Seven-Mile Creek Watershed Project

A Resource Investigation within the Middle Minnesota Major Watershed

Diagnostic Study Report

Sponsored by

Brown Nicollet Cottonwood Water Quality Joint Powers Board

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BROWN NICOLLET COTTONWOOD
WATER QUALITY BOARD

October 2001

A MPCA funded program

Sponsored by Brown Nicollet Cottonwood Water Quality Board

Final Report and Diagnostic Study by: Kevin Kuehner

Seven-Mile Creek Watershed Project
Executive Summary

The Seven Mile Creek Watershed Project application is based on three years of intensive monitoring, assessment, modeling, evaluation, and coalition building. The work was undertaken through funding by a MPCA Resource Investigation Grant with contributions from several other local and state agencies from 1999-2001. The 23,551-acre study watershed is located in the Minnesota River Basin, within the Middle MN Major Watershed in South Central Minnesota. The watershed is located between the communities of Nicollet and St. Peter. 86% of the watershed land use is under a corn/soybean cultivation. Seven Mile Creek is Nicollet County's most visible natural resource with a 640-acre county park located at the mouth of the watershed. Since 1985, the creek has been designated as a class 1-D marginal trout stream by the MN DNR.

Cooperators

The coalition interested in improving this watershed includes normal water resource players (SWCD, Environmental Services, etc), as well as an extraordinary roster, which includes two branches of the University of Minnesota (Soils/Ag & Public Health), the MN DNR, the national Center for Agricultural Partnerships, USDA paired watershed study, and the McKnight Foundation. In addition, the watershed's biggest business, 3,000-head proposed Northern Plains Dairy operation, and Red Top Farms, southern Minnesota's longest-running demonstration farm, are both interested in being part of any Phase II project. The Brown-Nicollet-Cottonwood Water Quality Board is the project sponsor; a total of 15 agencies, citizens groups, and private enterprises are involved in this watershed project.

Diagnostic Study Results

Throughout the 2000 and 2001 study period, flow-weighted mean concentrations (FWMC) for sediment at the mouth of the watershed were 5 times higher than the expected values for minimally impacted streams of the same eco-region (western corn-belt plains). Nitrates were 3 times higher and average phosphorus concentrations were 1.2 times higher. Fecal coliform levels were above the 200-col./100ml limit 45% of the tested time. Average FWMC during the two-year study was 227 mg/l, 13.7 mg/l, .340 mg/l and .234 mg/l for total suspended solids, nitrate-nitrogen, total phosphorus and ortho-phosphorus respectively. The watershed yielded an average of 6,712 tons of suspended sediment or 570 lbs./acre or 52 lbs./acre/inch of runoff during the growing season (April-September). The watershed loads approximately 10.7 tons of phosphorus, .912 lbs./acre or .156 lbs./acre/inch of runoff. About 60% of the total phosphorus was found to be in the dissolved reactive form. Considering the size of the drainage area, the watershed contributes high levels of nitrate-nitrogen to the MN River. The two-year average nitrate load measured from the watershed amounts to 320 tons or about 27 lbs./acre or about 3.2 lbs./acre/inch of runoff. Most of the nitrate-nitrogen leaching within the watershed is derived from an over application of commercially applied fertilizers, tile drainage network, soil mineralization, and climatic factors. About 50-70% of the pollutant loads came during the months of April, May, and June. Sediment modeling results indicate that about 42% of the sediment is derived from bank erosion sources, 37% upland, 13% riparian corridor, and 8% from open tile intakes. Phosphorus delivery modeling indicates that 52% of the phosphorus load is from upland sources, 14% bank erosion, 12% non-complying septics and 11% riparian and open tile intakes. Main stem water quality goals will require pollutant reductions of 25% for TSS and 25% for phosphorus and 40% reduction for nitrate-nitrogen. Along with numeric goals, watershed surveys documenting behavioral changes before and after the Clean Water Partnership (CWP) will track project success. Overall, water storage and nutrient management will be the most important BMPs in the watershed restoration effort. The diagnostic study has enabled the watershed technical committee to make informed responses to TMDL recommendations and to target remediative strategies during implementation phases for watersheds like Seven Mile located in the eastern half of the Middle MN Major Watershed.

Implementation Funding

The Water Quality Board is seeking $ 196,432 cash and $ 550,000 in septic improvement loan funds from the CWP program. This will be added to $21,000 local cash (from county agencies and a DNR Environmental Partners grant) and over $ 650,000 in in-kind contributions from the coalition described above to carry out the proposed implementation plan.

Implementation Action Plan

The three-year plan includes targeted Best Management Practice (BMP) activities based on the two-year water quality study. BMPs are based on agroecoregions of MN (wetter clays and silts). Because nutrient and sediment levels are high relative to the size of the watershed, <u>Nutrient Management</u> will be promoted through nitrogen rate on farm demonstrations, soil testing, record keeping, and follow-up education, and detailed manure management. To reduce further sediment and nutrient levels, the project will promote the adoption of <u>Vegetative Practices</u>, including land enrollment in CREP, the use of rye as a cover crop, new Farmed Wetland Pilot Program, and installation of riparian buffer strips and grass waterways. <u>Primary tillage system</u> conservation techniques such as strip tillage and minimum tillage of soybean residue will be promoted. <u>Structural changes</u> will also be emphasized—to include installation of innovative floodplain rock-cross vanes, wetland restorations, tile outlets to wetlands, upgrades of at least 75 polluting septic systems, and habitat improvements in the creek itself. <u>Monitoring</u> will take place during the project, with special emphasis on "before & after" analysis downstream of the BMP modifications. The SMC County Park will be featured during <u>outreach and education</u>, which will also include basin–wide coordination and regional activities. Nicollet SWCD, Env. Services, and BNC Waters Board staff will be key players in the implementation phase.

The leveraging effect of the many activities in place now and planned for this watershed will make this Phase II Project a really outstanding example of effective partnership, and will guarantee new ways of improving water quality—both through assisting citizens in adopting proven, education driven, voluntary BMPs and through exciting new treatment technologies.

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Chapter 1 Introduction and Project Background

Middle Minnesota Major Watershed Resource Investigation and Seven Mile Creek

This report is the end product of a scientific attempt at understanding and protecting water quality in a small agricultural watershed in South Central Minnesota. The outcomes of this report are two-fold.

- Develop a list of action priorities, which provide the most effective enhancement for water quality with the smallest economic impact on stakeholders.
- Provide realistic pollution reduction goals and implementation plan for the watershed.

To do this effectively, five basic components of the watershed needed to be addressed. This report covers the first three components listed below.

1. the sources of pollution
2. the pathways of movement
3. the factors affecting delivery to the study area
4. the relative cost and effectiveness of various management strategies
5. the potential socio-economic impacts of these strategies on stakeholders.

Major funding sources during the two-year water resource investigation project included the Minnesota Pollution Control Agency, Nicollet County, and the Minnesota Department of Natural Resources.

Project Background & History

The Middle Minnesota Basin covers 1,350 square miles in parts of eight counties in south central Minnesota--Redwood, Brown, Cottonwood, Blue Earth, and Le Sueur on the south and east side of the Minnesota River, and Renville, Nicollet, and Sibley on the north side. The basin ranks sixth in area of the twelve watersheds supplying the Minnesota River.

Map 1 gives the location of the Middle Minnesota Major Watershed and Seven Mile Creek in context to the state and map 2 shows the Middle MN in more detail.

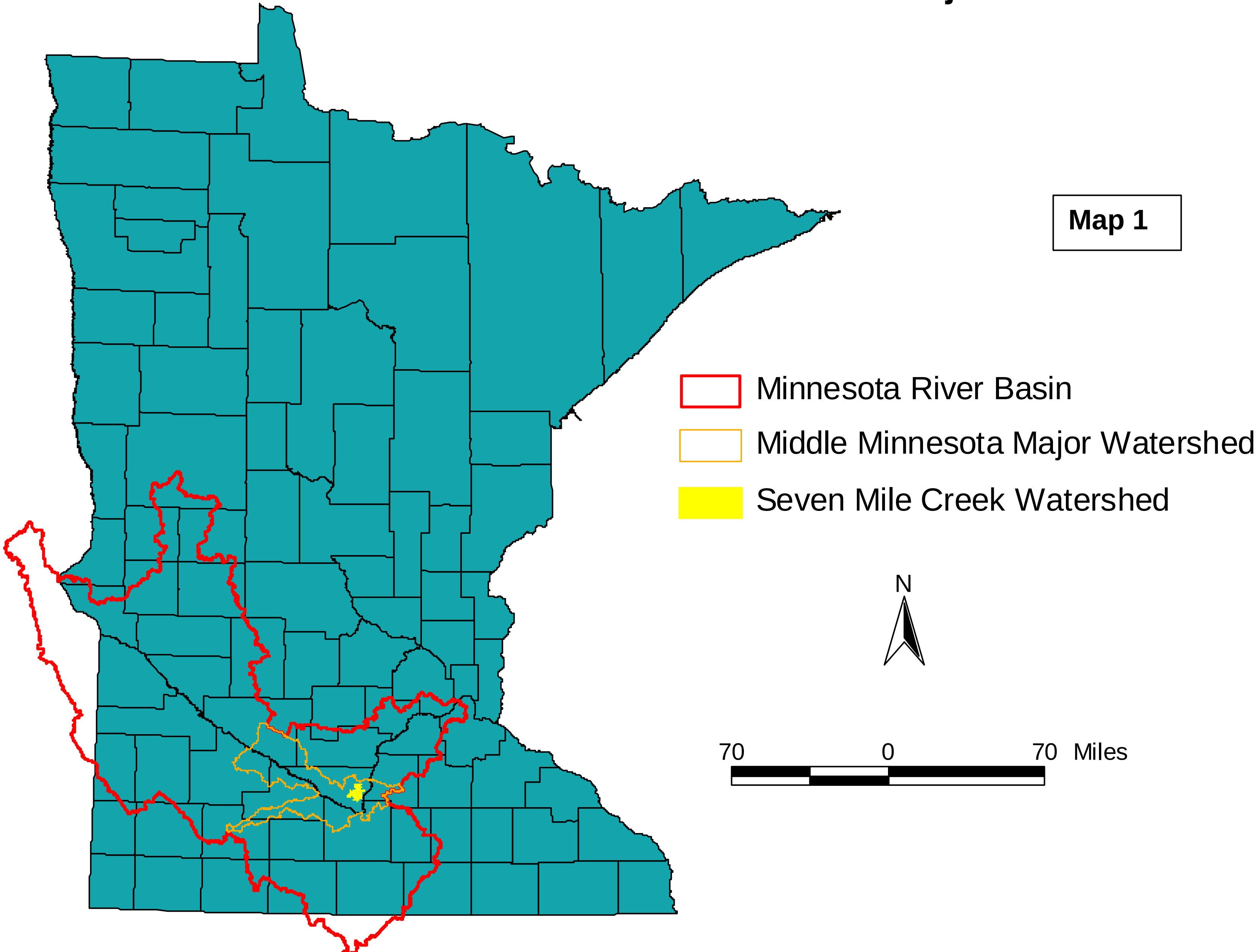
Except for the Little Cottonwood River, the streams comprising the Middle Minnesota Basin are first- or second-order streams. That makes this basin somewhat unique; the rest of the twelve basins all have identifying dendritic rivers. The Middle also differs from all the other basins in that there is no single reach on the main river where the effects of the basin drainage can be monitored. This is because the mouths of four entire basins (Cottonwood, Blue Earth, Watonwan, and Le Sueur) enter the Minnesota at points in the area of the Middle Minnesota. Due to the large number of small streams feeding the Minnesota River, this can pose difficulty in establishing water resource monitoring and implementation plans for the Middle Minnesota Major Watershed.

This project does not include work on two streams, which are already under assessment by separate Clean Water Partnerships--the Little Cottonwood River Project (see *Little Cottonwood River Restoration Project*, 2000 for more information on that particular watershed) and the Lake Crystal-Minneopa Creek Project.

The Major Middle MN streams on the south and east sides of the Minnesota are: Wabasha Creek, Hindeman (also known as Spring) Creek, the Little Cottonwood River, Minneopa Creek, and Shanhaska Creek. Major streams on the north side of the Minnesota include: Birch Coulee, Ft. Ridgely Creek, Eight Mile Creek, St. George Creek, Nicollet Creek (also known as the Swan Lake Outlet), North Ridge Outlet, Hiniker Creek, Seven Mile Creek, and Robart's (also known as Robert's or Roger's) Creek. The Middle Minnesota Basin includes several small pothole lakes, and two major lakes--Crystal Lake in Blue Earth County and Swan Lake in Nicollet County.

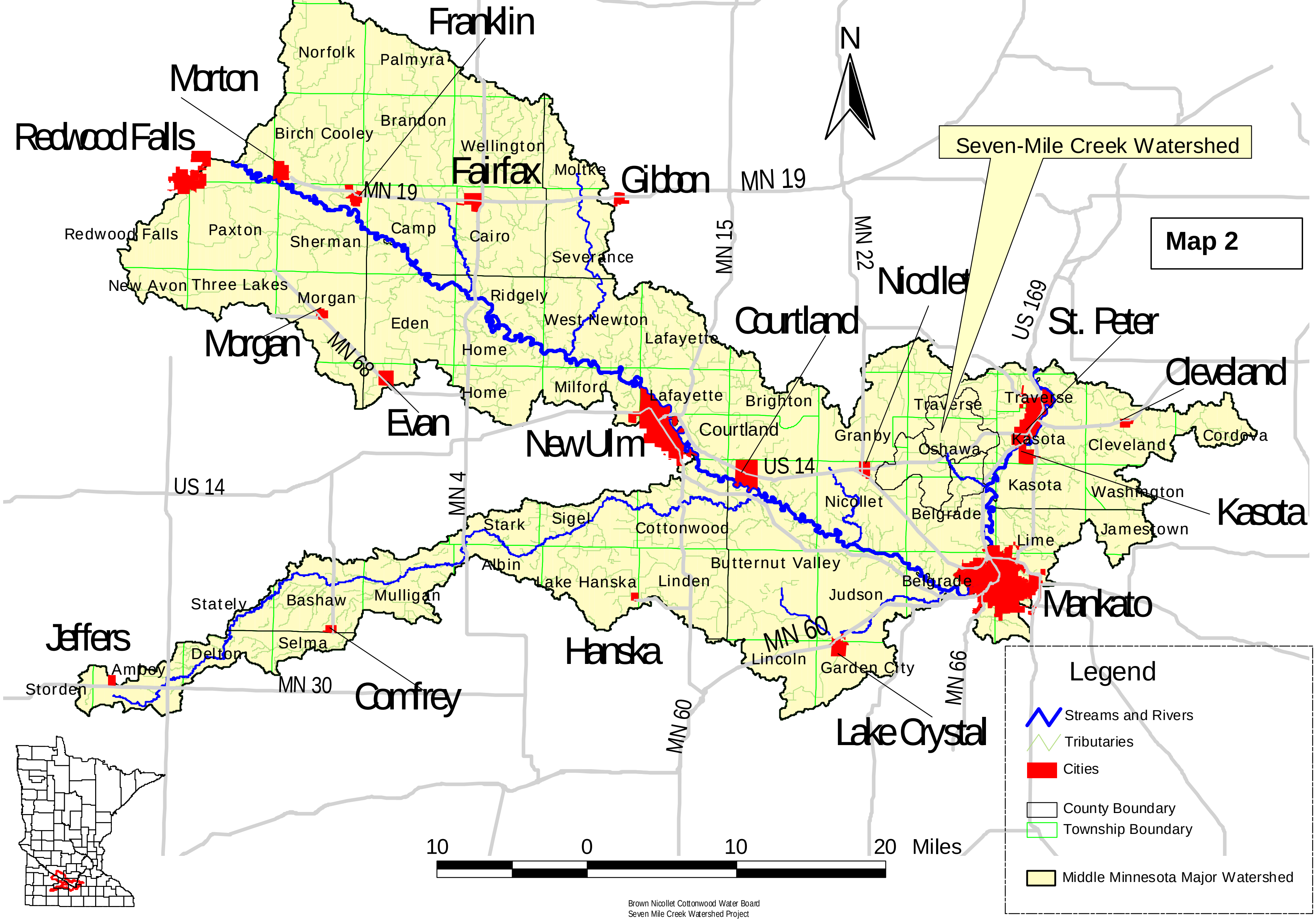
Seven Mile Creek Watershed

in Relation to Minnesota River Basin and Middle MN Major Watershed



Middle Minnesota Major Watershed

Seven Mile Creek Minor Watershed



The Middle Minnesota basin contains five wildlife management areas, two state parks, two city/county parks/campgrounds, and six historical sites. The population residing in the Middle Minnesota watershed is over 50,000. It covers part or all of 56 townships and the following cities:

Blue Earth County: Lake Crystal, part of Mankato

Brown County: Evan, Comfrey

Le Sueur County: Cleveland, Kasota

Nicollet County: St. George, Klossner, Nicollet, Courtland, North Mankato, St. Peter

Redwood County: Morgan, Lower Sioux Indian Reservation

Renville County: Fairfax, Franklin, Morton

Sibley County: Gibbon

Two of the communities, St. George and Evan, are considered "unsewered communities."

-St. George has recently been updated using wetlands.

The upland areas of the basin were formerly prairie; stream ravines were (and still are) forest. As in many other rural Midwest areas, the Middle Minnesota Basin is undergoing change. The increase in numbers of large animal production farms is resulting in controversy regarding the long- and short-term effects of new feedlots, and increased scrutiny focused on manure and nutrient management. Drainage issues are also contentious. Other land use issues emerging in the Middle Minnesota include the changes from two-crop agriculture to land retirement through the Conservation Reserve Enhancement Program (CREP), and long-term effects of urban and suburban expansion.

Why the Project is Taking Place

The Minnesota River does not meet state and federal water quality standards and is a major source of pollution to the Mississippi River. It is a high priority of the State of Minnesota to restore the Minnesota River to fishable and swimmable conditions within ten years, from 1992-2002. The Minnesota River Assessment Project (MRAP) recommendations translate this general goal into specific pollutant reduction targets and suggest changes required to achieve the targets.

Recommendations include:

- Forty percent reduction in total suspended solids
- Maintenance of nitrate concentrations at less than ten parts per million
- Development of a phosphorus standard for the basin
- The implementation of sediment-reduction and cropland soil loss programs
- Removal of bacteria and other pathogens, which make the river unsafe for human contact

The Middle Minnesota streams covered by this project are mostly first- or second-order streams. In many cases, these streams flow only a few miles before entering the Minnesota River. The Middle Minnesota Basin project began by studying the pollutant contributions of selected streams to the Minnesota/Mississippi system specifically that of the Seven Mile Creek Watershed. Due to the watershed's size, location, trout fishery, and applicable research Seven Mile Creek Watershed was chosen. It was felt the watershed could serve as a demonstration for other watersheds in terms of cost effective modeling using GIS nutrient management/manure management demonstrations and new ecosystem management techniques. The project also evaluated remediation strategy options and goals, and began citizen awareness and other educational initiatives.

Existing Water Quality Conditions and Problems

During the MRAP study, major tributaries and the main stem of the Minnesota River were monitored for flow and water quality parameters. Springs and general biological integrity were also evaluated to determine the relative impairment of the riverine environment. The results of the study suggested that not only do flows increase from west to east, but also that loads of sediment and nutrients increase in a downstream progression. Monitoring of Seven Mile Creek Watershed is providing further evidence of that trend. The implication is that every small tributary likely contributes to the overall pollutant load. None of the Middle Minnesota streams were directly monitored during the MRAP study. Follow-up monitoring on the streams in the Middle Minnesota Basin is needed to more clearly define their potential impacts on the Minnesota River.

Some of the streams have been monitored since 1989 as part of groundwater studies, or county water planning initiatives, and localized resource investigation projects. The following Middle MN streams were monitored in 1996 and 1997 in the Middle/Lower Assessment Project (MLAP), a resource investigation project cosponsored by the MPCA:

Camp Pope in Redwood County

Hindeman (also known as Spring) Creek in Redwood and Brown Counties

Shanhaska Creek in Le Sueur County

Fort Ridgely Creek in Renville and Nicollet Counties

Eight Mile Creek in Sibley and Nicollet Counties

St George Creek in Nicollet County

Nicollet Creek (also known as Swan Lake Outlet) in Nicollet County

Seven Mile Creek in Nicollet County

Robart's (also known as Roberts and Rogers) Creek in Nicollet County

The streams were sampled under two schemes; the channel/bed status was evaluated using Tailored Integrated Stream/Watershed Assessment (TISWA), and potential wetland restoration site exploration was begun. The MLAP project also began other watershed assessment activities and established communications with watershed landowners.

Monitoring has also taken place at the following Middle Minnesota locations:

Birch Coulee Creek in Renville County

City of Fairfax inputs from storm and sanitary sewers to Fort Ridgely Creek

Hiniker Creek in Nicollet County

The management of water has strongly influenced current water quality and habitat conditions of the Minnesota River. The nature and character of drainage facility development has produced channel instability and overall ecological dis-equilibrium. The current array of ditches, open-tile intakes, side inlets and subsurface tile lines has transferred flooding problems downstream to other land operators, created highway maintenance problems, and major ditch clean-out expenses.

Drainage augmentations have also influenced water quality in the tributaries and the Minnesota River itself. Drainage from unsewered communities, septic systems directly connected to underground tiles and/or ditches, animal manure from feedlots and winter field applications have increased levels of bacteria and other pathogens. Nitrates and phosphorus are other contaminants of concern from the above situations; contribution of these nutrients is also occurring through untimely and/or heavy applications of chemical fertilizers. Another concern is that of high sediment loads resulting from erosion due to overland runoff, bank erosion and rapid drainage resulting from ditching and tiling.

Urban situations also lead to water quality impairment of the streams and the river. These include sediment, nutrients, and other contaminants from storm runoff, periodic inundation of sewage treatment ponds located in the river flood plain, and pollution resulting from over application of fertilizers within tributary communities.

Working with counties, communities, agriculture, industry, institutions and citizens to increase awareness and concern about the above contaminant contribution situations is the highest priority of the Middle Minnesota Basin Project.

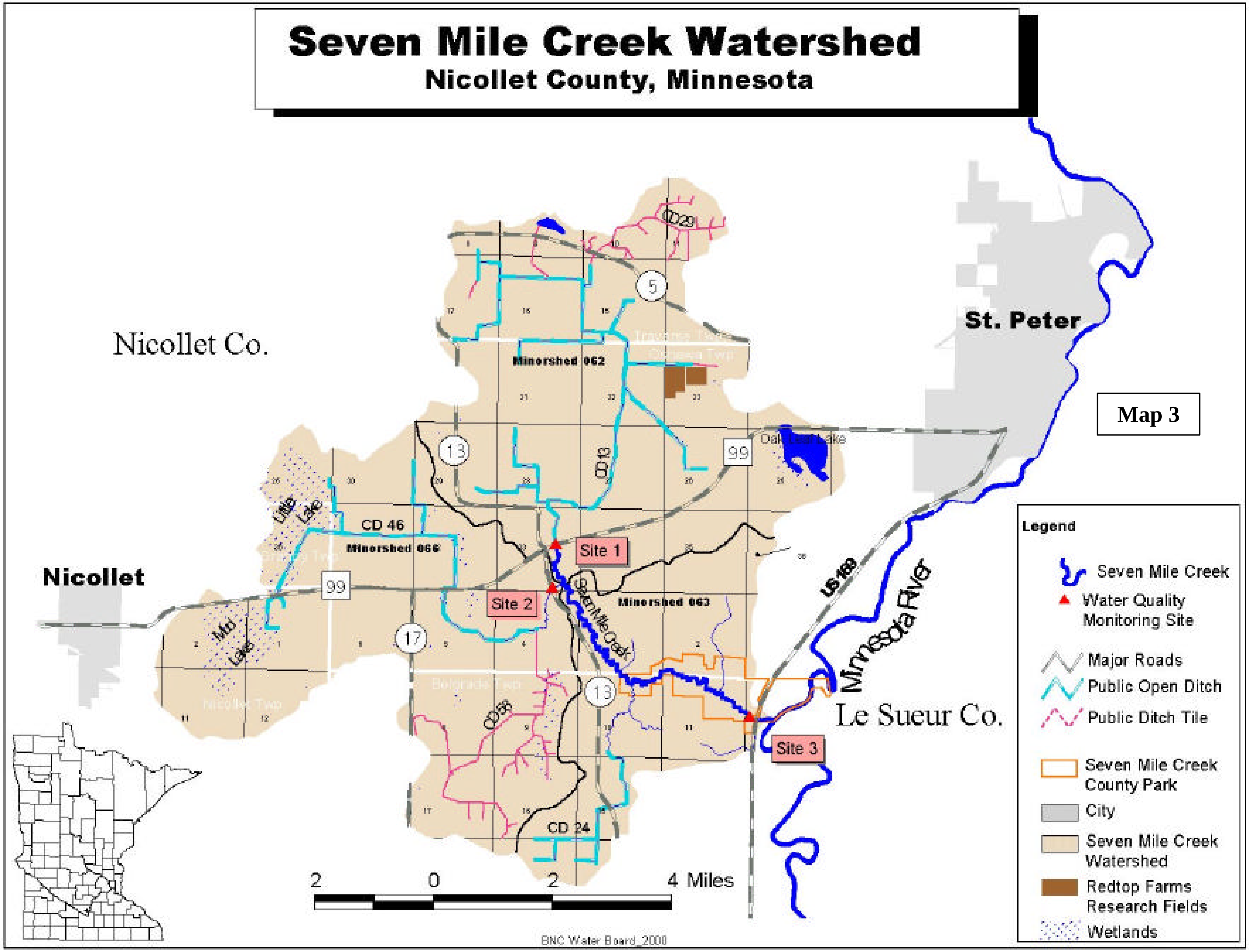
Seven Mile Creek Watershed Project

Due to the nature of the Middle Minnesota Basin, a sub-watershed within the Middle was chosen for a two-year water quality monitoring study. Seven Mile Creek Watershed located just south of St. Peter in Nicollet County was chosen as a study watershed during the two-year grant. See map 3.

Background

The Seven Mile Creek Watershed was chosen for a Water Quality Resource Investigation Grant following the 1990 Middle Lower Assessment Project funded through the Minnesota Pollution Control Agency. The two-year study was postponed following the 1998 tornado, with monitoring resuming in earnest in 1999 and 2000. The water quality study was funded through a Water Resource Investigation Grant administered by the MPCA. The $50,000 grant was expended by 2000. Watershed assessments and monitoring continued in 2001 and is currently temporarily funded through the DNR Environmental Partnerships Program, Nicollet Environmental Services and Soil and Water Conservation District.

The watershed is 23,551 acres in size and comprises about 3% of the Middle MN Major watershed and covers 8% of Nicollet County. Monitoring within this watershed has taken place since the early 1990s. Minnesota State University in Mankato and Gustavus Adolphus College have also studied the creek through classroom exercises. Since 1985 the ecological classification of the stream has been a class1-D or marginal trout fishery. With the start of the Middle MN project in 2000, three monitoring sites were established at the mouth of the watershed and two upper reaches to estimate loads within Seven Mile Creek Watershed and its effect on the MN River. Water Quality data from the project and other watershed information can be found in the following chapters.


Seven Mile Creek Watershed
Nicollet County, Minnesota
Nicollet Co.
Nicollet
St. Peter
Le Sueur Co.
Minnesota River
Map 3
Minorshed 062
Minorshed 066
Minorshed 063
CD 46
CD 24
CD29
CD13
CD58
Little Lake
Mud Lake
Oak Leaf Lake
Seven Mile Creek
Site 1
Site 2
Site 3
US 169
5
13
17
99
2 0 2 4 Miles
Legend
Seven Mile Creek
Water Quality Monitoring Site
Major Roads
Public Open Ditch
Public Ditch Tile
Seven Mile Creek County Park
City
Seven Mile Creek Watershed
Redtop Farms Research Fields
Wetlands
BNC Water Board_2000

The 23,551-acre watershed was chosen for several reasons.

- Size and location-- smaller watersheds under 50,000 acres are easier to monitor model, and track improvements.

- High levels of public support and interest.

- Seven Mile Creek County Park--attracts thousands of visitors yearly from the Midwest, and serves as easy access point for schools and public education events.

- Unique fishery—Seven Mile Creek is the only water resource in South Central Minnesota that supports water temperatures and habitats suitable for trout production. Although currently classified as a marginal trout water fishery, DNR fisheries biologist feel watershed management techniques can transform Seven Mile Creek into a successful long-term fishable trout fishery.

- Red Top Farm Research Fields— A ninety-acre site located on the Red Top Farm near St. Peter in the northern portion of the watershed provides a unique opportunity to study on a field-scale the quality and quantity of water and agricultural chemicals moving through subsurface drainage tile systems. Results from Red Top fill a critical gap between university research, and the effectiveness of Best Management Practices on a production "real world" scale.

- St. Peter source water protection--The city of St. Peter is increasing its efforts to ensure safe and dependable drinking water for its 11,000 residents. Since portions of the wellhead protection area lie within and around the watershed, efforts between the two projects are planned to work together since they both are trying to accomplish the same goals.

From the spring of 2000 through the fall of 2001, loading rates were determined for the watershed at three locations. In addition to water quality monitoring, watershed assessments, sediment and nutrient modeling, mass balance, bank erosion/tile intake/private tile line inventories, and educational outreach initiatives were conducted during the span of the two-year project. The results of the two-year study can be seen in the following chapters. The Seven Mile Creek study will be used as a template for other study areas within the Middle MN Major Watershed.

Seven Mile Creek Watershed Goal:

To encourage voluntary land use practices within the watershed using sound research to reduce sediments, pathogens, and nutrient loads to Seven Mile Creek.

Statement of Project Goals & Outcomes

A. Overall Resource Goals

The ultimate goal for the Middle Minnesota Basin is to encourage land use changes that will reduce sediment and nutrient discharges to the river thereby improving its ecological, recreational and aesthetic value. Improvements of this nature will also help reduce pathogens in the streams and river and increase bank stability, moving the Minnesota River toward the goal of becoming swimmable and fishable.

The project will document factors affecting hydrology, and pathogen, sediment and nutrient transport to the Middle Minnesota streams. In addition, it will determine reductions necessary to meet both the mainstem (Minnesota River) and local goals for the basin.

B. Desired Outcomes of the Project

The project intends to work toward the achievement of these conditions:

* Fish populations of greater diversity and abundance
* Wildlife habitat of greater diversity and abundance
* Landscape vegetation of greater diversity and abundance, with more native species
* Lower chemical transport, with reduced nitrogen, phosphorus, and herbicides
* Less soil displacement, with decreased sheet and bank erosion
* More stable stream channels, with lower energy and greater desynchronization of storm flows
* Less transport of bacteria, thus leading to swimmable waters
* Less loading of pollutants to the mouth of the Minnesota River
* Stronger stewardship attitudes throughout the watershed
* Increased sense of pride and ownership of the water resources
* Greater public awareness of land and water interconnections
* Greater public awareness of links between upstream and downstream neighbors
* Increased watershed storage through reestablished wetlands and longer tributary retention times

C. Overall Project Goals

1) Provide assistance to projects throughout the Middle Minnesota Basin.

2) Serve as the liaison for Middle Minnesota planning through the MN River Joint Powers Board LCMR Basin project; provide coordination for Middle Minnesota activities.

3) Develop outreach materials for public awareness activities through the basin including:

   a) display for use at Middle Minnesota events and county fairs

   b) materials for Middle Minnesota citizens and businesses

   c) informational kiosk for Seven Mile Creek

4) Establish a demonstration monitoring project at Seven Mile Creek that includes:

   a) citizen monitoring assistance

   b) monitoring to assess current conditions

   c) monitor to track impacts of impending changes such as new ditching, new feedlots

   d) develop monitoring protocol for future use as small stream template

   e) bridge GIS spatial analysis with research from Red Top Farms, UM research, field studies within the watershed and water quality data to obtain realistic water quality goals, and implementation plans to efficiently incorporate best management practices

Project Organization & Responsibilities

The project sponsor is the Brown-Nicollet-Cottonwood Water Quality Joint Powers Board composed of County Commissioners representing the full county boards of the three counties.

The administrative management committee includes:

Kevin Kuehner - Coordinator	Brown-Nicollet-Cottonwood Water Quality Board
Marcy Pengilly - Accountant	Brown-Nicollet CHS
Bonnie Holz	Brown-Nicollet Environmental Health
Pam Rivers-Water Planner	Nicollet County Environmental Office

Mike Hanson	Cottonwood County Planning and Zoning
Lee Ganske	Project Manager-MPCA
Pat Baskfield	Project Hydrologist-MPCA
Bill Vanryswick	Dept. of Agriculture (Red Top Farms)
Kevin Ostermann	Nicollet County SWCD
Bill Geary	Nicollet County NRCS
Todd Kolander	MN DNR Fisheries
Norm Kuhlman	Nicollet County Environmental Services
Tina Rosenstein	Nicollet County Environmental Services
Charles Guggisberg	Brown County Commissioner
Don Wellner	Brown County Commissioner
John Oeltjenbruns	Cottonwood County Commissioner
Ken Elg	Cottonwood County Commissioner
David Dehen	Nicollet County Commissioner
Judy Hanson	Nicollet County Commissioner

The coordinating committee also includes:

Scott Sparlin	Citizens Coalition for a Clean MN River
Lauren Klement	Sibley County Water Planning
Joe Stengel	Renville County SWCD
Cathy Fouchi	DNR - Minneopa Project
Julie Conrad	Blue Earth Environmental Office
Paul Davis	Brown County Water Planning (MM Basin)

Milestone Schedule

Program Element & Actions	Start	Completion

PE 1: Preparatory Activities		
A. Work plan development	Feb 99	Apr 99
B. Basin plan development	Jan 99	Aug 99
PE 2: Watershed Project Assistance		
A. Data analysis	throughout project timeline	
B. Assistance to projects	throughout project timeline	
PE 3: Basin Coordination		
A. Communications	bimonthly & as necessary throughout project	
B. Support spokesperson	throughout project	
C. Develop basin plans	Aug 99	Oct 99
PE 4: Outreach Activities		
A. Seven Mile Newsletter	Spring & Fall 99	Spring 00
B. MM Display	Spring 99 then use throughout project timeline	
C. Presentations & exhibits	throughout project	
D. Informational Kiosk	Fall 99	Summer 00
PE 5: Seven Mile Monitoring & Assessment		
A. Develop citizens monitoring project	Spring 99	Summer 00
B. Measure flows	Spring 99	Summer 00
C. Monitoring	Spring 99	Summer 00

D. Analyze above data	Summer 99	Fall 00
E. Assess land use	Summer 99	Fall 99
F. TISWA	Spring 99	Fall 99
G. GIS	Summer 99	Summer 00
H. Report on Results	Summer 00	Fall 00

PE 6: Administration

A. Personnel training & supervision	throughout project timeline
B. Fiscal management	throughout project timeline
C. Project management	throughout project timeline

Chapter 2

Project Area Description

General Summary

Entire Watershed

Most of the upper portion of the watershed is completely level (0-2% slopes). As Seven Mile Creek descends into the Minnesota River valley (210 feet drop), land slope changes to a steep dendritic drainage (40-60% slopes near the channel). Row cropping (corn/soybean rotation) is the dominant agricultural use. Many wetlands and drained lakes lie within the 23,551-acre watershed. Soils consist mostly of poorly drained clay loams and silty loams on level land. The watershed is nearly all privately owned except for a 626-acre county owned park at the mouth of the watershed.

Land Adjacent to the Creek

Soils are mainly well-drained loams to poorly drained clay loams. The lower reach has a high gradient and is densely wooded. The mid and upper reaches are privately owned wooded areas and eventually open up to cultivated farmland. Seven Mile Creek Park is located from 0-1.6 river miles. The park includes 320 acres of wooded property. A public access to the Minnesota River is located near the mouth of the creek on the East side of the County Park near Highway 169.

The Study Watershed

Seven Mile Creek Watershed was chosen for a Water Quality Resource Investigation Grant following the 1996 Middle Lower Assessment Project funded through the Minnesota Pollution Control Agency. The two-year study was postponed following the 1998 tornado; monitoring resumed in earnest in 1999 and 2000. Watershed assessments and monitoring continued in 2001 and is currently temporarily funded through the DNR Environmental Partnerships Program. Map 4 shows the location of the watershed and relation of the watershed with respect to St. Peter, Seven Mile Creek County Park, Research Fields, Minnesota River, water ways, transportation networks and St. Peter Wellhead Protection Area.

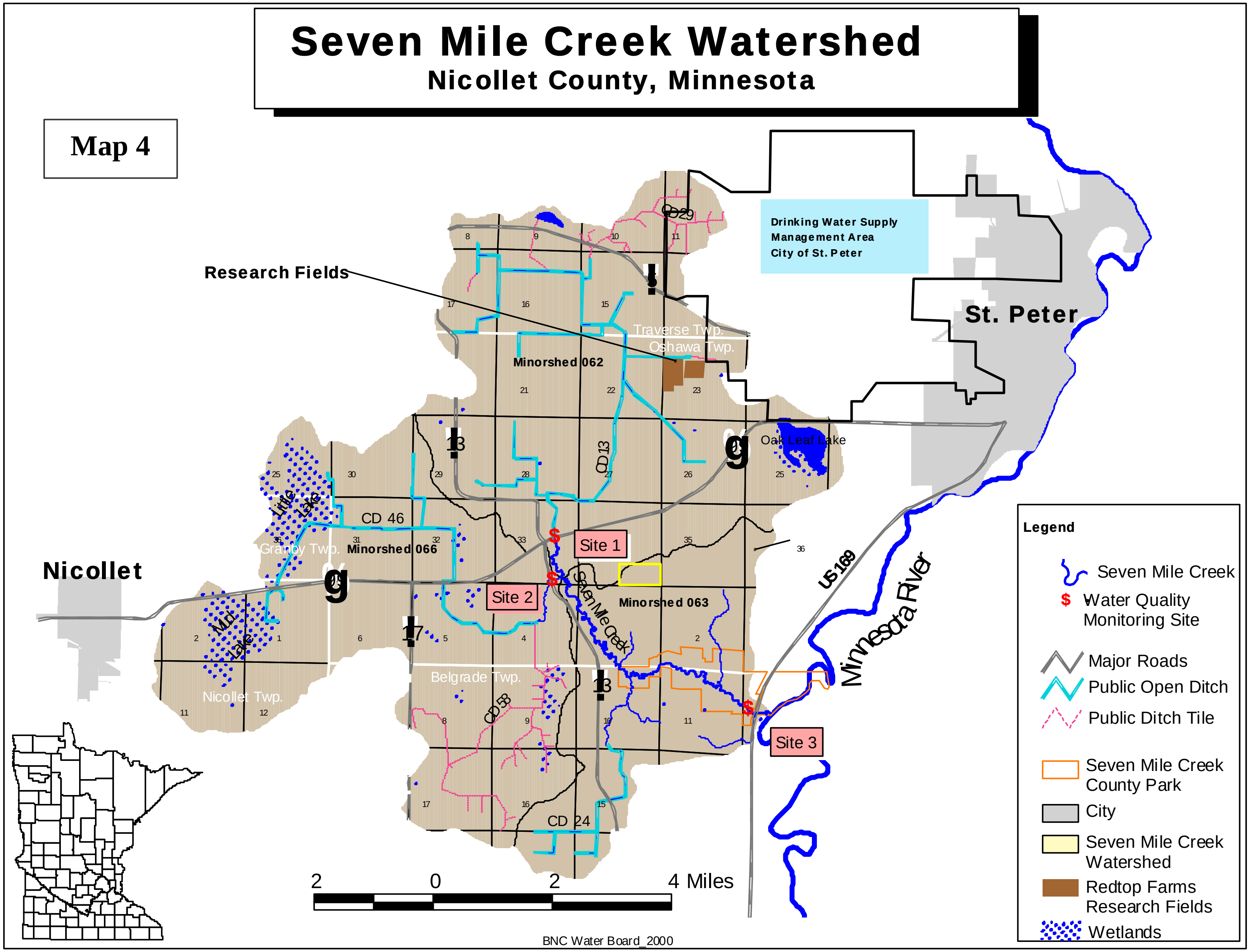
Seven Mile Creek is 6.1 miles long and receives most of the drainage from three constructed ditches, CD 46, CD 13, and CD 24. The creek itself does not start until after Highway 99. There are also two major public ditch tile systems. Those include County Ditch 29 and County Ditch 58. The public open drainage ditches are generally intermittent in nature in that they dry up completely and do not provide substantial flows to Seven Mile Creek after the month of July in a typical year. The creek itself maintains a minimum of 1-3 cubic feet per second of flow as a result of ground water upwelling near the upper portion of the County Park. These flows are consistent throughout the year and presumed to be from the Jordan Sandstone Aquifer. At certain times of the year, water from the upper ditches infiltrates into the alluvial material found in watershed 3. This groundwater and surface water interaction is of great interest to the watershed staff since surface water quality might be affecting groundwater quality. More studies need to be completed to further the understanding of groundwater and surface water interactions within Seven Mile

Creek. The watershed contains three minor watersheds. Hydrologic units include: minorshed 28062 (9956 acres), minorshed 28066 (9120 acres) and minorshed 28063 (4475 acres). For simplistic purposes, this report describes the minorsheds as watershed 1, watershed 2, and watershed 3 respectively. Soil type, soil internal drainage, and landscape slope steepness distributions are very similar in watershed 1 and watershed 2. Watershed 3 contains much steeper slopes, and transitions from a cultivated land use to mature deciduous forest. Three monitoring stations were installed in 2000 to monitor CD 46, CD 13, and the mouth of the watershed. Through subtraction, the influence of watershed 3 is determined.

The majority of the watershed land use is under row crop corn/soybean rotation agriculture. 86% of the land is under cultivation; 6% is deciduous forest, with the remaining nearly equally divided between wetlands, grassland, and farmsteads. Residential development is growing in the watershed, and current recreational use is medium to high, mainly because of the county park.

The watershed is 23,551 acres or 36.8 sq. miles in size. It comprises about 3% of the Middle MN Basin and covers 8% of Nicollet County. The watershed study will be used as a template for other watershed projects within the eastern region of the Middle Minnesota Major Watershed. Since 1985 the ecological classification of the stream has been a class 1-D or marginal trout fishery, because of its cool water temperatures and ideal habitats. Other unique features include: the Seven Mile Creek County Park, which attracts thousands of visitors yearly and serves as an education site for area schools and colleges; the Red Top Farms Research Fields; and the St Peter Source Water Protection project.

Photo 1. Seven Mile Creek near the mouth with Seven Mile Creek County Park. Much of the lower reach of creek is surrounded by sandstone bedrock outcrops and mature deciduous forest on steep ravines.


Seven Mile Creek Watershed
Nicollet County, Minnesota
Map 4
Research Fields
Drinking Water Supply
Management Area
City of St. Peter
St. Peter
Traverse Twp.
Oshawa Twp.
Minorshed 062
Oak Leaf Lake
Little Lake
CD 46
Granby Twp.
Minorshed 066
Nicollet
Site 1
Site 2
Seven Mile Creek
Minorshed 063
Mud Lake
Belgrade Twp.
Nicollet Twp.
CD 58
CD 13
CD 29
CD 24
Site 3
US 169
Minnesota River
2 0 2 4 Miles
Legend
Seven Mile Creek
Water Quality Monitoring Site
Major Roads
Public Open Ditch
Public Ditch Tile
Seven Mile Creek County Park
City
Seven Mile Creek Watershed
Redtop Farms Research Fields
Wetlands
BNC Water Board_2000

Recently several other developments within the watershed have increased its uniqueness as a water quality project. They Include:

- A paired watershed study involving Seven Mile Creek and Huelskamp Creek watersheds in western Nicollet County was recently funded though the Department of Agriculture Section 406. The outcomes of the three-year study will help determine the most cost-effective Best Management Practices to increase water quality within an agricultural setting.

- Northern Plains Dairy plans to construct one of Minnesota's largest dairies within the watershed. Proposed construction site is located on map 22.

- Innovative model developed by BNC and PCA staff to estimate sediment and phosphorus delivery pathways.

- McKnight Foundation of Minnesota is considering funding a pilot constructed wetland demonstration project to mitigate nitrate concerns in Seven Mile and Little Cottonwood watersheds.

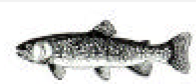
- Considerations have been underway to convert county ditch tile 29 to an open drainage ditch or enlarge the existing drainage tile.

- Seven Mile Project and Little Cottonwood River Watershed Project recently formed partnership with Center for Agricultural Partnerships Mid-Western Water Quality Project. The project involves innovative nutrient management demonstrations involving nitrogen-rate demonstrations, yield monitor and GPS/GIS technologies, and economical optimum nitrogen rate analysis for corn producers within the watershed.

Unique Watershed Features

Trout Stream:

Seven Mile Creek flows through Nicollet County's only park. The 625-acre park is a visible site for public awareness, and is often used for picnics, and educational seminars by local schools and universities. Seven Mile Park has over 7 miles of hiking/biking/horse trails, as well as abundant bird and wildlife populations. Seven Mile Creek was the first release site of wild turkeys in the MN River Basin. The watershed also contains a few small lakes and larger wetlands.



Unique Stream

Seven Mile Creek is a designated trout stream. This type of fishery is very rare for an area like South Central Minnesota. A trout stream requires a certain mix of streambed geology, adequate groundwater, and compatible land use within the watershed in order for sensitive fish like trout to survive. One of the most important factors is temperature. Trout need cold water and cannot tolerate temperatures above 75 degrees. In an area where prairie and now cropland dominate, cool temperatures are not typical. Seven Mile Creek is an exception. Because the Seven Mile area contains steep gradients, heavily forested vegetation, and gravelly substrate, a very unique habitat and fishery can exist. The lower reaches of Seven Mile flow all year long due to groundwater upwelling from the Jordan aquifer. This also substantially increases fisheries habitat.

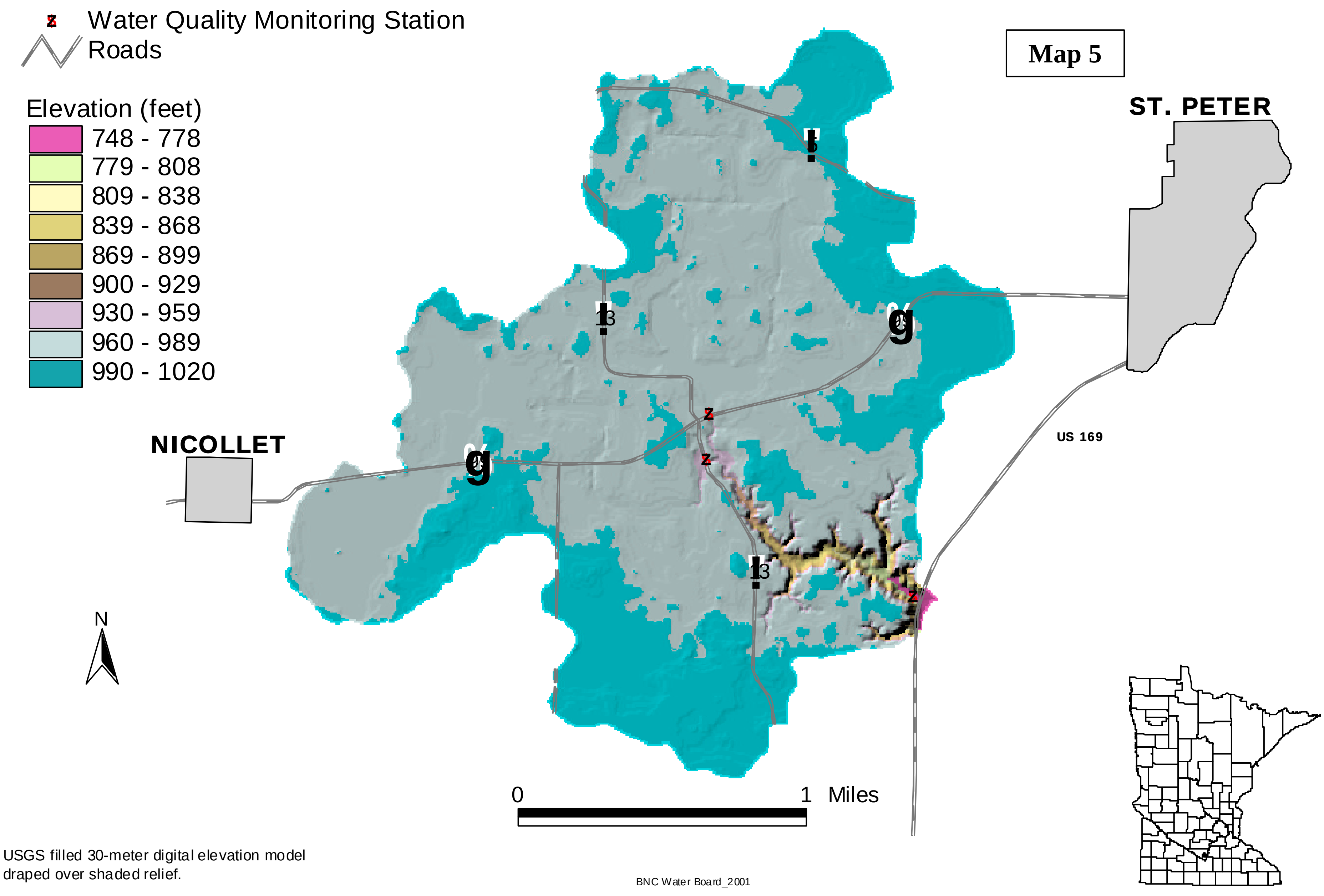
Topography

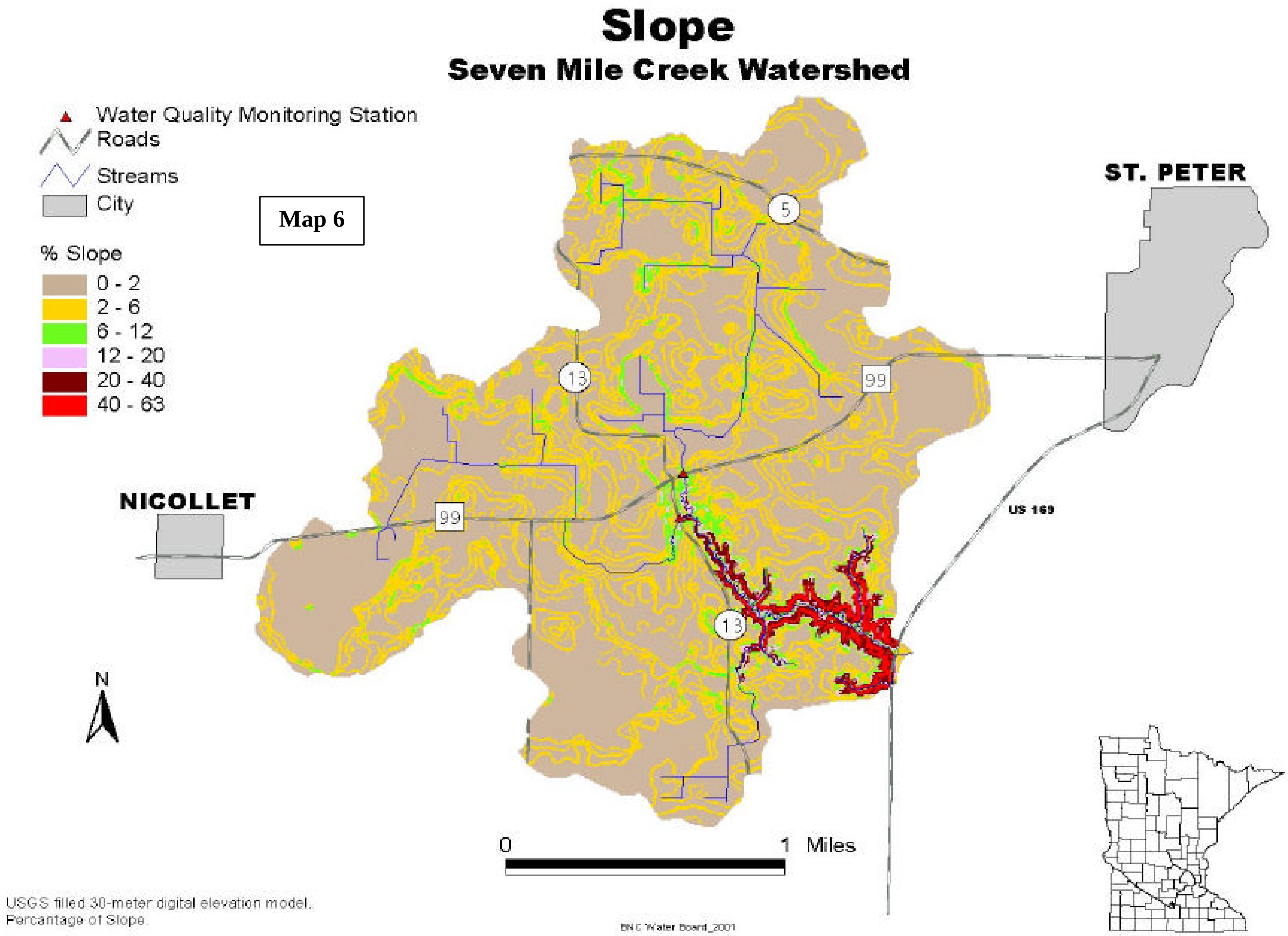
Topography of Watershed

A majority of the watershed is nearly level or gently sloping. The topography is steepest in the lower portion of the watershed. Land along the river is also steep as the river descends into the MN River valley. Map 5 is a Digital Elevation Model representing land slope within the watershed. Percentage of slope was reclassified into six categories (map 6). Both the land slope and shaded relief maps were derived from 30-meter resolution USGS Digital Elevation Models.

Elevation

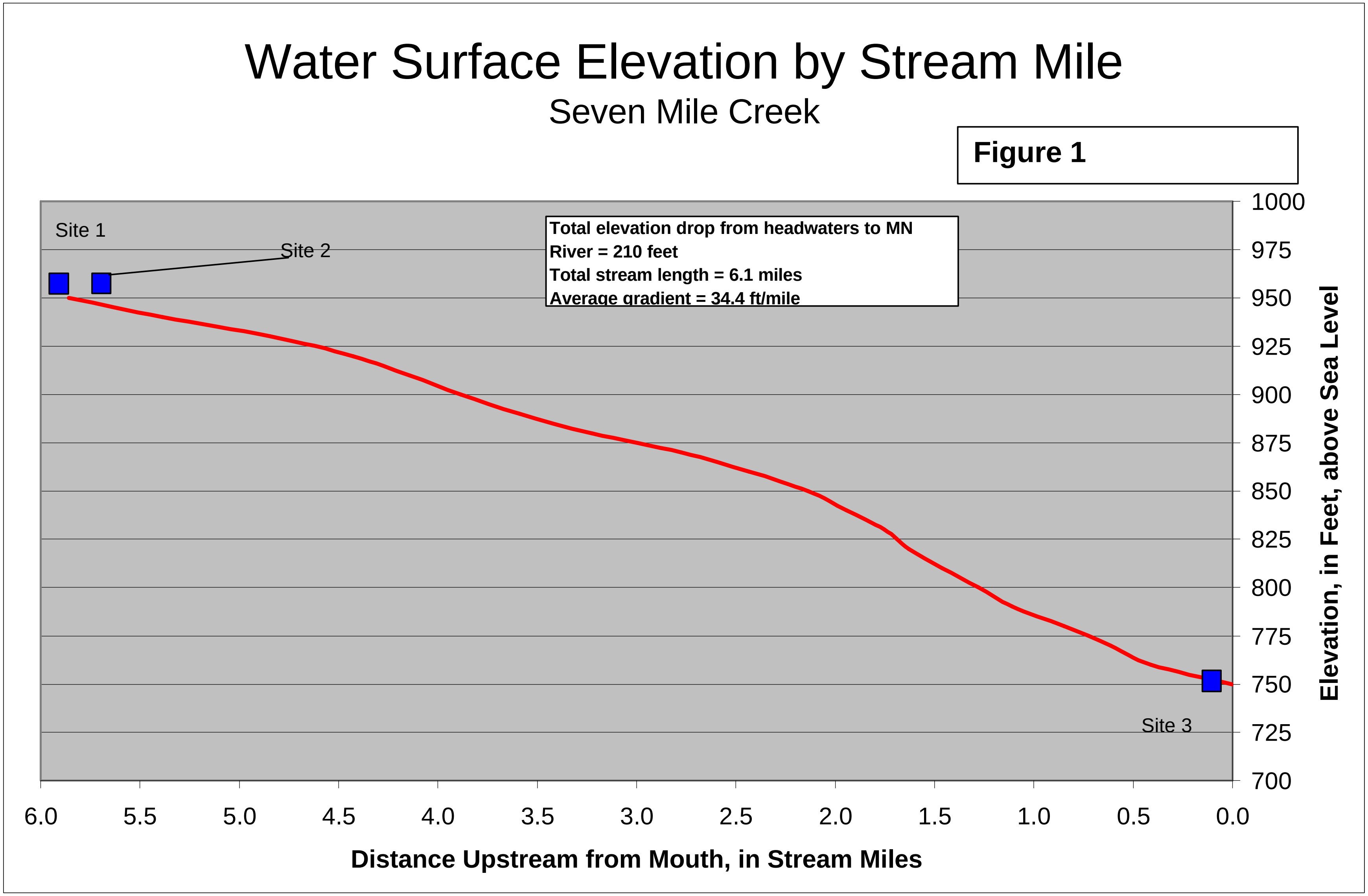
Seven Mile Creek Watershed




Slope
Seven Mile Creek Watershed
Water Quality Monitoring Station
Roads
Streams
City
Map 6
% Slope
0 - 2
2 - 6
6 - 12
12 - 20
20 - 40
40 - 63
ST. PETER
NICOLLET
5
13
99
99
13
US 169
N
0
1 Miles
USGS filled 30-meter digital elevation model.
Percantage of Slope.
BNC Water Board_2001

Topography of Seven Mile Creek Water Course

Seven Mile Creek is 6.1 miles long and receives most of the drainage of the watershed from two constructed ditches. (CD 58 and CD 13). Elevation of the surface water starts at 1020 feet. Elevation of the creek at the mouth is 748 feet. Overall the river drops a total of 210 feet from monitoring site 1 to monitoring site 3 at the mouth with an average gradient of 34.4 feet/mile. Figure 1 shows a cross-sectional view of the creek's gradient from state highway 99 to the confluence of the MN River.


Water Surface Elevation by Stream Mile
Seven Mile Creek
Figure 1
Site 1
Site 2
Site 3
Total elevation drop from headwaters to MN River = 210 feet
Total stream length = 6.1 miles
Average gradient = 34.4 ft/mile
1000
975
950
925
900
875
850
825
800
775
750
725
700
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Distance Upstream from Mouth, in Stream Miles
Elevation, in Feet, above Sea Level

Climate

Seven Mile Creek Watershed is continental, with cold dry winters and warm wet summers. Climatic records from St. Peter, MN, which is just north of the watershed, show the average monthly temperatures in St Peter is 46.2 ^oC. Annual precipitation rates average 28.91 inches. Average annual runoff is estimated to be between 5-6 inches.[1]

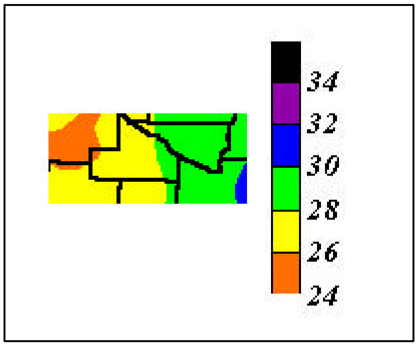


Figure 2. Normal average annual precipitation rates for the project area (inches) (1961-1990 State Climatology Office).

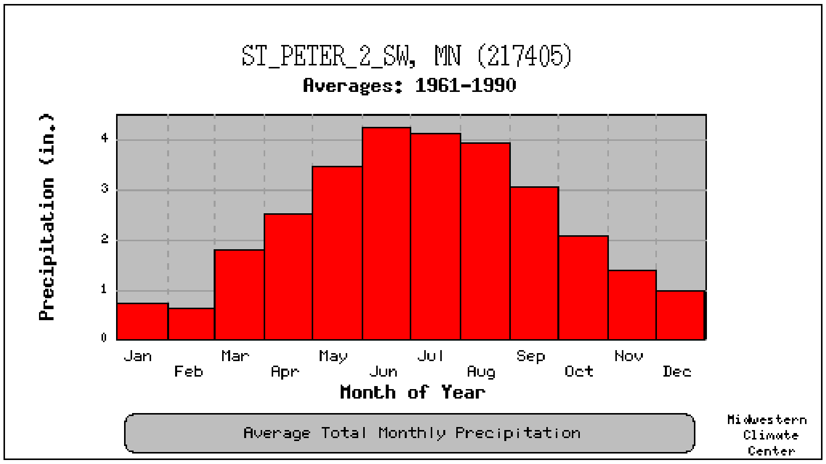


Figure 3. Normal average annual precipitation rates (inches) (1961-1990 State Climatology Office).

