inexpensive. Below the dam, fishing is favorable for smallmouth bass, walleye, and sauger. Again, the amount of smallmouth bass caught has been associated with fingerling stockings two to three years previously. Maintenance of the smallmouth bass is necessary to maintain this fishery; however, these stockings were discontinued in 1991 to determine the contribution of previous stockings. In addition, the Northern Pike fishery has varied contingent upon water levels in the east branch of the Blue Earth River. Year classes of this species are often produced in Walnut Lake, which migrate to the Blue Earth River.

Copies of the standard reports are available from the Waterville Fisheries Station. The methodology used for stream surveys is contained in the publication titled, “Minnesota Stream Survey Manual (1978).” The purpose of this summary is to acknowledge the fisheries resource in the Blue Earth River, and to help all that are involved to improve fishing opportunities for the public.

The Stream Management Plan defines the Mainstem of the Blue Earth River according to type, fish species management, ecological classification, goals, and operational plans for stream miles. The following items are abstracted directly from the stream management plan:

Stream Type:	Warm water
Ecological Classification:	Mainstem of Blue Earth River, miles 0-11.8 class IIE Mainstem of Blue Earth River, miles 11.8-95.7 class IIC West Branch of Blue Earth River, III Middle Branch of Blue Earth River, III East Branch of Blue Earth River, III
Species Managed:	Walleye
Stocking Plan:	1,207,500 fry on alternate years (1989-present)

Recreation

There are recreational values related to improving the river systems in the Blue Earth River Watershed. Communities are connected to the river systems through a variety of activities including: historic, cultural, scenic, wildlife management areas, boat and canoe accesses, camp sites, hiking and biking trails. The Minnesota River Comprehensive Recreational Guidance Document and Trail Corridor Concept Plan was developed for the State of Minnesota to serve as a tool for the people of the Minnesota River Basin to manage and enhance the quality and quantity of recreational opportunities in communities (Appendix K).

Many residents in the community are avid fishing enthusiasts connecting them to the rivers and lakes. However, many feel that there has been a decline in the quality of fishing. Therefore, restoration efforts throughout the Blue Earth River Watershed can provide local people and many others with another recreational resource to be utilized, allowing for economic improvement throughout the watershed. The Minnesota Department of Natural Resources (MN DNR) has managed the Blue Earth River as a fishery for walleye, catfish, and northern pike. Within the watershed, Judson Township in Blue Earth County contains three designated trout streams (Appendix G). Currently there are no classified trout streams in Faribault and Martin Counties, but there is an interest at the county level along with local support to upgrade water quality conditions to meet trout stream standards. Faribault County has limited opportunities for water-based recreation and is generally not known as a tourist area for providing these recreational opportunities. However, this could change with water quality improvements throughout the watershed.

Many lakes located in the Western Corn Belt Ecoregion are shallow and are subject to eutrophication. Most lakes in Martin County have a relatively "good" population of game-fish species, such as northern pike, walleye, yellow perch, channel catfish, and crappie. Martin County has been involved with the DNR to currently manage fisheries in Elm Creek, Center Creek, and Cedar Run Creek. These successful efforts must continue to improve recreation and wildlife conditions in the Blue Earth River Watershed.

Other sources of recreation and value to the Blue Earth River Major Watershed include wetland ecosystems and wildlife management areas that support a diversity of wildlife and provide additional economic benefits to the area. The Blue Earth River Valley and riparian wetlands serve as an important wildlife corridor. Local residents, as well as those visiting, can enjoy the recreational opportunities that these sites offer. Active sportsmen's groups within the watershed have the ability to contribute to the economic well being of the watershed by supporting these efforts.

The Blue Earth River Major Watershed contains Rapidan County Park, which is located at the west shore of the Rapidan Dam on the Blue Earth River. The park provides picnic areas, playground areas, and a view of the river valley and Rapidan Dam. The Rapidan Dam is historically a popular attraction for local residents and tourists. Local attention has focused on County efforts to enhance the park and to provide a canoe access below the Rapidan Dam. The park at Rapidan Dam provides a view of the river valley and the Dam. Blue Earth County has investigated removing the dam, maintaining the existing dam, or constructing a new dam. Removing the dam would have significant environmental effects because of sediment that has settled behind the dam. This is of particular importance to the Blue Earth River Major Watershed.

Concerns related to the removal of the dam include the potential for downstream movement of accumulated sediment, loss of a historic landmark, loss of hydroelectric generation, and cost. Benefits of dam removal include free movement of fish, restoration of high gradient reach of the Blue Earth River, elimination of water quality problems associated with the reservoir, and the potential for cost savings over the long term.

The Blue Earth River Valley is a scenic feature of the Blue Earth River Major Watershed. Faribault County has many unique scenic features including the hills of Kiester, the Blue Earth River Valley and small pothole lakes. Faribault County is taking the necessary steps to protect these areas to ensure their survival for the next generation. The gravel prairie and the remaining Mixed Forest are two sensitive communities, which are home to a number of endangered species. In Faribault County, all of the main channels of the Blue Earth River and some of the branches are scenic areas that have a high population of wildlife, including a pair of nesting bald eagles.

Recreational Land Uses and Parks

There are a variety of recreational uses throughout the Blue Earth River Watershed including fishing, swimming, picnicking, camping, canoeing, and hiking. The location of parks in Blue Earth, Faribault, and Martin Counties enable local citizens and tourists to enjoy these resources in the communities and increase local revenue. Canoe routes are designated reaches used by the public. The recreational lands and parks are identified in Table 10.

Table 10. Recreational Land Uses and Parks in the Blue Earth River Watershed.

Facility Name	County	Location	Acres	Resource Type
Rapidan County Park	Blue Earth	T107N, R27W, S7	3.4	Fishing, Picnicking
Phil's County Park	Faribault	T102N, R24W, S17	19	Camping, Picnicking
Woods Lake County Park	Faribault	T101N, R27W, S19	37	Fishing, Swimming, Picnickng, Hiking, Biking
Morin Lake	Freeborn			Water-Access Trailer
Cedar Lake & Hanson Memorial	Martin	T104N, R34W, S30/S24	24	Picnicking, Hiking,
Timberlane County Park	Martin	T101N, R30W, S32	50	Picnicking, Hiking
Klessig County Park	Martin	T101N, R30W, S32	1	Fishing, Swimming, Picnicking Water-Access Trailer
Wolter County Park	Martin	T101N, R29W, S7		Picnicking, Swimming, Picnicking
Amber Lake Park	Martin	T102N, R30W, S30	3	Fishing, Picnicking

Wildlife Management Areas

There are fifteen Wildlife Management Areas (WMAs) located in the watershed, covering approximately 3,935 acres (Table 11).

