Minnesota Pollution Control Agency

I am pleased to provide you with a copy of the state of Minnesota's 2001 – 2005 Nonpoint Source Management Program Plan (NSMPP).

Developing this document was a huge statewide undertaking. Dedicated and knowledgeable individuals and organizations interested in improving the quality of Minnesota's waters were critical to its development. In all, over 250 people, representing over 50 federal, state, and local governmental units, and public and private organizations served on the 19 technical committees that developed the 19 chapters/strategies of this document.

Only a few generations ago, waterborne diseases were a constant threat. Great progress in remedying point sources of pollution has been made in Minnesota. Among the challenges that were identified through input are contaminated runoff from agricultural and urban areas, mining and forestry operations, loss of wetlands and other habitat, degradation of water quality of rivers and lakes, and atmospheric deposition of pollutants into virtually all of our waters. How we approach this new generation of problems will determine whether we can accomplish as much in the next quarter century as we did in the last one.

As you look at this document, the level of detail on nonpoint source (NPS) policies, laws, regulations, programs and knowledge regarding NPS pollution may make an impression on you. In order to fully discuss the very broad NPS pollution area, this level was needed to fully discuss and adequately address NPS pollution.

As mentioned in the Executive Summary, this document was prepared, in part, to meet requirements of the Clean Water Act for continuation of section 319 funds to Minnesota. However, the NSMPP is intended to reach beyond this purpose by setting Minnesota's statewide NPS goals, and laying out a statewide, five-year approach for addressing water quality problems from NPS pollution. Also, the NSMPP provides guidance on NPS issues for consideration by federal, state and local governmental units in other NPS planning efforts.

We trust this document will be used routinely to guide policy and decision making on NPS water pollution issues in the coming years.

Sincerely,

Elizabeth Shevi
Division Director
Policy and Planning Division

ES:mbo

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Acknowledgments

The State of Minnesota 2001-2005 Nonpoint Source Management Program Plan (NSMPP) is a result of outstanding commitment, expertise and skills of technical committee chairs, co-chairs, technical committee members and others who contributed to the development of the chapters and strategies of this plan.

Each technical committee was chaired or co-chaired by a representative from the University of Minnesota, Minnesota Board of Water and Soil Resources, Minnesota Department of Agriculture, Minnesota Department of Health, Minnesota Department of Natural Resources, or Minnesota Pollution Control Agency. The Minnesota Pollution Control Agency coordinated overall development of the NSMPP.

Many individuals, agencies and organizations contributed to this document. In particular, representatives of the:

- Project Coordination Team
- Minnesota Board of Water and Soil Resources
- Minnesota Geological Survey
- Minnesota Planning
- Minnesota Department of Agriculture
- Minnesota Department of Health
- Minnesota Department of Natural Resources
- Minnesota Department of Transportation
- Minnesota Pollution Control Agency
- Metropolitan Council (Twin Cities Metropolitan Area)
- University of Minnesota
- U.S. Department of Agriculture
- U.S. Department of the Interior
- Minnesota Lakes Association and
- Individual Counties, Soil and Water Conservation Districts, Municipalities, Watershed Districts, businesses and other public and private organizations.

Each technical committee developed one of the 19 chapters/strategies of this plan. Twenty-five individuals chaired or co-chaired these committees. Collectively, technical committees were comprised of more than 250 members from over 50 federal, state and local governmental agencies and public and private organizations.

In recognition of their contributions, their names and the organizations they represent are presented at the beginning of each chapter/strategy of Minnesota's 2001 – 2005 Nonpoint Source Management Program Plan.

Their contributions are gratefully acknowledged and appreciated.

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EXECUTIVE SUMMARY

Minnesota 2001 – 2005 Nonpoint Source Management Program Plan

Nonpoint Source Management Program of
Section 319 Federal Clean Water Act

The Minnesota 2001 – 2005 Nonpoint Source Management Program Plan (NSMPP) is posted on the Minnesota Pollution Control Agency Web Site at:

http://www.pca.state.mn.us/water/nonpoint/mplan.html

To Receive a Compact Disk of the Minnesota 2001 – 2005 NSMPP contact the:

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- 2001 -

MINNESOTA'S 2001 – 2005 NONPOINT SOURCE MANAGEMENT PROGRAM PLAN

Executive Summary

Clean water is a necessity. People and industries, fish and wildlife, crops and forests, city and country — all need clean water to thrive. Whether we live in urban or rural areas, clean water depends on the thoughtful, informed choices of every individual, when in the house, in the yard, at work, enjoying the outdoors, or being involved in our government.

Everyone knows Minnesota is the "Land of 10,000 Lakes." But actually, we have 11,842 lakes of 10 acres or larger. Add smaller lakes and the total is above 14,000. We also have more than a trillion gallons of ground water, and 92,000 miles of streams and rivers. Three continental watersheds originate here, sending our waters north to Hudson Bay, east to the Atlantic Ocean, and south to the Gulf of Mexico via the Mississippi. Water is the dominant feature of Minnesota's landscape. Ask any Minnesotan about his or her top environmental concern and the likely response will be, "clean water."

A 1999 series of citizen forums on the environment, co-sponsored by the Governor's Office and the Minnesota Pollution Control Agency (MPCA), showed clean water as a top priority in all areas of the state. In addition, in a recent statewide citizen telephone survey, respondents were read a list of four reasons for protecting the environment, then asked how important they thought each reason was. The responses showed the public believes preserving the environment for future generations is the most important reason for protecting the environment. Other reasons given were health concerns, plants and animals, and recreational opportunities.

In addition to the positive environmental benefits of protecting our waters, clean water also impacts our state's economy. Overall, tourism contributes $10 billion annually to the Minnesota economy, supporting over 177,000 jobs. Each year, over 1.5 million anglers fish Minnesota waters, representing a tremendous pool of customers for Minnesota businesses. Total fishing related expenditures is about $846,000,000 million in Minnesota. Ninety-eight percent of Minnesota's resorts, 80 percent of campgrounds, and 24 percent of hotels/motels are on a lake and/or river.

Minnesota has made great progress in cleaning up "point sources" of pollution – discharges of municipal and industrial wastewater. It is the "nonpoint sources" – pollutants that rain and snow-melt pick up off the land and carry to surface or ground waters, or that falls from the sky with the rain or snow – that now pose the greater challenge. Both must be controlled and prevented to reach the original goal of the United States Clean Water Act (CWA) – "fishable and swimmable" waters for all Americans.

In 1987 Clean Water Act (CWA) amendments attempted to deal with a source of pollution that had not been addressed in previous CWA amendments: polluted runoff from farm fields, roads, and other diffuse sources. As point sources of pollution came under greater control, the proportion of adverse environmental conditions attributed to these nonpoint sources of pollution grew.

Minnesota's 2001 Nonpoint Source Management Program Plan (NSMPP)

Updating the NSMPP approximately every five years is a requirement for Minnesota to accept Section 319 (federal Clean Water Act) nonpoint source (NPS) funds from the U.S. Environmental Protection Agency (USEPA).

Federal Clean Water Act - Section 319

Section 319 of the CWA requires each state to assess nonpoint sources of pollution within its boundaries. State investigations must identify nonpoint sources of pollution that contribute to water quality problems, as well as waters or stream segments unlikely to meet water quality standards without additional nonpoint source controls. State management programs must;

1) run for a specific number of years (the Minnesota NSMPP runs through December 31, 2005);
2) identify the nonpoint source controls necessary;
3) specify the programs that will apply the controls;
4) certify that the state has adequate authority to implement these measures;
5) identify all sources of funding for these programs; and
6) establish a schedule for implementation.

As a minimum, Minnesota's 2001 – 2005 NSMPP was prepared to satisfy federal CWA requirements, as well as to satisfy Minn. Stat. § 103F.751 for the development of a state nonpoint source pollution control plan.

Minnesota's 2001 – 2005 NSMPP:

- Sets Minnesota 2001 – 2005 Statewide NPS Goals to address NPS pollution.

- Provides assistance to the Interagency Project Coordination Team with prioritizing future Section 319 grant awards.

- Lays out a statewide five-year (2001-2005) approach for addressing water quality problems from nonpoint source (NPS) pollution.

- Assesses emerging NPS issues and re-evaluates recommendations of the 1994 NSMPP.

- Addresses new legislation, programs, rules, studies, initiatives and knowledge regarding nonpoint source water pollution since the 1994 NSMPP.

- Provides a forum for officials from federal, state and local units of government, and private and public organizations to discuss nonpoint issues.

- Presents opportunities to representatives of federal, state, local and private organizations to develop 2001 – 2005 Action Plans recommending their priorities for 2001 – 2005.

- Includes NPS activities that officials of other NPS funding programs can use to prioritize NPS funding activities.

- Provides recommendations for consideration by federal, state and local governmental units in their NPS planning efforts.

- Details NPS policies, laws, regulations, programs and knowledge to help guide policy and decision making on NPS water pollution issues in the coming years.

What are the Challenges?

Minnesota's prosperity and quality of life depend on a healthy environment. But air and water are not constrained by geographic borders. Increasingly, environmental issues must be viewed from regional, national and even global perspectives. Factors outside the state influence our environment, and our actions in Minnesota have consequences beyond our borders. Minnesota's position near the center of North America, atop three major continental watersheds, gives us an abundance of surface and ground water, and a varied landscape of bedrock and glacial features spanning more than 3 billion years of geologic history.

Only in the last century, have human impacts on Minnesota's environment become a concern. One reason is our population, which has grown from 1.7 million in 1900 to an estimated 4.5 million in 2000. Growth brings major changes to the landscape. Suburban areas expand, taking over farmland and wildlife habitat. Sprawling development paves over sensitive areas that feed underground drinking water supplies, and sends untreated runoff into rivers and lakes.

Climate Change

Around the globe, carbon dioxide and other "greenhouse" gases are increasing in the atmosphere. In the past 130 years, the average surface temperature of the earth has risen almost two degrees Fahrenheit. It looks like the planet is warmer now than any time in the past 1,000 years.

So, what does this mean for Minnesota? Forecasting the future is full of uncertainties. However, evidence suggests the state will probably warm four to eight degrees Fahrenheit over the next century, based on projections by the Intergovernmental Panel on Climate Change and computer modeling results. We will probably experience earlier springs and later falls. We may have more intense rainfall. Plants and animals will move to Minnesota from the south and our forests will move north — which means our boreal forest in the Boundary Waters Canoe Area and Voyageurs National Park may disappear. Potentially, warming water may essentially eliminate our cold-water fishery.

As a result of these changes, heat-related illnesses and deaths could increase in Minnesota. We may experience more severe summer air pollution due to higher peak temperatures. Agriculture, forestry, fisheries and tourism — important economic sectors in the state — may be significantly affected.

Many of these potential changes are not far off in the future. They could begin soon, certainly during the lifetime of today's children. As a state, we need to determine now what we can do to reduce these potential threats.

Hypoxia in the Gulf of Mexico

When nitrogen runoff from the Mississippi River basin reaches the Gulf of Mexico, it steals oxygen from the gulf's waters. A large "dead zone" has formed, knocking out commercial fisheries and threatening aquatic life. In a typical year, about a third of the nitrogen reaching the gulf comes from Upper Midwest states, including Minnesota. Efforts are under way to control this runoff, especially in the Minnesota River basin, but repairing the damage will take many years.

Impacts of Development on the Environment

How exactly does our use of the land connect with the health of our environment? One clear connection is soil erosion. Erosion removes irreplaceable soils, and carries pesticides, organic (oxygen-consuming) materials and excess nutrients into surface waters, where they cause harm. Erosion is strongly influenced by surface cover — the kinds of plants and soil tillage patterns most common in the area.

Agricultural drainage (tile lines and constructed ditches) can improve crop yields by drying fields faster and preventing water from pooling on the land. Much of Minnesota's cropland uses drainage systems, and 200 million feet of new tile are installed each year. The environmental tradeoffs are declines in water quality and undesirable changes in water quantity, such as increased frequency and intensity of flooding.

Development can have many consequences in our watersheds as well. More roads, roofs and parking lots accelerate runoff, which gathers contaminants along its way into our waters. Without proper management of urban runoff, nutrients, toxic chemicals and organic materials pollute nearby waters.

The clear trend in Minnesota's major cities and in many smaller communities is growth. The USDA estimates that 62,000 acres per year — equal to 170 acres per day — were developed from 1992 through 1997, more than double the rate of the previous decade. If present rates continue, Minnesota will double its current area of developed land in less than 40 years.

Numerous toxic pollutants affect Minnesota's waters, for example mercury, which eventually finds its way into the tissues of fish. Consumption advisories for some game fish remain in effect due to mercury in numerous Minnesota lakes. Health officials issue the advisories to inform anglers how much fish of certain types and sizes can be safely eaten. It is not possible to test all lakes in Minnesota. However, in 2001 health officials extended consumption advice to all lakes and rivers in the state. Minnesota continues to monitor fish contamination trends while working hard to reduce atmospheric deposition of mercury, the main avenue of contamination.

Ground Water - Two-thirds of us draw our drinking water from the ground, and we are increasingly tapping ground water aquifers for other uses. Nitrate, a pollutant of concern for very young children, is found frequently in Minnesota's ground water. While some nitrate occurs naturally, higher-than-normal concentrations come from activities on or near the surface, such as use of fertilizers containing nitrogen and failing septic systems. The heavy fertilization and irrigation used for some crops can put chemically enriched water directly into shallow aquifers.

Lakes - Minnesota lakes face an uncertain future. Shoreland and watershed development, expanding uses and users, the spread of exotic species and water pollution all threaten lakes. Too much phosphorus and nitrogen, which act as fertilizer to algae and weeds, are reaching our lakes, carried in soil erosion and runoff from roads, yards, farms and septic systems.

The coming decade will be pivotal. Hundreds of crucial decisions about lakeshore development, nearby development and land use will face citizens, developers and government.

Lakes are Minnesota's most visible and valuable natural resource — the cornerstone of the recreation and tourism industry and a significant portion of many local economies. Painful experience has taught that once a lake declines, recovery is costly and can take many years. Full recovery may not be possible. Prevention is the key. What happens to Minnesota lakes and their watersheds in the next 10 years - how well we handle all the converging pressures – will essentially determine the quality of those lakes for the next 100 years.

Rivers and Streams - The best long-term data about Minnesota streams comes from measuring six key pollutants at 80 stream locations over the past four decades. On average, they show significant reductions in ammonia, biochemical oxygen demand, phosphorus, total suspended solids and fecal coliform bacteria. However, nitrogen has increased over the same period. It is important to keep in mind that some streams that show overall improvement still do not meet standards designed to protect human health, aquatic life and wildlife. Further, it is not currently possible to measure conditions of all 92,000 miles of streams.

Wetlands - The status of wetlands — which naturally filter pollutants from water, reduce flood damage and provide wildlife habitat — has also changed.

According to the Minnesota Board of Water and Soil Resources, more than 5.5 million acres of Minnesota wetlands have been lost since the early 1900s. In the early to mid-1900s, with government encouragement, landowners drained thousands of acres of wetland. In contrast, during the 1980s and 1990s, more wetland acres were lost through urban development than through agriculture, according to USDA figures. Fortunately, we now understand the importance of wetlands. They are much better protected and the loss rate has declined considerably. However, significant losses still occur from actions that do not require approvals or permits, according to the state Wetland Conservation Act report.

The 1998 national 305(b) report, titled "National Water Quality Inventory, 1998 Report to Congress" lists sources of impairment for *rivers and streams*. Nationwide, they are in order (1) Agriculture, (2) Hydromodification, (3) Urban Runoff/Storm Sewers, (4) Municipal Point Sources, (5) Resource Extraction, (6) Forestry, (7) Land Disposal and (8) Habitat Modification. Nationwide, sources of impairment for *lakes* are in order (1) Agriculture, (2) Hydromodification, (3) Urban Runoff/Storm Sewers, (4) Municipal Point Sources, (5) Atmospheric Deposition, (6) Industrial Point Sources, (7) Habitat Modification, and (8) Land Disposal.

Innovations in NPS Control

Some recent innovations for controlling nonpoint source water pollution are discussed below.

Basin Management

A basin (or drainage basin) is an area of land drained by a river and its tributaries. There are 10 major drainage basins in Minnesota, from which water flows in three directions: the Red River of the North and the Rainy River flow north to Hudson Bay; the Lake Superior Basin drains east to the Atlantic Ocean; and the remaining seven basins drain south to the Gulf of Mexico.

Each of these major watersheds in turn has numerous minor watersheds that are the drainage of the smaller tributary streams. The U.S. Geological Survey (USGS) has identified 84 major watersheds within the state's basins. The Minnesota Department of Natural Resources (MDNR) delineated these in turn into some 5,600 minor watershed units.

Key elements of Basin Management includes integration of existing programs, watershed-based permitting, identification of specific goals and priorities, and greater involvement by partners and the public in management of Minnesota's water resources.

Traditional water protection efforts under the 1972 Clean Water Act focused on controlling specific types of pollutants and pollution sources, primarily municipal and industrial. Such point source pollution issues still remain; however, the water quality problems at the forefront today include nonpoint sources of pollution. As the focus on protecting and improving water quality changes, Minnesota is moving toward a more integrated, resource-based approach. Basin management helps focus and coordinate efforts based on clearly defined water quality priorities within each of Minnesota's major basins. Basin management is discussed in Chapter 3, "Watershed Planning and Management Framework."

Total Maximum Daily Loads

A recent approach to help control water pollution is through Total Maximum Daily Loads (TMDLs). The Clean Water Act requires states to adopt water quality standards to protect the nation's waters. These standards define how much of a pollutant can be in a surface and/or ground water while still allowing it to meet its designated uses, such as for drinking water, fishing, swimming, irrigation or industrial purposes. Many of Minnesota's water resources cannot currently meet their designated uses because of pollution problems from a combination of point and nonpoint sources. TMDLs determine all sources of pollutants in a water body which is not meeting its designated uses, including nonpoint sources and those that may not be located near the water body but are in its watershed. The information is used to allocate load limits from all sources in the watershed for each pollutant in violation. Minnesota has recently begun to implement TMDLs on some water bodies as required by the Clean Water Act. TMDLs are discussed in Chapter 3, "Watershed Planning and Management Framework."

Clean Water Action Plan

The Clean Water Action Plan, released by the USEPA in February 1998, provides new federal resources for protecting the nation's waters and a new approach for doing so. Based on a broad vision of cooperative watershed protection, it integrates new protections for America's water resources and associated natural resources with traditional esthetic and human health objectives for restoring and protecting water quality. The watershed scale focus creates opportunities for comprehensive solutions to problems in specific geographic areas. This approach promotes integration of existing programs and coordination of implementation plans tailored to specific areas. The Clean Water Action Plan is discussed in Chapter 2, "Programs and Funding for Implementing NPS Program."

Integrated Funding System

The MPCA will consider proposing a strategy that would integrate the point and nonpoint source water quality grants and loans process, currently somewhat fragmented, into one system. The MPCA will begin development by focusing on the funding programs it administers. Other state and federal agencies with water quality funding programs encouraged MPCA to broaden the scope of this project to include non-MPCA funding. While these programs fund different activities, they are complementary and would be enhanced through a single process to allocate funds that have diverse sources.

This system would streamline the existing system by combining many of the administrative aspects of these funding programs, including a single funding application, integrated priorities and criteria for funding, and a unified scoring and ranking process. In addition to being more accessible by applicants, this system would eliminate duplication of effort by administering agencies.

The second component of the integrated system would be that point source (wastewater treatment) projects and nonpoint source activities would be ranked together on a single, prioritized list of projects. The overall funding priorities would focus on those established by water resource managers in the state's major drainage basins. State and federal priorities also will be incorporated in the overall system. Considering all applications for multiple funding sources together using one set of criteria and priorities will help ensure that funded projects would deliver the best environmental results for the money spent.

Funding Priorities

The Project Coordination Team (PCT) was established by statute to advise MPCA in preparation of rules, evaluate projects, and recommend to the Commissioner of MPCA those projects that the PCT believes should receive financial or technical assistance or both. After approval of assistance for a project is granted, the team reviews project activities and assists in the coordination of the state program with other state and federal resource management programs.

The PCT will consider building more local influence into the process of scoring, ranking and awarding 319 grants. The intent is to fund 319 projects that more closely reflect local NPS needs and priorities.

Environmental Quality Incentives Program

This program replaces the Agriculture Conservation Program. However, like that program, the Environmental Quality Incentives Program (EQIP) offers cost sharing for soil, water and forestry practices of long-term benefit. The Natural Resource Conservation Service (NRCS) of the U.S. Department of Agriculture administers the program. The NRCS, through Soil and Water Conservation Districts, provides technical assistance in determining where conservation activities are needed and feasible, preparing farm conservation plans, and designing specific best management practices. NRCS also supervises and certifies the proper installation of some of these practices. The EQIP is discussed in Chapter 2, "Programs and Funding for Implementing NPS Program," and Chapter 9, "Agricultural Nutrients."

Cost sharing of up to 75 percent of the total cost is available under five or 10-year contracts with farmers or ranchers for projects on eligible land designed to solve resource conservation and agricultural pollution problems. In recent years, an emphasis on water pollution control has led to use of some EQIP funding for specific nonpoint-related water quality projects.

Nonpoint State Revolving Fund Loan Program
One of the more significant funding sources for water quality protection in Minnesota is the State Revolving Fund (SRF) loan program. Traditionally, the SRF had been used exclusively for municipal wastewater treatment projects, but since 1995 the state has used SRF funds as part of its nonpoint source management program. The program uses existing state delivery systems already servicing targeted clientele.

Minnesota's Public Facilities Authority (PFA) receives the state's capitalization grant for the SRF. Under the SRF nonpoint source pollution initiative, the PFA has negotiated with lead agencies to establish funding for their respective programs. Projects receiving NPS SRF funding must meet requirements of the federal Clean Water Act, Title 3, Section 319. Minnesota's nonpoint source pollution initiative provides an innovative and flexible approach for local governments, farmers, individual homeowners, and businesses to access low-interest, environmentally directed loans. The SRF is discussed in Chapter 2, "Programs and Funding for Implementation of NPS Programs."

Introduction to Chapters/Strategies of Minnesota's 2001 Nonpoint Source Management Program Plan (NSMPP)

How serious is nonpoint source pollution in Minnesota? Chapters/strategies of the NSMPP provide information on water quality and/or public health concerns associated with NPS pollution. Here's a quick introduction to the 19 chapters/strategies of Minnesota's 2001 NSMPP.

Chapter 1. Updated Nonpoint Source Assessment

The NPS Assessment is an ongoing NPS problem identification process which was initiated in 1987 to meet the requirements of Section 319 of the Clean Water Act Amendments of 1987, as well as to evaluate the state's long-term assessment and planning needs.

The first NPS Assessment Report was completed in 1988 and designed to be a companion document to the 1988 NPS Management Program. To ensure that the assessment information more directly drives the management program milestones, both documents were combined in the 1994 NSMPP.

The USEPA requires the NPS Assessment to use all available information to describe, on a watershed basis, the nature, causes, extent and effect of NPS pollutants on state waters. Specific requirements based on USEPA guidance for the Section 319 program include the following:

- Identification of navigable waters within the state which, without additional action to control nonpoint sources of pollution cannot reasonably be expected to obtain or maintain applicable water quality standards (WQS) or support their designated uses.

- Identification of categories and subcategories of nonpoint sources which add significant pollution to each portion of a navigable water in amounts which contribute to such portion(s) not meeting WQS.

Chapter 2. Programs and Funding for Implementing Nonpoint Source Programs

The diffuse nature of nonpoint source pollution makes it very expensive to abate. Insufficient funds are the most frequently noted barrier to implementing comprehensive management programs. Amassing enough money to deal with nonpoint source pollution comprehensively even in one small area is a daunting task. A number of federal and state programs designated to prevent and abate nonpoint source pollution have been enacted to address the problem.

Water quality degradation from point sources has been largely remedied. This was accomplished, however, with substantial financial support over a long period of time. From 1972-1987, the federal government alone invested over $50 billion to help local communities build secondary wastewater treatment plants to meet requirements of the Clean Water Act. In contrast, the total Section 319 appropriation for nonpoint source pollution for the past six federal fiscal years was $805 million.

Chapter 3. Watershed Planning and Management Framework

In Minnesota, water planning occurs on many different scales, from statewide plans to local plans. These major efforts include:

- Minnesota State Water Plan 2000
- The Minnesota 2001 Nonpoint Source Management Program Plan
- Development of basin plans for the 10 major drainage basins of the state under the coordination of the MPCA
- Watershed planning efforts by groups representing major and minor watersheds in many areas of the state
- County water plans
- Planning by watershed districts and watershed management organizations (concentrated in the Red River Valley and Twin Cities metro area)

Though each level of planning has its purpose, significant workload issues at both the local and state levels can arise if local and state task-force members and staff are expected to participate in these multiple water-related planning efforts at the same time. In addition to the potential for the time frames for many of these planning efforts to overlap, there is also some lack of understanding of the purpose of these planning efforts and how they all fit together.

The purpose of Chapter 3 is twofold:

1) to identify the overall water planning framework currently in place in Minnesota, and how the different levels of planning interact and influence each other, and
2) to identify the current status of planning activities in the state's major drainage basins.

Goals for Chapters/Strategies 4 through 15 of the 2001 NSMPP

Chapters/Strategies 4 through 15 include the table, "Needs, Priorities and Milestones, 2001 – 2005 Action Plan." This Executive Summary provides only the goals for these chapters/strategies.

Recommended Action Steps detailing specific actions to be carried out during 2001-2005 are provided at the end of chapters/strategies 4 through 15 in the Needs, Priorities and Milestone tables.

Chapter 4. Overall Strategy for Each Water Resource

Because of the interrelation among 4.1 Ground Water, 4.2 Lakes, 4.3 Rivers and Streams and 4.4 Wetlands, strategies for these resources are included in Chapter 4.

4.1 Ground Water Strategy

Ground water supplies drinking water to almost 100 percent of the rural population of Minnesota and to 932 of 956 community water supply systems. Concerns over the impacts that land use and improper waste disposal practices have on ground water quality have resulted in broad-based ground water protection laws in Minnesota. The importance of potential ground water contamination through NPS activities is currently recognized in several Minnesota laws and programs (e.g., the 1989 Minnesota Ground Water Protection Act and the State Clean Water Partnership Program).

Monitoring during the past two decades has indicated widespread contamination by improper management of nonpoint sources. For example, studies conducted by the Minnesota Department of Agriculture (MDA) and the Minnesota Department of Health (MDH) indicate that certain pesticides are present in Minnesota ground water, some in hydrogeologically sensitive areas. The MPCA and the MDA concluded from examination of nitrate data from over 25,000 Minnesota wells that nitrate contamination of ground water is clearly a problem in many areas of Minnesota.

Goals 2001-2005

Goal 1: Continue The Coordination Of NPS Activities With Existing And Planned Ground Water Protection Efforts In The State.

Goal 2: Promote Education And Outreach Efforts For Implementing NPS Controls That Protect Ground Water Resources.

Goal 3: Continue Identification Of Geologically Sensitive Areas To Help Prioritize Efforts On Areas Where Ground Water Resources Are Most Susceptible To NPS Contamination.

Goal 4: Focus Resources On Areas Where Ground Water Protection Efforts Relating To NPS Contamination Are Most Worthwhile.

Goal 5: Identify NPS Contamination Sources That Are Not Being Adequately Addressed By Local, State, Or Federal Efforts.

Goal 6: Promote Hydrologic Unit Based Management Where It Provides A Mechanism For Effectively Addressing NPS Contamination Of Ground Water Resources.

Goal 7: Assist Local Governments With Developing And Implementing Ground Water Protection Programs.

Goal 8: Implement Management Strategies For Controlling NPS Impacts On Ground Water.

Goal 9: Define Measurable Objectives For Controlling NPS Impacts On Ground Water And Conduct Adequate Monitoring To Assess Results.

Goal 10: Provide Information Needed To Effectively Implement NPS Controls For Protecting Or Remediating Susceptible Ground Water Resources.

4.2 Lakes Strategy

Preserving Minnesota's nearly 14,000 lakes from nonpoint source pollution requires a balanced approach of protection and restoration, using a variety of management strategies in a structure that recognizes regional differences in lake ecology and land use. Restoring lakes with impaired uses or degraded water quality or habitat has been the major focus of management efforts in the past. This strategy identifies assessment and protection of unimpaired lakes as a higher priority. Management strategies include regulations, incentives, education, planning and acquisition.

Goals 2001-2005

Goal 1: Work With USEPA On The Development Of Ecoregion-Based Nutrient Criteria As A Part Of The Clean Water Action Plan.

Goal 2: Promote Lake Monitoring, Protection And Prioritization At The Local Level Including Local Comprehensive Plan Development And Implementation And Source Water Protection.

Goal 3: Provide Funding And Technical Assistance To Lake Watershed Management Projects Where Lake And Watershed Evaluations Have Been Conducted And Lake Water Quality Improvements Are Projected Based On Implementation Of Specific Best Management Practices (BMPs), (With An Emphasis On Protection Whenever Possible).

Goal 4: Expand The State's Lake Water Quality Database Via Conventional And New Technologies And Use Of Citizen Volunteers. Focus On Those Lakes Most Likely To Be Impacted By Development And Other Land Use Changes.

Goal 5: Develop Incentives Program For Protection Of Shoreland (Aquatic And Terrestrial) Vegetation And Broader Implementation Of BMPs.

Goal 6: Expand Information And Education On Appropriate BMPs, Ordinances And Strategies For Lake Protection.

Goal 7: Evaluate Soil-Phosphorus Fertility And Develop Management Strategies For Residential Turf, Recreational Turf (E.G., Golf Courses And Park Land) And Agricultural Lands.

Goal 8: Promote Monitoring And Compilation Of Data On Bacteria At Beaches.