[1] Minnesota River, Basin Information Document, 1997, MPCA

Summary of Precipitation During Water Quality Monitoring Period

2000

Growing season (April-Sept.) rainfall amounts deviated from normal in the spring and fall. During these seasons the watershed experienced abnormally dry conditions. The months of April and September were below normal. No spring runoff conditions were present. Up until May 17 there was very little rainfall. In contrast, May proved to be above normal rainfall with very intense rainfall frequencies. On May 17/18 and July 10 the watershed received most of its precipitation. After May a more normal rainfall pattern occurred. June, July and August were normal. Rainfall for watershed was determined by averaging selected sights in and around the watershed. See map 7 for monthly precipitation totals.

2001

The winter of 2000 and 2001 proved to be one for the record books. Record snowfall amounts fell in the MN River Basin over the winter period and resulted in flood levels comparable to 1997. Fortunately, the snow melted gradually starting in mid March through the early part of April. The upper tributaries, CD13 and CD 46a, eventually opened up by the first week of April. Monitoring equipment was installed around this time with some difficulty. Large drifts of snow in some places up to 8 feet deep were deposited in and around the water quality monitoring sites. The sites had to be literally dug into the snow in an effort to capture the spring runoff conditions. Ice jams were consistent problems as well. Spring runoff conditions peaked around mid-April. Compounding the high water levels, over six inches of additional rainfall fell within the watershed in addition to the 4-6 inches contributed by winter snowfall. Several intense 2" rainfall events occurred in April. By May, rainfall levels decreased to normal levels. June, July and August rain levels decreased substantially. Total monthly rainfall levels for June and August were roughly half of what is considered normal rainfall for those particular months within the St. Peter area. By late July, the two main tributaries supplied little to no flow to the lower reach of the Creek. Groundwater dominated the source of flows in Seven Mile by late summer, which is very typical of this watershed. September rainfall levels were considered normal to just below normal.

Photo 2. Spring runoff conditions within the watershed. It is estimated that approximately 70% of the pollutants in 2001 came through the watershed during the spring snowmelt conditions. Phosphorus was the dominant source of pollution within the watershed during the snowmelt conditions.

Photo 3. Snowmelt conditions at monitoring site 2 on April 7, 2001.

Photo 4. April 11, 2001. Spring runoff conditions at site 2. The monitoring sites had to be dug into the snow pack in order to capture the spring runoff conditions.

Table 1. Monthly rainfall totals during growing seasons of 2000 and 2001

Rainfall in SMC Watershed growing season 2000

April	May	June	July	August	September	Total
0.75	6.19	5.19	4.32	3.21	0.67	20.34

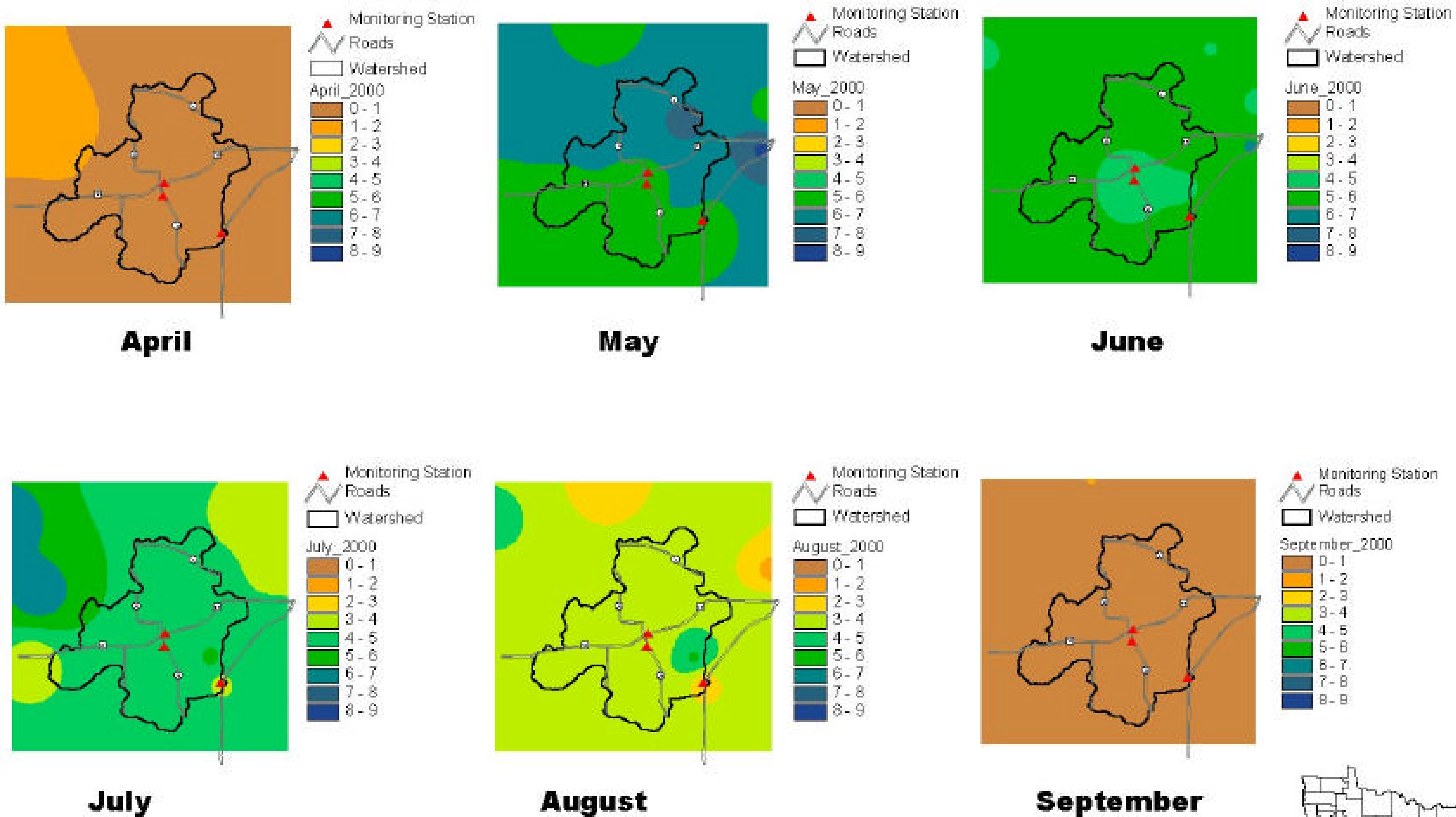
Rainfall in SMC Watershed growing season 2001

April	May	June	July	August	September	Total
6.10	3.53	3.28	4.13	1.57	2.83	21.44

*Normal is simply a 30 –year arithmetic mean computed once per decade. The normals presented in the graph above use the observation period 1961-1990. These values are the benchmarks to be used throughout the 1990's and into the year 2000. New normals will be computed by the State Climatology Office in 2001 and will use data from 1971-2000.

Monthly Precipitation Totals

Seven Mile Creek Watershed, Growing Season 2000



Total rainfall per month (expressed in inches)
based on 12 data points in and
around the watershed.
Interpolated GRID using IDW closest neighbor method.

Map 7

BNC Water Board_2001

Table 2. Monthly rainfall for SMC Watershed during 2000 growing season.

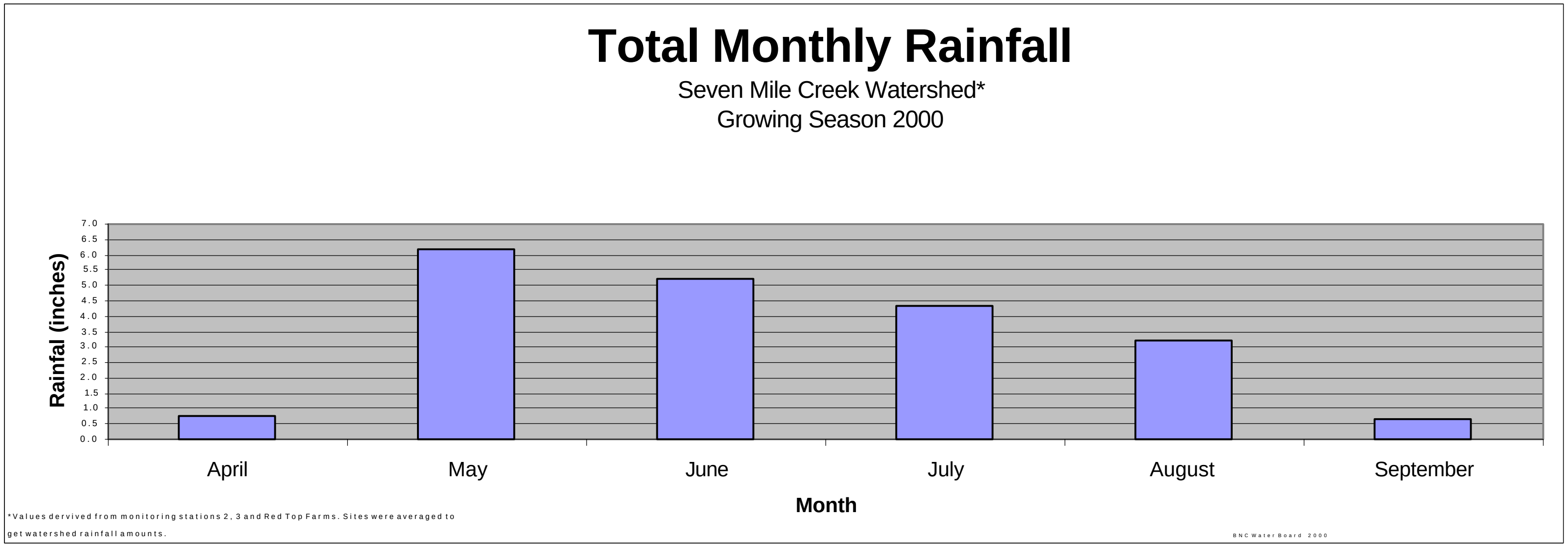


Table 3. Monthly precipitation totals for St. Peter and SMC Watershed during 2000 growing season.

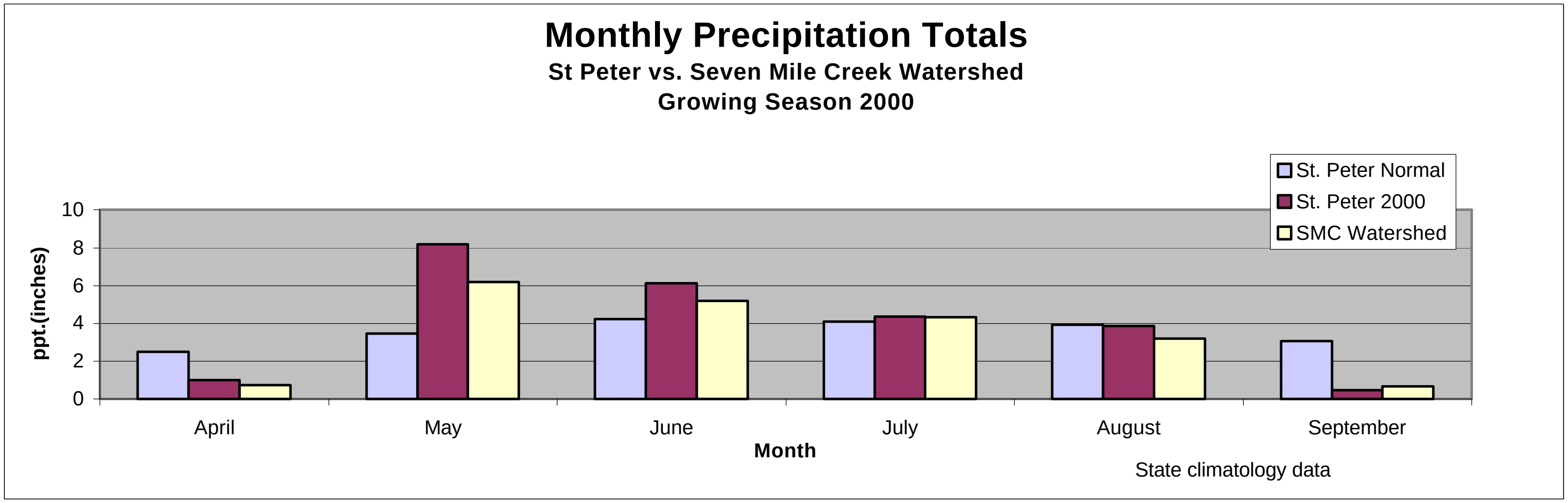


Table 4. Monthly rainfall for SMC Watershed during 2001 growing season.

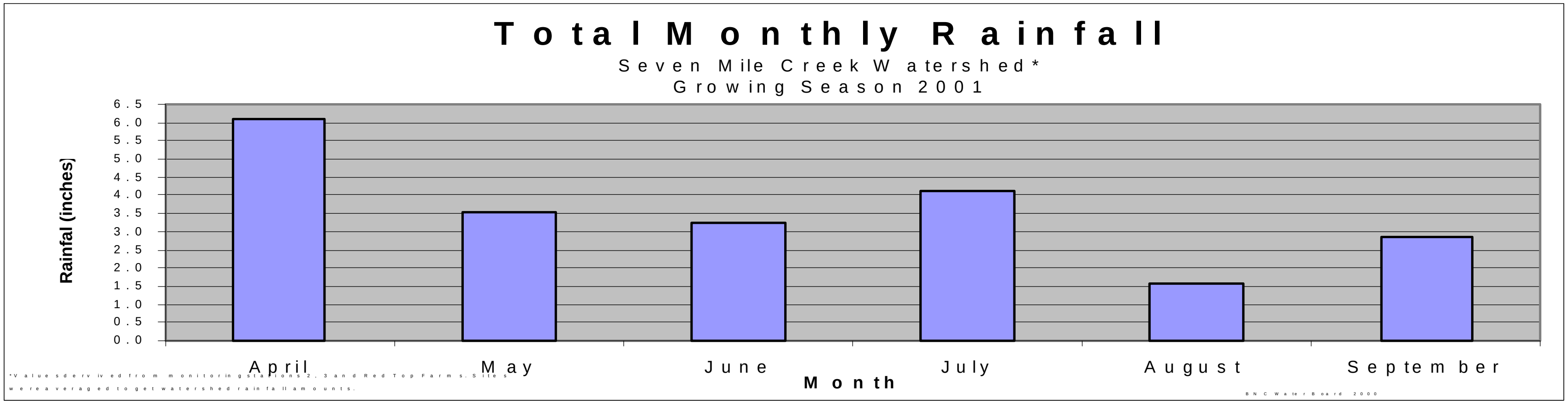
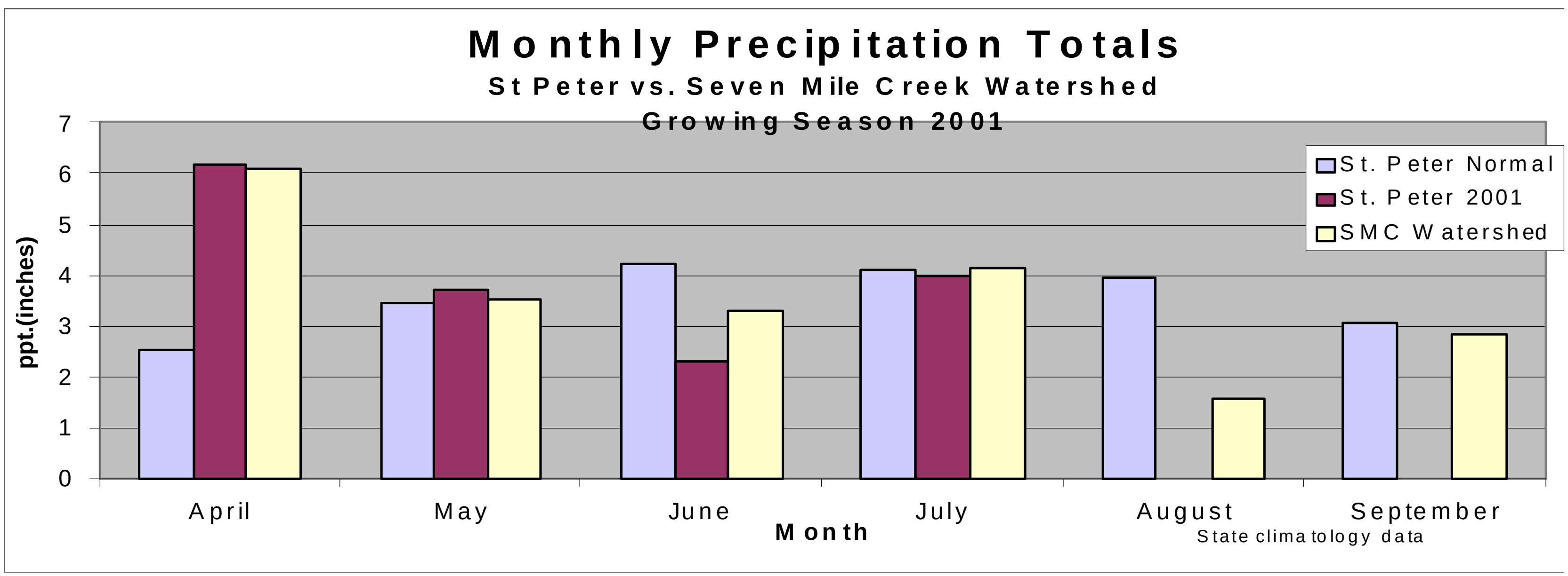


Table 5. Monthly precipitation totals for St. Peter and SMC Watershed during 2001 growing season.



Land Use

Since the 1850s the watershed has been transformed from open prairie and wetlands to an intensively developed agricultural area. Whereas the market for the products of the early farmers was limited to areas only about 30 miles away, much of the current agricultural production is marketed around the U.S and overseas. Roads on virtually every section line provide transportation routes[2].

Cultivated crops are the predominant land use (corn and soybeans), with some pasture and occasional feedlots, and small forested areas. No municipalities exist within the watershed. Land use within Seven Mile Creek Watershed is primarily agricultural, accounting for approximately 86% of the land area. Two- year corn/soybean rotations comprise close to 90% of cropped lands within the watershed; small grains-oats, peas, hay, and grasslands and areas enrolled in the Conservation Reserve Program make up the majority of the balance.

Residential development is becoming more common in and around Seven Mile Creek Park. Current recreational use of watershed waters is medium to high. Land cover is based on 1990 land use (map 8).

Table 6

1990 Land Use and Land Cover

Land use	Acres	% of Area
Cultivated Land	20181	86
Deciduous Forest	1478	6
Wetlands	649	3
Grassland	643	3
Farmsteads and other rural Developments	438	2
Water	154	0.7
Other Rural Developments	6	0.02
Grassland-Shrub-Tree (deciduous)	1	0.01

[2] Soil Survey, Nicollet County, USDA, 1994.

1990 Land Use

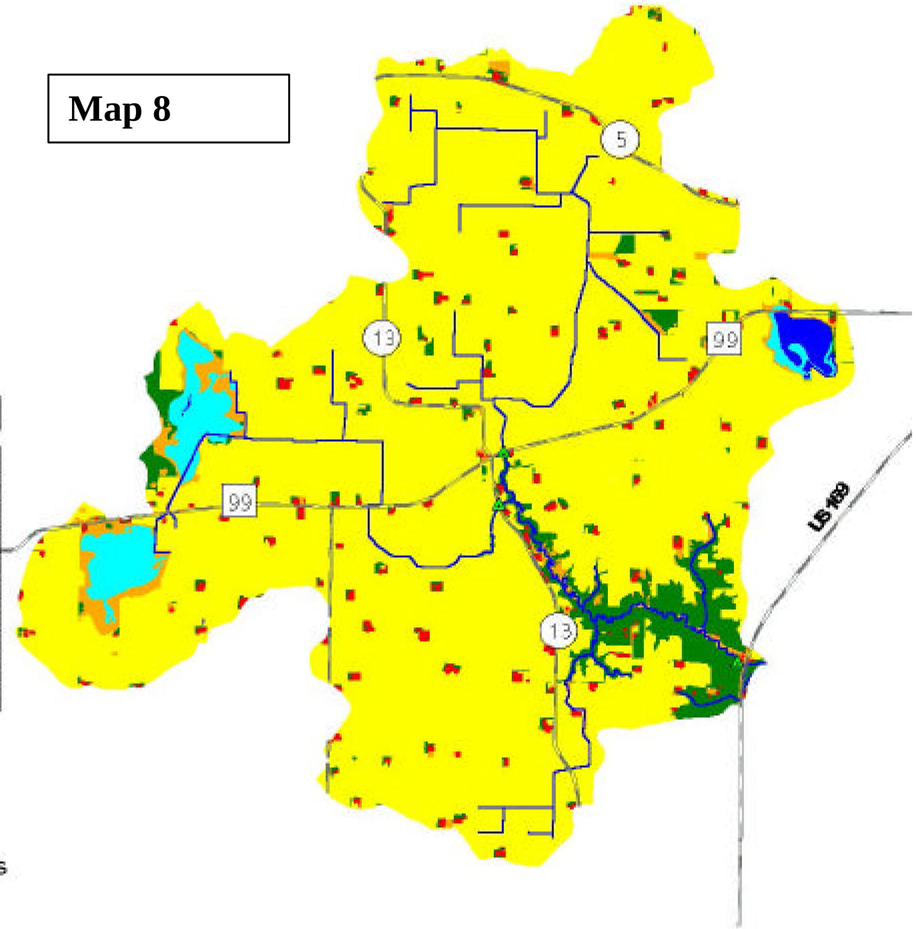
Seven Mile Creek Watershed

Map 8

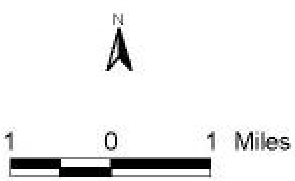
- Water Quality Monitoring Sites
- Stream and Tributaries

1990 Land Use

- Cultivated Land
- Deciduous Forest
- Exposed Soil; Sandbars and Sand Dunes
- Farmsteads and Rural Residences
- Grassland
- Grassland-Shrub-Tree (deciduous)
- Other Rural Developments
- Water
- Wetlands



Land Use	Acres	% of area
Total	23551.0000	100.00
Cultivated Land	20180.9100	85.69
Deciduous Forest	1478.4200	6.28
Wetlands	648.8500	2.76
Grassland	643.3700	2.73
Farmsteads and Rural Residences	438.0200	1.86
Water	153.5800	0.65
Other Rural Developments	5.8100	0.02
Grassland-Shrub-Tree (deciduous)	1.3800	0.01
Exposed Soil; Sandbars and Sand Dun	0.6100	0.00

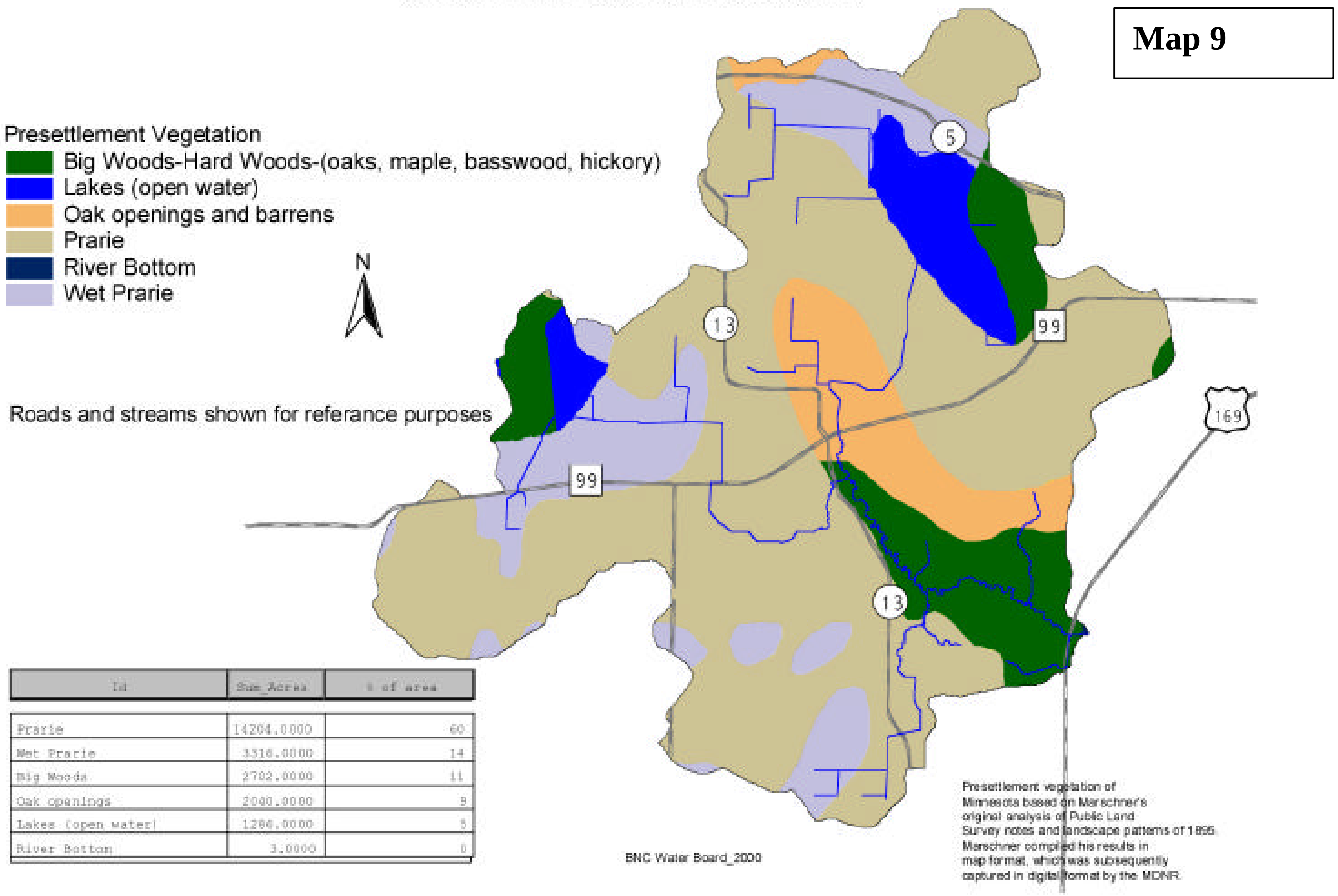


BNC Water Board_2000

Presettlement Vegetation

Seven Mile Creek Watershed

Map 9



Id	Sum_Acres	% of area
Prarie	14204.0000	60
Wet Prarie	3316.0000	14
Big Woods	2702.0000	11
Oak openings	2040.0000	9
Lakes (open water)	1286.0000	5
River Bottom	3.0000	0

Soils

According to the University of Minnesota's Department of Soil, Water and Climate the Lower Middle MN Major Watershed is mainly comprised of wetter Blue Earth Till deposits. These deposits are a complex mixture of relatively flat (2-6%) well drained soils and very flat (0-2%) poorly drained soils. Soils within these deposits are generally loamy in texture.

Adopted from Nicollet County Soil Survey, 1994

Because the water table is high in about 62% of the soils, artificial drainage systems were installed in the 1880s to enhance crop production within Nicollet County. The systems incorporated open ditches and tile drains. Today more than 24 miles of open ditches and approximately 15 miles of public drain tile exist in Seven Mile Creek Watershed. Private tile line is expected to be three to four times this. The use of most drained areas has changed from pasture and hay to cash crops, such as corn and soybeans. This change in land use has resulted in a shift from the many small dairy and hog farms to just a few mostly confined systems. Most of the watershed is a nearly level and gently undulating upland till plain that is characterized by dark, loamy soils that formed glacial deposits. Some soils bordering in the lower reaches of Seven Mile Creek as it empties into the MN River Valley were formed in weathered bedrock and alluvium. The original vegetation in the watershed was predominantly tall prairie grasses and wetlands, but small areas of mixed deciduous hardwood forests were scattered in the eastern portion of the watershed. Remnants of this oak, beech and maple forest can be seen in the 320 forested acres of Seven Mile Creek County Park.

As the creek descends into the MN River a much older relief can be seen. Very steep wooded bluffs separate the upland from the floodplain. This Paleozoic sandstone and dolomite was deposited about 570-480 million years ago in a shallow sea environment. Outcrops of these stratified rock outcrops (Jordan Sandstone) can be seen in the park. The Seven Mile Creek channel was formed by the melt waters released during the retreat of the Des Moines lobe ice sheet about 12,000 years ago.

Physiography, Relief, and Drainage

Most of the upper portion of the watershed lies in the Olivia Till Plain section of the MN Lowlands province. It is covered by a thick mantle of glacial drift varying in thickness of 50-200 feet. The nearly level terrain, which has many small depressions, marshes, swales, and low drainage, is characteristic of the immature drainage network of a young till plain.

Geomorphilogical composition of the SMC Watershed is predominantly till plains. Most of the soils in the watershed were developed in glacial till, under tall grass prairie conditions and are of the Mollisol soil order.

Near the mouth of the creek alluvial deposits and coarser textured materials dominate. Water erosion potentials are moderate on 46% of the land within this geomorphic setting.

The three dominant soil series within the watershed are the Canisteo Glencoe complex, Cordova clay loam and Canisteo clay loams. Together these soils comprise nearly 40% of the watershed area. Map 10 shows the spatial occurrence of the various soil series in the watershed and is based on the 1994 soil survey. The three dominate soil series are color coded to stand out from the rest of the minor soil series.

Canisteo Glencoe Complex and Canisteo Clay Loam Series

These soils are characterized as very deep, very poorly drained, formed out of Glacial till, slightly alkaline and have slopes in the 0-2% range.

Cordova Clay Loam

These soils are characterized as very deep, poorly drained with moderately slow in the upper part and moderate in the lower part permeability, formed from ground moraines in glacial till and have slopes in the 0-2% range.

Most of the watershed contains excellent soils for crop production with some limitations as can be seen in following maps (maps 10-15). Over 85% of the watershed is classified as prime farmland and many areas, which have been considered un-prime, have been extensively tiled to convert to prime. Other limitations for crop production, besides poor drainage, include steeper slopes near the lower portion of the watershed. The Revised Universal Soil Loss Equation was used to identify highly erodible areas. Areas with soil loss above five tons per acre/year should have special conservation practices associated with them.

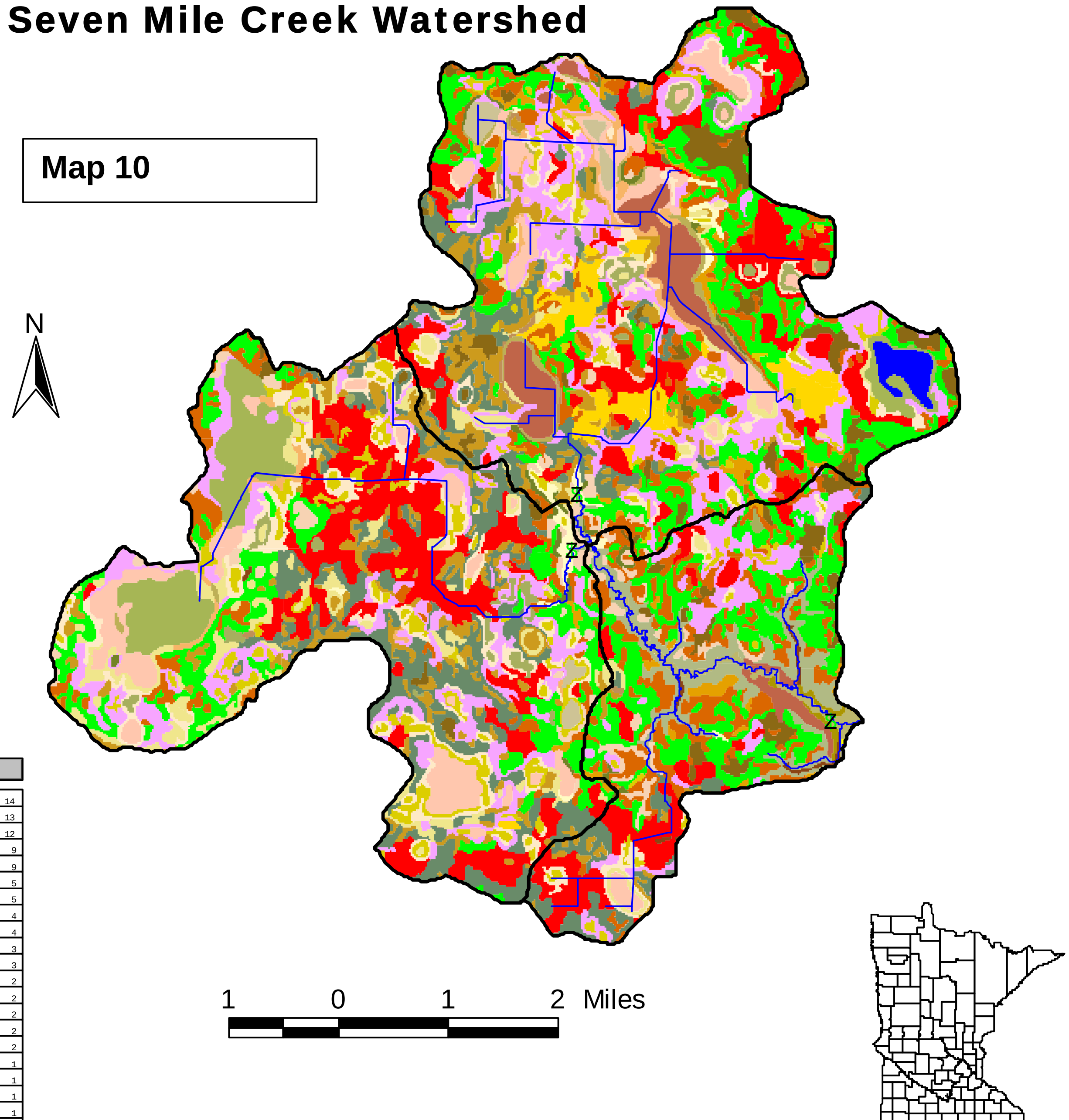
Severe limitations for septic systems exist for most of the watershed and most need a more expensive mound treatment system.

The organic matter map (map 14) indicates areas of drained wetlands or historic locations of lake beds within the watershed (red areas).

Soil Survey

Seven Mile Creek Watershed

Map 10



Top Three Soils

- CANISTEO-GLENCOE COMPLEX
- CORDOVA CLAY LOAM
- CANISTEO CLAY LOAM

Soil Descriptions

- BLUE EARTH MUCKY SILT LOAM
- BROWNTON SILTY CLAY
- CANISTEO SILTY CLAY LOAM; DEPRESSIONAL
- CHASKA LOAM
- CLARION LOAM; 2-6 % SLOPES
- CLARION-STORDEN COMPLEX; 2-6 % SLOPES
- CLARION-STORDEN COMPLEX; 6-12 % SLOPES; ERODED
- CLARION-STORDEN-HAWICK COMPLEX; 2-6 % SLOPES
- COPASTON-ROCK OUTCROP COMPLEX; 2-60 % SLOPES
- CORDOVA-ROLFE COMPLEX
- CRIPPIN LOAM
- DELFT CLAY LOAM
- ESSEXVILLE SANDY LOAM
- GLENCOE SILTY CLAY LOAM
- HARPS CLAY LOAM
- KLOSSNER MUCK
- KLOSSNER-MUSKEGO SOILS; PONDED
- LE SUEUR CLAY LOAM
- LE SUEUR-LESTER COMPLEX; 1-6 % SLOPES
- LESTER LOAM; 2-6 % SLOPES
- LESTER LOAM; 6-12 % SLOPES; ERODED
- LESTER-STORDEN COMPLEX; 18-70 % SLOPES
- LESTER-STORDEN-ESTHERVILLE COMPLEX; 18-70 % SLOPES
- MARNA SILTY CLAY LOAM
- MINNEISKA SANDY LOAM; 0-2 % SLOPES
- MINNEISKA-KALMARVILLE COMPLEX; FREQUENTLY FLOODED
- MUSKEGO MUCK
- NICOLLET CLAY LOAM
- OKOBOJI MUCKY SILTY CLAY LOAM
- OKOBOJI SILTY CLAY LOAM
- OSHAWA SILTY CLAY LOAM
- TERRIL LOAM; 1-6 % SLOPES
- WATER
- WEBSTER CLAY LOAM

- Sub-shed
- Water Quality Montitoring Sites
- Stream and Tributaries

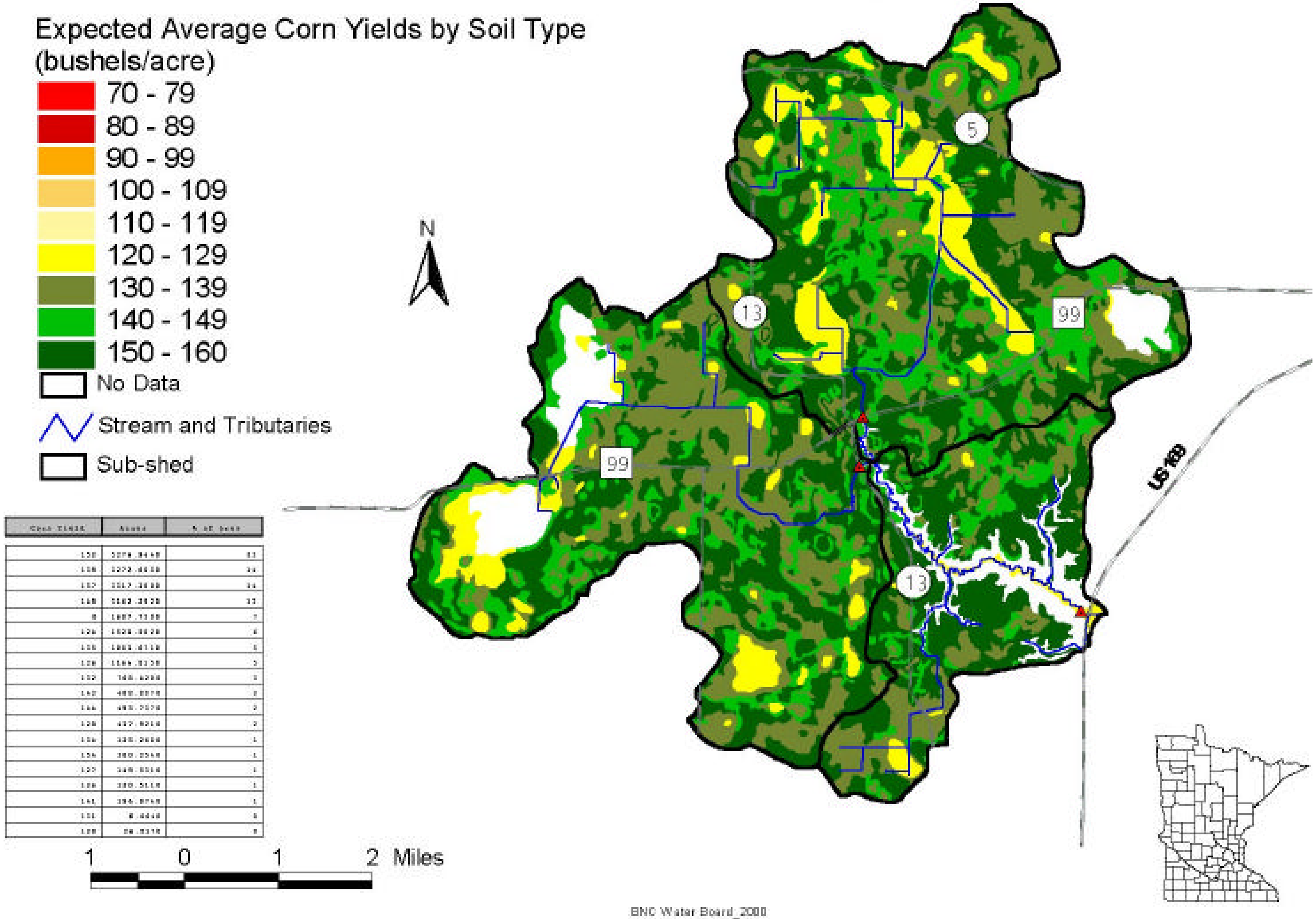
Top 20 Soils

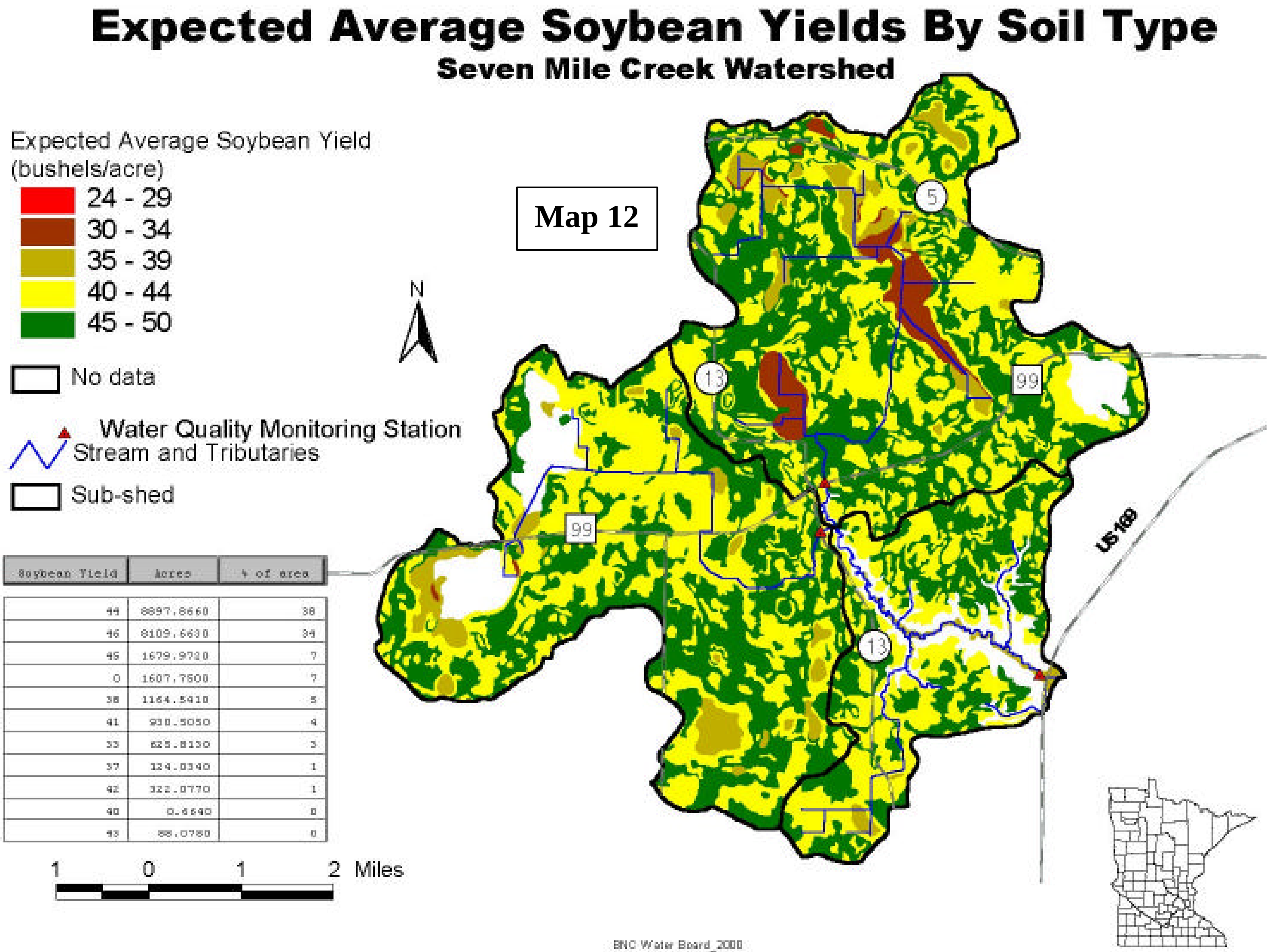
Soil Description	Acres	% area
CANISTEO-GLENCOE COMPLEX	3184.5270	14
CORDOVA CLAY LOAM	3164.3180	13
CANISTEO CLAY LOAM	2771.7860	12
LE SUEUR CLAY LOAM	2031.4630	9
WEBSTER CLAY LOAM	2035.4360	9
HARPS CLAY LOAM	1083.6710	5
NICOLLET CLAY LOAM	1285.8370	5
KLOSSNER MUCK	1023.2000	4
GLENCOE SILTY CLAY LOAM	918.2150	4
KLOSSNER-MUSKEGO SOILS; PONDED	785.4900	3
CORDOVA-ROLFE COMPLEX	768.4200	3
LESTER LOAM; 2-6 % SLOPES	408.8870	2
LESTER-STORDEN COMPLEX; 18-70 % SLOPES	564.1420	2
CLARION LOAM; 2-6 % SLOPES	493.7370	2
MARNA SILTY CLAY LOAM	390.5060	2
BLUE EARTH MUCKY SILT LOAM	505.3020	2
ESSEXVILLE SANDY LOAM	120.5110	1
DELFT CLAY LOAM	138.1230	1
OKOBOJI SILTY CLAY LOAM	246.6000	1
WATER	122.3490	1

BNC Water Board

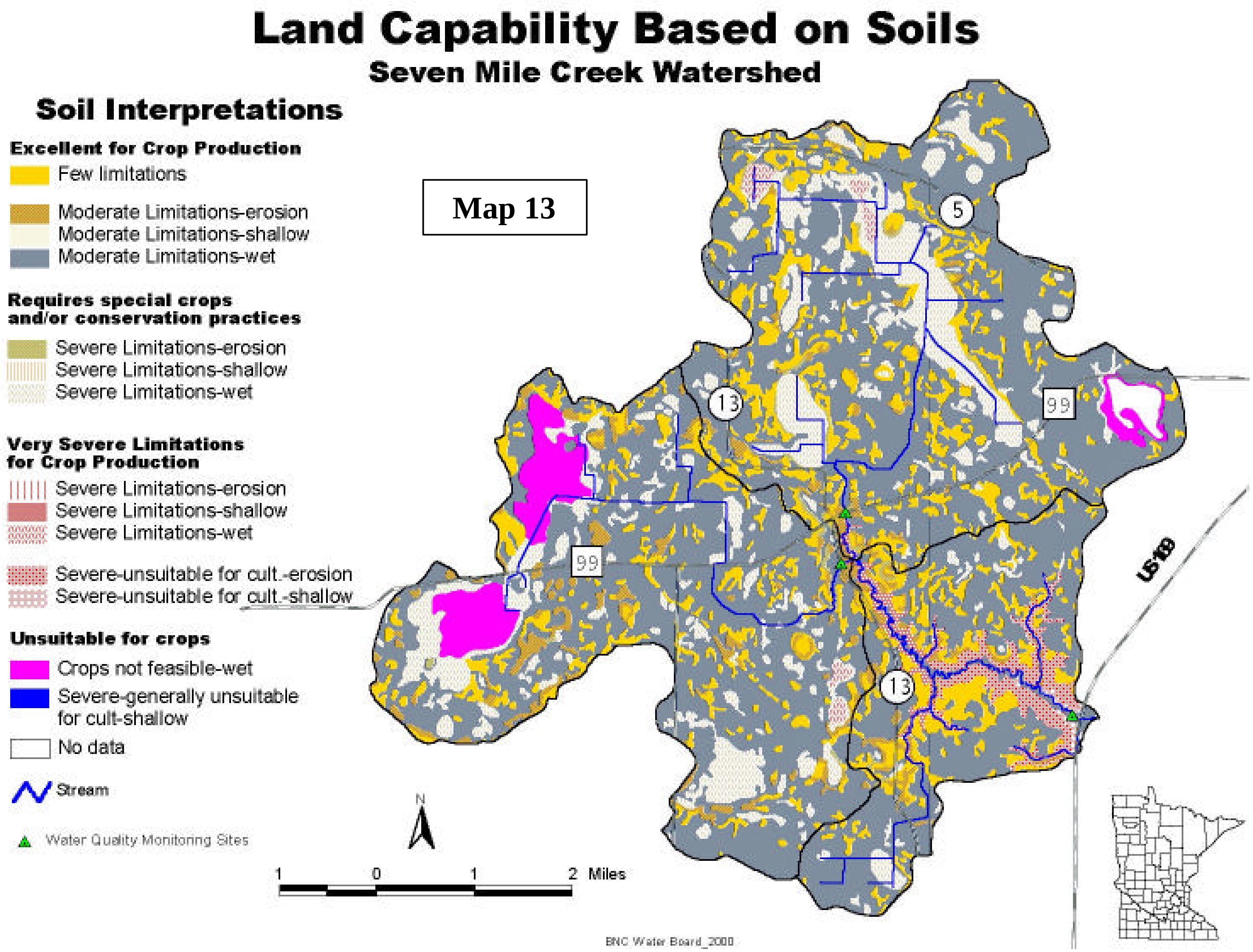
Expected Average Corn Yield By Soil Type
Seven Mile Creek Watershed

Map 11

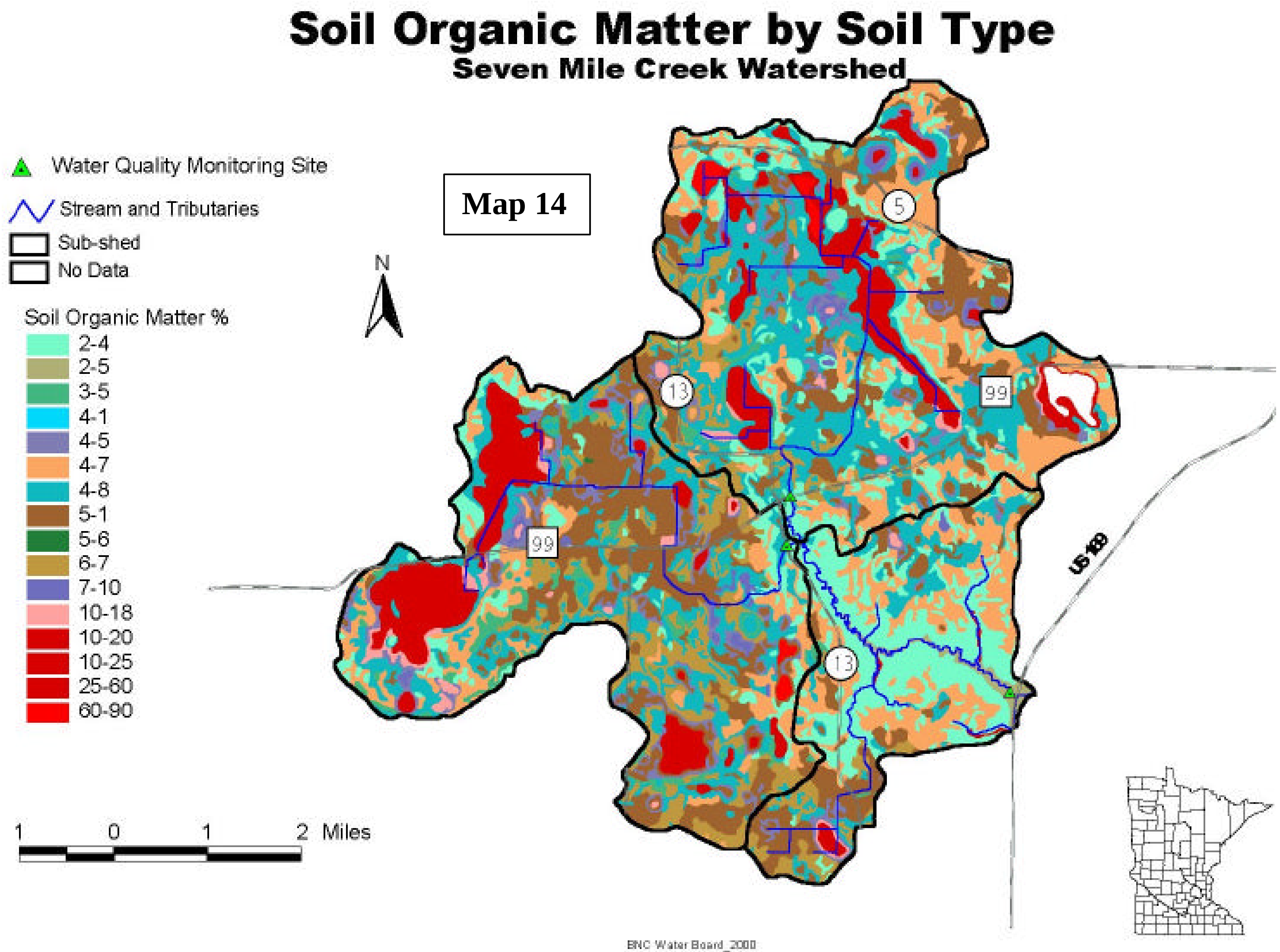




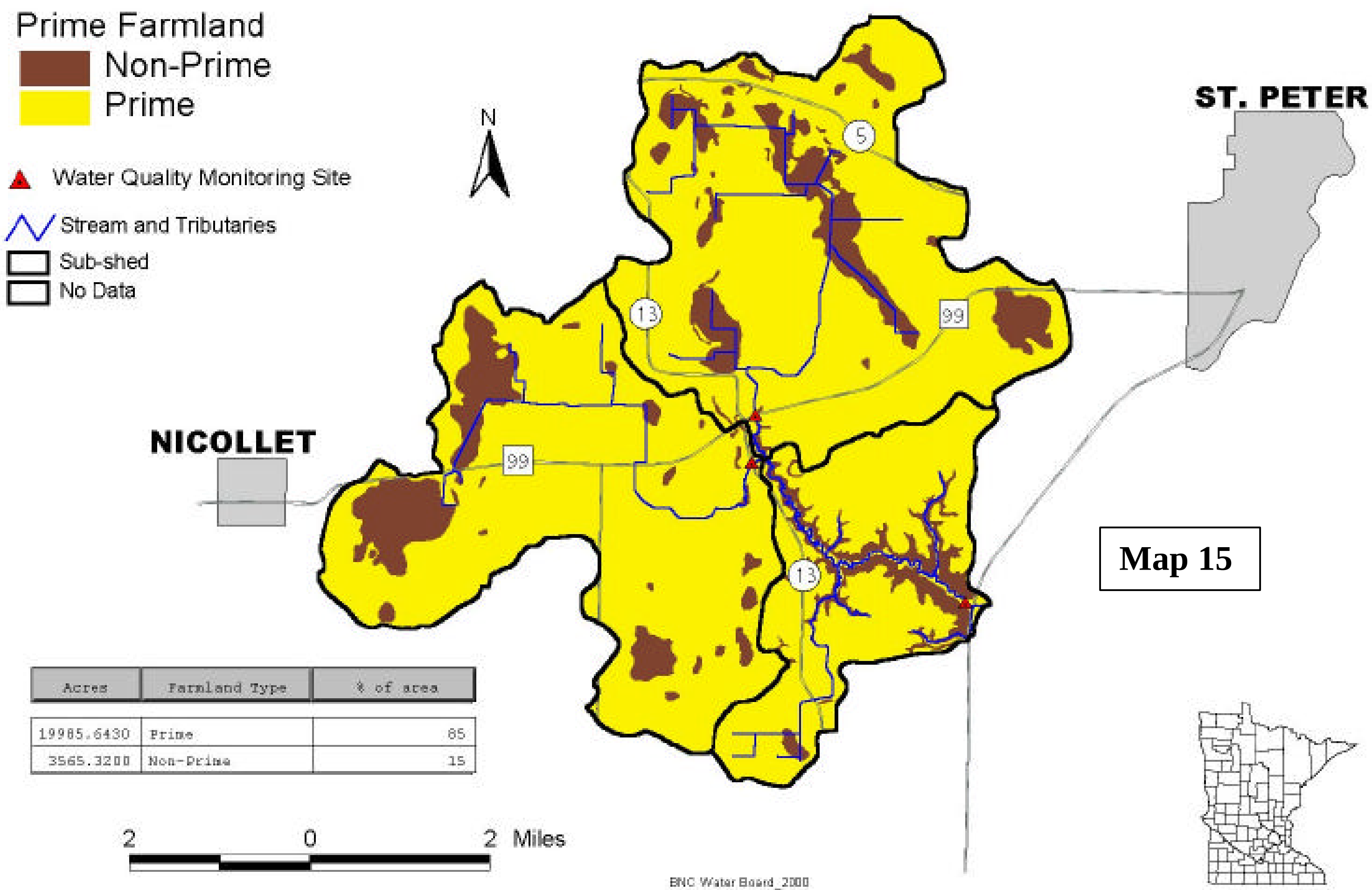
Soybean Yield	Acres	% of area
44	8897.8660	38
46	8109.6630	34
45	1679.9720	7
0	1607.7500	7
38	1164.5410	5
41	938.5050	4
33	625.8130	3
37	124.0340	1
42	322.0770	1
40	0.6640	0
43	88.0780	0


Land Capability Based on Soils
Seven Mile Creek Watershed
Map 13
Soil Interpretations
Excellent for Crop Production
Few limitations
Moderate Limitations-erosion
Moderate Limitations-shallow
Moderate Limitations-wet
Requires special crops
and/or conservation practices
Severe Limitations-erosion
Severe Limitations-shallow
Severe Limitations-wet
Very Severe Limitations
for Crop Production
Severe Limitations-erosion
Severe Limitations-shallow
Severe Limitations-wet
Severe-unsuitable for cult.-erosion
Severe-unsuitable for cult.-shallow
Unsuitable for crops
Crops not feasible-wet
Severe-generally unsuitable
for cult-shallow
No data
Stream
Water Quality Monitoring Sites
N
1 0 1 2 Miles
5
13
99
US169
BNC Water Board_2000

Map 14


Soil Organic Matter by Soil Type
Seven Mile Creek Watershed
Water Quality Monitoring Site
Stream and Tributaries
Sub-shed
No Data
Soil Organic Matter %
2-4
2-5
3-5
4-1
4-5
4-7
4-8
5-1
5-6
6-7
7-10
10-18
10-20
10-25
25-60
60-90
N
5
13
99
99
13
US 169
1 0 1 2 Miles
BNC Water Board_2000

Prime Farmland
Seven Mile Creek Watershed



Acres	Farmland Type	% of area
19985.6430	Prime	85
3565.3200	Non-Prime	15

Map 15

Soil Erosion Potential Model

Soil erosion is frequently associated with sediment and phosphorus transport to surface water bodies. Identifying the extent and location of area with high erosion will help managers pinpoint areas where Best Management Practices should be implemented (i.e. buffer strips, or conservation tillage). To estimate the amount of soil loss specific to the watershed the Revised Universal Soil Loss Equation (RUSLE) was used. RUSLE is a USDA-NRCS derived model used to assess the degree of rill and interrill erosion (in tons per acre per year), identify situations where erosion is serious, and guide development of conservation plans to control erosion. RUSLE is a widely used model to predict soil loss on any field condition where soil erosion by water is possible.

RUSLE is applicable to sheet and rill detachment only. It does not estimate erosion in channels or compute deposition. Map 16 displays the results of the model.

Table 7 describes the numerical results of analysis. The table shows the amount of acres and percent of minorshed by erosion category. Table 8 takes the data a step further by listing the amount of RUSLE erodible acres within 300 feet of a tributary within the watershed.

Table 7

Percent of Sub-shed and acres by RUSLE erosion category

	Soil Erodibility Category (Tons/Acre/Year)				
Subwatershed	**0-3**	**3-5**	**5-15**	**15-30**	**> 30**
28062 WS 1	99% (9639 a)	0.95% (91.2 a)	0.05% (4.6 a)	0	0.03% (2.5 a)
28066 WS 2	99.7% (8293 a)	0.33% (27.3 a)	0.01% (1.0 a)	0	0.004% (.32 a)
28063 WS 3	98% (4374 a)	0.7% (31.4 a)	0.8% (35.4 a)	0	0.74% (33.3 a)

Table 8

Number of acres within 300 feet of a waterway by Soil Loss Category (T/A/Yr)

subwatershed	**3-5**	**5-15**	**15-30**	**> 30**
28062 WS 1	10.0	1.8	0	2.5
28066 WS 2	4.1	0.31	0	0.32
28063 WS 3	0	1.5	0	12.0

For 28063, 100 foot buffer around upland and dendritic drainage interface was used in addition to 300 feet buffer around drainage ditch tributary.