Table 11. Wildlife Management Areas Located in the Blue Earth River Watershed.

County	Name	Township-Range-Section	Acres	Use
Martin	Caron W.M.A	T103N, R33W, S23-26	414	Hunting/Hiking
Martin	Krahmer W.M.A.	T103N, R31W, S30-31	360	Hunting/Hiking
Martin	Fox Lake State Game Refuge	T102N, R32W, S3-10	34	
		T103N, R32W, S31-34		
Martin	Leudtke W.M.A	T102N, R29W, S15	160	Hunting/Hiking
Martin	Isalnd W.M.A	T102N, R31W, S29	45	Hunting/Hiking
Martin	East Chain W.M.A	T101N, R29W, S6-7 T101N, R30W, S12	233	Hunting/Hiking
Martin	Minowa W.M.A	T101N, R31W, S33-34	99	Hunting/Hiking
Martin	Swag W.M.A.	T101N, R31W, S6	80	Hunting/Hiking
Faribault	Lane W.M.A.	T103N, R28W, S20 and S29	61	Hunting/Hiking
Faribault	Lake Guckeen W.M.A.	T102N, R28W, S5	54	Hiking
Faribault	Walnut Lake W.M.A.	T102N, R25W, S1-2, S11-13 T102N, R24W, S6-8, S18 T103N, R25W, S36	2,094	Fishing/Hunting/Hiking
Faribault	Wells W.M.A	T103N, R24W, S15	30	Hunting/Hiking
Blue Earth	Evans W.M.A	T106N, R29W, S34	84	Hunting/Hiking
Blue Earth	Gage W.M.A	107N, R27W, S32	31	Fishing/Hunting/Hiking
Blue Earth	O.A. Vee Memorial W.M.A.	T108N, R27W, S30 T108N, R28, S26	156	Hunting/Hiking

Unique Features and Scenic Areas

The focus of the Minnesota Department of Natural Resources, Division of Ecological Services is to collect, analyze and deliver ecological information to the public, creating a better understanding and appreciation of unique ecosystems, and their importance for a sustainable quality of life. Information is collected into a database regarding rare resources and exotic species, to identify, locate, and manage those species.

The Blue Earth River Watershed is primarily located in the Prairie Grassland Community. Dry Prairies, Dry Oak Savannas, Mesic Prairies, Wet Prairies, and Calcareous Seepage Fens are natural communities found in the watershed. Prior to European settlement, the prairie was dominated primarily by tall grass such as big bluestem, sparsely vegetated areas, and many wetlands. Along many of the stream floodplains there were forests of silver maple, elm, cottonwood, and willow. Typical animal species included the bison, elk, upland sandpiper and the sandhill crane. However, since European settlement, the original state of the ecosystem has been altered for agriculture and urbanization.

The Blue Earth River Valley is a scenic asset of the Blue Earth River Watershed. The park at the Rapidan Dam provides a view of the river valley and the historic dam. High bluffs and some bedrock exposure are noticeable along the downstream reaches of the Blue Earth River.

Scientific and Natural Areas

There is one Scientific and Natural Area located in the Blue Earth River Watershed, which is located in Table 12.

Table 12. Scientific and Natural Areas in the Blue Earth River Watershed.

Name	County	Location	Acres	Resource Use
Osmundson Prairie	Faribault	T101N, R24W, S36	9	Hiking

Historical Sites

There are a variety of official historical sites located throughout the watershed. The Minnesota River Comprehensive Guidance Document and Trail Corridor Concept Plan lists historical sites located in the Blue Earth River Watershed. Table 13 indicates the official historical sites located in the Blue Earth River Watershed. Locations of these sites can be found in Appendix K.

Table 13. Historical Sites in the Blue Earth River Watershed.

County	Resource Type	Description
Faribault	Historic Site	Faribault County Courthouse
Faribault	Museum	Faribault County Historical Museum
Faribault	Historic Site and Museum	Wakefield House
Faribault	Museum	Elta Ross Historical Museum
Faribault	Museum	Winnebago Area Museum
Martin	Historic Site	Fairmont Opera House
Martin	Historic Site	Martin County Courthouse
Martin	Historic Site	Livingston Log Cabin
Martin	Historic Site	George Wohlhunter Mansion
Martin	Historical Marker	Singing Oak Indian Legend
Martin	Pioneer Museum	Martin County Historical Society
Martin	Historic Site	Chubb House
Martin	Interpretive Center	Heritage Acres
Martin	Museum	Welcome Historical Museum
Martin	Museum	Trimont Museum
Martin	Sisseton Sioux Model RR Club	

Human Health

The ecological integrity of the Blue Earth River and its tributaries are directly connected to human health. There is a need to upgrade and continue monitoring feedlots; to upgrade and develop urban storm water management plans; to upgrade and monitor individual septic treatment systems; to upgrade unsewered communities; and to upgrade and monitor waste water treatment facilities and industries. Additional indicators of water quality to protect human health require involvement and awareness throughout the watershed. The development and maintenance of a consistent current database of these continual efforts is important to the health of the rivers, which are connected to human health throughout the Blue Earth River Watershed.

The waters of concern within the Blue Earth River Watershed are particularly important to the City of Fairmont, the largest city in Martin County with a population of approximately 11,000. Fairmont draws its drinking water from Budd Lake, which is a part of the Fairmont Chain of Lakes. Half the population of Martin County is supplied with this source of drinking water. The City of Fairmont contributes to the Chain of Lakes via storm sewers. Two agricultural minor watersheds, Dutch Creek (30072) 10,949 acres and Amber Lake (30066) 12,926 acres, also contribute to the Fairmont Chain of Lakes. The Fairmont Chain of Lakes contributes to the Center Creek minor watershed (30067), which is a priority area within the Phase I Diagnostic Study and the Phase II Implementation Plan. The Martin County Water Plan recognizes the Fairmont Chain of Lakes as providing a regional resource for recreation and quality of life for local residents. Thus, protection and further prevention of the degradation of this natural resource is a priority.

Point Source Discharges

There are thirteen Wastewater Treatment Facilities (WWTF), two Water Treatment Plants (WTP), and eleven major industries in the Blue Earth River Watershed. These point sources can have a direct impact on the receiving waters within the watershed, based on the millions of gallons per year (mg/y) that they discharge. A description of treatment, flow and receiving waters is located in Table 14.

Table 14. Point Sources Located in the Blue Earth River Watershed.