Goal 9: Minimize The Impact Of Urban Storm Water Runoff To Lakes.

Goal 10: Complete Analysis Of Sediment Core And Water Quality Data From The Legislative Commission On Minnesota Resources (LCMR) "Sediment Core Lakes Project." Augment Or Complement This Data As Necessary.

Goal 11: Review Impacts To Lakes Caused By Ditch Projects And Clean-Outs.

4.3 Rivers and Streams Strategy

Streams and rivers integrate terrestrial conditions of the landscape with aquatic conditions. This interaction occurs in four processes:

1. Hydrological, relating to the movement of water
2. Geomorphic, relating to the action of water on the stream channel, riparian area, and watershed
3. Chemical, relating to the cycling of materials from the land through the water

4. Biological, relating to the processes that support plant and animal life in the stream or river and its watershed.

To assure the health of streams and rivers, effective management strategies for nonpoint source pollution must recognize the interrelation of these processes. Emphasizing one or the other will alleviate a symptom but not remove the cause. This strategy will provide some guidance for managers seeking to improve understanding of how nonpoint source pollution arises and how it can be managed, and then present goals, milestones and action steps to manage nonpoint source pollution in Minnesota's streams and rivers for the next five years

Goals 2001-2005

Goal 1: Promote Healthy Hydrological Regime For Minnesota's Streams And Rivers.

Goal 2: Promote Healthy Sediment Regime For Minnesota's Streams And Rivers.

Goal 3: Promote Healthy Nutrient Regime For Minnesota's Streams And Rivers.

Goal 4: Promote Healthy Biological Communities For Minnesota's Streams And Rivers.

Goal 5: Promote Wise Goal-Setting For Citizens And Government.

Goal 6: Support Infrastructure For Nonpoint Source Management That Is Holistic, Comprehensive And Watershed-Based, And Provides Access To Decision-Making For All Residents And Users.

Goal 7: Research, Demonstration And Education That Encourages Understanding Of Origin And Remedy For Nonpoint Source Pollution Problems.

4.4 Wetlands Strategy

Minnesota supports one of the richest wetland heritages in the coterminous United States. From the bogs and peatlands of the north, to the prairie potholes of the central and southern part of the state, wetlands are complex hydrologic systems with intrinsic values and functions. These wetland resources are recognized for their benefits and are worth maintaining. Aside from their valuable ecological functions, Minnesota wetlands provide utilitarian benefits such as improving and protecting the quality of surface and ground water by retaining storm water and filtering pollutants. Intrinsically, wetlands also provide important recreational resources, essential habitat for many plants and animals, environmental learning opportunities, and aesthetic open spaces.

Goals 2001-2005

Goal 1: Support Local Government Wetland Management And Protection Efforts.

Goal 2: Complete Or Update Wetland And Related Inventories.

Goal 3: Monitoring And Evaluation Of Wetland Resources At The State And Local Level.

Goal 4: Support Improvements In Understanding And Response To Agricultural Practices On Wetlands.

Goal 5: Improve Wetland Restoration Efforts.

Goal 6: Wetland Education And Outreach.

Goal 7: Support Improvement In Storm Water Management And Planning.

Goal 8: Promote Understanding Of Wetland Responses To Pollutants.

Goal 9: Wetland Research Needs.

Chapter 5. Monitoring

Water monitoring provides the information necessary to determine whether the quality and quantity of our water resources are adequate for the many uses they serve. Water monitoring specific to nonpoint source pollution is necessary for determining what contaminants come from nonpoint sources, as well as evaluating the success of efforts used to manage those sources. This chapter reviews past and present monitoring and makes recommendations for future directions. The monitoring strategy is consistent with, "The Minnesota Water Monitoring Plan" prepared under the auspices of the Minnesota Environmental Quality Board in April 1992. Excerpts from that document have been included in this chapter. This chapter differs from that document in that it focuses on monitoring activities with a direct relationship to nonpoint source pollution management.

Goals 2001-2005

Goal 1: Develop Baseline Data Necessary To Allow Establishment Of Good Status And Trend Information Relative To Surface Water And Ground Water At The State/Regional Level.

Goal 2: Establish Reference Conditions, Criteria Or Standards For Those Waterbody Types Or Types Of Measurement For Which Such References Do Not Currently Exist.

Goal 3: Improve Monitoring Designed To Characterize Nonpoint Source Contributions To Water Quality Problems.

Goal 4: Promote Effective Use Of BMPs Through Assessing The Improvement In Water Quality Relative To Specific Nonpoint Source Reduction Actions.

Goal 5: Design Monitoring Programs To Meet Management Information Needs, Then Use Information Obtained For Resource Management Decision-Making.

Goal 6: Improve Communication Linkages Both Between State And Local Resource Managers As Well As Among The Various Local, State And Federal Agencies Within The State For Purposes Of Expanding The Water Quality Monitoring Database And Enhancing Accessibility To It.

Chapter 6. Information and Education

Investment in education must be considered an essential and integral part of every step in the 2001 NSMPP. Education cannot be a viewed as a minor component but rather one of the many steps that must be taken to meet the plan's goals. In almost every chapter/strategy of this management plan, education is recognized as an important means of reducing water pollution from nonpoint sources.

The information and education program recommended in this chapter includes community analysis, planning, instruction, promotion, evaluation and reporting. Over the years, most of the programs funded with Section 319(h) funds and state Clean Water Partnership (CWP) funds relied on voluntary participation. For the last 10 years, about 25 percent of the Section 319(h) projects had an educational emphasis. As the CWP program continues to move forward, good information about the condition of waters and the health of aquatic systems on a watershed scale is absolutely critical. Mitigation measures will consist of education and pollution reduction incentives.

The role of information and education in Minnesota's 1994 NSMPP was to increase overall awareness and knowledge of nonpoint source pollution issues and move targeted groups toward action or behavior change.

The statewide nonpoint source information and education strategy was updated using information from ongoing and Phase 2 Clean Water Partnership projects and local county water planning. The purpose of the updated strategic planning effort was to establish specific educational requirements for the 2001 NSMPP. The idea that this strategy gets its direction from local nonpoint source educational needs is a powerful one. Respondents to the Minnesota River Education Initiative focus groups said educators do not listen to landowners enough to find out what will and what will not work. Local coalitions and participatory processes are vital to motivate local governments and citizens, and the recommended action steps laid out in this strategy focuses on these concepts. It is much easier to build public consensus for action when people feel they are protecting a particular water resource. Local educational activities should be planned with participants and partners whose mutual intent is achieving outcomes that have impacts.

Goals 2001-2005

Goal 1: Raise Public Awareness Of The General Public With Respect To The Nature Of Nonpoint Source Pollution, How Communities And Individuals Contribute To It, And What Governmental Organizations And Individuals Are Doing About It.

Goal 2: Promote Stewardship And Active Citizen Involvement By Focusing Nonpoint Source Information And Education Efforts On The Natural Resources In Which Local Audiences Have A Stake.

Goal 3: Improve Information And Education Outreach Network For Local Officials And Resource Managers.

Goal 4: Foster Coordination And Cooperation Between Governmental Agencies And Private, Nonprofit, And Other Organizations To Carry Out Information And Education Efforts.

Goal 5: Initiate Long-Term Early Education Programs That Focus On Water Quality Protection Through Nonpoint Source Controls.

Goal 6: Improve The Ability To Effectively Evaluate Nonpoint Source Information And Education Activities.

Chapter 7. Feedlots

Animal manure, when properly used as fertilizer, is a useful resource. It contains valuable nutrients such as nitrogen, phosphorus and potassium. It can improve soil quality, including aggregate stability, infiltration, water-holding capacity, aeration, soil organic-matter levels, and earthworm activity. However, animal manure improperly stored, handled, disposed of or allowed to leach or run off to surface or ground waters, can create serious water pollution hazards. These hazards include excess nitrogen, excess phosphorus, pathogens, hormones, and trace metals. The impacts of this pollution can be felt locally, regionally, or nationally, as in the issue of hypoxia in the Gulf of Mexico. A study prepared by the Minnesota Nitrogen Task Force (funded by the Minnesota State Legislature) has indicated that although Minnesota farmers are doing a good job of managing nutrients applied in commercial fertilizers, often inputs of nutrients from other sources such as manure are not credited accurately.

Nutrients in manure, useful on cropland, can promote algae and weed growth in surface waters. Manure and runoff from animal confinement and manure storage areas may also contain; 1) substances that deplete oxygen in surface waters, 2) materials such as ammonia that in high concentrations can be toxic to aquatic life, and 3) disease-causing organisms. Manure solids and soils disturbed by animal traffic on open lots may increase sediment loadings in surface waters.

Ground water concerns include potential human and animal health effects from nitrates and pathogens. Potential pathways for these pollutants to enter ground water include leakage from earthen storage basins, improperly built drinking-water wells, and recharge from polluted surface waters.

Goals 2001-2005

Goal 1: To Further Develop And Maintain Forums For Communication Between Agencies And Groups With Interests And Responsibilities Related To Animal Production, Manure Management, And Related Aspects Of Pollution Control.

Goal 2: Establish, Maintain Or Improve Effective Education And Technical Assistance Programs To Provide Consistent Information Regarding Water Quality Impacts From Animal Confinement And Manure Storage Facilities. Targeted Program Audiences Would Include Producers; Contractors; Federal, State And Local Government Agency Staff; Educators And Consultants. Local Staff Include CFOs, Zoning Officials, Water Planning Staff, Etc.

Goal 3: Increase And Improve The Information And Options Available For Design And Assessment Of Animal Confinement And Manure Storage Areas To Minimize Or Eliminate Impacts On Water Quality.

Goal 4: To Establish Flexible Programs For Financial Assistance Used To Correct Pollution Hazards From Animal Confinements And Manure Storage Areas.

Goal 5: To Provide Clear, Consistent Guidance And Requirements Related To Control Of Pollution From Animal Confinement And Manure Storage Facilities.

Goal 6: To Develop Strategies And Plans For Program And Policy Development Which Resolve Current Issues And Anticipate Future Issues Related To Pollution From Animal Production.

Chapter 8. Agricultural Erosion

Soil is one of Minnesota's most valuable resources. Minnesota's fertile topsoil and skilled agricultural producers make Minnesota one of the outstanding crop-producing regions in the world. As global population and agricultural markets increase, so does demand for the numerous products (e.g., food, clothing, and shelter) that come from the soil. It is important that this demand be translated into careful conservation and management of soil and not merely into exploitation. Minnesota's soil resources must be maintained permanently because future needs for productive soil will be even greater than those of the present.

Soil and water quality problems caused by agricultural land uses are now recognized by society as significant environmental concerns. Sediments from eroded cropland interfere with the use of water bodies for transportation, threaten investments in dams, locks, reservoirs and other developments, and degrade aquatic ecosystems. Sediments contain nutrients that accelerate the eutrophication of lakes, streams and wetlands. Compaction and declining levels of organic matter in the soil are other forms of soil degradation, which also may result in accelerated erosion and greater sedimentation.

Storm water and snowmelt runoff from cropland and pastures carry sediment nutrients, bacteria and organic contaminants into nearby lakes, streams and wetlands. Table 8.1 of this chapter indicates the water quality impacts of sediment and nutrients.

The U.S. Department of Agriculture indicates the primary source of pollution to rivers and lakes of the nation affected by nonpoint sources is agriculture. Specifically, 64 percent of affected rivers and 57 percent of the affected lakes receive most of their pollution from agricultural sources. Sediments and nutrients combine for 60 percent and 81 percent respectively, of the primary type of pollutants in rivers and lakes. Sediment accounts for nearly half of all pollutant types in the nation's rivers and over one-fifth of all pollutants in lakes.

For a broader review of the sources and impacts of nutrients on the quality of Minnesota's surface and ground waters, see Chapter 9 Agricultural Nutrients.

Goals 2001-2005

Goal 1: Improve Interagency Coordination In The Development And Implementation Of Statewide Policies And Programs Concerning Agricultural Erosion And Sediment Control.

Goal 2: Improve Technical Assistance And Education Associated With The Application And Adoption Of Best Management Practices (BMP) For Agricultural Erosion And Sediment Control.

Goal 3: Continue To Improve The Reliability And Accuracy Of Decision-Making Tools Associated With Agricultural Erosion And Sediment Control.

Goal 4: Increase The Adoption And Effectiveness Of Agricultural Erosion And Sediment Control BMPs.

Goal 5: Focus Agricultural Erosion And Sediment Control Activities In Watersheds Contributing The Most Sediment.

Chapter 9. Agricultural Nutrients

Nitrogen and phosphorus are the primary nutrients posing the greatest environmental threat to Minnesota's surface and ground waters. Nitrogen effects on humans, domestic animals, and aquatic species have been summarized for Minnesota conditions in "Nitrogen in Minnesota Ground Water" (DeLuca, 1991) and more recently in "Generic Impact Statement on Animal Agriculture" (Mulla et. al, 1999). The principal human health concern associated with nitrate consumption (via drinking water or dietary intake) is methemoglobinemia, a condition that affects the respiratory system in infants. The most recent reported case of methemoglobinemia in Minnesota was a non-fatal case that occurred in 1979. However, it is highly probable that the number of reported cases are seriously underestimated since most states, including Minnesota, do not have an established methemoglobinemia medical registry. Little is known about the long-term impacts on adults.

Eutrophication in surface waters can be rapidly accelerated by phosphorus and nitrogen enrichment and the toxic breakdown chemicals from algae decomposition pose health concerns in drinking supplies (Sharpley et. al, 1999). Recent outbreaks of pfiesteria in the Chesapeake Bay area have also been linked to excess nutrient loading.

Goals 2001-2005

Goal 1: Accelerate And Enhance Educational Programs, Implementation Of Nutrient Management Plans, And Affiliated Certification Programs Related To The Management Of Fertilizers, Manure, And Organic Sources Of Agricultural Nutrients. Targeted Audiences Should Include Farmers, Agricultural Crop Retailers, Consultants, Commercial Manure Applicators, Local And State Resource Managers, And Affiliated Agricultural Services.

Goal 2: Continue Research, Development And Refinement Of Best Management Practices That Minimize Nutrient Losses From Agricultural Systems Via Leaching, Runoff And Atmospheric Emissions. Determine Long-Term Sustainability Of BMPs On Minnesota's Water Resources And Provide Guidance And Management Tools To Resource Planners/Managers. Provide Guidance To The Agricultural Community For The Proper Selection Of BMPs And Expected Performance/Outcomes.

Goal 3: Provide Accurate Assessments Of Adoption Rates Of BMPs And Related Advancements, Establish A Framework Of "Performance Indicators" For Gauging Future Trends, And Evaluate Subsequent Impacts On Minnesota's Natural Resources Through Surface And Ground Water Monitoring Programs.

Goal 4: Develop Effective Statewide Policies For Decreasing The Transport Of Agricultural Nutrients To The State's Water Resources And Improve The Coordination Framework Necessary To Accomplish These Policies.

Chapter 10. Agricultural Pesticides

For both urban and rural landowners, the term "pest" describes many different threats to our crops and lawns, including insects, rodents, weeds, and a variety of plant diseases. To manage this vast array of pests effectively, urban and rural landowners use a variety of pest control tools and management strategies.

Finding the balance between the responsible use of pesticides and the protection of our water resources is an ongoing challenge. While certain areas of the state, including the central sand plains and the Karst regions of southeast Minnesota, are particularly vulnerable to ground water contamination, all of our surface and ground water resources need to be protected from the potential risk of contamination by pesticides.

By finding the balance, we will be able to continue using pesticides as a tool for protecting crops, shrubs, trees, lawns and gardens from pests.

Goals 2001-2005

Goal 1: Improve Water Resource Protection Decisions Through The Collection, Storage And Dissemination Of Data Related To Pesticide Products, Environmental Persistence, Toxicology And Alternative Pest Management.

Goal 2: Develop And Document Measures Of The Effectiveness Of Pest Management Practices As They Relate To Water Quality.

Goal 3: Continue To Develop Effective Educational Tools And Campaigns To Educate The Public On Pesticide Management Practices As They Relate To Water Quality.

Goal 4: Improve The Coordination And Communication Linkages Between State And Local Resource Managers, As Well As Between State Agencies.

Goal 5: Provide Information And Education To All Minnesotans On Integrated Pest Management (IPM) Practices That Can Aid In The Reduction Of Pesticide Use And Positively Affect Water Quality.

Goal 6: Continue Working With Other State And Federal Agencies On The Implementation Of IPM On State And Federally Owned Land, Particularly In The Area Of Weed Management, So As To Increase Its Use By Governmental Agencies Thereby Aiding In Their Own Efforts To Positively Impact Water Quality.

Goal 7: Increase The Understanding Of IPM And Its Environmental Benefits So That IPM Is Incorporated Into The Pest Management Plans Of K-12 Schools In Minnesota.

Chapter 11. Urban Runoff

Urban Runoff is runoff from developed or developing urban areas wherever they may be found in the state. Some major water quality concerns associated with urban runoff are: sedimentation, nutrient (phosphorus, nitrogen) runoff, oxygen demanding substances, toxic chemicals, chloride, bacteria, parasites, viruses, temperature changes on water resources and floatable trash and litter.

Many reports by the Center for Watershed Protection and others have summarized the impacts of urbanization on water resources. The two main issues can be summarized as quantity and quality. The USEPA, Metropolitan Council, U.S. Geological Survey, and the MPCA, among many others, have documented these impacts. The latest USEPA 305b report for 1998 shows urban runoff as the third leading source of pollutants causing impairment of fresh waters behind agriculture and hydromodification:

Goals 2001–2005

Goal 1: The State Should Take The Lead Role In Developing Methods To Assess The Reliability And Technical Accuracy Of Technical Evaluation And Research, And In Focusing This Evaluation And Research On Minnesota's Most Pressing Urban Issues.

Goal 2: Develop Consistent And Clear Statewide Policies On Urban Runoff Issues Through Improved Interagency Coordination.

Goal 3: Coordinate The Various Federal, State And Local Regulatory Programs So That There Is Consistency Between The Various Regulatory Requirements.

Goal 4: Increase Adoption And Improve Appropriate Application Of Urban BMPs Through Evaluation Of Existing BMPs And Identification Of New Types Of BMP's Needed To Meet Water Quality Goals In Urban Areas.

Goal 5: Establish An Effective Technical Assistance And Education Delivery System Focused On Improving Urban Water Quality Through Application Of Urban Runoff Best Management Practices. To Achieve Maximum Effectiveness, Target Audiences For Technical Assistance, Education And Information Delivery As Appropriate For Local Resource Managers And/Or The General Public.

Goal 6: To Focus BMP Planning And Implementation Activities On A Watershed Basis To More Effectively Assess The Specific Water Quality Needs And Better Demonstrate Implementation Successes.

Goal 7: To Develop Policies, BMPs And Assess The Effectiveness Of Housekeeping Practices Of Business And Municipal Separate Storm Sewer Systems Related To Urban Runoff.

Chapter 12. Forestry

Minnesota is blessed with vast acreages of forestland and an abundance of high-quality water resources. Forest management activities are extensive in nature and often take place in close proximity to or adjacent to water resources, or in wetland areas. Sustainable forest management is only possible when society's needs for forests are balanced against maintaining diverse, healthy forest ecosystems. Forest managers, landowners and operators must ensure that all forest management activities are accomplished in a manner that minimizes impacts to the environment and water quality.

Goals 2001-2005

Goal 1: Education: Improve Adoption And Use Of BMPs Through Effective Educational Programs.

Goal 2: Monitoring: Evaluate And Quantify Implementation Of BMPs.

Goal 3: BMP Development And Implementation: Continue BMP Development And Implementation Efforts To Improve The Effectiveness And Use Of BMPs And Expand The Protection Of Resources.

Goal 4: Research: Target Research Efforts To Evaluate Costs And Benefits As Well As Effectiveness Of BMPs In Reducing Negative Impacts Of Forest Management Practices.

Goal 5: Restore Forest Vegetation On Riparian Areas Through Tree Planting To Improve Water Quality, Absorb Nutrients, Restore Habitat, Provide Alternative Crop, Improve Aesthetics, Slow Flood Discharge And Trap Sediment.

Chapter 13. Mining

Historically, iron-ore mining created hundreds of mine pits, tailings basins, and stockpiles. Most pits have filled with water and although there are sections of pit walls that are eroding, the general water quality in these abandoned pits is very good. Several cities use the pit water as their drinking water supply, and some pits have been stocked with trout.

For most mining operations in Minnesota, the water quality concerns are related to the control of suspended solids and resulting turbidity and sedimentation in receiving waters. These are currently addressed by existing state programs. Site-specific issues that may need to be addressed in the future could include the following.

- Increased levels of total dissolved solids in wetlands and certain receiving waters.
- Discharge of water containing elevated concentrations of sulfate, which may impact the growth of wild rice and affect the rate of methyl mercury production.
- Releases of nitrate from fertilized areas and blasting residuals.
- Discharge of low-pH water and phosphorus from peat mining operations.
- The fate of reagents used in taconite processing.

Goals 2001-2005

Goal 1: To Develop And Test Best Management Practices (BMPs) For Non-Ferrous Mining.

Goal 2: To Identify BMPs For Sand And Gravel Operations,
- To Develop New Management Practices As Needed
- To Distribute The Information To Operators
- To Perform Follow-Up Audits To Insure That The BMPs Are Being Implemented.

Goal 3: To Develop BMPs To Control Mercury Release From Mining Areas.

Chapter 14. Land Treatment and Disposal

Strategy 14.1 Individual Sewage Treatment Systems

According to the 1990 census, 492,000 or 27 percent of the housing units in Minnesota are served by individual sewage treatment systems (ISTS). These figures reflect a 22 percent increase in the number of housing units served by an ISTS between the 1980 and 1990 censuses. The total number of housing units grew 13 percent in the same period. Assuming this same rate of growth from 1990 to 2000, about 600,000 homes currently would be served by an ISTS.

Ground water contamination is a concern from malfunctioning or inadequate ISTSs and older cesspools, seepage pits, and drywells. Surface water also can be affected by the discharge of contaminated ground water. Direct surface-water contamination is a concern from systems discharging to agricultural drain tile, ditches, or to the ground surface. These concerns are magnified in areas of higher population density.

Goals 2001-2005

Goal 1: To Have All Counties Adopt A Countywide (Vs. Shoreland Only) ISTS Ordinance (Unless All Cities And Townships Within That County Have Adopted An Ordinance).

Goal 2: To Have All LGU's Effectively Administering Their ISTS Ordinance.

Goal 3: To Effectively Enforce The ISTS Licensing Program.

Goal 4: To Increase The Knowledge And Skill Levels Of ISTS Professionals.

Goal 5: Provide Technical And Financial Assistance To Areas With Inadequate Sewage Treatment (Small Communities, Rural Subdivisions, Lakeshore Areas, Unincorporated Communities, Etc.)

Goal 6: Provide Education To Local Decision-Makers, The Public And Special Groups.

Goal 7: Increase Regulatory Control Of Operation And Maintenance Of ISTS.

Goal 8: Research New ISTS Technologies In Minnesota, Including Demonstration Projects And Information Dissemination.

Goal 9: Revise State ISTS Rules Per Needed Updates, Simplification And Flexibility.

Strategy 14.2, Land Application/Treatment of Biosolids, Industrial By-products, and Commercial Wastes

Land application/treatment of many types of wastes occurs in Minnesota. The primary categories of wastes that are land-applied include:

- Animal wastes (manure, paunch manure, and animal bedding).
- Biosolids (sewage sludge) generated from the treatment of wastewater treatment.
- Septage generated by ISTS.
- Commercial wastes from a variety of small businesses.
- Industrial by-products
- Irrigated industrial and municipal effluents.
- Landfill leachate.
- Municipal compost.
- Petroleum contaminated soils.

Goals 2001-2005

Goal 1: Evaluate Effectiveness Of Current Land Application Programs In Preventing Nonpoint Source Pollution.

Goal 2: Coordinate Efforts To Control Nonpoint Source Pollution.

Goal 3: Develop Comprehensive Risk Criteria Or Risk Evaluation Procedure For Land Application Of Wastes.

Goal 4: Improve Nutrient Management On Land Application Sites.

Goal 5: Develop And Update Type IV Certification Training And Outreach Materials.

Goal 6: Continue To Develop Permitting Program For Land Application Of Industrial By-Products.

Goal 7: Evaluate The Regulatory Needs For Land Application Of Commercial Wastes.

Chapter 15. Effects of Atmospheric Pollution on Water Quality

Pollutants in the upper atmosphere can be a significant source of pollution to surface water, particularly for acid rain, mercury, PCBs, and nutrients such as nitrogen and phosphorus. It is sometimes assumed that pollutants in urban runoff are picked up by clean precipitation running off dirty surfaces. Yet the rain itself may already contain some pollutants. In the case of urban runoff, impervious surfaces alone may create a nonpoint source pollution problem for surface water, even without considering other nonpoint sources in the watershed such as lawn care, pet feces, soil erosion, and vegetative litter.

Goal 2001 – 2005

Goal: To Develop A Quantitative Understanding Of The Effect Of Air Pollutants On Water Quality, And To Develop Appropriate Best Management Practices To Minimize The Impact Of Air Pollution On Water Resources.

Related Web Sites

Learn more about the environment and how you can help protect it, check out the following web sites focusing largely on water resources.

Minnesota Pollution Control Agency
www.pca.state.mn.us
(651) 296-6300
Detailed information on air, land and water conditions. Also kids' page, hot topics, and thousands of environmental documents and reports.

Minnesota Department of
Natural Resources
www.dnr.state.mn.us
(651) 296-6157
Recreation, hunting, wildlife and ecosystems, public water access, lake finder. Water resources management and information.

Minnesota Department of Health
www.health.state.mn.us
(651) 215-5800
Fish consumption advisories, lead safety information, drinking-water supply information, ground water.

Minnesota Board of Water and Soil Resources
www.bwsr.state.mn.us
(651) 296-3767, TTY (800) 627-3529
Local water planning, grants, Wetland Conservation Act, links to local governments."

Minnesota Department of Agriculture
http://www.mda.state.mn.us
(651) 297-2200
Information on nutrient and pesticide management practices; ground and surface-water quality; regulations for pesticides, fertilizers, weed, feed and seed.

Minnesota Environmental Quality Board
http://www.mnplan.state.mn.us/eqb/water.html
651-296-2603
Minnesota Water Management Unification Initiative, Minnesota Watermarks; Gauging the Flow of Progress 2000 – 2010 and links with other water-related information.

Minnesota Planning/Local Planning Assistance
http://www.mnplan.state.mn.us/commplan/assistancecenter.html
651-298-6550
Local Planning Assistance as a resource for communities regarding comprehensive land use planning.

Minnesota Office of Environmental Assistance
www.moea.state.mn.us
(651) 296-3417
Reducing waste, environmental education, sustainable communities.

Metropolitan Council
www.metrocouncil.org/
(651) 602-1000
Metro rivers and lakes, smart growth, wastewater treatment, watersheds.

University of Minnesota Water Resources Center
http://wrc.coafes.umn.edu/
(612) 624-9282
Connects water resources research, education, and outreach to solve local problems and simplify access to the University.

Minnesota Association of Watershed Districts
www.mnwatershed.org
(651) 452-8506
Information on general watershed issues and individual watershed districts throughout Minnesota.

Rivers Council of Minnesota
www.riversmn.org
(320) 259-6800
Information for beginners and experts alike on how to measure the health of your favorite river, develop a deeper understanding of its condition, and what to do about it.

Minnesota Lakes Association
www.mnlakesassn.org
(800) 515-LAKE or (218) 825-1909
Lake planning, management and education resources.

Minnesota Association of Soil and Water Conservation Districts
www.maswcd.org
(651) 690-9028
MASWCD is a non-profit organization that provides to Minnesota's SWCDs:
Information on Conservation Issues; Policy Development; Lobbying Services;
Coordination of Training for SWCD Board Members and Personnel; Conservation
Education; Leadership Training; and Annual Convention and Tradeshow.

U.S. Environmental Protection Agency
www.epa.gov
Huge site with lots of information including useful stuff for teachers, kids (Explorer's Club), home and office.

General environmental information
Environmental Organization Web Directory
www.webdirectory.com
Billed as the "Earth's biggest environment search engine."

The Environment: A Global Challenge
http://library.thinkquest.org/26026
Oriented toward students and teachers. Many links to environmental articles and sites.

National Library for the Environment Online
www.cnie.org/nle
Links to papers, congressional reports, environmental news sources, job opportunities in the environment.

Smart Growth
1000 Friends of Minnesota
www.1000fom.org
(651) 312-1000
Smart growth issues and maintaining Minnesota's quality of life.

What you can do
Center for a New American Dream
www.newdream.org
Reducing and shifting consumption, sound practices, simple living, building strong families and communities.

Earthshare
www.earthshare.org
Everyday tips to improve the earth, topics such as green gifts, camping, recycling, paper reduction.

Union of Concerned Scientists
www.ucsusa.org
Suggestions on what individuals can do to influence policy at community, state, and national levels.

North American Lake Management Society
(NALMS)
www.nalms.org
Lakes Appreciation Week, publications, U.S. lakes facts, volunteer monitoring.

Chapter 1 Updated NPS Assessment

Technical Committee Members
Sylvia McCollor, Minnesota Pollution Control Agency (Chair)
Carrie Bartz, Minnesota Pollution Control Agency
Elizabeth Brinsmade, Minnesota Pollution Control Agency
Jean Garvin, Minnesota Pollution Control Agency
Lynda Nelson, Minnesota Pollution Control Agency
Katrina Randall, Minnesota Pollution Control Agency
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Introduction

The Nonpoint Source (NPS) Assessment is an ongoing NPS problem identification process which was initiated in 1987 to meet the requirements of Section 319 of the Clean Water Act Amendments of 1987, as well as to evaluate the state's long term assessment and planning needs.