Modeled Rainfall Erosion Loss using RUSLE

Seven Mile Creek Watershed

Map 16

Soil Loss (Tons of soil/acre/year)

- 0 - 3
- 3 - 5

Tolerable Soil Loss Ranges

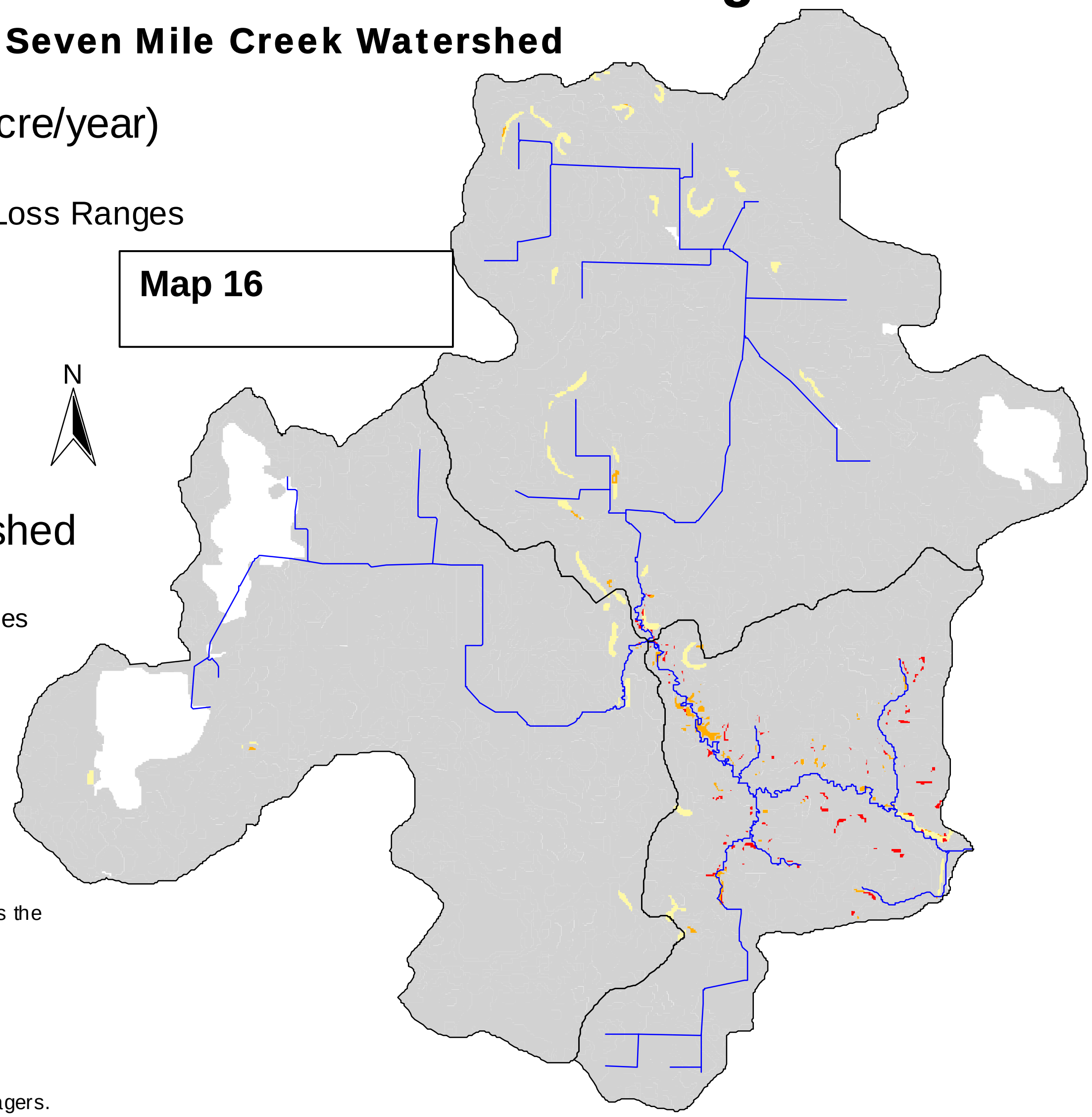
- 5 - 15
- >15

Target Areas

Streams

Seven Mile Watershed

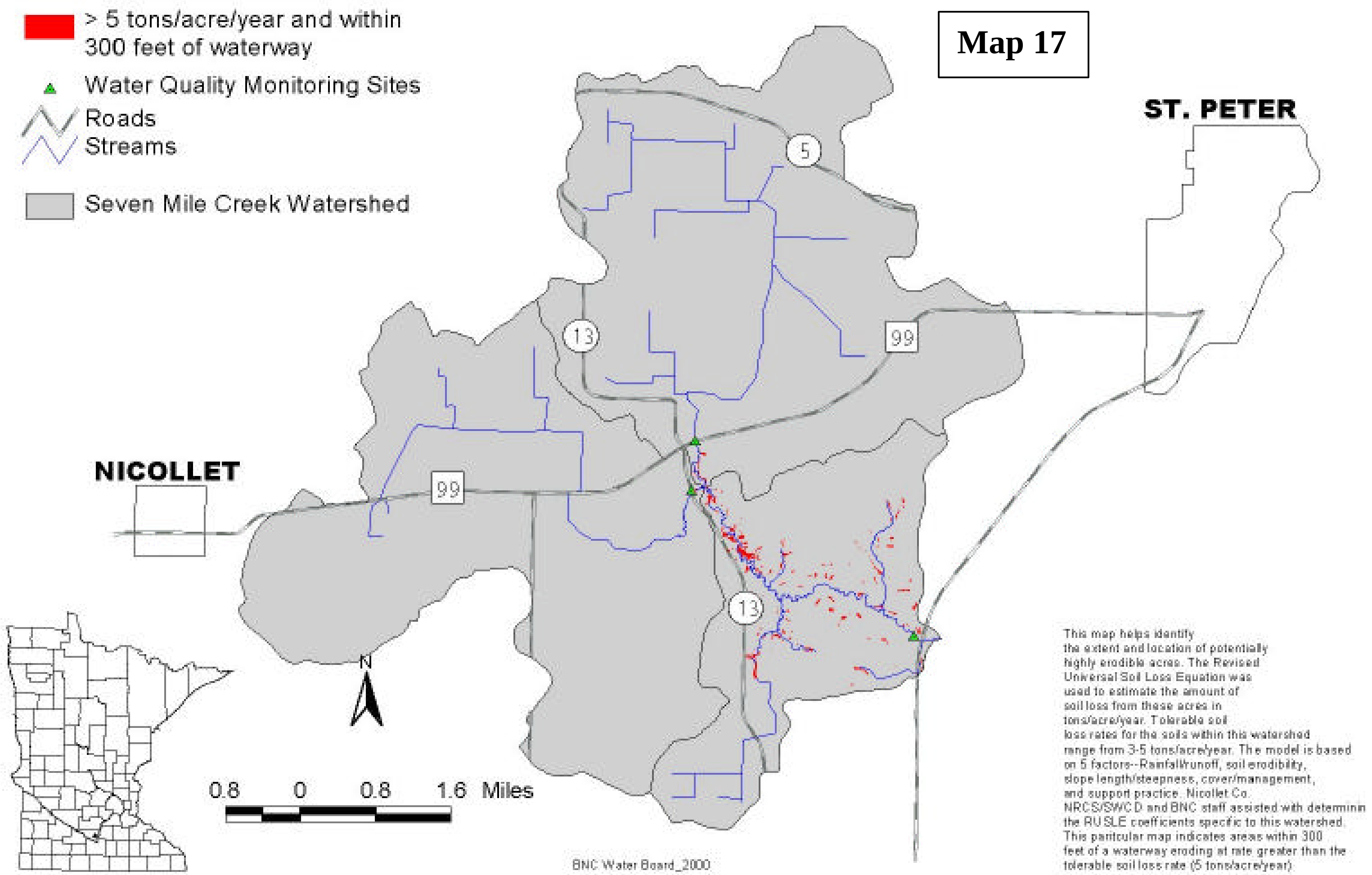
1 0 1 2 Miles



Soil erosion is frequently associated with sediment and phosphorus transport to surface water bodies. Identifying the extent and location of areas with high erosion(>5) will help managers pinpoint areas where BMPs should be implemented (i.e. buffers) To estimate the amount of soil loss specific to this watershed the Revised Universal Soil Loss Equation (RUSLE) was used. RUSLE is a USDA-NRCS derived empirical model used to assess the degree of sheet and rill detachment in tons per acre per year, identify problems areas, and guide development of conservation plans to control erosion. RUSLE is widely used to model soil loss on any field condition where soil by water is possible. Factors used in this model were taylored specifically to this watershed by NRCS and water resource managers.

Seven Mile Creek Watershed

Modeled Soil Erosion Potential using RUSLE



Soils and Slope Classes

Areas of land with higher % of class A, B, C, D, E and F slopes have high potential for soil erosion (table 9). Table 10 below lists those sub watersheds, which have a higher percentage of the six slope classes. Although the majority of the soils with slopes in D and F classes have permanent vegetation they are still listed for management purposes.

Table 9

Slope Classes

Slope Classes	% Slope
A	0-2
B	2-6
C	6-12
D	12-20
E	20-40
F	>40

Table 10

Subwatersheds and Slope Classes

Subwatershed	A slope % of Area	B slope % of Area	C slope % of Area	D slope % of Area	E slope % of Area	F slope % of Area
28063	na	na	na	na	na	na
28066	na	na	na	na	na	na
28063	na	na	na	na	na	na

Wetlands

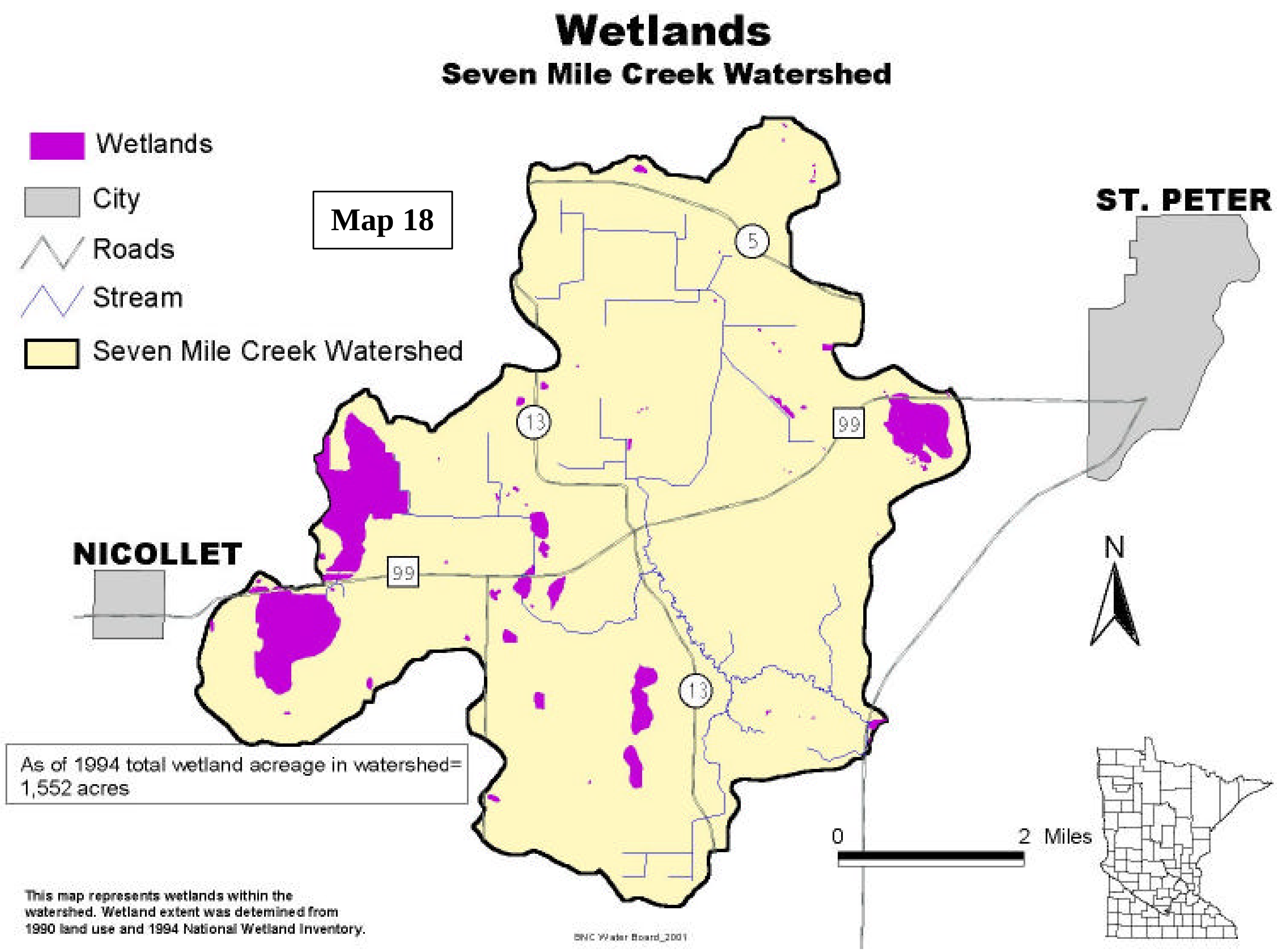
The National Wetlands Inventory (NWI) of the U.S. Fish and Wildlife Service produces information on the characteristics, extent, and status of the Nation's wetlands and deepwater habitats. Map 18 shows current wetland status as of the 1995 NWI survey and map 19 shows the potentially restorable wetlands within the Seven Mile Creek Watershed.

According to the National Wetland Inventory approximately 1552 acres of the watershed land area is classified as a wetland habitat ecosystem

Table 11

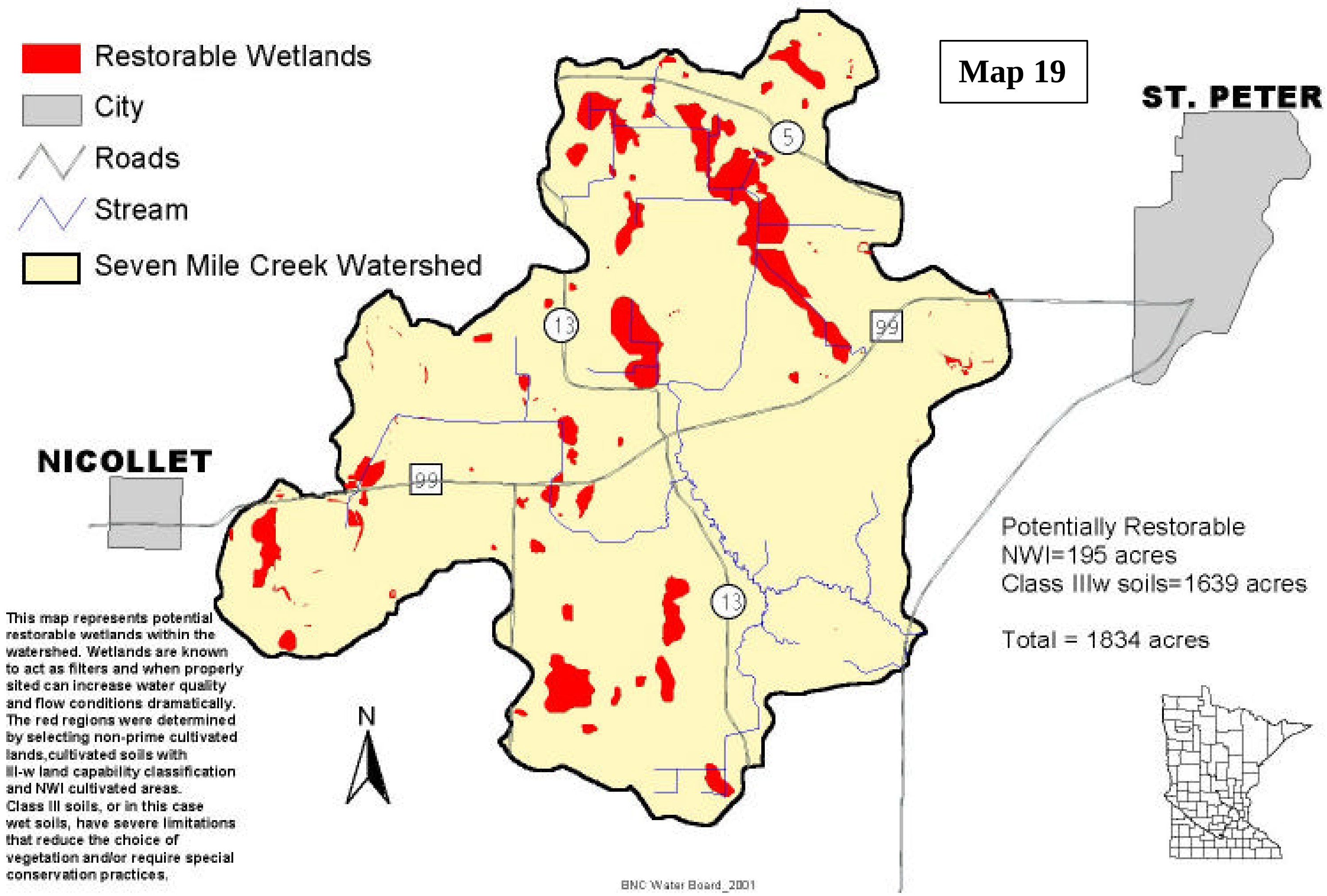
Wetland Characteristics

Subwatershed	Acres of wetlands(NWI)
28062	283
28066	1259
28063	10


Wetlands
Seven Mile Creek Watershed
Map 18
Wetlands
City
Roads
Stream
Seven Mile Creek Watershed
ST. PETER
NICOLLET
5
13
99
N
0
2 Miles
As of 1994 total wetland acreage in watershed=
1,552 acres
This map represents wetlands within the watershed. Wetland extent was determined from 1990 land use and 1994 National Wetland Inventory.
BNC Water Board_2001

Potentially Restorable Wetlands

Seven Mile Creek Watershed



Drainage

More than 24 miles of open ditches and approximately 15 miles of public drain tile with many more miles of private tile lines are located within the watershed. Private tile lines are not shown on the included map. This network of drainage, has converted much of the watershed into some of the most productive soils in the state, and country. However, the concerns over large-scale drainage projects within the watershed in terms of quantity and quality have steadily increased along with the amount of drainage the past 10 years.

Permitted Feedlots

The figures shown below are the result of on farm visits and the review of permitted feedlot applications by Nicollet county staff. The figures are current as of 2000. It is likely the size and number of the feedlots have changed somewhat since the 2000 survey. **The animal units associated with each feedlot represents the maximum capacity the feedlot is permitted for and does not necessarily indicate the actual amount of animal units during the time of the survey.** Map 20 shows the locations and relative size of the feedlot operations within the watershed. Table 13 takes the feedlot data a step further. Table 13 provides estimates of livestock manure contributions to the 2000 total phosphorus load from the watershed. This analysis of the feedlot data helped to establish realistic phosphorus goals for the watershed. For example, table 13 helps to estimate how much of the phosphorus load came from direct runoff of feedlot sources. Being conservative, and assuming only 1% of the manure reached Seven Mile Creek in 2000, approximately 7.4% of the total phosphorus load (4633 lbs.) was derived from feedlot sources. In addition, if only 5% of the livestock associated phosphorus reaches the river, this could account for almost 40% of the phosphorus load. Other scenarios with higher delivery percentages are given in the table.

Watershed 28062 has eight feedlots with an average density of 1,245 acres per feedlot. Watershed 28066 has six feedlots with an average of 1,520 acres per feedlot. These are primarily hog feedlots in the size class range of 100-999 animal units. Watershed 28063 has six feedlots with an average of average of 746 acres per feedlot. Animal units per acre of agricultural land for watershed 28062, 28066, and 28063 are 0.23, 0.43, and 0.45 respectively. If Northern Plains Dairy constructs the Jersey Dairy as planned, feedlot numbers would increase from 1,464 to 4,464 animal units within minorshed 28063.

Table 12. Feedlot statistics of Seven Mile Creek Watershed by sub-shed.

	FEEDLOTS		*ANIMAL UNITS*				
MINOR WS #	**# OF FEEDLOTS**	**% OF FEEDLOTS IN MINOR WS**	**SUM**	**MAX**	**MIN**	**MEAN**	**% OF AU IN MINOR WS**
28066	6	30	3306	1210	38	551	48
28062	8	40	2091	800	48	261	30
28063	6	30	1464	848	48	244	21
TOTAL	20	100	6861				100

Table 13. Analysis of Potential Phosphorus Contribution From Livestock in Seven Mile Creek Watershed

Part I. Low, Medium, and High estimates of total phosphorus produced by livestock (lbs./ animal unit)

	Low	Medium	High	
lbs./year/a.u.	5	11	26	Adapted from: Livestock Waste Facilities Handbook-3rd ed.
Cattle and Swine				Midwest Plan Service, Iowa State Univ., 1993
				Converted to total phosphorus (TP)
				using TP = 0.44 x P_2O_5

Part II. Estimated livestock numbers and low, medium, and high estimates of mass of phosphorus produced by livestock in Seven Mile Creek watershed (lbs./year)

minor watershed	a.u.'s	Low	Medium	High
28066	3306	16530	36366	85956
28062	2091	10455	23001	54366
28063	1464	7320	16104	38064
Totals	**6861**	**34305**	**75471**	**178386**

Part III. Estimated number of acres required for land application of all manure produced in watershed based on application rate of 80 lbs./acre P_2O_5

Acres of crop land in Seven Mile Creek Watershed: 20,181	Low	Medium	High
	975	2144	5068

Part IV. Comparison of annual load of total phosphorus to estimate of phosphorus produced by livestock

	Low	Medium	High
Livestock estimate (pounds per year)	34305	75471	178386
2000 measured load (pounds)	4632.5	4632.5	4632.5

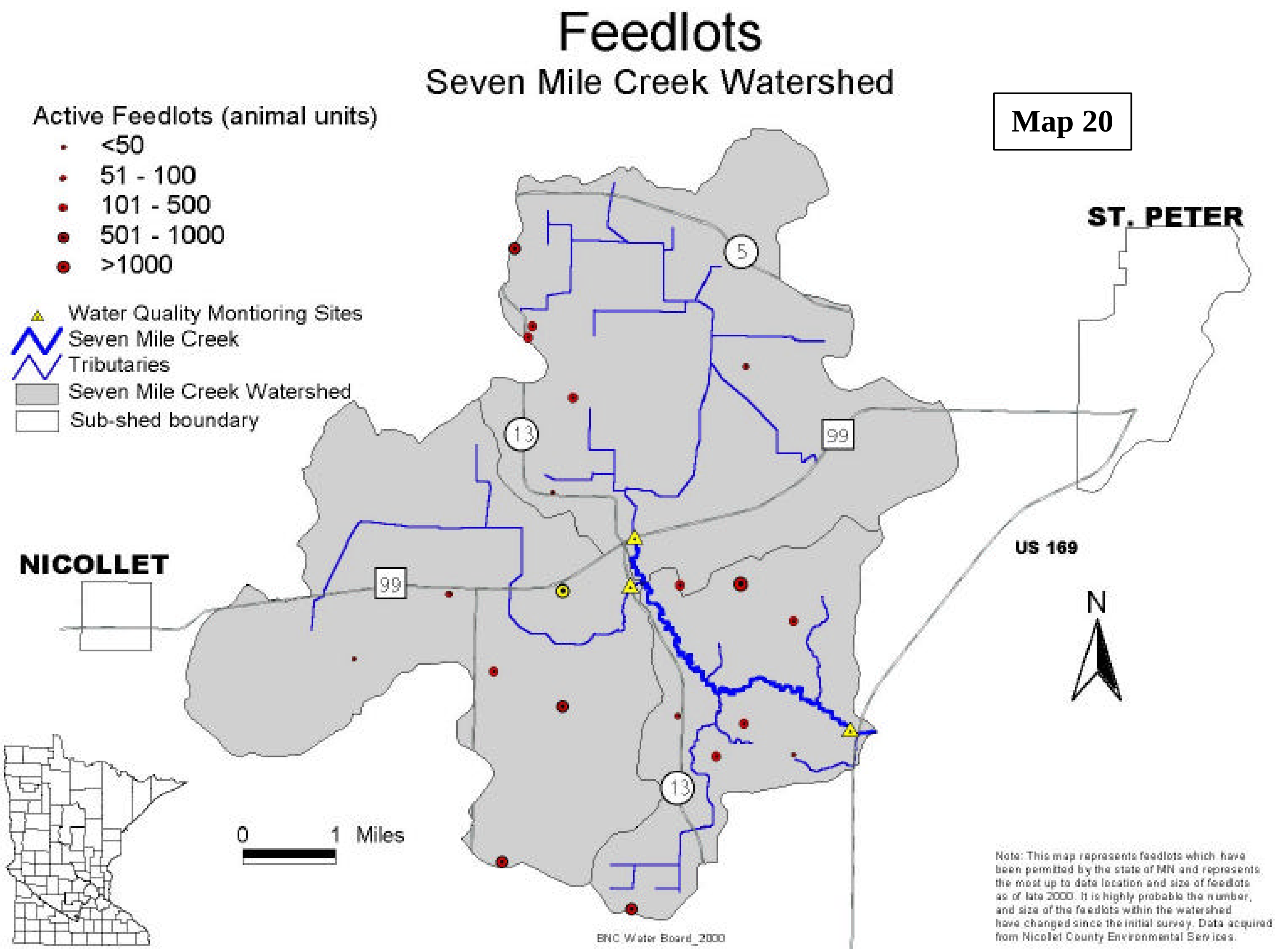
Part V. Percent of 1999 load that could be from livestock manure based on different assummed delivery percentages

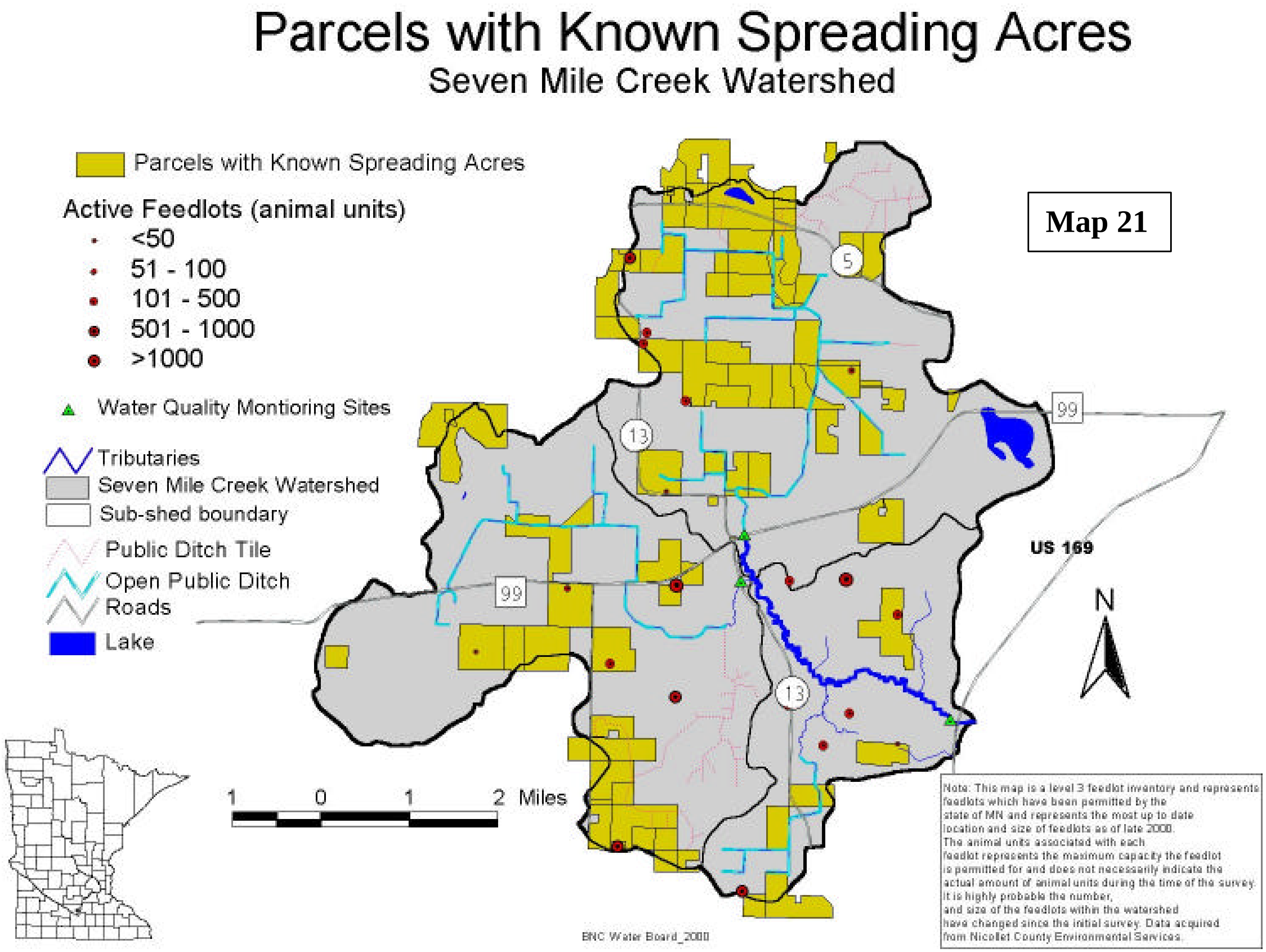
		% of annual load from livestock*		
Explanation of delivery percentages:	1%	7.4%	16.3%	38.5%
A 5% delivery, for example, means	5%	37%	81%	193%
that 5% of the total phosphorus	10%	74%	163%	385%
associated with manure makes its way	20%	148%	326%	770%
from feedlots or fields to the	50%	370%	815%	1925%
Seven Mile Creek	100%	741%	1629%	3851%

* A percentage greater than 100 indicates more phosphorus than was measured in 2000.

The type of analysis done in Part III. could be applied to individual minor watersheds In either case, it is important to recognize that manure could be land applied in different minor watersheds from where it is produced, or outside of the Seven Mile Creek watershed altogether.

Map 20


Feedlots
Seven Mile Creek Watershed
Active Feedlots (animal units)
<50
51 - 100
101 - 500
501 - 1000
>1000
Water Quality Montioring Sites
Seven Mile Creek
Tributaries
Seven Mile Creek Watershed
Sub-shed boundary
ST. PETER
NICOLLET
US 169
5
13
99
N
0
1 Miles
BNC Water Board_2000
Note: This map represents feedlots which have been permitted by the state of MN and represents the most up to date location and size of feedlots as of late 2000. It is highly probable the number, and size of the feedlots within the watershed have changed since the initial survey. Data acquired from Nicollet County Environmental Services.


Parcels with Known Spreading Acres
Seven Mile Creek Watershed
Map 21
Parcels with Known Spreading Acres
Active Feedlots (animal units)
<50
51 - 100
101 - 500
501 - 1000
>1000
Water Quality Montioring Sites
Tributaries
Seven Mile Creek Watershed
Sub-shed boundary
Public Ditch Tile
Open Public Ditch
Roads
Lake
5
13
99
US 169
N
1 0 1 2 Miles
BNC Water Board_2000
Note: This map is a level 3 feedlot inventory and represents
feedlots which have been permitted by the
state of MN and represents the most up to date
location and size of feedlots as of late 2000.
The animal units associated with each
feedlot represents the maximum capacity the feedlot
is permitted for and does not necessarily indicate the
actual amount of animal units during the time of the survey.
It is highly probable the number,
and size of the feedlots within the watershed
have changed since the initial survey. Data acquired
from Nicollet County Environmental Services.

Northern Plains Dairy

Adopted from MPCA Water Quality/Feedlot July Newsletter

Northern Plains Dairy is proposing to construct a dairy in Oshawa Township, Nicollet County, approximately 4.5 miles southwest of St. Peter in Seven Mile Creek Watershed (watershed 28063, Sec. 34 of Oshawa Twp.). This site plan follows two previous proposals at different locations and incorporates several new environmentally protective features that were not in the two previous plans. The "third site" is currently being evaluated by the MPCA through the permit and environmental review process as this report is being written. If the dairy passes state and county review, construction for one of the states largest dairies could start in the fall of 2001 or spring of 2002. Most of the spreading acres will be in minorshed 28062. The dairy will increase manure acres by an estimated 2500 acres within the watershed, or a 50% increase.

General Site Information

The proposed project is for a 3,000 Jersey cow dairy feedlot (3,000 animal units). The dairy will be located on a portion of the 102-acre site owned by one of the three investors. The feedlot includes three total-confinement barns using freestall housing, a holding area, milking parlor, and administrative offices. Two anaerobic digesters and solid separators would be used to treat the manure prior to storage of treated effluent in an earthen basin that has a maximum design capacity of 39 million gallons. The basin, consistent with applicable federal and state rules, is capable of storing 15 to 18 months of treated manure, barn floor wash water, and precipitation from a 5" rainstorm. As a result of its larger capacity, the present design allows for greater flexibility of manure application during wet periods compared to a conventional design. A majority of the basin's construction will be at or below ground level with one corner of the dike proposed to be approximately 2 –3 feet above ground.

Location of the dairy in respect to the watershed and wellhead protection area can be found on map 22.

Manure Management/Anaerobic Digestion

Anaerobic digestion is a biological treatment process used to treat feedlot waste. This process generates methane, a bio-gas, that can be collected and used as fuel in gas-powered electrical generators. The anaerobic digester at the dairy would generate approximately 280 kilowatts of electrical energy. Excess electrical energy will be sold to a local power company and supply power for up to 90 homes.

In addition to the electrical power generation benefits, the anaerobic digestion process also: reduces odors; converts nitrogen into a source of nitrogen that is more available to crops; creates nitrogen that is valuable to crops; creates a waste that is valuable as a soil amendment, destroys many of the pathogens found in manure; and separates solids from the anaerobic digester so that manure can be easily composted for reuse as an animal bedding.

Affects of the Dairy on Seven Mile Creek Watershed

Many concerns about the dairy from the Department of Natural Resources and local citizens near the dairy have been raised since its inception. The major concerns have been centered on the environment. Those concerns include odor issues, increase in truck traffic, power line development, and potential impacts of manure and silage on groundwater and surface water resources within the watershed. Conversely, proponents argue that the dairy features technologies that will mitigate the environmental concerns with the use of manure digestion. Nonetheless, Northern Plains Dairy will continue to be controversial and closely scrutitzed. From a water quality perspective, watershed staff also see costs and benefits associated with the construction of a large concentrated dairy operation.

Benefits

- Increase in the amount of alfalfa acres within the watershed. It is proposed that approximately 400 acres will be needed within the watershed for feed sources for the Jersey based dairy. By increasing another crop into the corn/soybean rotation, nitrogen and sediment losses can be minimized.

- Comprehensive Manure Nutrient Plan (CMNP) developed on spreading acres. As per Minnesota feedlot rules, a CMNP is required for larger confined animal feedlot operations. Northern Plains Dairy plans on incorporating fall stalk nitrate test, spring nitrate soil test, manure crediting and other manure Best Management Practices. Approximately 2,500 spreading acres is needed within the watershed. If the CMNP is managed properly, the 2,500 acres would switch from an inorganic commercially applied source of nitrogen to a organic form. In the long-term this should supply the watershed with a more efficient and less wasteful form of nitrogen fertilizer.

- Opportunity to scientifically demonstrate whether or not large confined animal feedlot operations have dramatic impacts on water quality. Seven Mile Creek has several years of extensive water quality data that can be used to help answer that complex question. Through phase II funding, monitoring will continue to be a large component and therefore document any water quality changes as a result of the new dairy operation.

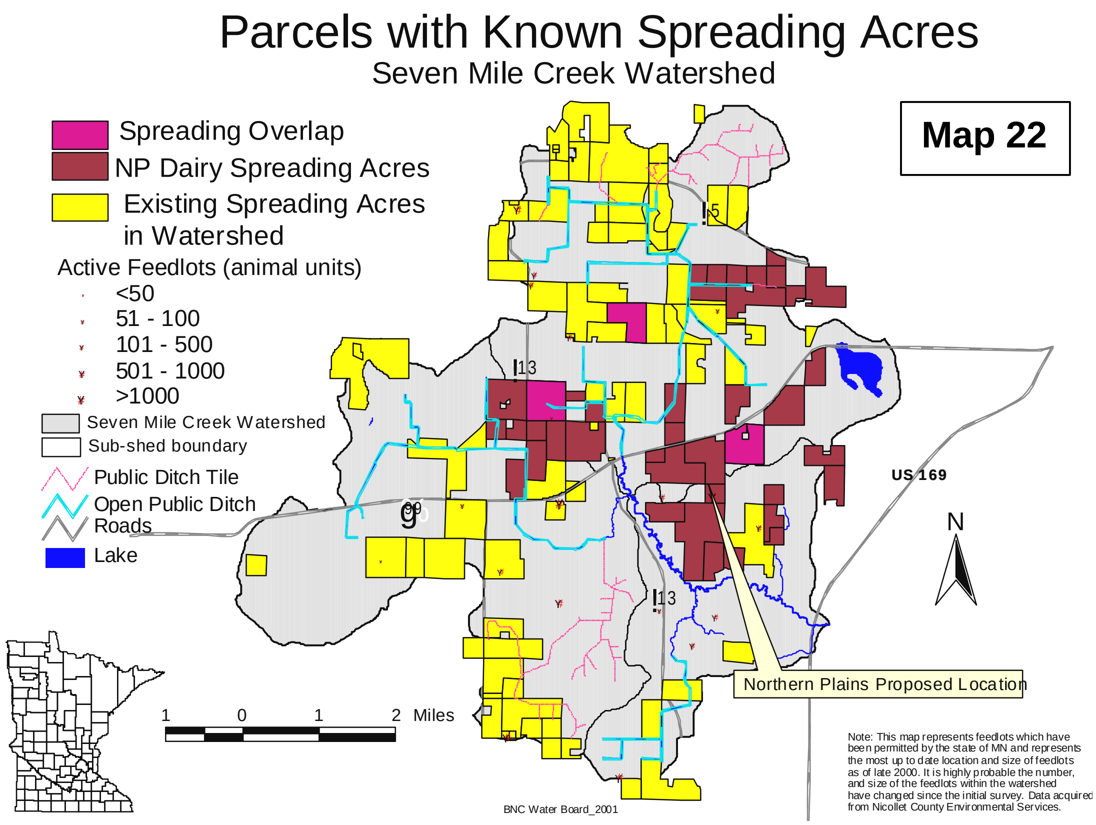
- Opportunity for the watershed project to partner with NP Dairy to address mutual concerns. It is planned NP dairy and Seven Mile Watershed Project will coordinate on various activities such as filter strips along ditches, nutrient management field days, new manure management technologies, and assistance with educational outreach and promotion of Best Management Practices.

Disadvantages

- Higher probability of less conservation tillage. All of the liquid digested manure will need to be applied in the fall via incorporation onto soybean residue. According to the 2001 tillage transect survey, bean ground was very low in conservation tillage. With manure incorporation in the fall via chisel points, bean residue will be reduced.

- 50% increase in manured spreading acres within the watershed. Increase in manured acres increases the potential of phosphorus, low dissolved oxygen, ammonia, and bacteria levels within Seven Mile Creek, which could have detrimental effects on the aquatic life of Seven Mile Creek.

Watershed staff are working closely with Baumgartner Environics of Olivia, MN (NP Dairy environmental engineers) to help address some of the environmental concerns. They have expressed their support for the watershed project and will be a crucial link in the long-term success of the watershed project.



- Present spreading acres vs. proposed NP dairy. Location of Dairy in respect to the watershed. Proposed NP Dairy location- Sec. 34 of Oshawa Twp.

Septic Systems

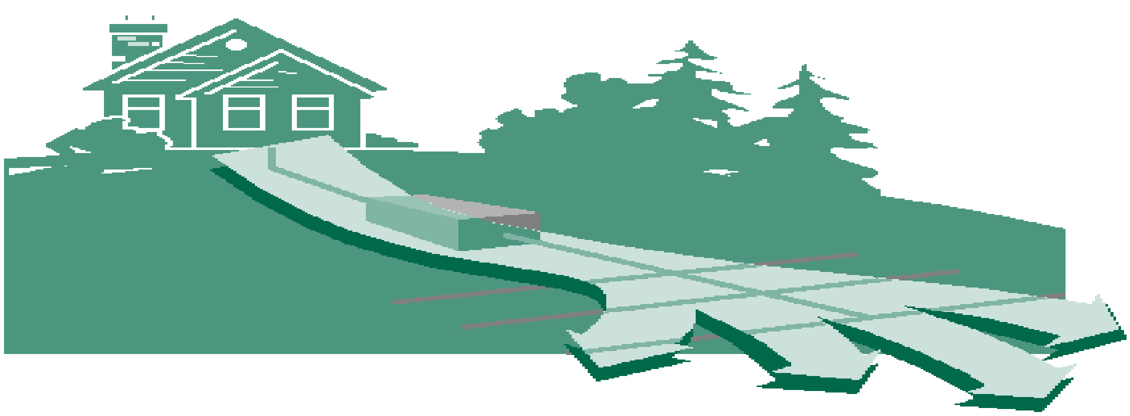
Norm Kuhlman (ESD)

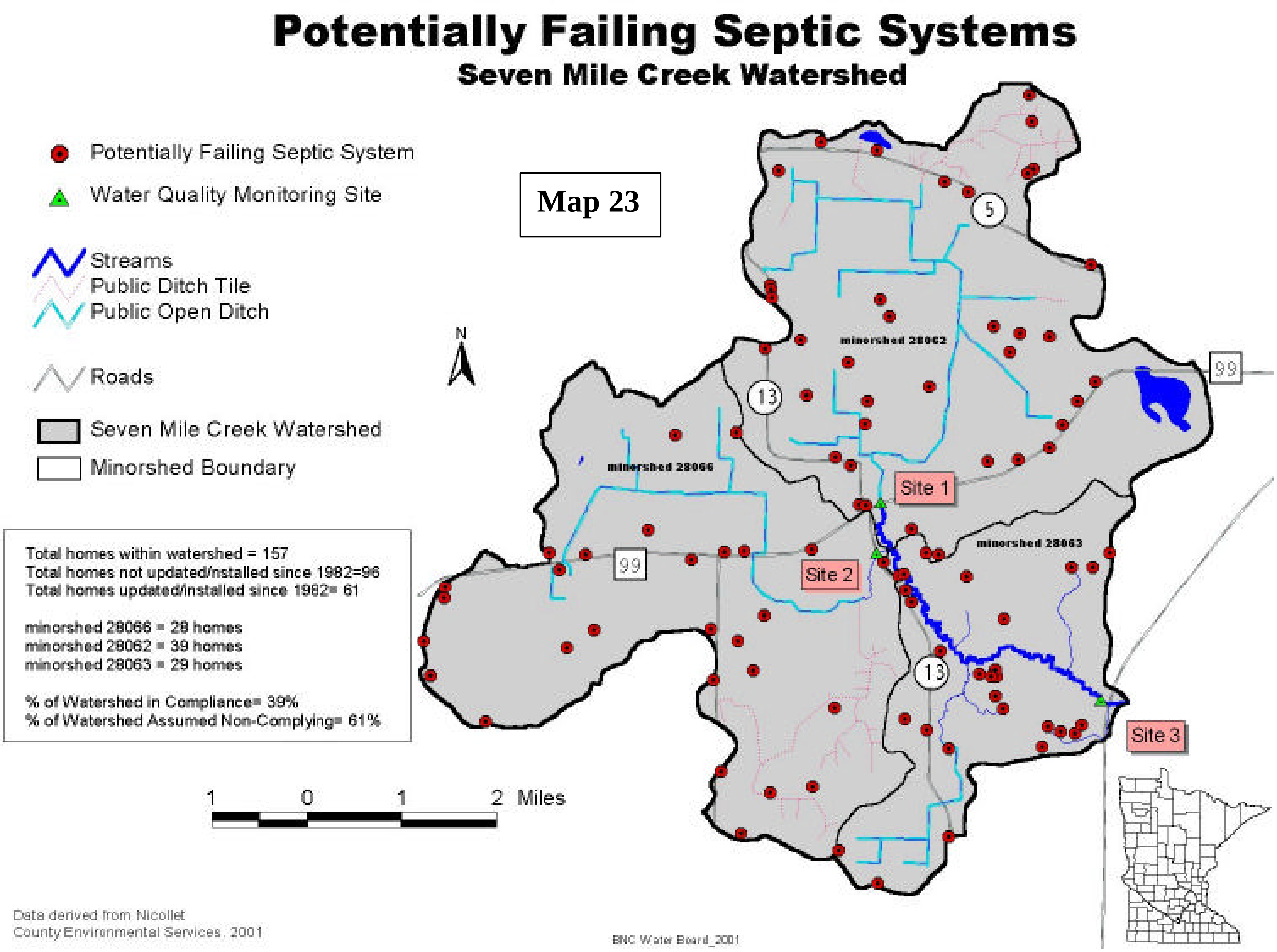
The Nicollet County Environmental Services Department (ESD) has records for 483 (24%) of existing septic systems built prior to 1995. Installation records go back as far as 1980 but inspections of all installations may not have been done until the late 1980s. These records lack much of the information required today to make any determination as to whether these systems are in compliance. Based on compliance inspections done on existing systems over a three period from 1998 –present, most of these septic systems are not in compliance (failing) and would require upgrading within 5 years after the system has been determined as failing as required in the Nicollet County Ordinance.

The status of approximately 1000 (47%) of septic systems from rural households in Nicollet County is unknown. Based on the age of these residences, past experience (compliance inspections at point of sale of property and discovery by ESD staff) most of these systems constitute an imminent threat to public health (ITPH) as defined by the state of Minnesota. An ITPH is defined as a discharge of sewage to the ground surface, discharge of sewage to drain tile or surface waters, sewage backup into dwelling or any situation with potential to immediately and adversely impact or threaten public health or safety.

Based on records from Nicollet county ESD and consultation from Norm Kuhlman of ESD (25 years experience with septic systems and soils) it is estimated that within Seven Mile Creek Watershed 39% of the watershed homes have systems, which are in compliance. This leaves 61% of the homes in the watershed assumed to be potentially discharging sewage into tiles, ditches, and eventually Seven Mile Creek. See map 23 for details. At average cost of $7,500 per household, $720,000 would need to be spent to upgrade the 96 imminent threats to public health at today's construction costs. Approximately 100 Individual sewage treatment systems are being constructed annually. At the current rate of installations it would take about two years to bring those systems that constitute imminent threat to public health into compliance. An additional 1-2 years would be needed to bring failing non-ITPH systems into compliance.

It is estimated that approximately 60% of households within the watershed are non-complying. That amounts to nearly $720,000 needed in low-interest loan money for septic system improvements.




Potentially Failing Septic Systems
Seven Mile Creek Watershed
Potentially Failing Septic System
Water Quality Monitoring Site
Streams
Public Ditch Tile
Public Open Ditch
Roads
Seven Mile Creek Watershed
Minorshed Boundary
Map 23
N
Total homes within watershed = 157
Total homes not updated/installed since 1982=96
Total homes updated/installed since 1982= 61
minorshed 28066 = 28 homes
minorshed 28062 = 39 homes
minorshed 28063 = 29 homes
% of Watershed in Compliance= 39%
% of Watershed Assumed Non-Complying= 61%
1 0 1 2 Miles
Data derived from Nicollet
County Environmental Services, 2001
BNC Water Board_2001
minorshed 28062
minorshed 28066
minorshed 28063
Site 1
Site 2
Site 3
5
13
99

Lakes

Oakleaf Lake

Oakleaf is a high quality, type IV wetland and designated as a waterfowl feeding and nesting area.

Game Management Lakes are defined as, “lakes shallower than six feet, which ordinarily contain water throughout the year. They are ordinarily deeper marshes.” Game Ecological Classifications are used to describe lakes that are, “of very high fertility, usually with an abundance of aquatic vegetation present. Winterkills may occur annually. This type of lake is characterized by substantial populations of muskrats and/or waterfowl.”

Population

Based on SIDWELL dwelling locations it is estimated there are a total of 157 homes within the watershed. With an average household containing 3.3 people the watershed population is estimated at just over 500 people. See map 24 for household locations within the watershed.

Rare Natural Features of Seven Mile Creek County Park

The 625-acre park at the mouth of the watershed has three bird species and two plant species that are of special concern according to the MN Department of Natural Resources. In addition the Yellow Sandshell mussel, a state endangered species, has been found where Seven Mile joins the MN River.

Rare Natural Features

Birds

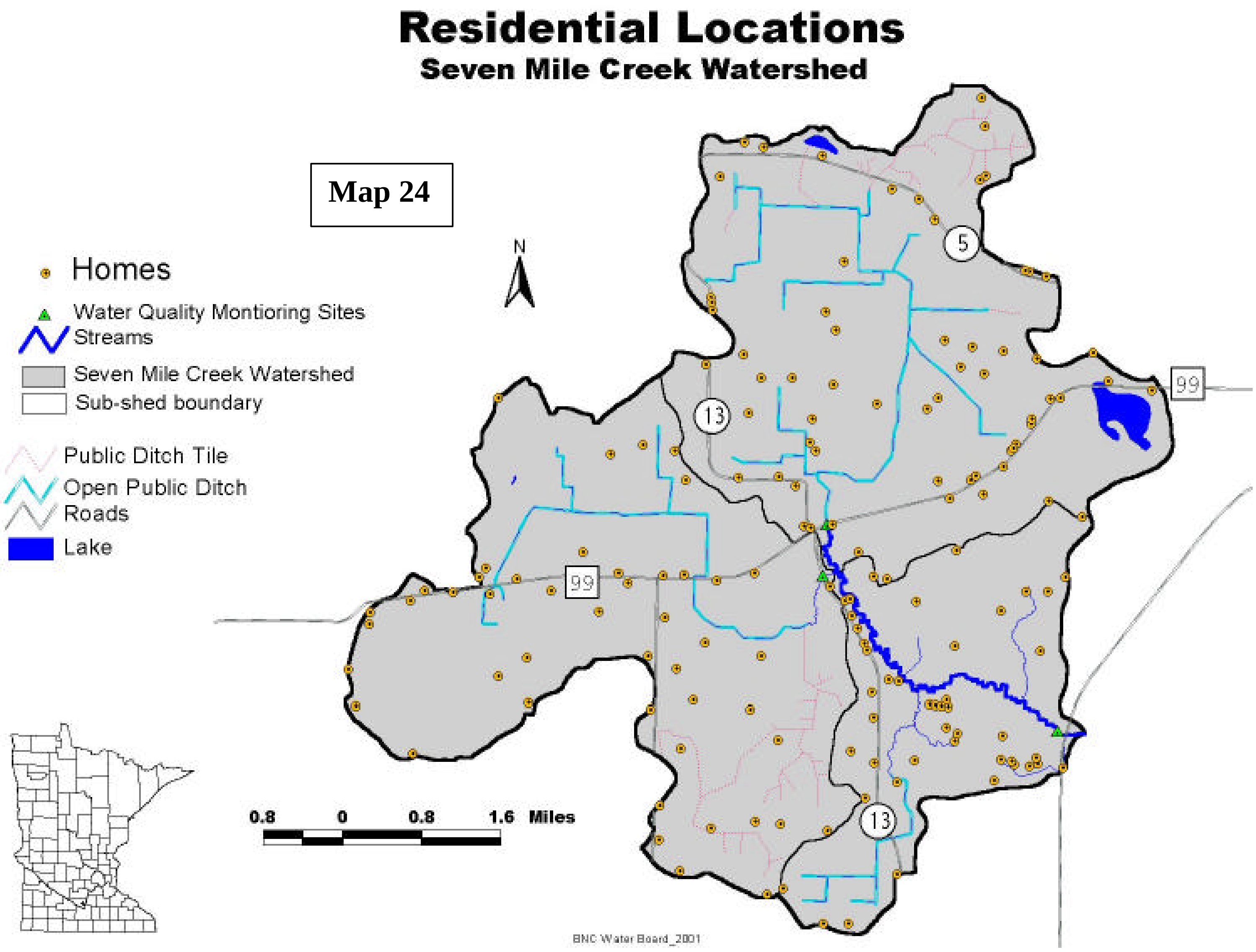
- Cerulean Warbler
- Louisiana Waterthrush
- Acadian Flycatcher

Plants

- American Ginsing
- Snow Trillium

Mussel

- Yellow Sandshell Mussel


Residential Locations
Seven Mile Creek Watershed
Map 24
Homes
Water Quality Montioring Sites
Streams
Seven Mile Creek Watershed
Sub-shed boundary
Public Ditch Tile
Open Public Ditch
Roads
Lake
N
5
13
99
0.8 0 0.8 1.6 Miles
BNC Water Board_2001

Chapter 3

Approach and Methods

Water Quality Monitoring

As part of the water quality study for the Seven Mile Creek Watershed sediment and nutrient loadings were calculated at two tributaries (county drainage ditch 13 and 46a) and the main stem of the creek. In addition, fecal bacteria, dissolved oxygen, transparency tube readings, pH, conductivity, and temperature levels were studied. The information derived from water quality monitoring will:

- ❖ Help identify areas within the watershed that are contributing more or less of a particular pollutant of concern and therefore increase the efficiency of implementing sparse cost share dollars for remediation purposes.
- ❖ Allow water resource managers to rank Seven Mile Creek Watershed with other similar watersheds with the Middle MN River Basin in an effort to prioritize funding and clean up efforts.
- ❖ Help determine realistic Total Maximum Daily Load (TMDL) and water quality goals needed to meet local, state, and federal standards.

Three water quality monitoring sites were established within Seven Mile Creek Watershed. The three sites were selected based on spatial proximity to areas of environmental concern, feasibility of determining stream discharge relationships, and previous monitoring history. The three sites are characterized as Hwy 99, Cty RD 13, and mouth site and are labeled as sites 1, 2, 3, respectively. The locations of all water quality sampling sites are shown graphically on map 3, chapter 1 with respected subsheds. Detailed site descriptions can be found in section A of the appendix. Photos 5-7 at the end of this chapter are also included to portray the overall setting of monitoring sites as well as some of the equipment used in the study.

Basis for Site Selection

- Spatial proximity to capture entire minorshed
- Proximity to road or culvert
- Previous water quality study location
- Rating curve development feasibility

Specifics for each site. See map 3 chapter 1 for locations within watershed (photos of the sites are shown at the end of this chapter)

Site 1 is located downstream of State Highway 99 West of St. Peter near county ditch 13. Stage at site 1 is measured by a stilling well. A Cambell Scientific CR-500 records the changes in water level sent from a potentiometer housed in a wooden box atop of the stilling well. All of the equipment was installed in March of 2000. A staff gage was installed on the cement culvert as well.

Downstream of State Highway 99. Samples taken near Box culvert. Stream Flow taken upstream in ditch about 100 yards.
Nicollet County, Oshawa Twp, T110, R27 Sec 23, NE1/4, SW1/4

Site 2 is located downstream of County RD 13 near county ditch 46. The site contains a similar monitoring system to site 1. The only difference is that a Texas Instruments tipping bucket is installed to measure rainfall.

Downstream of Cty Rd 13. Stream flow taken just inside of box culvert on downstream side.
Nicollet County, Oshawa Twp, T110, R27 Sec 23, SE1/4, SW1/4

Site 3 is located in Seven Mile Creek County Park near the mouth of the watershed (near first foot bridge). A staff gage, and CR-10 data logger were installed to determine stage. A Texas Instruments tipping bucket rain gage was in operation at this site from 2000. An INW pressure transducer measures stage at this location.

Mouth site, upstream of first footbridge in County Park. Stream flows taken upstream of bridge about 50 yards.
Nicollet County, Belgrade Twp, T109, R27 Sec 12, NW1/4, SW1/4

**In year 2001 three automatic samplers (ISCO and SIGMA) were installed to refine loading estimates and examine polluto-graph characteristics. The sampling equipment is actuated by time paced. Both composite and discrete samples are taken, depending on the storm event.

Sampling Protocol

Samples were collected at all three sites during monthly scheduled times from March through October in 2000. **All loading rates and other calculations are based on the growing season of April 1 through September 30 (roughly 180 days).** In addition, water samples were collected over a range of river discharge conditions to characterize the change in water quality as the creek responded to both dry and wet conditions. Additional samples were taken at all three sites during low flow (baseflow conditions) to assess the influence of point sources of pollution such as septics. Conversely, samples were also taken during high flow to document the effects of non-point source pollution from storm water runoff. Strict attention was made during the monitoring season to gather a wide spectrum of climatic/flow conditions to insure the best possible representation of the water quality in the watershed at the time of the study.

Sampling for water quality parameters and flows under climatic conditions included:

- Early Spring (first storm after snow melt)
- Emergent Crop Period Storm
- High Evapo-transpiration (ET) - Low Flow (late July or early August)
- Post ET (fall) Low Flow (late fall)

In general, all three sites were sampled from early April through September. In 2000, a total of 15 grab samples were taken. In 2001 a total of 16 grab samples were taken with two additional taken from automatic samplers.

Monitoring Season

Monitoring season length is an important variable to consider when evaluating the reported data. Many of the organizations within the MN River Basin begin monitoring in early April and quit in early October. This period captures the months when loads are expected to be the highest for nutrients and sediment, and the time of year the majority of flow occurs. Seven Mile Creek monitoring runs from late March or early April through September or mid-October. The monitoring season is typically 180-200 days depending on weather conditions.

The advantages or justifications of a partial monitoring season are two fold. First, monitoring costs, time and equipment maintenance are reduced. Second, the vast majority of the flow in the Minnesota River Basin occurs approximately mid-March through mid-August. Most of the loads of the commonly monitored pollutants (sediment, phosphorus, nitrogen and fecal coliform bacteria) also pass through during this period. A disadvantage of partial year monitoring involves the potential for missing a portion of the annual load of the common pollutants. In Seven Mile, this is a lesser problem since all of the tributaries are intermittent in nature (dry up in the fall). Another potential complication relates to delays associated with getting station equipment established during high water or snow levels in the spring.

Monitoring Season Description

2000

Water quality sampling began early in early April and quickly subsided due to lack of significant rainfall. Although low flows were common until mid-May, sampling continued to characterize baseflow (groundwater) dominated conditions. A major rain event occurred May 17. Thereafter, precipitation patterns for the watershed began to normalize with more frequent and heavier rainfall frequencies. A total of 15 samples were taken with 33% taken in the month of June. At least one sample was taken every month from April through September. By mid-August the watershed and surrounding counties experienced below average rainfall, hence monitoring intensity decreased. By early September, low to zero flow conditions were present on all tributaries. This pattern continued through early November well after the growing season. Due to the flashy nature of the drainage system, it is recommended that auto-samplers be installed to refine pollutograph and loading estimates.

2001

The winter of 2001 was one for the record books. Above average snowfall and below normal temperatures resulted in one of the top 10 worst winters in Minnesota's recorded history. The high snowfall amounts allowed for spring snowmelt runoff monitoring, which has been a rarity the past several years. High snow pack levels and heavy rainfall amounts in late march and April resulted in very high flows for Seven Mile Creek and the Minnesota River. In early April the Minnesota had reached levels above or near 1997 flood levels. Flow equipment was up and running at all sites by April 13 and grab samples were taken at early snow melt conditions on April 3. However, by late April, site 3 in the park had to be removed for fear of destruction by spring flooding. The site was reinstalled three weeks later. Very high flows characterized Seven Mile Creek during the early part of the season, however by late July drought conditions were starting to become apparent. Low precipitation levels occurred from July through August. By September precipitation levels became near normal. A total of 16 grab samples were taken with a majority taken in April and May. Automatic samplers were installed at all three locations in mid-May. Two storms were utilized from the automatic instrumentation.

Water samples were sampled and analyzed according to methods adopted by the USGS MPCA, and US Environmental Protection Agency protocol. Collection of all grab samples followed protocols established by the Environmental Protection Agency[1].

Samples were field-tested using portable meters for pH, temperature, specific conductance, dissolved oxygen and transparency. Field meters were calibrated before each day of use. Samples were analyzed by the Brown Nicollet Environmental Health state certified lab in St. Peter, MN for the following parameters: total suspended solids, total phosphorus, ortho-phosphorus, nitrate-nitrogen, fecal coliform bacteria, and total coliform bacteria. Reporting units and methods are shown in table 14.

[1] U.S., Environmental Protection Agency, Handbook for Sample Preservation of water and Wastewater. 1982.

Table 14

Reporting Units and Method

Constituent or physical Property	Reporting Unit	Laboratory Method
Bacteria, fecal coliform, membrane filter	Col/100ml	Membrane filter
Bacteria, fecal streptococci, membrane filter	Col/100ml	Membrane filter
Bacteria, total coliform, membrane filter	Col/100ml	Membrane filter
Discharge	ft^3/sec	Velocity meter
Dissolved oxygen (DO)	mg/L	Membrane electrode
Nitrogen, as No3-N	mg/l	Electrode or Hach Spectrophoto meter
pH	Units	Electrometric
Phosphorus, dissolved ortho as P	mg/L	Hach manual digestion with automated color development
Phosphorus, total as P	mg/L	Hach manual digestion with automated color development
Sediment, suspended, concentration (TSS)	mg/L	Filtration and membrane
Specific Conductance	micromhos/cm	Wheatstone-Bridge meter
Transparency (tube)	Cm	
Water Temperature	℃	

Water Quality Monitoring Equipment

The instruments at the monitoring sites provided a detailed account of the conditions in the two major tributaries and creek 24 hours a day. The instruments continually monitored stage (water elevation) every 60 seconds. As of 2001, automatic samplers were installed at each of the three locations. An automatic sampler collects 24 water samples every two hours (default) from the river when pre-determined stage conditions are met. This sampling helps characterize storm runoff conditions to a higher degree. At sites 2 and 3 a rain gage was also installed to measure cumulative rainfall amounts and rainfall intensities. Rainfall amounts from Red Top Farms and a network of rain gage readers are used in addition to the monitoring sites. During a rain event, the rain gage at the monitoring site records every 0.01 inch of precipitation. In 2001, three automatic samplers were installed to help advance the understanding of the water chemistry during storm events. An ISCO 3700 portable sampler was installed at site 3 and 1. They are both owned by Nicollet County Environmental Services. At site 2 a SIGMA 900 portable sampler is used. It is currently being loaned through MET Council Mankato Field Office. The operation of all these instruments is coordinated by a CR-500 data logger, which also stores and outputs the data. The data logger program outputs a line of information every

15 minutes, including Julian date, time, automatic sampling data, and precipitation amounts. It also triggers the automatic sampler to start and stop sampling according to preset stage conditions. All of the data from the CR-500 was downloaded as a comma delimited ASCII file. PC208, a Cambell Scientific program, was used to manage and calculate the large data files.