Name	County	Pop.	Type	Treatment	Flow (mg/y)	Receiving Water	Comments
Alden	Martin	610	WWTF	Stabilization Ponds	22.78	Ditch to Foster Creek	
Amboy	Freeborn	551	WWTF	Activated Sludge	35.06	Ditch #49 to Maple River	
Blue Earth	Faribault	3,707	WWTF	Activated Sludge	217.67	Blue Earth River	SIU: Custom Foods Processing
			WTP	Filter Backwash	5.23	Blue Earth River	Discharge has been terminated
Bricelyn	Faribault	418	WWTF	Stabilization Ponds	5.04	Brush Creek	
Elmore	Faribault	694	WWTF	Stabilization Ponds	23.40	Ditch to Blue Earth River	
Fairmont	Martin	11,337	WWTF	Activated Sludge	440.21	Center Creek	SIU: 3M Company
Granada	Martin	374	WWTF	Stabilization Ponds	4.07	Center Creek	
Kiester	Faribault	594	WWTF	Stabilization Ponds	24.60	Brush Creek	
Northrop	Martin	274	WWTF	Stabilization Ponds		Ditch #8 to Elm Creek	
Trimont	Martin	740	WWTF	Mechanical	30.43	Cedar Run Creek	
Vernon Center	Blue Earth	333	WWTF	Aerated Ponds	7.74	Blue Earth River	
Welcome	Martin	784	WWTF	Activated Sludge	7.85	Lily Creek to Eagle Lake	
Winnebago	Faribault	1,546	WWTF	Activated Sludge	123.17	Blue Earth River	SIU: Corn Plus, Star Plating
			WTP	Filter Backwash	0.44	Blue Earth River	
Fairmont Dredge	Martin		Industrial Dredge	Sediment Ponds	500.00	Hall Lake	
Fairmont Foods	Martin		Industrial	Land & Noncontact Cooling	358.00	Center Creek	Vegetable Processing
Fairmont Tamper	Martin		Categorical Ind.	Pretreatment	0.13	Fairmont WWTF	Metal Finishing
Harvest States	Blue Earth		Industrial	Noncontact Cooling Water	1330.00	Blue Earth River	Grain Milling
Interstate Power	Martin		Industrial	Noncontact Cooling Water	6788.60	Fox Lake	Power Generation Cooling water
Midwest Electric	Blue Earth		Industrial	Activated Sludge & NCC	16.28	Unnamed Creek	Manufacturing
Neusch Farms	Martin		Silage Leachate	Land Application	1.50		Silage Storage
Owatonna Canning	Faribault		Industrial	Cooling Water	15.50	Brush Creek	Land application of process water
Seneca Foods	Faribault		Industrial	Cooling Water	49.30	Blue Earth River	Land application of process water
Star Plating	Faribault		Categorical Ind.	Pretreatment	0.0003	Winnebago WWTF	Electroplating
Weigh-Tronix	Martin		Categorical Ind.	Pretreatment	0.12	Fairmont WWTF	Electroplating

Unsewered Communities

There are 36 unsewered communities in the Blue Earth River Watershed with failing Individual Septic the input of fecal coliform bacteria, phosphorous, and biological oxygen demanding substances. This is of particular importance since residents in the rural sector do not have centralized wastewater treatment rivers and lakes. Table 15 identifies the population, location by county, flow and receiving waters.

Table 15. Unsewered Communities in the Blue Earth River Watershed.

Name	County	Pop.	Type	Treatment	Flow (mgy)	Receiving Water
Frost	Faribault	240	Unsewered	Failing ISTS	5.26	Ditch to Blue Earth River
Skyline	Blue Earth	343	Unsewered	Failing ISTS	7.51	Blue Earth River
Walters	Faribault	82	Unsewered	Failing ISTS	1.78	Ditch to East Branch Blue Earth River
Bergen	Jackson	10	Unsewered	Failing ISTS	0.22	Elm Creek
Guckeen	Faribault	15 homes	Unsewered	Failing ISTS	0.82	Little Badger Creek
Huntley	Faribault	38 homes	Unsewered	Failing ISTS	2.08	Center Creek
Riverside Heights	Faribault	30 homes	Unsewered	Failing ISTS	1.64	Blue Earth River
South Bend	Blue Earth	500	Unsewered	Failing ISTS	10.00	
Village of East Chain	Martin	20	Unsewered	Failing ISTS	0.44	East Chain Lake
Village of Fox Lake	Martin		Unsewered	Failing ISTS		Fox Lake
Village of Immogene	Martin		Unsewered	Failing ISTS		Tirbutary To Center Creek
Arlom Acres	Martin		Unsewered	Failing ISTS		
Askvold Add.	Martin		Unsewered	Failing ISTS		
Cedar Bluff Add.	Martin		Unsewered	Failing ISTS		
Charlotte Oaks Add.	Martin		Unsewered	Failing ISTS		
Ebel's Fox Lake Subd.	Martin		Unsewered	Failing ISTS		
Everett Sub.	Martin		Unsewered	Failing ISTS		
Fox Lake Shore North Shore	Martin		Unsewered	Failing ISTS		
Fox Lake Park	Martin		Unsewered	Failing ISTS		
Grathwohl Oskvold Add.	Martin		Unsewered	Failing ISTS		
Harvis Farm Subd.	Martin		Unsewered	Failing ISTS		
House's S. Lake Add.	Martin		Unsewered	Failing ISTS		
Jensenn's Subd	Martin		Unsewered	Failing ISTS		
Kabes Subd./Polzin Add.	Martin		Unsewered	Failing ISTS		
Lenz 1st Add.	Martin		Unsewered	Failing ISTS		
Livermore N. Silver Lake A	Martin		Unsewered	Failing ISTS		
Maple Leaf Add.	Martin		Unsewered	Failing ISTS		
Oak Acres	Martin		Unsewered	Failing ISTS		
Oak Haven Oak Tree Add.	Martin		Unsewered	Failing ISTS		
Porter's S. Lake Add.	Martin		Unsewered	Failing ISTS		
S. Silver Lakes Add.	Martin		Unsewered	Failing ISTS		
Seely Shavers Timber Lots	Martin		Unsewered	Failing ISTS		
Shady Oaks Add.	Martin		Unsewered	Failing ISTS		
Sun View Add.	Martin		Unsewered	Failing ISTS		
Two Creek Add.	Martin		Unsewered	Failing ISTS		
Vanners Subd.	Martin		Unsewered	Failing ISTS		

Landfills/Dump Sites

The information pertaining to the landfill and dump sites in the Blue Earth River Watershed are compiled from the 1980 Outstate Dump Inventory (ODI). The information has been updated when needed. The list includes municipal solid waste disposal facilities, industrial surface impoundments, and closed dump sites in outstate Minnesota. There are a total of 21 dump sites in the Blue Earth River Watershed (see Table 16).

Table 16. Dump Sites Located in the Blue Earth River Watershed.