The first NPS Assessment Report was completed in 1988 and was designed to be a companion document to the 1988 NPS Management Program. To ensure that the assessment information more directly drives the management program milestones, both documents were combined in the 1994 Nonpoint Source Management Program Plan (NSMPP).

The 1994 report and the 2001 NSMPP are referred to only as the NPS Management Program, with the understanding that the assessment report is an integral part.

ASSESSMENT REQUIREMENTS

The United States Environmental Protection Agency (USEPA) requires the NPS Assessment to use all available information to describe, on a watershed basis, the nature, causes, extent and effect of NPS pollutants on state waters. Specific requirements based on USEPA guidance for the Section 319 program include the following:

- Identification of waters within the state which, without additional action to control nonpoint sources of pollution, cannot reasonably be expected to obtain or maintain applicable water quality standards (WQS) or support their designated uses.

- Identification of categories and subcategories of nonpoint sources or, where appropriate, particular nonpoint sources which add significant pollution to each portion of a navigable water in amounts which contribute to such portion(s) not meeting WQS.

Basin Planning

MINNESOTA'S BASIN MANAGEMENT APPROACH

The Minnesota Pollution Control Agency (MPCA) is implementing a geographically based approach for managing the state's water quality resources. This approach, called basin management, is focused around the state's ten major river basins. Key elements of this approach include emphasizing environmental results, building alliances with communities to establish shared goals, setting water quality (WQ) priorities and developing integrated point and NPS pollution reduction strategies. By focusing on hydrologic units (basins and watersheds) instead of individual sources of pollution, the Minnesota Pollution Control

Agency (MPCA) will be better able to address the cumulative effects of different types and sources of pollution. Basin management will also provide a coordination framework to help tailor strategies to the needs of specific water resources and geographical areas.

MINNESOTA'S AGREEMENT WITH THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (USEPA)

Waterbody assessments for streams and lakes are completed for 305(b) reporting. The 2000 305(b) Report (Report) reflects the Minnesota Pollution Control Agency's third reporting cycle during the transition into the basin management process. This is in lieu of the previous statewide 305(b) biennial reports required by the 1972 Clean Water Act (CWA). It is also in fulfillment of the 1995 agreement between the USEPA and the MPCA, which stated MPCA's 305(b) reporting commitments. These commitments are to update waterbody assessments at least annually and to prepare a comprehensive statewide 305(b) report after waterbody assessments for each basin have been developed through the basin management process. This agreement is also reflected in the 1999 Environmental Partnership Performance Agreement (EnPPA).

MINNESOTA'S BASIN PLANNING AND MANAGEMENT TIMELINE

The MPCA began to implement basin management in 1995. Work in the basins will be staggered and phased in over several years. Each phase will include a group of three or four basins. The MPCA's goal is to establish a rotating planning and management cycle and complete basin plans for each of Minnesota's ten basins by the year 2003.

The statewide map on page 1-5 outlines the intended phases of the basin planning cycle.

THREE BASINS REPORTED FOR 2000

Basin management began in 1996 in the Minnesota River, the Red River of the North (Red River) and Lake Superior basins. Basin planning efforts in the Lower Mississippi River, Cedar River, St. Croix River, and Upper Mississippi River basins began in 1997. Efforts for the Missouri River, Des Moines River, and Rainy River basins are just getting underway. Efforts for these last three basins will initially involve compiling information, preparing the basin information documents and beginning to create partnerships with other agencies, local governments, businesses and other organizations. The basin information documents will include waterbody assessments, a compilation of existing information on geophysical characteristics, WQ conditions and pollutant sources in the basin. These documents will also identify existing implementation activities in the basins and provide preliminary analysis of WQ problems, key issues and possible strategies for each basin. The basin information documents will serve as a starting point for discussions with partners on shared goals and pollutant reduction strategies.

The basin information documents will be submitted under separate cover from the 305(b) General and Ground Water Sections. The basic format of the MPCA's Report is displayed in the diagram on the following page.

Rivers and Streams Assessment Development

Implementing the monitoring and assessment strategy, considerable progress has been made incorporating additional data and information from other local, regional, state and federal monitoring and management entities. The MPCA actively seeks both narrative and numeric data from all sources utilizing appropriate Quality Assurance/Quality Control (QA/QC). Criteria used to determine whether to use data from other sources are outlined in the document "Minnesota Pollution Control Agency Lake and Stream Water Chemistry Monitoring QA/QC guideline for 305B Use Assessments" developed by MPCA staff. Data from the Citizen Lake Monitoring Program are used as part of the database for assessing lakes. Determinations are being made on how data from the relatively new Citizen Stream Monitoring Program can be used. Important outside sources of numeric data include the Metropolitan Council Environmental Services, United States Geological Survey, Long Term Resource Monitoring Program on the Mississippi River at Onalaska, WI, Upper Mississippi River Headwaters Board, Wisconsin DNR, Western Lake Superior Sanitary District, the National Forest Service, and the Hennepin County Conservation District. Data is used from Clean Water Partnership (CWP) projects that meet the criteria. CWP projects are funded by the MPCA and monitoring is done by local governments. Staff from other agencies contributing monitoring data have also participated in the professional judgment group process.

The major limiting factor in making use of data from external sources has been inaccessibility of some data due to diverse storage formats; lack of information on how data was collected; and difficulty of interpreting measures that lack established WQS, but have intuitive or practical value for local programs.

Two major goals of the Clean Water Act (CWA), "fishable and swimmable" waters, are assessed here in terms of aquatic life use support (ALUS) and swimming/recreation use support.

RIVERS AND STREAMS USE SUPPORT ASSESSMENT METHODOLOGY

A. Water quality standards consist of two parts: beneficial uses for a waterbody and WQ criteria to protect and support those uses.

   1) Beneficial uses are the desirable uses that WQ should support, legally defined in Minn. R. ch. 7050, to include domestic consumption, aquatic life, recreation (swimming), agriculture and wildlife, industrial consumption, and aesthetics. The level of 'use support' describes the

quality of the waterbody with respect to its designated uses. A 'use impairment' occurs when a waterbody cannot support its designated uses fully. Existing and threatened use impairments are considered WQ problems and may require corrective or preventive action.

2) Numeric WQ criteria establish the minimum chemical and physical parameters required to support a beneficial use. Physical and chemical numeric criteria may set maximum concentrations of pollutants, acceptable ranges of physical parameters, and minimum concentrations of parameters such as dissolved oxygen (DO).

B. Waterbody Delineation

Assessments of use support in Minnesota are made on individual waterbodies. The waterbody unit used for river system assessments is the river reach. Minnesota uses the USEPA Reach File 1 (RF1) river reach numbering system, augmenting it to include reaches not in RF1. A river reach is typically less than 20 miles in length and extends from one tributary river to another. Reach File 1 reaches may be further divided when there is a change in the use classification (as defined in Minn. R. ch. 7050) within a reach, or when there is a significant morphological feature such as a dam, within the reach. Each waterbody is identified by a unique waterbody identifier code, comprised of the United States Geological Survey (USGS) eight digit hydrologic unit code, plus the three digit RF1 or MPCA segment number. It is for these specific reaches that the data are evaluated.

Aquatic Life Use Support

Assessments of ALUS are conducted to determine if the waters are of a quality to support the aquatic life that would be found in the stream under the most natural conditions. Two types of data were used in the assessments: water chemistry data and biological and habitat information.
Table I-1 on pages 1-8 and 1-9 includes this information.

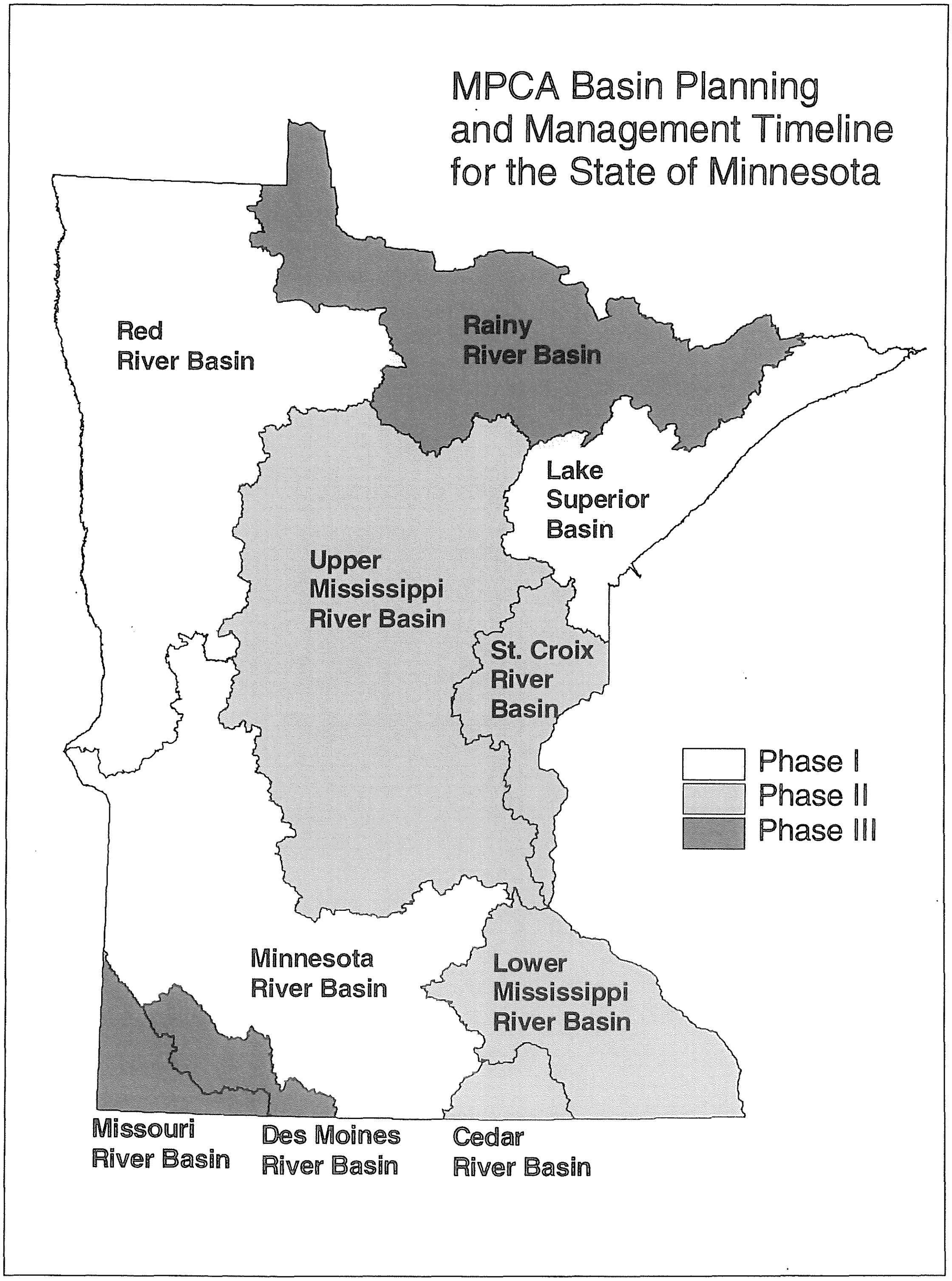
The following guidelines were used to evaluate each of the data sources for a reach, and to combine them when more than one type of information was available.

A. Water Chemistry Data

To evaluate chemical and physical parameters of WQ, the MPCA uses data and sampling site information that are stored in the USEPA's WQ data storage and retrieval system (STORET) by the MPCA and others. Ten years of data are used where available, based on water year, believing that the time period is sufficient in most cases to pick up impairments under a variety of climatic and flow conditions.

Samples are evaluated against WQS set forth in Minn. R. ch. 7050, as minimum requirements needed to support aquatic life. Determinations of use support are based on the 'frequency of exceedance' of the "chronic" standards applicable for a given water class.

1) Conventional parameters include DO, pH, turbidity measured directly, and turbidity estimated from total suspended solids measurements. At


MPCA Basin Planning
and Management Timeline
for the State of Minnesota
Red
River Basin
Rainy
River Basin
Lake
Superior
Basin
Upper
Mississippi
River Basin
St. Croix
River
Basin
Phase I
Phase II
Phase III
Minnesota
River Basin
Lower
Mississippi
River Basin
Missouri
River Basin
Des Moines
River Basin
Cedar
River Basin

least ten samples from a reach are needed during the ten-year time frame for a parameter to be evaluated. For each parameter evaluated, levels of support are then defined as:

- Fully supporting - fewer than 10 percent of samples exceed the standard.
- Partially supporting - 10 to 25 percent of the samples exceed the standard.
- Not supporting - more than 25 percent of samples exceed the standard.

2) Toxicants include un-ionized ammonia, chloride, arsenic, cadmium, chromium, copper, lead, nickel, selenium, and zinc. At least five samples are needed for a given toxicant to be evaluated. For each toxicant evaluated, levels of support are then defined, according to USEPA guidance, as:

- Fully supporting - not more than 2.8 percent of samples exceed the standard (not more than one violation in three years of monthly sampling).
- Not supporting - more than 2.8 percent of observations exceed the standard.

3) Nonpoint Source Indicators

In addition, total phosphorus (TP), nitrate/nitrite, total suspended solids (TSS), and biochemical oxygen demand (BOD) are evaluated as indicators of nonpoint source (NPS) pollution. They do not affect use-support status. In contrast to the support parameters described above, Minnesota has not established legal standards for the NPS indicators. However, the MPCA has developed ecoregion expectations for them from data collected at a small set of least impacted sites. At least ten observations are needed for an indicator to be evaluated, and a reach is identified if more than ten percent of the observations of an indicator exceed the ecoregion expectation.

4) Preliminary assessment based on physical/chemical parameters of WQ

For each reach, the evaluations described above are combined into a preliminary assessment of the waterbody's ability to support aquatic life. The level of support is assumed to be no greater than the support provided by the weakest of the elements measured. Therefore, the preliminary assessments are defined as follows:

- Not supporting - At least one of the conventional or toxicants parameters indicates nonsupport.
- Partially supporting - the worst parameter indicates partial support.
- Fully Supporting - all measures show full support.

B. Biological/Habitat Data

The MPCA conducted fish community assessments for rivers and streams in the Minnesota (1990-1992), Red River (1993-1994) and the St. Croix (1996-1998) basins. The Index of Biotic Integrity (IBI) and a regional reference site approach were used to evaluate fish communities and develop biological criteria. Field investigations and IBI metric development were conducted in cooperation with numerous federal and state agencies including the USEPA, USGS, Minnesota Department of Natural Resources (MDNR), and the North Dakota Department of Health.

The typical time frame or index period for sampling fish communities was during normal to low flows in the summer (mid-June through September) and fall. A collection was only used to assess that portion of the reach that has similar physical/chemical characteristics.

The IBI is a composite index, evaluating 10 -12 characteristics of a fish community, with a total possible score of 12 to 60 points. The IBI classes were determined in relation to the best sites in the basin (for the Minnesota River) or the ecoregion (for the Red River). "Fair" (30) was considered to be the lowest acceptable condition in terms of meeting an aquatic life or biological criteria.

Therefore the use support levels were defined as:

- Fully supporting - IBI score 30 or above.
- Not supporting - IBI score below 30.
- Partially supporting - IBI scores disparate between two portions of a larger reach.

C. How we combined the information sources:

Some waterbodies had more than one category of data available for assessing use support. When this occurred, the judgment was based on the strongest information possible.

Biology was considered to be the strongest indicator of a waterbody's ability to support aquatic life, therefore IBI evaluations took precedence over any other preliminary assessments for a reach.

In the absence of biological measures, support levels were based on physical and chemical parameters of WQ, where available.

SWIMMING USE SUPPORT

Assessments for swimmable use support are conducted to determine whether the waters are of a quality to support primary body contact. Swimmable use was determined based on in-stream monitoring of fecal coliform bacteria.

Data were aggregated over the 13-year period October 1985 to September 1998. There must be a minimum of 10 observations total for a water to be assessed. There must be a minimum of five observations for a month (all years combined) to determine a geometric mean for that month. The standard applies from April 1 to October 31. Substitute appropriate water quality standard for support determination for each use classification.

Fecal Coliform Water Quality Standards

Class 2A	200 orgs/ 100mL	Not to exceed as geometric mean of 5 or more samples/ calendar month **OR**
	400 orgs/ 100mL	No more than 10% of samples/calendar month can individually exceed.
Class 2Bd, 2B, 2C, 2D	200 orgs/ 100mL	Not to exceed as geometric mean of 5 or more samples/ calendar month **OR**
	2,000 orgs/ 100mL	No more than 10% of samples/calendar month can individually exceed.

Table I-1. Water Quality Criteria: Aquatic Life Use Support in Rivers and Streams

Physical/chemical parameters - evaluated against state Water Quality Standards (Minn. R. ch. 7050)

Conventional: Dissolved oxygen, pH, Turbidity n $\geq$ 10 observations for each parameter

Use Support	Criteria for each parameter evaluated
Fully Supporting	The standard is exceeded in fewer than 10% of the observations.
Partially Supporting	The standard is exceeded 10% to 25% of the time.
Not Supporting	The standard is exceeded in more than 25% of the observations.

Toxicants: Ammonia, Chloride, Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Zinc n $\geq$ 5 observations for each parameter

Use Support	Criteria for each parameter evaluated
Fully Supporting	The standard is exceeded in fewer than 2.8% of the measurements. (Not more than 1 violation in 3 years of monthly sampling.)
Not Supporting	The standard is exceeded in 2.8% or more of the measurements.

NPS: Total phosphorus, Nitrite/nitrate, Total suspended solids, Biochemical oxygen demand (n $\geq$ 10) Evaluated against least impacted sites in the ecoregion

Not Used for Use Support	Criteria for each parameter evaluated (nonpoint source pollution indicators)
No Impact	The ecoregion expectation is exceeded in fewer than 10% of the observations.
Ecoregion Criteria Exceeded	The ecoregion expectation is exceeded in 10% or more of the observations.

Preliminary Assessment, based on physical and chemical parameters of water quality:

Aquatic Life Use Support	Criteria for each waterbody (river reach)
Fully Supporting (Good)	Parameters measured against WQ Standards are Fully Supporting.
Partially Supporting (Fair)	The worst parameter measured against WQ Standards is Partially Supporting.
Not Supporting (Poor)	At least 1 of the parameters measured against WQ Standards is Not Supporting.

Sampling by MPCA and cooperators. Data stored in the USEPA's STORET data system.

Table I-1 (Continued). Water Quality Criteria Aquatic Life Use Support in Rivers and Streams

Index of Biotic Integrity (IBI):	
Aquatic Life Use Support	Criteria (evaluated against regional expectations)
Fully Supporting (S)	The biological community is in fair or better condition, not significantly altered from what would be expected for the region under natural conditions. IBI score of 30 or above.
Not Supporting (NS)	Indications of a poor or very poor biological community, severely modified from what would be expected under natural conditions. IBI score less than 30.
Partially Supporting (PS)	Disparate levels of support between different portions of a larger reach.

Determination of Use Support, based on hierarchy of data sources:	
Aquatic Life Use Support	Criteria for each waterbody (river reach)
Full Support	IBI shows support for aquatic life (Biology=S). If no IBI, physical/chemical parameters are fully supporting (FS).
Partially Supporting	Partial support based on mixed Index of Biotic Integrity findings (PS). Partial support based on physical/chemical parameters (PS).
Not Supporting	IBI shows nonsupport (NS). If no IBI, physical/chemical parameters show nonsupport (NS).

Full Support:
If the geometric mean for each month (all years combined) did not exceed 200 orgs/100 ml **and**
If less than 10% of all observations for the ten-year period exceed 2,000 orgs/100ml.

Partial Support:
If the geometric mean for one or two months (all years combined) exceeds 200 orgs/100ml **or**
If 10-25% of all observations for the ten-year period exceed 2,000 orgs/100ml.

Nonsupport:
If the geometric mean for three or more months (all years combined) exceeds 200 orgs/100ml **or**
If more than 25% of all observations for the ten-year period exceed 2,000 orgs/100ml.

STATISTICALLY BASED MONITORING PROGRAM

The MPCA in 1996 initiated an "integrated, statistically based" stream-and-river-monitoring program as a complement to its ongoing fixed-site "milestone" and special studies monitoring. The program uses a random-site approach to allow the state for the first time to gain a statistically valid representation of overall WQ in a given area. Monitoring thus far has begun in the St. Croix, Lake Superior and Upper Mississippi basins, with approximately 55 randomly selected sites (using USEPA's EMAP protocol) in each. The monitoring is focusing on biological measures, with the sites being examined for fish, macroinvertebrates and habitat, plus flow and basic water chemistry. Additional sites are being monitored as reference sites to develop the necessary ecoregion-specific biocriteria for assessing stream health.

Data from the fieldwork is now being analyzed, and biocriteria are being developed. Following work in the first three basins, the program will then be extended to other parts of Minnesota, eventually providing an unbiased assessment of overall stream and river WQ for the state as a whole.

Lakes Assessment Methodology

Twenty-eight years of data (1970-1998) from USEPA's STORET has been used for the lake assessments.

The focus of lake assessments is on trophic state and its relation to support and nonsupport of designated uses, specifically swimming and aesthetics uses. The parameters used to assess trophic state were epilimnetic TP, chlorophyll-a (chl-a) and Secchi Disk (SD) transparency.

DATA USE AND ANALYSIS PROCEDURES

1. **Monitored Data**

   Lakes with data collected between calendar years 1989-1998 with summer data (defined as the time period from June through September) were considered monitored. Summer data are preferred for assessments to better represent the maximum productivity of a lake and yield the best agreement among trophic variables. They also reflect the maximum use period of the resource. Summer means were calculated for each variable.

2. **Evaluated Data**

   Lakes without data meeting monitored criteria but with TP, chl-a or SD transparency measurements collected between 1970-1988 were treated as evaluated. Summer data were used for calculating mean chl-a and SD transparency. Mean TP was calculated from data collected during the open water season (May through November). Expanding the season for TP allows for inclusion of a larger number of lakes in northern Minnesota. These lakes were often sampled only during spring or fall turnover as part of the MPCA Acid Rain Lake Monitoring Program.

TROPHIC STATUS

Trophic Status was determined for each lake using Carlson's Trophic State Index (TSI). This index was developed using the relationship among summer SD transparency, epilimnetic concentrations of chl-a, and TP.

The TSI values are calculated as follows:

* *Secchi disk* (SD) TSI (TSIS) = 60 - 14.41 natural log (ln) SD;
* *Total phosphorus* (TP) TSI (TSIP) = 14.42 ln TP + 4.15;
* *Chlorophyll-a* (chl-a) TSI (TSIC) = 9.81 ln chl-a+30.6; (chl-a and TP in micrograms per liter (ug/L) and SD transparency in meters).

The index ranges from 0 to 100 with higher values indicating more eutrophic conditions. The TSI scale and corresponding use supports are shown in Figure I-1 on page 13. The TSI values were calculated for each variable, then averaged for each lake.

IMPAIRED STATUS

The supporting, partially supporting, not supporting status of lakes was assessed by ecoregion. An ecoregion map is located on the following page 12. Phosphorus criteria (Heiskary and Wilson, 1988) for each ecoregion were used in conjunction with

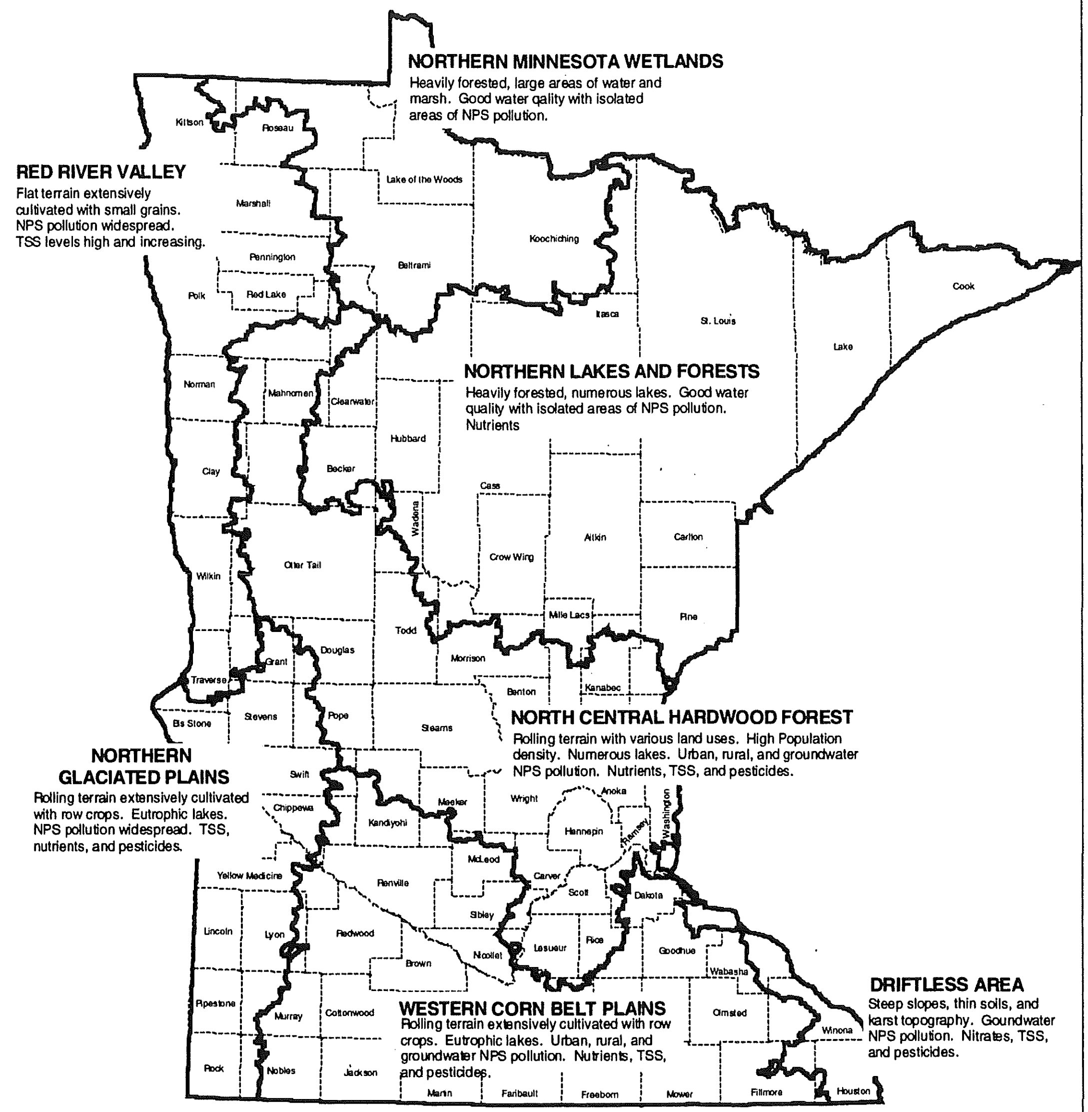
Carlson's TSI scale to establish use support thresholds (Figure I-1). Phosphorus criteria are based on ecoregion characteristics and reflect several considerations such as lake morphometry, attainability and lake user perceptions (Heiskary and Wilson, 1988). Specific ecoregion phosphorus criteria are shown in Figure I-1. Determining use support by ecoregion provides a more reflective picture of the condition of Minnesota lakes, as opposed to assessing all lakes by a single scale, which ignores important regional differences such as lake morphometry and lake user perceptions.

Use support thresholds for each ecoregion are also defined in Figure I-1. These thresholds are consistent with those used since the 1994 305(b) Report. The previous statewide thresholds are included for comparison. In general, use support thresholds for the Northern Lakes and Forests and North Central Hardwood Forests ecoregions are somewhat more restrictive than the previous thresholds, while those for the Western Corn Belt Plains and Northern Glaciated Plains are somewhat less restrictive. Differences in lake user perceptions of "impaired swimming" and what constitutes nuisance algal blooms, along with differences in lake morphometry and attainability are primary reasons for the regional differences.

The Northern Lakes and Forests and North Central Hardwood Forests ecoregions phosphorus criteria levels, 30 micrograms per liter (ug/L) and 40 ug/L, respectively, serve as the upper thresholds for full support (marginal) of swimmable use. Those concentrations correspond to Carlson's TSI values of 53 and 57, respectively. Full support of swimmable use is set at slightly lower concentrations, 25 ug/L and 30 ug/L, respectively, which ensure that conditions associated with "impaired swimming" would occur less than ten percent of the summer. Phosphorus concentrations above criteria levels would result in greater frequencies of nuisance algal blooms and increased frequencies of "impaired swimming." The upper threshold for partial support of swimmable use was set at 60 and 63 Carlson's TSI units, respectively, for these two regions. As phosphorus concentrations increase from about 30 ug/L to 60 ug/L, summer mean chl-a concentrations increase from about ten ug/L to 30 ug/L, and SD transparency decreases from about 1.7 meters to 0.8 meters (Figure I-1). Over this range, the frequency of nuisance algal blooms (greater than 20 ug/L chl-a) increases from about five percent of the summer to about 70 percent of the summer (Heiskary and Wilson, 1990). The increased frequency of nuisance algal blooms and reduced SD transparency results in a high percentage of the summer (26-50 percent) perceived as "impaired swimming."

Phosphorous concentrations above 50 ug/L (Northern Lakes and Forests) and 60 ug/L (North Central Hardwood Forests) were associated with nonsupport of swimmable use. At phosphorous concentrations above 60 ug/L, severe nuisance algal blooms (greater than 30 ug/L chl-a) may occur over 40 percent of the summer. This will result in a high frequency (greater than 50 percent of summer) of impaired swimming and greater than 25 percent as "no swimming."