Discharge Ratings

Stream flow at sites 1, 2, and 3 was determined by developing a stream-discharge relationship. PCA hydrologists and BNC staff determined the rating curves for all the sites during monitoring year 2000 and 2001. A total of seven discharge readings were used for 2000. High flow readings to refine the rating curve occurred in 2001. Due to flooding issues, beaver dams, and stream bank erosion, monitoring site 2 and site 3 is under consideration for relocation. Development and use of stage-discharge relationships required measurement of stage, datum, channel dimensions, water velocity and discharge as specified in the MPCA quality control manual and USGS protocol. Periodic readings were taken at each site with a reading near zero flow up to moderate and high flow conditions with wading rod and Price or Pygmy current meters. During high flow conditions a bridge board or crane apparatus was used.

Total discharge and instantaneous stage were plotted using USGS methods and power equations. The correlation coefficient, or R^2 values were calculated to describe the stage-discharge relationship.

Flow Conversion and Data Management

Average 15-minute stage readings were converted to flow through Cambell Scientific PC-208 software. The average 15-minute flow values were simultaneously converted to average daily flows by substitution into the derived rating equation. Precipitation data was also converted to total daily precipitation amounts. The data was then exported to Excel as an ASCII file and graphed/managed as an Excel workbook.

Field Equipment

Instruments used to determine field parameters include an Orion 835a D.O./Temp probe, Hach conductivity meter, MPCA transparency tube, and ISFET model IQ125 pH meter. Both the dissolved oxygen and pH meter were calibrated before each use. Current readings were taken using AA Price (>1.5’) or Pygmy (<1.5’) meter with a 6’ wading rod. During high flows, velocities were measured using a bridgeboard apparatus.

Water Sample Analysis

All parameters were tested by the state certified Brown Nicollet Environmental Health (BNEH) laboratory in St. Peter, MN. The lab is used jointly by Public Works wastewater staff and the BNC Water Board. Transportation of samples from field to lab was done by project staff. Samples were transported in ice filled coolers, and analyzed within 12-24 hours of sample collection. Since the lab and watershed is within close proximity, many of the samples were analyzed within 12 hours.

The BNEH lab is a certified state lab. Therefore the lab is open to audit by the MPCA, and Minnesota Department of Health. **Minnesota State lab number is 027-103-259 and EPA lab code is MN00090.**

Quality Assurance

Only approved laboratory and field methodology was used in the capture of water quality data. Clear and accurate data was the continuous objective. In the event that errors did occur, they were identified and corrected. Spikes, duplicates and blanks are run every ten samples. Both field and laboratory staff were readily able to identify outliers. When these emerged, re-sampling was performed as soon as possible, instruments were checked, and/or unusual circumstances (such as rainfall dilution or contamination by a point source) were identified and annotated.

Runoff and Yield Normalization Defined

Runoff is that part of precipitation that appears in rivers and streams, including base flow, storm flow, flow from ground water, flow from point sources, and so on. Essentially it is all the flow passing a particular location along the river. By evaluating runoff, comparisons can be made of the relative amount of water coming out of the individual watersheds. To calculate growing season runoff, we add up the total flow or amount of water that came past the station during the monitored period. This value is converted to acre-inches of water, then divided by the total number of contributing acres, thus converting to inches of runoff.

Example:

Take for example year 2001 flow data for site 3 of the watershed. It was found that a total of 16,371 cubic feet of water entered the MN River from the Seven Mile Creek Watershed from April-Sept. The first step to determine runoff from a watershed is to convert cubic feet per second (cfs) to acre-feet. This translates into a conversion factor which is the following: 16371*60*60*24/43,560=32,472 acre-feet. This is basically the amount of area in acres that would be covered by water at a depth of one foot. The next step is to convert acre-feet to runoff: 32,472acre-feet/23,551acres in watershed*12=16.5 inches of runoff. In the truest sense this does not represent the actual amount of water that ran off the surface of the land. Research shows that for this area around 1/6 of the runoff goes to surface water runoff. So if there is six inches of runoff, about 1 inch is in the form of actual runoff and the remaining five inches is in the form of shallow subsurface tile flow tributaries and groundwater near the stream.

Conceptually, this is equivalent to redistributing all the flow out equally over the watershed, then measuring the depth in inches. Typically, the more precipitation that occurs in the basin, the more runoff there will be. However, the timing and intensity of the precipitation, antecedent soil moisture conditions, soil types, land slopes as well as several other factors can dramatically influence the final runoff number.

Yield Normalization

By evaluating runoff as well as the mass or load simultaneously, we can better determine if a particular watershed had higher or lower loads simply because it was wetter than the comparative watersheds or whether it was actually related to land use characteristics. In general, runoff tends to be quite high in Seven Mile Creek due to the clay soils and curve numbers (see map 9, chapter 2). However, the high amount of private sub-surface tile drainage tends to decrease the long-term effect of these high curve numbers.

Storm Event Sampling Methodology

Grab sampling and automatic samplers are the two methods of storm event sampling utilized in the Minnesota River Basin. Automatic sampler collection is typically supplemented by grab samples during non-event (baseflow) periods. The objective of the automatic sampler methodology is to completely characterize the entire stormflow volume with either equal-time increment (ETI) sampling or equal-flow increment (EFI) sampling. Generally with ETI sampling, the autosampler is used to collect discrete grab samples during the stormflow event at a pre-specified sampling time interval, for instance every hour. Those grabs can then be composited based upon flow or used as discrete samples. In year 2001, automatic samplers were added to increase the precision of the water chemistry during storm events. The equal-time increment sampling method was used. The samplers were set to trigger at a pre-defined stage. At site 3 the sampler instrumentation was set to activate when the lowest recorded stage value exceeded 0.5 feet. At site 1 and 2 it was set at 0.25 feet. These threshold levels were adjusted throughout the year, pending on the four climatic periods.

With EFI sampling, composite samples are collected throughout the event with discrete sub-samples representing equal volumes of flow. For example, 200 ml of river water may be collected for every 1,000 cfs of flow resulting in one composite sample that represents several days (or hours on smaller streams) of flow. In theory, EFI composite sampling gives greater data resolution as all flow conditions are represented in one sample.

However, auto-samplers have inherent problems associated with their use. They are very high maintenance. A major maintenance issue associated with autosampler use relates to controlling sample intake tube location to collect samples from the most representative portion of the stream and premature battery failures. This can be a significant challenge during times of rapidly changing flow. Also of potential concern are issues associated with maintaining adequate velocities in the sample tube, potential contamination sources in the sampler/tubing and maintaining a relatively clean intake orifice.

There are also problems associated with collecting samples without automatic equipment. Small stream systems can be very flashy in nature, and the risk of missing the peak or a major portion of the hydrograph is great, especially when the peak occurs at night. Larger river systems have storm hydrographs that can last for weeks. During these periods, it can be difficult to accurately assess the timing and number of grab samples necessary to accurately characterize the flow. In addition there are complexities associated with sampling methods, equipment and the most appropriate location to collect the grab storm sample.

Sediment and Nutrient Modeling

A variety of assessment tools were integrated into this watershed project to help interpret the water quality data for realistic water quality goal setting and implementation plan development. A "behind the envelope" model was developed by Jim Klang and Kevin Kuehner to help assess sediment and phosphorus sources and relative contributions within the wateshed based on delivery pathways. Nitrogen mass balance methodologies developed by professors and researches in the mid-west were used to assess the nitrogen sources within the watershed. Descriptions of the methodologies and results can be found in chapter 6.

Loading Estimates

A load is a measure of mass passing a specific location that occurs over a specified amount of time. Loading estimates for most of the projects are provided in tables 23-28, Chapter 5. FLUX, an interactive program that allows users to estimate loads and flow weighted mean concentrations from grab sample concentration data and continuous flow records over the sampling period, was the primary calculation method in the basin for 2000. For a more detailed explanation of FLUX calculations see appendices D, E and G.

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

Flow Weighted Mean Concentrations and Loading Rates

FLUX Calculations

Individual water samples, particularly those with no associated flows, gives only a snap shot in time of water quality conditions. Large variations in climatic conditions, and therefore flows can influence the chemical and physical make up of riverine systems on a daily or even hourly basis. To obtain a better representation of water quality during a particular season, flow weighted mean concentrations (FWMC) and mass and loading rates (e.g. tons of sediment per day) are often used to help accurately portray water quality. A statistical computer model, FLUX Version 5.1, was used to determine FWMC's and loading rates for Seven Mile.

FLUX is an interactive program developed by the U.S. Army Corp of Engineers that allows the user to estimate loadings from grab sample concentration data and continuous flow records.[2] It is designed for use in estimating loadings of nutrients or other water quality components passing a tributary sampling station over a given period of time. The estimates are based on flow-weighted average concentrations multiplied by the mean flow over the monitoring period. Data requirements include:

- Grab sample water chemistry results, typically measured at a weekly to monthly frequency for the growing season
- Water sample results from several storm events
- Corresponding flow measurements (instantaneous or daily-mean values)
- Complete flow record for the period of interest

[2] Department of the Army, U.S. Army Corp of Engineers, Empirical Methods for predicting Eutrophication in Impoundments, Report 4, Phase3, Application Manual,1987..

Using six calculation techniques, FLUX maps the flow/concentration relationship developed from the sample record onto the entire flow record to calculate total mass discharge and associated error statistics. An option to stratify the statistics into groups based upon flow, date, and or season is also possible. In many cases stratification allows one to decrease the coefficient of variance and thereby increase the accuracy and precision of FWMC and loading rates. Flux also provides information, which can be used to improve the efficiencies of future monitoring programs.[3]

Loading Terms Defined

As defined above, a "load" is an estimate of the total amount of material or mass coming out of a specific watershed or passing a specific point. A better way of assessing loads and comparing watersheds of different sizes is to determine the "yield" or the mass per unit area (such as lbs./acre) coming out of the individual watershed. This normalizes the mass on an area basis and allows for a more relative comparison between all the watersheds. Yield is calculated by dividing the total mass or load associated with the time frame of interest by the area (acres) in the respective watershed. When comparing Seven Mile Creek with other watersheds, yields are further reduced by dividing them by the number of inches of runoff for the respective watershed, producing a "normalized yield". As such, when yields are normalized one must keep in mind the geographic differences in precipitation and runoff. Similar to normalized yields, "flow weighted mean concentrations" (FWMC) are calculated by dividing the total mass or load for the given time period by the total flow. The FWMC is mass normalized for flow.

Ecoregions and Stream Water Quality

MPCA Ecoregion values from minimally impacted streams were used to further refine the categories.[4] In Minnesota there are 7 defined ecoregions. The SMC is part of the Western Corn Belt Plains ecoregion. Summer mean values from 1970-1992 were used to help determine the categories.

The U.S. Environmental Protection Agency has divided the continental United States into ecoregions based on soils, geomorphology, land use, and potential natural vegetation. For Minnesota, this results in seven fairly distinct ecoregions (map 25). For example, the Northern Lakes and Forests ecoregion (NLF) is predominantly forested with numerous lakes and covers the northeastern part of MN. The Western Corn Belt Plains ecoregion, located in the southern third of MN, has rolling terrain and is extensively cultivated with row crops. Land use, topography, and water quality characteristics of the ecoregions were reviewed to assess the non-point source pollution problems across the state. This review can be found in a 1993 MPCA report by McCollor and Heiskary. The ecoregion framework provides a good basis for evaluating differences and similarities in Minnesota's streams. Reference streams, which are felt to be representative and reflect expected water quality for a region, were sampled by the MPCA to characterize stream conditions for each ecoregion. This provides a baseline with which to compare other streams. In other words, the reference streams are one yardstick by which to measure other streams. Table 15 lists the typical total phosphorus, total suspended solids, and turbidity for reference streams in six ecoregions[5].

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[3] FLUX Stream Loaf Computations Version 4.5 Environmental Laboratory USAE Waterways Experiment Station Vicksburg MS, 1995.
[4] Water Quality Division, Selected Water Qualtity Characteristics of Minimally Impacted Streams from Minnesota's Seven Ecoreresions. February 1993.
[5] MPCA, 1998 Report on the Water Quality of MN Streams, Environmental Outcomes Division, 1998.

Ecoregions are based on similarities of land use, soils, land surface form, and potential natural vegetation. Water Quality information from minimally impacted streams by the MPCA within these regions is used to assess the degree of impairment on a water resource.

Map 25

Minnesota's Seven Ecoregions. Mapped by USEPA.

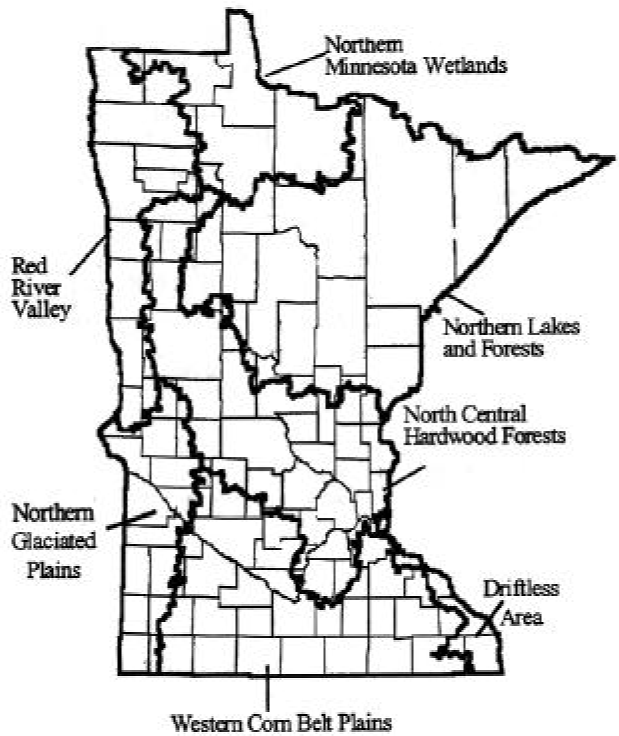

Table 15 Interquartile Range of Concentrations for Reference Streams in Minnesota by Ecoregion.[1] Distributions of annual data from 1970-1992 (McCollor and Heiskary, 1993; note 1 mg/L = 1 ppm = 1,000 ppb)

	Total Phosphorus (mg/L)			Total Suspended Solids (mg/L)			Turbidity (NTU)		
Region/ Percentile	**25%**	**50%**	**75%**	**25%**	**50%**	**75%**	**25%**	**50%**	**75%**
NLF	0.02	0.04	0.05	1.8	3.3	6.0	1.7	2.5	4.3
NMW	0.04	0.06	0.09	4.8	8.6	16.0	4.1	6.0	10.0
NCHF	0.06	0.09	0.15	4.8	8.8	16.0	3.0	5.1	8.5
NGP	0.09	0.16	0.25	11.0	34.0	63.0	5.6	15.0	23.5
RRV	0.11	0.19	0.30	11.0	28.0	59.0	6.0	12.0	23.0
WCBP	0.16	0.24	0.33	10.0	27.0	61.0	5.2	12.0	22.0

[1]Interquartile range is determined by sorting measures from lowest to highest and represents those measures between the 25th and 75th percentile.

Site 1

Photo 5. Monitoring site 1 near State Highway 99. Contains rain gauge, CR-10 data logger and stilling well. A stilling well is comprised of an 8" PVC pipe with 1" holes submerged into the stream, float, cable, and communication device (potentiometer). When the float rises, the attached cable turns the potentiometer wheel located in the housing box. A complete revolution equals a one-foot increase in stage. Stage values are recorded every 180 seconds and averaged to a 15-munute interval. Values are recorded continuously. The stage value is recorded in the data logger and downloaded via a storage modular and eventually to personal computer. Stage values are then converted to flow via the rating curve developed for the site. The data logger is run by a sealed NICAD 12-volt rechargeable battery.

Site 2

Photo 6. Monitoring site 2 near Nicollet County RD 13. Installation in March of 2000. Equipment is similar to site 1, however a tipping rain gauge is installed to measure rainfall intensities and totals. During a rain event, the rain gauge at the monitoring site records every 0.01-inch of precipitation.

Site 3

Photo 7. Monitoring site 3 in Seven Mile Creek County Park. Stage is measured by an INW pressure transducer submerged in the creek and attached to the staff gage. A rain gauge is also located at this site. Picture shows ISCO sampler results and housing box after a May 22, 2001 storm.

Chapter 4 Watershed Assessments and Techniques

Watershed Assessments

Several different approaches were used to analyze the watershed. Analysis of the watershed included:

- Pollutant load estimations using water quality and hydrology monitoring.
- Current research applicable to this watershed. Red Top Farms, St Peter Wellhead protection FANMAP survey and nutrient management demonstrations, and University of MN and Extension Service research.
- Nutrient and Sediment Transport (Advanced RUSLE Modeling) and Mass Balance (chapter 6).
- Tillage Transect Survey.
- Stream Bank Erosion Inventory for lower riparian corridor in minor shed 2.
- SWCD/NRCS. Local, state, federal agencies and watershed resident knowledge.
- Field Surveys. TISWA, stream bank erosion, tile and intake inventories.
- Producer practice surveys.

Spatial Analysis

- GIS modeling using USGS DEMs and Hydro-Tools
    - Flow Accumulation–Used in hydro-analysis. Can help identify sighting of waterways and intermittent streams.
    - Wetness Index–Used to identify locations of tile intakes and wetland restoration sites.
    - Sediment Transport Index–Used to identify potential areas of high stream bank and in stream erosion locations based on topography.

All of this information is integrated to obtain load reduction goals and BMP targeting locations.

Minnesota's Tillage Transect Survey for Monitoring Trends in Crop Residue Management

Minnesota Board of Water and Soil Resources

Every spring since 1995, local government staff in Minnesota's agricultural counties have driven along a designated route to build an annual record of crops grown, tillage type, and surface residue remaining after planting. For each participating county, the route is designed as a grid that equally represents all cultivated areas. Local staff from the SWCD, NRCS and other conservation organizations cooperate to cover the route, stopping every half mile to record field conditions to the left and right of the road. With 450-500 field observations in each county, the data represents a statistical average of the entire cropland area. This tillage transect survey procedure was developed by the Department of Agronomy at Purdue University.

The results are entered on forms that are scanned into a computer program that aids in summarizing the data. Each data point is associated with its county, major watershed, slope length and steepness and other RUSLE based erosion information. A methodology has been developed to conduct the survey in minor watersheds, and participating watersheds will be able to compare crop residue trends with stream monitoring data.

Counties facing growing expectations for water and soil resource conservation are finding the data useful for demonstrating the importance of promoting conservation tillage, and prioritizing where those efforts should be targeted. The data also enables conservation staff to monitor outcomes from tillage programs, and recognize the success (or failure) of agricultural producers in meeting crop residue targets. When it is used to demonstrate needs, prioritize efforts, track progress and recognize success, the Tillage Transect Program's data enables a county to secure funding and achieve conservation objectives.

Trends in crop residue management are summarized using a method that calculates the percent of fields in the corn-soybean rotation that meet crop residue targets. **It is computed as the average of the percent of corn acres planted into >15% residue, and the percent of soybean acres planted into >30% residue.** From 1995 to 1999, the number of Minnesota counties conducting the survey has been 37, 37, 27, 39, and 43, respectively. During those years, the percent of cropland meeting residue targets has been 31%, 41%, 50%, 39% and 37%, respectively. There is large variation in surface residue management from county-to-county, and year-to-year. The amount of residue left on the surface depends on many factors, most importantly opportunity to till (based on weather conditions) and intent to maintain residue.

A summary of the conservation tillage results for counties within the watershed is shown in table 16

Seven Mile Creek Watershed Tillage Transect Survey

On May 30, 2001 Kevin Ostermann of Nicollet County SWCD and Kevin Kuehner of BNC Water Board conducted a tillage survey of the watershed. The tillage survey followed BWSR tillage transect survey protocol. 161 fields were sampled within the watershed with survey locations taken every ¼ to ½ mile. Of the 161 locations, 156 were actually utilized for the survey. Some points had to be emitted due to some fields not being planted or other factors affecting the visibility of the fields. To maximize equal representation of the watershed, a travel route using air photos and GIS was used to aid in the process. In addition to documenting the residue for individual fields, present crop level, tolerable soils loss, previous crop, K factor, tillage system, percent slope, slope length, P factor, drainage outlet, and ephemeral erosion were surveyed. Where possible, open tile intakes and highly erodible areas were inventoried and mapped. The results of the survey can be found below in table 14. Approximately 60% of the cultivated acres within the watershed were surveyed. 96% of the fields surveyed were found to have a corn/soybean rotation. Results of the survey indicated that a majority of the watershed fields (65%) were meeting conservation tillage requirements while the remaining 35% of the fields were left with little or no residue after spring planting. The majority of fields with little or no residue were corn planted into soybeans.

C Factor

The C factor represents the condition of the cover found in the landscape. The results of the tillage transect survey were then used to obtain a more accurate C factor for use in the Revised Universal Soil Loss Equation. C values specific to the fields surveyed were taken from a USDA publication technical guide[1]. Corn and soybean yield was considered high for the cultivated acres, and assumed fall and spring mulch till. The area weighted factor for the watershed was 0.13.

[1] **Predicting Rainfall Erosion Losses, USDA-NRCS Technical Publication, January 1997.**

Table 16. Tillage Transect Survey results for Seven Mile Watershed.

Seven Mile Creek Watershed, Nicollet County, Tillage Transect Survey Results
Completed by: Kevin Kuehner and Kevin Osterman, May 30, 2001

Number of Sample Points	168
Number of Sample Points Utilized	156

Estimated cultivated acres surveyed in watershed(based on parcels)	11974
Estimated acres of cultivated land in watershed	20181

% of area surveyed	59

Residue	Fields	%
0-15%	37	23.72
16-30%	64	41.03
31-50%	44	28.21
51-75%	11	7.05

	%
% of fields surveyed **out** of conservation tillage*	35
% of fields surveyed **in** conservation tillage*	65

2001 Crop	Fields	%
Beans	85	52.80
Corn	74	45.96
Hay	2	1.24

2000 Crop	Fields	%
Beans	76	48.72
Corn	82	52.56
Other	3	1.92

Number of fields following corn soybean rotation	149
% of fields following corn/soybean rotation	95.51

C Factor

Corn Year (Previous Crop=Soybeans)

% of fields in conservation tillage	71.23

	Residue	*Fields*	*% Area*	*Area*	*C Factor*	*Area Weighted*
	0-15%	21	29	0.29	0.21	0.060410959
	16-30%	46	63	0.63	0.14	0.088219178
	>30%	6	8	0.08	0.13	0.010684932
Total		73	100			0.159315068
					C Factor	0.16

Bean Year (Previous Crop=Corn)

% of fields in conservation tillage	59.04

	Residue	*Fields*	*% Area*	*Area*	*C Factor*	*Area Weighted*
	0-15%	16	19	0.19	0.15	0.028915663
	16-30%	18	22	0.22	0.11	0.023855422
	>30%	49	59	0.59	0.07	0.041325301
Total		83	100			0.094096386
					C Factor	0.09

**Average C factor for cultivated land in Seven Mile Watershed	(.09+.16/2)	0.13

*"in conservation tillage"=computed as the average of the percent of corn acres planted into >15% residue, and the percent of soybean acres planted into >30% residue.

**C factor values taken from RUSLE 1.5 and 1997 USDA-NRCS-MN Technical Guide, Sec. I-C
Assumed yield level High, corn/soybean rotation, fall and spring mulch till, Table 4H

Watershed Modeling Techniques

Geographic Information System

Minnesota State University Water Resources Center, Mankato (MSUWRC) has provided technical assistance with the creation of a Geographic Information System (GIS) database for much of the MN River basin including that of the Seven Mile Creek watershed. An extensive database of existing and newly gathered information through inventories of feedlots, land use, drained wetlands, etc. has been obtained. The information provided by MSUWRC is an important tool to assist in the selection of priority management areas, watershed modeling, on land water quality improvements, and general communication of projects through maps.

Data used for this study was created by the MSUWRC, which employs strict quality control assurance procedures. Some data layers however were not created by MSUWRC and were created by BNC Water Board staff and Nicollet County Environmental Services. Examples of those coverages include: feedlots, septics, spreading acres and spatial analysis. Similar control procedures however were also used to ensure reliable, accurate and up to date information. All GIS analysis for the project was conducted by BNC staff.

Predicting Rainfall Erosion Losses—Revised Universal Soil Loss Equation (RUSLE)

Soil erosion is frequently associated with sediment and phosphorus transport to surface water bodies. Identifying the extent and location of high erosion areas within a watershed can help managers pinpoint vulnerable areas and what kind of best management practices should be implemented such as filter strips, or conservation tillage. Maps 16 and 17 of chapter 2 depict modeled soil erosion in Seven Mile Creek Watershed.

RUSLE is a soil erosion potential model developed by the United States Department of Agriculture. RUSLE is an erosion prediction model that enables conservation planners to predict the long-term average annual rate of interill (sheet) and rill soil erosion on a landscape as described by the factor values for site-specific conditions. RUSLE computes soil erosion rates to guide planning conservation systems for individual fields by evaluating the impact of present or planned land use management.

RUSLE is the rate of soil erosion from the landscape, not the amount of sediment leaving a field or watershed via a waterway. The calculated soil loss is an average erosion rate for the landscape profile.

The soil erosion potential model was calculated using RUSLE for sheet and rill erosion predications. The RUSLE equation is:

A= R Factor * K Factor * LS Factor * C Factor * P Factor

Methodology

The clipped land use and soils for the watershed were unioned in ArcView to produce a coverage that combined attributes of all three. Once the coverage was cleaned for “ghost” polygons, the RUSLE equation was used to calculate erosion rates for each unioned polygon. The values were then classified into four soil loss categories. The P factor or conservation factor was given a value of 0.875. It was assumed special conservation practices such as conservation tillage, strip cropping, or other practices represented half the watershed while the other half had little conservation being practiced. Although there are many areas where conservation is incorporated on cultivated land, P factor was given a default value of 0.75 based on NRCS staff information. Below is a short description of each factor and the values used for the watershed.

- Soils and land use unioned
- Wetlands and sinks deleted from new unioned coverage
- Cleaned up ghost polygons as a result of union process
- R, K, LS, C, and P factors added to soils attribute table, C factor adjusted as a result of 2001 tillage transect survey
- RUSLE reclassified into four categories

To quantify the number of acres within each category by minor shed, the five reclassified RUSLE categories were queried and converted to shape files. The minor5 field was selected and a summary of the acres was produced for each minor shed per five RUSLE categories.

<u>R Factor (Rainfall and Runoff)</u>

- Incorporates the rainfall frequencies of geographic areas. RUSLE contains expanded and more precise information for locations across the United States. R factor has the ability to calculate the effect that ponded or puddled water has on raindrop erosion.
- Values used for analysis:

  Nicollet County=115

<u>K Factor (Soil Erodibility)</u>

- More significant erodibility data from around the world such as the soil type, the diameter of soil particles, and the presence of rock fragments. Adjusted to account for soils in South-Central Minnesota.
- K values assigned by specified soil unit and adjusted for RUSLE zone 100B/C:

0.28 adjusted to 0.26	0.20 adjusted to 0.17
0.32 adjusted to 0.30	0.24 adjusted to 0.22

-9.00 were not included in analysis-represents wetlands and lakes

<u>LS Factor (Slope Length and Steepness)</u>

- Known value found in the soil survey
- Possesses the ability to predict soil loss on complex slopes

- Can apply different functions based on the relative amounts of rill and inter-rill erosion

C Factor (Cover and Management)

0.13 cultivated land (based on 2001 tillage transect survey)

0.02 grassland/CRP/shrubs

0.003 deciduous forest

0.26 Urban and industrial

0.45 exposed soil, sandbars, dunes

0.0 shallow or seasonal wetlands (types 1, 2, 3)=0.003

0.45 gravel pits and open mines

0.15 farmsteads and other rural developments

0.0 lakes and deeper water wetlands

P Factor (Support Practice)

A P factor value of 0.875 assumed some special practices such as contour farming, buffer strips, and waterways on half the acres and the other half with no conservation practices.

Advanced Sediment and Phosphorus Transport Modeling using RUSLE and Loading Rates

See Chapter 6

Slopes, Elevations, Hill shading

All coverages were created using USGS 30 meter resolution Digital Elevation Models (DEM). DEMs were obtained from MDNR as GRIDS. The GRIDS were transformed using ArcInfo Import 7 to allow for ArcView Spatial Analyst readability. DEMS were then added to the view as GRIDS. DEMs from Cottonwood, Brown and Cottonwood Counties were clipped to the watershed boundary using USGS Spatial Analysis extension. X tools extension was then used to convert the shape file boundary into a graphic before clipping the DEM. The merge command in the USGS spatial analysis extension was used to combine the three individual clipped DEMS into one DEM.

Spatial Analyst Extension within ArcView 3.2 was then used to perform calculations, reclassifications and analysis to construct slope as percentage and hill shading within the watershed.

Biological

Historical Fishery Assessment- MN DNR

Seven Mile Creek ecological classification is a 1-D Marginal Trout Waters. Below is an excerpt taken from the 1993 fisheries survey by Todd Kolander.

Length of Stream: 12.2 miles

Average width: 3.4 m

Mouth Location: T109N R27W Section 12

Initial source of sustained flow: ditch at T110 R27 S17

Gradient: 18.9 feet/mile

Sinuosity: 2.1

(MN DNR Todd Kolander 1993 Stream Survey)

Comparisons with past investigations and surveys:

Fingerling brown trout were first introduced into Seven Mile Creek in 1986. Prior to this introduction, the stream supported a fish community dominated by cyprinid species. Fish species such as northern pike, yellow perch and walleye typically use the stream in the summer, migrating up from the Minnesota River.

The initial stream survey was completed in 1985. Data on the physical and biological make up of the stream indicated it could support a marginal trout fishery. Stream population checks were completed in 1986, 1987 and 1991. Population checks confirmed that the brown trout stockings were providing a trout population in marginal trout water.

History of fishing conditions

Prior to and following the introduction of brown trout, most fishing occurs at the confluence of the Seven Mile Creek and the Minnesota River. The cool water coming from Seven Mile Creek attracts game fish during warm summer months. During peak runoff periods, fish in the Minnesota River will migrate up Seven Mile Creek. Other times fish will become stranded in shallow pools as flows decrease.

Discussion of Fishery

The initial survey of Seven Mile Creek was in 1985. Population checks were done in 1986, 1987 and 1991. Results indicate that brown trout fingerlings have successfully provided a fishable trout population. Stocked fingerlings have survived in sections of stream both above and below the low-head dam (mile 4.7).

Seven Mile Creek is not without watershed problems. Lost riparian vegetation, increased tiling, and intense row-crop agriculture in the upper watershed (miles 5-12.3) are destabilizing the stream hydrograph and increasing summer water temperatures and stream loading. Currently, extreme high and low flows occur in a very short time period. This type of flow regime is stressful for most aquatic organisms. High flows create elevated velocities that pick up loose bottom material (silt, sand and gravel) that scour the stream bottom, disrupting its inhabitants. Conversely, low flows restrict the available habitat to any remaining pools. Increased competition and predation in these pools adds to the stress on surviving organisms. Removal of the wooded riparian zone in the upper watershed (miles 5-12.3) and replacement with open drainage ditch has increased summer stream temperatures. Elevated stream temperature (>70 F) is stressful for brown trout and can affect other species of fish and invertebrates. Increased sediment loading from row-crop agricultural practices has inundated pools and created turbid water conditions.

The variable that most limits adult brown trout survival in Seven Mile Creek is the lack of deep pools having overhead cover. Literature addressing factors limiting large brown trout in streams show a strong positive relationship between this habitat type and the presence of large brown trout. Seven Mile Creek contains only a few deep pools, and these lack any associated overhead bank cover. Some log jams that may provide overhead cover exist; however these lack deep water adjacent to them.

The fish community present in Seven Mile Creek is diverse, reflecting the different habitat types. A total of 19 species were identified from all the investigations. Of the species sampled, two were darter species, the presence of which suggests good water quality. Darters were only sampled in the lower reach (mile 0-4.7), while the upper reach favored more tolerant species such as fathead minnows, creek chubs, and black bullheads. Investigators sampled some young-of-the-year game fish (walleye, northern pike, and yellow perch). These species may be using the stream as a nursery area because of the available food and suitable environmental conditions.

Summary

At present, the only active management on Seven Mile Creek is annual stocking of 7500 brown trout fingerlings. This had produced an adequate and fishable trout population. As with other marginal trout streams in this area, no data exist on harvest rates or the fishing pressure that occur on Seven Mile Creek. All available information suggests that both fingerlings pressure and harvest occur at low levels. Fishing access along the lower reach (mile 0-1.8) is good, with the county park providing a scenic setting for a variety of outdoor activities. Good access and good survival of fingerlings make trout management an attractive and justifiable expenditure of time and money.

The need to improve habitat for adult brown trout is a future management need. Installation of inexpensive habitat structures should be done in the lower reach of Seven Mile Creek. Structures will be evaluated for fish use and how they improve the carrying capacity of a marginal trout population. Future stream management should also include establishing good riparian buffers in the upper reach of the stream. This should improve the stream hydrologic cycle, while lowering water temperatures and sedimentation rates.

Summary of 1996 Survey (Craig Berberich)

At present the only active management on Seven Mile Creek is annual stocking of 2,500 brown trout fingerlings. Good survival of fingerlings to age three has produced an adequate and fishable trout population. No harvest estimates or fishing pressure data were available, but indications are that both have been low. The county park is an attractive setting for outdoor activities. With some effort in improving pool depth and creating cover, the carrying capacity of large trout could be improved in the lower reach.

Summary 1987 Survey (Duane Williams)

The estimated size of the brown trout population in the 0-4.7 mile reach of Seven Mile Creek was 421 plus or minus 552 (95% CI). This represents 6% survival of the 7,000 brown trout fry planted in 1986. The population should be assessed in 1988 to determine the survival of the 1986 plant and also the 7,000 brown trout planted in 1987.

Summary 1986 (Duane Williams)

The upper reach of SMC (above dam at mi. 4.7) is nearly all open drainage ditch intensively farmed right to the banks. Gradient is relatively low, bottom types mostly sand and silt, and cover for game fish poor. Only three species of fish were sampled—fathead minnow, creek chub, and brook stickback.

The lower reach (below dam at mi. 4.7) is an entirely different type of stream. It flows through a heavily wooded valley to the MN River. Gradient is very high and bottom type is mostly boulder, rubble, and gravel. Cover for game fish is good. Fish species present are the various minnows, suckers, and darters common to most Southern MN streams. No game fish are present. This reach is the one being proposed for trout stocking.

Aquatic and Biological management problems discussed in surveys

- Low flows are the major management problem on Seven Mile Creek. If brown trout stocking is successful, the lack of cover could limit the abundance of adult fish (1988).

- Unstable flows are a problem on Seven Mile Creek. Lack of pools and suitable cover limits the carrying capacity of trout in the lower reach (1997).

- Low flows are the biggest management problem on Seven Mile Creek. If trout management takes place, as proposed, lack of cover for adult fish would also be a problem (1986).

Comments from DNR Fisheries Staff regarding the management of trout and other aquatic Fishery

- Extreme flow conditions pose the single greatest threat and challenge for fisheries management within the creek. Water storage is considered the most important management strategy for attempting an ecosystem-based restoration. The scope of the water quality concerns in the watershed requires solutions on a scale commensurate with the magnitude of the problems. Over the past century the watershed has changed dramatically. About 95% of the watershed has been converted from prairie and wetland to cultivated land and artificial drainage structures. The net effect of the extreme flow conditions includes massive stream bank failures, and high sediment and nutrient loads. A best management practice, which would help address the issue of water quantity, is water storage.

    - An example of a management strategy would be to store 10,000 acre-feet through the use of wetlands. In 2001, about 32,500 acre-feet came through the system. If wetlands were installed at recommended levels, a 30% reduction in flows would be obtained.

- Water quality and water quantity are directly correlated. The volume of water entering seven mile has the largest impact on the trout fishery of Seven Mile.

- Adopt a **"no-net increase"** in drainage within the watershed. If drainage improvements are made, encourage and work with engineers to design features within the construction that will mitigate the cumulative affects of the additional water downstream. If this is not feasible, restore, construct or augment existing wetlands within the minor shed.

- Need for in-stream restoration efforts. Create additional habitat through the use of bank hide structures and rock crossvane structures.

- Create diverse habitats, which in turn encourage diverse fish, amphibian, mussel, invertebrate, and plant communities.

- Increase water quality. Maintain or improve dissolved oxygen levels. Maintain temperatures below 70 ^{o}F.

- Maintain natural and sustainable flow regimes.
- Stabilize stream banks and streambed substrates

Chapter 5

Results & Discussion

Diagnostic Study Results and Discussion

Water Quality Monitoring

Water quality monitoring in Seven Mile Creek Watershed focused on suspended sediments, nutrients, and bacteria. The values below represent grab samples and automatic sampling taken from three sites within the watershed. Parameters include: total suspended solids (TSS), nitrate-nitrogen (No2+No3-N), total phosphorus (TP), Ortho-phosphorus (PO_4), and Fecal Coliform bacteria. Other parameters can be found in tabular format (appendix C). Those include dissolved oxygen, temperature, transparency, and conductivity.

The results listed in the tables include samples taken from the monitoring period of the diagnostic study. Those years include 2000 and 2001. Since monitoring on Seven Mile has taken place since 1996 by BNC staff, graphs including all monitoring years are included in the graphs.

Sediments, phosphorus and bacteria are of concern to Seven Mile Creek when in large concentrations and over sustained periods of time.

Sediment–suspended soil particles that make rivers look muddy and turbid, restricts the ability of fish to spawn, limits biological diversity, and carries phosphorus into the river.

Nutrients

Phosphorus–stimulates the growth of algae. As algae die and decompose, oxygen levels in the water are lowered, which may kill fish and other aquatic organisms.

Nitrogen–can affect drinking water. At high enough concentrations, nitrate-nitrogen in drinking water can limit the ability of blood to carry oxygen in children. Recently researches have expressed concern about a possible link between nitrate and stomach/esophageal cancer. The magnitude of risk is not yet known. At times, SMC contributes to groundwater; therefore high nitrates in the creek become a groundwater issue. In surface water nitrogen contributes to a stratified zone of low oxygen known as hypoxia in the Gulf of Mexico-Mississippi River Delta.

Pathogens–bacteria and viruses that cause disease. The presence of fecal coliform bacteria may indicate that human and/or animal wastes are entering the river along with the possibility of pathogenic organisms. If people, especially children come in contact with pathogens, they might get sick.

Total Suspended Sediment

Total suspended sediment measurement in water refers to particles of soil and organic matter including algae cells that are suspended in solution. Sediment is the biggest pollutant found in the MN River. As mentioned earlier, excess sediment makes rivers look muddy and turbid, restricts the ability of fish to spawn, limits biological diversity, and carries phosphorus into the river. It also accelerates the need to dredge and clean drainage ditches, lakes and streams, which can be very costly to tax payers.

For reference it is estimated that pre-settlement monthly mean TSS levels were less than 10-100mg/l[1]. Total suspended sediment concentrations varied widely in the watershed over the study period. A table of statistics representing the grab sample concentrations can be found in table 17. Figure 7 is a graph of the fluctuating TSS concentrations on a log scale over time. In general TSS levels are the highest from site 3. It is thought the large amounts of flow from the two ditches help accelerate the bank erosion within the channel of Seven Mile Creek. Over 35% of the time the SMC was sampled, concentrations were above set limits and ecoregion values. Ecoregion values are taken from reference streams that are felt to be representative and reflect expected water quality for a particular region (See McCollar and Heiskary, 1993 for additional details). During storms of 1" or more TSS levels typically rise from below 100 mg/l to 250 mg/l or even more. Maximum values were seen as high as 2096 mg/l at site 3 during a summer runoff event in 2001. Typically, sites 1 and 2 had lower TSS levels than site 3 during storms. However, during low flow periods the upper sites had higher TSS levels due to organics attributed to algae growth. Median TSS concentrations for the three sites range from 10-14 mg/l with an interquartile range of 4-174 mg/l.

During storm events, suspended sediment increased substantially in the SMC watershed. An automatic sampler was installed at site 2 in 2000 to further document changes in nutrient and sediment concentrations. The sampler was programmed to take samples from the river every two hours for 24 hours soon after a major storm event. Typical of suspended sediment and phosphorus concentrations, TSS levels in the SMC reach a maximum when the stream discharge is at or near the peak. Figure 4 shows a typical TSS response found during a 1.6" storm over 2 days.

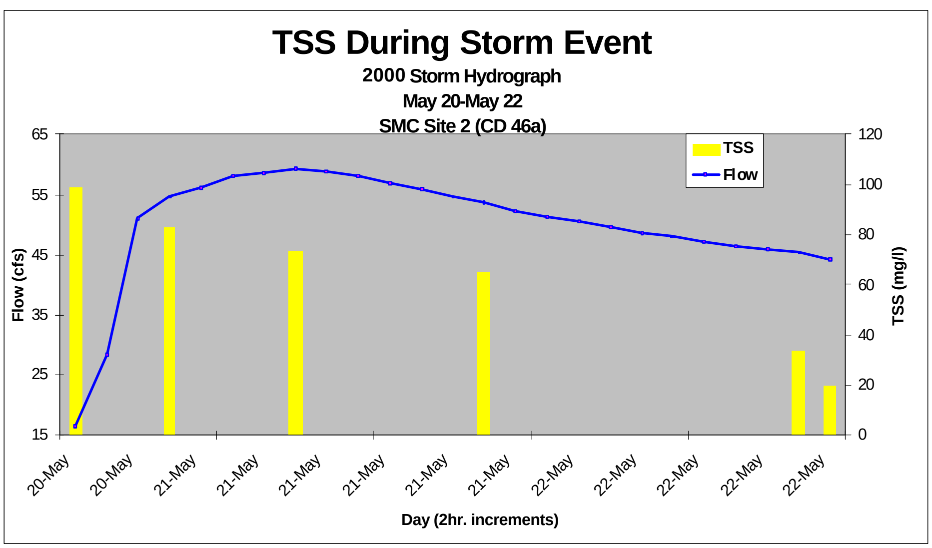

Figure 4. TSS and storm hydrograph

[1] Basin Information Document, MPCA.1997.

Nutrients

Nutrients are necessary for growth and maintenance of all life forms. However, nutrients can cause problems in aquatic systems when they are present in quantities that greatly exceed the amounts normally needed to sustain organisms living in the system. A process of nutrient enrichment (eutrophication) can cause production of algae and other aquatic plants to exceed desirable levels.[2] This study investigated two nutrients, phosphorus and nitrogen, which have been frequently identified as contributors to eutrophication when present in high quantities, and, in the case of un-ionized ammonia and nitrate, can be toxic. Besides being a concern for Seven Mile, elevated nutrient levels raise environmental concerns downstream. Within the past decade research and clean up efforts have concentrated on the MN River since it has been designated by the EPA as a heavily impaired water resource. A segment of the MN River from Mankato to Shakopee is a Total Maximum Daily Load designated reach. High nutrient levels and bacteria from tributaries have been identified as a major source for the water quality impairments. In addition, from a global perspective, recent concern over the "dead zone" (hypoxic zone-low oxygen levels) in the Gulf of Mexico has drawn attention to contributing areas of the Upper Midwest such as the MN River valley.

Nitrogen

Water samples were collected and analyzed for nitrogen in the form of Nitrate-Nitrogen. Nitrate in drinking water may cause methemoglominemia (Blue Baby Syndrome) in young children and a maximum nitrate concentration of 10 mg/l has been adopted to protect public health (MPCA, 1990). This level is also used as reference for surface waters.

Stream discharge during this part of the runoff is predominantly derived from subsurface drainage water by ditches and tiles. This suggests that much of the nitrate is reaching the river through a shallow subsurface pathway. Randall (1986) and Montgomery (1999 Red Top Farms Demonstration Project) reported average nitrate concentrations that ranged from 16 to 172 mg/l in tiles draining shallow ground water at agricultural experiment stations located in the Minnesota River Basin[3]. Other sources of nitrate include failing septics, runoff from feedlots, and natural derived sources. Figure 5 shows nitrate concentrations during a storm. The lower levels at the rise of the hydrograph indicate dilutions. As more water infiltrates through the soil profile, No_3 is pushed deeper into the soil, until it reaches drainage tile. From there it enters ditches and Seven Mile Creek.

Nitrate is considered one of the largest water quality concerns for the watershed. For its size, the watershed contributes very large nitrogen loadings and concentrations. Average concentrations ranged from 13-14 mg/l. Of the 40 samples taken, about 80% of the samples exceed the Western Corn Belt Ecoregion values. The highest concentrations observed were 27-28mg/l. Nitrate concentrations are generally very low during the pre-plant period. Concentrations peak around eary July and are directly correlated with rainfall. As crops enter full canopy in mid-August nitrate concentrations decrease substantially due to less rainfall and crop uptake of nitrogen sources within the soil profile.

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[2] Minnesota River Assessment Report, Physical and Chemical Assessment. January 1994
[3] Red Top Farms Demo Site Synopsis, MN Department of Agriculture, 1999.

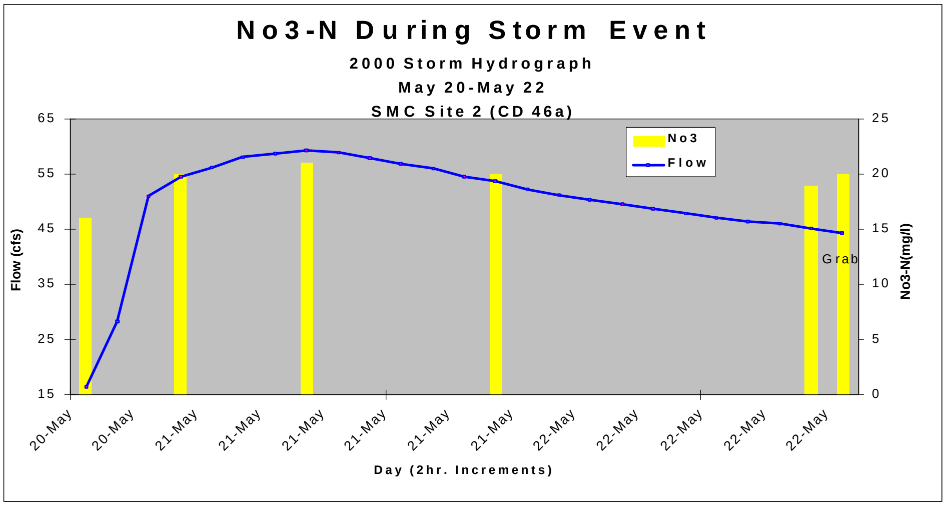

Figure 5. Nitrate-Nitrogen vs. time during 2000 storm event.

Phosphorus

Water samples were analyzed for both dissolved and particulate forms of phosphorus. Dissolved ortho-phosphorus (Po_4) is regarded as problematic because it is in a readily available form utilized by algae. Phosphorus in the particulate form can also be problematic because it can be transported as part of the suspended load, potentially affecting aquatic systems located further downstream. The combined amounts of dissolved and particulate phosphorus are termed total phosphorus. Ortho-phosphorus and total phosphorus concentrations found coming from the watershed are adding to the Minnesota River. Average total phosphorus concentrations found at the three monitoring sites ranged from 0.184 to 0.251 mg/l. About 60% of the total phosphorus was in the form of ortho or dissolved reactive phosphorus. Phosphorus and sediment were found to be directly correlated. Highest concentrations were found during low flow conditions, indicating septic system influences as well as natural phosphorus bio-geo-chemical processes during low dissolved oxygen or variable pH conditions.

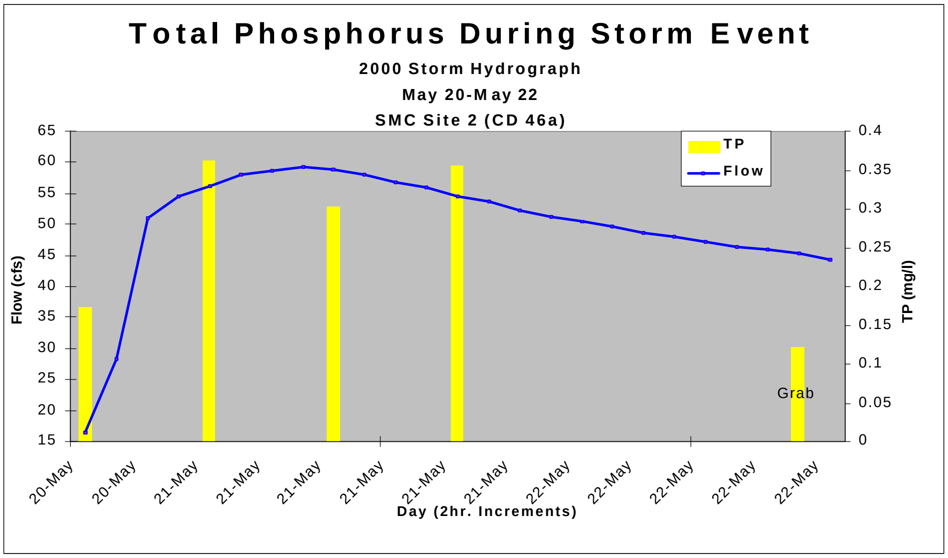

Figure 6. Total phosphorus vs. time during a 2000 storm event.

Bacteria

During the diagnostic study fecal coliform bacteria were tested. The presence of coliform bacteria may indicate that human and/or animal wastes are entering the river along with the possibility of pathogenic organisms. The potential presence of disease-causing organisms sometimes found with coliform bacteria limit the overall recreational suitability of the water for health and safety related reasons. Listed in Table 18 are fecal coliform levels found from 1996-2001. For reference, a public beach in Minnesota is closed if fecal coliform levels exceed a geometric mean of 200-col/100 ml with no less than five samples per month, or if a one-time sample exceeds 2000 col/100ml.

In Seven Mile Creek and the tributaries feeding it, geometric mean concentrations ranged from 200 to 300-col./100 ml. Concentrations during storms ranged from 100 to 14,000 col./100 ml indicating manure spreading acres or feedlot sources. Fecal bacteria during low flow conditions ranged from 10 to 800 col./100 ml. Higher levels during low flow periods (>200) indicate failing septic systems within the watershed.

Table 17

Total Suspended Solids (TSS, mg/L)

Site	Mean (mg/l)	Median (mg/l)	Max (mg/l)	Min (mg/l)	25%[1] (mg/l)	75%[1] (mg/l)	% of Samples Exceeding Limits[2]	% of samples Exceeding WCBP Ecoregion Average[3]	Count
Site 1	44	10	418	2	4	32	25	11	36
Site 2	170	14	711	1	5	95	39	30	23
Site 3	255	13	2096	2	4	174	43	38	42

[1] Inter-quartile ranges determined by sorting the lower 25 percentile values and higher 75 percentile values

[2]Limit of 30 mg/l (reference applied to permitted point source discharges)

[3] Mean 1970-1992 Annual Western Corn Belt Plains Ecoregion Average based on 45.3 mg/l

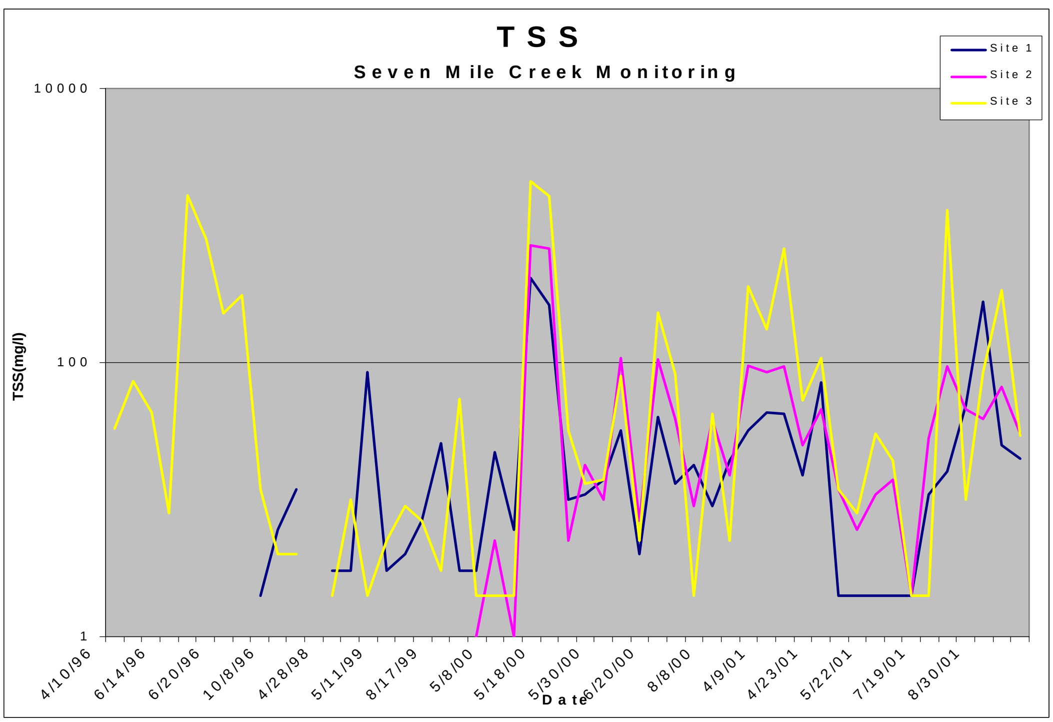

Figure 7: TSS concentrations vs. time.

Table 18

Nitrate Nitrogen

Site	Mean (Mg/l)	Median (Mg/l)	Max (Mg/l)	Min (Mg/l)	25%[1] (Mg/l)	75%[1] (Mg/l)	% of Samples Exceeding Limits/Standards[2]	% of samples Exceeding WCBP Ecoregion Average[3]	Count
Site 1	13.2	13.8	27.0	.5	6.0	20.8	50	76	38
Site 2	12.8	9.9	27.5	1	8.9	19.3	33	83	24
Site 3	12.7	13.6	28.3	.9	8.0	17.5	52	86	44

[1] Inter-quartile ranges determined by sorting the lower 25 percentile values and higher percentile values

[2]Limit based on 10 mg/l

[3] Mean 1970-1992 Annual Western Corn Belt Plains Ecoregion Average based on 4.8 mg/l

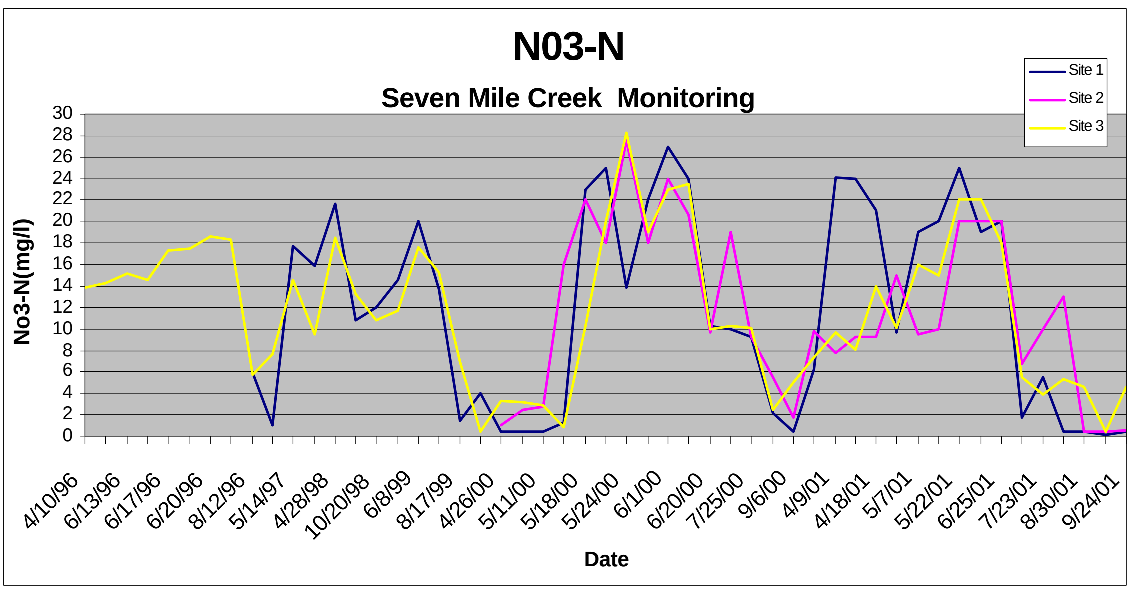

Figure 8. Nitrate concentrations vs. time.

Table 19

Total Phosphorus

Site	Mean (mg/L)	Median (mg/L)	Max (mg/L)	Min (mg/L)	25%[1]	75%[1]	% of samples Exceeding WCBP Ecoregion Average[2]	Count
Site 1	.251	.205	.664	.033	.150	.328	36	36
Site 2	.206	.212	.378	.035	.148	.298	39	23
Site 3	.184	.182	.499	.035	.122	.241	21	38

[1] Inter-quartile ranges determined by sorting the lower 25 percentile values and higher 75 percentile values

[2] Mean 1970-1992 Annual Western Corn Belt Plains Ecoregion Average based on .280 mg/l

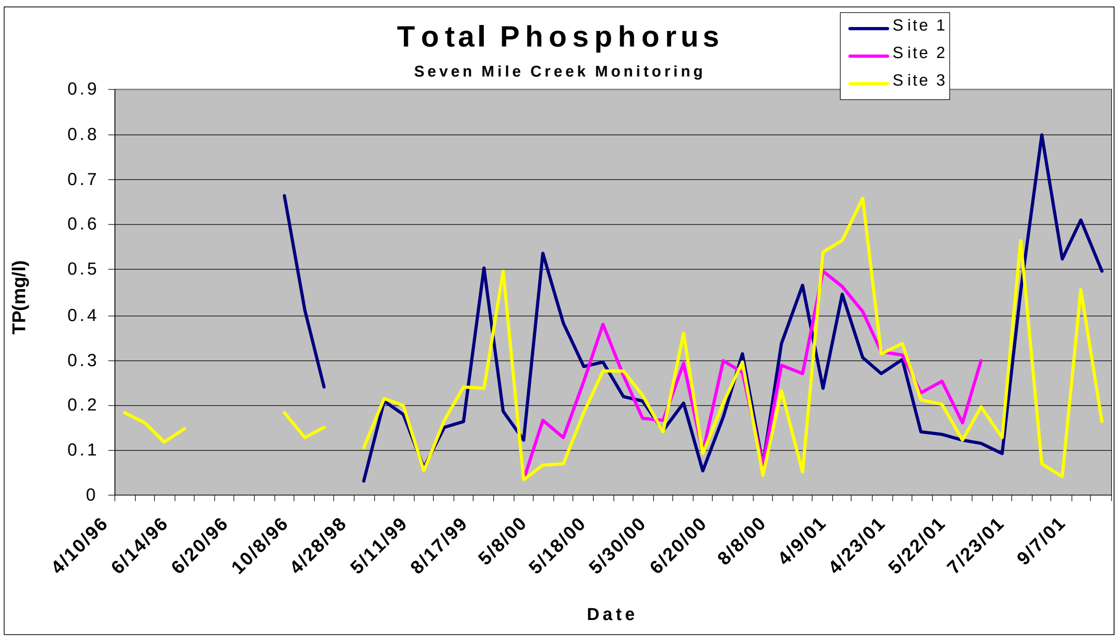

Figure 9. Total phosphorus concentrations vs. time.