Name	County		MPCA ID
Amboy Dump		Amboy	MNOD10000110
	Blue Earth	Vernon Center	
Unnamed Dump	Blue Earth		MNOD10000115
Blue Earth Dump		Blue Earth	MNOD10000315
	Faribault	Bricelyn	
Elmore Dump	Faribault		MNOD10000318
Frost Dump		Frost	MNOD10000314
	Faribault	Kiester	
Lilly Viall Dump	Faribault		MNOD10000323
Walters Dump		Walters	MNOD10000322
	Faribault	Wells	
Winnebago Dump	Faribault		MNOD10000320
Alden Dump-2		Alden Township	MNOD10000326
	Freeborn	Alden	
Army Crops of Engineers	Martin		MNOD10000660
Eagle Engineering & Manufactur	Martin	Welcome	MND990730350
Fairmont City Dump	Martin	Fairmont	MNOD10000648
Granada Dump	Martin	Granada	MNOD10000651
Northrop Dump	Martin	Northrop	MNOD10000646
Sherburn Dump	Martin	Sherburn	MNOD10000647
Trimont Dump	Martin	Trimont	MNOD10000655

Solid Waste Sites

have permits to handle and dispose of solid wastes.

Table 17. Solid Waste Sites Located in the Blue Earth River Watershed.

Name	County	City	MPCA ID
Blue Earth/Ponderosa Sanitary Landfill	Blue Earth	Rapidan	MNSW00000087
NSP Wilmarth Ash Disposal Facility	Blue Earth	Mankato	MNSW00000298
Faribault County Sanitary Landfill	Faribault	Easton	MNSW00000069
Gofer Sanitary Landfill	Martin	Northrop	MNSW00000076

Voluntary Investigation Clean Up Program

Two industries listed in Table 18 are involved in a Voluntary Investigation Clean Up Program. Staff from activities, if necessary. The program has been successful with investigation and clean up. The investigation process may lead to no clean up in specific cases.

Name	County	City	MPCA ID
Minnegasco Meter Site-Green Giant Plant	Faribault	Blue Earth	MNPT00069021
Minnegasco Meter Site-Power Plant	Faribault	Blue Earth	MNPT0006902H

Former CERCLIS Sites

There are three sites in the Blue Earth River Watershed that have no further remedial action planned (Table 19). These sites have been removed from the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS).

Table 19. Former CERCLIS Sites in the Blue Earth River Watershed.

Name	County	City	MPCA ID
Williams Pipeling Co. - 5	Blue Earth	Mankato	MND000685784
Eagle Engineering & Manufacturing	Martin	Welcome	MND990730350
Fairmont Railway Motors	Martin	Fairmont	MND096488986

National Priority Sites (Superfund Sites)

There is one site in the Blue Earth River Watershed listed on the National Priorities List (NPL). This site represents a significant threat to public health and to the environment, making it a priority for remedial action (Table 20). This list is updated on an annual basis.

Table 20. National Priority Site (Superfund Site) in the Blue Earth River Watershed.

Name	County	City	MPCA ID
LeHillier Mankato Site	Blue Earth	Mankato	MND980792469

Delisted Site from the State Superfund Site List

There is one site in the Blue Earth River Watershed that has been delisted from the permanent list of priorities (State Superfund Site List) by the MPCA (Table 21). Removal of a site from this list could include the completion of the site clean up, a determination that the site no longer poses a threat, or that the site is being addressed under a different regulatory program.

Table 21. Delisted Site from the State Superfund Site List in the Blue Earth River Watershed.

Name	County	City	MPCA ID
Howe Chemical Soil Contamination Site	Martin	Granada	MNPLP0000017

History of the Project

The Blue Earth River Basin Implementation Framework is a diagnostic study of the Blue Earth River and Watonwan River Major Watersheds funded through Minnesota's Pollution Control Agency (MPCA) as a Phase I Clean Water Partnership. A concurrent study, the Le Sueur River Implementation Framework, is a diagnostic study of the Le Sueur River Major Watershed, also funded through the Clean Water Partnership program. These two projects are similar in structure and together comprise the study area of the Greater Blue Earth River Watershed. Both projects are sponsored by the South Central Minnesota County Comprehensive Water Planning Project (SCMCCWPP), a 13 county joint powers that has been in existence since 1987. The project representative, designated by SCMCCWPP resolution, is Dr. Henry Quade of Minnesota State University, Mankato, Water Resources Center (MSUWRC). Contributing sponsors of the Blue Earth River Basin Implementation Framework include Blue Earth, Brown, Cottonwood, Faribault, Freeborn, Jackson, Martin, and Watonwan counties (County Water Planners and Soil and Water Conservation Districts), the U.S. Geological Survey (USGS), the City of Mankato and MSUWRC. Hydrologic and water quality monitoring was conducted cooperatively by the USGS, MSUWRC, and county personnel. The Blue Earth River Major Watershed portion of the diagnostic study includes Blue Earth, Brown, Cottonwood, Faribault, Freeborn, Jackson, Martin, and Watonwan county personnel. The project workplan, *Blue Earth River Basin Implementation Framework Workplan*, was developed by MSUWRC and approved by the MPCA. The original time line for the project was 1996 – 1998. Due to the scale of this project, it was extended until 2000.

Following the completion of the sampling season, a watershed technical committee met periodically to review and recommend analysis procedures for the Blue Earth River watershed assessment. The Blue Earth River Watershed Team, formerly WILL, includes a cross section of locals (watershed view) and agency (basin view) personnel, is the recipient of this report. The watershed team developed the implementation plan (goals and strategies) in response to the diagnostic study findings.

Purpose of the Project

Numerous water quality studies have been conducted in the Blue Earth River Watershed, but none of this scale. The purpose of this project includes the following goals:

1. Characterize sediment, phosphorus, nitrogen and bacteria concentration and loading for the Blue Earth River and selected tributaries during periods of base flow and storm event flow in order to identify priority areas.
2. Create a Geographic Information System (GIS) for the Blue Earth River Watershed to provide spatial natural resources data for each sampling sub watershed. The GIS will a.) characterize the watershed through spatial analysis of the landscape, b.) provide a means of displaying data as maps to inform and educate the watershed team, agencies, organizations and citizens, c.) accommodate on-going analysis of the watershed through the comparison and correlation of past and present natural resource data to water quality data, and d.) serve as a tool for the continued planning and management of natural resources in the watershed.
3. Determine the relationship of the Blue Earth River to the Greater Blue Earth River Watershed.
4. Determine the relationship of the Blue Earth River to the Minnesota River.

The Minnesota River Assessment Project (MRAP) indicated that sediment is the major contributor of pollutant loading in the Minnesota River Basin and is related to flow, therefore, sediment is the parameter of analytical focus. The diagnostic report will be used to develop the goals and strategies of the Blue Earth River Watershed Implementation Plan. The implementation plan contains water chemistry goals based on both local and basin (or statewide) scale interest. At the basin scale, mass loads of pollutants leaving the mouth of the Blue Earth River are of primary concern. At the local scale, pollutant concentrations for a particular stretch of river may be more important. These goals will therefore be a partnership of bottom up (watershed view) and top down (basin view) with ownership by both resulting in compatible goals and strategies for the Blue Earth River watershed.