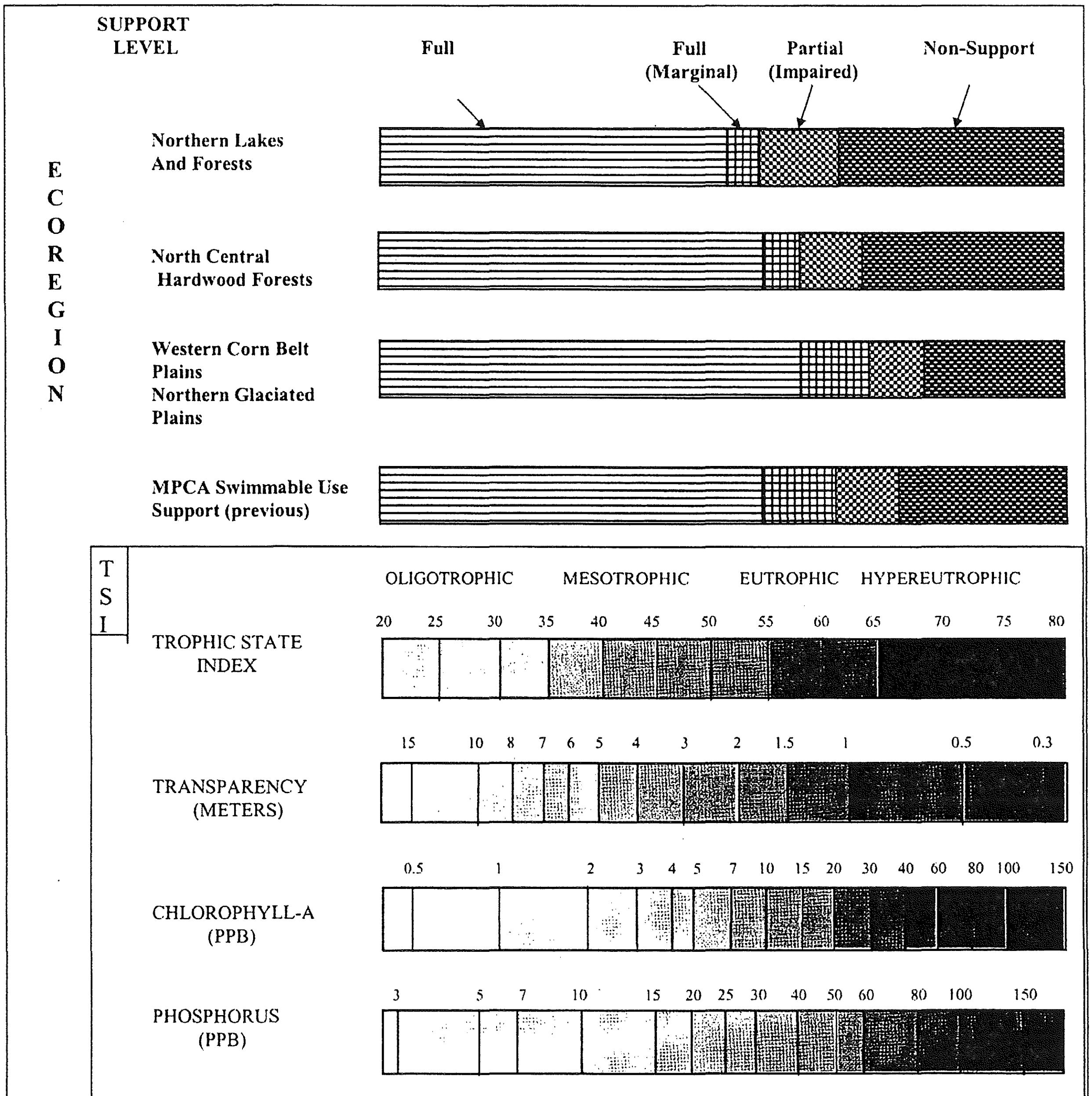
For the Western Corn Belt Plains and Northern Glaciated Plains the upper TP thresholds for fully supporting and fully supporting (marginal) are 40 ug/L and 50 ug/L respectively, which correspond to Carlson's TSI units of 57 and 60. At a TP concentration of 50 ug/L, summer mean chl-a concentrations average 20-22 ug/L, and SD transparency is about one meter. Nuisance algal blooms (greater than 30 ug/L chl-a for these regions) would occur for approximately ten to 15 percent of the summer. Few lakes in these two ecoregions have TP concentrations of 40 ug/L or less.



Ecoregions in Minnesota

Minnesota Pollution Control Agency

Figure I-1
Use Support Classification for Swimming (MPCA Method)
Relative to Carlson's Trophic State Index by Ecoregion



Carlson's TSI box from: Moore, L. and Thorton, K. [Ed.] 1988. Lake and Reservoir Restoration Guidance Manual. USEPA> EPA 440/5-88-00.

Partial support, which corresponds to a TP concentration of 90 ug/L or less (Carlson's TSI = 69), is a more reasonable goal for the majority of the lakes in these two ecoregions. Total phosphorus concentrations greater than 90 ug/L are considered not supporting of swimmable use. At TP concentrations greater than 90 ug/L, SD transparency averages 0.5 meters or less and nuisance algal blooms may occur over 75 percent of the summer.

Lakes in the Red River Valley ecoregion were assessed using the North Central Hardwood Forests criteria. This is because there were too few lakes to establish reference conditions in the Red River Valley ecoregion.

Specific ecoregion phosphorus criteria are shown in Figure I-2 below.

Qualitative Data

The abundance of waterbodies in the state prohibits the kind of extensive monitoring necessary for quantitatively measuring the level of WQ impairment across the state, or determining the land use activities contributing to impairment. A more qualitative method of data collection was administered in 1987, 1989 and 1991, as a supplement to the quantitative monitoring data. This survey provides the best estimates we have of the contributions to impairments from specific types of NPS pollution, such as feedlots, urban storm sewers, on-site wastewater systems, road construction, and others. However, the survey also has serious limitations as an assessment tool. These include:

- The survey asked respondents only to list waterbodies that were threatened or impaired by NPS pollution, and so does not indicate whether unlisted waterbodies are unimpacted and unthreatened, or if the respondent did not know what their condition was.
- The response "impaired" does not indicate degree of impairment.
- Waterbodies are listed by name, and the specific extent of the impact is therefore difficult to identify.
- The survey is not very applicable to wetlands and ground water.

Figure I-2. Minnesota Lake Phosphorus Criteria (Heiskary and Wilson, 1988)

	Ecoregion			
	Northern Lakes and Forests	North Central Hardwood Forests	Western Cornbelt Plains	Northern Glaciated Plains
	(Phosphorus in micrograms per liter)			
Most Sensitive Uses				
Drinking Water	<15	<30	<40	--
Cold Water Fishery	<15	--	--	--
Primary Contact Recreation and Aesthetics (Full Support)	<30	<40	<40	--
Partial Support	--	--	<90	<90

- There was variability among respondents about what constitutes "impaired" and what constitutes "threatened."
- Very little guidance was provided on how to complete the survey.

Because of the limitations of the survey, the decision was made to revise the survey and the survey process before it would be administered again. Efforts to revise the survey have been started and interrupted, but there are plans to resume these efforts.

Total Maximum Daily Loads and Minnesota's Waterways

A new approach to help solve the old problem of water pollution is developing Total Maximum Daily Loads (TMDLs). Waterbody assessments form the basis for identifying a waterbody as needing a TMDL study.

For each pollutant that causes a water body to fail to meet state water quality standards, the federal Clean Water Act requires the MPCA to conduct a TMDL study. A TMDL study identifies both point and nonpoint sources of each pollutant that fails to meet water quality standards. Water quality sampling and computer modeling determine how much each pollutant source must reduce its contribution to assure the water quality standard is met. Rivers and streams may have several TMDLs, each one determining the limit for a different pollutant.

The Clean Water Act requires states to publish, every two years, an updated list of streams and lakes that are not meeting their designated uses because of excess pollutants. The list, known as the 303(d) list, is based on violations of water quality standards and is organized by river basin. Some of the waterbody assessments mapped in this chapter are based on screening level data, that is either the quality or the quantity of the data is less than that required for TMDL listing. On the other hand, there are waterbodies on the TMDL list for localized toxicants concerns, high temperature in trout streams, and mercury in the water column. Because statewide assessments are not done for these conditions, those waterbodies are not included in the assessments mapped in this chapter.

The list that Minnesota submitted to USEPA in 1998 included streams throughout the state. By establishing TMDLs in these areas, the MPCA will be able to take steps to regain designated uses in these waters. For example, the lower Minnesota River TMDL was created in the mid-1980s. It was developed in response to dissolved oxygen concentrations that were significantly below water quality standards and could threaten fish populations. The TMDL included both point source and nonpoint source reduction goals. As a result, the two large metropolitan wastewater facilities have significantly improved their treatment. In addition, there has been a sustained, basin wide effort to reduce nonpoint sources of pollution. It has been estimated that there has been a 25 percent reduction in sediments in the river since the TMDL was created. This TMDL is an excellent example of how point sources and nonpoint sources work together to reduce a variety of pollutants after a TMDL is created. The TMDLs set the environmental goals and recommend approaches for improving water quality.

Pollutant Trends for Minnesota Rivers and Streams

The best available information on pollutant trends in rivers and streams comes from Minnesota Milestone sites. These are a series of 80 monitoring sites across the state with good, long-term data. While the sites are not necessarily representative of Minnesota's rivers and streams as a whole, they do provide a valuable historical record for many of the state's waters. Monitoring results over the period of record, which in some cases goes back to the 1950s, show significant reductions across the state for biochemical oxygen demand, total suspended solids, phosphorus, ammonia and fecal coliform bacteria. These results reflect the considerable progress made during that time in controlling municipal and industrial point sources of pollution. At most locations, it is simply known that municipal and industrial wastewater treatment improved during this time period. At some locations, such as the Rainy River, St. Louis Bay and Metro area Mississippi, specific studies were done which relate wastewater treatment improvements with improvement in stream conditions. Nitrite/ nitrate levels, on the other hand, show increases at many of the Minnesota Milestone sites, perhaps reflecting continuing NPS problems. The table on the next three pages, and the six maps following this table, provide further detail.

Table I-2. Pollutant Trends at Minnesota Milestone Sites

Basin	Station	Length of Record	Biochemical Oxygen Demand	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Unionized Ammonia	Fecal Coliform
Big Sioux	PC-1.5	1963 - present	decrease	no trend	decrease	increase	decrease	decrease
Cedar – Des Moines	CD-10	1967 - present	Decrease	no trend	decrease	increase	decrease	decrease
	CD-24	1967 - present	decrease	no trend	decrease	no trend	decrease	no trend
	OK-25.6	1973 - present	decrease	insuf data	increase	increase	decrease	insuf data
	SR-1.2	1961 - present	decrease	decrease	no trend	increase	decrease	no trend
	WDM-3	1967 - present	no trend	no trend	decrease	increase	decrease	decrease
Lake Superior	BRU-0.4	1973 - present	decrease	insuf data	decrease	insuf data	insuf data	insuf data
	BV-4	1973 - present	no trend	decrease	decrease	no trend	increase	decrease
	KN-0.2	1973 - present	insuf data	decrease	decrease	increase	insuf data	decrease
	LE-0.2	1973 - present	insuf data	decrease	decrease	insuf data	insuf data	decrease
	POP-0	1973 - present	insuf data	insuf data	decrease	insuf data	increase	insuf data
	SLB-1	1974 - present	decrease	decrease	decrease	decrease	no trend	decrease
	SL-9	1953 - present	decrease	decrease	decrease	no trend	decrease	decrease
	SL-38	1953 - present	decrease	no trend	decrease	no trend	decrease	decrease
	SL-110	1967 - present	decrease	no trend	decrease	no trend	no trend	decrease
Minnesota	BE-0	1967 - present	decrease	no trend	decrease	increase	decrease	decrease
	CEC-23.2	1974 - present	decrease	no trend	decrease	increase	decrease	decrease
	CO-0.5	1967 - present	decrease	no trend	no trend	increase	decrease	decrease
	MI-3.5	1974 - present	decrease	no trend	no trend	no trend	decrease	no trend
	MI-64	1955 - present	decrease	no trend	decrease	no trend	decrease	decrease
	MI-88	1955 - present	decrease	no trend	decrease	no trend	decrease	decrease
	MI-133	1957 - present	decrease	no trend	decrease	increase	decrease	decrease
	MI-196	1967 - present	decrease	no trend	decrease	increase	decrease	decrease
	MI-212	1957 - present	insuf data	insuf data	insuf data	increase	decrease	insuf data
	PT-10	1971 - present	decrease	decrease	decrease	increase	decrease	decrease
	RWR-1	1974 - present	decrease	no trend	decrease	increase	decrease	no trend
	WA-6	1968 - present	decrease	no trend	decrease	increase	decrease	decrease
	YM-0.5	1967 - present	decrease	no trend	no trend	increase	decrease	decrease
Missouri	RO-0	1962 - present	decrease	no trend	decrease	increase	decrease	no trend
Rainy	BF-0.5	1971 - present	insuf data	decrease	decrease	increase	insuf data	decrease
	KA-10	1967 - present	decrease	decrease	decrease	no trend	no trend	decrease
	LF-0.5	1971 - present	insuf data	insuf data	insuf data	increase	insuf data	decrease
	RA-12	1958 - present	decrease	decrease	decrease	increase	no trend	decrease
	RA-83	1953 - present	decrease	decrease	decrease	increase	no trend	decrease
	RA-86	1974 - present	decrease	decrease	decrease	increase	insuf data	insuf data
	RP-0.1	1971 - present	insuf data	decrease	decrease	increase	decrease	insuf data
	WR-1	1958 - present	insuf data	insuf data	decrease	increase	decrease	insuf data
Red	OT-1	1953 - present	decrease	no trend	decrease	increase	decrease	decrease
	OT-49	1967 - present	decrease	decrease	decrease	insuf data	decrease	decrease
	RE-298	1995 - present	decrease	no trend	no trend	increase	decrease	decrease
	RE-403	1967 - present	decrease	no trend	no trend	increase	no trend	decrease
	RE-452	1971 - present	no trend	increase	no trend	increase	decrease	decrease
	RE-536	1953 - present	no trend	no trend	no trend	increase	decrease	decrease
	RL-0.2	1953 - present	decrease	decrease	decrease	no trend	decrease	decrease

Table I-2. Pollutant Trends at Minnesota Milestone Sites (Cont.)

Basin	Station	Length of Record	Biochemical Oxygen Demand	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Unionized Ammonia	Fecal Coliforms
	RL-23	1955 - present	decrease	insuf data	decrease	insuf data	decrease	decrease
	SK-1.8	1971 - present	decrease	insuf data	insuf data	insuf data	decrease	insuf data
	TMB-19	1971 - present	decrease	insuf data	decrease	insuf data	decrease	decrease
St. Croix	KE-11	1967 - present	decrease	decrease	decrease	no trend	decrease	decrease
	SC-17	1967 - present	decrease	decrease	decrease	increase	no trend	decrease
	SC-23	1953 - present	decrease	decrease	decrease	insuf data	insuf data	decrease
	SC-111	1957 - present	decrease	decrease	decrease	no trend	no trend	decrease
	SN-10	1971 - present	decrease	decrease	decrease	insuf data	insuf data	decrease
	SUN-5	1974 - present	decrease	insuf data	insuf data	insuf data	increase	insuf data
Upper Miss - - Lower Portion	CA-13	1953 - present	decrease	decrease	decrease	no trend	decrease	decrease
	GB-4.5	1981 - present	decrease	no trend	no trend	increase	decrease	no trend
	RT-3	1958 - present	decrease	no trend	decrease	increase	decrease	decrease
	ST-18	1955 - present	decrease	no trend	decrease	no trend	decrease	decrease
	UM-698	1958 - present	decrease	no trend	decrease	increase	decrease	no trend
	UM-714	1962 - present	decrease	decrease	decrease	no trend	decrease	decrease
	UM-738	1974 - present	decrease	no trend	decrease	increase	decrease	no trend
	UM-815	1958 - present	decrease	no trend	decrease	increase	decrease	decrease
	UM-826	1975 - present	decrease	increase	decrease	increase	decrease	decrease
	UM-840	1973 - present	decrease	increase	no trend	increase	decrease	decrease
	VR-32.5	1981 - present	increase	decrease	no trend	increase	decrease	no trend
	WWR-26	1974 - present	decrease	no trend	no trend	increase	decrease	no trend
	ZSF-5.7	1973 - present	decrease	no trend	decrease	increase	decrease	no trend
Upper Miss - - Upper Portion	CR-0.2	1953 - present	decrease	no trend	no trend	increase	decrease	decrease
	LPR-3	1974 - present	no trend	no trend	no trend	increase	decrease	decrease
	RUM-0.6	1953 - present	decrease	decrease	decrease	insuf data	insuf data	decrease
	RUM-34	1955 - present	decrease	decrease	decrease	increase	decrease	decrease
	SA-0	1953 - present	no trend	no trend	no trend	no trend	decrease	decrease
	UM-859	1953 - present	decrease	no trend	decrease	increase	decrease	decrease
	UM-895	1976 - present	no trend	no trend	decrease	increase	decrease	no trend
	UM-914	1967 - present	decrease	no trend	no trend	increase	no trend	decrease
	UM-930	1953 - present	decrease	decrease	decrease	increase	decrease	no trend
	UM-982	1967 - present	decrease	no trend	decrease	increase	decrease	decrease
	UM-1172	1974 - present	decrease	no trend	decrease	increase	decrease	decrease
	UM-1186	1967 - present	decrease	decrease	decrease	increase	decrease	decrease
	UM-1292	1967 - present	decrease	decrease	decrease	increase	decrease	decrease
	UM-1365	1965 - present	decrease	decrease	decrease	increase	decrease	decrease

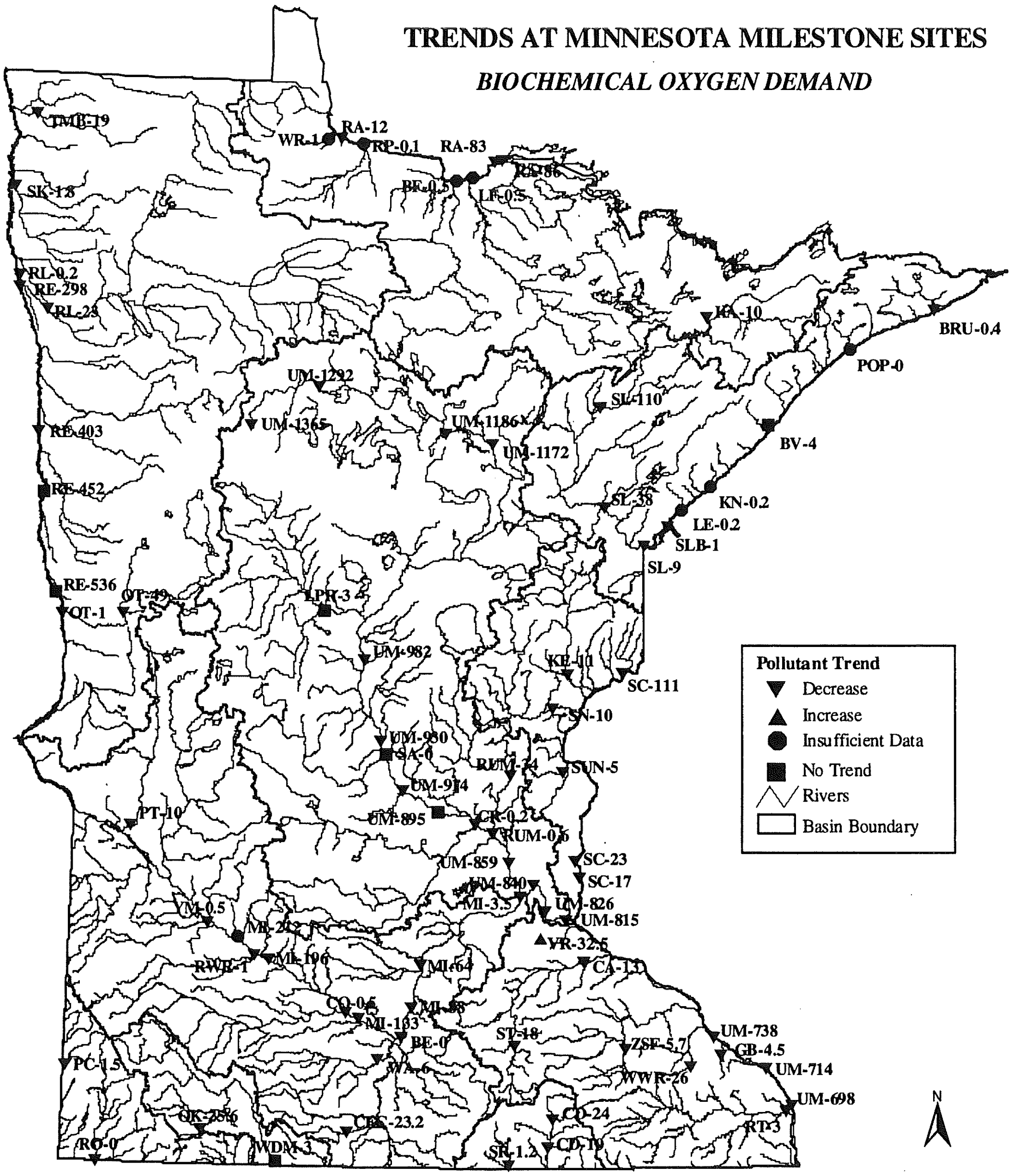
Table I-2. Pollutant Trends at Minnesota Milestone Sites (Cont.)

Milestone sites (having sufficient data) showing:						
Decreasing pollutant trend	**89%**	**41%**	**78%**	**1%**	**83%**	**82%**
Increasing pollutant trend	**1%**	**4%**	**1%**	**75%**	**4%**	**0%**
No trend	**10%**	**54%**	**21%**	**23%**	**13%**	**18%**
Milestone sites (out of 80) having insufficient data:	8	10	4	11	9	9

(Insufficient data means $p > .05$ and $n < 80$)

((Logs of) TSS, TP, BOD, and fecal coliforms analyzed using Pearson's correlation coefficient and p values; NH_3 and NO_2/NO_3 analyzed using Kendall's Tau B and p values)

(Nov, Dec, Jan, and Feb data not used; NH_3 data prior to 1979 not used)



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RUM=Rum River
RWR=Redwood River
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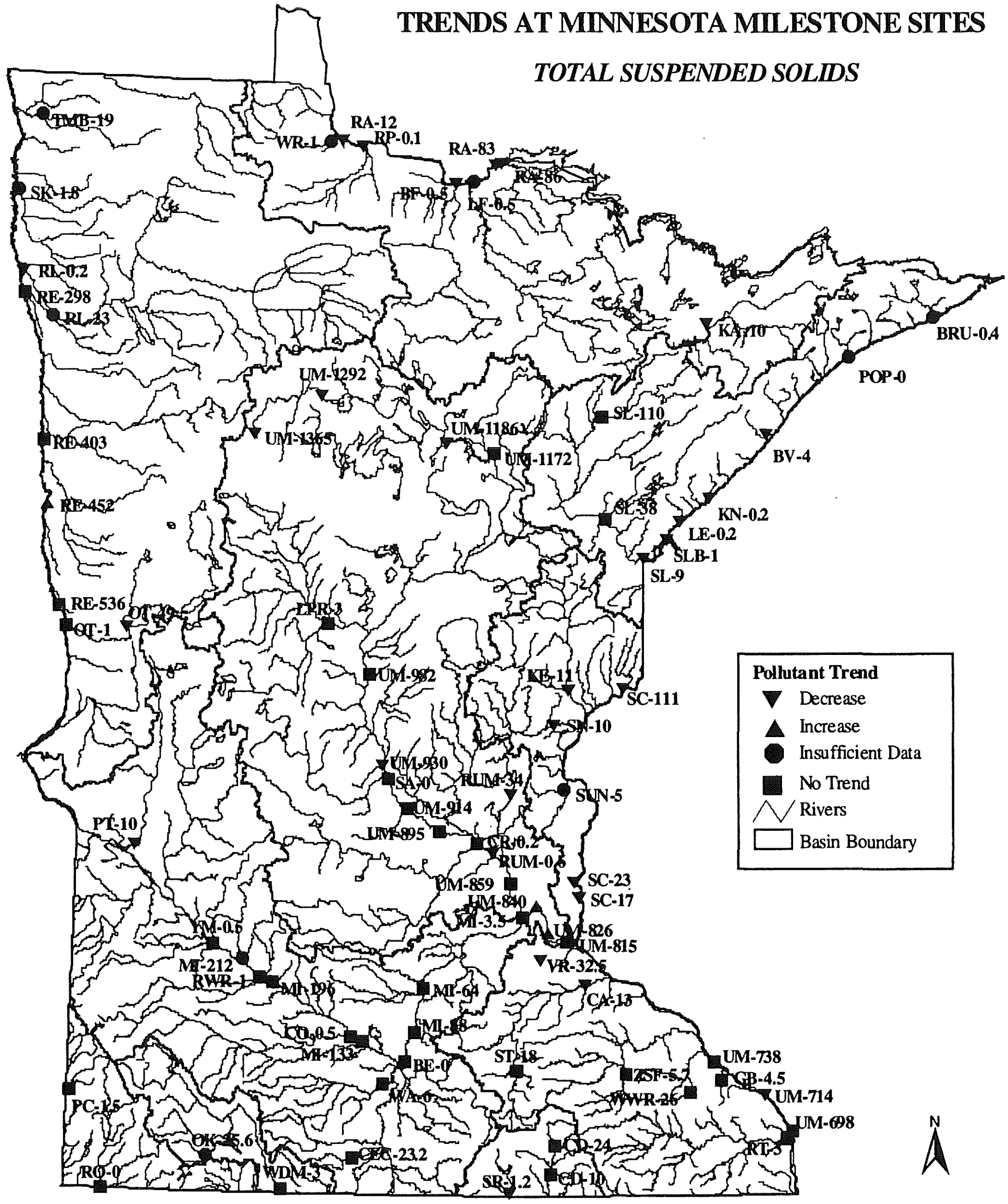
SR=Shell Rock River
ST=Straight River
SUN=Sunrise River
TMB=Two River (Middle Branch)
UM=Upper Mississippi River
VR=Vermillion River
WA=Watonwan River
WDM=Des Moines River (West Fork)
WR=Winter Road River
WWR=Whitewater River
YM=Yellow Medicine River
ZSF=Zumbro River (South Fork)

TRENDS AT MINNESOTA MILESTONE SITES

TOTAL SUSPENDED SOLIDS



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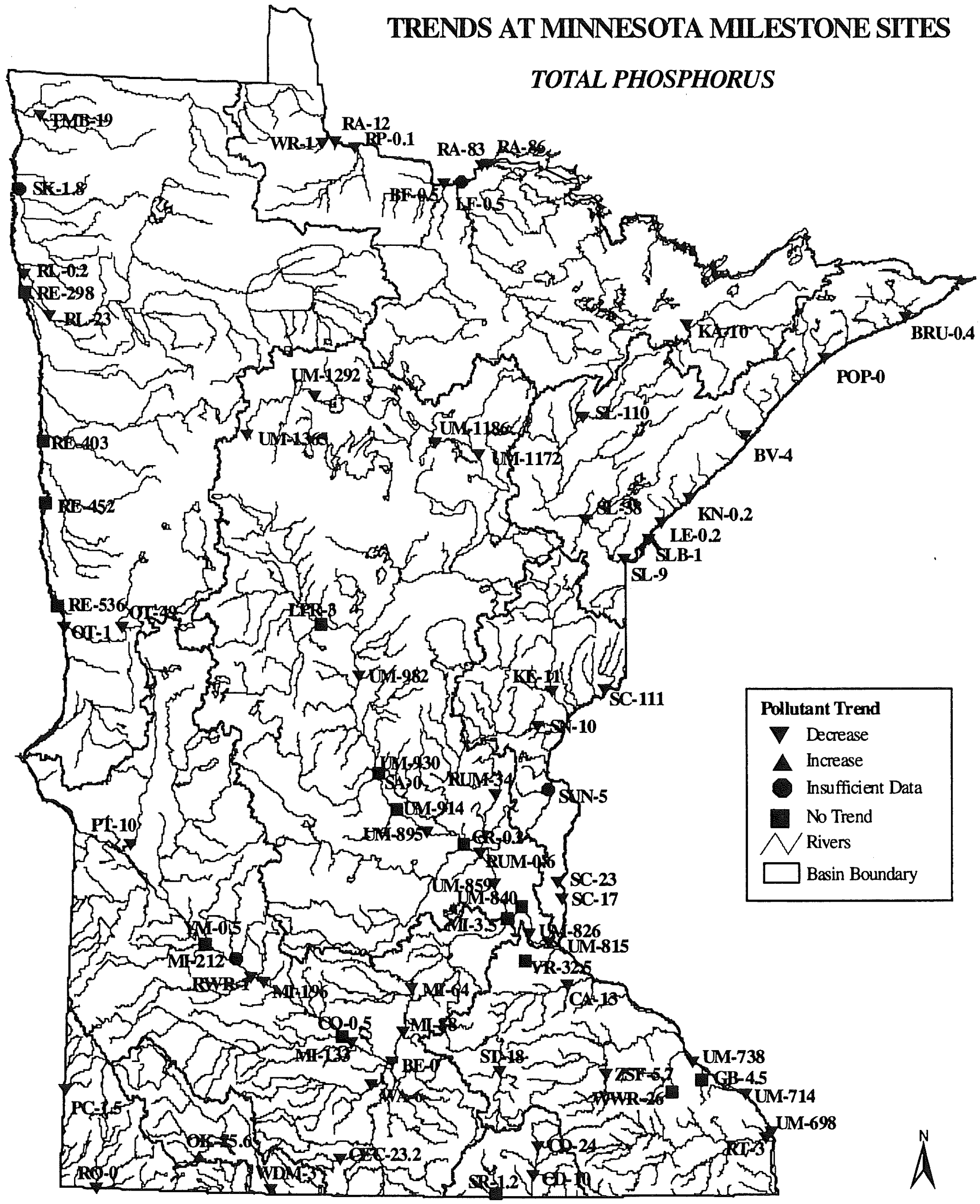