Table 20

Ortho-Phosphorus

Site	Mean (mg/L)	Median (mg/L)	Max (mg/L)	Min (mg/L)	25%[1]	75%[1]	% of Samples Exceeding Limits/Standards	% of samples Exceeding WCBP Ecoregion Average	Count
Site 1	.133	.098	.391	.003	.028	.232	Na	Na	36
Site 2	.127	.091	.332	.019	.043	.239	Na	Na	23
Site 3	.084	.052	.300	.003	.015	.179	Na	Na	38

[1] Inter-quartile ranges determined by sorting the lower 25 percentile values and higher 75 percentile values

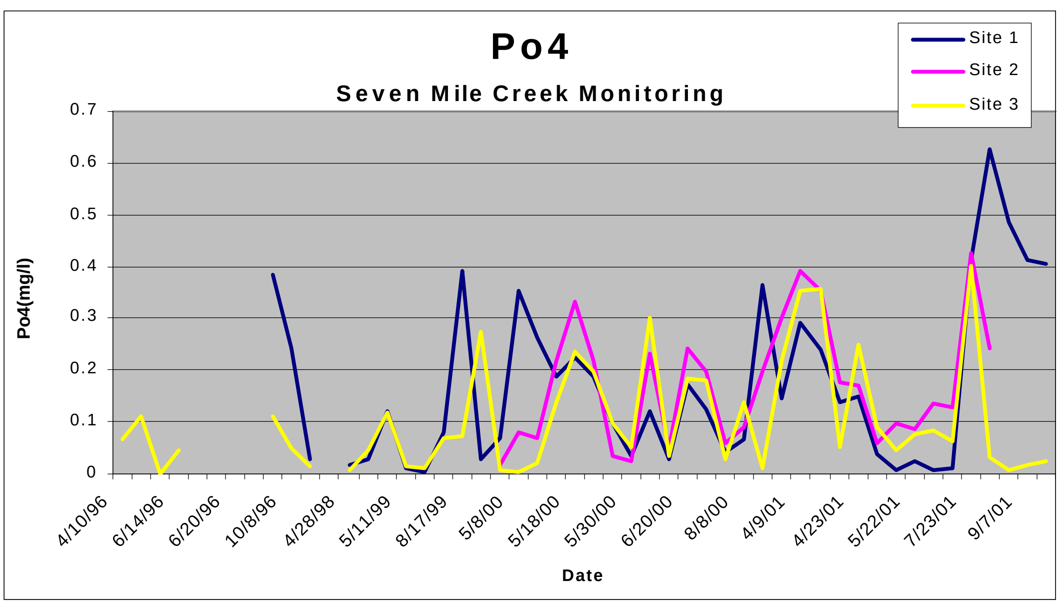

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Figure 10. Ortho-phosphorus levels vs. time.

Table 21

Fecal Coliform Bacteria

Site	Mean (col./100ml)	Median (col./100ml)	Max (col./100ml)	Min (col./100ml)	25%[1] (col./100ml)	75%[1] (col./100ml)	% of Samples Exceeding Limits[2]	% of samples Exceeding WCBP Ecoregion Average[3]	Geometric Mean	Count
Site 1	1812	200	23900	10	100	1100	10	43	269	21
Site 2	1216	435	13600	20	125	675	14	64	314	22
Site 3	1420	100	12400	10	75	550	22	39	198	23

[1] Inter-quartile ranges determined by sorting the lower 25 percentile values and higher percentile values

[2]Limit based on 2000 col/100ml

[3] Mean 1970-1992 Annual Western Corn Belt Plains Ecoregion Average based on 230 col/100ml

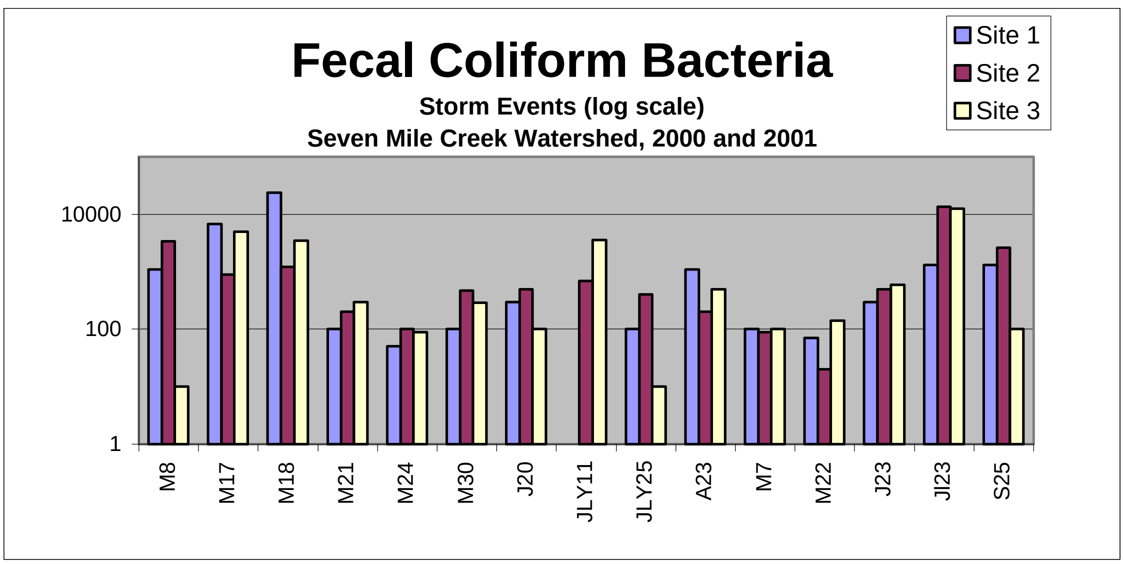


Figure 11. Fecal Coliform levels on various sampling dates for Seven Mile Creek.

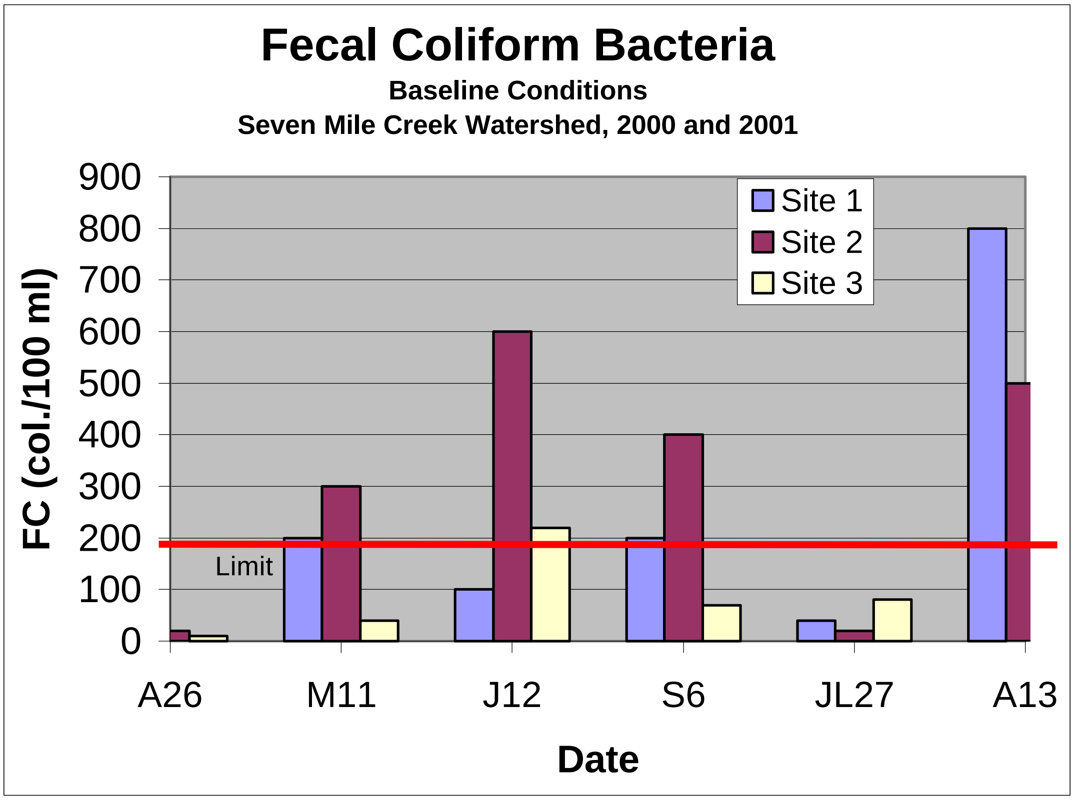


Figure 12. Fecal Coliform levels with reference to upper allowable limit.

Hydrology

Extreme flow conditions are common in the Seven Mile Creek Watershed. Extreme low flows are common during April, May and June, but by August, flows are reduced to less than three cubic feet per second. In general, the hydrographs are flashy in nature. During a storm event, the river rises quickly and recedes just as fast. Figures 13-15 show the three major climactic periods in the watershed. Changes in climate (water cycle), growth of crops, and antecedent moisture conditions help explain this. Topography of the river course also helps explain the gradual increase and decrease of river flows in the watershed. Below are storm hydrographs taken during different parts of the growing season. Flows are very high in the early part of the season. Any additional precipitation causes a rapid, flashy response to the hydrograph. However, as the summer progresses and crops are at full canopy, precipitation within the watershed has little affect on the stream.

Ground water dominates the flows in watershed 3 and sustains the flow throughout the entire year. Little information is known about the stream upwelling and down welling processes. It is known that at times, typically later parts of the growing season, that surface water losses occur due in part to the fractured bedrock, sandstone and gravel alluvial materials found in the lower reach of the watershed. Sub watershed 3 is at the mouth of the creek with a fall of 210 feet down through Jordan sandstone features. The characteristics of flow pathways posed an interesting problem as there is a small loss of water (losing reach) in the channel as it travels from the mouth of watershed 1 and 2 to the monitoring station in subwatershed 3. By checking the hydrograph flows in subwatershed 3 against the combined hydrograph flows of subwatershed 1 and 2, it was found that for periods of time, on the tail of the hydrograph during storm events and also during base flow periods, watershed 3 yielded less than 1 and 2. At first glance this is a major concern for sediment, phosphorus and nitrogen projections. However, through the following discussions it becomes clear that the overall projection for sediment and phosphorus is likely affected less than 5% by this feature.

Photo 8. Spring snow melt conditions in the park on April 4, 2001.

Photo 9. Spring snow melt, Site 1 Highway 99.

Examples of flashy nature of flows-- spring, mid-summer, and late summer.

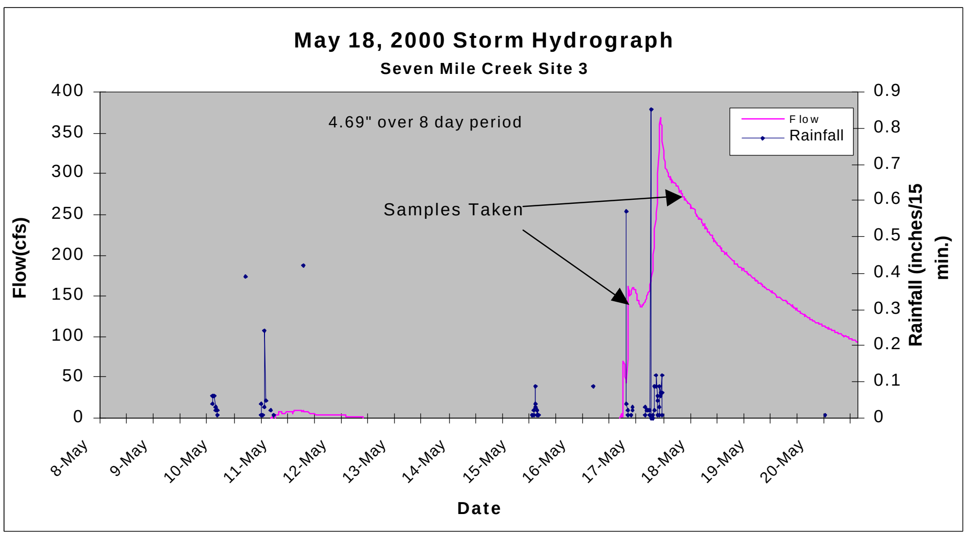


Figure 13. Seven Mile Creek hydrograph in early summer before crop canopy formed. Very high flows.

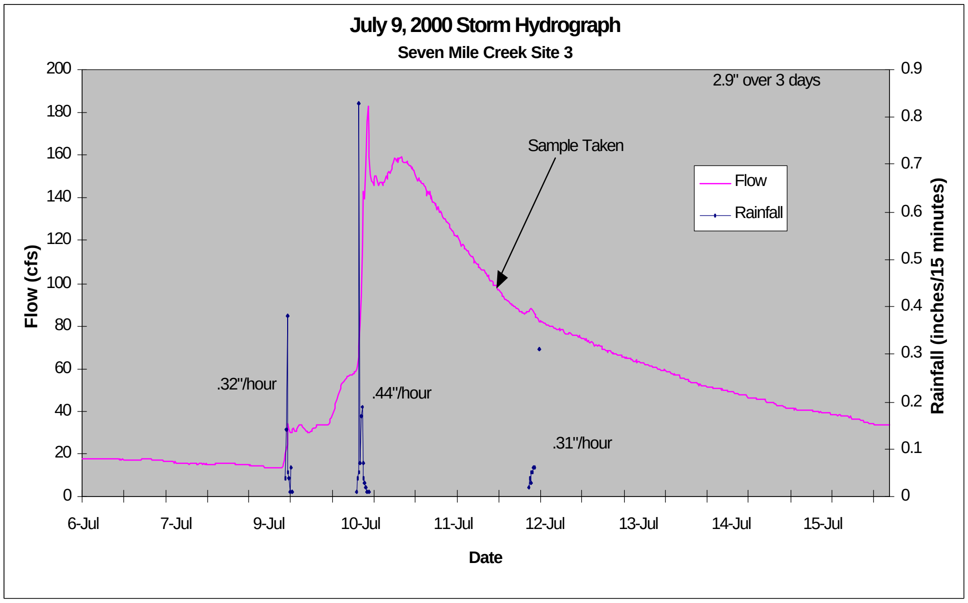


Figure 14. Seven Mile Creek hydrograph in mid-summer; crop canopy almost enclosed. High flows.

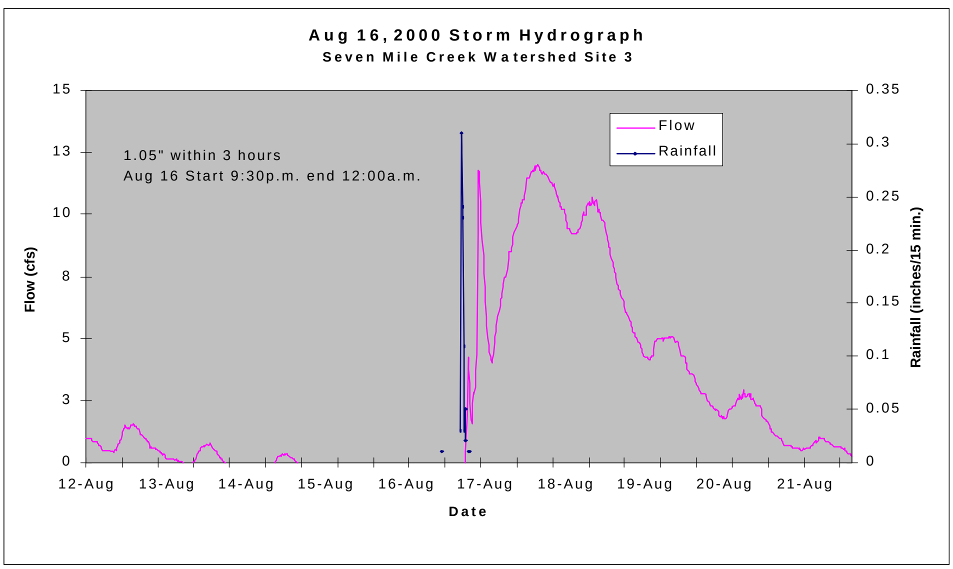


Figure 15. Seven Mile Creek hydrograph in late summer; evapotranspiration at peak within the watershed. Low flows-much less flashy even with an inch of rain.

Table 22. 2000 and 2001 flow stats.

2000 flow stats

Site	Mean (cfs)	Med. (cfs)	Max (cfs)	Month of Max Occurrence	Min (cfs)	Month of Min Occurrence	Total Precip.	Total Runoff (inches)	% Runoff
Site 1	9	0	120	May	0	April	20.34	3.84	18.8
Site 2	8	0	69	May	0	April	20.34	3.62	17.8
Site 3	19	1.1	229	May	3	April	20.34	3.53	17.5

[1] April through September

2001 flow stats

Site	Mean (cfs)	Med. (cfs)	Max (cfs)	Month of Max Occurrence	Min (cfs)	Month of Min Occurrence	Total Precip.	Total Runoff (inches)	% Runoff*
Site 1	43.8	18.8	235	April	.05	September	21.4	19.2	
Site 2	8	9.4	170	April	0	September	21.4	16.5	
Site 3	89.4	21.3	474	April	3	September	21.4	16.6	

[1] April through September

*Beacause total precipitation does not include the very large snowmelt contributions from the winter of 2000 and 2001, % runoff values are not calculated

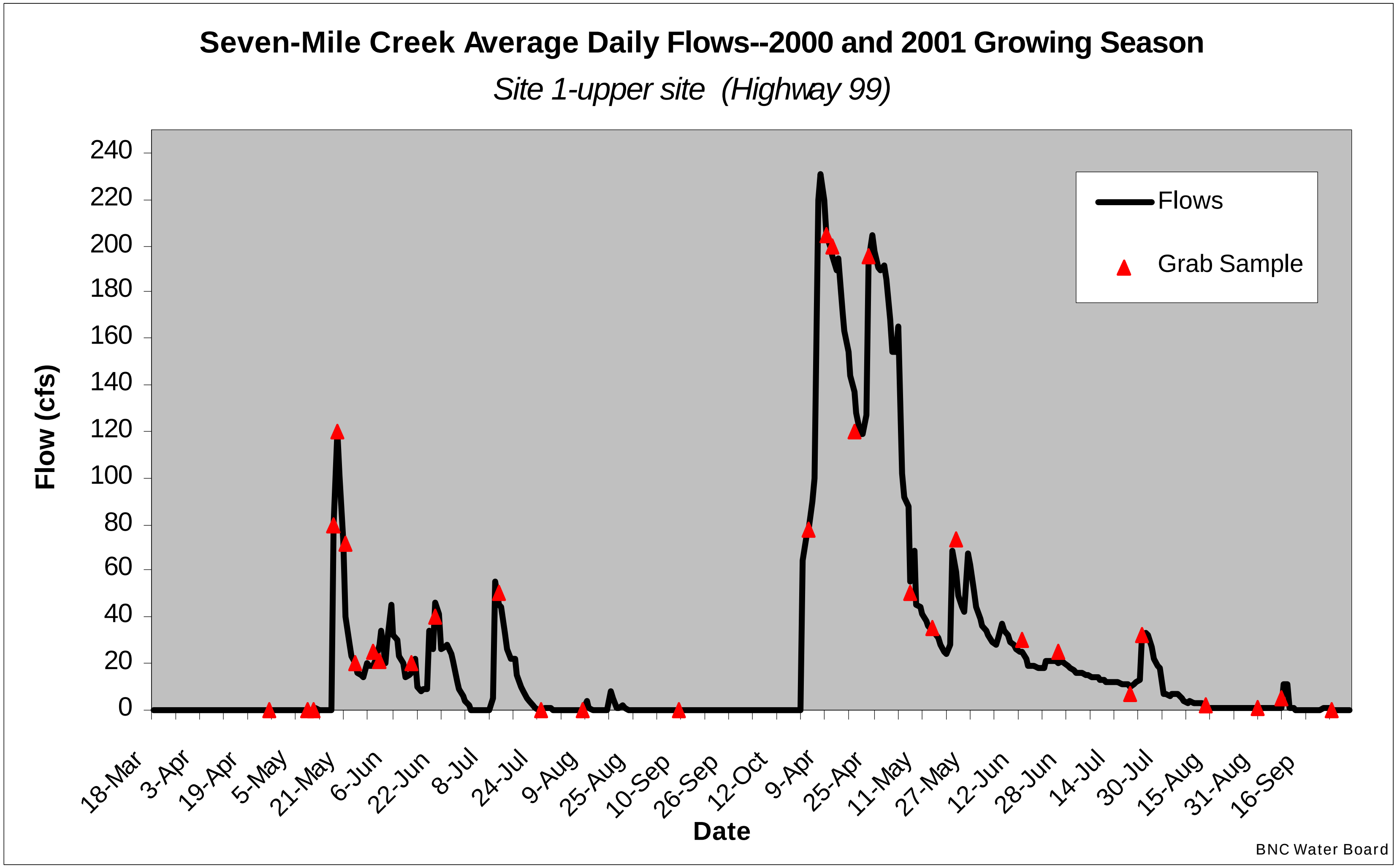


Figure 16. Site 1 hydrograph.

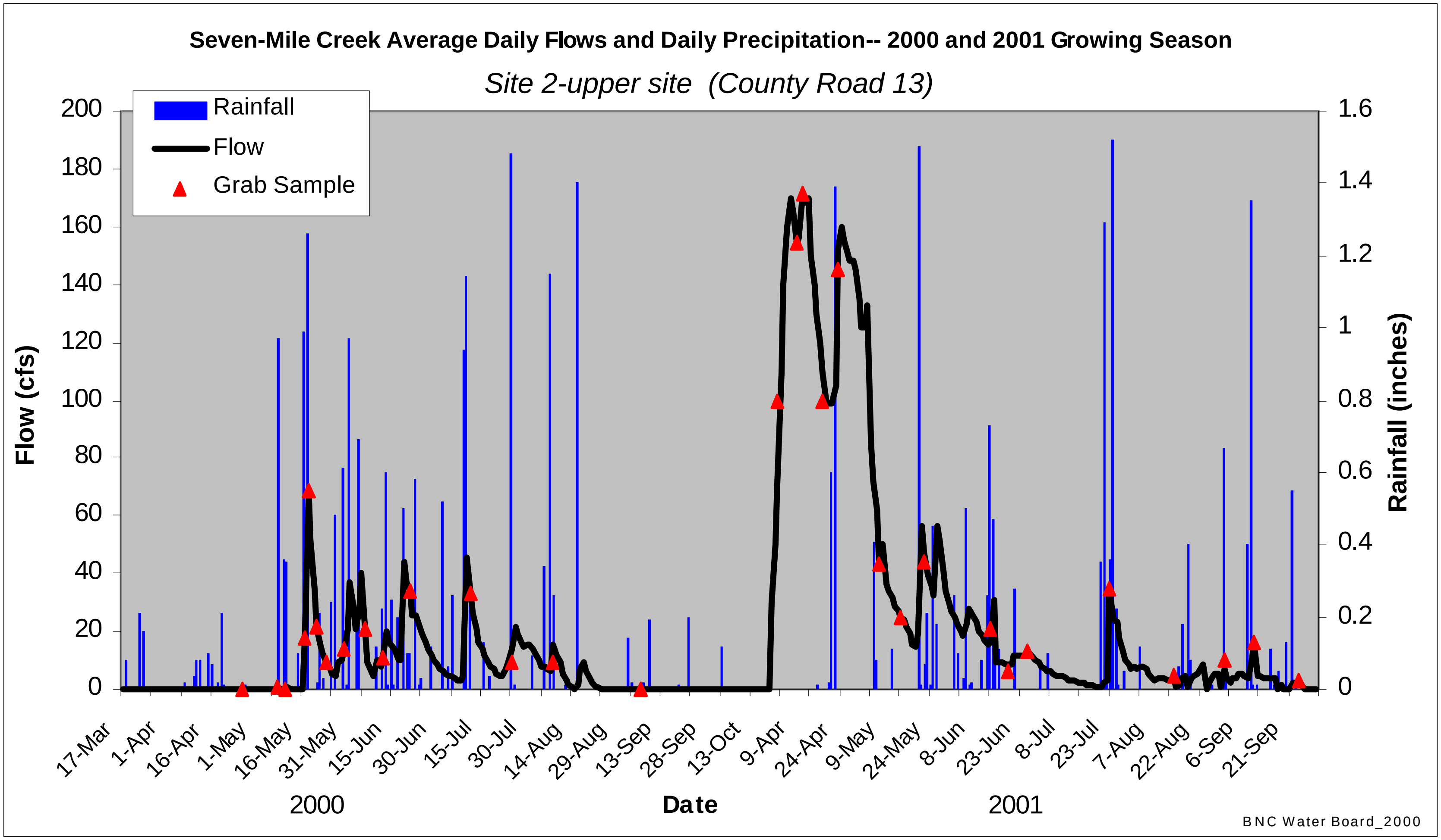


Figure 17. Site 2 hydrograph.

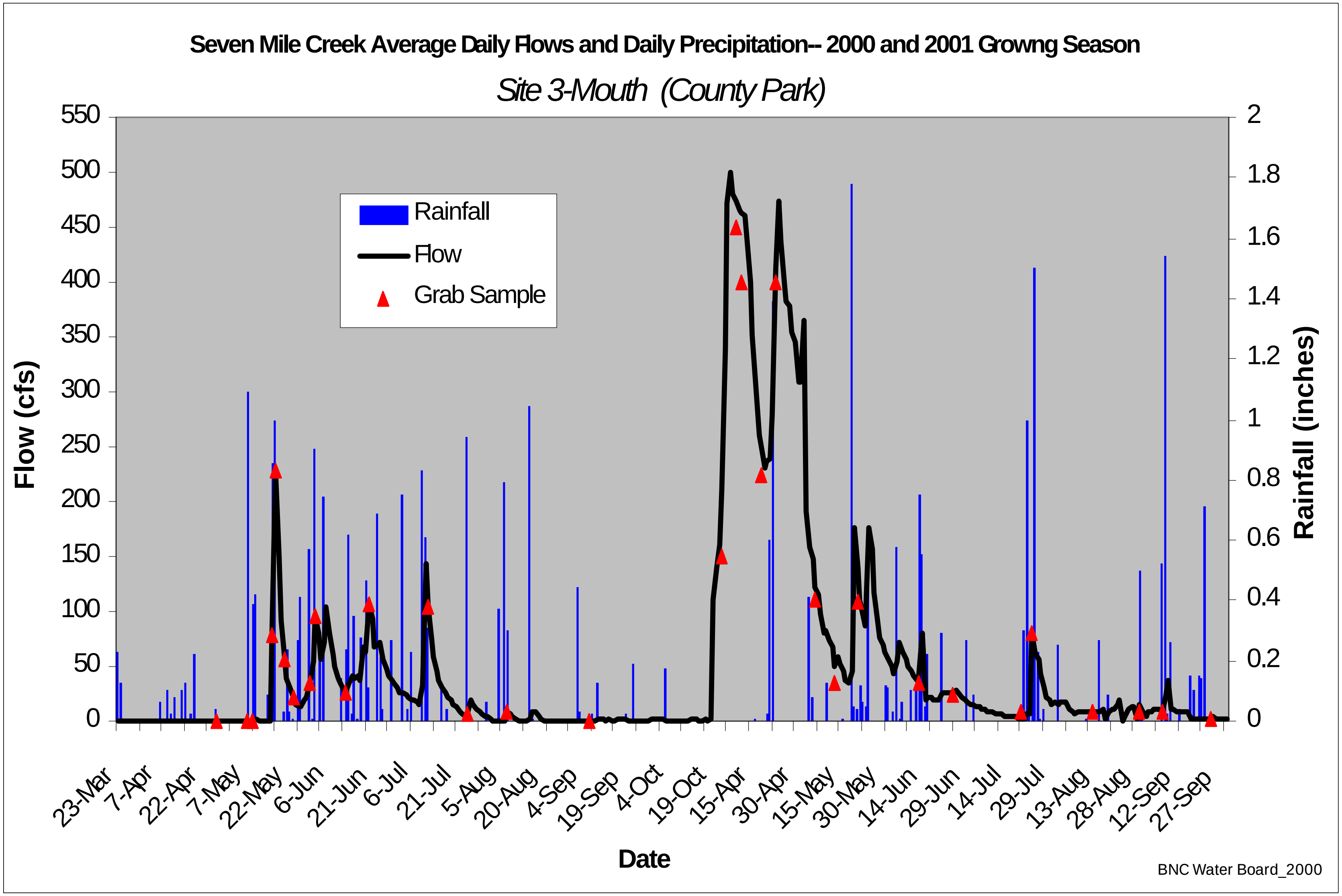


Figure 18. Site 3 hydrograph.

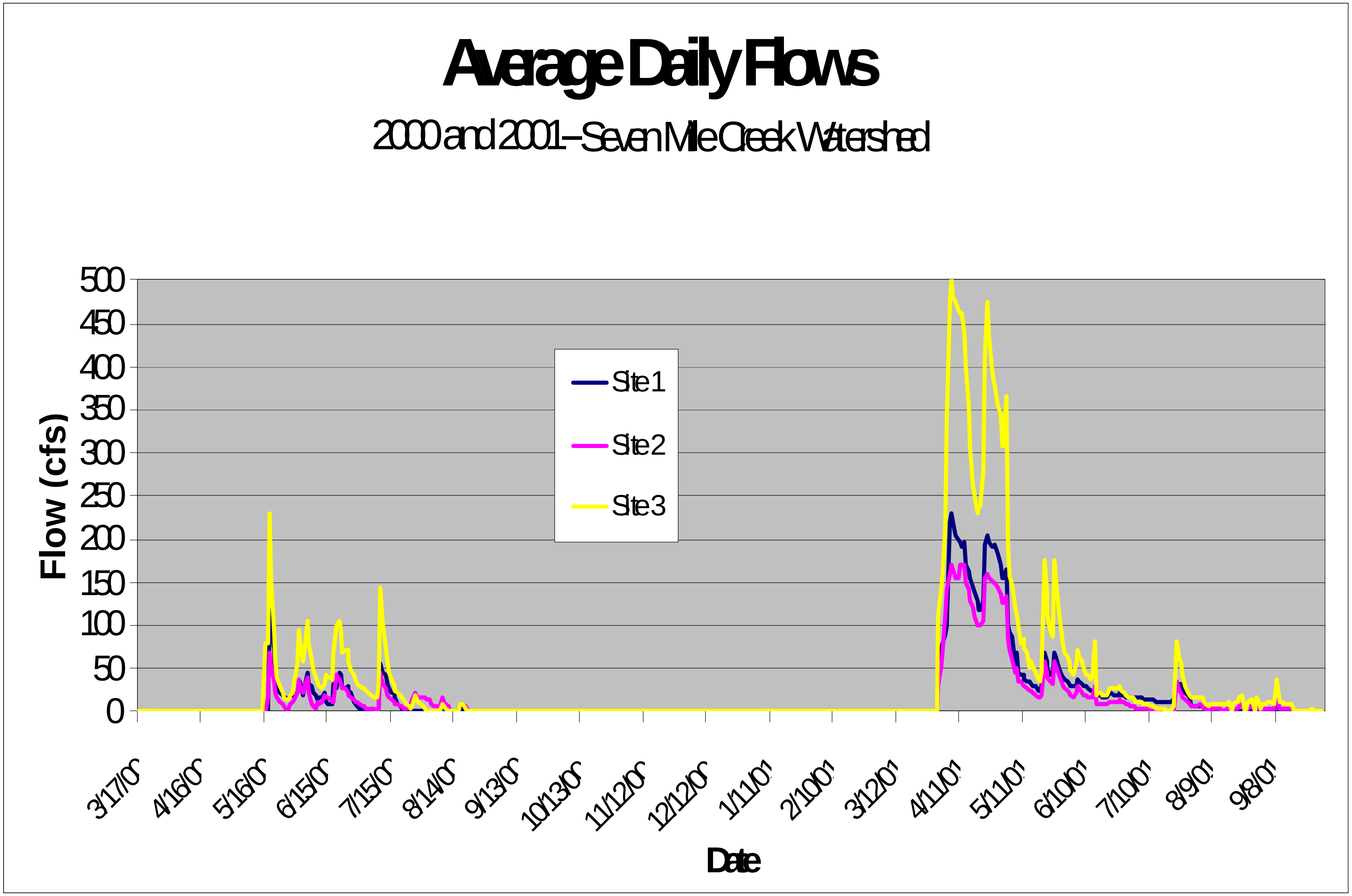


Figure 19. Average daily flows for each site vs. time.

Photo 10. Stream flows taken for stage-discharge rating curve development during higher flows at site 1 on CD 13.

Pollutant Loading Estimates

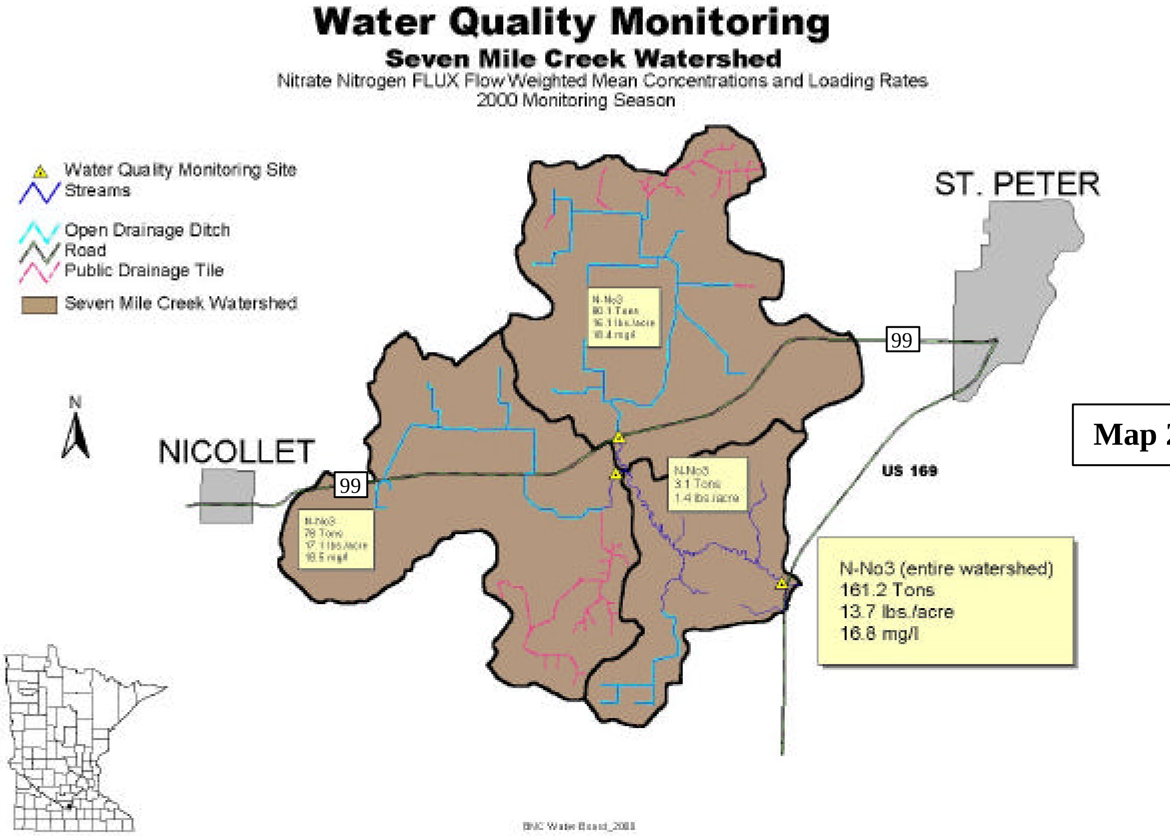
FLUX - - Flow Weighted Mean Concentrations and Yields

As reported earlier, the 2000, and 2001 sampling seasons were different in terms of rainfall, flow, and amount of samples taken. Consequently, loading estimates will vary considerably between monitoring years (figure 20). In addition to climatic differences and therefore overall runoff, the timing of grab sampling can sometimes overestimate or underestimate the amount of a particular water parameter of concern. As can be seen from the hydrographs the red triangles indicate when the samples were taken in terms of water flow conditions. Ideally, grab samples should be taken during a variety of flow conditions.

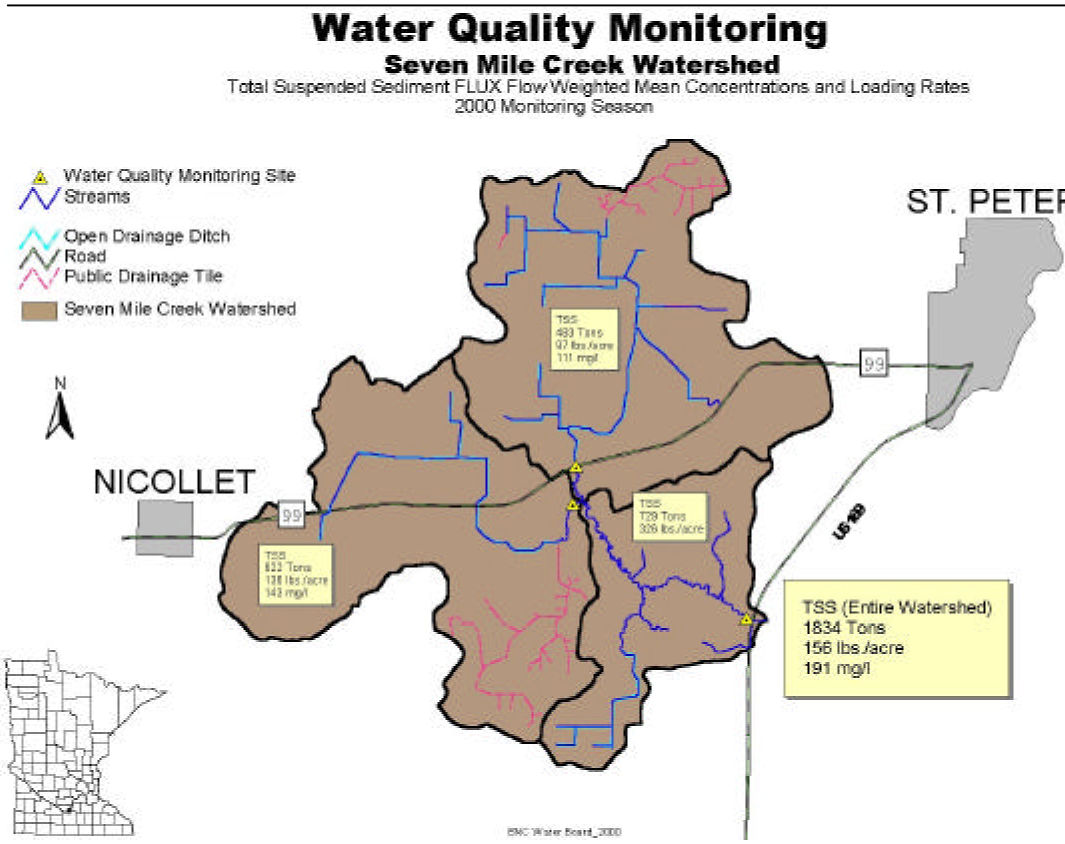
A combination of two years worth of data with a greater number of samples taken during a wide variety of flow, groundwater/base flow and runoff dominated conditions have resulted in a more accurate portrayal of the chemical and physical makeup of the SMC resource during the study.

Relative Water Quality in the Watershed for 1999 Monitoring Season

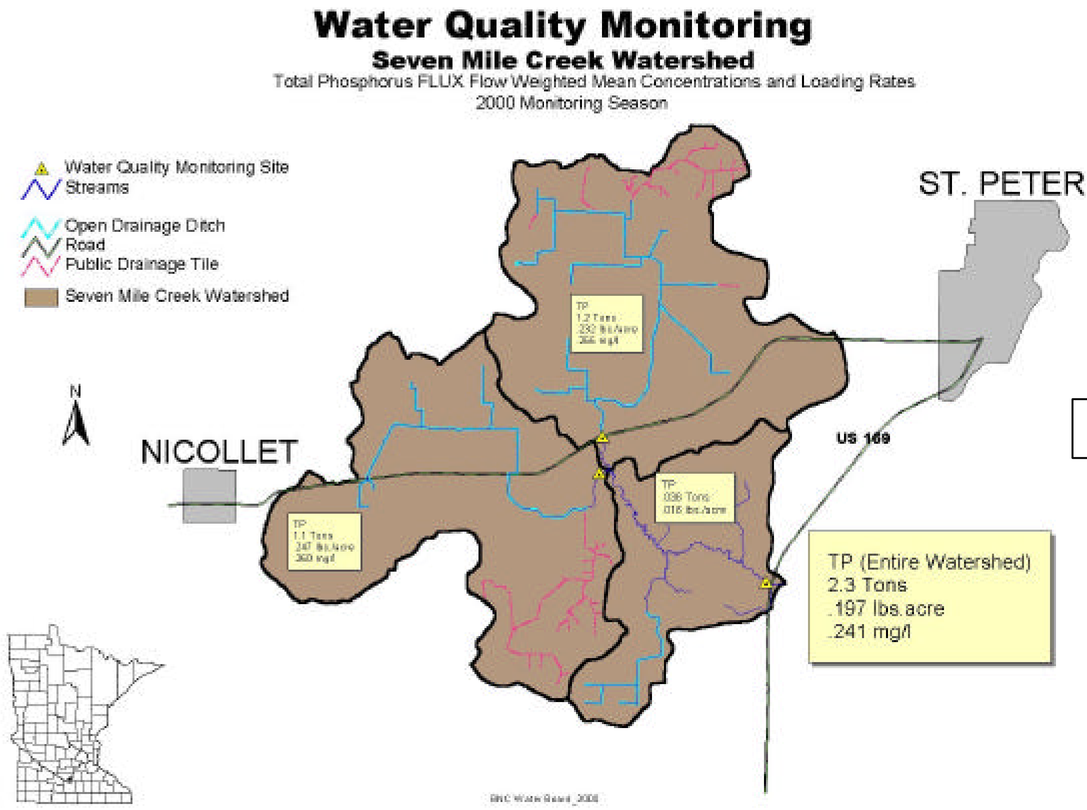
Spatial Representation of Water Quality


Water Quality Monitoring
Seven Mile Creek Watershed
Nitrate Nitrogen FLUX Flow Weighted Mean Concentrations and Loading Rates
2000 Monitoring Season
Water Quality Monitoring Site
Streams
Open Drainage Ditch
Road
Public Drainage Tile
Seven Mile Creek Watershed
ST. PETER
NICOLLET
99
US 169
N
N-No3
N-No3
N-No3
N-No3 (entire watershed)
161.2 Tons
13.7 lbs./acre
16.8 mg/l

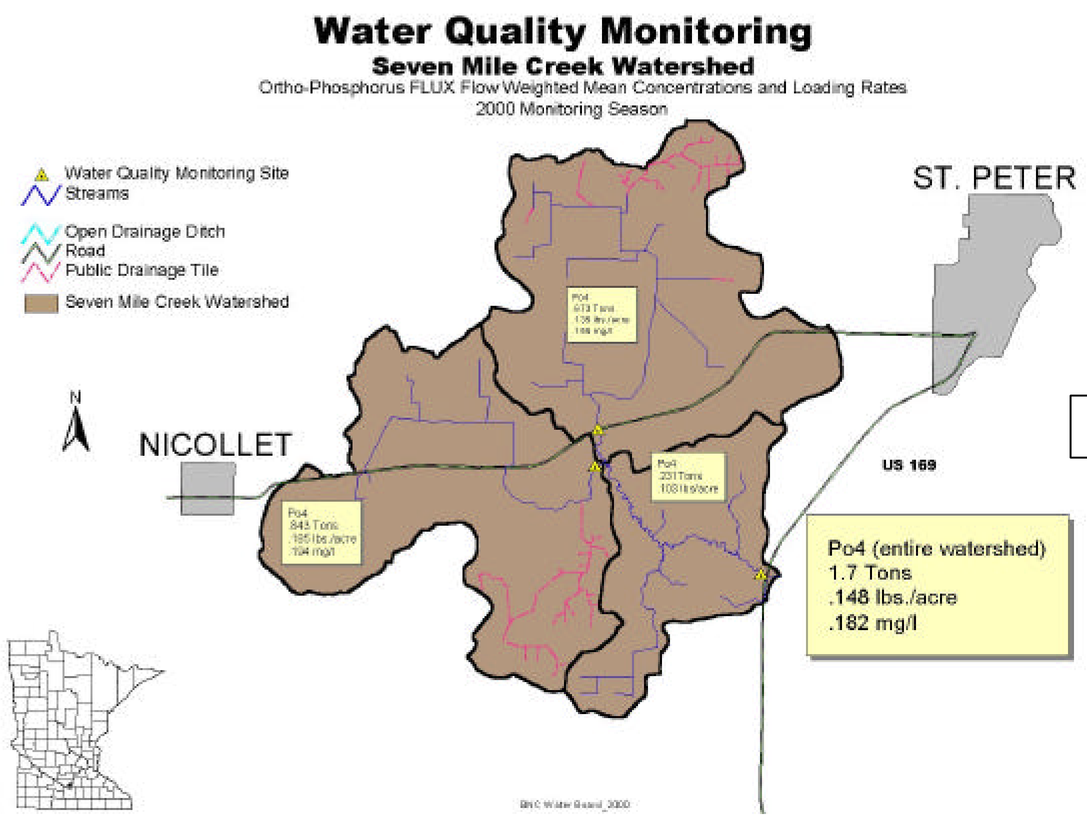
Map 26


Water Quality Monitoring
Seven Mile Creek Watershed
Total Suspended Sediment FLUX Flow Weighted Mean Concentrations and Loading Rates
2000 Monitoring Season
Water Quality Monitoring Site
Streams
Open Drainage Ditch
Road
Public Drainage Tile
Seven Mile Creek Watershed
ST. PETER
NICOLLET
99
N
TSS
TSS
TSS
TSS (Entire Watershed)
1834 Tons
156 lbs./acre
191 mg/l

Map 27


Water Quality Monitoring
Seven Mile Creek Watershed
Total Phosphorus FLUX Flow Weighted Mean Concentrations and Loading Rates
2000 Monitoring Season
Water Quality Monitoring Site
Streams
Open Drainage Ditch
Road
Public Drainage Tile
Seven Mile Creek Watershed
N
NICOLLET
ST. PETER
US 169
TP
1.2 Tons
TP
1.1 Tons
TP
.036 Tons
.018 lbs./acre
TP (Entire Watershed)
2.3 Tons
.197 lbs.acre
.241 mg/l

Map 28


Water Quality Monitoring
Seven Mile Creek Watershed
Ortho-Phosphorus FLUX Flow Weighted Mean Concentrations and Loading Rates
2000 Monitoring Season
Water Quality Monitoring Site
Streams
Open Drainage Ditch
Road
Public Drainage Tile
Seven Mile Creek Watershed
N
NICOLLET
ST. PETER
US 169
Po4
Po4
.843 Tons
Po4
.231 Tons
Po4 (entire watershed)
1.7 Tons
.148 lbs./acre
.182 mg/l

Map 29

2000

Table 23
Flow Weighted Mean Concentrations (mg/l)

Site	TSS	No3	TP	Po4
Site 1	111	18.4	.266	.155
Site 2	143	18.5	.260	.194
Site 3	191	16.8	.241	.182

Table 26
Yield (lbs/acre)

Site	TSS	No3	TP	Po4
Site 1	97	16.1	.232	.135
Site 2	136.4	17.1	.247	.185
Site 3	155.7	13.7	.197	.148

Table 32
Normalized Yield (lbs/acre/inch of runoff)

Site	TSS	No3	TP	Po4
Site 1	25.3	4.4	.060	.040
Site 2	37.7	4.7	.068	.051
Site 3	44.1	3.9	.056	.042

2001

Table 24
Flow Weighted Mean Concentrations (mg/l)

Site	TSS	No3	TP	Po4
Site 1	34.8	17.7	.281	.153
Site 2	51.2	11.2	.363	.239
Site 3	262.5	10.5	.438	.295

Table 27
Yield (lbs./acre)

Site	TSS	No3	TP	Po4
Site 1	151.4	77	1.22	.665
Site 2	191.2	41.7	1.36	.895
Site 3	984.4	39.4	1.64	1.10

Table 32
Normalized Yield (lbs/acre/ inch of runoff)

Site	TSS	No3	TP	Po4
Site 1	7.9	4.0	.064	.035
Site 2	11.7	2.5	.082	.054
Site 3	59.3	2.4	.100	.070

2002

Table 25
Flow Weighted Mean Concentrations (mg/l)

Site	TSS	No3	TP	Po4
Site 1				
Site 2				
Site 3				

Table 28
Yield (lbs/acre)

Site	TSS	No3	TP	Po4
Site 1				
Site 2				
Site 3				

Table 32
Normalized Yield (lbs/acre/ inch of runoff)

Site	TSS	No3	TP	Po4
Site 1				
Site 2				
Site 3				

Table 29

Average FWMC for 2000 and 2001 (mg/l)

Site	TSS	NO3	TP	Po4
Site 1	73	18.1	0.274	0.154
Site 2	97	14.9	0.312	0.217
Site 3	588	13.7	0.941	0.591

Mean 1970-1992 Annual Western Corn Belt Plains Ecoregion Average for:

TSS = 45.3 mg/l

Nitrate = 4.8 mg/l

TP = .280

Table 30

Average Yield for 2000-and 2001 (lbs/acre)

Site	TSS	NO3	TP	Po4
Site 1	124	47.0	0.726	0.400
Site 2	164	29.4	0.804	0.540
Site 3	570	26.6	0.912	0.624

Average Normalized Yield for 2000 and 2001 (lbs/acre/inch of runoff)

Site	TSS	NO3	TP	Po4
Site 1	16.6	4.2	0.062	0.038
Site 2	24.7	3.6	0.075	0.053
Site 3	51.7	3.2	0.156	0.056

Summary of pollutant loads

A primary goal of this study was to examine specific pollutants, the processes affecting their transport, and appropriate measures to reduce their delivery to the water resource. Examination of the relative amount of pollutant load assists in accomplishing this goal. Below is a brief summary of the loading rates for the SMC.

Sediment

When each of the three watersheds are separated out, it is found that watershed 3 is the largest contributor of sediment. Most of this sediment is thought to be derived from bank erosion sources. When comparing the upper two watersheds, watershed 2 is on average, a higher loader of sediments. Again, most of this is derived from bank erosion in the lower un-ditched riparian corridor near the lower section of the watershed, upstream of monitoring site 2. Average flow weighted concentrations (FWMC) during the two year study were found to be 73, 97 and 227 mg/l at sites 1, 2 and 3 respectfully. The watershed yielded an average of about 52 lbs/acre/inch of runoff or 570 lbs/acre.

Phosphorus

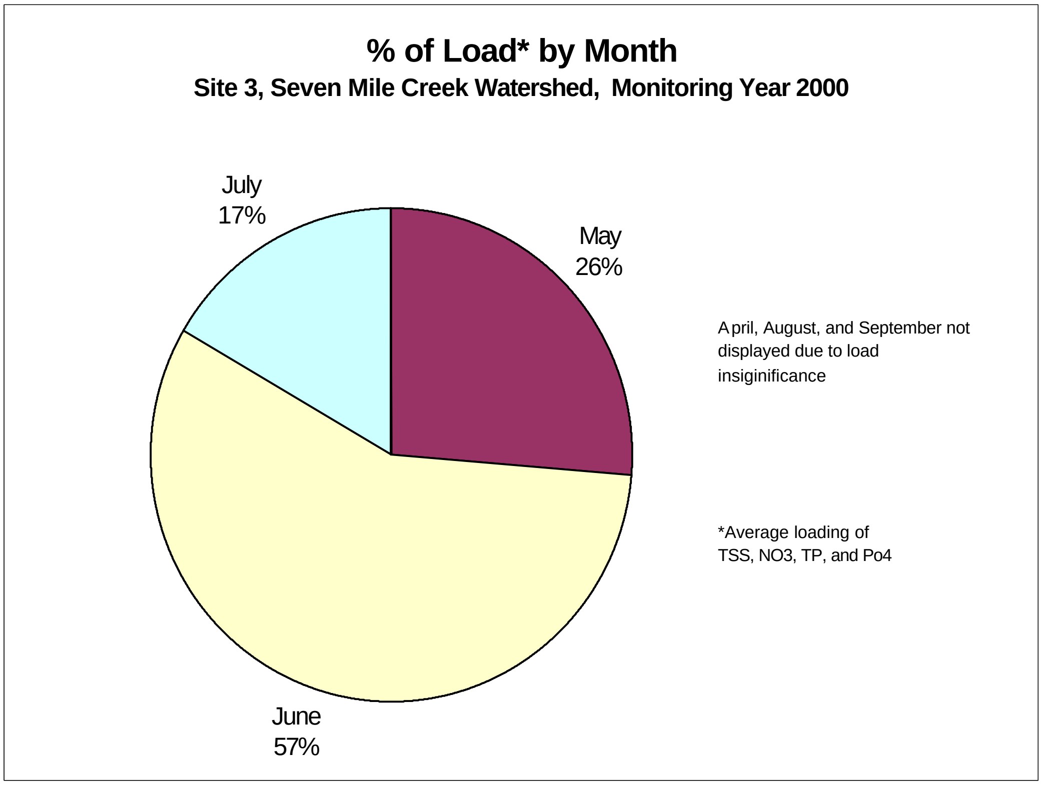
Average FWMC for the watershed were 0.340 mg/l for TP and 0.239 for ortho-phosphorus. About 60-70% of the total was found to be in the dissolved reactive form. It appears that watershed 1 and watershed 2 had virtually the same concentrations. These concentrations are adding to the MN River. Average concentrations on the MN River are 0.230 mg/l. The watershed loads approximately 0.156 lbs/acre/inch of runoff for total phosphorus and 0.056 lbs/acre/inch of runoff of ortho-phosphorus or 0.912 and 0.624 pounds per acre respectfully.

Nitrates

Nitrates are considered excessively high for this size of watershed. It confirms other watershed studies around the Midwest that small watersheds can be significant loaders of nitrates in agricultural environments. An average concentration of 14 mg/l was found for the watershed. Watershed 1 appears to have the highest concentrations with 18 mg/l compared to watershed 2 with 15 mg/l. Seven Mile Creek yielded approximately 3.2 pounds per acre/inch of runoff (27 pounds/acre or 318 tons) to the MN River during the growing season. These high numbers of nitrate nitrogen indicate virtually no de-nitrification is occurring within the watershed and surpluses of nitrogen are in excess of what plants need within the watershed.

Time Series

The majority of nutrient and sediment load came during the months with the most rainfall and snowmelt occurred. This information is utilized when considering remediation methods. By far the majority of sediment, phosphorus and nitrates are delivered to the MN River by Seven Mile Creek in just three months. Those months are typically April, May and June. BMPs that address these months should be utilized. In 2000, about 60% of the pollutants measured, entered the MN River in May, June, and July. In 2001, over 70% of the pollutants measured occurred in April. This is much more representative of pollutant loading in Seven Mile Creek since 2000 had virtually no snow melt.



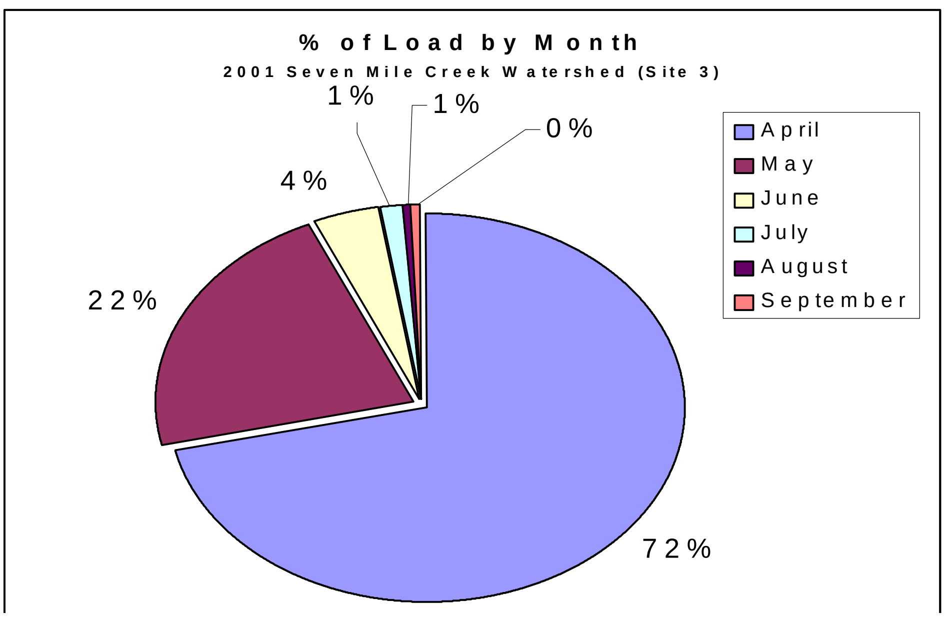


Figure 20. Percent of pollutant load by month for the 2000 and 2001 growing seasons.

Loading Rates vs. Monitoring Year

Appreciable differences in yield exist between monitoring years. Figures 20-22 show the differences in loading rates between various parameters in 2000 and 2001. These figures further demonstrate of many years worth of monitoring over various climatic conditions to get a true representation of the water quality at a watershed scale. Overall during the monitoring period of Seven Mile Creek, an average to below average runoff year was monitored in 2000, and an above average runoff year was monitored in 2001 due to heavy snowmelt conditions. The combination of both monitoring years is a better representative of the water quality within the watershed. In general, yield is directly correlated with concentration for all parameters except nitrogen. In 2001, No_3 has an inverse relation. This can be explained by dilutional processes. Higher flows in 2001 are in effect diluting the No_3.

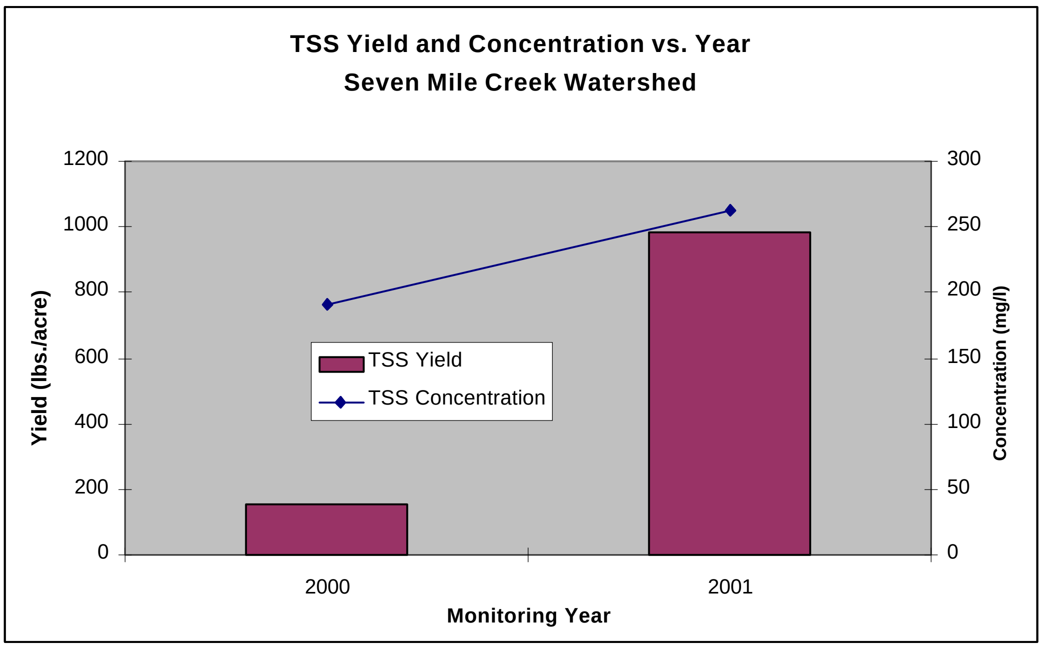


Figure 21. TSS vs. monitoring year.

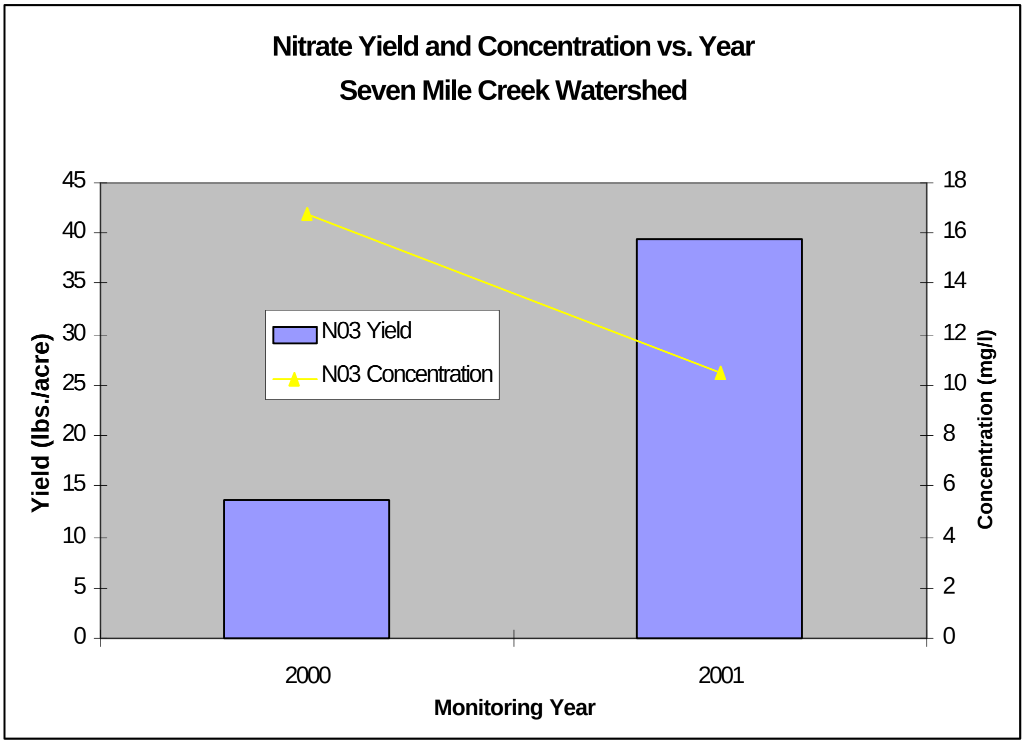


Figure 22. Nitrate vs. monitoring year.