Project Milestones

A more detailed description of the project milestones for the Blue Earth and Watonwan River Watersheds is contained in the *Blue Earth River Implementation Framework Workplan*.

Work Plan Development

Establish Resource Committee	5/95 to 12/95
Initial Draft Preparation	5/95 to 12/95
Review	12/95 to 3/96
Final Plan	2/96 to 12/96

Hydrologic Monitoring: Primary and Secondary Sites

Activate Eight Monitoring Sites (Hydrology and Water Quality)	4/96 to 11/96
River Rating Curve Development	4/96 to 11/96
Final Hydrology Report	11/96 to 6/97

Water Quality Monitoring: Primary and Secondary Sites

Sampling of Primary Sites	4/96 to 11/96
Sampling of Secondary Sites	4/96 to 11/96
Water Quality Analysis	4/96 to 12/96
Final Water Quality Report (Primary or Secondary)	12/96 to 6/97

Hydrologic Monitoring: Tertiary Sites

Establish and Prepare Sites, Training	6/95 to 3/96
Establish Estimated Rating Curves	4/96 to 11/96
Volunteer Stage Height Reading	4/96 to 12/96
Volunteer Rain Gauge Reading	5/96 to 11/96
Report to MSU	12/96 to 6/97

Water Quality Monitoring: Tertiary Sites

Training of County Personnel	6/95 to 4/96
Collecting of Samples and Delivery to MSU	4/96 to 11/96
Water Quality Analysis	4/96 to 12/96
Final Water Quality Report (Tertiary)	12/96 to 6/97

Watershed Assessment

Develop Soils GIS Layer	5/95 to 6/97
Develop Point Source Outfall Layer	5/95 to 6/97
Develop Feedlot Layer	5/95 to 6/97
Obtain and Incorporate State Land-Use Layer	5/95 to 6/97
Develop Hydrologic Layer	6/97 to 8/97
Develop Water Quality Layer	6/97 to 8/97

Data Analysis

GIS Analysis of Monitoring Site Watersheds	6/97 to 3/98
Development of Transport Curves for Primary and Secondary Sites	6/97 to 3/98
Determine Relationships of Hydrology and Transport Curves to Watershed	7/97 to 3/98
Run HSPF Models	6/97 to 3/98

Implementation Plan

Diagnostic Report to Resource Committee	1/98 to 3/98
Identification of Priority Areas and Parameters	3/98 to 4/98
Recommendations of Priority Areas/Parameters	4/98 to 5/98
Recommendations Resource Needs and Existing Program Limitations	4/98 to 5/98

Fiscal Management

5/95 to 6/98

Project Budget

The total cost of the project for the Blue Earth and Watonwan River Watersheds was \$728,921. Of this amount, \$348,269 was funded by a Clean Water Partnership Grant, the remaining \$380,652 was in-kind contributions from a variety of sponsors. A more detailed description of the project budget for the Blue Earth River and Watonwan River Watersheds is located in the *Blue Earth River Implementation Framework Workplan*. The total project budget summary is outlined in Table 22.

Table 22. Project Budget for the Blue Earth and Watonwan River Watersheds.

Program Element	Cost	In-Kind	Cash
Work Plan Development	\$22,913	\$16,034	\$6,879
Hydrologic Monitoring: Primary and Secondary Sites	\$15,982	\$8,430	\$7,552
Water Quality Monitoring: Primary and Secondary Sites	\$99,112	\$35,259	\$63,853
Hydrologic Monitoring: Tertiary Sites	\$208,616	\$163,918	\$44,698
Water Quality Monitoring: Tertiary Sites	\$55,721	\$42,053	\$13,668
Watershed Assessment	\$151,463	\$34,963	\$116,500
Data Analysis	\$132,797	\$47,838	\$84,959
Implementation Plan	\$33,742	\$23,582	\$10,160
Fiscal Management	\$8,575	\$8,575	\$0
Total	\$728,921	\$380,652	\$348,269

Methods

Site Selection

A core group of county, state, and federal personnel met in 1995 to select sampling sites based on hydrologic divisions of the Blue Earth, Le Sueur and Watonwan River Watersheds (the three major watersheds of the Greater Blue Earth River Watershed) in order to track the contributions from the various tributaries. The sampling sites were designated as primary sites (the mainstem of the river), secondary sites (main tributaries) or tertiary sites (smaller tributaries). The sampling sites selected for the Blue Earth River Major Watershed in the following sub watersheds are described in Table 23, and shown in Figure 2.

Table 23. Sub Watershed Description and Sampling Site Location.

Sub Watershed	Stream Name	Sampling Site Location
BP1	Blue Earth River	U.S. Highway 169
BP2	Blue Earth River	County Road 34
BS1	Elm Creek	Township Road above Blue Earth River Confluence
BS2	Blue Earth River	County Road 10
BS3	East Branch of Blue Earth River	County Road City of 16 Blue Earth
BS4	Blue Earth River	County Road 6
BT1	Lily Creek	School Bridge
BT2	Lake George Outlet	At Dam
BT3	South Creek	County Road 1
BT4	Center Creek	County Road 1
BT5	Willow Creek	County Road 20
BT6	Cedar Creek	Township Road 123
BT7	West Branch of Blue Earth River	County Road 9
BT8	Blue Earth River	County Road 9
BT9	Coon Creek	At Old Bridge on Minimum Maintenance Road
BT10	Badger Creek	Township Road above Blue Earth River Confluence
BT11	Elm Creek	Near Township Road 123

Figure 3 illustrates the hierarchical nature of the sampling sites and their sub watersheds indicating BP1 and BP2 as the primary sites for the Blue Earth River. The mainstem of the Blue Earth River at sampling site BP1 receives all flow and water quality contributions from the Blue Earth, Le Sueur, and Watonwan River Watersheds. The mainstem of the Blue Earth River at site BP2 receives all flow and water quality contributions from all of the secondary and tertiary sub watersheds. Sampling sub watersheds and area are shown in Table 24.

Figure 2. Sampling Sites and Watersheds of the Blue Earth River Major Watershed

Figure 3. Direction of Flow from the Sampling Sub Watersheds.

Table 24. Sampling Sites and Sub Watershed Area.