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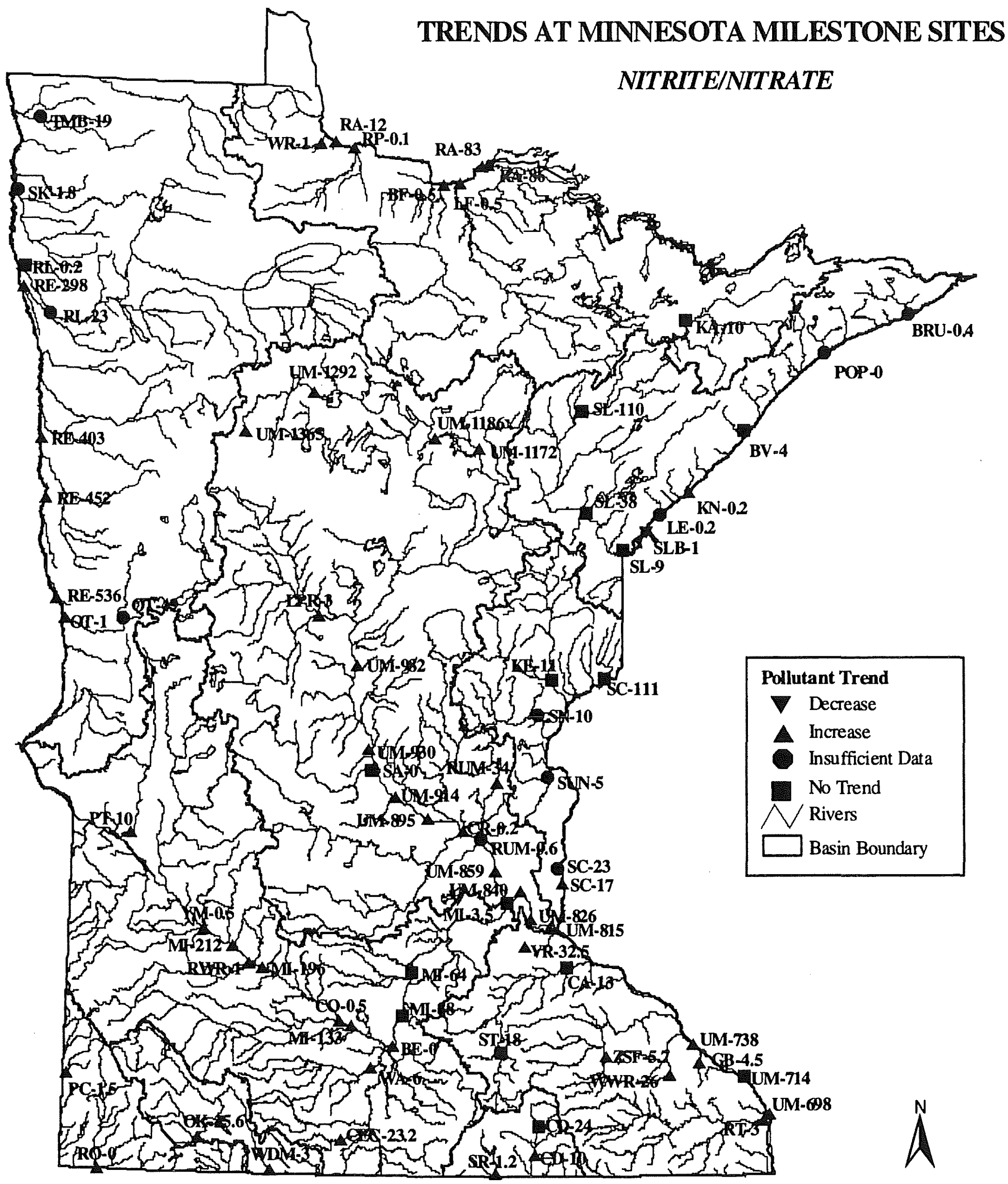

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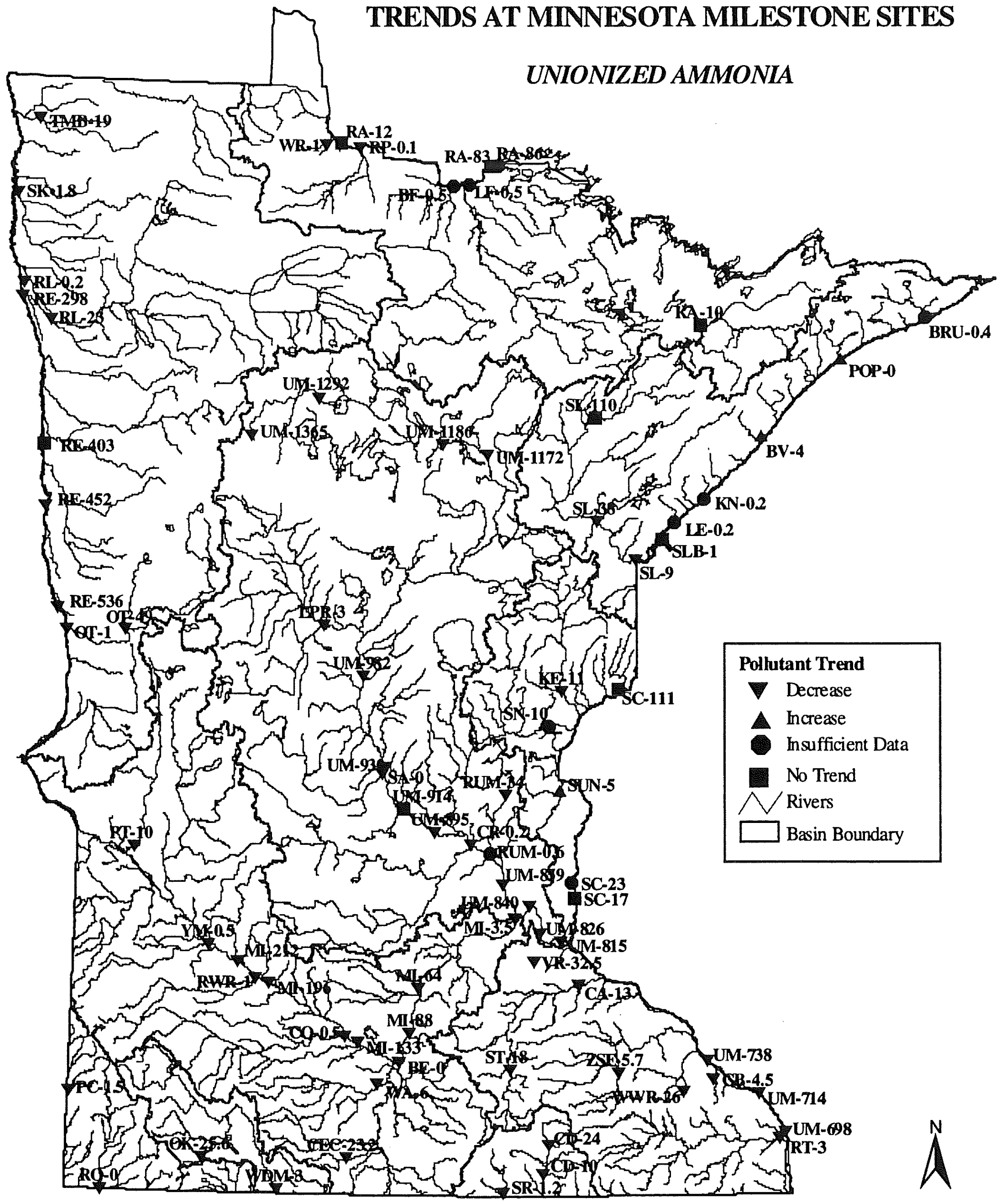
TRENDS AT MINNESOTA MILESTONE SITES

UNIONIZED AMMONIA



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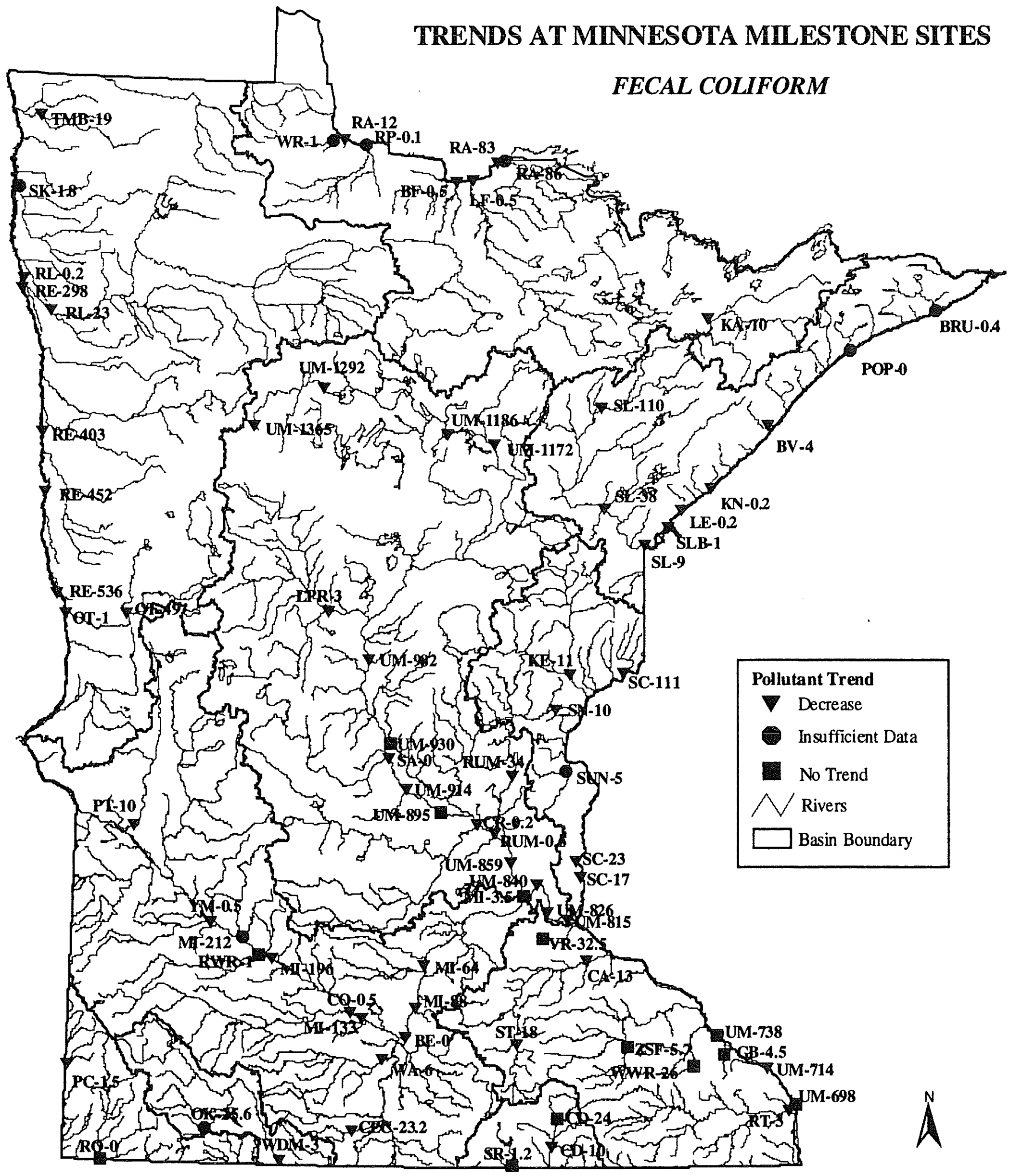
			ZSF=Zumbro River (South Fork)

TRENDS AT MINNESOTA MILESTONE SITES

FECAL COLIFORM



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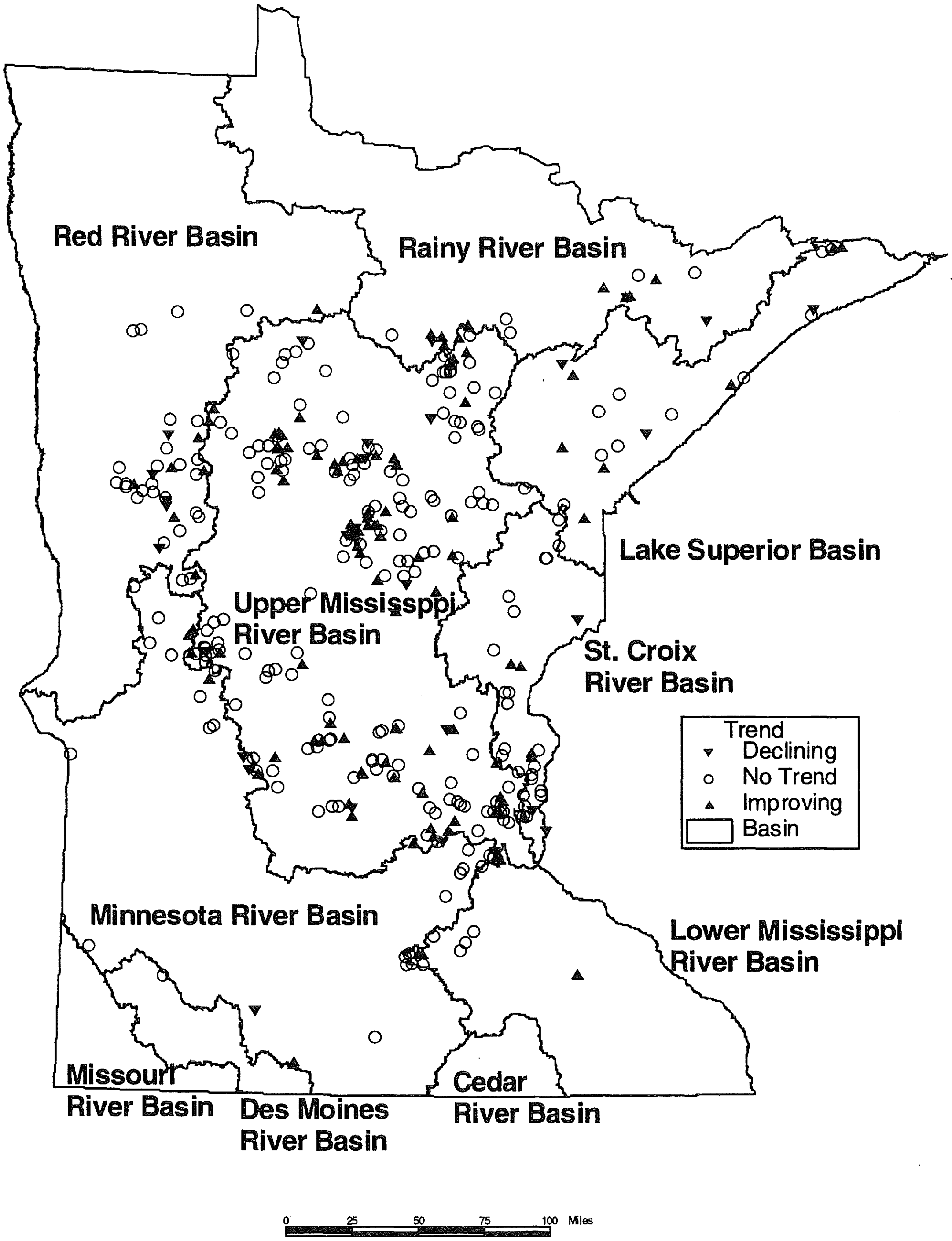
Water Quality Trends for Minnesota Lakes

In addition to characterizing trophic status, detecting changes (trends) in WQ over time is a primary goal for many lake monitoring programs. Detecting trends requires many measurements each summer and several years' worth of data. An ideal database for trend analysis consists of eight or more measurements per summer with eight or more years of data at a consistent site in the lake. One of the best parameters for characterizing the trophic status of a lake and trend detection is Secchi transparency. Secchi transparency is the preferred parameter for many reasons: low cost, it is easily incorporated in volunteer monitoring programs and it allows for the collection of a large number of samples in a given sampling period on many lakes. A variety of statistical tests can be used to perform trend analysis. Kendall's tau-b is a statistical test that has been used in previous MPCA 305(b) reports to Congress (MPCA, 1990 and 1992) for assessing trends in Secchi transparency over time. Kendall's tau-b is a nonparametric test which computes correlation coefficients between variables (Gilbert, 1987) — in this case, summer-mean (June-September) Secchi transparency versus year. The Kendall's tau-b (R_k) ranges from $-1 \leq$ tau-b ≤ 1. The closer the value is to ± 1, the stronger the trend. Our null hypothesis is that there is no change (*i.e.,* no trend) in mean summer Secchi transparency over time. Positive R_k values in our analysis would suggest an increasing trend in transparency. Negative R_k values would conversely suggest a decreasing trend in transparency. A probability level (p) ≤ 0.1 was used as a basis for identifying significant trends in transparency. At this "p" level, there is a 10 percent chance of rejecting the null hypothesis of "no trend" when it is true (*i.e.,* a 10 percent chance of identifying a trend when none exists). Simply stated, the smaller the "p" value for our analysis, the more likely the events were not random. When performing trend analysis, it is important to consider the strength of the correlation, "p" level and years of measurement.

TABLE I-3. TREND LAKES WITHIN MINNESOTA MAJOR RIVER BASINS

River Basin	# Improving Lakes	# Degrading Lakes	# Lakes with No Change
Lake Superior	7	3	8
Upper Mississippi	83	13	122
Minnesota River	8	3	13
St. Croix River	11	3	13
Lower Mississippi	2	0	1
Red River	10	5	21
Rainy River	9	3	4
Cedar River	0	0	0
Des Moines	0	0	0
Missouri River	0	0	0
TOTALS:	**130**	**30**	**182**

Water Quality Trend Lakes



Ground Water Assessment

MAJOR SOURCES OF GROUND WATER CONTAMINATION (TABLE I-4)

Table I-4, Major Sources of Ground Water Contamination, is based on a November 5, 1999, survey of eleven staff from one federal and seven state agencies. Most of the participants are involved in ground water monitoring in Minnesota. The survey indicates that five categories stand out as the most important sources of ground water contamination:

- Animal feedlots
- Fertilizer applications
- Pesticide applications
- Septic systems
- Urban runoff

An earlier (February 1999) survey with 18 participants indicated Minnesota's major sources of ground water contamination were as follows:

- Pesticide application
- Septic systems
- Fertilizer applications
- Irrigation practices
- Storage tanks (underground)
- Hazardous waste sites
- Animal feedlots
- Industrial facilities

GROUND WATER PROTECTION PROGRAMS (TABLE I-5)

Table I-5 was compiled by interviewing personnel that are most familiar with each program or activity. Most of the information was obtained from the Minnesota Pollution Control Agency (MPCA) personnel although staff from various other state of Minnesota offices also contributed.

Minnesota has been a leader in addressing many sources of ground water contamination such as Superfund sites, leaking underground storage tanks (LUST), agrichemical incident cleanup, voluntary investigation and cleanup (VIC) sites, and landfills. Table I-5 summarizes the status of ground water protection. Successes in these programs are well described in other documents, program-by-program and site-by-site. In recent years, Minnesota has increased its emphasis on nonpoint sources, including the development of Best Management Practices (BMPs) for sources such as feedlots, manure management, and agrichemical application.

Detailed monitoring is now carried out in selected wells as part of Minnesota's Source Water Protection effort. A summary of progress on Minnesota's Source Water Protection work can be seen on the List of Wellhead Protection Program Water Suppliers on page 35.

In the past, Minnesota has focused its limited state resources on cleanup, source control, and direct protection efforts, and requires ground water monitoring at many sites to assess individual facilities' compliance. However, we are now dedicating more resources to assess whether we can measure changes in local and regional ground water quality as a result of these efforts.

GROUND WATER CONTAMINATION SUMMARIES

A Minnesota "Ground Water Contamination Summary"(not shown), was compiled by requesting data from the appropriate, individual state programs. Of special note are some of the programs with a large number of sites (see table on page 31).

Table I-4. Major Sources of Ground Water Contamination

Based on a 2 November 1999 Survey of eleven staff from one federal & seven state agencies

Contaminant Source	Ten Highest-Priority Sources (√)[1]	Factors Considered in Selecting a Contaminant Source[2]	Contaminants[3]
Agricultural Activities			
Agricultural chemical facilities			
Animal feedlots	X	A C D E H	E J L
Drainage wells			
Fertilizer applications	X	A C D E H	E
Irrigation practices	x	A E	E
Pesticide applications	X	A D E F H	A B D
On-farm agricultural mixing and loading procedures			
Land application of manure (unregulated)	x	C D E	E J L
Storage and Treatment Activities			
Land application (regulated or permitted)			
Material stockpiles			
Storage tanks (above ground)			
Storage tanks (underground)	x	A C D E	C D
Surface impoundments			
Waste piles			
Waste tailings			
Disposal Activities			
Deep injection wells			
Landfills	x	A C E	C H J M
Septic systems	X	A C D E H	E J L
Shallow injection wells			
Other			
Hazardous waste generators			
Hazardous waste sites	x	A C E	C D H
Large industrial facilities			
Material transfer operations			
Mining and mine drainage			
Pipelines and sewer lines			
Salt storage and road salting			
Salt water intrusion			
Spills			
Transportation of materials			
Urban runoff	X	A B C D E H	A B D E G H
Small-scale manufacturing and repair shops			
Other sources (please specify)			

[1] The lowercase x's denote sources checked as a top ten source by less than 50% of those surveyed (that still qualified as one of the ten most frequently checked sources for the overall survey group)

[2] See the following page for Key to Letters Used to Represent Contaminant Source Factors

[3] See the following page for Key to Letters Used to Represent Contaminants

Key to Letters Used to Represent Contaminant Source Factors and Contaminants
(for Table I-4)

<u>Factor(s) Used to Select Each of the Contaminant Sources (3rd column)</u>

A. Human health and/or environmental risk (toxicity)
B. Size of the population at risk
C. Location of the sources relative to drinking water sources
D. Number and/or size of contaminant sources
E. Hydrogeologic sensitivity
F. State findings, other findings
G. Documented from mandatory reporting
H. Geographic distribution/occurrence
I. Other criteria (please add or describe in the narrative)

<u>Contaminants/Classes of Contaminants Considered to be Associated with Each Source Checked (4th column)</u>

A. Inorganic pesticides
B. Organic pesticides
C. Halogenated solvents
D. Petroleum compounds
E. Nitrate
F. Fluoride
G. Salinity/brine
H. Metals
I. Radionuclides
J. Bacteria
K. Protozoa
L. Viruses
M. Other

For septic tanks (otherwise known as Individual Sewage Treatment Systems {ISTS}) and feedlots, there are so many sites that we are not able to track the exact number of sites at this time. In some cases, additional data are available but not readily accessible in a summarized or electronic form.

Clearly, many sites have been investigated and cleaned up but many others remain to be investigated or cleaned up. Programs that were given higher priority in the past (e.g., due to greater perceived risks) have more of their sites investigated or cleaned up. In general, these are industrial, military and underground storage tank sites. Nonpoint sources, such as ISTS and feedlots, generally have large numbers of sites and, most of them have not been evaluated on an individual basis. This suggests that a continued shift of our environmental protection and restoration resources toward addressing such nonpoint sources of contamination may be appropriate.

GROUND WATER DATA NEEDS

Ground water data to support local and regional ground water quality assessments is not as accessible or as easily used as needed. The data have been collected to varying standards of completeness and accuracy, for differing purposes, and as a consequence are difficult to compare and compile. Certain desired information, such as accurate locations and the identity of the aquifer are not in some databases. This makes it difficult to map the data and sort it by aquifer, watershed, or hydrogeologic setting.

ACCESSIBILITY OF BASELINE GROUND WATER DATA BY AQUIFER, REGION & BASIN

In March 1998, the Ground Water Monitoring and Assessment Program (GWMAP) published "Baseline Water Quality of Minnesota's Principal Aquifers". This report is based on detailed chemical analysis of ground water samples collected from nearly 1000 wells throughout the state. The interpretation of results includes summary statistics of an extensive list of water-quality parameters that are presented for each of the principal aquifers of the state. To further assist customers around the state, customized versions of the baseline report were prepared for each of the MPCA regions. In these reports, ground water quality summary statistics were presented for that portion of each principal aquifer that falls within the boundaries of the region. Finally, to assist the MPCA basin planning efforts, an additional report was prepared that presented the ground water quality information by major surface-water basin. This version of the data is available on the MPCA's World Wide Web site.

Program	# of Sites (estimated)
ISTS[4]	360,000 (nonconforming systems)
Feedlots	40,000 (potential contamination sources)
State Site Assessment Program	>25,000
LUST	16242

[4] This entry (360,000) represents the estimated number of NONCOMFORMING ISTS systems; the total number of ISTS systems in Minnesota is estimated to be 600,000.

Table I-5. Minnesota - Summary of Ground Water Protection Programs*
2000 Electronic Update

(Table information was obtained by contacting individual program managers from state and federal agencies.)

Programs or Activities	Check	Implementation Status	Responsible State Agency
Active SARA Title III Program	X	fully established	Dept. of Public Safety
Ambient ground water monitoring system	X	fully established[1]	MPCA
Aquifer vulnerability assessment	X	continuing efforts	DNR
Aquifer mapping	X	continuing efforts	DNR, MGS, USGS
Aquifer characterization	X	continuing efforts	DNR, USGS, MGS
Comprehensive data management system	X	continuing efforts	LMIC[2]
USEPA-endorsed Core Comprehensive State Ground Water Protection Program (CSGWPP)	no	extensive state assessment completed	MPCA
Ground water discharge permits	no		
Ground water Best Management Practices	X	continuing efforts	various
Ground water legislation	X	fully established	various
Ground water classification	no		
Ground water quality standards		HRL's used for cleanup, permitting, etc.[3]	MDH, MPCA
Interagency coordination for ground water protection initiatives	X	implemented	EQB
Nonpoint source controls	X	continuing efforts	MPCA, MDA
Pesticide State Management Plan	X	fully established	MDA
Pollution Prevention Program	X	fully established	MOEA[4]
Resource Conservation and Recovery Act (RCRA) Primacy	X	fully established	MPCA
Source Water Assessment Program	X	fully established	MDH
State Superfund	X	fully established	MPCA
State RCRA Program incorporating more stringent requirements than RCRA Primacy	X	fully established	MPCA
State septic system regulations	X	fully established	MPCA

Programs or Activities	Check	Implementation Status	Responsible State Agency
Underground storage tank installation requirements	X	fully established	MPCA
Underground Storage Tank Remediation Fund	X	fully established	Dept. of Commerce, MPCA
Underground Storage Tank Registration Program	X	fully established	MPCA
Underground Injection Control Program	X	continuing efforts	MPCA
Vulnerability assessment for drinking water/wellhead protection	X	fully established	MDH
Well abandonment regulations	X	fully established	MDH
Wellhead Protection Program (USEPA-approved)	X	fully established	MDH
Well installation regulations	X	fully established	MDH
Other Programs or Activities (please specify)			

** Please see the following page for "footnotes" and the list of acronyms and abbreviations.*

Supplement to Table I-5
Minnesota - Summary of Ground Water Protection Programs
2000 Electronic Update

List of acronyms and abbreviations

DNR	Department of Natural Resources
EQB	Environmental Quality Board
HRL	Health Risk Limit
LMIC	Land Management Information Center
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MERC	Minnesota Emergency Response Commission
MGS	Minnesota Geological Survey
MOEA	Office of Environmental Assistance
MPCA	Minnesota Pollution Control Agency
SARA	Superfund Amendments and Reauthorization Act
USGS	United States Geological Survey

"Footnotes"

1: The statewide ground water baseline monitoring effort was completed by the GWMAP program in 1996. Other monitoring efforts are outlined in this year's update for the ground water portion of the 305(b) report summary text.

2: LMIC does not house all of Minnesota's ground water data. There is no centralized database at this time that contains all of Minnesota's ground water data.

3: HRLs are used in a risk-based approach. Depending on the program objectives, hydrogeologic setting, risk-based models, etc., a multiplier (e.g., HRL x 1/4) may be used in conjunction with HRLs to determine the appropriate requirement, action or non-action.

4: OEA, MERC, and MPCA are involved.

Wellhead Protection Program

List of Public Water Suppliers Participating (8/2/99)

Communities currently delineating wellhead protection areas:

Duluth Region:
Keewatin
National Steel Pellet Co.