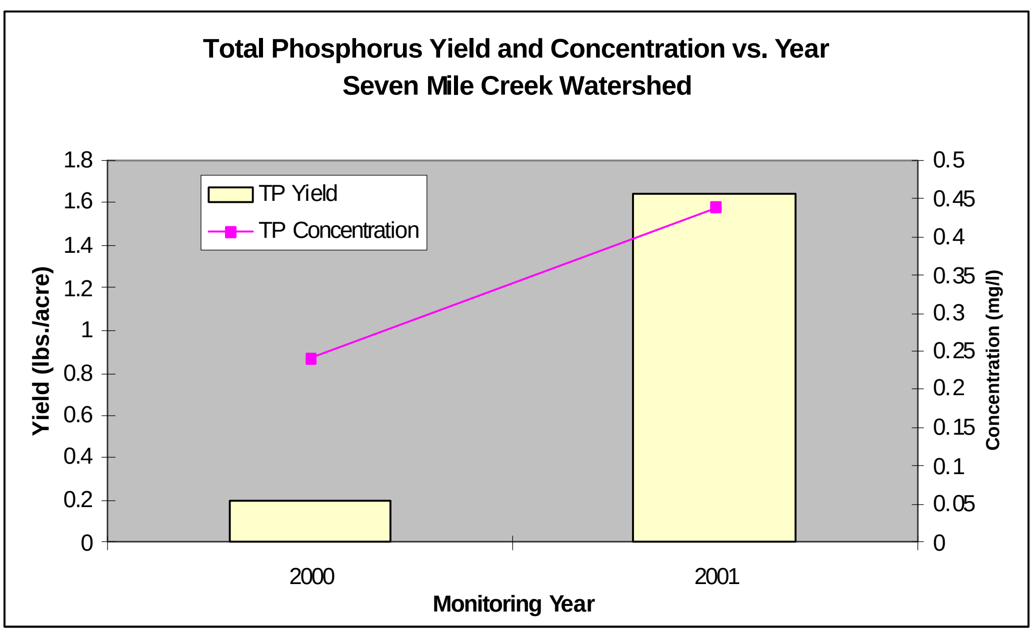


Figure 23. Total phosphorus vs. monitoring year.

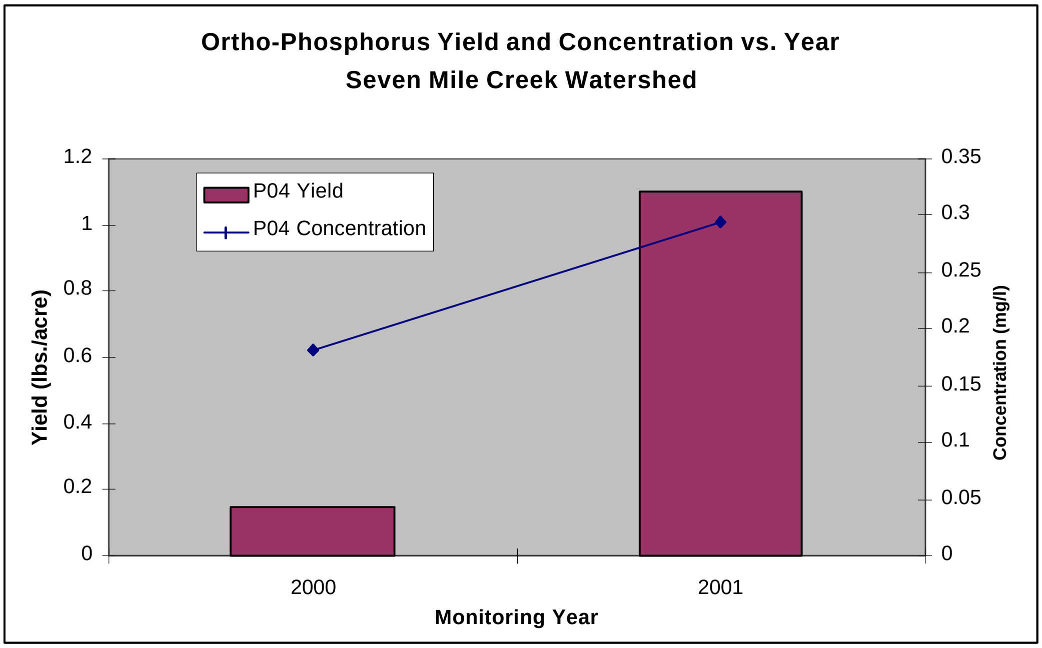


Figure 24. Ortho-phosphorus vs. monitoring year.

2000 Watershed Comparisons

This section of the report presents results from many of the current monitoring projects in the Basin. Graphics are set up to allow comparative review of the data and are organized from upstream to downstream locations along the Minnesota River. Data were collected and compiled by the respective monitoring organizations. Data were organized by Department of Agriculture and Met Council Field office staff.

Like SMC, several other watersheds have performed water quality studies either through Clean Water Partnerships or other similar programs. To understand how the SMC ranks with other watersheds, data from those projects were included in this report for comparative purposes. Watershed technicians, engineers and CWP staff affiliated with the projects, submitted the yield data in 2000. Methods, monitoring season, and approaches for calculating yields are assumed to be similar and/or identical to the SMC. Values shown (figures 25-27) below represent the normalized yield and Flow Weighted Mean Concentrations at the mouth of the watershed for 2000 during April- Sept.

When comparing Seven Mile Creek with other watersheds, yields are further reduced by dividing them by the number of inches of runoff for the respective watershed, giving a "normalized yield". As such, when yields are normalized one must keep in mind the geographic differences in precipitation and runoff.

As can be seen from the following graphs, Seven Mile is a "heavy loader" of nitrates for its size. When compared with other watersheds nitrate yields and concentrations really stand out. Figure 29 presents results for NO3-N yield for the reporting tributaries and main stem sites. Figure 30 also reports the growing season runoff value in inches for the year 2000. The Le Sueur River had the highest yield at 16.99 lbs./acre. Seven Mile Creek had the next highest estimated yield at 13.03 lbs./acre. Inspection of the runoff data presented in figure 30 indicates that Seven Mile Creek had approximately the same amount of runoff as did the Blue Earth River, but over twice the yield.

Normalized yields for nitrates are shown in figure 29. Seven Mile Creek results clearly standout with respect to normalized yield at 3.84 lbs./acre/inch of runoff. Watershed size and subsurface drainage pathway are suspected to be the main reason for high levels of nitrates. In Seven Mile, nitrogen applied from fields has a much more direct pathway from the soil profile –to the sub-surface drainage—to the ditches and eventually the creek. In other watersheds, dilution and natural de-nitrification processes during transport through the watersheds take effect, thereby reducing nitrogen overall effect on the MN River.

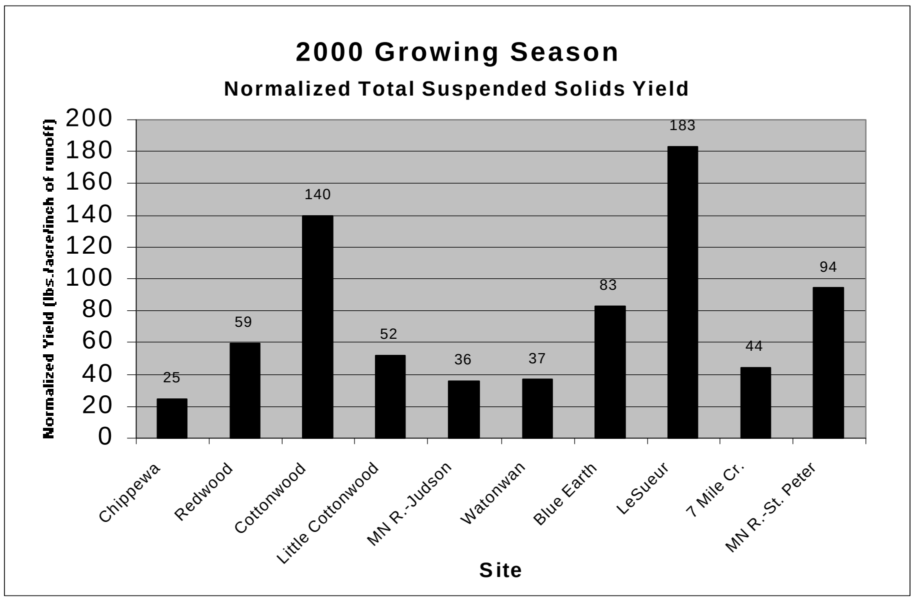


Figure 25. TSS yield comparison.

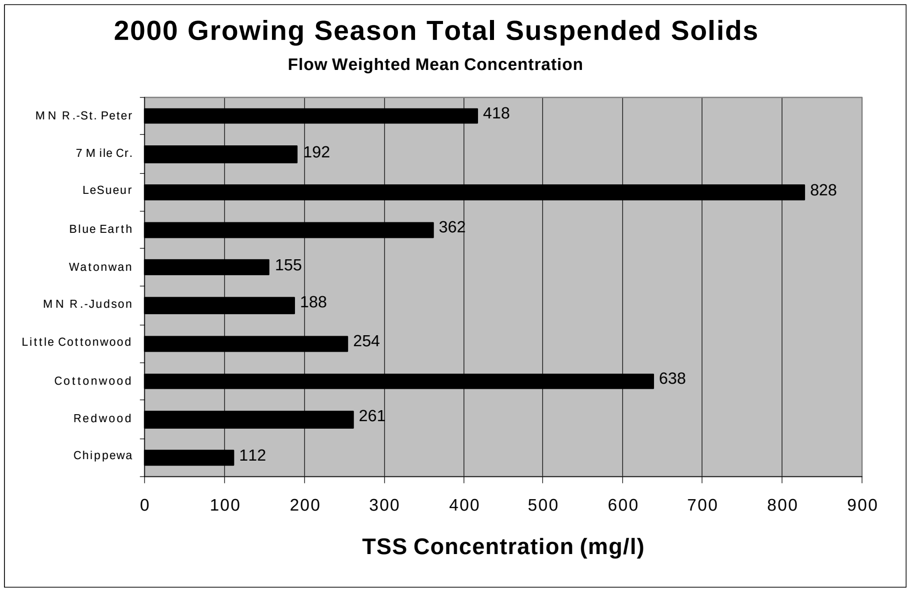


Figure 26. TSS concentration comparison.

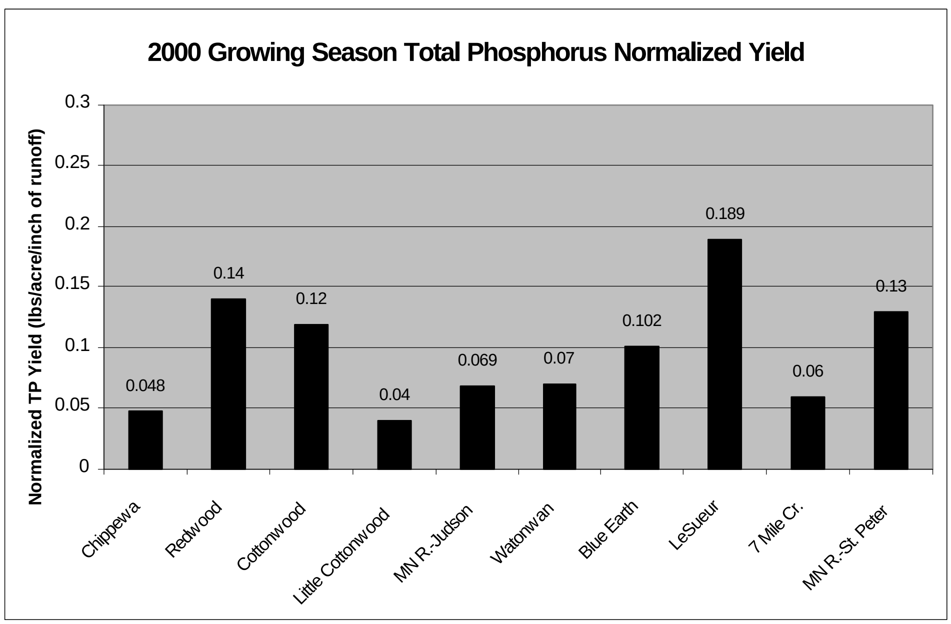


Figure 27. Total phosphorus normalized yield for 2000.

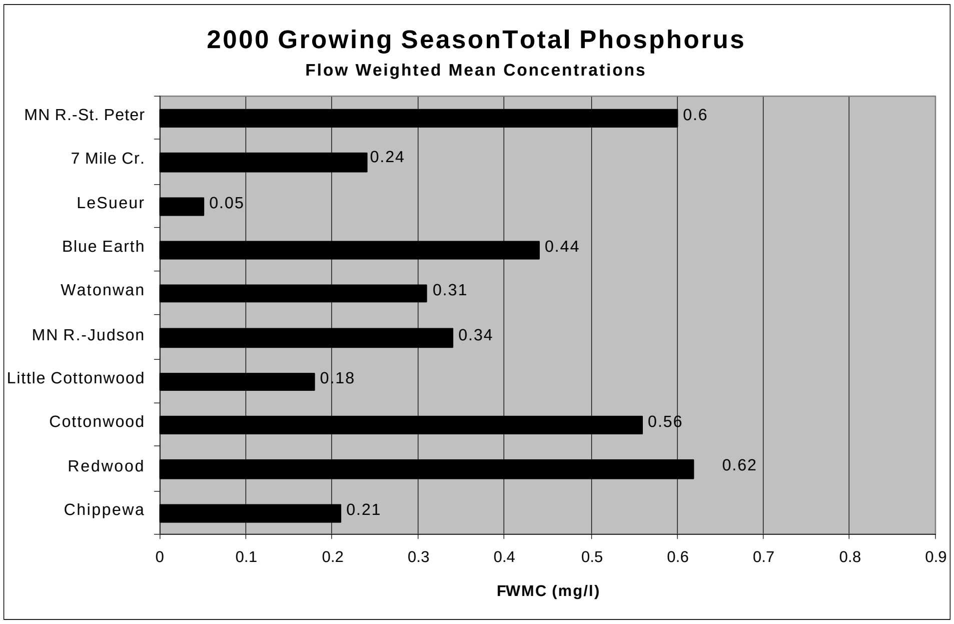


Figure 28. Total Phosphorus for 2000.

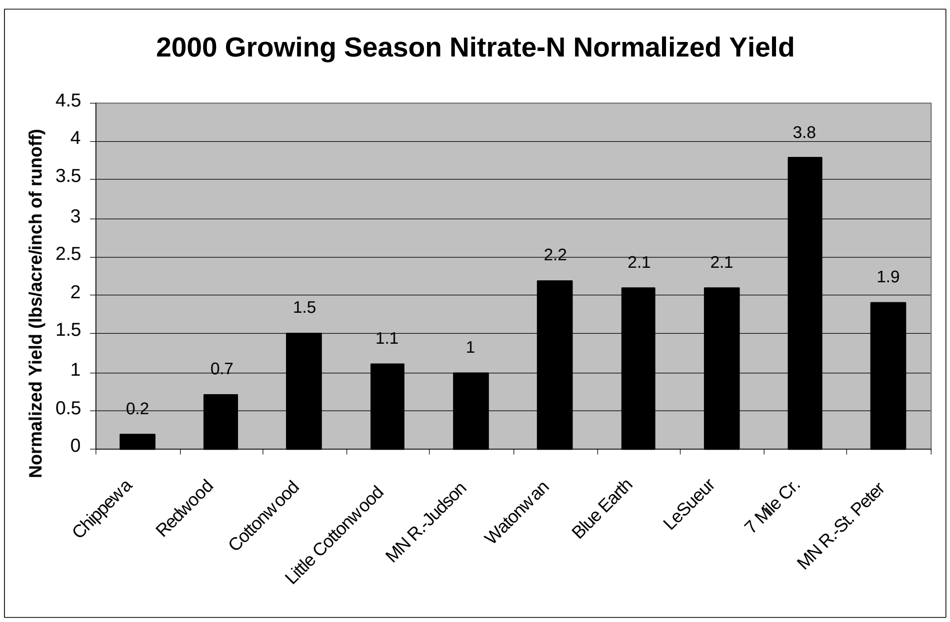


Figure 29. Normalized yield for nitrate nitrogen for 2000.

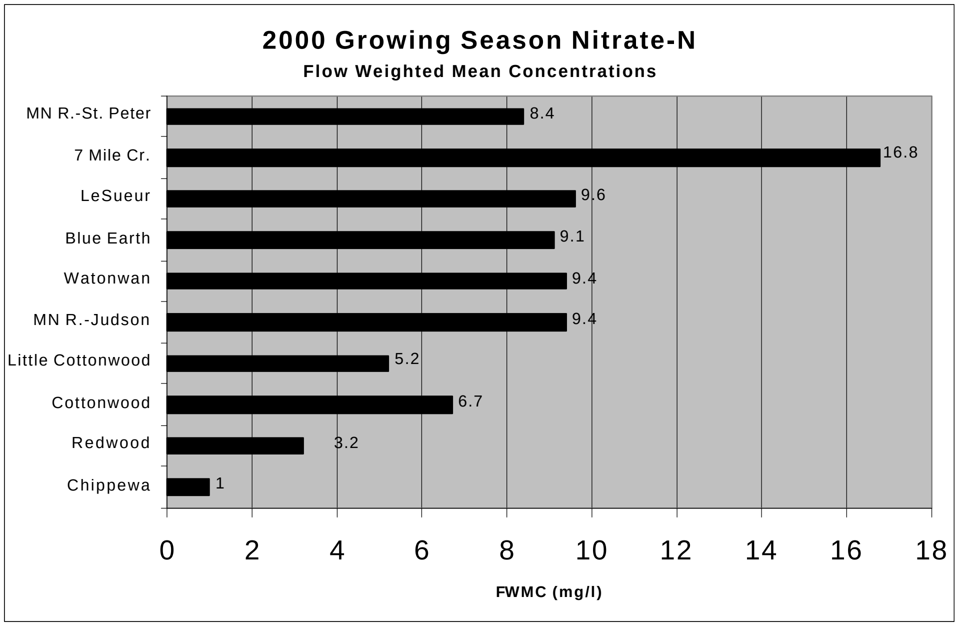


Figure 30. NO3-N comparison.

TSS vs. Transparency Tube Readings

Information adopted from MPCA 1998 report on water quality of MN streams[4]

The transparency tube was developed in Australia as a tool for measuring stream water clarity, which serves as a basic indicator of water quality. The tube is 2 feet long X 1.5 inch diameter, made of clear plastic, and has a release valve at the bottom. A stopper inserted at one end of the tube is painted black and white so that when you look down into the tube a distinct symbol is visible at the bottom. To measure water clarity, the tube is filled with water collected from a stream or river. Looking down into the tube, water is released through the valve until the black and white symbol is visible. The depth of the water when the symbol becomes visible is recorded in centimeters, which are marked on the side of the tube. If the symbol is visible when the tube is full, the transparency is "> than 60" cm. A greater transparency reading in centimeters reflects higher water quality.

In various studies conducted by the MPCA on Minnesota streams it was found that transparency and total suspended solids were interrelated. Based on preliminary work conducted during 1997, MPCA staff identified significant relationships between transparency tube measurements, TSS, and turbidity. These relationships are reflected by the high correlation coefficients (R^2) between transparency tube readings and TSS (r^2=0.75) and turbidity (r^2=0.86). Correlation coefficients provide a numerical measure of the strength of relationship between two factors. The significant relationships described above suggest the potential to predict stream TSS or turbidity based on transparency tube measurements. Understanding the interaction among transparency, TSS, and turbidity could provide a

[4] 1998 Report on the Water Quality of Minnesota Streams, MPCA, Environmental Outcomes Division December 1999.

basis for characterizing the health of a stream relative to existing water quality standards, such as the 25 NTU turbidity standard; or by comparisons to ecoregion "yardsticks" as compiled from reference streams (table 15, chapter 3). For example, TSS in the 10-60 mg/l is typical for streams in the WCBP eco-region. In terms of transparency, this corresponds to measurements in the 45 to 15 cm range for the WCBP.

TSS vs. Transparency Specific to SMC

Similar to MCPA methods of correlating TSS with T-tube readings, a correlation was conducted using data specific to the SMC. The T-tube readings were correlated with TSS lab results. Figure 31 represents the results of the correlation. 67 T-tube readings were utilized in the correlation. The r^2 value or tightness of fit, of 0.81 shows a very good correlation between TSS lab readings and in field transparency readings. The average t-tube reading of 36 cm was found during the two year study. A river specific relationship between TSS and transparency is of great value to the project since the simple and quick T-tube test could be substituted for more expensive TSS laboratory procedures in the future. It also increases the value of watershed volunteers using T-tubes, water quality awareness, and refinements to BMP implementation.

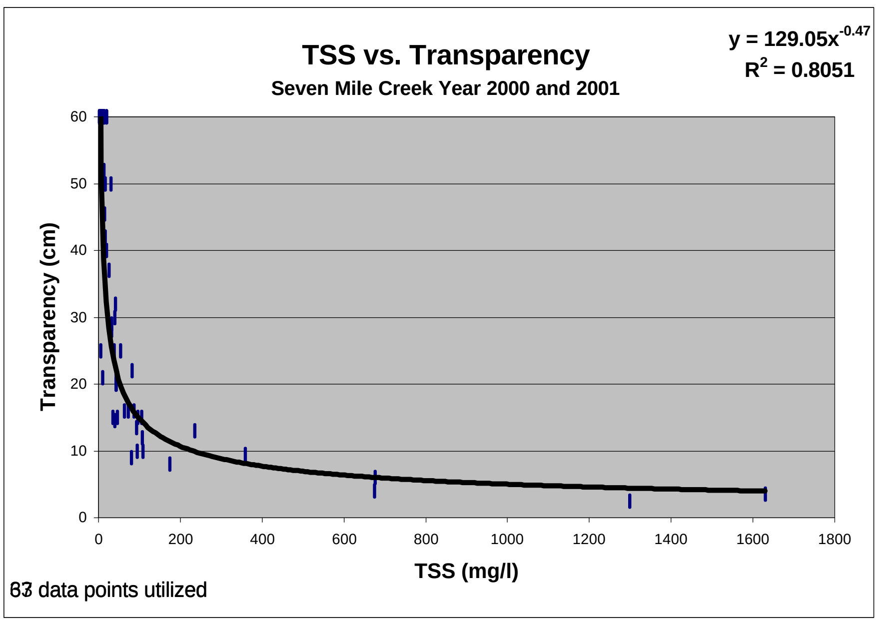


Figure 31. TSS and transparency relationship for Seven Mile.

2001 Conservation Tillage Survey Results

Every spring since 1995, local government staff in Minnesota's agricultural counties have driven along a designated route to build an annual record of crops grown, tillage type, and surface residue remaining after planting. In the spring of 2001 Kevin Ostermann of the Nicollet county Soil and Water Conservation District and Kevin Kuehner of BNC Water Board conducted a similar survey in the Seven Mile Creek Watershed. Results of the data have numerous uses. Some of the uses include: help in the targeting, prioritizing, and promotion of conservation tillage, general agricultural practices and helps managers refine

“C” factors for use in the Revised Universal Soil Loss Equation. The data also enables conservation staff to monitor outcomes from tillage programs, and recognize the success or failure of agricultural producers meeting crop residue targets.

What was surveyed

• Present Crop/T Level	• Percent slope/Slope Length
• Previous Crop/K factor	• P-Factor/Drainage Outlet
• Tillage System/Residue Cover	• Ephemeral Erosion

How the watershed was surveyed

The route in Seven Mile Creek watershed was designed as grid that equally represents all cultivated areas. Conservation tillage survey staff stopped every half mile to record field conditions to the left and right of the road. The transect survey route covered over 60 miles and surveyed approximately 60% of the cultivated land within the watershed utilizing 311 survey points. Some data points were not utilized in the analysis since some fields were not planted. With over 300 field observations in the watershed, the data represents a statistical average of the entire cropland area. This tillage transect survey procedure was developed by the Department of Agronomy at Purdue University and transferred to staff in MN by the Board of Water and Soil Resources.

The results are entered on forms that are scanned into a computer program that aids in summarizing the data. The data point locations and attributes were then transferred into GIS database which can be seen below. Each data point is associated with its field, slope length, and steepness and other USLE based erosion information. Since field information is not available from the Farm Services Agency in digital format, parcel information was used as a field boundaries.

Trends in crop residue management are summarized using a method that calculates the percent of fields in the corn-soybean rotation that meet crop residue targets. It is computed as the average of the percent of corn acres planted into >15% residue, and the percent of soybean acres planted into >30% residue. The amount of residue left on the surface depends on many factors, most importantly opportunity to till (based on weather conditions) and intent to maintain residue.

Map 30 shows the survey route with survey points and the results of the survey can be found in table 31.

Results

It was estimated that approximately 65% of the fields surveyed in the spring of 2001 were meeting residue targets, while 35% of the fields were below residue targets. A majority of the fields that were not meeting conservation tillage targets were fields that were planted with soybeans the previous year. Of the 20,000 cultivated acres, corn and soybeans accounted for 99% of the crops planted and about 96% of the fields were in a corn and soybean rotation within the watershed. Around 53% of the fields were planted with beans, 46% corn and the remainder in peas or hay.

The conservation tillage survey of 2001 showed a majority of the producers are utilizing conservation tillage. However the results need to be checked every year to verify residue levels. It is hoped that new technologies such as satellite imagery can be used to further the knowledge and accuracy of tillage levels on a minor watershed scale. This could save large amounts of time and money. Currently, the use of satellite imagery is being looked at as a possible tool by the BNC Water Board, BWSR, NASA and other conservation agencies within Minnesota.

A possible best management practice that can still be promoted is "no-fall tillage of soybean ground" or "one pass cultivation." Another potential BMP is strip tillage. Since no till is not feasible for this area (soil temperature concerns and wet soil conditions limit its use) however strip tillage is thought to be a viable alternative. It was found that those fields where the previous crop were soybeans, conservation tillage levels dropped to <10% residue. Soybean ground is typically more conducive to water and wind erosion anyway so this potential BMP could prevent accelerated soil erosion due to agricultural practices.

Conservation Tillage: Leaving last year's crop residue before and during planting operations provides cover for the soil at a critical time of the year. The residue is left on the surface by reducing tillage operations and turning the soil less. Pieces of crop residue shield soil particles from rain and wind until plants can produce a protective canopy. Crop residue management includes no-till, muclh till, ridge till and strip till.

Conservation Tillage Defined: Any tillage and planting system that covers 30 percent or more of the soil surface with crop residue, after planting, to reduce soil erosion by water.

In the Seven Mile watershed conservation tillage analysis, where previous crop was soybeans at least 15% residue must be maintained and when previous crop is corn at least 30% must be maintained.

Seven Mile Creek Watershed, Nicollet County, Tillage Transect Survey Results
Completed by: Kevin Kuehner and Kevin Osterman, May 30, 2001

Number of Sample Points	168
Number of Sample Points Utilized	156

Estimated cultivated acres surveyed in watershed(based on parcels)	11974
Estimated acres of cultivated land in watershed	20181

% of area surveyed	59

Residue	Fields	%
0-15%	37	23.72
16-30%	64	41.03
31-50%	44	28.21
51-75%	11	7.05

	%
% of fields surveyed **out** of conservation tillage*	35
% of fields surveyed **in** conservation tillage*	65

2001 Crop	Fields	%
Beans	85	52.80
Corn	74	45.96
Hay	2	1.24

2000 Crop	Fields	%
Beans	76	48.72
Corn	82	52.56
Other	3	1.92

Number of fields following corn soybean rotation	149
% of fields following corn/soybean rotation	95.51

Tillage	Acres
High	4535
Moderate	5380
Low	3253

C Factor

Corn Year (Previous Crop=Soybeans)

% of fields in conservation tillage	71.23

	Residue	*Fields*	*% Area*	*Area*	*C Factor*	*Area Weighted*
	0-15%	21	29	0.29	0.21	0.060410959
	16-30%	46	63	0.63	0.14	0.088219178
	>30%	6	8	0.08	0.13	0.010684932
Total		73	100			0.159315068

C Factor 0.16

Bean Year (Previous Crop=Corn)

% of fields in conservation tillage	59.04

	Residue	*Fields*	*% Area*	*Area*	*C Factor*	*Area Weighted*
	0-15%	16	19	0.19	0.15	0.028915663
	16-30%	18	22	0.22	0.11	0.023855422
	>30%	49	59	0.59	0.07	0.041325301
Total		83	100			0.094096386

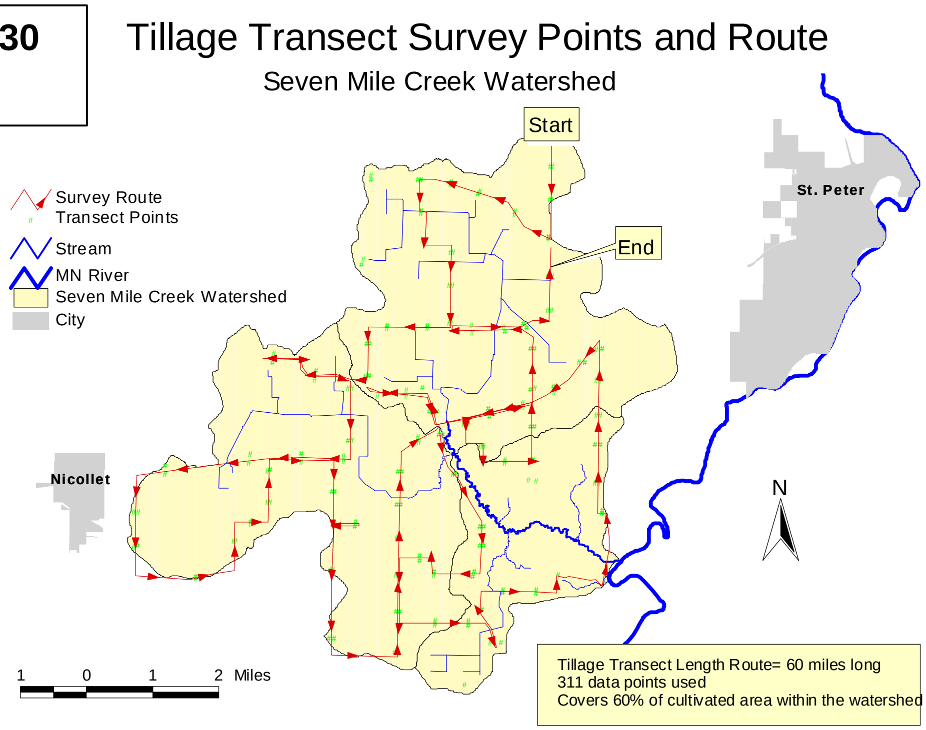
C Factor 0.09

**Average C factor for cultivated land in Seven Mile Watershed (.09+.16/2) 0.13

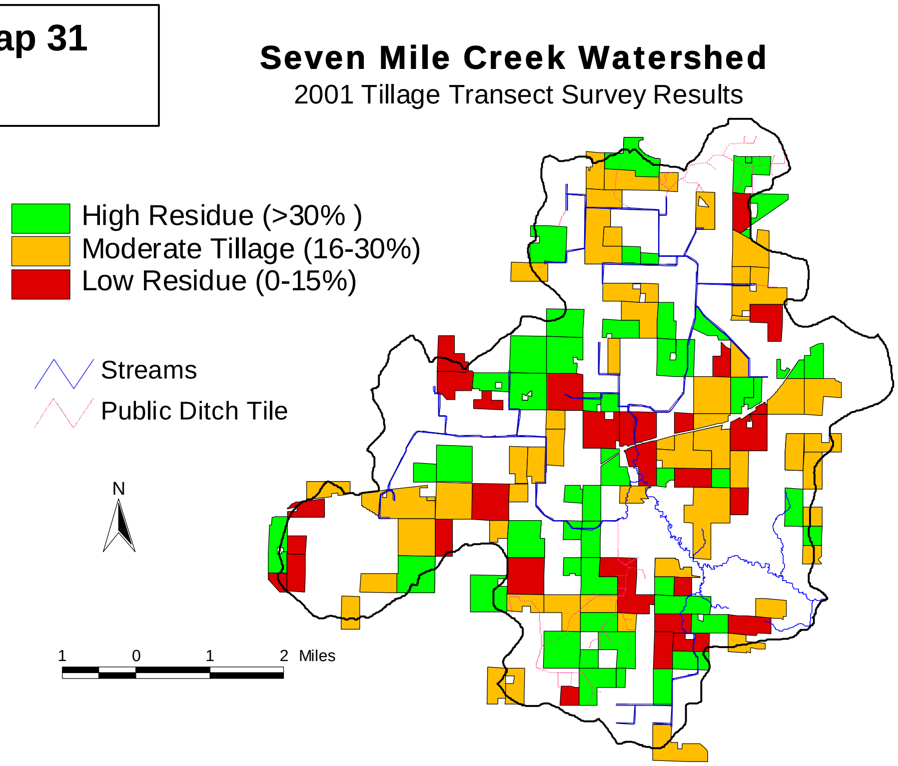
*"in conservation tillage"=computed as the average of the percent of corn acres planted into >15% residue, and the percent of soybean acres planted into >30% residue.
**C factor values taken from RUSLE 1.5 and 1997 USDA-NRCS-MN Technical Guide, Sec. I-C
Assumed yield level High, corn/soybean rotation, fall and spring mulch till, Table 4H

Table 31. Tillage transect survey results.

Map 30


Tillage Transect Survey Points and Route
Seven Mile Creek Watershed
Start
End
Survey Route
Transect Points
Stream
MN River
Seven Mile Creek Watershed
City
St. Peter
Nicollet
N
1 0 1 2 Miles
Tillage Transect Length Route= 60 miles long
311 data points used
Covers 60% of cultivated area within the watershed

Map 31


Seven Mile Creek Watershed
2001 Tillage Transect Survey Results
High Residue (>30%)
Moderate Tillage (16-30%)
Low Residue (0-15%)
Streams
Public Ditch Tile
N
1 0 1 2 Miles

2001 Watershed Inventories and Open Tile Intake Survey Results

Adequate soil drainage is an important consideration for profitable corn and soybean production on many Minnesota landscapes and soils. Internal soil drainage can be enhanced by using subsurface pattern tiling. In depressional areas with no surface drainage pathway, inlets to underground tile are often used to conduct water off the field. There has been some concern that this provides a direct pathway for pollutants associated with surface runoff to enter Seven Mile Creek. Research by University of Minnesota Scientists have found that on average about 20% of the sediment and particulate phosphorus is delivered to open surface inlets within the depressional areas of fields during rain storms[5]. Realizing the potential impact of open tile intakes on water quality within the watershed a road survey was conducted to survey the number of open tile intakes per square mile and the average open intake watershed acreage. Jim Klang of the MPCA and Kevin Kuehner of BNC Water Board conducted the survey in each of the three minor watersheds in late May of 2001. Results of the survey were used as an input value for the sediment and Phosphorus delivery modeling using RUSLE and CREAMs. In addition, replacement costs were also estimated.

Results of the survey indicated that there are about 9 intakes per square mile on cultivated acres within the watershed with an average drainage area of 10 acres in size. It is estimated that approximately 300 open intakes exist within the watershed. Research is showing from Carver County that replacing open intakes with gravel inlets will reduce sediment that is delivered to the inlets by about 50% and particulate phosphorus by about 60%. The average cost of replacement is around $200/inlet. If all open inlets were replaced it would cost around $60,000. Normally 75% would be cost-shared under watershed projects so this would result in a total cost to the watershed of $45,000.

While conducting the open intake survey other inventories were taken at the same time.

- Stream Bank Erosion Survey. Length, width, height and recession were measured at various locations within the lower reaches of minorshed 2 and upper reaches of minorshed 3. Recession was estimated by looking at the exposed root structure of trees. Diameter and tree species was noted. Based on the tree size diameter age was determined (Mankato DNR Forestry Tables), and therefore bank erosion recession was estimated. Total volume was computed from stream bank erosion site measurements. An average of 75 lbs/cubic feet of soil was used for mass calculations of bank erosion volumes. Stream bank erosion values were used for sediment delivery modeling.

    - Lower reach of CD 46a

- Stream Bank Erosion and County Ditch Total Phosphorus Soil Tests. Various stream bank erosion sites were sampled within the watersheds. Topsoil samples were composited for each of the three minors and sub-soil samples were composited for each of the minors. MVTL labs in Mankato tested the soil samples. Results were integrated into phosphorus delivery modeling.

- Wet cultivated areas-potential wetland restoration/construction sites

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[5] 2000. Evaluation of the Impact on Runoff Losses and Profitability by replacing Open Surface Tile Inlets with Gravel Inlets. John Moncrief, Andry Ranaivoson.

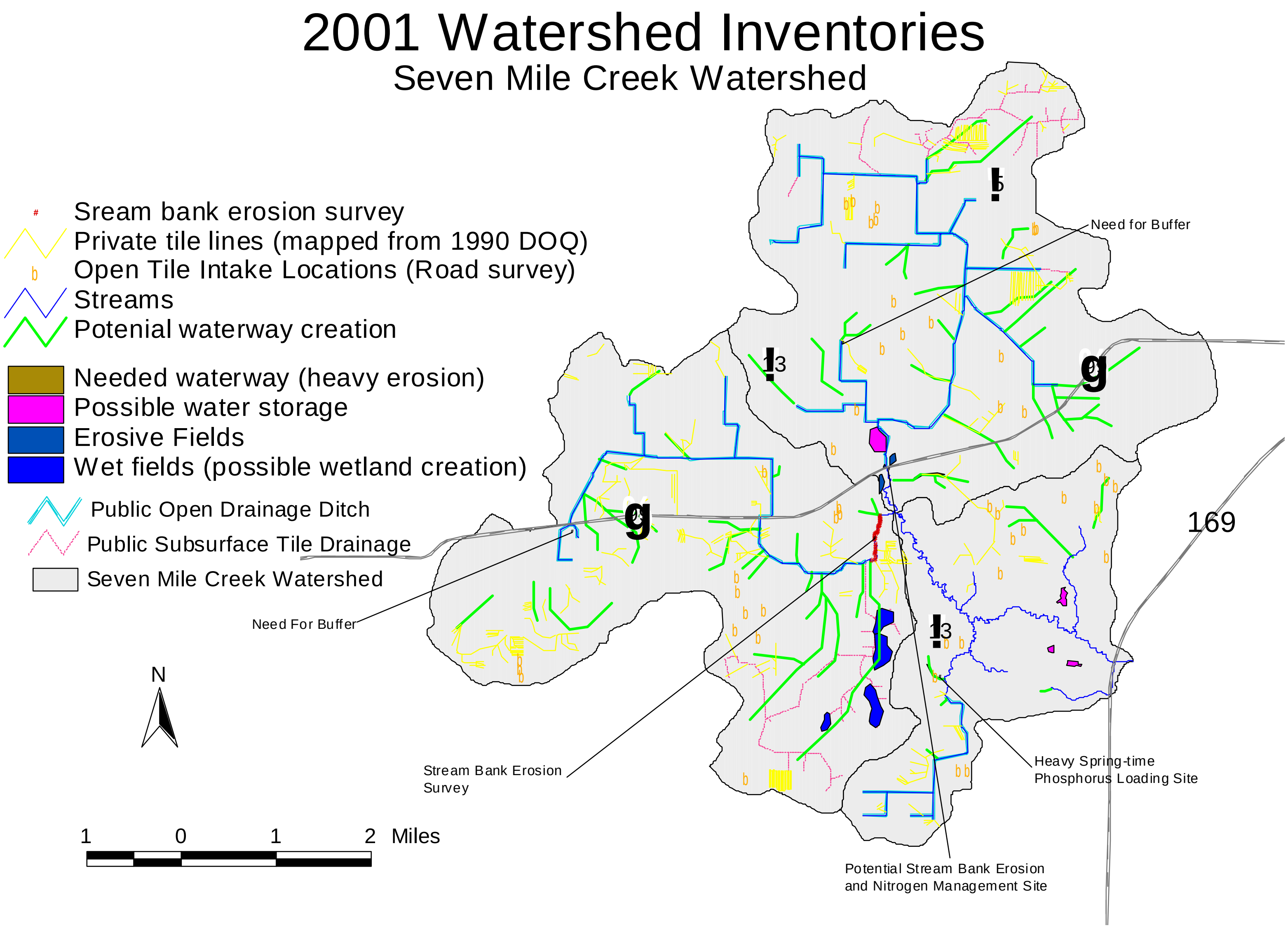
- Private Tile Lines (assessed from 1990 DOQ air photos)
- Potential Waterway Locations (1990 DOQ and 30 Meter USGS DEMs)

Results of the survey can be seen on map 32.

Open Intakes	9 open intakes/per square mile
Stream Bank Erosion Site (county road 13, lower reach of County Ditch 46a	Estimated at 256 tons/year/10year recession period (high end)
Stream Bank Erosion Soil Tests	Average of 1.0 lbs./ton of soil for stream bank erosion sites, 1.25 lbs./ton of soil for upland areas near stream bank erosion site

Photo11. Stream bank erosion soil samples.

Photo12. Stream bank erosion site.


2001 Watershed Inventories
Seven Mile Creek Watershed
Sream bank erosion survey
Private tile lines (mapped from 1990 DOQ)
Open Tile Intake Locations (Road survey)
Streams
Potenial waterway creation
Needed waterway (heavy erosion)
Possible water storage
Erosive Fields
Wet fields (possible wetland creation)
Public Open Drainage Ditch
Public Subsurface Tile Drainage
Seven Mile Creek Watershed
Need For Buffer
Need for Buffer
N
1 0 1 2 Miles
Stream Bank Erosion Survey
Heavy Spring-time Phosphorus Loading Site
Potential Stream Bank Erosion and Nitrogen Management Site
169

Chapter 6 Sediment and Nutrient Modeling

Sediment and Phosphorus

By Jim Klang– MPCA

Kevin Kuehner– BNC Water Board

Introduction

The watershed restoration management process has traditionally attempted to gather water quality and quantity information to compare with land use information for selection of restoration efforts. Many tools are utilized to help assist watershed managers characterize the pollution problems and determine strategies which would best remediate the water quality concerns. Some of the tools utilized include the use of a water quality monitoring network, watershed inventories such as the (Tailored Integrated Surface Water Assessment), and Geographic Information System (GIS) database technologies. All of these tools help to gain further understanding of possible Best Management Practices (BMPs), and an understanding of the social, political and economic endorsements or limits that exist. Furthermore, analysis models, communication tools, educational materials, and financial incentives are employed to ease the transition and provide risk management for selecting changes.

Described in this chapter are two models or tools that were utilized by project staff to aid in the success of a watershed restoration management process in the Seven Mile Creek watershed. The first model describes a new methodology developed by Jim Klang and Kevin Kuehner for modeling sediment and phosphorus sources. This is a very new method and has not been adequately peer reviewed due to application deadline concerns. It is felt this model could be used by many other clean water partnerships at the minor shed level. The write-up describing the process is at times broad and is no way designed to be a detailed methodology; rather it is designed to indicate the general process of conducting the analysis. A more complete report on the approach, methods, and results of the modeling efforts will be available sometime this fall or winter. Through other funding sources, the ADAPT model will be run on Seven Mile Creek watershed as part of a USDA paired watershed study. This could provide a unique opportunity to see how the two sediment and phosphorus approaches compare and contrast and further the understanding of water quality at a watershed scale.

The second analysis tool described below was used for nitrogen analysis. To better understand nitrogen sources and outputs within the watershed, nitrogen mass balance was conducted. Estimating N budgets for soil-crop systems is a theoretically sound and time-honored approach that has been used for more than 100 years. Like sediment and phosphorus modeling, nitrogen budgets are based on the concept of conservation of mass that simply states that the inputs into a particular ecosystem less the N outputs must be equal to the change of N stored within the ecosystem.

The following is an example of how Seven Mile Creek watershed managers attempted to answer water quality questions using an innovative, simplified, and cost effective modeling approach.

The GIS-based methodology described was developed to advance the understanding of land use impacts in an affordable and practical way within Seven Mile Creek. Keeping in mind the relationship between resources (i.e. staff and financial capital) and accuracy is often linear, this model and information protocol are intended to improve the effectiveness of targeted investment dollars and staff time while achieving a higher quality output for land use assessments. This process has been tested in Seven Mile Creek watershed (a relatively homogenous agricultural watershed) with good success, and may be applied to other similar watersheds with slight changes to the methodology.

This methodology provides land use analysis by a logic process that combines ground-truthed watershed inventories with information from GIS coverages to explain sub watersheds and/or source types and loadings. The fore mentioned information is combined with current Minnesota research and principles of more complex models. The data is organized, calculated and analyzed in an Excel spreadsheet. Besides the benefits of the end results, the information gathering process develops a local and tailored understanding of the unique watershed and ultimately a more affordable process.

As hinted to above, this methodology's accuracy improves with more investment like any other analysis tool. Likewise, if extreme weather events dominate the watershed data, the annual average estimations of RUSLE[1] (the primary sheet erosion estimator) will be less applicable. Therefore, when this methodology is used for targeting implementation program dollars, care should be given to compare only relative size of source contributions and not to take the resulting number as absolute. Once BMP programs have been selected and a watershed manager is evaluating a particular site within a project, this same methodology can assist with determining reductions in watershed loading again by using relative size of contributions and not ignoring the averaging that takes place when estimating delivery ratios.

Advantages of the Model

- Helps identify the significance of bank erosion contributions to watersheds.
- Ideal for Clean Water Partnership Phase I watershed projects.
- Relatively cheap and cost effective. In the MN River Basin, most watershed managers already have access to GIS layers, tillage transect surveys, and other tools needed for the analysis. It is estimated that the entire process was completed at a cost of $10,500 (2 people @ 15 hours a week for three months or approximately 400 hours @ 25$/hour). Other costs: $500 (travel, soil tests, etc.).
- Ease of use. Utilizes a widely used and accepted soil erosion prediction tool (RUSLE).

- Results correlate with university research conclusions.

- Multi-faceted and holistic approach. Integrates current and localized research literature, field surveys, water quality data (loading estimates), and GIS into one tool for refining watershed management decisions. Information can be plugged into spreadsheet.

- Water quality and education promotion. Help watershed managers convey water quality data into an easy to understand format. Allows for discussion points at public meetings. Helps landowners understand the importance of the implementation plan and potential positive outcomes.

- Allows manager to target BMPs and set realistic goals.

- Allows watershed manager to get into the watershed through inventories thereby connecting the person with the data.

Model Disadvantages

- Works best on smaller scale where staff have the time and resources to inventory. Larger watersheds could be assessed.

- The minor watersheds must be homogenous in nature.

- Moderate margin of error. Model is not meant to quantify but to describe sources and their relative impact on the watershed.

- Model has spring runoff limitations. RUSLE is used mainly as a summertime erosion runoff model and therefore does not work well when there are heavy spring snowmelt conditions.

- Must have at least one or two year's worth of water quality of data before analysis can be run.

- Sources of pollution coming from cities or bank erosion may skew the sediment and phosphorus mass balance.

Inputs

- GIS databases (i.e. soils and land use)

- Tile intake survey

- Non-complying septics inventory

- Conservation tillage survey (for C factor adjustments)

- Stream bank erosion survey on targeted areas

- **C**hemicals, **R**unoff, and **E**rosion from **A**gricultural **M**anagement **S**ystems (CREAMS), phosphorus enrichment algorithm

- **R**evised **U**niversal **S**oil **L**oss **E**quation (RUSLE), rainfall soil erosion prediction model

Outputs

- Relative contributions of pollutants and their respective surface water loading pathways

Approach and methods

Water quality loads from the FLUX program were used to balance sediment values derived from the RUSLE program. Excel spreadsheets were used to evaluate the data. The monitoring and FLUX model runs are enhanced by a Geographic Information System (GIS) spatial analysis database. The GIS tool allowed averaging/estimating of small diverse soil erosion contributions to be combined with information and inventoried larger "point source" type loadings. The results are a holistic look at the watershed. The principles are to use current literature for sediment erosion, nutrient enrichment and delivery ratios, and inventories of bank erosion, septic tanks (and conditions) to source partition the non-point source loads for better understanding of how to target the BMPs in the implementation phase.

An acknowledgement that differences exist even in research due to climate changes, soil types, slopes, geomorphology of the watershed and cropping techniques is paramount. To overcome these dynamic changes and differences, from site to site, a few key assumptions are made:

- Seven Mile watershed, subdivided into three watersheds, has zones in each subwatershed with like characteristics.

- Since a water quality monitoring year is based on six months (April-Sept.) and RUSLE (tons of soil loss/acre/year) is based on a 30-year annual average, RUSLE needs to be normalized for the monitoring year. To normalize, we took the watershed runoff value for 2000 growing season and divided it by the 30-year average runoff value for this area, which is published by the MDNR. Another way to normalize for differences in time scale is to divide watershed monitoring year precipitation by 30-year average precipitation levels found at St. Peter.

- A "Delivery Ratio" will be defined as not just the ratio of sediment delivered as compared to the sediment eroded, but also includes a correction factor for other assumptions on normalizing yearly rainfall averages and variations in rainfall intensity.

- To proceed carefully–the modeler must make judgments in the first watershed and check/confirm them in the second watershed prior to proceeding on with the assumed "Delivery Ratios."

- For phosphorus projections, it was assumed that non-complying septics are connected to tile lines and a high-end value was used for total phosphorus concentrations.

This model combines soil and land use information with the **R**evised **U**niversal **S**oil **L**oss **E**quation (RUSLE) developed by the USDA-NRCS, and the **C**hemicals, **R**unoff, and **E**rosion from **A**gricultural **M**anagement **S**ystems (CREAMS) sediment-attached phosphorus algorithms to balance soil and nutrient loading from the FLUX pollutant loads. 2000 pollutant loads were used in the analysis. By comparing the FLUX results as the mass of sediment or phosphorus that must be balanced, the RUSLE results are first adjusted from a long-term annual average to better reflect the precipitation that occurred in the monitoring period. (In this particular analysis we took the runoff value from the watershed in 2000 and divided that by the 30-year average runoff value for the area.) Then zones with like runoff characteristics are used in GIS to select the right delivery ratios. In this watershed, the zones are riparian (first 100 feet along ditches and streams), intakes (the depressional areas served by subsurface tile intakes) and the remainder is left in a zone called upland. The zones were delineated with ArcView GIS.

Delivery zones used in sediment modeling:

1. Riparian corridor (100 feet buffer on ditches)
2. Open tile intake basins
3. Upland
4. Bank erosion (subtraction of 1-3 from entire RUSLE value)

Delivery zones used in phosphorus modeling:

1. Riparian corridor (100 feet buffer on ditches)
2. Open tile intake basins
3. Upland
4. Non-complying septics
5. Bank erosion

To determine the riparian zone, the GIS system mapped out the 100 feet perpendicular to the watercourse. For the intake zone, a surface tile intake representative survey was performed in spring prior to crops coming up to determine the number and the size of the area surveyed. This survey was then extrapolated up to represent each specific subwatershed density and the GIS soil map allowed selection of probable soils for intakes to be placed. The remainder of soils in the upland zone was those soils not previously selected by the first two zones.

Using University of Minnesota research to select delivery ratios from 0-20 percent for upland areas outside of a quarter mile, 10 to 40 percent for surface tile intakes, and 50 to 100 percent for soils along watercourses, the first watershed was balanced. The results were then applied to subwatershed 2[1], which contained six tenths of a mile ditch with extreme bank erosion. Using an inventory process to set the minimum range for the bank erosion in subwatershed 2, the determined delivery ratios for subwatershed 1 were applied. (Note: the GIS model would have been improved if the monitoring placement had excluded the bank erosion source that was found at the mouth. This "point source" type load can be solved for if isolated in a paired watershed effort.) After a few feedback loops, the selected delivery ratios to use are:

Riparian zone: 95% delivery ratio

Intake zone: 25% delivery ratio

Upland: 7.5% delivery ratio

This balance is used for sediment and phosphorus projections given in figures 33 and 34.

Through subtraction, bank erosion sources are estimated from each of the three minor watersheds. It was found that bank erosion was very low in the upper two watersheds due to the high concentration of ditch systems. An exception to this was within the lower un-channelized area of watershed 2. Within this area, the bank erosion survey indicated large areas of extensive incising, degradation, slumping, and general bank instability (photo 12, chapter 5). It is estimated that within this quarter of a mile section of riparian corridor in watershed 2, about 50% of the sediment load was attributed to bank erosion. It is estimated that approximately 50% of the sediment load is coming from bank erosion within the entire watershed as well.

Phosphorus

The phosphorus projections operate on a similar principle but take into account nutrient enrichment processes as eroded material advances toward a watercourse. As sediment and attached phosphorus moves through its various pathways to a watercourse, the heavier sands drop out and the lighter clays and silts continue on. These lighter clays and silts are in effect increasing the concentration of phosphorus since these soil particles contain more phosphorus by weight. Therefore, CREAMS provides a projection tool that uses the erosion rate, phosphorus content of the parent soil, and an algorithm to project how much phosphorus is delivered in the sediment attached form from sheet erosion predicted by RUSLE. Bank erosion or gully erosion does not use this process and assumes the phosphorus eroded by channelized water delivers the whole amount in this watershed.

[1] For simplification, minor-watershed 062, 066, and 063 are called watershed 1, 2 and 3 respectfully.

Using the sediment budget, CREAMS algorithm, and the estimate of septic tank discharges in the watershed (table 32) a phosphorus mass budget was put together for subwatersheds 1 and 2. The remaining phosphorus is assumed to be the soluble fraction from agricultural land use. Phosphorus from bank erosion was determined by sampling soils from bank erosion sites and analyzing the total phosphorus content. Results of the soil survey indicated roughly 1.0 lb. of phosphorus per ton of soil and 1.25 pounds/ton of soil in the upper A horizon of the soil profile.

Problems associated with the mass balance assumption for watershed 3

Sediment

Subwatershed 3 is at the mouth of the creek with a fall of 210 feet down through Jordan sandstone features. This geomorphology posed an interesting problem as there is a small loss of water (losing reach) in the channel as it travels from the mouth of watershed 1 and 2 to the monitoring station in subwatershed 3. By checking the hydrograph flows in subwatershed 3 against the hydrograph flows added up in subwaterhsed 1 and 2, it was found that for periods of time, on the tail of the hydrograph during storm events and also during base flow periods, watershed 3 yielded less than 1 and 2. At first glance this is a major concern for sediment, phosphorus and nitrogen projections However, through the following discussions it becomes clear that the overall projection for sediment and phosphorus is likely affected less than 5% by this feature.

In the year 2000 data, the acre-inches of runoff for watershed 1 was 3.84 acre-inches, watershed 2 was 3.62 acre inches, and the total for the entire watershed was 3.53 acre-inches. When using the total acreage for each subwatershed and comparing the acre-inches of runoff for the total acreage of the entire watershed, one finds subwatershed 3 yielded only 2.66 acre-inches of runoff. These figures at first glance seem to reflect the total loss occurring in subwatershed 3, but on closer look 50 to 60 percent of the subwatershed 3 land use is in forest cover. Forest cover yields less runoff then other land uses, so not all of the decrease in the above numbers is attributable to surface water infiltration. If a water budget is calculated with:

3.84 acre-inches across 9956 acres in watershed 1,

3.62 acre-inches across 9120 acres in watershed 2, and

3.53 acre-inches across 4475 acres in watershed 3 (an overly large projected lost flow, hence a conservative estimator for determining error);

then the projected runoff unaccounted for is approximately 3900 acre-inches. This amount at a flow combined with the station's weighted average concentration of 191 mg/l yields approximately 85 tons of underestimated sediment. This value of underestimated projected sediment is less than five-percent of the total watershed yield as determined by Flux.

A significant portion of the sediment load unaccounted for is still carried out of the watershed at different times. The physical processes of riverine systems allow scour and redeposition to occur as needed by the energy present at any one time. With less flow/energy, a riverine system allows sediment to be redeposited to balance the sediment transport capacity. The sediment is stored in the channel bed for: a) long periods, or b) carried out of the watershed at base flow periods (low sediment yields), or c) snow melt periods when erosion on the land may be minimal but flow energy in the channel is high (high sediment yields). Bed load, another transport mechanism has the ability to transport large quantities of sediment and nutrient yields. In addition to water column load there is bed load yield during high flow-high energy periods that can transport small and large bed material in great volumes as bed load. This process carries the sediment through two methods. The first method is as smaller materials as large as small boulders or larger cobblestones bouncing on the bottom. The second is capable of transporting extremely large rocks that end up floating along on a greater mass of moving bed material. When the bed becomes saturated with fast moving water, it is possible to begin acting like a slurry; the whole section of bed material “slips” and moves all at once in a loosely connected mass floating the larger materials out of the watershed on a bed of moving “marbles.”

Since no visual aggradation zones existed in the 2000 monitoring period, it can be concluded that not all of the underestimated sediment was left in the subwatershed 3, but in fact much of it was carried out in one of the above described processes.

Nutrients

Related predictions of nitrogen and phosphorus should also be discussed. As discussed above, sediment and therefore sediment attached nutrient projects are minimally affected by the lost flows in subwatershed 3. The primary phosphorus tools used for the nutrient balance used sediment-attached phosphorus loading and solved for soluble fractions. It is commonly agreed in literature that the largest fraction of phosphorus in water quality runoff is the sediment-attached fraction in an annual balance. Literature does demonstrate that the soluble fraction dominates during snowmelt periods, however the year 2000 monitoring period did not capture snowmelt runoff. The soluble fraction during the growing season will be interacting with soils as the surface water infiltrates and the exchange will probably be highly affective at sequestering that small fraction.

Nitrogen poses bigger questions regarding unaccounted water, although it is a small percent of the monitored flow. Nitrogen, predominately nitrates, travel in soluble fractions that do not have the affinity for soil adsorption that phosphorus does. This pollutant follows the water pathway more closely temporally and spatially. In the 2001 dry periods, Seven Mile Creek was observed to dry up at the head area of the County Park, and downstream flow would again appear approaching the monitoring station at watershed 3. An outstanding question about the water pathway is if the water emerging in the springs is the same as the water infiltrating into the shallow alluvial material or if it is older water that traveled through a deeper groundwater system and does not necessarily have the same nitrate loading. More information is needed to confirm this station’s results. However, whether the nitrate from the upper watershed emerges again in the channel, recharges deeper ground water aquifers, or emerges closer to or in the Minnesota River, it remains a pollutant of concern that can be reduced.

What the analysis tells us

- General direction of what BMPs to use
- Where to locate BMPs
- Where to cost-effectively implement cost-share dollars

The accuracy of the resulting percentages is not precise to the decimal points given in the spreadsheet. What is important is the relative differences between sources.

Discussion

Results of the sediment and phosphorus modeling can be seen in figures 33 and 34. In terms of sediment, bank erosion is a very large pathway for sediment within the watershed. As mentioned earlier, most of the bank erosion is occurring within watershed 3 and the lower portion of watershed 2. It is presumed that the major driving force behind the bank erosion is derived from accelerated drainage and climatic changes within the watershed. A combination of more rainfall coupled with more subsurface and surface drainage networks, leads to more frequent, flashier discharges. Higher discharges lead to more bank full or stream forming discharges. The stream therefore needs to adjust to the increase in energy and instability within the stream channel. This adjustment can be witnessed in the lower reaches of watershed 2 and the entire area of watershed 3. Stream incising or entrenchment, scour, bank slumping and stream bank failure are commonplace within these areas of the watershed. From an implementation management perspective, fixing these problem areas may not be cost-effective. A more pro-active and indirect way to help decrease the acceleration of bank erosion within the watershed is to use water storage techniques such as wetland restorations, off-channel storage areas, restoration of floodplain through the use of rock cross-vane structures, and no-net increases in public tile or surface water drainage. If funded, a proposal through the McKnight foundation would help fund this effort within the watershed.

The second dominant source of soil erosion within the watershed is upland sources (cultivated areas). As mentioned, a majority of the soils within this watershed are meeting tolerable soil loss ranges. However, over the long-term these areas do contribute a significant source of soil to Seven Mile. The main reason stems from the fact that the upland zone dominates the overall area of the watershed. It is felt that the most cost effective way to manage this sediment pathway is through the targeting of cultivated areas, which are losing greater than 5 tons per acre per year. To further increase targeting, areas that are greater than 5 t/a/yr and within 300 feet of a waterway could be targeted for specialized soil saving measures. Conservation tillage, waterways, and warm season grass buffer strips would be utilized in these areas to reduce the effect of these “hot spots.” Through GIS analysis it is found that most of these hot spots occur near the upland and dendritic drainage interface of watershed 3.

(figure 32) Buffer strips and/or conservation tillage would be most effective within these areas. In addition, no or minimum spring tillage of soybean stubble would be encouraged for further soil saving measures.