Sub Watershed	Individual Sub Watershed Acres	Sub Watersheds Contributing to Site	Sub Watershed Cumulative Acres
BP1	35,161	All	2,265,492
BP2	50,619	All (Except BP1)	956,873
BS1	59,214	BS1, BT6, BT11	178,439
BS2	35,677	BS2, BS3, BS4, BT1, BT2, BT3, BT4, BT7, BT8, BT9, BT10	694,867
BS3	189,226		
BS4	56,119	BS4, BT7, BT8, BT9	269,583
BT1	24,858		
BT2	28,737		
BT3	67,279		
BT4	30,006	BT4, BT1, BT2	83,601
BT5	53,473		
BT6	33,405		
BT7	95,203		
BT8	55,716		
BT9	62,545		
BT10	49,501		
BT11	85,820		

Water Quality Monitoring

The monitoring plan for the Blue Earth River Major Watershed was developed in conjunction with the Le Sueur River and Watonwan River Major Watersheds. The monitoring plan for the three watersheds includes identical sampling protocol and sampling period. The size of the project areas as well as budget constraints limited the number of sampling sites, as well as stream data collected on water quality parameters tested.

The Blue Earth River Watershed monitoring plan was developed to measure water quality and flow for the Blue Earth River and other designated streams in the watershed. The Blue Earth River monitoring plan in Section 6 of the *Blue Earth River Implementation Framework Workplan* describes the parameters and frequency of monitoring. A full complement of water quality parameters was tested including phosphorus, nitrate and sediment for the primary and secondary sites. The tertiary sites were sampled at the same frequency as the primary and secondary sites but the water quality parameters tested were limited. The water quality parameters for the primary, secondary and tertiary sites are listed in Table 25.

The stream monitoring included water quality and flow measurements completed by multiple teams. The primary sites, BP1 and BP2, are USGS gauging stations with rating and sampling done by the USGS. The secondary sites, BS1, BS2, BS3, and BS4 were rated by the USGS, with water quality sampling and stream height gauging done by MSUWRC. The ten tertiary sites were rated by MSUWRC. The County Water Planners and the SWCD staff were trained by the USGS and MSUWRC to provide consistency in the collection of stream water levels and water quality samples. MSUWRC and county personnel surveyed the tertiary sites. The survey data was digitized to develop a cross section and reference table with monitoring reference information for each tertiary site. A site sheet was created for each tertiary site with the site location, cross section, and reference table for sampling depth based on the height of water utilizing a staff gauge or measurement tape value.

Table 25. Water Quality Parameters Sampled.

Parameter	Primary Sites	Secondary Sites	Tertiary Sites
Suspended Grain Size	X	X	X
Total Suspended Solids (TSS)	X	X	X
Total Suspended Volatile Solids (TSVS)	X	X	
Total Phosphorus (not filtered) (TP)	X	X	
Total Dissolved Phosphorus (filtered) (TDP)	X	X	
Ortho Phosphorus(filtered) (P-PO ₄)	X	X	
Ammonia (filtered) (N-NH ₃)	X	X	
Nitrate + Nitrite (filtered) (N-NO ₃ /NO ₂) Referenced in report as N-NO ₃	X	X	
Chemical Oxygen Demand (COD)	X	X	
Chlorophyll-a (CHL-a)	X	X	
Fecal Coliform Bacteria	X	X	
pH	X	X	
Total Kjeldahl Nitrogen (TKN)	X	X	
Temperature	X	X	
Dissolved Oxygen (DO)	X	X	
Turbidity	X	X	X
Conductivity	X	X	X
Field Analysis	EPA Method Number		
	Standard Methods-16th ed.		
Conductivity	120.1		
Dissolved Oxygen (DO)	360.1		

Water Quality Collection

Water quality samples were collected using standard USGS water sampling methods for the primary and secondary sites with a depth-integrated water sampler. Water quality collection at the tertiary sites was performed using a modified grab method of sampling. The modified sampling method consisted of two water sample collection options: 1) using a one or two liter sample bottle attached to a long PVC pole that was inserted vertically into the water column; or 2) using a bucket attached to a long rope that was dropped vertically into the water column. The water samples were not depth integrated but instead were collected just below the surface to mid-depth of the water column over the deepest point of stream to ensure adequate flow throughout the sampling season. The sampling site location, as indicated by the cross section diagram of the site, was marked on the bridge structure to provide a consistent sampling site location.

Water quality sampling was performed by the USGS at the primary sites, by MSUWRC staff at the secondary sites, and by the County Water Planners and SWCD staff at the tertiary sites. Field data sheets for sampling sites are found in Appendix L. Table 25 lists the water quality parameters tested by site designation.

The samples were analyzed at the state certified Environmental Quality Lab at Minnesota State University, Mankato. The QA/QC Manual is on file at the lab. All lab analyses were EPA approved methods as specified in the Code of Federal Regulations Clean Water Program, Title 40, Section 136.3 (Appendix M). Table 26 lists the water quality parameters and analysis methods.

Table 26. Water Quality Analysis Methods.

Laboratory Analysis	EPA Method Number
Suspended Grain Size	USGS Method
Total Suspended Solids (TSS)	160.2
Total Suspended Volatile Solids (TSVS)	160.4
Total Phosphorus(not filtered) (TP)	365.1 (Lachat 10-115-01-1-C BlockDigestion)
Total Dissolved Phosphorus(filtered) (TDP)	365.1 (Lachat 10-115-01-1-C BlockDigestion)
Ortho Phosphorus(filtered) (P-PO ₄)	365.1 (Lachat Method 10-115-01-1-A & -B)
Total Kjeldahl Nitrogen (TKN)	351.2 (Lachat 10-107-06-2-E Block Digestion)
Ammonia (filtered) (N-NH ₃)	350.1(Lachat Method 10-107-06-1-B)
Nitrate + Nitrite (filtered) (N-NO ₃ /NO ₂)	353.2 (Lachat Method 10-107-04-1-C & -A)
Chemical Oxygen Demand (COD)	HACH Reactor Digestion Method 410.4
Chlorophyll-a (CHL-a)	1002G (Standard Methods-16th ed.)
Fecal Coliform Bacteria	909C (Standard Methods-16th ed.)
Turbidity	180.1 (Hach-turbidimetric)
pH	150.1
Field Analysis	EPA Method Number
	Standard Methods-16th ed.
Conductivity	120.1
Dissolved Oxygen (DO)	360.1

Precipitation

The South Central Minnesota County Comprehensive Water Planning Project (SCMCCWPP) Volunteer Rain Gauge Network is located in the 13 county region in and near the project area. The extensive network of volunteers collected the precipitation data used for the project (Figure 4). An average daily rainfall record was created using the available data from the rain gauge sites within the sampled sub watersheds. The number of sites within the sampling sub watersheds varied from zero to fourteen sites. Because the rain gauge readers record precipitation at various times of the day, the daily precipitation data may be recorded for up to 24 hours after the rainfall had occurred. The precipitation recorded represents a total amount for the proceeding 24-hour period. Additional information pertaining to the rain gauge locations and data are found in Appendix N.