Brainerd Region:
Elk River
Albany
Bertha
City of Browerville
Cold Spring
Cold Spring Granite
Gold'n Plump, Cold Spring
Paynesville
Sauk Rapids
Viking Ind., St. Joseph

Detroit Lakes Region:
Ashby
Kittson-Marshall Rural Water
Mahnomen
Marshall-Polk Rural Water
Moorhead
Park Rapids

Marshall Region:
Benson
Blue Earth
Eden Valley
Hector
Litchfield
Lincoln-Pipestone Rural Water
LuVerne
Windom

Rochester Region:
Faribault
Nicollet
Winthrop

Metro Area:
Apple Valley
Brooklyn Center
Burnsville
Champlin
Eagan
Eden Prairie
Farmington
Hastings
Medford
Oak Park Heights
Oakdale
Rosemount
Shakopee
South St. Paul
Waconia

Communities currently conducting contaminant source inventory and developing management plan:

Brainerd Region: Brainerd; Zimmerman, Wadena, Camp Ripley
Detroit Lakes Region: Argyle, Detroit Lakes; Perham; St. Hilaire
Marshall Region: Edgerton
Rochester Region: Lafayette; Medford (Well #1); Northfield
Metro Area: Andover, Bloomington; North St. Paul, Woodbury; Edina

Wellhead plan approved/implementing plan:

Brainerd Region: Clear Lake
Marshall Region: Renville
Rochester Region: St. Peter, Le Center

Recommendations for Improvement

NPS ASSESSMENT

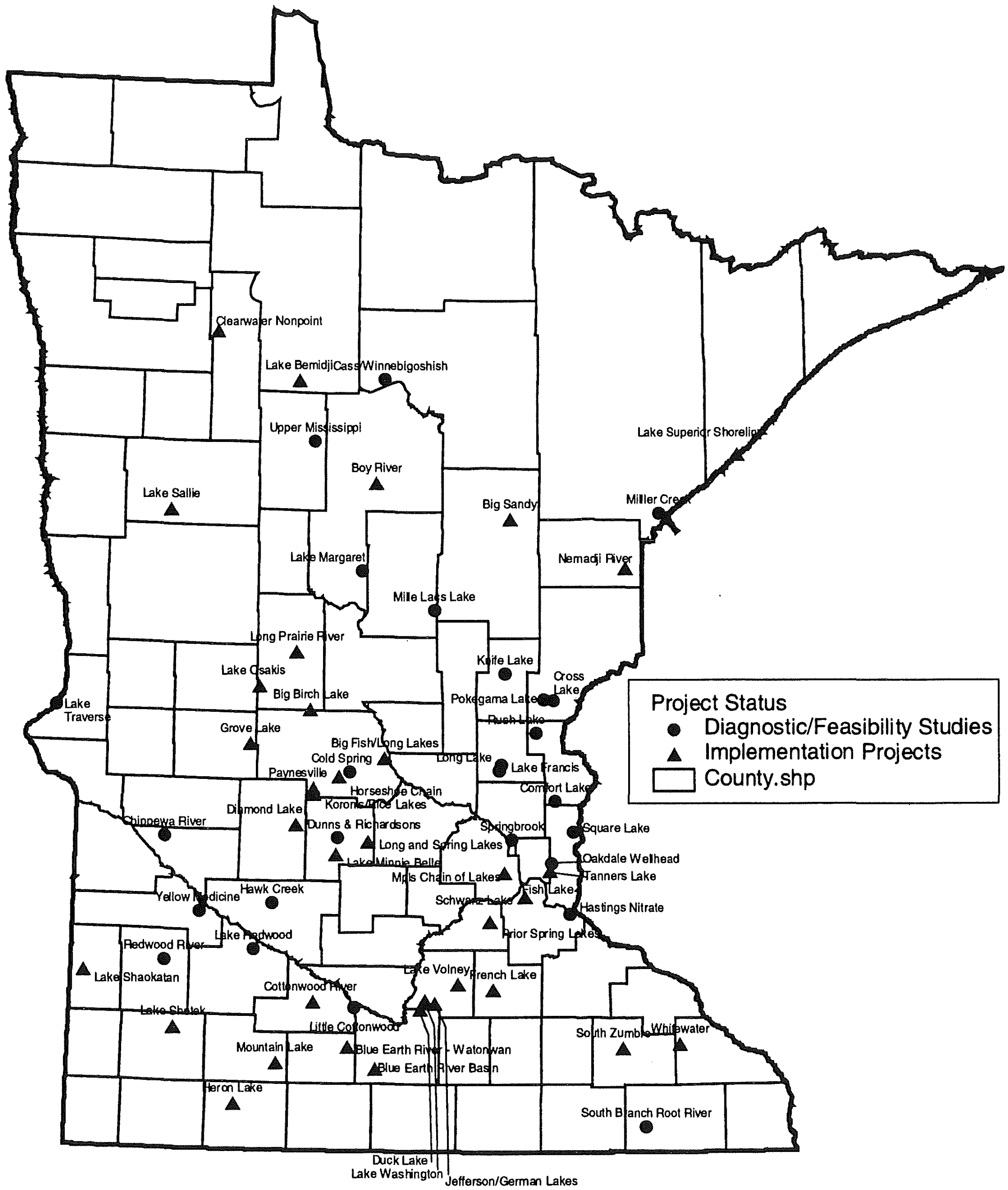
Recommendations for Improvement – Assessments of Waterbody Condition and Problem Identification

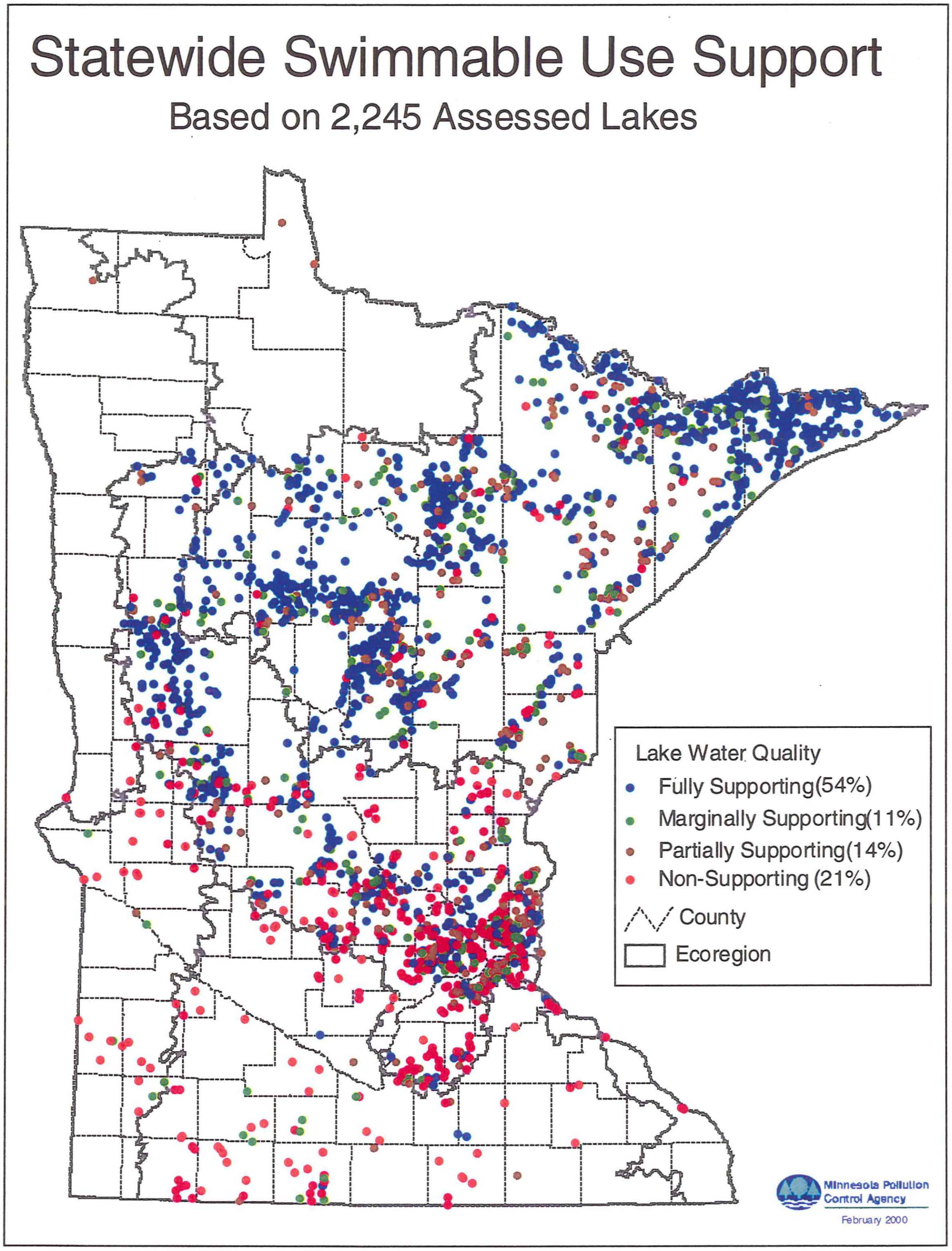
- Establish interagency partnership (led by USGS on federal level and DNR on the state level) to maintain a network of long-term monitoring installations for major river basin-scale NPS pollution load.
- Continue to build and support state-local partnerships to execute minor and major watershed-scale NPS load monitoring where needed to focus implementation.
- PCA should design and implement a timely report format for citizens and partners with information about current loadings compared with load reduction goals.
- Continue to expand the PCA basic statewide citizen stream and lake monitoring programs, which provide data management and interpretation.
- Strengthen the linkages between assessment procedures and local water planning.
- Support locally-grown citizen monitoring that is used to inform local resource management decisions. Identify appropriate niches for such information in statewide assessments. Develop resource centers for data management, reporting, and access to technical assistance and training to provide the program continuity necessary for statewide assessments.
- Continue the interagency cooperative work led by MPCA to calibrate biological indices of stream integrity in all the ecoregions of the state.
- For both surface water and ground water, improve Web access to assessments and information.
- Upgrade the NPS Survey.
- Continue to explore, develop and utilize new monitoring technology, equipment and methods to improve the quality and quantity of our NPS assessments.

Recommendations for Improvement – Assessment of Effectiveness of BMPs and Improvement to 319 Program

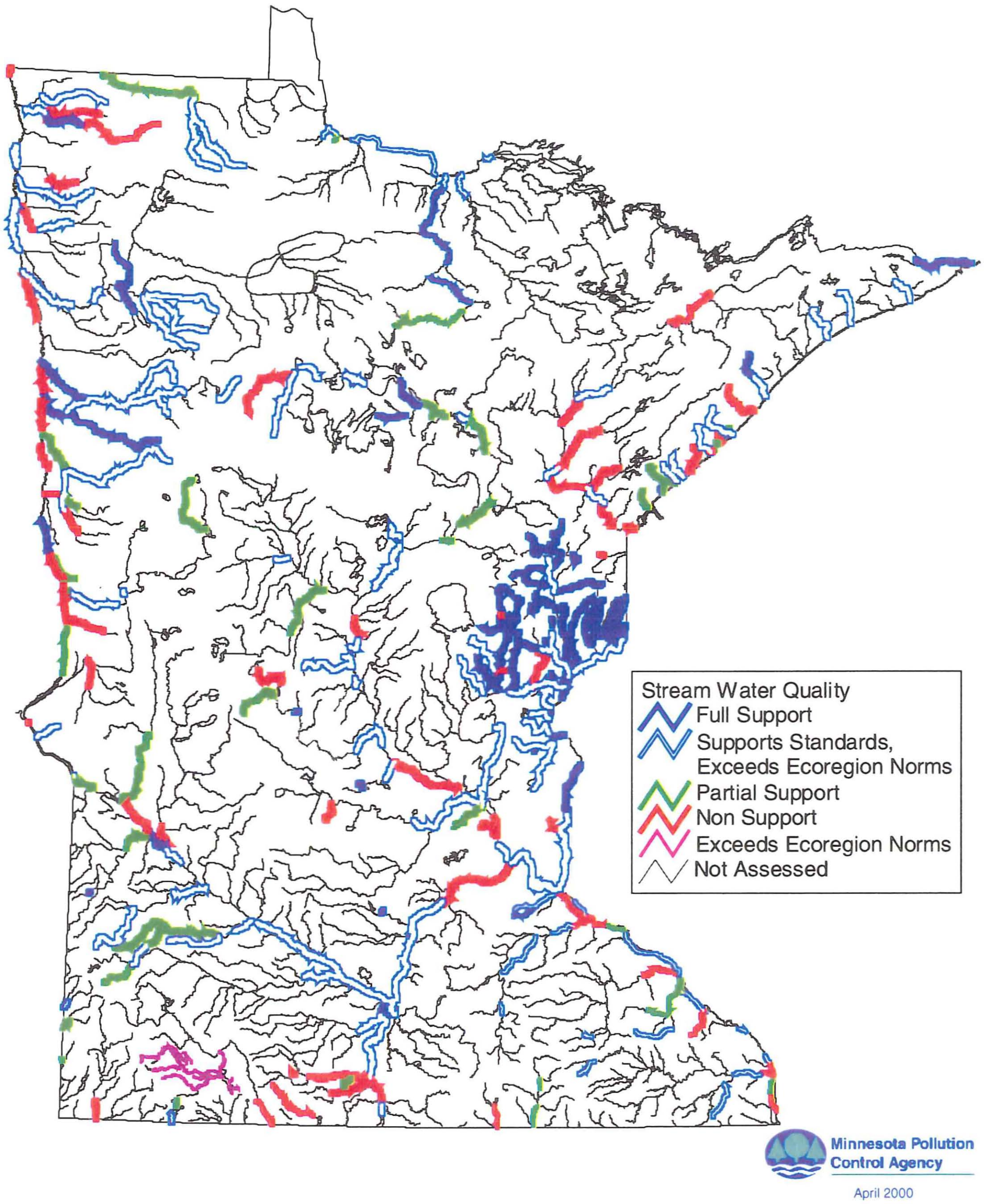
- There is a growing need to develop yardsticks to measure the environmental outcome of NPS projects, chiefly implementation of BMPs and improvements to the 319 program. The MPCA plans to work with partners to discuss the feasibility of developing measures to estimate water quality benefits of NPS activities. These discussions will likely focus on monitoring results, modeling, developing new or revising existing calculations, statistical analysis, conducting site visits and other potential methods for assessing environmental outcomes.

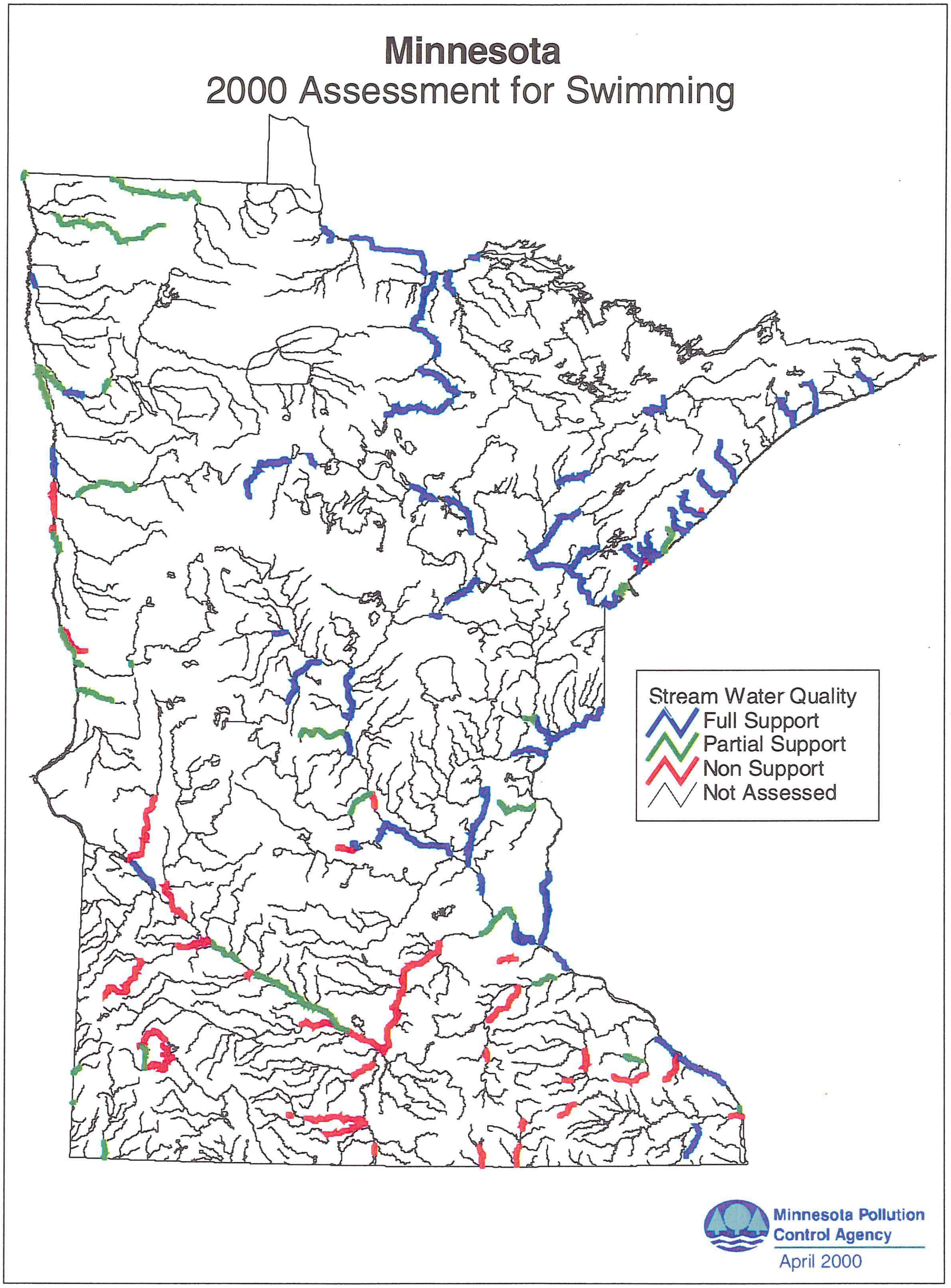
Clean Water Partnerships



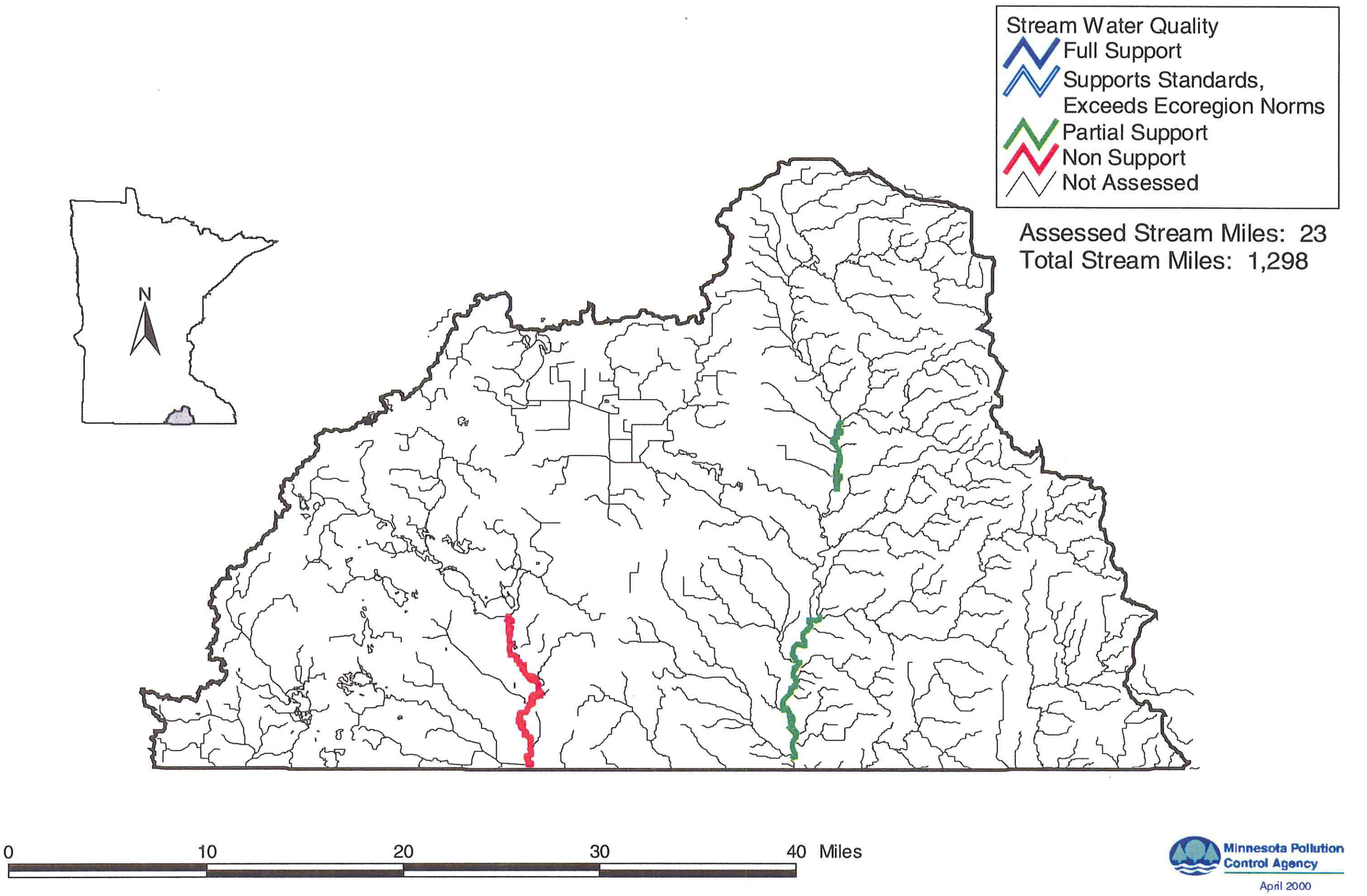

Statewide Swimmable Use Support
Based on 2,245 Assessed Lakes
Lake Water Quality
Fully Supporting(54%)
Marginally Supporting(11%)
Partially Supporting(14%)
Non-Supporting (21%)
County
Ecoregion
Minnesota Pollution Control Agency
February 2000

Minnesota
2000 Assessment for Aquatic Life



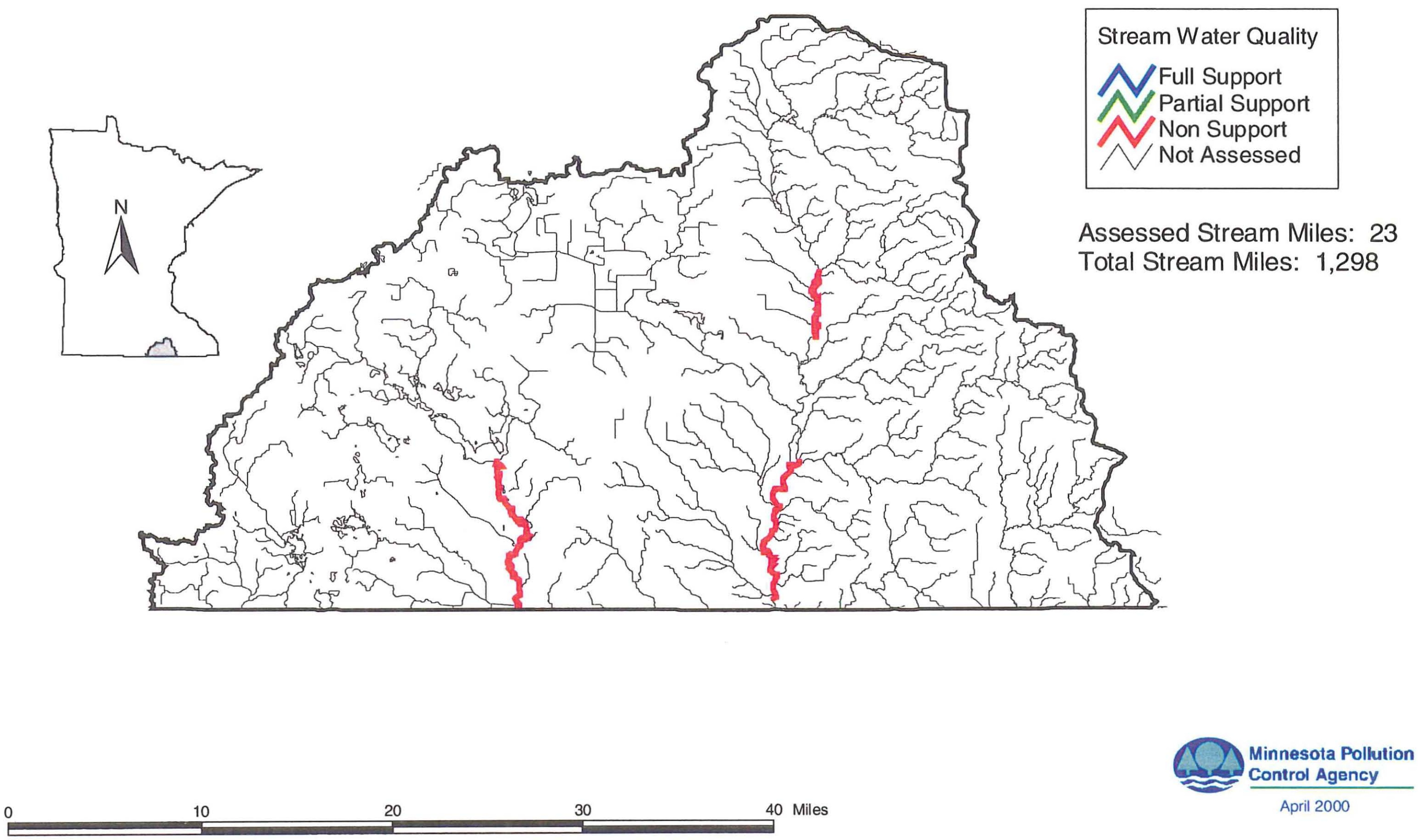

Minnesota
2000 Assessment for Swimming
Stream Water Quality
Full Support
Partial Support
Non Support
Not Assessed
Minnesota Pollution
Control Agency
April 2000

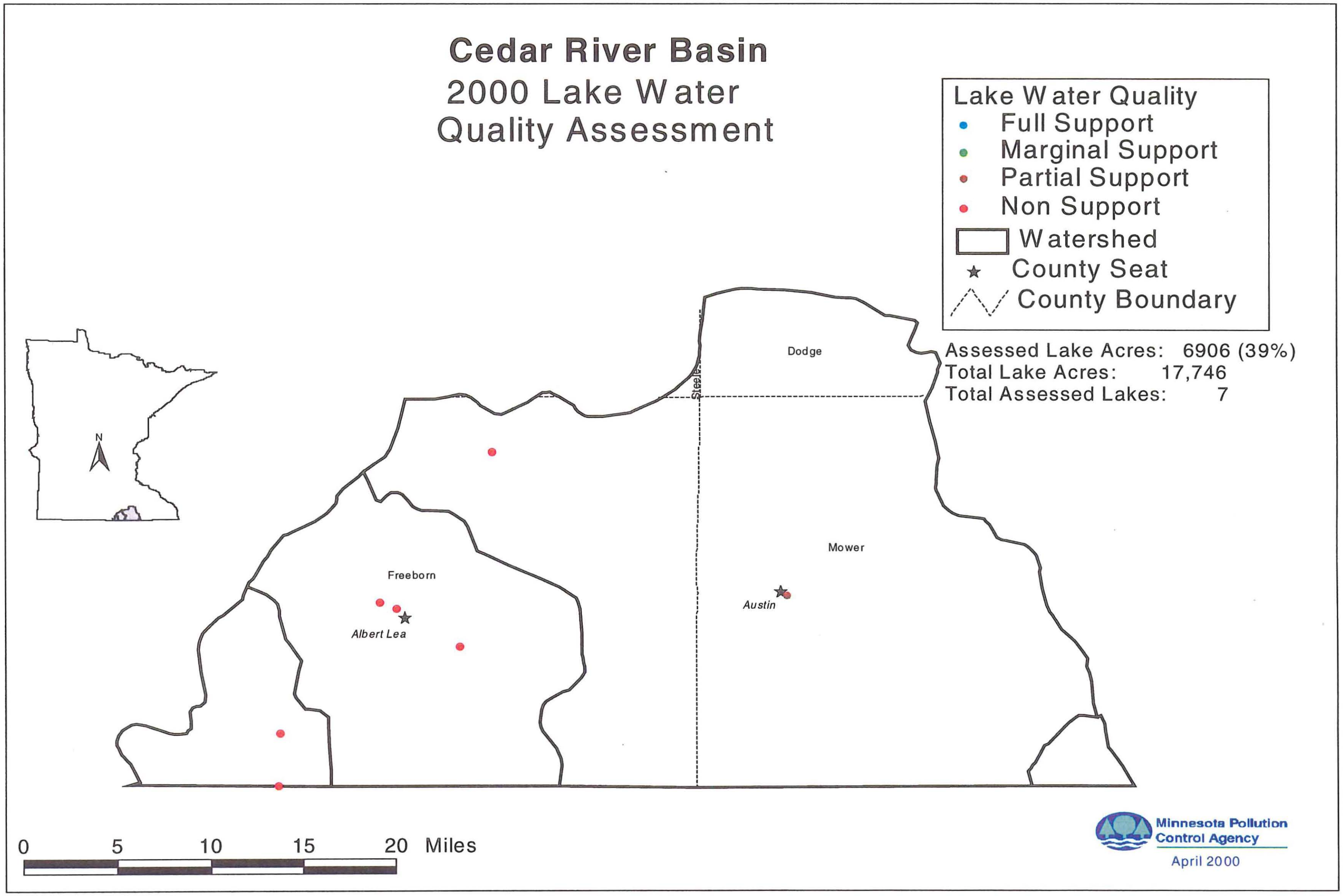
Cedar River Basin
2000 Assessment for Aquatic Life