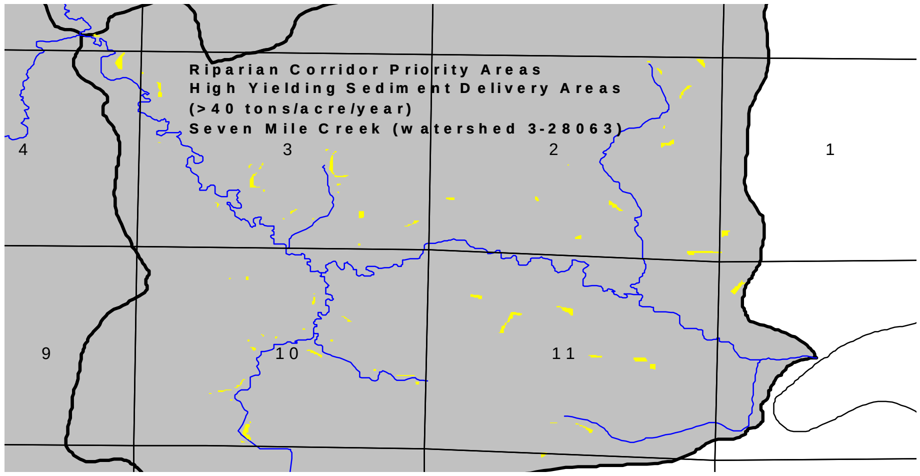


Figure 32. Areas shown in yellow (about 15 acres) are priority areas within the lower reach of watershed 3 for sediment reduction BMPs as indicated by RUSLE modeling.

The last two zones, riparian corridor and open intakes are the smallest overall contributors of sediment within the basin. Grass buffer strips and gravel inlets would be the most effective BMP to help slow the sediment delivery to Seven Mile Creek.

As for phosphorus, the most dominant pathway within the watershed is the upland delivery zone. Because over 95% of the upland zone is in a corn and soybean crop rotation, nutrient management will be the key best management practice strategy. Soil phosphorus testing, and manure crediting will be key features of the implementation plan to reduce the overall phosphorus load. In addition, waterways and buffer strips in critical areas will be encouraged to slow down the overall phosphorus transport mechanisms. Average soil test values for the watershed are estimated to be 22 ppm Bray and 29 ppm Olsen[2]. These soil tests are interpreted as very high for plant available phosphorus. However, with key nutrient management changes, these soil tests and overall potential loss into the surface waters could be reduced in 5-10 years.

Through a combination of careful targeting of open intakes, nutrient management, and general septic upgrades it is estimated that approximately 25-40% of the long-term phosphorus load could be reduced.

[2] **Average of Clients within Seven Mile Creek Watershed, Blue Earth Agronomics ,2001.**

Table 32. Phosphorus contributions from septics.

Watershed	# of ISTS 1	# of people/ ISTS 2	# of people/ 2	Gallons per person 3	High TP Concentrations(mg/l) 4	# of days monitored 5	Phosphorus contribution from septics (lbs.) =2*3*5/1000000*8.34/4
WS 1	39	2.5	98	45	30	239	262
WS 2	28	2.5	70	45	30	239	188
WS 3	29	2.5	73	45	30	239	195

Results

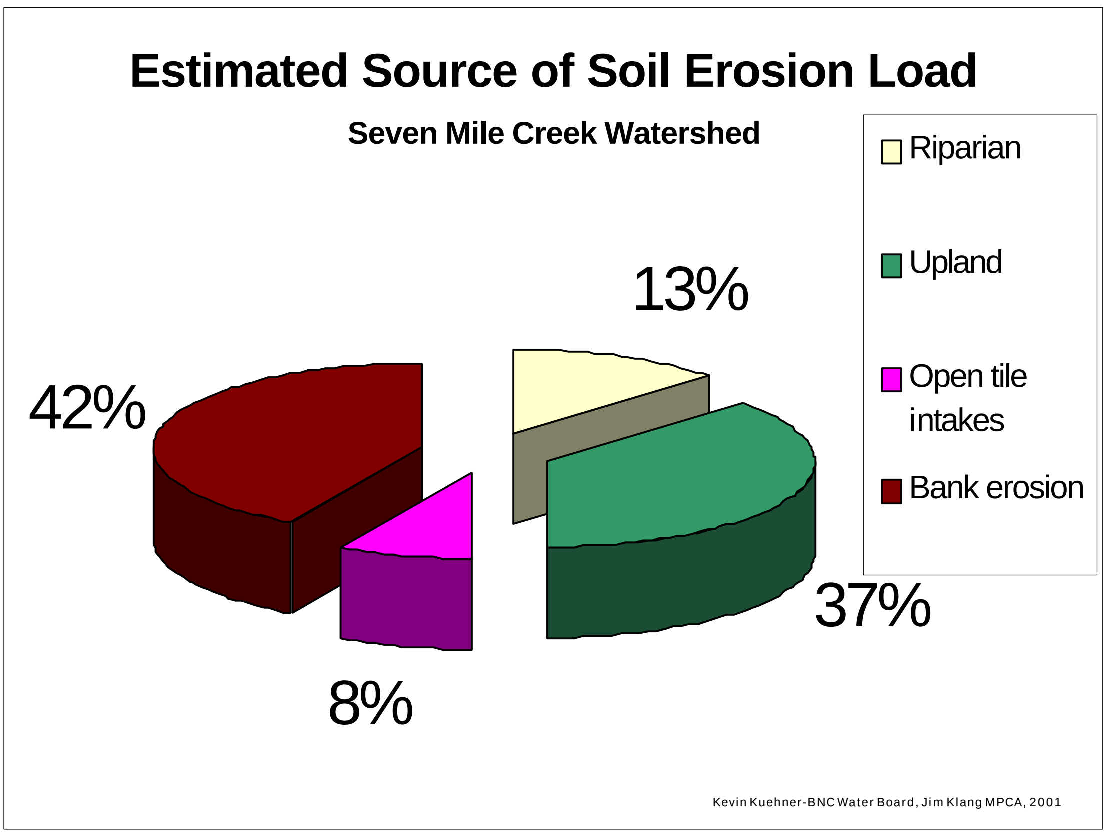


Figure 33. Sources of sediment in Seven Mile Creek watershed.

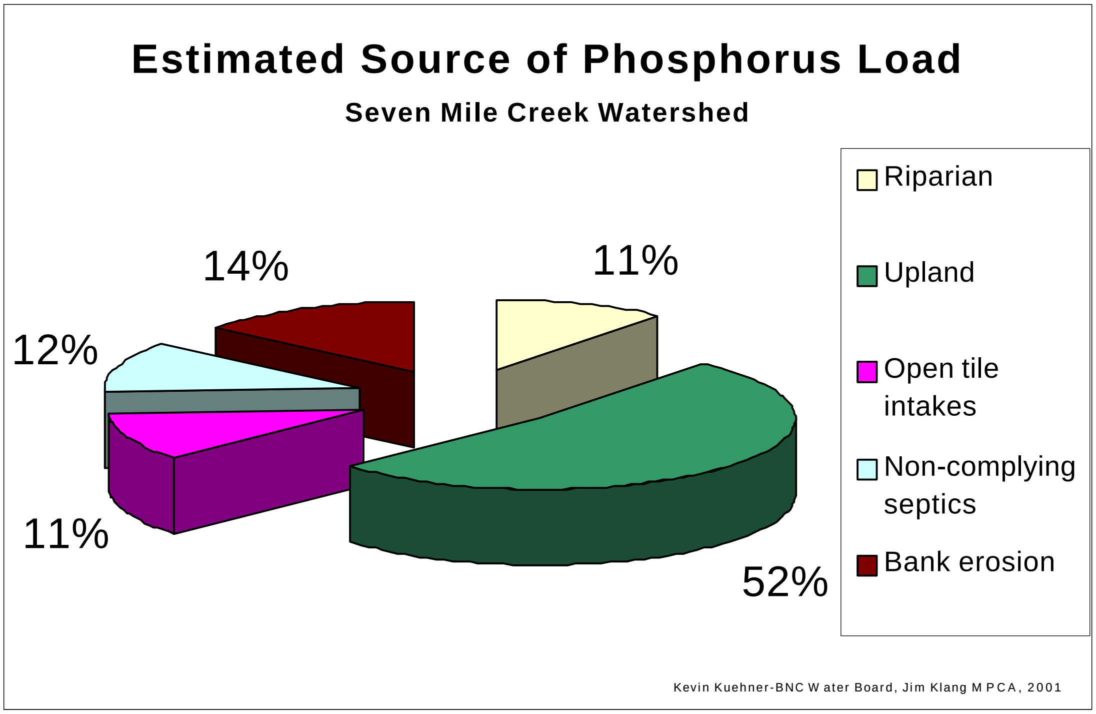


Figure 34. Sources of Phosphorus in Seven Mile Creek watershed.

Nitrogen Mass Balance Methods and Approach

Nitrogen is a large source of pollution within Seven Mile Creek. Knowing the inputs and outputs is very important in terms of setting realistic water quality goals and implementation strategies for the watershed. To better understand the fate of nitrogen on a watershed scale, a mass balance approach was used. The main objective of this very basic approach was to develop a N-screening tool that would quickly estimate watershed scale N sources. It should be noted that a large number of assumptions had to be made when conducting the N-mass balance. Wherever possible, the most recent and local data was used. However, it should be noted that because of the many complexities involved with the nitrogen cycle at the field and watershed scale, the N mass balance work does contain a significant margin of error. The fate of nitrogen in a natural environment is very complex and therefore the intent of this exercise is not meant to quantify, rather this exercise is meant for educational purposes. Local data and expertise from extension agents and soil scientists were used as much as possible to help assist in the development of N inputs and outputs of the watershed system. It is hoped the mass balance process and understanding of nitrogen fluxes in an agricultural setting can be refined through the use of the ADAPT model which will be performed through the paired watershed study and information gathered at Red Top Farm research fields.

Inputs to the N-Mass Balance

- 1996 St. Peter Wellhead Protection Farm Nutrient/Pesticide Management Assessment Program (FANMAP) survey by Minnesota Department of Agriculture.
- Nicollet County Feedlot Permits
- Nicollet County Soil Survey
- N Balance publications and technical journals
- Local soil scientists and agronomists
- UM Extension Publication of Livestock nutrient manure levels
- UM Extension Publication of Crop Nutrient Removal
- National Atmospheric Deposition Program web site-Lamberton Site

The nitrogen mass balance approach taken in this analysis uses digital databases, GIS, and published research values. The data sets were combined to calculate six general categories of nitrogen sources and five general losses. The difference between the two indicates the long-term potentially leachable nitrogen sources in the watershed.

The basic methodology and sources for the calculations can be found in table 33.

Table 33. Nitrogen mass balance for Seven Mile Creek.

Seven Mile Creek Watershed
Eastern Nicollet County, Minnesota

Watershed area is 23,551 acres, 86% cultivated land use, 20,181 crop acres
Assumed, 100% corn/soybean rotation (10,091acres beans, 10,091 acres corn), 150 bu/acre avg. corn yield, 45 bu/acre avg. soybean yield, pH >7 with high CEC, sub-humid climate
Average Organic Matter content is 5%, average bulk density is 1.42 (g/cm3) cultivated land soils(top 9)=Canisteo-Glencoe Complex(15.5%),Cordova Clay Loam (14%),
Canisteo Clay Loam (13%), Webster Clay Loam (9.7%), Le Sueur Clay Loam (8%), Nicollet Clay Loam (6%), Harps Clay loam (5%), Klossner Muck (4%),
Glencoe Silty Clay Loam (4%)

Source (entire ws)	***lb. of N/acre***			***Calculation notes with referances***
Nitrogen Inputs				
Fertilizer on Corn acres	66			154 lbs./acre applied on corn ground
				Based on 1996 survey of 22 producers in the St. Peter Drinking Water Area
				over entire ws=154lbs.acre*10091=777 tons/23551=66lbs./acre
				Supply Management Area
				FANMAP Survey, 1996
				Meisinger and Randall, Table 5-2
				assumes no N on soybeans
		U of M	Randall	
Manure	10.1	39	28	=827dairy@1000lbs*140lbs N/yr
				=280 beef@750lbs*90lbs N/year
				=5754 swine@150lbs*25lbs N/year
				6127 spreading acres, animal units=# of animals that could be permitted.
				whole ws=39lbs/acre*6127=119 tons/23551=10.1lbs/acre
				Meisinger and Randal, 5-3.1 and 5-3.2
				Max capac.,PCA Permits, Nicollet County Env. Services, 2000
				Assume 30% loss due to storage, scraping, etc.
				U of M Extension Publications
				With NP dairy=70lbs.acre or about 30 lbs more N
Symbiotic N2 Fixation	32			**N removed=3.3lbs N/acre*50bu/acre*10,091 acres of beans in ws
				N removed (833 tons) *55%(table)=N2 Fixation from soybeans
				=375 tons fixed from soybeans, whole ws=32lbs./acre
				Meisinger and Randal, Table 5-4 and 5-5
Manageable Totals		**108.1**		
Irrigation	0			No irrigation in watershed
Precipitation	8.4			Lamberton 2000 data
				NADP web site
Dry Deposit	8.4			assumed equal to ppt
				Meisinger and Randal
Crop seed	0			assumed negligible
Nonsym. Fixation	0			assumed neglible
Mineralization	106			Mineralizable N=1000*bulk density of specific soil
				*Organic matter content of soil (%)
				*volume of 30cm thick soil in 1 ha (constant=3000m3)
				*elemental N fraction of soil organic matter (constant 3%)
				*annual mineralizable portion of soil organic N (constant 2%)=106.5
				Burkart and James, p 854 and GIS database
				Randall assumes 10-20lbs. Per % of OM=15*5=75 lbs N/acre
Ammonia Redeposition	2.5			75% of manure and fertilizer ammonia loss
				=1.8+1.5+3.3*.75%=2.5
Total Input	233.4	183.4		

Nitrogen Outputs

Crops	142		=150 bu/acre*.83=Corn Used high end of table Meisinger and Randal, Table 5-4 Crop nutrient Removal, 1986 =45 bu/acre*3.5=Beans Meisinger and Randall, Table 5-4 Crop nutrient Removal, 1986 Average watershed uptake=158+125/2=142
Fertilizer Ammonia Loss	1.8	5	Anhydrous=66 lbs/acre N*3% lost=2 lbs/acre, whole ws=.42lbs/acre UAN=66 lbs/acre *10% lost=6.6 lbs/acre, = whole ws 1.4lbs/acre =anhyd+UAN=1.8 assumed subhumid, pH>7 with CEC soils, moderate tillage Meisinger and Randall, Table 5-3.2.1
Manure Ammonia Loss	1.5		assumed half manure solid other liquid, with short term fate, broadcast no incorp. 5 lbs/acre*.15=.75 5 lbs/acre*.15=.75 =1.5 lbs N lost Meisiger and Randall, 5-6.2
Denitrification	20.6		Assume somewhat poorly drained soils=20% Obtained by multiplying total inorganic N imputs (fert +rainfall) by est. % denitirification loss and net manure input by twice estimated loss =66+17=83*20%=16.6 =10.1(manure)*40%=4, 34.2+14.2=20.6 Meisinger and Randall, Table 5-7
Erosion Runoff	10		=avg RUSLE value*%OM*2 1* 5% *2 Meisinger and Randall, pg 111
Misc gaseous ammonia	0		Negligible
Total	175.9		
Long Term Potentially Leachable Nitrogen (LPLN)	57.5		

Interpretation	High

LPLN is in High category

If producers are applying 34 lbs/acre acre(154-120) over UM Recs (120 lbs./acre)
This equates to $7.50/acre loss or $75,000 for watershed corn acres

Referances

1996 St Peter Wellhead Protection MDA FANMAP survey

Estimating Nitrogen Budgets for Soil-Crop Systems, Meisinger and Randall.

1991Managing Nitrogen fo Groundwater quality and farm profitability, Soil Science Society of America, Madison, WI

Agricultural-Nitrogen Contributions to Hypoxia in the Gulf of Mexico, Journal of Environmental Quality, Burkart and James. 1999

1996 Nicollet County Soil Survey

BNC Water Quality Board GIS database

National Athomospheric Deposition Program, http://nadp.sws.uiuc.edu/nadpdata/state.asp?state=MN

Crop Nurtrient Removal, S.R. Alsdrich et al, 1986, Minnesota Extension Service Publication

Gary Hachfeld, Nicollet County Extension Service

Gyles Randall, Univeristy of MN Research Outreach, Waseca

Kimm Crawford, Olmsted County Soil and Water Conservation District Supervisor

Results

According to the nitrogen mass balance analysis for the watershed, mineralization (natural process of nitrogen converting organic matter within the soil to No_3-N within the soil by bacteria) is considered the largest overall source of nitrogen within the watershed, followed by inorganic fertilizers, which are spread on cornfields, soybean nitrogen fixation, precipitation, manure, and ammonia redeposition.

The watershed contains inherently high sources of nitrogen due to the high organic matter content of the clay loam soils. To illustrate why mineralization could be the largest overall source of nitrogen within the watershed consider the following:

On average every percentage point of soil organic matter contains 1,000 pounds of N. Assume that soil organic matter mineralizes at a rate of about 2.5% per year (depends on weather). In Seven Mile Creek watershed the average soil organic matter content on cultivated land is 5.5% O.M. That is 5,500 pounds of N, mineralizing 2.5% X 5,500 = 137.5 pounds of N per acre per year made available from soil organic material. This further demonstrates that mineralization can be a significant form of plant available nitrogen within the watershed. Furthermore, any additional nitrogen beyond 120 lbs./N per acre (UM Corn Fertilizer Recommendation for this area) can increase the long-term potentially leachable nitrogen.

The largest removal of nitrogen was in the form of crop uptake and removal, followed by denitrification, erosion, and fertilizer and manure ammonia losses during application and storage.

A general feature common to many agricultural watershed N budgets is that the largest No3-N losses are associated with areas that receive excess N inputs. That is, sites where manure or fertilizer inputs greatly exceed crop N removals. Within Seven Mile, it was found the nitrogen sources (233 lbs.) minus the nitrogen losses (176 lbs.) equals around 60 pounds of long term potentially leachable nitrogen. The nitrate concentrations in Seven Mile Creek correlate very well with the mass balance data. For 2000 and 2001 the average nitrate loss from the watershed was estimated at 27 pounds per acre per. This is roughly half of what was modeled. Considering the complexity and fate of nitrogen in the landscape, this is a fairly important tool for small watershed projects to utilize, especially when local data exists.

Results from a 1998 MN Dept. of Ag. survey[2] reported on average, approximately 54 pounds/acre of N was being applied above UM recommendations on corn following soybean rotations in the wellhead protection area. Assuming producers are over applying N by just 34 lbs./acre for additional insurance purposes, 170 tons of N would have the potential of being leached away through the soil and into the tile lines, drainage ditches, and eventually Seven Mile from corn fields within the watershed. If the current rate was cut back from 150 lbs./acre to 120 lbs./acre, the 22 producers could save $750,000 or an average $7.50/acre/year on their corn ground (assuming $0.22/lb for N).

In conclusion inorganic fertilizers are the largest manageable source of nitrogen within the watershed. It is assumed that producers and fertilizer dealers are continually underestimating the nitrogen credits associated with legumes and manure inputs or are simply applying insurance nitrogen and therefore are applying fertilizer at rates of

30-50 lbs. over what is needed by the corn plants for the purpose of maximizing yield (University of MN Extension Service recommendations). As the water quality monitoring indicates, this is ultimately showing up in the form of at least 15-40 pounds per acre nitrate loss from the watershed.

Field scale N-rate demonstrations have shown within the wellhead protection area of St. Peter that 90 pounds/acre might be more than adequate if considering net profits (figure 41). Intensive economic and agronomic analyses have been conducted through the University of MN, BNC Water Board and agronomic consulting firms using field-scale demonstrations Producers may not be comfortable applying 90 pounds of N per acre to soybean stubble for corn production, but research is showing that applying more than 120 pounds might cut into farm profits and water quality for Seven Mile Creek. An N-rate in between might provide the best yield and profit scenario for individual farmers. It is proposed in the implementation plan that further N-rate and profitability demonstrations be conducted within the watershed through the Center for Agricultural Partnerships Mid-Western Water Quality Project and Phase II of a Clean Water Partnership. In addition to nutrient management education, the use of wetlands, tile outlet to wetlands, and restoration of active floodplains will play key roles in reducing overall nitrate loads.

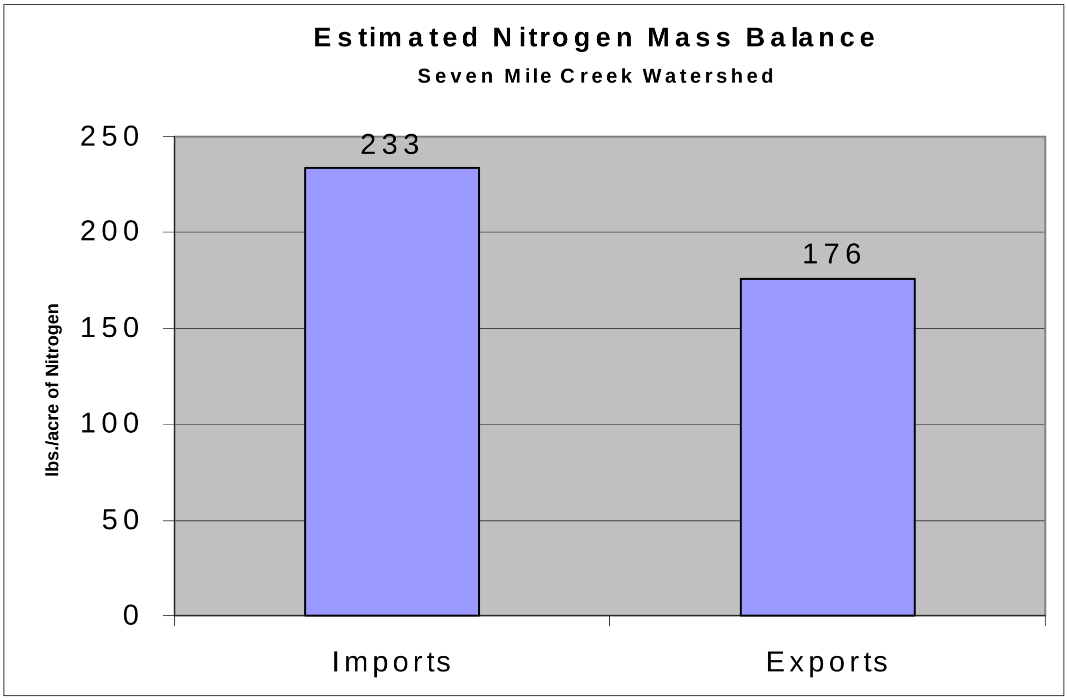


Figure 35. Nitrogen mass balance estimate for Seven Mile Creek.

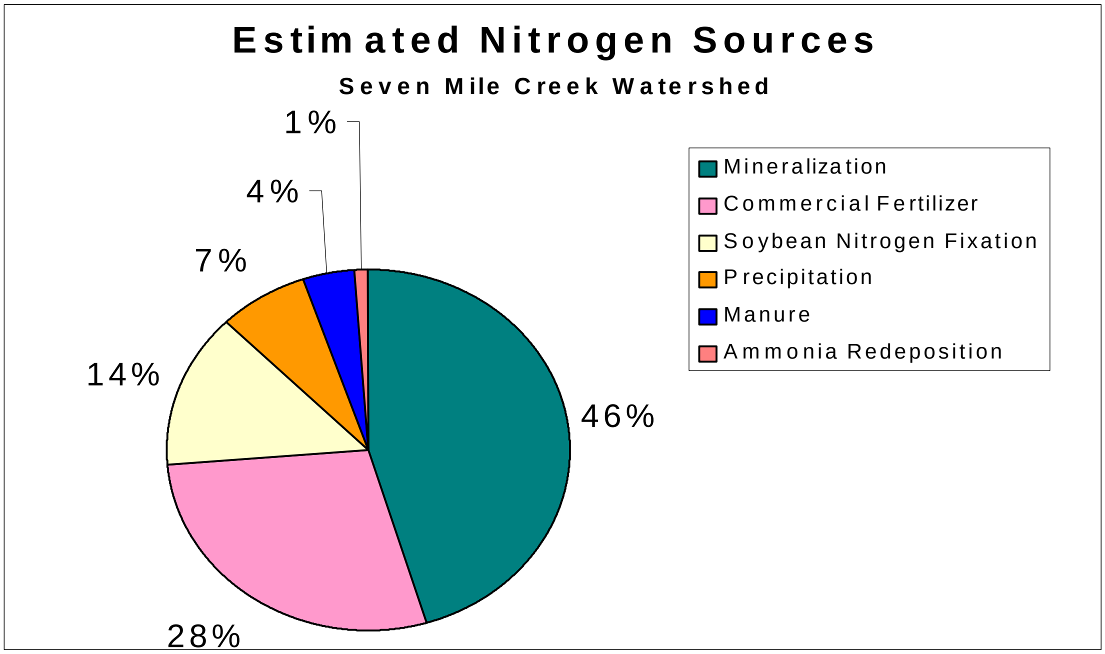


Figure 36. Estimated Nitrogen sources for Seven Mile Creek watershed.

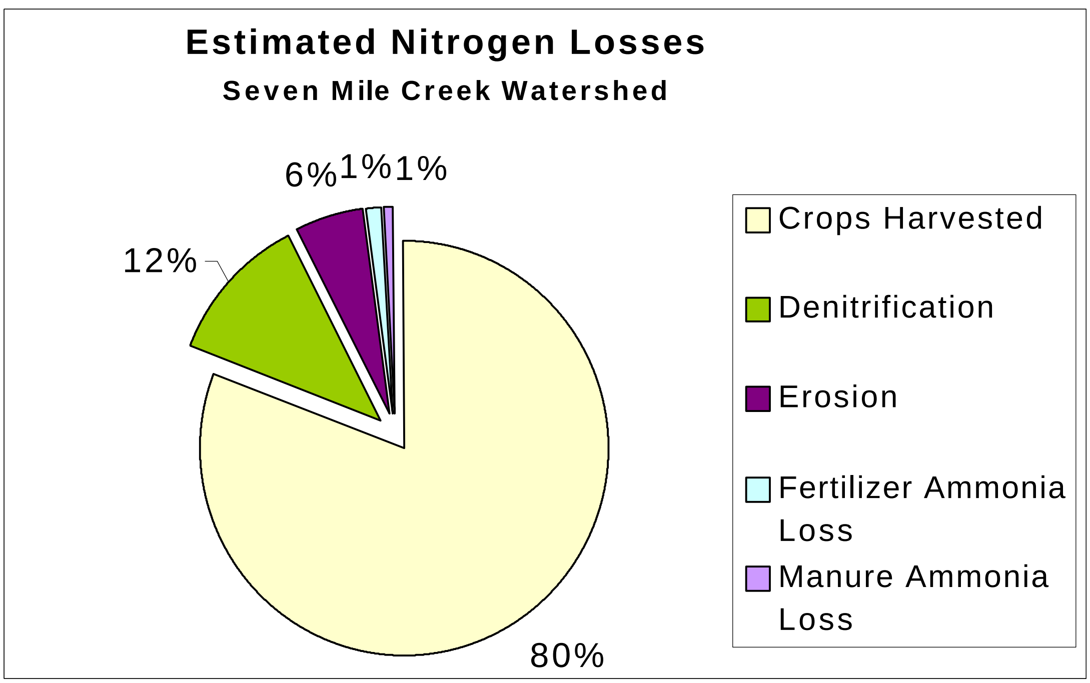


Figure 37. Estimated Nitrogen losses from Seven Mile Creek watershed.

Chapter
7 Conclusions & Goals

Seven Mile Creek Diagnostic Study

The primary scope of the Seven Mile Creek Water Resource Investigation was to measure the movement of sediments and associated pollutants within the watershed and factors affecting their transport to the creek and Minnesota River. Examination of the relationship between land use and water quality was the primary method for documenting such factors. The second main goal of the diagnostic study was to determine realistic goals for both the watershed and Minnesota River and ultimately how and where to implement cost effective practices which would help reach those goals.

Water quality and quantity monitoring over a variety of flows and seasons provided information about both spatial and temporal variability in water quality during the two-year study. Like many other watersheds in the southern portion of the Minnesota River Basin, water quality in Seven Mile is impaired by non-point source pollutants. Because there are no communities or permitted discharges, there are no point sources of pollution located within the watershed. Pollution from the drainage ditch tributaries supplying Seven Mile Creek and the creek itself consists primarily of sediment, phosphorus, nitrogen and bacteria. All of these pollutants increase substantially during and after rain events within the entire watershed. The most significant levels occur during the early growing season, typically April through July. During this period, levels increase far above recommended levels.

Sediment

Pollution from the drainage ditch tributaries supplying Seven Mile Creek and the creek itself consists primarily of sediment, phosphorus, nitrogen, and bacteria. Seven Mile Creek delivers about 6,712 tons of sediment each year to the Minnesota River during the growing season (April through September) or about 570 pounds per acre or 52 pounds/acre/inch of runoff. The primary source of sediment in the watershed is bank erosion. Bank erosion sources are mainly found within the lower reaches of watershed 2 and 3. Other major pathways for sediment include upland erosion from cultivated cropland, riparian corridor and open tile intakes. It is estimated that approximately 40% of the sediment is due to bank erosion sources, about 40% from upland sources, and the remaining 20% is split between that area closest to the drainage ditches and around open tile intakes. More frequent, and higher intensity flows from CD 46a and in particular CD13 is the main reason for the accelerated bank erosion processes. Natural stream channels within the system are adjusting to dissipate the increases in stream flow energy. Stream bank slumping and incising through much of the non-ditched riparian corridors of the lower portion of watershed 2 and watershed 3 are evidence to the effects of the land use and hydrology changes. Other reasons for accelerated sediment losses are due to the steep land gradient drop in watershed 3 and the dynamics of climate.

Phosphorus

Seven Mile Creek also generates about 10.7-tons/growing season of total phosphorus. This translates to 0.9 lbs./acre or 0.156 lbs./acre/inch of runoff. Average concentration is 0.340 mg/l for total phosphorus and 0.239 mg/l for dissolved reactive phosphorus. Approximately 60% of the phosphorus was measured in the more soluble ortho-phosphorus form. This high percentage indicates a very potent and detrimental form of phosphorus to the environment. Over 70% of the phosphorus is delivered in the months of April, May and June. Spring runoff from cultivated fields is presumed to be the main reason for this substantial loading period. Although not substantial in terms of yield, phosphorus concentrations increase substantially in the upper watersheds during low flow periods. This can be attributed to septic influences and pH/dissolved oxygen chemical reactions. Modeling conducted by the BNC Board and MPCA staff has estimated that over half of the measured phosphorus load arises from upland sources, around 15% from bank erosion, and the remaining divided among non-complying septics (12%), riparian corridor (11%) and open tile intakes (11%).

Nitrates

Nitrate loads generated from Seven Mile Creek were the most alarming. For its size, Seven Mile Creek has the highest loads overall when compared to nine other watersheds within the Minnesota River Basin for year 2000. The two-year average nitrate load measured from the watershed amounts to 320 tons or about 27 pound/acre or about 3.2 pounds/acre/inch of runoff. Flow weighted average concentrations were about 14 mg/l during 2000 and 2001 growing seasons.

Table 34. Nitrate losses from 1987-1994 averaged across a corn-soybean rotation at the Waseca Southern Research and Outreach Center research fields found the following nitrate –N losses from tile drainage water.

Treatment	Nitrate-N loss (Pounds/acre/inch of runoff)
Fall Applied Anhydrous Ammonia w/o N-serve	3.8
Fall Applied Anhydrous Ammonia with N-serve	3.1
Spring Applied Anhydrous Ammonia before planting w/o N-serve	3.1
Spring Applied Anhydrous Ammonia before planting (40%) and side-dressed when corn was 12" tall (60%)	3.3

The results of the Waseca Research Station indicated that Seven Mile Creek nitrate values are similar to that of nitrogen coming straight from a field. This demonstrates that in Seven Mile the primary source of nitrate is tile drainage losses from cultivated row cropped land receiving excessive amounts of fertilizer and manure. The 1996 St. Peter Wellhead Protection Survey FANMAP survey also coincides with this reasoning. In the survey, which interviewed many of the same farmers within the watershed, it was found that producers were applying about 30-50 pounds over the University of MN extension corn fertilizer recommendations. The report concluded that producers and fertilizer dealers were simply not crediting for manure and legume nitrogen contributions. Based on a basic Nitrogen mass balance conducted on the watershed scale, it was found that mineralization (46%), fertilizers (28%), soybean fixation (15%), precipitation (7%), manure (4%), and ammonia redeposition (1%) make up the nitrogen sources. When subtracting the sources from the losses such as crop removal, it is estimated that there is a 60 lb/acre long term potentially leachable nitrogen source within the watershed. The extensive network of public and private surface and subsurface tile drainage may also be accelerating nitrate losses within the watershed. There are about 50 miles of public drainage systems with many more miles of private drainage tile. This drainage network provides a direct pathway for nitrate to travel from the soil profile, to the sub-surface drainage tile, to the ditches and eventually Seven Mile Creek. Unlike larger watersheds, which typically have more floodplains, mud flats, meanders, and other natural areas (where anaerobic bacteria can thrive and consume oxygen molecules from the No_3 thereby reducing nitrogen to a gaseous form = denitrification), the current physiography of Seven Mile is not conducive to such natural processes. The 30-50 pounds of surplus N/acre which are being supplied on average above UM recommendations through commercial fertilizer sources and the inputs derived from natural processes such as mineralization, land use changes, and the extensive network of tile drainage all help explain the high nitrate concentrations found in Seven Mile Creek.

Conclusions:

The two-year study has provided some very important results that could be utilized for the enhancement of watershed based projects throughout the Middle Minnesota Major Watershed and state. The Seven Mile Project provides some interesting results that suggest small watersheds (<20,000 acres in size) can produce very large pollutant loads. The information derived in this report could be extrapolated to other similar watersheds, especially in the eastern half of the Middle Minnesota Major River Basin.

Hydrology

- Changes in watershed hydrology and land use- (ditching, extensive network of tile subsurface tile drainage tile, draining of wetlands) are considered the largest factors affecting water quality in Seven Mile Creek Watershed. <u>Sediment, Phosphorus and Nitrogen losses are directly correlated with increases in drainage.</u>

- Water Storage is considered the most important best management practice. Wetland restoration, retention basins and/or culvert downsizing may be an important BMP for controlling peak water flows downstream.

- The extensive network of drainage systems within the watershed that have been installed over the past half-century are severely increasing the rate of stream bank instability, and stream bank erosion processes. Watershed 3 is considered the biggest contributor to this problem.

- Surface water at times is contributing to groundwater in watershed 3. This has important water quality implications, since surface water is also adding high levels of nitrates. It is not known how much of an effect this could be having on the groundwater aquifers in the area.

Sediment

- Most of the sediment load, 50%, is derived from bank erosion sources.

- RUSLE values are well below tolerable soil loss limits (5 tons acre/year) for this watershed in most upland areas.

- Conservation tillage on soils indicated by RUSLE as > 5 tons/acre/year may be the most efficient way of decreasing upland sediment loads.

- Sediment from upland sources are highest during the months of May and June.

Phosphorus

- Phosphorus concentrations and loads are being added to the Minnesota River.

- Most of the phosphorus within the watershed (52%) is coming from upland sources (cultivated soil).

- Sediments and phosphorus are directly correlated. The majority of the total phosphorus and soluble phosphorus is derived during storm events and spring snowmelt conditions. Over 70% of the phosphorus loading is occurring during spring runoff conditions.

- 60% of the total phosphorus in the watershed is in the more detrimental dissolved form.

Nitrates

- When compared to nine other watersheds in the MN River Basin, Seven Mile is the heaviest loader for its size.

- Nitrates are elevated in much of the watershed up until the end of July. After July leaching is minimized due to crop uptake and little or no leaching because of high evapo-transpiration rates during this part of the season. Highest loads and concentrations occur at the mouth of watershed 1.

- Based on samples taken from storm events, much of the nitrate is reaching the river through a shallow subsurface pathway. This pathway is mainly through underground public and private tile systems.

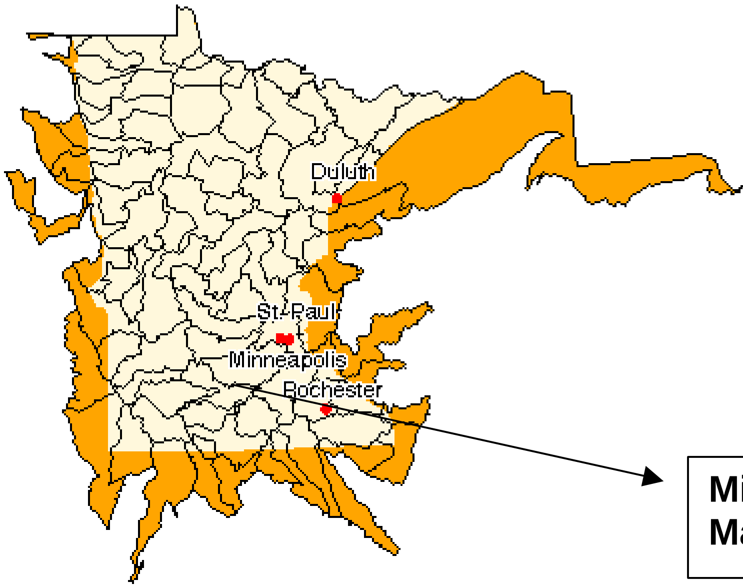
- It appears over fertilization and mineralization are the main causes for elevated No_3 levels in Seven Mile.

Pathogens

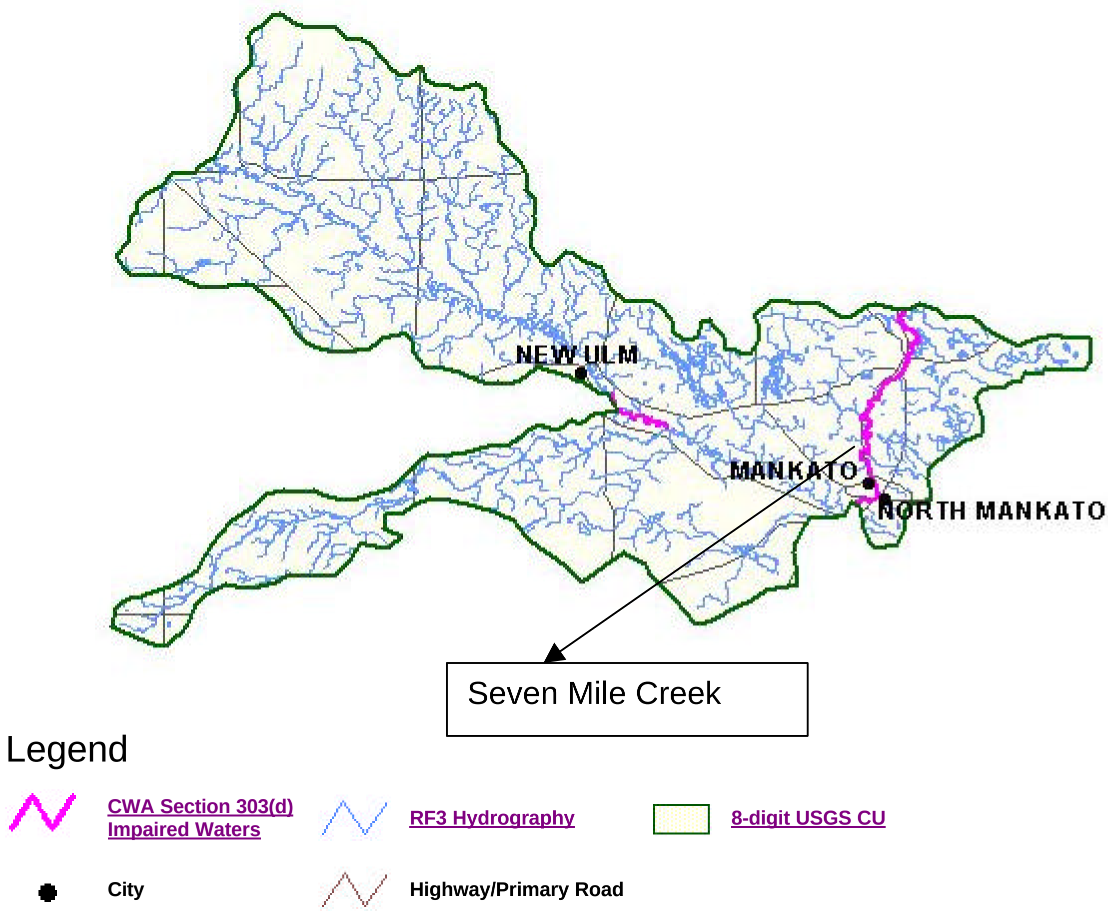
- High levels of fecal bacteria typically occur in July and August within the park. This should be of particular concern to the park users and county park managers.

- Most of the elevated fecal coliform bacteria counts occur during runoff events, suggesting sources of bacteria from feedlots and spreading acres. High counts during low flow conditions did occur as well during the study suggesting point sources. Failing septic systems are considered a large contributor to high bacteria concentrations during low flow events.

Map 33



Middle MN River Major Watershed.



Map 34. The Minnesota River from Mankato to Shakopee is considered a TMDL stretch of river. Eventually the state of MN and EPA must submit guidelines that limit the amount of pollutants within this reach of the river. Seven Mile Creek watershed contributes considerable pollutant loads for its size to this section.

TMDL Definition – What is a total maximum daily load (TMDL)?

A TMDL or Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.

Water quality standards are set by states, territories, and tribes. They identify the uses for each water body, for example, drinking water supply, contact recreation (swimming), and aquatic life support (fishing), and the scientific criteria to support that use.

A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and non-point sources. The calculation must include a margin of safety to ensure that the water body can be used for the purposes the state has designated. The calculation must also account for seasonal variation in water quality.

The Clean Water Act of 1972, section 303, establishes the water quality standards and TMDL programs.

The New TMDL Rule

These recommendations were used to guide the development of proposed changes to the TMDL regulations, which EPA issued in draft in August, 1999. After a long comment period, hundreds of meetings and conference calls, much debate, and the Agency's review and serious consideration of over 34,000 comments, the final rule was published on July 13, 2000. However, Congress added a "rider" to one of their appropriations bills that prohibits EPA from spending FY2000 and FY2001 money to implement this new rule.

Current TMDL Program

The current rule remains in effect until 30 days after Congress permits EPA to implement the new rule. TMDLs continue to be developed and completed under the current rule, as required by the 1972 law and many court orders. The regulations that currently apply are those that were issued in 1985 and amended in 1992 (40 CFR Part 130, section 130.7). These regulations mandate that states, territories, and authorized tribes list impaired and threatened waters and develop TMDLs.

TMDLs and Seven Mile Creek

The state of Minnesota will eventually need to develop and submit TMDLs for designated areas of impaired water bodies within the state. Seven Mile is located adjacent to a impaired area (map 34). This report maybe used by policy makers to help them develop realistic and attainable TMDLs for this stretch of river.

Watershed Water Quality Goals

Factors used to derive attainable water quality goals for Seven Mile Creek:

- Minnesota River and TMDL goals
- Develop a list of action priorities which provide the most effective enhancement for water quality with the smallest economic impact on stakeholders.
- Revised Universal Soil Loss Equation model
- FLUX loading model
- Sediment and nutrient delivery pathway modeling
- Red Top Farms Nitrogen Management Demonstration Site
- Current EPA water quality standards for surface and groundwater

For the purpose of setting water quality goals for this watershed, concentration and loads were considered to be a 1:1 correlation. This is based on a concentration vs. yield regression analysis.

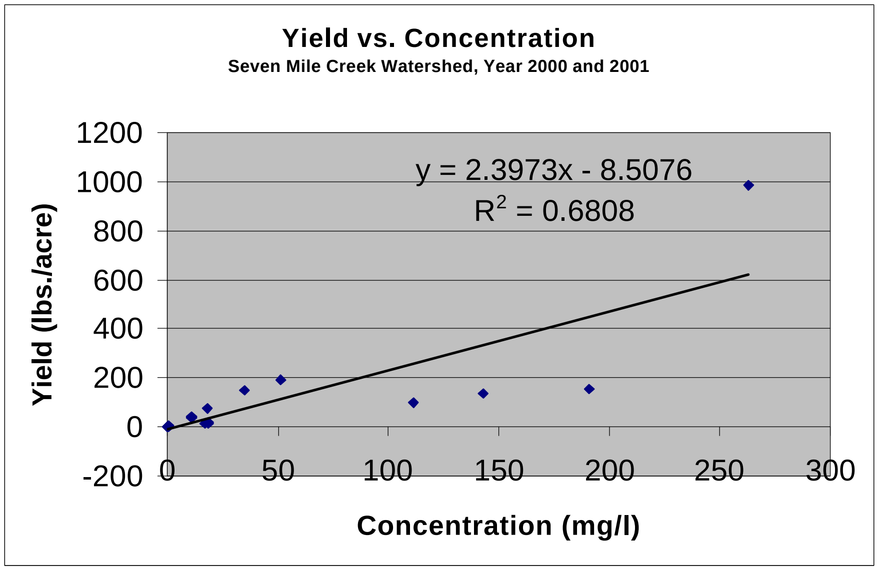


Figure 38. Yield vs. concentration for Seven Mile Creek.

Goals

- Secure buffers on half the eligible acres within the watershed (300 acres).
- Stabilize large stream bank erosion site (which yields an estimated 50 tons per year).
- Replace 50 open tile intakes with gravel inlets.
- Alter rate, timing, and method of phosphorus and nitrogen applications. Apply 0 pounds per acre of broadcast P for soils that test high/very high in P, apply in the spring, and band/incorporate fertilizer. For nitrogen, apply at UM recs (120 lbs/acre); apply urea or anhydrous ammonia in the spring.
- No net increase of public drainage within the watershed.
- Upgrade most to all non-complying septics in the watershed (70-100 homes).
- Encourage conservation tillage on highly erodible areas, particularly soybean ground.
- Get producers and fertilizer dealers to apply nitrogen at UM Recommendations on a majority of the corn acres (10,000 acres) in the watershed.
- Encourage and facilitate record keeping and nutrient management plans for crop, livestock, and dairy producers.
- Manage stream for brown trout fishery.

Sediments

The 2000-2001 flow-weighted mean total suspended solids (TSS) concentration at the mouth of Seven Mile Creek Watershed was 277 mg/l and the average yield was found to be 570 lbs./acre. Based on eco-region reference values, as well as the turbidity standard for the watershed (which can be roughly equated to TSS), a flow-weighted mean concentration in the 50-100 mg/l range would be desirable. This may not be a feasible goal, however, in a three-year project due to excessive bank erosion within lower reaches of the watershed. The soil erosion potential model (RUSLE), summarized in tables 7 and 8 of chapter 2 and the sediment erosion model discussed in chapter 6 provide some sense for what might be feasible. Chapter 6 contains major pathways of soil erosion within the watershed. If soil erosion best management practices were targeted toward half the manageable sediment sources such as open tile intakes, riparian corridors, and upland sources, and assuming on average BMPs such as gravel inlets, and waterways, prevent 50% of the soil from entering Seven Mile, the sediment load would get reduced by 25% or an average of 1,678 tons of soil per year. **Based on these figures, a load reduction goal of about 25% is aggressive, yet reasonable. This translates to a flow-weighted mean concentration goal of about 200 mg/l or 430 lbs/acre.**[1]

Assume 50% reduction of pollutant delivery to surface water due to best management practices and water quality outcomes in 5-10 years.

Phosphorus

Based on eco-region reference values, as well as comparisons with other watersheds and the Minnesota River, total phosphorus concentrations and yield in SMC Watershed is high, particularly for dissolved reactive phosphorus. Eco-region reference values, as well as phosphorus levels recommended for the MN River Basin, a flow-weighted mean concentration of less than 0.150 mg/l of total phosphorus would be desirable. There are many sources of P, but in this watershed sources are mainly derived from: human and animal waste, soil attached, and commercially applied fertilizer. Figure 34 in chapter 6 helps to set some realistic water quality outcomes after a period of accelerated BMP implementation. It was assumed that BMPs would prevent 50% the phosphorus from reaching the Creek. Assuming most failing septic systems in the watershed were fixed (12% reduction), 50 open intakes replaced (2% reduction), and half of upland areas were secured in conservation tillage (25% reduction), then when all these reductions are added up it equates to a 40% reduction. However, this may not be realistic considering the complexities of adoption rates and soil/phosphorus interactions within the watershed. In addition, Pete Cooper's work of the NRCS provides some indication of what may be more realistic. Average soil phosphorus tests in the watershed interpret as high and very high for the Olsen and Bray methods (Blue Earth Agronimics). Normal application rates of phosphorus in the watershed ranges from 45-75 lbs/acre. This is an over application of about 35-65 lbs/ acre above UM recs considering the soil test interpretations. If most of the producers switched from fall broadcast to spring banding of fertilizer, Cooper's research on farms in the eastern potion of the Minnesota River Basin suggest phosphorus losses could be reduced by 20%. **A combination of soil saving measures along with the alterations of rate, timing, and method of application of phosphorus within the upland zone could result in a more attainable goal of a 25% reduction in the**

[1] Assume percent reductions apply equally to flow weighted mean concentrations and yields. For the goal setting process it was assumed flow weighted mean concentrations and yields were equal. In most years during the study the two categories--- FWMC(mg/l) and yields (lbs./acre) were similar enough to assume correlation.

average phosphorus loads/concentrations. This translates into a goal of 0.255g/ml FWMC or 0.684 lbs./acre total phosphorus yield at the mouth of the watershed in a ten to fifteen year time frame.

Nitrate Nitrogen

Based on eco-region reference values, as well as the nitrate standard being recommended for the MN River Basin, a flow-weighted mean concentration less than 10 mg/l would be desirable. The flow-weighted mean concentration for nitrate nitrogen for SMC is 14 mg/l. An average load of 27 pounds per acre of Nitrate-N leaves the watershed system on average during the growing season. In the lower reaches of the watershed, where an interconnectedness of surface water and groundwater has been observed, maintaining a nitrate concentration below 10mg/l is important. To further refine nitrate reduction goals in the watershed recent research from Red Top Farms was used. Research conducted by Minnesota Department of Agriculture special projects unit staff at the Red Top Farm in Nicollet County, within the watershed, have documented reductions in tile drainage nitrate of up to 60% (from average of 23 mg/l to 11.5 mg/l) when nitrogen rates are reduced to UM Recommendations.

Water quality results from the first four years of the Red Top Farms study[2] indicate that producers can have a profound impact on the amount of nitrate leaching from their fields. Nitrate (No_3-N) concentrations in 1995-96 drainage waters (subsurface drainage tile) at the start of the demonstration were typically 20-25 mg/l. These numbers appeared to be typical ranges found under tile-drainage fields in southern Minnesota. By simply changing several basic nitrogen management strategies during the 1997 corn season, significant water quality improvements were observed. The farmer at Red Top switched to a spring-applied nitrogen program and lowered his fertilizer inputs to take the full 40 lb./acre legume credit from the previous year soybeans. Implementation of existing Nitrogen BMPs and University of MN Fertilizer Recommendations for southern MN resulted in a 40-60% reduction in the nitrate concentrations and no yield loss. Additionally, the results have been extremely positive for the majority of pesticide products that have been studied at the site since 1996. Figure 39 shows the decrease in nitrate within the tile water of the demonstration field at Red Top after key nitrogen management changes occurred.

[2] Minnesota Department of Agriculture, Red Top Farm Demonstration Site, Montgomery & Wotzka, 2000.

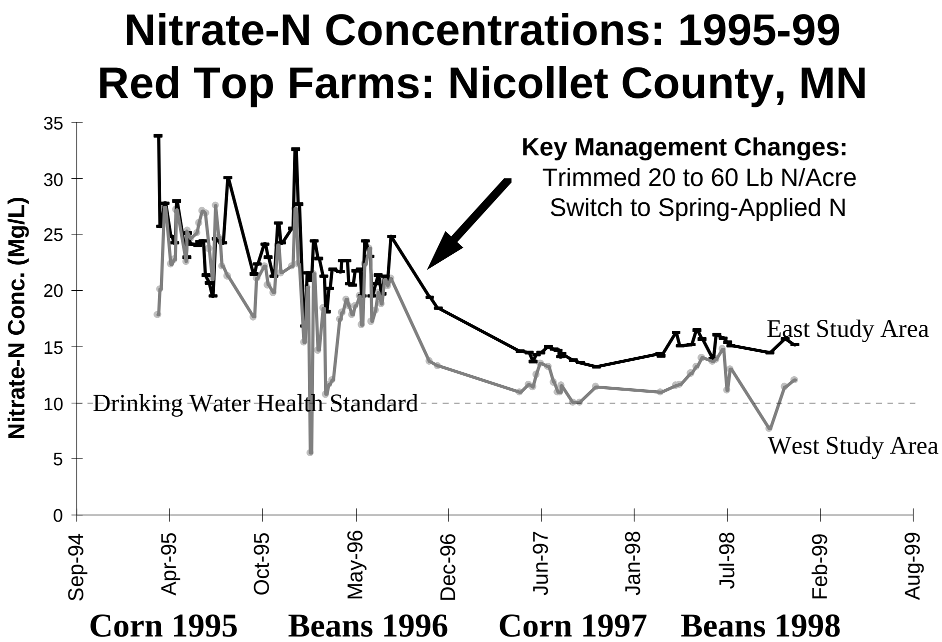


Figure 39. Nitrate reductions at Red Top Farms Study (1995-1999). Sub-surface tile drainage from two 30-acre fields is monitored for nitrate-nitrogen at the Nicollet County farm. The graphic above shows the response after improvements in nitrogen management were implemented. By simply changing several basic nitrogen management strategies, reductions of 40-60% were documented.

With intensive nutrient management activities in the watershed, similar reductions are feasible. In SMC, a combination of key education based nitrogen management changes on corn acres and utilization of floodplains and wetlands, **a 40% reduction in nitrate concentrations and yields would be aggressive yet attainable in ten years. This translates to a long-term flow-weighted mean concentration goal of about 8.5 mg/l or 16.0 lb./acre yield at the mouth of the watershed.**

Pathogens

Concentrations above 200 col./100ml were observed during both high flows and low flows indicating feedlot/manure spreading acres and septics. Overall, fecal coliform bacteria levels in Seven Mile Creek are of concern due to the high recreational use of the waters by park visitors. Upgrading all the failing septics and proper manure management will have a very large impact on reducing bacteria levels. This should be of concern for park visitors and managers. **As such, the goal of this project is to consistently meet state water quality standards for fecal coliform bacteria.** (below 200 col./100ml)

Biological-Fishery

Management plans have been documented for the creek regarding the biological structure, and informal fisheries goals by the DNR have been set as a result of fish surveys. Game fish such as walleye, northern pike, and small mouth bass have been present in the lower creek area during spawning periods and their presence should be of special concern to the area along with the stocked trout populations. The following are general informal guidelines presented by the DNR.

- **No net increase in public drainage for the watershed.**
- **Increase of water storage within the watershed through the use of wetlands.**
- **Maintain adequate DO, pH and temperature levels suitable for trout production.**
- **Maintain temperature levels below 70 ^{o}F.**
- **Maintain DO levels above 6 mg/l.**

Realistic Water Quality Goals for the Watershed within a 5-10 year time period:

- **25% reduction in TSS**
- **25% reduction in Phosphorus**
- **40% reduction in Nitrates**
- **Fecal Bacteria below 200col./100 ml at all times**

===

With all these goals in mind an estimated total of:

- **1678 tons of soil/ year**
- **2.7 tons of phosphorus/year**
- **125 tons of nitrate/year**

could be reduced from entering the impaired TMDL designated reach of the Minnesota River from Seven Mile Creek every year.

Chapter 8 Implementation Plan

Introduction

Analysis of data from the two-year water resource investigation shows that reductions in sediment, nitrate-nitrogen, and phosphorus would contribute to improvements in the water quality of Seven Mile Creek and Minnesota River. The technical committee has identified several premeditative actions, which will result in lower amounts of these non-point source derived contaminants. When completed, the implementation plan for the watershed will help to achieve:

- 25% reduction in TSS
- 25% reduction in Phosphorus
- 40% reduction in Nitrates
- Fecal Bacteria below 200col. /100 ml at all times
- Greater habitat quality for fish and other aquatic life
- Increased habitat for wildlife
- More sustainable agriculture

Watershed team members realize that the scope of the environmental and water quality concerns in the Minnesota River Basin and small watersheds like Seven Mile require solutions on a scale commensurate with the magnitude of the problems. Possible federal legislation to change the current farm bill from a corn/soybean-based subsidy to a conservation-based subsidy through the Conservation Security Act is an example of this scale. Likewise, the scale of the implementation plan of Seven Mile Creek does not rely on one funding source or focus on one particular strategy. The implementation plan is designed to be holistic, taking into account the entire ecosystem. As many groups as possible were pulled together to make the implementation plan sustainable, powerful, and long lasting. The project brings together and leverages the experience of farmers, consultants, private enterprise, researchers, local, state, and federal agencies, private organizations, and farmer funded commodity organizations to help address the water quality concerns for Seven Mile Creek. The watershed project is truly an example of leveraging many stakeholders to ensure a successful grassroots watershed effort.

The implementation plan is based on three major components. Those components are education, demonstrations, and structural practices. The implementation plan is based on three years. Many water quality improvement tools to reduce non-point source pollution will be utilized. The success of the project will be documented through watershed resident behavior surveys, before and after the project, as well as intensive long-term monitoring.

Water storage within the watershed of Seven Mile Creek is considered the most important best management practice. Proper nutrient management would have the second largest positive impact on water quality.

Education Based

- Nitrogen Rate Demonstrations that will show producers and fertilizer dealers Economic Optimal Nitrogen Rates thereby encouraging a more efficient rate of nitrogen and decreasing "insurance nitrogen." The goal is to obtain as many farmers to participate in the program.

- Hold workshops and one to one training in cooperation with an agronomic consulting firm to share with farmers a new record keeping system to ultimately enhance and simplify nutrient management decisions. Watershed staff will also be trained.

- Promote the use of minimal tillage or no tillage of soybean residue within the watershed.

- Work with schools, citizen groups and County Park staff for educating ecosystem based natural resources management. Develop environmental education display in kiosk within County Park.

Demonstration Based

- Incorporate rye vegetation as a cover crop after soybean or corn harvest to reduce wind, and soil erosion while at the same time decreasing nitrogen leaching. Use rye on Red Top Farms Research Fields and other farms. Disseminate the information via field days.

- Host strip tillage demonstrations within the watershed.

- Promote soil, and manure testing.

Structural Based

- Work with dairies and producers to incorporate alfalfa along drainage ditches or target areas as identified by the Revised Universal Soil Loss Equation.

- Install continuous signup CRP-Filter Strips and riparian strips on the remainder of tributaries within the watershed. Also install buffer strips along the cropped upland and steep sloped transitional interfaces. Assuming a 100-foot buffer along all ditches or tributaries in the system, this would account for 600 acres. Acquiring 300 acres or roughly half of the eligible riparian areas would be an aggressive yet realistic goal considering the time frame.

- Install waterways in critical areas identified by watershed inventories.

- Construct or restore wetlands in critical areas for water storage and de-nitrification purposes utilizing the CREP permanent easement program, or new Federal Farmed Wetland Pilot Program, along with the McKnight Foundation. Divert nearby sub-surface tile lines into structure to further increase de-nitrification. Three sites are currently being proposed for CREP or FWP enrollment through the SWCD and NRCS.

- Install rock cross-vane structures at Highway 99 site for dual purposes. The placement of the rocks within the stream channel will redirect stream flows away from an eroding bank site. Design the cross vane to direct the more frequent 5 year storms into a floodplain area for storage and de-nitrification purposes. This will also serve as a demonstration for other watershed projects. The SWCD board and staff will help administer this program.

- Convert open tile intakes to gravel inlets to reduce field derived sediment and phosphorus loads. Goal is to convert 50 intakes or about 20% of the open intakes within the watershed.

- Fix non-complying septic systems. Goal is to upgrade 70 non-complying homes. This would account for over 70% of the non-complying homes within the watershed.

- Help match efforts to restore in stream trout fishery habitat.

Water quality monitoring, and watershed modeling will continue throughout the scope of the project to improve BMP implementation and communication. Along with the fore mentioned, surveys and interviews will be conducted before and after the watershed project to track behavioral changes and the overall success of the watershed project.

Included within this chapter is: a list of those groups which will be involved in the second phase of the water quality project, why the particular voluntary Best Management Practices (BMPs) were selected, activities to reduce the pollutants of concern, how some of the practices listed above will be implemented and their net effect on the water quality. Last of all, a budget needed to carry out the proposed activities is included at the end.

The watershed project is requesting $196,432 in grants from the Minnesota Clean Water Partnership Phase II Implementation program to carry out the proposed water quality improvement strategies. An additional $550,000 in low-interest loan money is being requested from the MPCA to upgrade non-complying septic systems. An additional $19,380 in cash is being leveraged from Nicollet county and other grant sources (SWCD $4,500, Environmental Services $2,500 and DNR Environmental Partnerships $7,380). An additional $120,000 from the McKnight foundation could be leveraged if a recent grant request is funded[1]. This brings the total grant amount to $765,812. With in-kind matching sources from the paired watershed study, and other watershed partner allocations, it is estimated that over 1,000,000 dollars has been leveraged for this watershed project. An equivalent full time person will be hired to coordinate and administer the proposed activities. The preliminary implementation plan contained within this chapter covers a time frame of three years; we expect that these activities can be completed by spring of 2005.