Figure 4. Rain Gauge Site Locations of the Blue Earth River Watershed.

Discharge Ratings

Stream discharge measurements were collected to determine the hydrologic conditions of the project area. The discharge data provided the foundation to calculate the yield and total loading estimates for several pollutants. Additionally, the data were used to characterize each sub watershed's hydrologic response to storm events. Discharge is reported as cubic feet/second.

The USGS obtained discharge measurements at the primary and secondary sampling sites following USGS methodology, using Price or Pygmy current meters (Appendix O). The USGS used the 1996 project data as well as historic data to develop the rating curves for the primary and secondary sampling sites.

MSUWRC collected water discharge measurements at the tertiary sites following USGS methodology using Price or Pygmy current meters. Table 27 summarizes discharge measurement collection.

Table 27. Stream Flow Data Collection Methods.

Sub Watersheds	Water Level Devices and Methods	Discharge Measurements Equipment and Organization	Rating Curve Development
Primary	USGS Gauging Station	Price current meter USGS	USGS
Secondary	USGS wire-weight gauge	Price current meter USGS	USGS
Tertiary	Staff gauge or surveying rod	Pygmy or Price Current meter MSUWRC	MSUWRC

Data Management and Statistics

Flow Calculation and Hydrographs

The rating curve is the relationship between the depth of the water and the amount of discharge (cubic feet per second). The discharge is calculated by measuring the flow at multiple points across the stream at a particular stage. The rating curve is created by measuring the discharge at a number of different water depths (stages) and plotting the data to produce a curve.

The Blue Earth River at primary sites, BP1 and BP2, were at a USGS gauging station with continuous flow data. The USGS compiled the data record to obtain a daily average flow. The primary site data did not require any further modifications. The USGS prepared a rating curve for sampling sites BP1 and BP2.

Stage height measurements were obtained by MSUWRC at the secondary sites, BS1, BS2, BS3, and BS4 using a stationary USGS wire-weight gauge. These stage height measurements were recorded during each sampling session and at regular intervals between baseline and storm event sampling. The USGS prepared a rating curve for sampling sites BS1, BS2, BS3, and BS4.

The County Water Planners and Soil and Water Conservation District staff collected stream height data at the tertiary sites. The data collections involved numerous sampling periods done at various hours of the day. Water height observations were made at the same time as water quality data collection and at regular intervals between water sampling periods. The measurements were made using a standard metric fiberglass-surveying rod, measuring from a known location at each sampling site. The distance of the known point to the water surface was recorded.

The hydrograph readings recorded at the secondary and tertiary sites were used to develop daily stream flow data for each site. These data were plotted as stage height (y-axis) and date/time (x-axis) for the days in the sampling season. Through electronic means, curves were drawn through the plotted data. This process smoothed the somewhat fragmented site data. The result was a continuous line that approximated the hydrograph for each site. The resulting chart image was exported and then sampled electronically using a digitizing program to obtain a discharge record for each day of the sampling season¹⁹. Additional information pertaining to the discharge relationships for the primary, secondary and tertiary sites is located in Appendix O.

Load and Yield Calculations

Flow data is used to calculate the yield and load of water quality parameters. Water quality constituent (pollutant) load is calculated using the equation:

$$\frac{\text{flow} * \text{concentration}}{\text{time}} = \text{load (pounds or tons)}$$

Water quality constituent (pollutant) yield is calculated using the equation:

$$\frac{\text{load}}{\text{Sub watershed acres}} = \text{yield (pounds/acre or tons/acre)}$$

The yield of pollutants expressed as pounds per acre or tons per acre of watershed normalizes the data allowing the comparison among watersheds with varying area. The yield and relative magnitude of the water quality parameters tested will provide needed information in the selection of priority management areas by the watershed team. Flow records allow runoff response time or “flashiness” of a watershed to be understood providing a crucial piece of information when selecting the Best Management Practices (BMPs) for the implementation plan. Loading for all water quality parameters at the primary and secondary sites and for the TSS at tertiary sites was calculated by using FLUX, a model developed by the US Army Corps of Engineers²⁰.

Watershed Assessment

Geographic Information System

The Geographic Information System (GIS) for the Greater Blue Earth River Watershed was created using ARC/INFO Version 7.1.2 on a SUN Ultra30 workstation by MSUWRC. All data were analyzed in ARC/INFO except feedlot data, which were developed using ArcView. Base layers were developed by digitizing data or by acquiring data from other groups such as counties in the watershed, South Central Minnesota County Comprehensive Water Planning Project (SCMCCWPP), Minnesota Department of Transportation (MnDOT), Minnesota Department of Natural Resources (MDNR), Land Management Information Center (LMIC), Minnesota Pollution Control Agency (MPCA), Minnesota Board of Water and Soil Resources (BWSR), Minnesota Department of Agriculture (MDA), University of Minnesota (U of M), Natural Resources Conservation Service (NRCS), United States Geological Survey (USGS), and United States Fish and Wildlife Service (USFWS). Scale of the spatial data ranged from 1:8,000 to 1:24,000. Databases were developed and joined with the spatial data. Although the GIS was used to analyze data related to ground conditions during the 1996 water monitoring period, most data were pre-1996, resulting in best estimate ground conditions for the monitoring period.

The GIS base layers used in the project include hydrographic data (streams, public ditch systems, lakes); watershed boundaries (major, minor, sampling, lake); sampling sites; National Wetlands Inventory wetlands; precipitation; land cover/land use; feedlots; Conservation Reserve Program (CRP); transportation (roads and road easements); soils; slope; water quality (TSS); and other boundaries (county, township, section, municipal). A summary of the data is listed below.