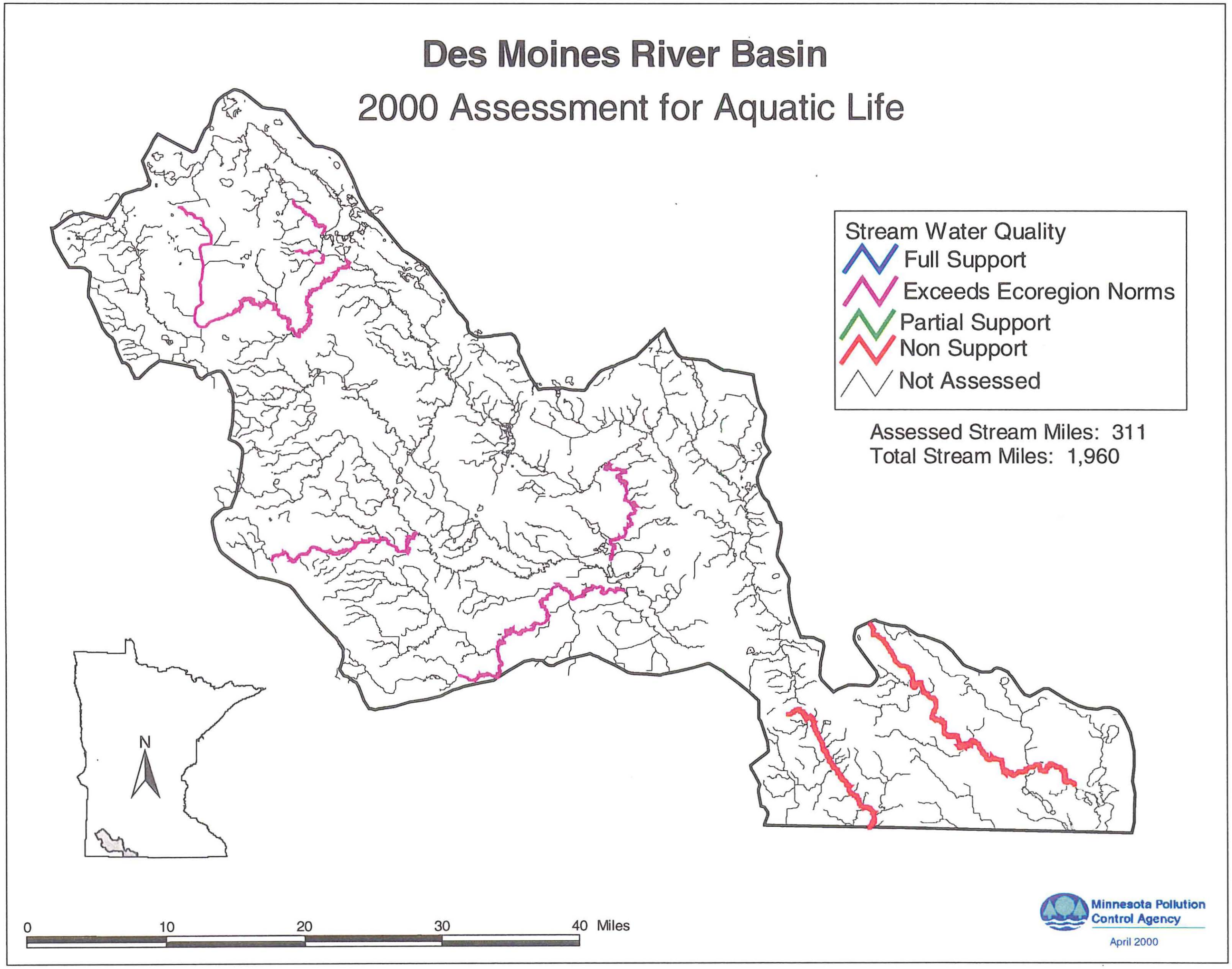


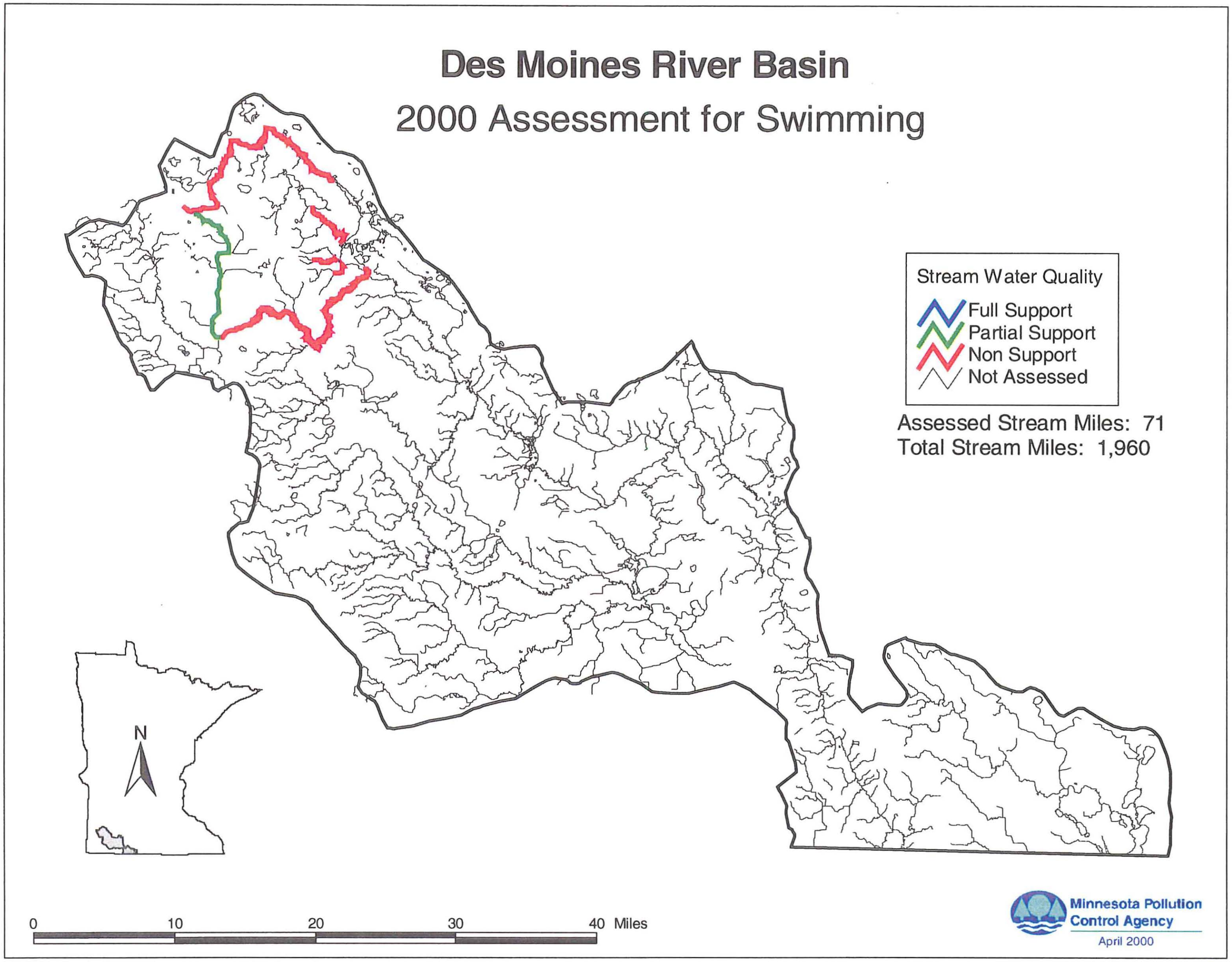
Cedar River Basin

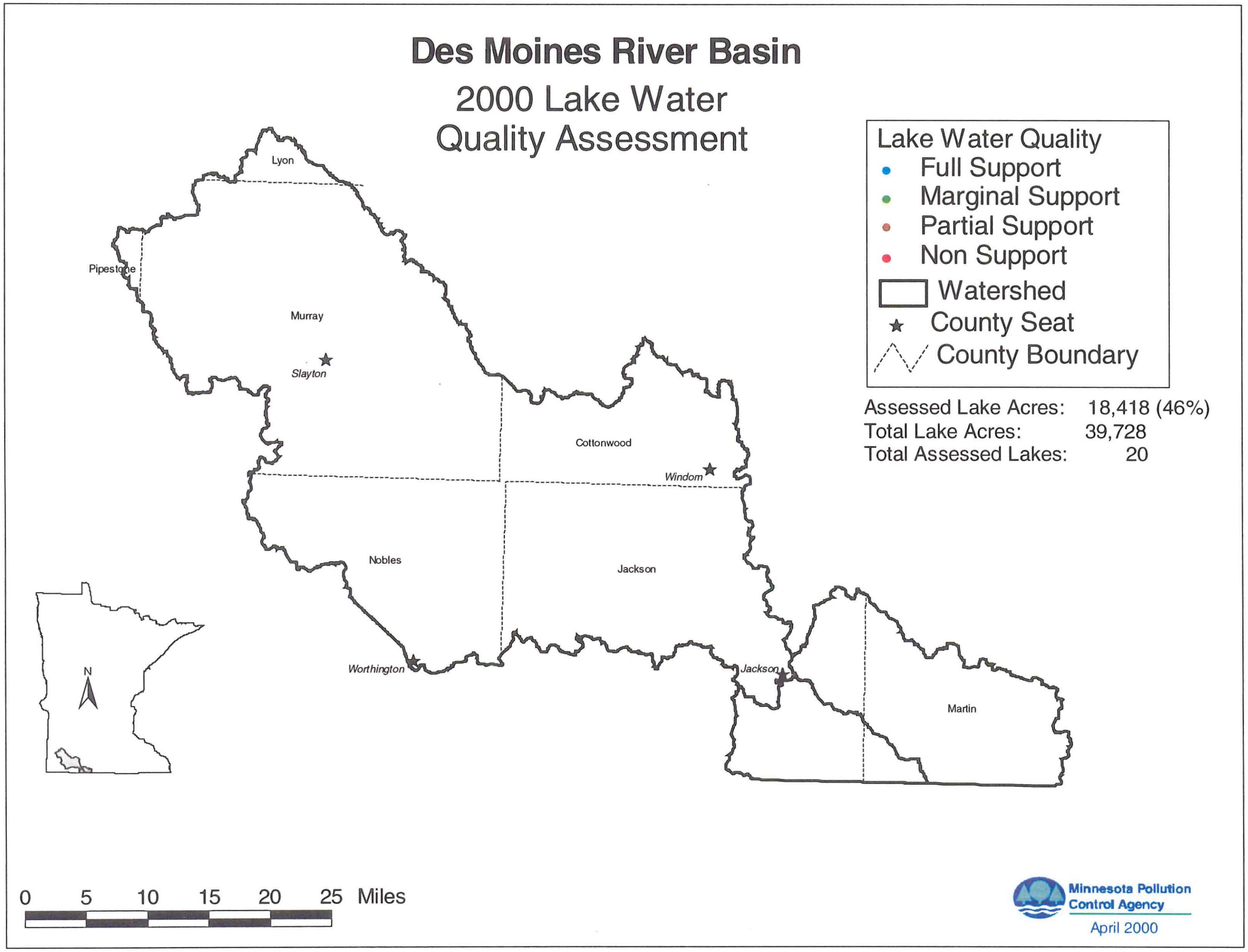
2000 Assessment for Swimming



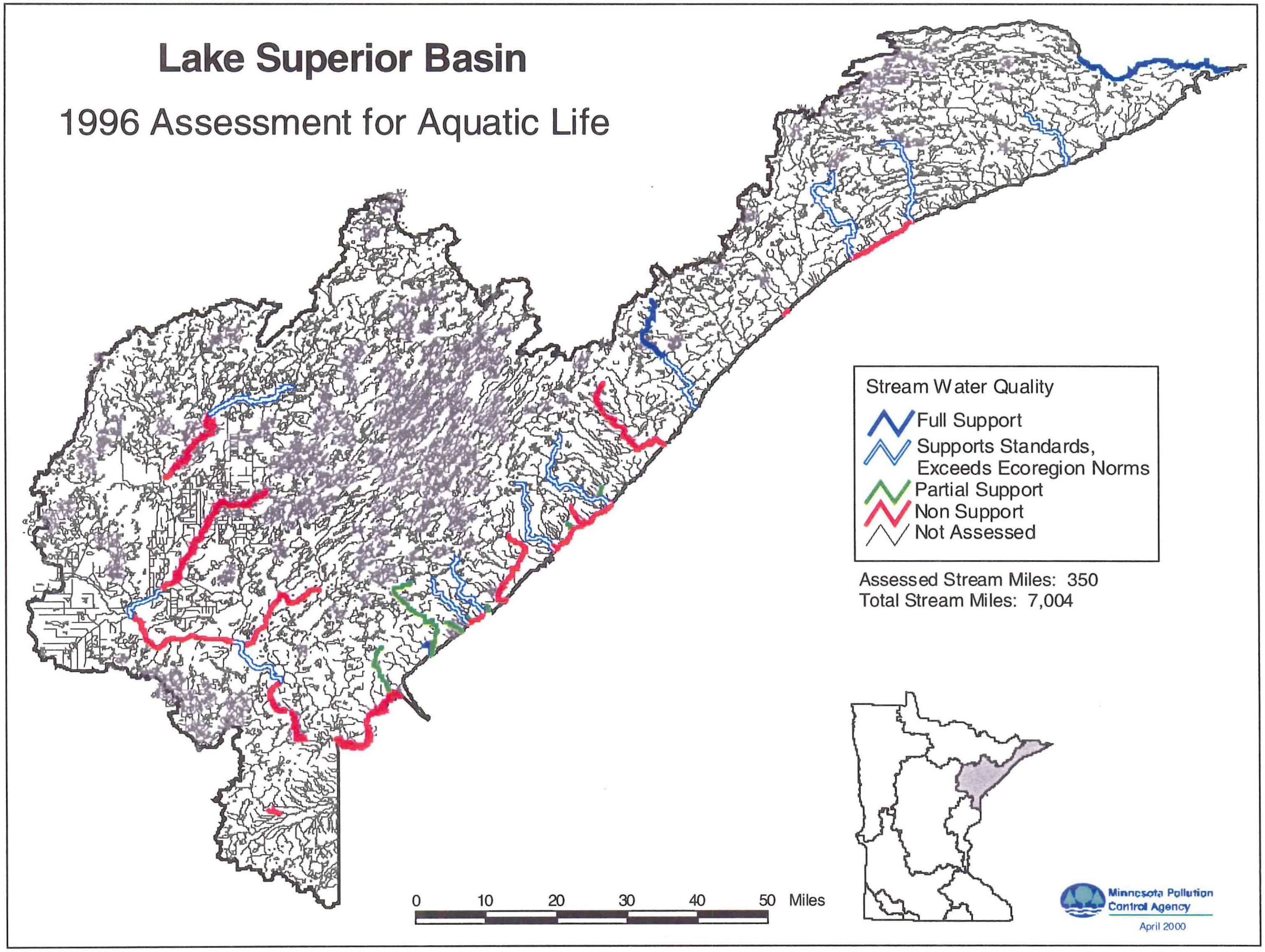

Cedar River Basin
2000 Lake Water
Quality Assessment
Lake Water Quality
Full Support
Marginal Support
Partial Support
Non Support
Watershed
County Seat
County Boundary
Assessed Lake Acres: 6906 (39%)
Total Lake Acres: 17,746
Total Assessed Lakes: 7
Dodge
Steele
Mower
Freeborn
Albert Lea
Austin
N
0 5 10 15 20 Miles
Minnesota Pollution Control Agency
April 2000

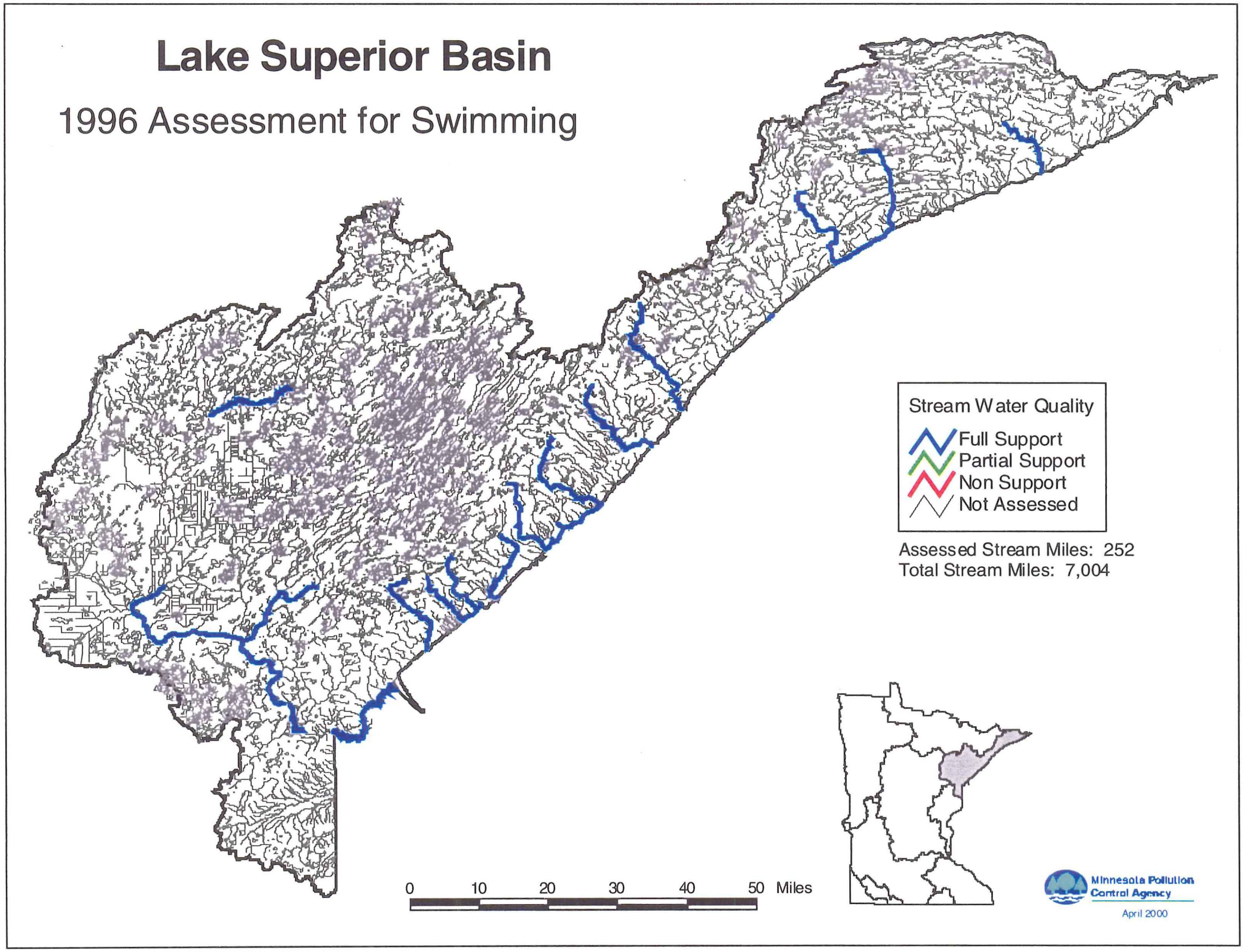

Des Moines River Basin
2000 Assessment for Aquatic Life
Stream Water Quality
Full Support
Exceeds Ecoregion Norms
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 311
Total Stream Miles: 1,960
N
0
10
20
30
40 Miles
Minnesota Pollution Control Agency
April 2000

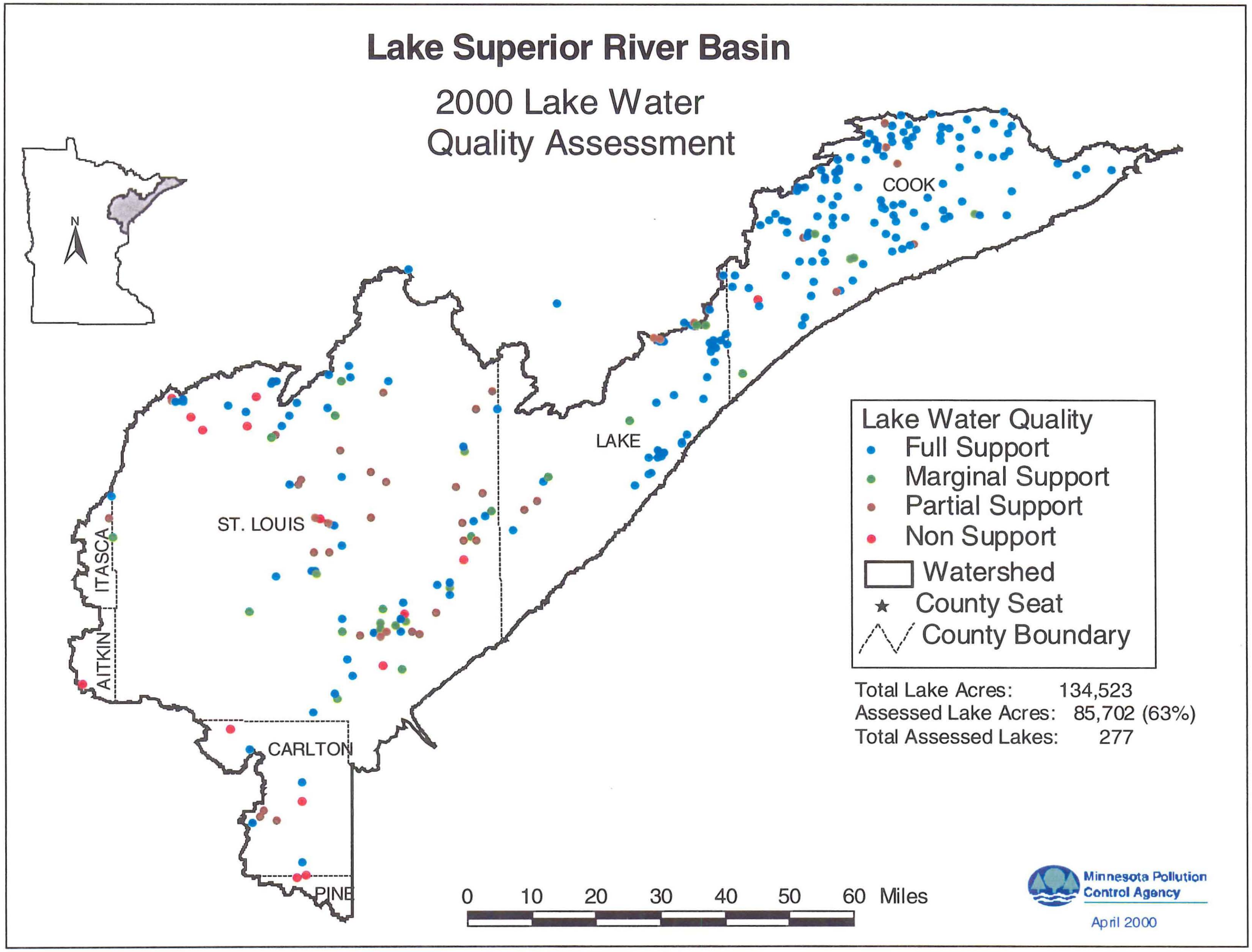

Des Moines River Basin
2000 Assessment for Swimming
Stream Water Quality
Full Support
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 71
Total Stream Miles: 1,960
N
0
10
20
30
40 Miles
Minnesota Pollution Control Agency
April 2000

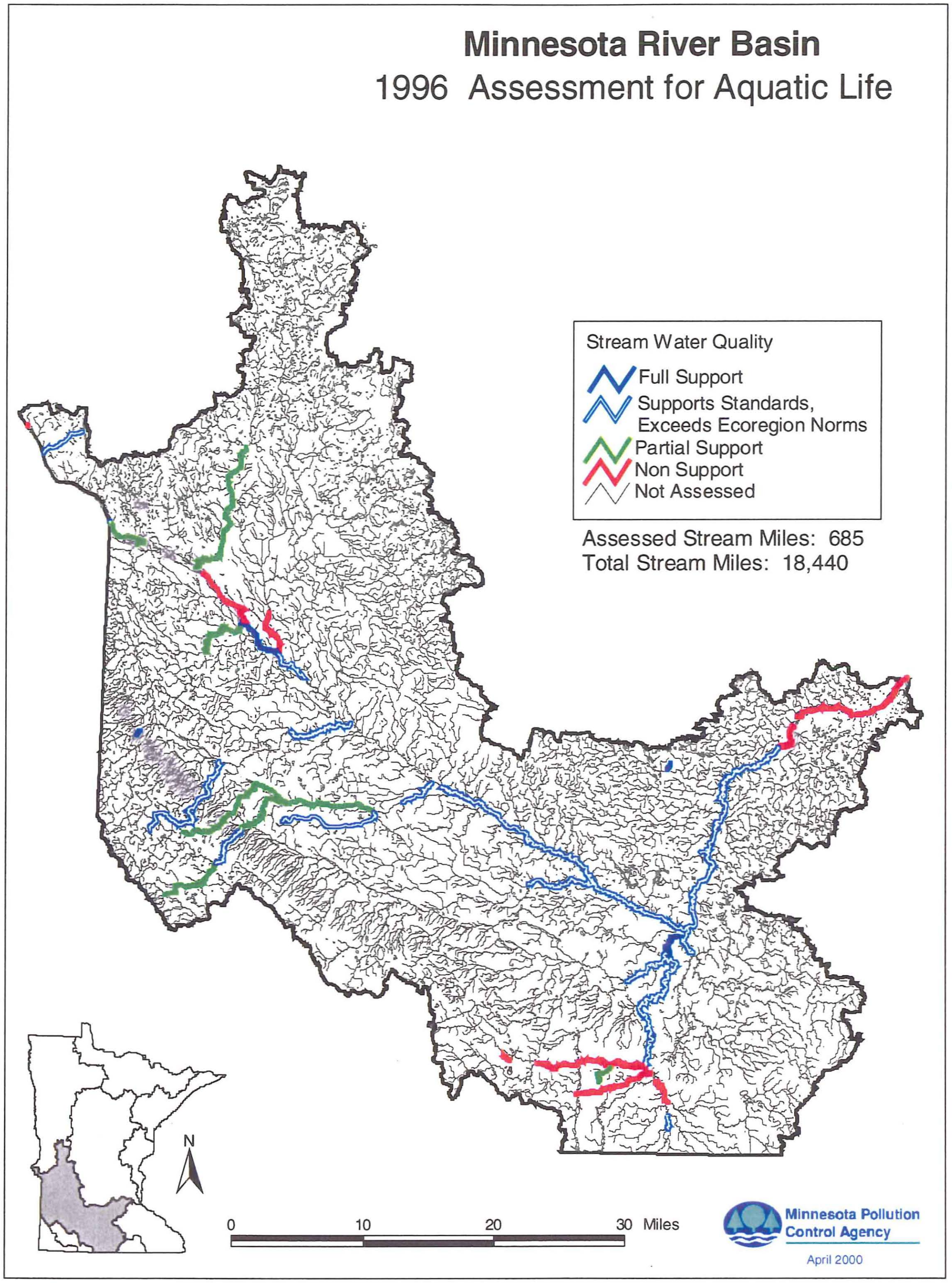


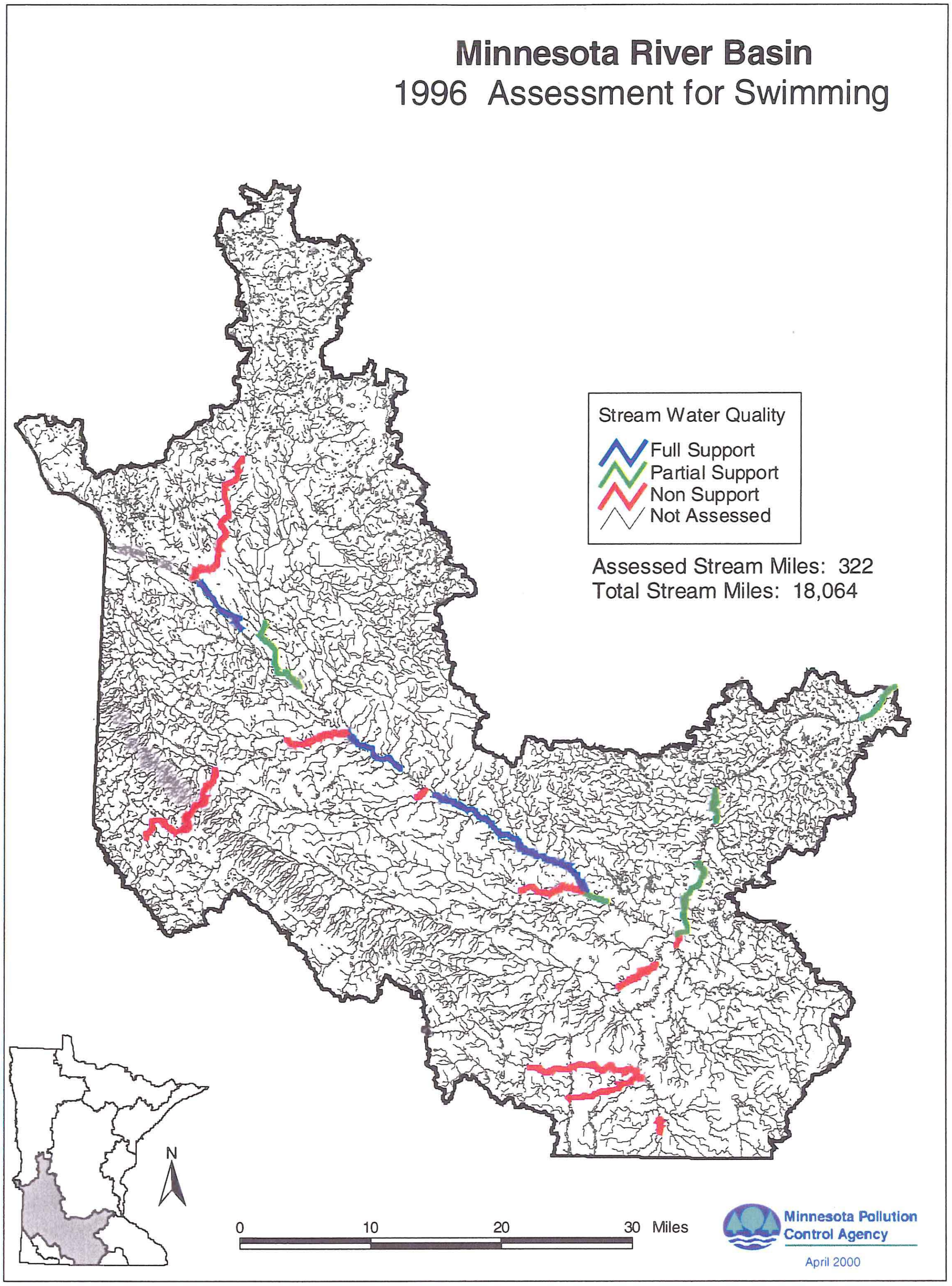
Des Moines River Basin
2000 Lake Water
Quality Assessment
Lake Water Quality
Full Support
Marginal Support
Partial Support
Non Support
Watershed
County Seat
County Boundary
Assessed Lake Acres: 18,418 (46%)
Total Lake Acres: 39,728
Total Assessed Lakes: 20
Lyon
Pipestone
Murray
Slayton
Cottonwood
Windom
Nobles
Jackson
Worthington
Jackson
Martin
N
0 5 10 15 20 25 Miles
Minnesota Pollution Control Agency
April 2000