Watershed Partners

- Center for Agricultural Partnerships Midwestern Water Quality Project, Based in North Carolina

- Blue Earth Agronomics-Private Consulting Firm based in Lake Crystal, MN

- McKnight Foundation. Possible funding source for the use and study of wetlands as a nitrate reduction practice. Private grant foundation, Minneapolis, MN.

[1] **Representatives from the McKnight Foundation have interviewed BNC Water Board staff and knowledge of approval will take place in the spring of 2002. McKnight Foundation cash contributions are not included in the overall cash budget since the request has not been secured as of the time of this report write-up.**

- University of Minnesota School of Public Health. Craig Hedberg, University Professor and others have been involved in DNA fingerprinting of bacteria, E. Coli, and other new bacteria monitoring techniques. This type of information will help further the understanding of potentially harmful bacteria sources and ways to fix them. Preliminary data was collected in Seven Mile this in 2001.

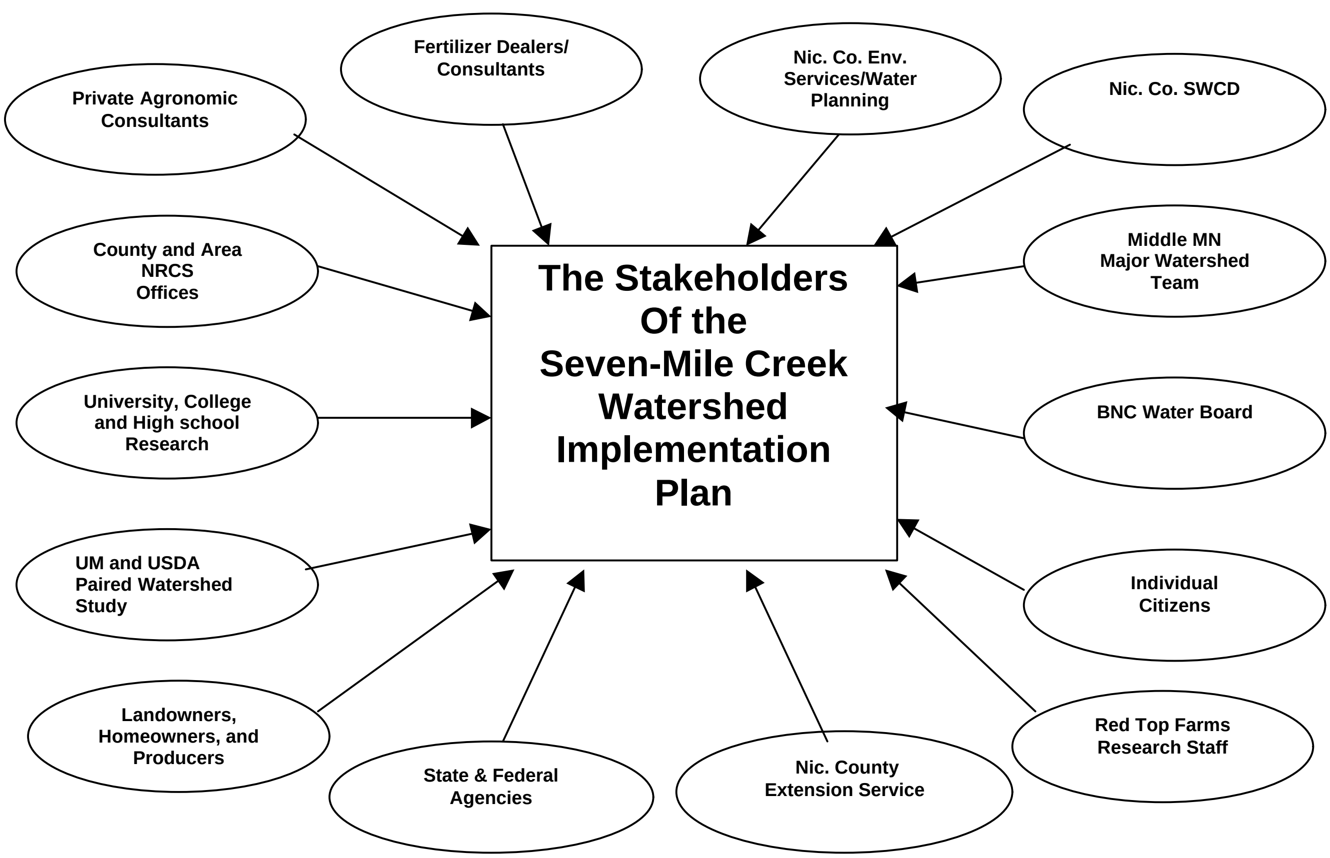
- Iowa State University-William Crumpton-Dept of Biology and Engineering. Assisting with the design, location, and cost/benefit analysis for the use of wetlands as nitrate reduction practices in Seven Mile and Little Cottonwood River Watersheds.

- Paired Watershed Study Team. The study is being conducted under leadership from Dave Mulla, Professor at the University of MN, Department of Soil, Water, and Climate. Includes numerous people at all levels: local, state and federal agencies, universities as well as private groups and businesses.

- Northern Plains Dairy. Working relationship has been established between owners and design engineers of proposed 3,000-cow dairy operation within the watershed. Based out of LeSueur MN.

- Nicollet County NRCS, SWCD and Environmental Services.

Implementation Plan Stakeholders



The Nicollet County Soil and Water Conservation District, NRCS, BNC Water Board, water planning, and Environmental Services will be the major facilitators of the implementation plan. Technical designs/engineering, landowner and public relations will be the main role of the SWCD. Education, public relations and management of the septic loan program will be the main responsibilities of the latter two agencies. Projects and consulting will be contracted for those aspects of the plan which agency staff are not qualified to administer.

Best Management Practices

Best Management Practices (BMPs) are defined as those practices, techniques, or measures for preventing or reducing source pollution to a level compatible with water quality goals.[2] BMPs are voluntary practices, which have been scientifically proven through public and private research to improve water quality while at the same time ensuring profit to the landowner and/or producer.

The basis for selecting the BMPs for Seven Mile Creek implementation was based on the following factors:

- Wetter Clays and Silts Agro-ecoregion as developed by U of M and NRCS
- Sediment and nutrient modeling
- Cost of implementing the practice and the respective water quality improvement effectiveness.
- Discussions with watershed residents, SWCDs, NRCS employees, Department of Natural Resources, and other conservation agencies.
- Realistic adoption of the proposed voluntary BMPs by watershed residents.
- Secondary benefits. Habitat for wildlife, general increases in plant, animal and fish diversity, overall enhancement of food production sustainability, and soil quality.
- Recommendations from the Minnesota River Citizens Advisory Committee.

Results of the Citizens Advisory Committee for the Minnesota River as compiled by the MN River Joint Powers Board

1. Restore floodplains and riparian areas
2. Restore wetlands
3. Manage drainage ditches as tributaries
4. Improve land management practices
5. Monitor water quality-track improvements
6. Establish a MN River Commission
7. Establish a Joint Powers Board
8. Improve Technical Assistance
9. Engage the general public
10. Enforce existing law

[2] Descriptions of BMPs taken from, Agriculture and Water Quality; Best Management Practices for Minnesota, and U. S. Department of Agriculture, Natural Resources Conservation Service, Conservation Choices.

Implementation Plan Structure

The BMP implementation plan consists of six major program elements.

1. **Initial Activities**
   - **Work plan development**
   - **Organizing Committees**
   - **Travel**
2. **Best Management Practices**

A. Nutrient Management

- **Phosphorus/Soil Tests**
- **Manure Mgt. Promotions and Demo**
- **Nitrogen Rate/ Timing Promos**
- **Travel**

B. Vegetative Practices

- **CRP Filters/CREP/WRP**
- **Riparian Strips**
- **Alternative crops-cover crops**
- **Waterways**
- **Travel**

C. Primary Tillage Systems

- **Conservation Tillage**
- **Minimum Tillage-soybean acres**
- **Travel**

D. Structural Practices

- **Tile Outlet to Wetland**
- **Wetland Restorations and FWP**
- **Stream Diversions and Rock Inlets**
- **Stream Bank Stabilization and Rock Vanes**
- **Septic System Upgrades**
- **Fish Habitat Improvements**
- **Travel**

3. Monitoring

- **Flow and Water Quality Measurements**
- **TISWA , Inventory, TMDL, and Land Use Assessments**
- **E. Coli DNA and Other Special Bacteria Assessments**
- **Travel**

4. Education and Outreach

- **Newsletters and Mailings**
- **Community Activities**
- **Basin Cooperative Activities**
- **Paried Watershed Collaboratives**
- **Professional & Education**
- **Website Development**
- **Travel**

5. **Data Management and Analysis**
    - **GIS Updates**
    - **Modeling**
    - **Technical Committee Review**
    - **Report Writing**
    - **Travel**

6. **Administration**
    - **Communications**
    - **Fiscal Activities**
    - **Project Direction**
    - **Office Management**
    - **Travel**

Activities to reduce sediments (TSS)

The proposed implementation activities will contribute to a reduction in the amount of soil entering the watershed. Upland non-point source controls include installation of filter strips along ditches and creeks, installation of rock inlets in tiled areas and grass waterways in sloped areas, and promotion of reduced tillage systems. Minimum tillage or no tillage of soybean stubble will be encouraged. Within the riparian area, stream bank stabilization will occur at a highly visible site along a highway. With the help of potential McKnight funding, the use of rock-cross vanes will be utilized to redirect flows away from eroding stream banks. As a second benefit the rock structures will be designed to redirect flows into existing floodplains for further pollution treatments.

Activities to reduce nutrients (phosphorus and nitrogen)

Since nitrates are quite high for this size of watershed, a very large portion of the implementation project will concentrate on the reduction of nutrients. Wetlands, and N -rate demonstrations will be key management strategies. In addition, new management practices such as the use of Rye as a cover crop to reduce soil erosion and decrease nitrogen leaching will be demonstrated within the watershed.

Key phosphorus reduction strategies are listed below.

- Conservation tillage
- Soil Testing
- Banding of fertilizer or injection/incorporation of manure
- Proper record keeping for manure applications
- Proper manure spreader calibration

- Lab analysis of manure nutrient content
- Reductions in animal feed P content
- Use of accurate yields goals to make fertilizer recommendations
- Buffer Strips/ Grassed Waterways
- Replacement of surface tile intakes with gravel inlets

Some of the above projects will also result in lower amounts bacteria entering Seven Mile. Other activities with this goal in mind are: the establishment of nutrient management test plots, animal waste management promotions, and upgrades for onsite sewage treatment systems.

Activities to provide overall water quality improvement

A few of our proposed remediations will provide substantial reductions in sediments and nutrients. Restoration of wetlands and the construction of sediment control basins will allow for settling of suspended solids and nutrient assimilation/deposition. It is felt water storage is perhaps one of the largest and most important BMPs to the project. The CREP program and Farmed Wetland Program will help facilitate this effort. Education is proposed to continue the long-term effort to raise public awareness of impacts on water resources.

BMP 1. Nutrient Management-CAP Project

This program element will be the largest expenditure. Sources of implementation will be derived mainly from the Clean Water Partnership, Center For Agricultural Partnerships (CAP) N-Rate Project, agronomic consulting services, and Red Top Farms research fields.

Nutrient management involves careful management of all aspects of soil fertility, so that crop needs are met while minimizing losses to surface and groundwater supplies. This requires management of nutrients applied to the soil including commercial fertilizers and manure as well as in-place nutrients. Soil tests to determine existing nutrient levels are essential to nutrient management, and are necessary to determine the appropriate fertilizer requirements for a specific soil. The fertilizer application rate should be calculated by using soil test results and Minnesota Extension Service recommendations. The fertilizer application rate should consider the crop, soil type, previous crops, history of manure application, and method of fertilizer placement.

Nutrient management has been shown to have a very beneficial effect on water quality. Through use of proper rates, placement and timing of fertilizer application, loss of nitrogen and phosphorus can be reduced by 50% to 90%. It is easily the most effective way to reduce transport of soluble forms of nutrients to surface and groundwater. Sound nutrient management also reduces input costs, thereby increasing the profitability of crop production.

Despite years of scientific research clearly linking current nutrient management practices to water quality issues and hence, gulf hypoxia problems and lake eutrification problems, and despite efforts detailing changes in practices that can reduce the problem, the agricultural and fertilizer dealer community has been hesitant to adopt nutrient management programs or abatement practices to reduce the problem. Numerous best management practices that minimize agricultures impact on water quality are known: altering the rate, form, method, and/or timing of nitrogen application; changing cropping practices, tillage systems, installing buffer strips, and controlling drainage systems. Yet a gap continues to exist between awareness and adoption of these technologies. The implementation plan of the SMC project plans to fill these adoption gaps by utilizing on-farm nitrogen rate/economical optimum nitrogen rate demonstrations, record keeping systems, and comprehensive nutrient management plans, on a goal of 60% of the watershed cultivated acres. The CAP project will be a major facilitator of this plan. A contract with Blue Earth Agronomics will be developed to help facilitate the nutrient management as well as other related activities as they develop.

Research conducted from the two-year water quality study has clearly linked nitrogen and land use practices within the watershed to water quality in Seven Mile. This can be demonstrated by the high nitrate loads, 1996 FANMAP nutrient management survey of producers, hydrology/drainage changes, and nitrogen mass balance work. Further promotion and development of the CAP project will be a major initiative within program element 2a. Specifically the SMC project will be partner with the CAP project by serving as CAP project representatives within seven mile creek, setting up plots, disseminating and tracking data, promotion, and encouraging participation. In addition to BNC Water Board and Seven Mile Creek Project there are many other partners including: Minnesota Corn Growers Association, iFARM Group, Precision Agriculture Center-University of Minnesota, National Alliance of Independent Crop Consultants, Corn Economics Group.

The Center for Agricultural Partnerships' Midwestern Water Quality Project is designed to develop and implement cost effective and information intensive nitrogen management systems over large acreage that will benefit the environment and farmers. By creating strong working relationships on the ground with growers, consultants, commodity organizations, universities, lenders and key agricultural businesses the project will achieve the following objectives:

1) Design and implement an information intensive system of field practices for nitrogen management decision-making based on objective field measurements that reduce environmental impacts;

2) Measure and evaluate the impacts of implementing nitrogen management systems at the individual field and regional watershed levels including changes in on-farm decision-making, nutrient usage, acres affected, yield, cost, and net revenue; and

3) Disseminate project progress and results to a) increase adoption and implementation of the nitrogen management system in subsequent years on additional farms, and b) demonstrate to both agricultural and non-agricultural audiences the on-farm benefits as well as the broader water quality and wildlife benefits to the Minnesota and Mississippi River Basins.

The outcomes of the project include: diagnostic tools to identify farmer/consultant decision-making processes to design compatible and effective education, training, and implementation efforts; a field record-keeping system to be used by farmers and consultants to document, quantify, evaluate, and demonstrate benefits from and changes in nitrogen management practices; and a communications program to generate awareness and inform the public on the value of information intensive nitrogen management to farm profitability and the environment.

The Issues

Many producers firmly believe that most land grant university fertilizer recommendations are too conservative and, as a result, frequently use nitrogen rates 20 to 60 lb/A more than the crop can effectively use. For example in the wellhead protection area of St. Peter, over 90% of the corn acres were receiving 30+ lb/A compared to UM recommendations. Convincing producers that these lower rates will perform under a variety of climatic conditions can be difficult. One effective method is to conduct "on-farm" strip trials over several growing seasons. Figure 40 illustrates the design used at Red Top and is currently being expanded to 10 additional farms in the St. Peter Wellhead Protection area in 2000.

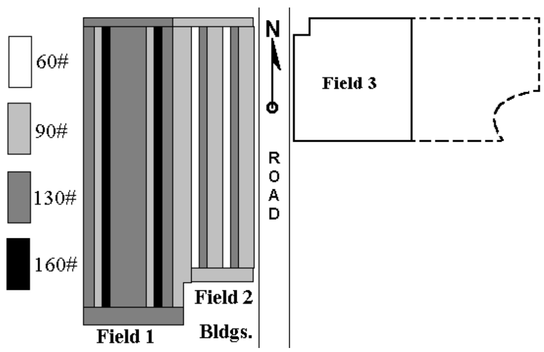


Figure 40. Design of the nitrogen rate strips used in 1997 and 1999 at Red Top Farms.

How CAP works.

Farmers with yield monitors enroll into the project and agree to apply five different rates (60, 90,120,150,180 lbs/acre) of nitrogen on a 50-acre field. The field is geo-referenced and soil types are delineated. After harvest, the GPS yield monitor information is sent to the Precision Agriculture Center-University of Minnesota and Blue Earth Agronomics of Lake Crystal. There the data is statistically analyzed. Economic optimum nitrogen rates are developed. The project also looks at soil types, plant population, seed rate, and other variables to determine the most profitable rate of nitrogen application for each participant. The data collected could help farmers in two ways. First, a better understanding of the nutrient needs of a specific plot could increase a producer's net profits by increasing yields or reducing nitrogen application costs. Second, the data could provide producers with a degree of protection in the event of government regulation of nutrient application rates. Examples of data collected from five farms in around the Seven Mile Creek Project can be found in figures 41 and 42. Results from this study show that the economically optimum N rate for corn ranges from 90-118 lb/ac, significantly less than the typical application rates of 145-185 lb/ac. The theory behind supporting this type of work in Seven Mile is that eventually producers will gradually reduce their rates to levels parallel with University of MN Extension recommendations (120lb./acre). Ultimately, it is hoped producers will make better well-informed decisions and demand a more economical type of fertilizer rate from their dealers and applicators.

Eventually it is hoped the farmers will cut back to UM of Recs. over time. It is estimated that the producers and fertilizer dealers are over applying N by 34 lbs./acre. This equates to an additional 170 tons of potentially leachable fertilizer that may not be needed by the crop every year. This equates to a $75,000 loss for the corn producers. In other words farmers could save $7.50/acre if they trimmed N rates.

Currently 10 farmers within the watershed, accounting for 2,000 acres of the watershed are enrolled in the program. A goal of an additional 10 farmers will be facilitated through the Seven Mile CWP. In return for participating in the project, the farmers receive $500 for possible yield loss and field set up time. In addition, the farmers receive a book containing geo-referenced maps including field boundary & soil type, yield & moisture, nitrogen application, nitrogen summary of results, result summary done on all the plot fields which will be used in educational and communication efforts, and access to a copy of the project data pool through advisor.

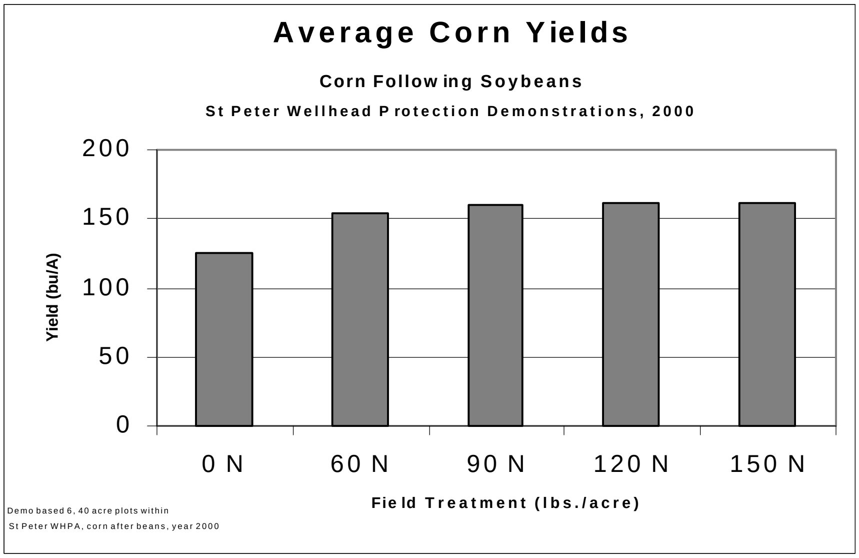


Figure 41. Average corn yields for different nitrogen applications.

Table 35. Economic analysis of nitrogen rates for five producers.

Farm	r^{2*}	Maximum Net Return ($)	Optimum Nitrogen Rate (lbs/ac)
A	0.99	588	118
B	0.74	506	107
C	0.98	553	117
D	0.99	571	108
E	0.52	531	77

**Fitting a quadratic model*

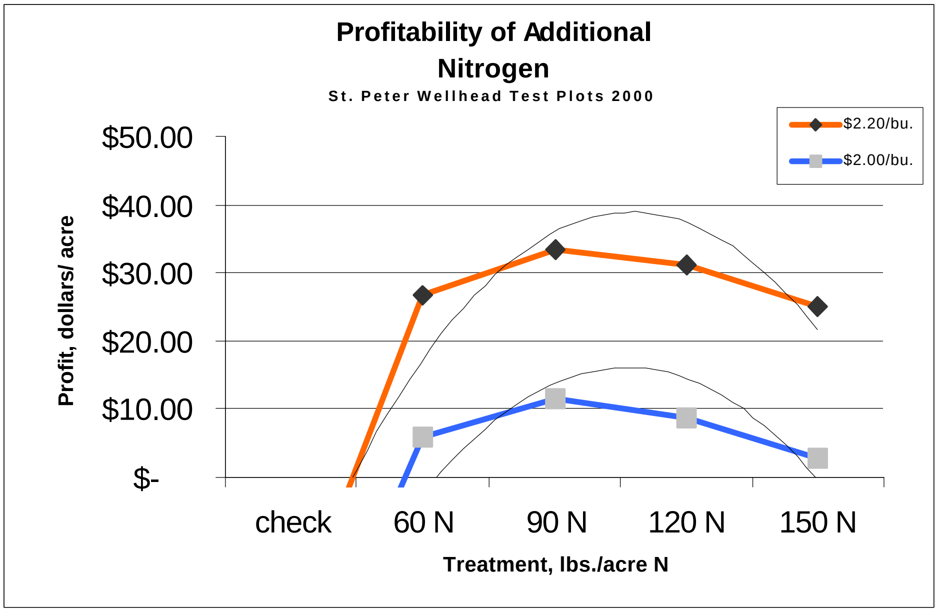


Figure 42. Profitability vs. nitrogen treatment.

Other initiatives involve consultation with fertilizer dealers, and private agronomic consultants to provide the following:

- Train farmers and watershed cooperators how to use field collection software to geo-reference all relevant information, such as tile intakes, buffer strips, weeds, diseases, etc., for inclusion in a GIS record-keeping system
- Establish training courses to help teach watershed farmers how to implement an extensive GIS record-keeping system, to include all field operations, such as crop (rye, corn, soybeans), planting (variety, date, seeding rate), pesticide (product, date, rate, environmental conditions), fertilizer (rate, date, type) tillage, etc.
- Continue to provide and distribute information on the Midwestern Water Quality Project through presentations at watershed meetings.
- Help develop and implement other nutrient management components of the project, such as possible strip till and rye cover crop demonstrations.

  Included in these demonstrations would be:
  - the development of demonstration protocols and farmer/participant agreements
  - contracting watershed farmers to participate in demonstrations
  - coordinating and monitoring of applications or treatments within the project fields
  - geo-referencing of demonstration fields and data associated with the study

- collecting and analyzing of data (yield, crop, planting date, etc.)
- generating reports and disseminating data to participating farmers and the BNC Water Quality Board

BMP 2. USDA and University of Minnesota Paired Watershed Study

Producers have been reluctant to adopt new management practices without research documenting the environmental improvement gained, as well as the direct and indirect costs from potential yield reductions. This project allows producers to get directly involved in determining which BMPs are more feasible for adoption, what they will cost to adopt, and how effective they are at reducing non-point source pollution.

Recently a USDA paired watershed study was funded for nutrient reductions. The farmer led and initiated, is a project to accelerate the voluntary adoption of BMPs for nutrient management in the MN River Basin, and improve waters quality. Farmers have helped to assemble a team of UM soil scientists, economists, and extension educators, local government water planners, state agricultural training and education personnel, BNC water board staff, and local government and policy makers to conduct paired watershed studies in two minor watersheds in western Nicollet County (minor watershed 28074 and 28075) along with Seven-Mile Creek (minor watershed 28062 and 28066). Specific objectives of the project use vigorous scientific approaches to:

1) Work with producers and agency personnel to develop a menu of BMP options that are feasible for adoption, maintain crop and animal productivity, and are effective at reducing nutrient losses from cultivate cropland to the MN River basin.

2) Measure the extent of water quality improvements in a Huelskamp Creek minorshed after implementation of BMPs relative to paired minorshed adjacent to the study watershed without BMP implementation. In addition compare the paired watersheds with a watershed that is undergoing a conventional local government led watershed project (Seven Mile proposed Clean Water Partnership) with the control and artificially induce BMP watershed.

3) Estimate the costs and benefits of water quality improvements achieved in paired watershed studies, and assess the potential for differential economic impacts of specific BMPs based on selected producer characteristics.

4) Develop public education programming to increase the adoption of BMPs pertaining to the MN River basin thereby improving water quality and maintaining farm productivity.

As apart of this paired watershed study, the Seven Mile project will benefit greatly in terms of increased in-kind support. It is estimated that about $20,000 will be leveraged from the paired watershed study.

- Increased educational strategies with the development of fact sheets and brochures and field days.

- ADAPT Water Quality Modeling-Very intensive and robust model, which evaluates the long-term impacts of changes in farm nutrient management. Used to simulate nutrient loads given certain “what if scenarios.”

BMP 3. Red Top Farms –Cover Crops such as Rye for de-nitrification purposes

Red Top Report

The ability to demonstrate the effectiveness of Best Management Practices (BMPs) is in an important component in the 1989 Ground Water Protection and Clean Water Act. A ninety-acre site located on the Red Top Farm near St. Peter provides a unique opportunity to study the quality and quantity of water and agricultural chemicals moving through the subsurface tile drainage system. Results from Red Top fills a critical gap between university research, which is typically conducted on a small-scale under a very controlled environment, and effectiveness on a production-scale.

For the last five years, two 60-acre fields in watershed 2 of Seven Mile Creek watershed had been monitored for nitrate and pesticide losses from tile line drains before and after adoption of reduced rates of nitrogen fertilizer application. In response to reduced nitrogen fertilizer application rates, tile drain nitrate rates tile drain nitrate concentrations decreased from over 25 mg/l to about 12 mg/l (figure 43). Implementation of existing nitrogen BMPs and University of Minnesota Fertilizer Recommendations resulted in a significant reduction in fertilizer inputs, maintained yields, and appears to have decreased nitrogen losses by 40 to 50 percent. Additionally, the results have been extremely positive for the majority of pesticide products that have been studied since 1996.

The overall concept of Red Top has proven to be a highly effective educational approach for farmers, agricultural professionals, and the non-agricultural community. The site has hosted many educational field days and has been featured in numerous agricultural magazines and newspaper articles.

Red Top Farms will be a great asset to the watershed project and therefore is included in the CWP implementation phase. Specifically the watershed will work closely with Red Top by:

- Incorporation of rye and organic sources of nitrogen such as manure on Red Top Farm Research fields and other fields in the watershed to assess the water quality benefits feasibility, and real world agricultural applications. Northern Plains Dairy could be a very large stakeholder in this research as well.

- Continue to evaluate crop response to various rates of N in corn-soybean rotations on soils specific to watershed producers.

- Increase producer's confidence in UM Nitrogen recommendations (120 lbs. N/acre).

- Host educational field days and promotional materials for watershed residents and conservation groups.

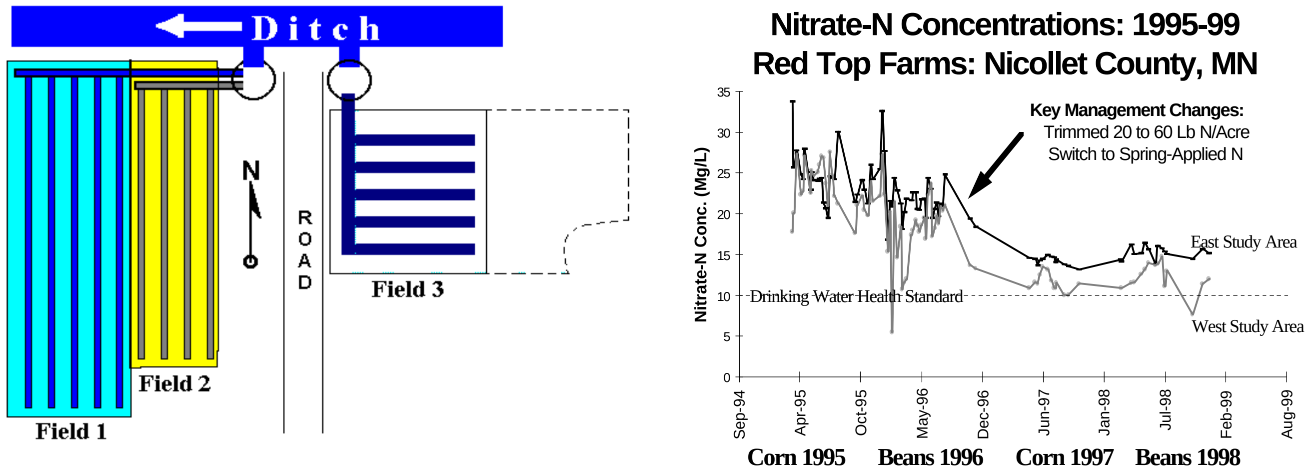


Figure 43. Field layout and nitrate concentrations at Red Top Farms.

BMP 4. McKnight Foundation Grant Proposal-Denritification, Bank erosion restoration and water storage

On September 28 of 2001, a representative from the McKnight Foundation interviewed BNC Water Board Staff after review of wetland demonstration project proposal submission. Possible funding could occur by January of 2002.

Wetland restoration or development can be achieved through use of small structures such as dikes to add water or regulate water levels in an existing wetland. Restoration can also be achieved by filling a surface drain or removing a subsurface drain. County or judicial ditches can also be modified to temporarily impound water. This practice is consistent with M.S. 103E, and can be accomplished in a way that does not impede drainage functions.

Wetlands are efficient sediment traps, preventing soil particles and attached pollutants from reaching lakes and streams. They also provide some removal of dissolved nutrients from runoff during the growing season. Wetlands provide habitat for waterfowl and other wildlife species and serve an important storage function in the watershed to help reduce peak stream flow.

In combination with traditional best management practices to reduce non-point source pollution it is felt that diversion of high pollution water through storage structures is one of the only few realistic ways to achieve water resource goals while considering the social, economic, and political systems within the watershed basin. Through the possibility of McKnight Foundation and CWP funding, project staff will treat nitrogen and high flows in two ways using wetland/detention practices. The first involves utilizing natural floodplain to reduce nitrogen and second involves diverting subsurface tile lines into existing or restored wetlands to further treatment of nitrogen and high flow events. The theory is that once water is detained for at least 2-3 days, anaerobic bacteria which thrive in those types of conditions will consume oxygen from No_3 thereby reducing it to N_2 gas (denitrification)

In Seven Mile, three potential sites have been identified. The following describes one of the proposed sites near a drainage ditch in which steam flows could be diverted away from an eroding stream bank and at the same time increase the frequency of (5-10 year storms) floodplain access through the use of rock cross-vane structures. Map 35 shows the location of the possible nitrogen, stream bank and flow reduction mitigation site. In addition there are currently two to three 20-acre wetland complexes that have the possibility of being enrolled into the CREP program within watershed 2. If the wetlands are enrolled into the program, the project hopes to divert subsurface tile lines into the wetlands to further nitrate reductions. Monitoring before and after the wetlands would also take place.

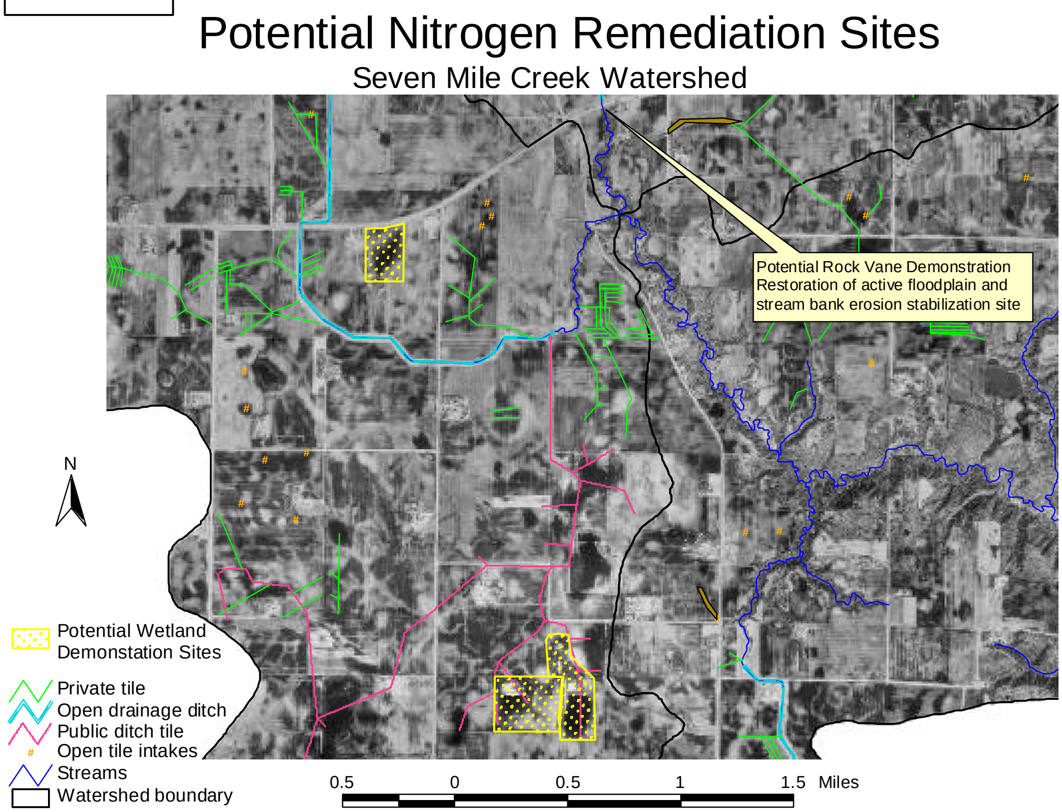
Riparian Nitrate-nitrogen Treatment Wetlands

Joe Magner

This proposal seeks nitrate-nitrogen load reduction in the Minnesota River by intercepting moderately high flow runoff at strategic locations in the Middle Minnesota watershed.

Seven Mile Creek has a significant grade change below state highway 99. There is a wooded riparian area that has several acres of accessible floodplain. The plan at this location would involve the construction of a cross-vain in the Seven Mile Creek channel. The cross-vain would consist of large diameter rock placed at the bankfull or channel forming stage. This low head structure will cause moderate or frequent floods (1-5-year) to spread more fully across the accessible riparian floodplain. Because of the change in hydraulic gradient in this reach, flood water will tend to have a slightly longer hydraulic residence time. We anticipate the combination of increased hydraulic residence along with vegetative contact will reduce nitrate-nitrogen concentrations in Seven Mile Creek by 2005.These systems are designed to be low maintenance, however, snag removal will be necessary to prevent off-shoot plugging and any channel or bank erosion. Nitrate-nitrogen loads and concentrations will be measured entering and exiting treatment wetlands to assess the effectiveness of the nitrate-nitrogen removal.

Map 35



Why Special Wetlands?

The Board and staff have identified eight reasons for trying this pilot project now:

1. The watershed projects have the data and data analysis sufficient to demonstrate the need for the wetland installations and to provide good evaluation of their effectiveness throughout the timeline of the project.

2. To effectively reduce pollutant loads and address the magnitude of the nutrient problems in south-central Minnesota watersheds, the natural denitrification processes found in wetlands and floodplains are needed to treat the high nitrate waters.

3. Success of this project in Iowa (Raccoon River Watershed) and Illinois (Des Plaines River Watershed) warrants its replication here.

4. The component of nutrient and sediment loading that comes from bank erosion is substantial enough to warrant a deceleration of the waters as would be afforded by the rock vane components. In Seven Mile Creek watershed it is estimated that 50% of the sediment load is derived from bank erosion. Most of this is attributed to increased surface and tile drainage within the watershed over the past century along with climatic changes.

5. These projects are at the early stages of implementation; adding these installations would enhance their overall visibility.

6. These projects have a large number of collaborators; the group consensus is that the timing is right to try additional and innovative remediation strategies.

7. Utilizing the Conservation Reserve Enhancement Program (CREP) makes this effort very timely. Ideally, SWP sites would be on CREP lands or have CREP eligibility. The Minnesota River CREP program ends September 30, 2002.

8. Leveraging of labor, education, monitoring by piggybacking on the existing projects such as Clean Water Partnerships, McKnight Foundation, and CREP will help keep the costs relatively low.

BMP 5.

Riparian Buffer Strips and Set-aside Programs

Riparian buffers consist of trees and other and other vegetation located in areas adjacent to streams and drainage ditches. The presence of permanent vegetation along a waterway is primarily designed to intercept surface runoff and help trap or remove nutrients, sediment, organic matter, pesticides, and other pollutants prior to entry of surface waters. Riparian buffers also serve to stabilize eroding banks and increase wildlife nesting and food habitat. Sediment delivery reductions up to 80% have been reported on 4% slopes where buffers have been installed.

(Implementation for SMC)

Another major component of the SMC Implementation Plan is to facilitate the enrollment of agricultural land into federal and state set-aside programs. Specifically, areas that will be targeted are riparian corridors (areas within 100 feet of drainage ditch or intermittent stream). Project staff will work individually with each producer to explain programs (CREP, CRP, Continuous CRP, RIM, WRP, SMC project programs, and others) to encourage participation, and to assist with program applications.

The strategy for increasing CRP buffers will consist of:

- Initial letter to all watershed landowners advertising the program and staff working with it.

- The mass watershed mailing will be followed by an actual $/acre calculation using GIS digital orthophotos, soil maps, and CRP excel spreadsheet. The calculations will show an air photo outlining eligible continuous CRP acres on each individual's property. A follow up phone call and visit to high priority areas will follow the mailing.

Farmed Wetland Pilot Program

The watershed project will try to take advantage of the many state and federal programs that already exist. Besides the CREP program, the new pilot Farmed Wetland Program (FWP) will be promoted to increase water storage and nitrogen treatment.

There is a new option for landowners with wetlands and prior converted cropland. The Farmable Wetland Pilot Project (FWP) is a new CRP practice that allows landowners to enroll small wetlands and prior converted cropland into a conservation program. The FWP falls under the CRP continuous sign-up so there is no competition or bidding process. The voluntary program offers annual rental rate payments and cost share assistance to establish resource cover on eligible land. Payments are very similar to those someone would receive for enrolling a grass filter strip. Eligibility requirements are:

- Row cropping history of at least 3 of the last 10 years
- No land on a flood plain is eligible
- Maximum wetland size is 5 acres
- Buffers enrolled around the wetland may not exceed three times the size of the wetland or 150 feet in width, whichever option is greater

Both producers and the environment stand to benefit from the FWP. First, landowners receive regular competitive payments for the retirement of marginal cropland. Payments are for 10 to 15 years depending on the length of the contract. Second, the FWP provides a good alternative to the Wetlands Reserve Program (WRP) as small sites do not generally compete well for WRP funding. Finally, enrolling land in the FWP will improve water quality, reduce flooding and enhance wildlife habitat while maintaining or even improving a landowner's bottom line.

BMP 6.

SMC Filter Strip

This conservation program is designed to be more flexible compared to the previous two programs, however does not pay as much per acre. This program was tailored to the needs of the SMC watershed and was designed to be flexible for the landowner therefore increasing overall participation. It was modeled after the very successful Lake Hanska Filter Strip Program.

A goal of five acres will be installed, mainly along cropped tributaries of SMC, waterways and highly erosive transitional areas. The vegetative buffer strip will be established for 10 years. SWCD Stage Cost-share paper work will be utilized for the contracts. A payment of $1000 per acre is the incentive payment for a minimum ten-year commitment. Strip widths between 33 and 200 feet will vary, depending on the width needed to be effective. Seeding will be of either warm season or cool season grasses. Unlike CREP and CRP, this program allows the filter strip to be utilized for a hay crop if desired between August 1-15 with a minimum stubble height of 8". Demand for this program would mainly come form dairy farmers near the middle and lower portion of the watershed. This project will not be encouraged to the extent of the CRP program, however where gaps exist this program is an option.

BMP 7.

Grassed Waterways

A grassed waterway is a natural or constructed channel, usually broad and shallow, that is planted with grass to protect soil from erosion by concentrated storm flow. Runoff water that flows down the drainage way flows across the grass rather than eroding soil and forming a gully. An outlet is often installed at the base of the drainage way to stabilize the waterway and prevent a new gully from forming.

Grassed waterways are estimated to reduce sediment losses from the flow area by 60 to 80 percent. Although grassed waterways act as a filter to remove sediment from runoff, waterways should not be utilized primarily as a filter strip because siltation leads to reduced filtering capacity. Likewise, the watershed above a waterway should be treated to control erosion before construction to prevent the waterway from prematurely filling in with sediment. Vegetation may be difficult to establish in a waterway, so erosion control barriers or mulching may be needed during vegetative establishment.

The watershed survey indicated many areas where waterways would be especially affective in controlling sediment and phosphorus runoff. A goal to install waterways on all of these areas is being proposed for the watershed. The SMC project would utilize state and federal programs as well as SMC filter strips to increase enrollment.

BMP 8.

Rock Inlets and other Tile Intake Alternatives

Rock Inlets

Surface, or open tile inlets are believed to be a direct pathway for sediment and nutrients to reach surface water. Although they are a useful component of cropland drainage systems, they do not allow for adequate filtration of runoff.

A counter practice to surface inlets is that of rock inlets. There are several configurations of this practice, but most commonly, it requires a fabric-covered perforated tile placed in a trench and connected to the existing tile line. The trench is filled with varying sizes of rock to one foot above ground level. This system eliminates the above-ground tile inlet. Normally this trench is approximately twelve feet long by three feet wide and three feet deep. Runoff from the surrounding landscape is filtered through the trench rather than drained through a pipe as before. Preliminary research indicates that approximately one-half of the sediment delivered through surface inlets are delivered through rock inlets.

Because rock inlets do not substantially interfere with use of farm machinery, they are well received within the farming community. Crops can be planted over the inlets, but care should be taken around them when doing tillage. Maintenance needs are limited to removing and replacing the top twelve inches of rock after drainage efficiencies have decreased.

Photo 13. Rock inlet installed by BNC staff in Lake Hanska watershed.

The project proposes to cost share replacement of open tile intakes with gravel inlets at a cost share rate of 75%. It is estimated that approximately 300 open tile intakes exist within the watershed. At an average cost of $250.00 per install this would cost a total of $75,000 or $56,250 when cost shared at 75%. Since open intakes account for an estimated 10-15% of the sediment and phosphorus in Seven Mile Creek, about 12% from the implementation budget will go to this effort. This equate to roughly $14,000 needed for approximately 55 open tile intake replacements. The rock Inlet program will model after Carver Co. SWCD and the successful Lake Hanska Project Rock inlet Program. The design is simple in that sediment and therefore attached phosphorus is reduced since runoff is filtered through a bed of rock before reaching the tile line. Currently BWSR and NRCS is looking at cost share for this, but has not decided as of this date until further research has been completed in regard to the rock inlets longevity. SMC project would help increase the enrollment of rock inlets, and alternatives such as close pattern tiling to mitigate the negative effects of open intakes. As ongoing research through the University of MN-LeSueur County Rock Inlet Research Site-Donny Eiler Farm, and other studies become available it will be incorporated into the promotion and use of this practice.

BMP 9.

Livestock and Feedlot Waste Management

Rain Gutter Construction

Livestock waste management practices are important methods of addressing nutrient concentrations in area streams. One cost effective way to keep runoff from feedlots entering waterways is through clean water diversion. By helping cost share roof gutters and other water diversion practices on barns and pole sheds, clean rainwater is kept away from stored manure sources. Constructing roof gutters on buildings near feedlots is a very cost effective an popular way in reducing potential manure runoff into waterways.

Spreading Acres

Runoff from feedlots is not considered a very large contribution to pollution problems within the watershed. A more efficient use of watershed resources will be directed toward proper manure management such as crediting, manure testing and incorporation. A Agronomic consultant will be contracted to perform proper manure handling, crediting and spreading within the watershed.

BMP 10.

Residue Management

Residue management is the practice of leaving last year's crop residue on the soil surface by limiting tillage. Tillage practices (conservation tillage) that leave at least 30% of the soil surface covered with crop residue are suitable to achieve adequate residue management. No-till, mulch till, and ridge till are three of the various techniques used to meet the 30% residue coverage rate.

Conservation tillage is effective for controlling soil erosion and helps control loss of nutrients that are attached to soil particles. Time, energy and labor savings from fewer tillage trips are related benefits of reduced tillage. These savings can offset the cost of tillage equipment needed to achieve adequate residue management. Residue management also helps maintain or develop good soil health, improve water infiltration and reduce evaporation from the soil surface while providing food and cover for wildlife.

The practice of residue management (>30% residue) does create additional challenges for the farmer. Factors such as crop sequence, soil texture and drainage, and climate must be considered. Under heavy residue conditions, well-drained soils are generally better suited to reduced tillage than poorly drained soils. Soil warming and drying can be delayed in the spring if high levels of residue are left on poorly drained soils.

Within the SMC watershed, loans from the AG BMP program will be used to help farmers purchase conservation tillage equipment at reduced rates. Since most of the watershed upland soil erosion occurs on the more highly erodible soybean stubble, minimum or no tillage will be promoted on soybean ground. Strip tillage demonstrations with cooperation of local dealerships will also be considered. Nicollet County Extension, NRCS, and SWCDs will be large contributors to this part of the plan.

BMP 11.

Individual Sewage Treatment Systems (Septic Systems)

Septic systems are recognized as an acceptable means for treating wastewater. The system consists of a septic tank and drain field. The septic tank provides a place for large solids to settle and to be decomposed by microorganisms. The drain field removes fine solids and destroys accompanying bacteria. Effluent from a septic tank contains solids, phosphorus, nitrogen, chloride, bacteria, viruses, and organic chemicals. For this reason, it is illegal to discharge a septic tank directly to a tile line or other surface water.

Pollutants from a properly sited, installed, and maintained septic system will be adequately treated within two to three feet below the drain field. Soil characteristics are important considerations in the design and installation of septic systems. A poorly functioning septic system is a threat to the water quality of nearby streams, lakes, and groundwater. Routine maintenance is critical to prevent septic system failure. The tank should be inspected at least once every year, and, with ordinary use and care, the tank should be pumped every one to three years.

Based on historical and current data acquired form ES of Nicollet County, it is estimated that approximately 96 of the 160 homes (60%) within the watershed have non-complying septic systems and therefore pose an imminent threat to human health (ITHH). In other words the septic system has a holding tank however does not have a drain field to treat the unsettled portion of the human waste effluent. In most cases the septic tank is connected to the nearest subsurface drainage tile. Due to the expansive network of sub-sufrace field drainage tile, this effluent eventually reaches the drainage ditches and Seven Mile Creek. High fecal coliform and phosphorus levels during low flow periods reconfirm these findings. The implementation plan for SMC requests $550,000 in state revolving funds (SRF) or low interest loan money for upgrading non-complying septics. Septic system upgrades within this watershed average $7500. More expensive mound systems are needed due to the extremely slow percolation rate of the Canisteo, Nicollet, Webster soil associations. The loan amount request would therefore upgrade over 70% (73 homes) of the non-complying homes within the watershed and reduce the immanent threat to public health dramatically. It is estimated that about 15% of the phosphorus load could be reduced as a result of upgrading these systems and fecal coliform bacteria levels at low flow periods could be cut in half. The county feels all of this money could be used to upgrade non-complying systems within the watershed and would take about 2-4 years. The program has been very successful in the past for updating septics and the grant request from the phase II is highly supportive by Nicollet County. The program would be administered through the Nicollet County Zoning and Planning office and environmental offices. The money would be transferred into already established “septic

BMP 12.

Streambank Restoration

Streambank erosion is a continually occurring natural condition that can be greatly accelerated by human activity. Over time, natural streams tend to reach equilibrium so that erosion at one location is roughly balanced by deposition at another. Human alterations to hydrologic and stream flow patterns can, however, upset this balance and lead to severe consequences. Streambank failure, defined as the collapse or slippage of a large mass of bank material into the steam, is one example of what happens when this balance is upset.

Because of the complexity of physical processes affecting streams, there is not one single type of streambank failure, but may different types. Consequently, streambank protection or restoration practices must be tailored to the specific causes of the streambank problem. Through an understanding of the problem’s cause and selection of the proper bank protection method, the likelihood of protecting an eroding streambank is significantly increased.

Bioengineering represents an attractive alternative to the use of rock riprap for streambank protection. This approach combines mechanical, biological, and ecological concepts to arrest and prevent shallow slope failures and erosion. Immediate soil reinforcement is achieved by specific plant arrangements at the site. In conjunction with the vegetative cover, structures should also be used. Structures stabilize slopes during the critical time for seed germination and root growth. A well-established root zone will provide shear strength and resistance to sliding. Overall benefits of bioengineering practices include slope stabilization, improved infiltration, runoff filtration, excess moisture transpiration, ground temperature moderation, habitat improvement, and aesthetic enhancement.

Bioengineering techniques can be used to develop sustainable systems for slope or streambank protection. The combination of correct assessments of stream corridors along with bioengineering practices has proven to be cost effective and environmentally sensitive. Installations can be labor intensive, but less costly than conventional engineering solutions.

Within the watershed, "hot spots" where excessive stream bank erosion is occurring will be stabilized according to SWCD and NRCS recommendations.

Table 36. SEVEN MILE CREEK IMPLEMENTATION PLAN - CASH EXPENDITURES

Program Element	Labor Hours	Labor Total*	Travel	Equipment & Supplies	Technical & Contracts	Educational Materials	Total
1 Initial Activities	180	4,915	50				4,964
2A. Nutrient Management	770	21,021	650	240	18,500	250	40,661
2B. Vegetative Practices	860	23,478	500	220	8,000	250	32,448
2C. Primary Tillage Systems	210	5,733	150	100	5,639	100	11,722
2D. Structural Practices	540	14,742	550	465	10,000	500	26,257
3 Monitoring	700	19,110	1,750	5,000	14,900		40,766
4 Education & Outreach	500	13,650	600	1,328	2,000	3,000	20,578
5 Data & Planning	440	12,012	500	1,000	4,450	250	18,212
6 Administration	480	13,104	400		6,700		20,204
Totals	4,680	127,764	5,156	8,353	70,189	4,350	215,812

* Labor is calculated at $ 27.30 per hour salary & fringe benefits averaged over the three-year period

Table 37. SEVEN MILE CREEK IMPLEMENTATION PLAN IN-KIND CONTRIBUTIONS

Program Element	BNC WQB	Nic. County	Colleges & U of MN	Citizens	Businsses	Basin Team	Brown Nic. E. H.	NRCS	State Agencies	Totals	Other In-Kind (not counted in CWP Budget)
1	1,915									1,915	
2A					21,500				5,000	26,o00	
2B		4,950			1,500					6,450	15,655
2C		1,650							3,000	4,650	
2D		3,850		550,000				1,000	3,300	558,150	120,000
3			2,200				9,000		4,500	13,700	
4	2,635				500	820			3,020	6,975	
5		5,250	20,000		500			1,000	2,000	28,750	
6	16,715							1,365		18,080	
Totals	21,265	15,700	22,200	550,000	23,500	820	9,000	3,365	18,820	664,670	135,655

Seven Mile Creek Budget

Clean Water Partnership Implementation

Program Element		Cash	In-Kind	In-Kind Support Agency	TOTAL	NA/IK	
1. Initial Activity							
	Workplan Development	$2,730.00	$1,365.00	BNC	$4,095.00		
	Organizing Committees	$2,184.00	$550.00	BNC	$2,734.00		
	Travel	$50.00			$50.00		
	Subtotal	**$4,964.00**	**$1,915.00**		**$6,879.00**		
2. BMPs							
2A. Nutrient Management							
	Phosphorus/Soil Testing	$9,144.00	$4,000.00	Blue Earth Agronomics	$13,144.00		
	Manure Mgmt. Promotions & Demo	$10,782.00	$4,000.00	N. Plains/MDA/Blue Earth Agronomics	$14,782.00		
	Nitrogen Rate/Timing Promos	$20,085.00	$18,250.00	CAP-Blue Earth Agronomics	$38,335.00		
	Travel	$650.00			$650.00		
		$40,661.00					
2B. Vegetative Practices							
	CRP Filters/CREP/FWP	$1,092.00			$1,092.00	$15,655.00	CREP
	Riparian Strips	$10,368.00	$3,150.00	SWCD/NPD	$13,518.00		
	Alternative crops-cover crops- ex. rye	$16,250.00	$1,650.00	SWCD,NRCS	$17,900.00		
	Waterways	$4,238.00	$1,650.00	SWCD,NRCS	$5,888.00		
	Travel	$500.00			$500.00		
		$32,448.00					
2C. Primary Tillage Systems							
	Conservation Tillage	$10,253.00	$1,650.00	BWSR	$11,903.00		
	Minimum tillage-soybeans	$1,319.00	$3,000.00	MDA	$4,319.00		
	Travel	$150.00			$150.00		
		$11,722.00					
2D. Structural Practices							
	Tile Outlet to Wetland	$2,641.00	$1,650.00	SWCD,NRCS	$4,291.00		
	Wetland Restorations	$7,000.00	$2,050.00	SWCD,NRCS	$9,050.00	$35,000.00	McKnight
	Stream Diversions and Rock Inlets	$13,000.00	$500.00	SWCD,NRCS	$13,500.00	35,000.00	McKnight
	Stream Bank Stabilization and rock vanes	$1,000.00			$1,000.00	$20,000.00	McKnight
	Septic System Upgrades	$1,545.00	$554,400.00	ESD & Citizens	$555,945.00		
	Fish Habitat Improvements	$521.00	$3,300.00	DNR	$3,821.00		
	Travel	$550.00			$550.00		
		$26,257.00					
	Subtotal	**$111,088.00**	**$595,250.00**		**$706,338.00**	$135,655	

3. Monitoring					
	Flow & WQ Measurements	$35,990.00	$11,500.00	BNEH/Met C.	$47,490.00
	TISWA & Land Use Assessments	$1,638.00			$1,638.00
	E. Coli DNA & Other Special Assessment	$1,638.00	$2,200.00	SPH-U of M	$3,838.00
	Travel	$1,500.00			$1,500.00
	Subtotal	**$40,766.00**	**$13,700.00**		**$54,466.00**
4. Education & Outreach					
	Newsletters & Mailings	$5,365.00	$2,635.00	BNC	$8,000.00
	Community Activities	$5,822.00	$3,520.00	NP and MES	$9,342.00
	Basin Cooperative Activities	$1,911.00	$820.00	Middle MN Team	$2,731.00
	Paired Watershed Collaboratives	$2,730.00			$2,730.00
	Professional & Education	$3,138.00		Extension	$3,138.00
	Website Development	$1,092.00			$1,092.00
	Travel	$520.00			$520.00
	Subtotal	**$20,578.00**	**$6,975.00**		**$27,553.00**
5. Data Management & Analysis					
	GIS Updates	$4,934.00			$4,934.00
	Modelling	$8,160.00	$20,000.00	Paired Watershed Study	$28,160.00
	Technical Committee Review	$1,638.00	$8,750.00	All (Technical Committee)	$10,388.00
	Report Writing	$2,980.00			$2,980.00
	Travel	$500.00			$500.00
	Subtotal	**$18,212.00**	**$28,750.00**		**$46,962.00**
6. Administration					
	Communications	$5,430.00	$1,640.00	BNC	$7,070.00
	Fiscal Activities	$6,144.00	$8,460.00	BNC	$14,604.00
	Project Direction	$5,164.00	$2,457.00	BNC	$7,621.00
	Office Management	$3,066.00	$4,158.00	BNC	$7,224.00
	Travel	$400.00	$1,365.00		$1,765.00
	Subtotal	**$20,204.00**	**$18,080.00**		**$38,284.00**
	TOTALS	**$215,812.00**	**$664,670.00**		
	TOTALS NA/IK		**$135,655.00**		**$1,016,137.00**

Total Grant Amount	$215,812.00
Nicollet County & DNR Cash Contributions	$19,380.00
PCA Grant Request	$196,432.00
Low interest Loan Monies for Septics	$550,000.00
Total	$746,432.00

Nicollet County Cash Contributions		
SWCD	$4,500.00	$1,500/yr
Env. Services	$7,500.00	$2,500/yr
DNR Grant	$7,380.00	
Total	$19,380.00	

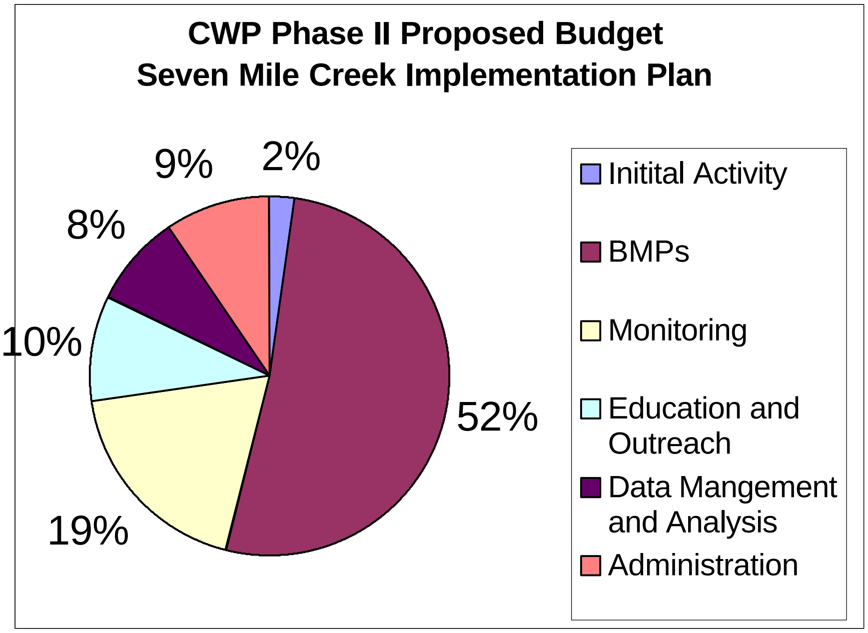


Figure 44. Proposed Seven Mile Creek budget.

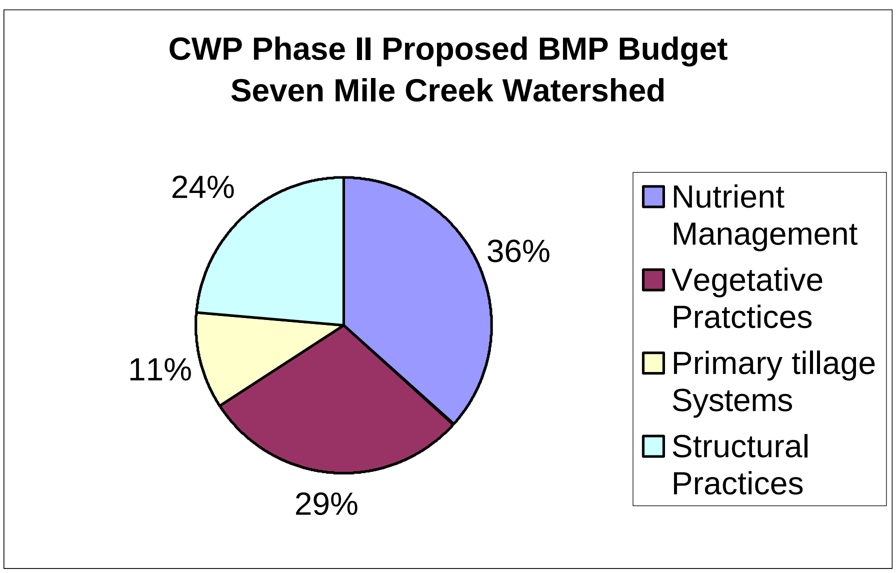


Figure 45. Proposed BMP budget for Seven Mile Creek.

Seven Mile Creek Watershed Project Milestone Schedule

Program Element	2002		2003		2004		2005
	March	Sept	March	Sept	March	Sept	March

1. Introductory Activities x----------x

Best Management Practices Activities

2A. Nutrient Management x--x

2B. Vegetative Practices x--x

2C. Primary Tillage Systems x--x

2D. Structural Practices x---x

3. Monitoring xxxxxxxx xxxxxxxx xxxxxxx

4. Education & Outreach x--------------------------throughout project timeline----------------------------------x

5. Data Management & Evaluation x--------------------------throughout project timeline----------------------------------x

6. Administration x--------------------------throughout project timeline----------------------------------x