1. Land Cover/Land Use: The following GIS coverages were combined to represent the 1996 landscape. The base coverage, Minnesota Land Use and Cover - Agricultural and Transition Areas, represents ground conditions during the years, 1988 – 1990. The National Wetlands Inventory (NWI) wetland data represent the time period, 1979-1988. County based CRP parcel coverages from 1996 were obtained from the Minnesota Department of Agriculture. Spatial road data were obtained from the Minnesota Department of Transportation (MN DOT) Base Map '98.
2. Feedlots: The feedlot site locations represent data compiled from county based feedlot information. Counties provided spatial data and attribute information or provided hard copy maps of feedlot locations. Feedlot data may be historic or current. A composite inventory was completed to display a general picture of animal operations, including historic and present day locations. These data were compiled using ArcView.
3. Hydrography: Streams, lakes, public drainage ditch systems, and watershed (major, minor, lake) boundary data provide the base map hydrographic data obtained from the 13 County ARC/INFO GIS developed by the MSUWRC. Sampling sites were located on and digitized from 7.5 minute USGS topographic quadrangle maps. Sampling watersheds were delineated from sampling site locations to intersect preexisting minor watershed boundaries onto the quadrangle maps using height of land and drainage information. Sampling sites and watersheds were digitized and ARC/INFO coverages were created. The National Wetlands Inventory, obtained from the State of Minnesota, was reviewed and updated by the MDNR in 1991-1994.
4. Precipitation: Precipitation data for the sampling watersheds were generated using data collected by the SCMCCWPP Rain gauge Network. Data was entered into the HIDDEN program using the State Climatology methodology. Grid files were created from the HIDDEN data, using Surfer (Golden Software). The ARC/INFO sample shed file was used to incorporate the sampling shed data with the grid files. Grids were created by month and combined using the grid math command to develop a cumulative total for the monitoring period (April 1, 1996 through November 21, 1996). The precipitation results are reported as the average volume of water in inches that fell within each sampling shed area (square meter inches/square meters) by month and by total monitoring period.

5. Soil: Soil data from the SSIS program generated files at the U of M were converted to township based EPPL7 files by U of M. These data were processed by BWSR to compile the data into county based ARC/INFO coverages. MSUWRC appended the MnDOT county boundary arcs into each county soil coverage to complete the necessary edge matching. County soil files were completed for Blue Earth, Cottonwood, Faribault, Freeborn, Jackson, Martin, and Watonwan Counties using the SSIS data. ARC/INFO soil coverages were obtained for Jackson and Martin Counties from LMIC. The MSU Water Resources Center appended the MnDOT county boundary arcs into the county soil coverages to complete the necessary edge matching between counties. The ARC/INFO county soil coverages were map joined to create a composite ARC/INFO soil coverage for the Greater Blue Earth River Watershed.

6. Slope: The USGS DEMS were used to create an ARC/INFO grid for the entire Greater Blue Earth River Watershed. The grid was converted to a polygon coverage with four slope classes: 0%, > 0% <= 3%, > 3% <= 6%, > 6%. Major watershed and sampling watershed boundaries were unioned to the slope coverage.

7. Stream gradient: Points were digitized at the intersection of the primary sub watershed stream with each 10 foot elevation contour (USGS 24,000 series topographic maps). These data were used to create elevation change attribute information for each stream segment. Stream segment length as miles was used to calculate change in elevation (feet) per stream mile. Subsequent calculations determined weighted stream gradient. The percent of each stream segment (based on 10 foot or less elevation change) to the total length of the primary stream was calculated. The calculated feet/mile was then multiplied by its percent of the stream. All stream segment values were then summed to calculate the weighted stream gradient for the primary sub watershed stream.

GIS Analysis

Additional ARC/INFO coverages were created from various combinations and queries of the base GIS layers at the direction of the watershed technical committee. Three buffer coverages were constructed from the stream coverage to define 16 foot, 99 foot, and 300 foot riparian areas for each stream in each sampling watershed. The three buffer coverages were used to create a representation of the riparian zone and extended riparian zones for selected coverages. Table 28 summarizes the additional coverages created.

Table 28. Derived GIS Coverages for the Blue Earth River Major Watershed.

<u>Coverage Created</u>	<u>Coverage(s) Used</u>
<i>Updated Land Cover/Land Use</i>	Minnesota Land Use - Agricultural and Transition Areas 1996 MDA CRP parcels National Wetlands Inventory wetlands 1998 MnDOT road and road easements Sampling watersheds
<i>Land Cover/Land Use Riparian Zones</i>	Land Cover/Land Use (Updated) 16, 99, 300 Foot Clip
<i>Land Cover/Land Use And Highly Erodible Lands</i>	Land Cover/Land Use (Updated) Soil
<i>Land Cover/Land Use And Highly Erodible Lands Riparian Zones</i>	Land Cover/Land Use (Updated) Soil 16, 99, 300 Foot Clip
<i>Land Cover/Land Use And Hydric Soil</i>	Land Cover/Land Use (Updated) Soil
<i>Land Cover/Land Use And Lakeshed</i>	Land Cover/Land Use (Updated) Lakeshed
<i>Potential Restorable Wetland Areas</i>	Soil National Wetlands Inventory wetlands
<i>Revised Universal Soil Loss Equation (RUSLE)</i>	Land Cover/Land Use (Updated) Soil
<i>Revised Universal Soil Loss Equation (RUSLE) Riparian Zones</i>	Land Cover/Land Use (Updated) Soil 16, 99, 300 Foot Clip
<i>Slope</i>	USGS DEM Sampling watersheds
<i>Slope Riparian Zones</i>	USGS DEM Sampling watersheds 16, 99, 300 Foot Clip
<i>Stream Gradient</i>	Stream Open Ditch Sampling watersheds

Soil Erosion Potential

The soil erosion potential was calculated using the Revised Universal Soil Loss Equation (RUSLE) for sheet and rill erosion predictions. The RUSLE equation is $A = R \text{ FACTOR} * K \text{ FACTOR} * L \text{ S FACTOR} * C \text{ FACTOR} * P \text{ FACTOR}$ where A is equal to the computed soil loss in tons/acres/year. Corn/soybean rotation, moderate residue cover, with no special practices were applied to all cultivated land acres in the watersheds. The factors and values used are listed as follows:

R FACTOR (Rainfall and runoff)

120 Blue Earth, Cottonwood, and Watonwan County
135 Faribault County
140 Freeborn County
125 Jackson County
130 Martin County

K FACTOR (Soil erodibility)

K values assigned by specified soil unit and adjusted for RUSLE zone 100 B/C
0.17 adjusted to 0.15
0.20 adjusted to 0.17
0.24 adjusted to 0.22
0.28 adjusted to 0.26
0.32 adjusted to 0.30
0.37 adjusted to 0.35
0.43 adjusted to 0.40

LS FACTOR (Slope length and steepness)

LS value assigned to a specified soil unit

C FACTOR (Cover and management)

0.16 cultivated land
0.02 grassland/CRP
0.003 forested
0.26 urban and industrial
0.15 farmsteads and other rural developments
0.45 gravel pits and open mines
0.0 lakes and deeper water wetlands
0.0 shallow or "seasonal" wetlands (e.g. types 1, 2, and 3) = 0.003

P FACTOR (Support practice)

1.0 Assume no special practices on any cultivated land (a constant of 1)

Potential Restorable Wetlands

The potential restorable wetland areas were identified using the soil land capability classification. Soils were regrouped using the IIIw or IVw soils to represent the drained and potentially restorable wetlands and the Vw, VIw, VIIw, VIIIw soils to represent present wetlands. Other soil land capability classifications were grouped as non-potentially restorable wetlands or as water.