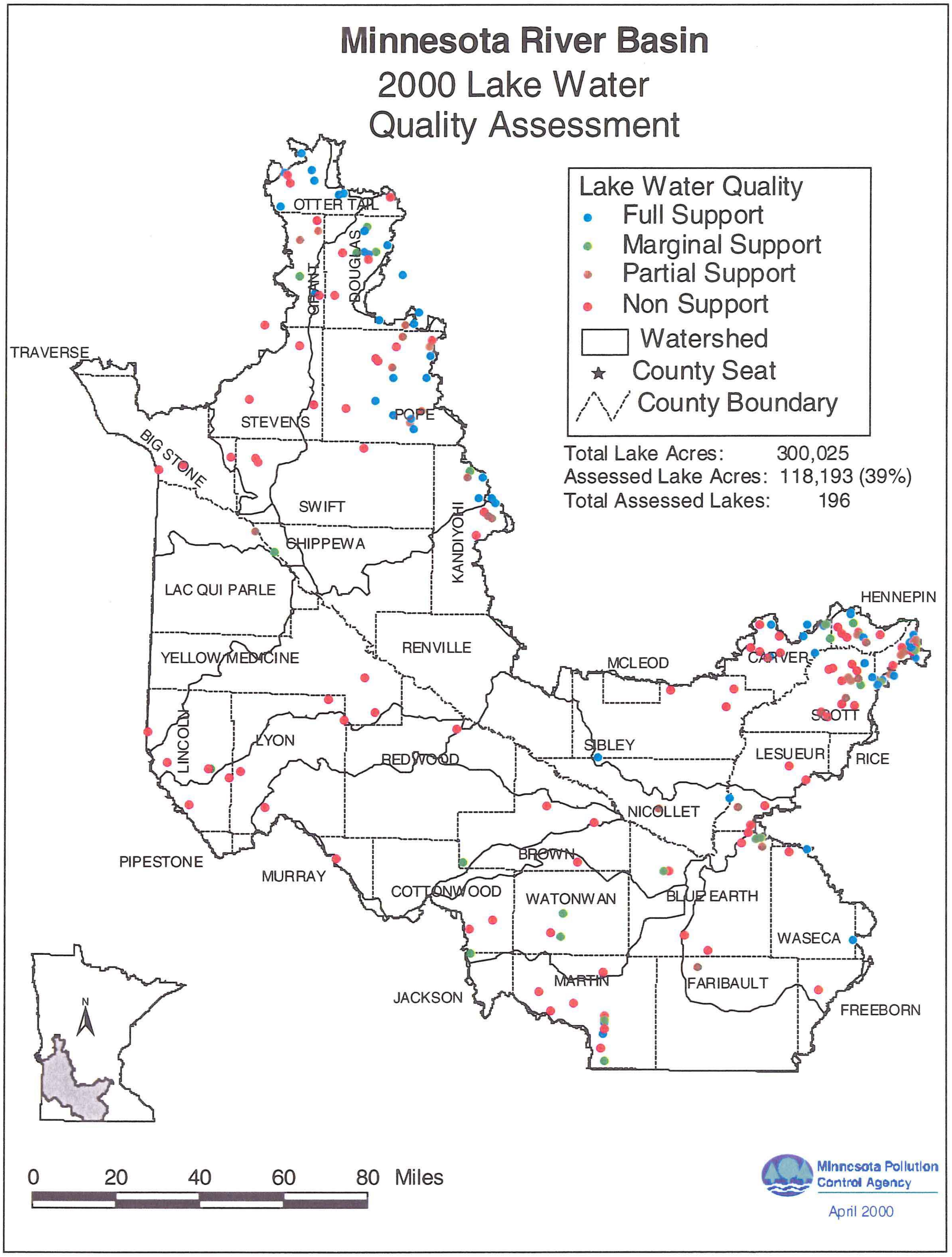

Lake Superior Basin
1996 Assessment for Aquatic Life
Stream Water Quality
Full Support
Supports Standards,
Exceeds Ecoregion Norms
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 350
Total Stream Miles: 7,004
0
10
20
30
40
50
Miles
Minnesota Pollution Control Agency
April 2000


Lake Superior Basin
1996 Assessment for Swimming
Stream Water Quality
Full Support
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 252
Total Stream Miles: 7,004
0
10
20
30
40
50
Miles
Minnesota Pollution Control Agency
April 2000


Lake Superior River Basin
2000 Lake Water Quality Assessment
N
COOK
LAKE
ST. LOUIS
ITASCA
AITKIN
CARLTON
PINE
Lake Water Quality
Full Support
Marginal Support
Partial Support
Non Support
Watershed
County Seat
County Boundary
Total Lake Acres: 134,523
Assessed Lake Acres: 85,702 (63%)
Total Assessed Lakes: 277
0 10 20 30 40 50 60 Miles
Minnesota Pollution Control Agency
April 2000

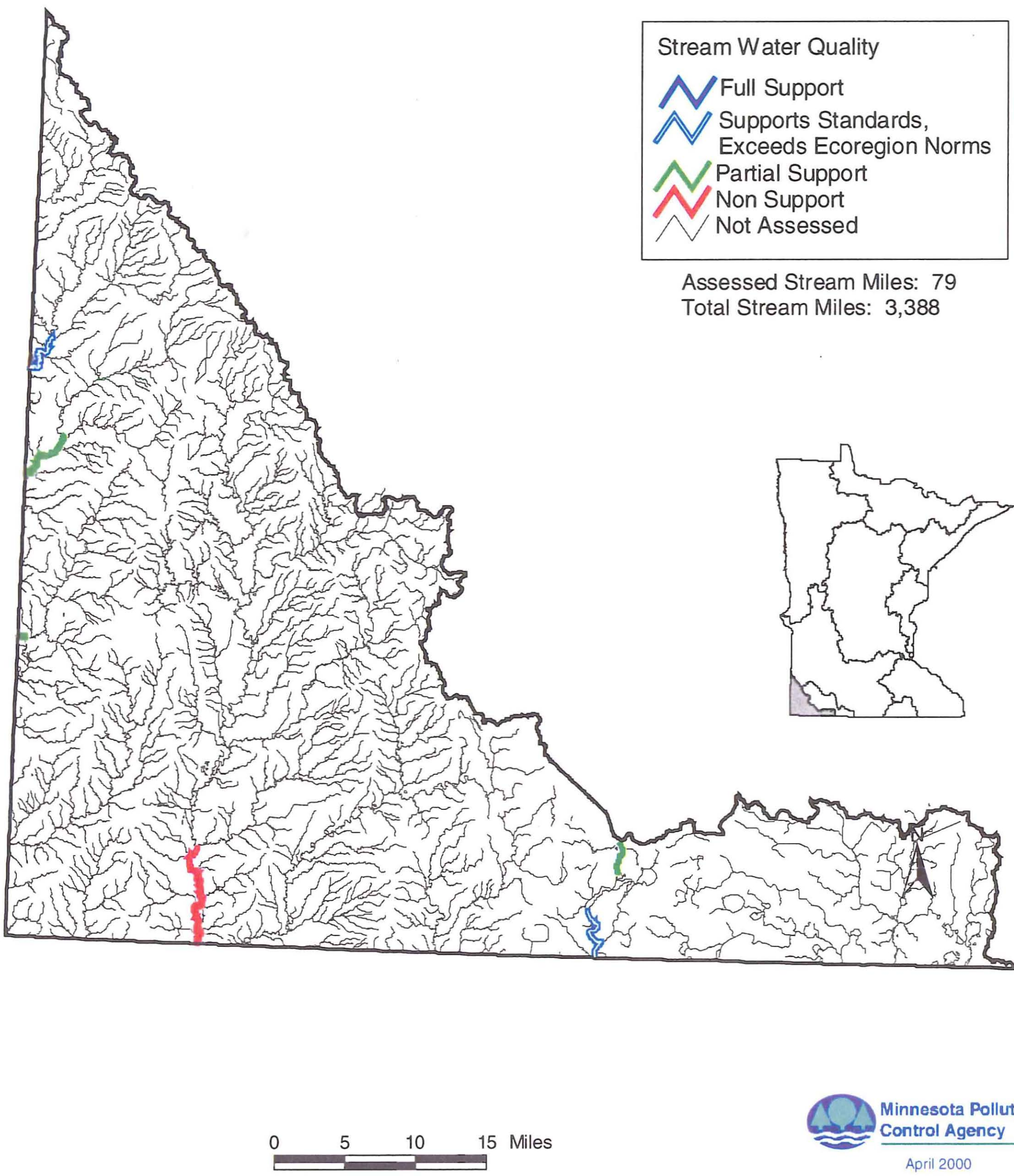

Minnesota River Basin
1996 Assessment for Aquatic Life
Stream Water Quality
Full Support
Supports Standards, Exceeds Ecoregion Norms
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 685
Total Stream Miles: 18,440
N
0
10
20
30 Miles
Minnesota Pollution Control Agency
April 2000


Minnesota River Basin
1996 Assessment for Swimming
Stream Water Quality
Full Support
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 322
Total Stream Miles: 18,064
N
0
10
20
30 Miles
Minnesota Pollution Control Agency
April 2000


Minnesota River Basin
2000 Lake Water
Quality Assessment
Lake Water Quality
Full Support
Marginal Support
Partial Support
Non Support
Watershed
County Seat
County Boundary
Total Lake Acres: 300,025
Assessed Lake Acres: 118,193 (39%)
Total Assessed Lakes: 196
OTTER TAIL
GRANT
DOUGLAS
TRAVERSE
STEVENS
POPE
BIG STONE
SWIFT
KANDIYOHI
CHIPPEWA
LAC QUI PARLE
HENNEPIN
RENVILLE
YELLOW MEDICINE
MCLEOD
CARVER
SCOTT
LINCOLN
LYON
SIBLEY
LESUEUR
RICE
REDWOOD
NICOLLET
PIPESTONE
BROWN
MURRAY
COTTONWOOD
WATONWAN
BLUE EARTH
WASECA
JACKSON
MARTIN
FARIBAULT
FREEBORN
N
0 20 40 60 80 Miles
Minnesota Pollution Control Agency
April 2000

Missouri River Basin

2000 Assessment for Aquatic Life

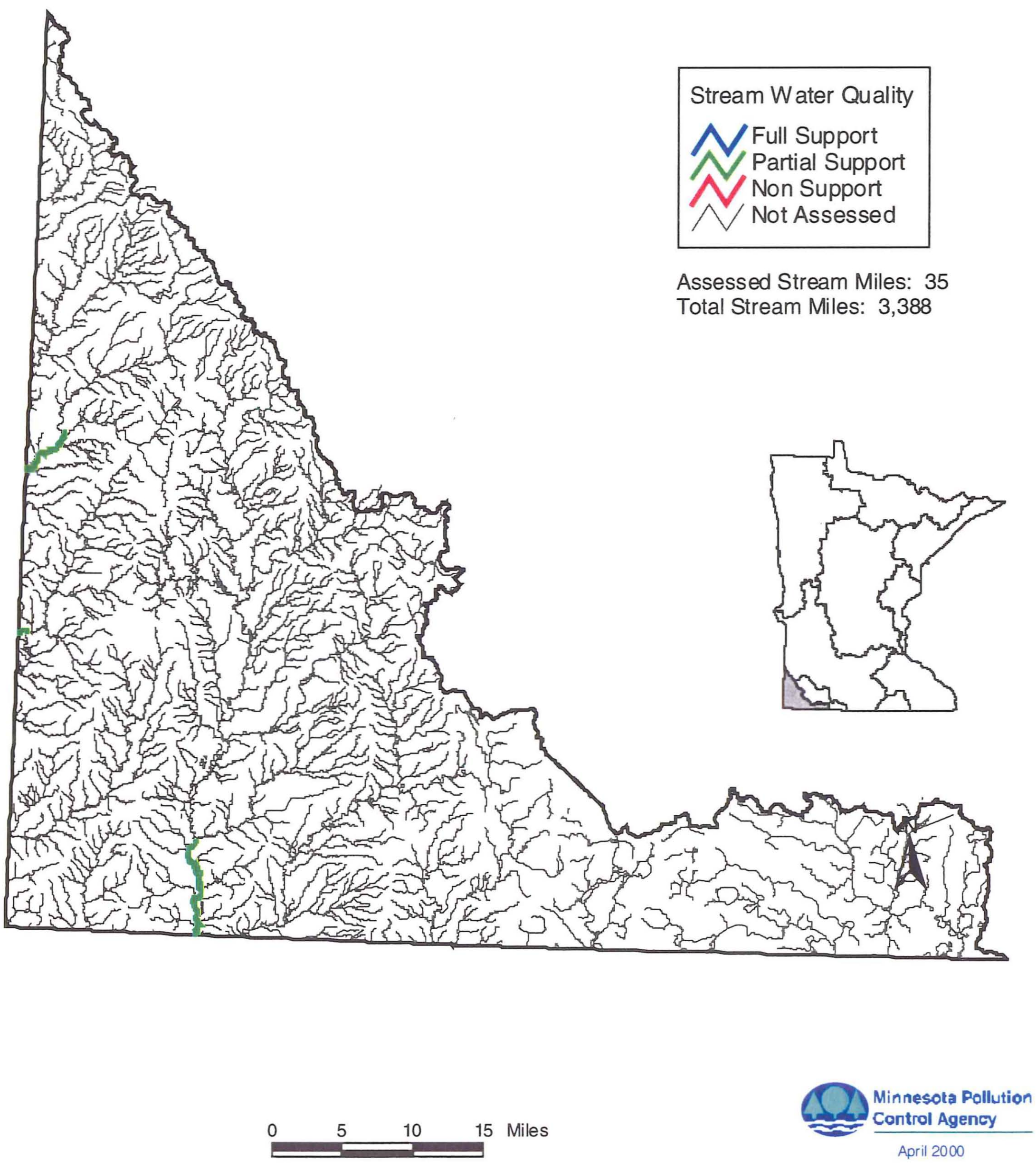


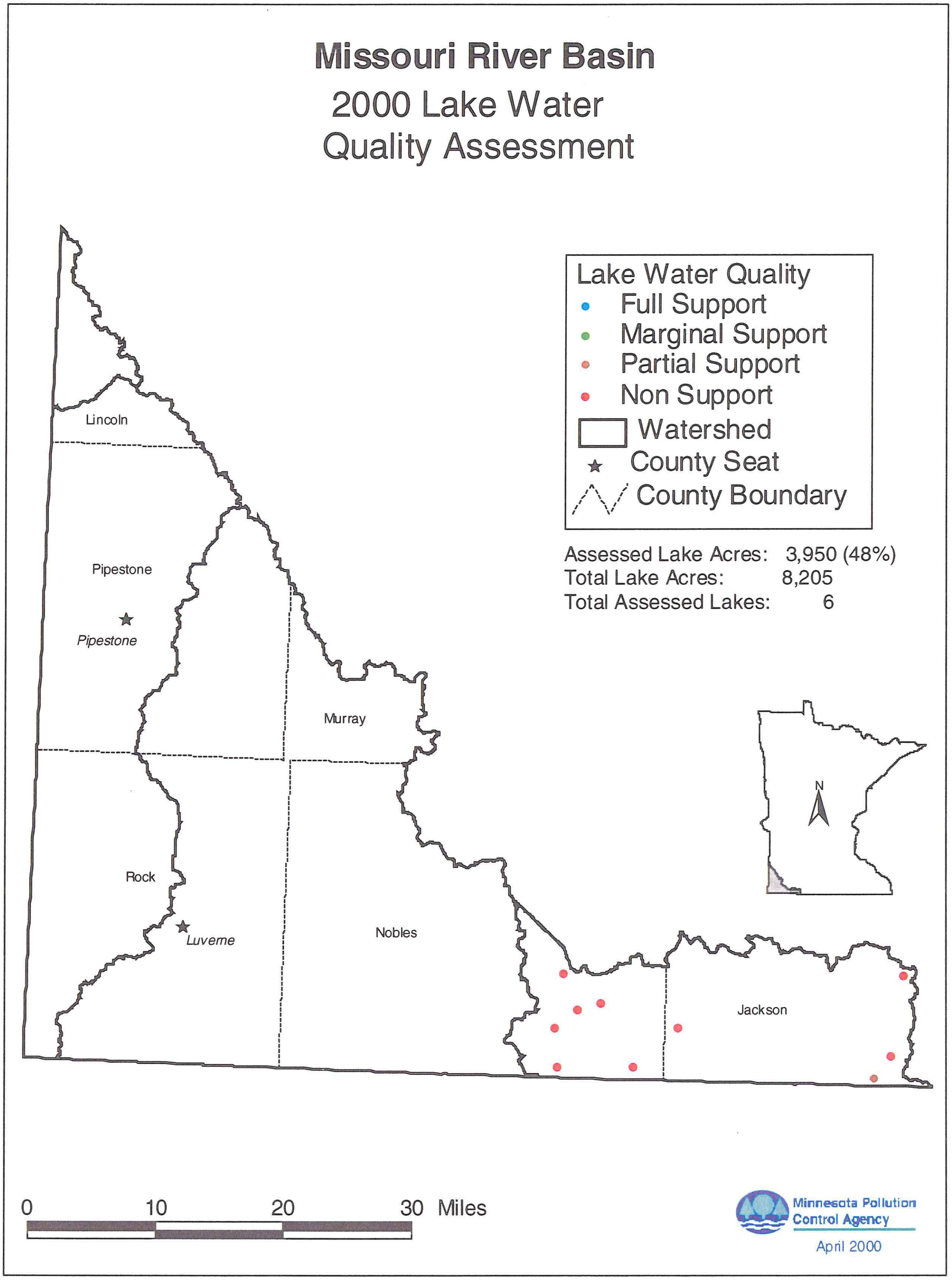
Minnesota Pollution Control Agency

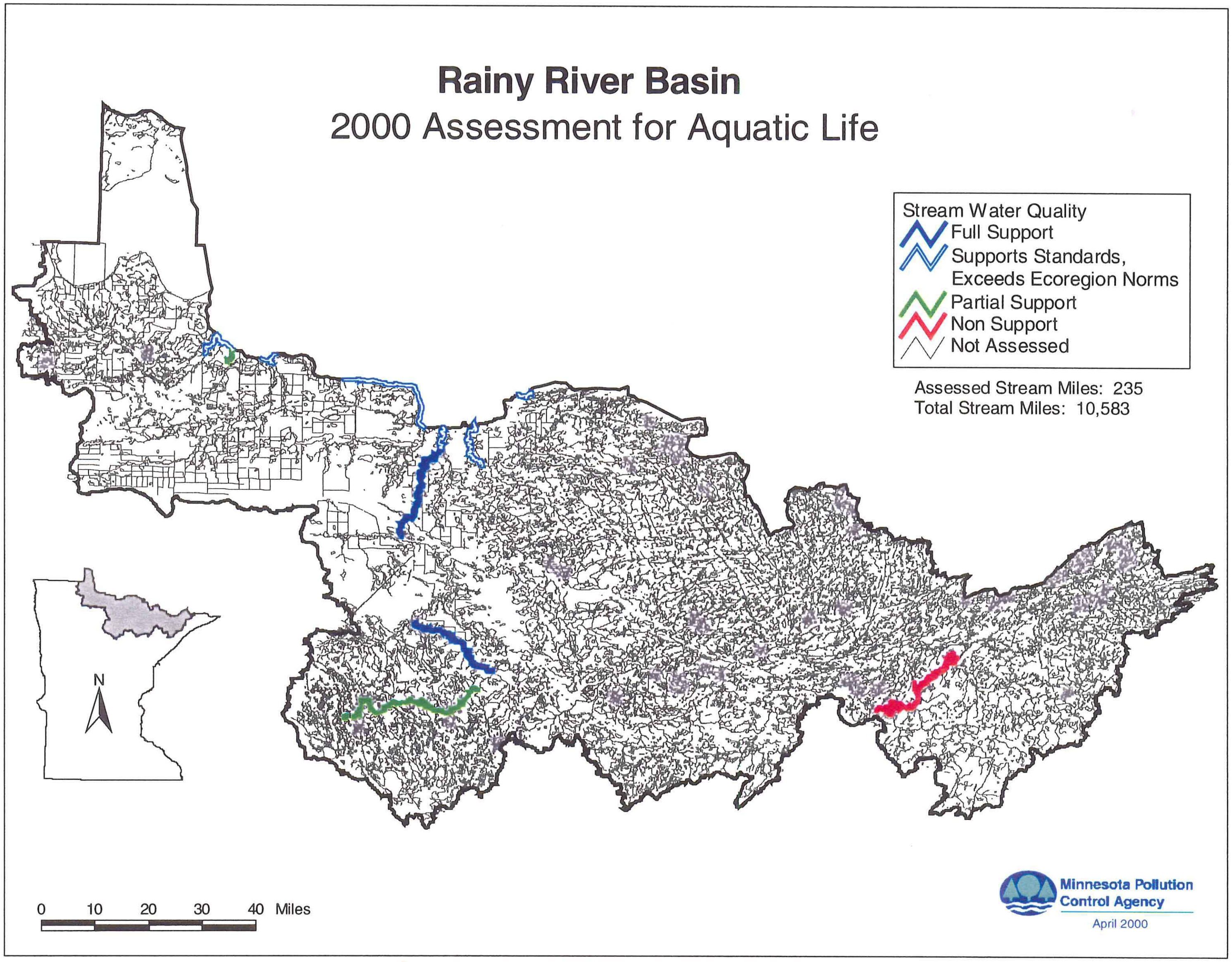
April 2000

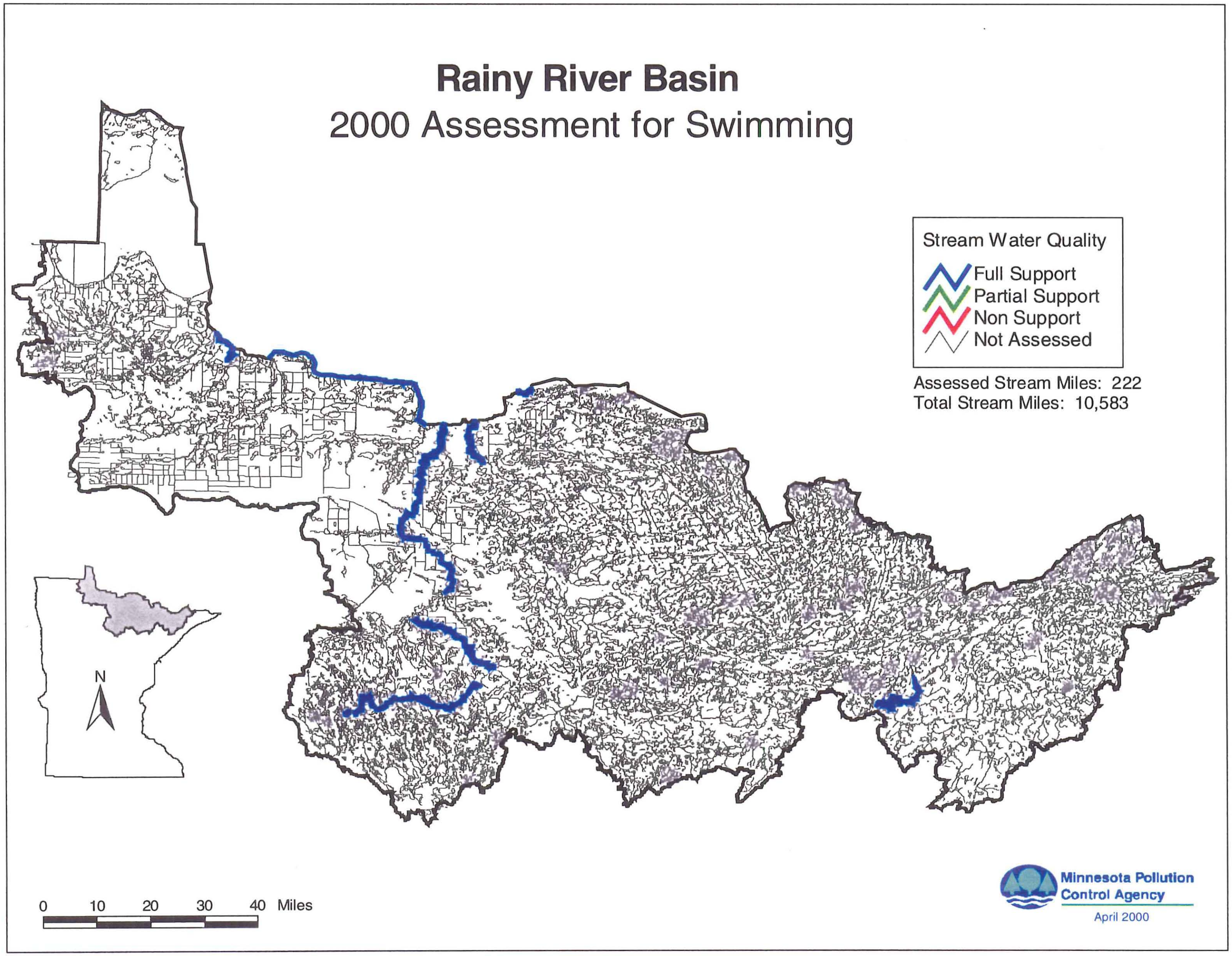
Missouri River Basin

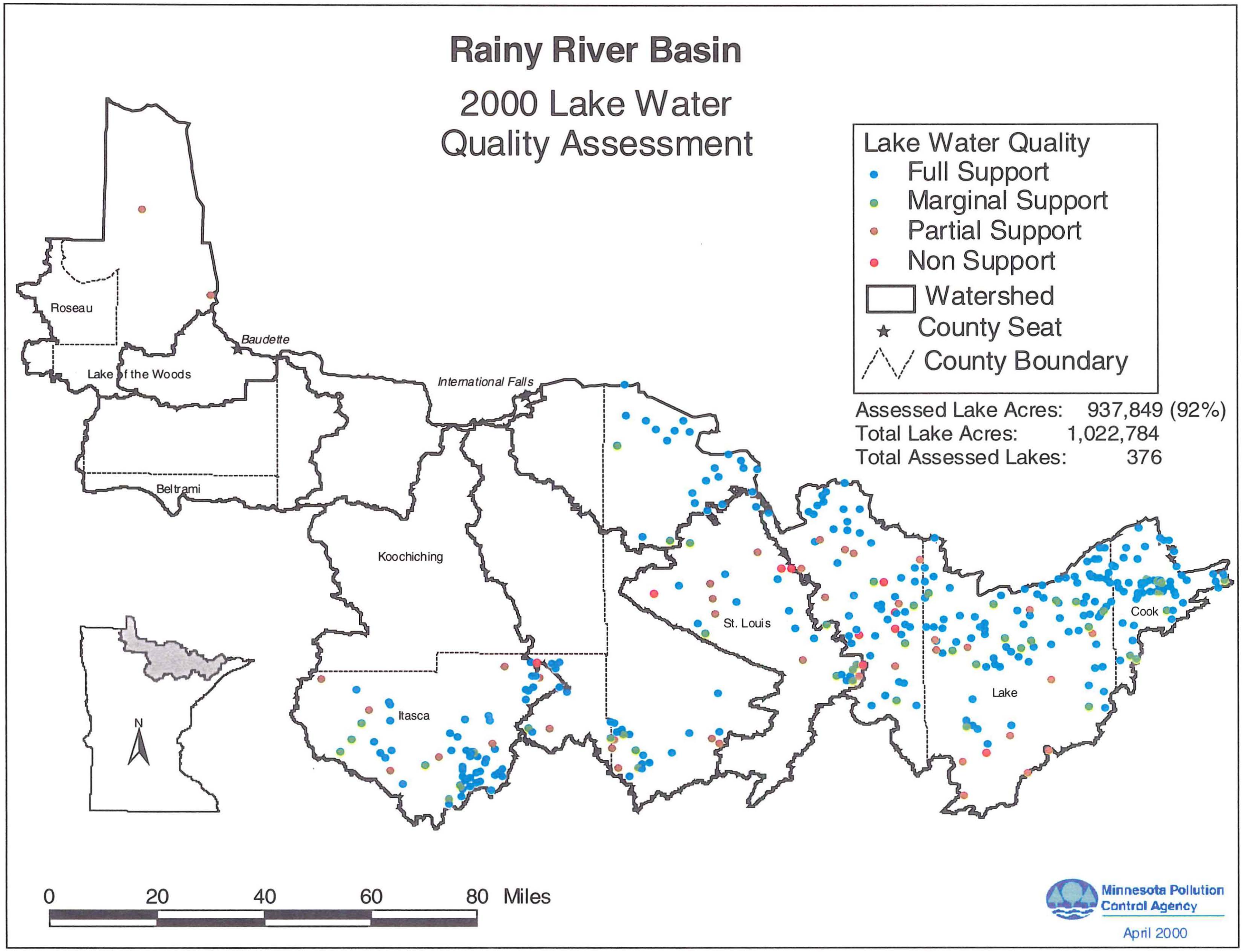
2000 Assessment for Swimming

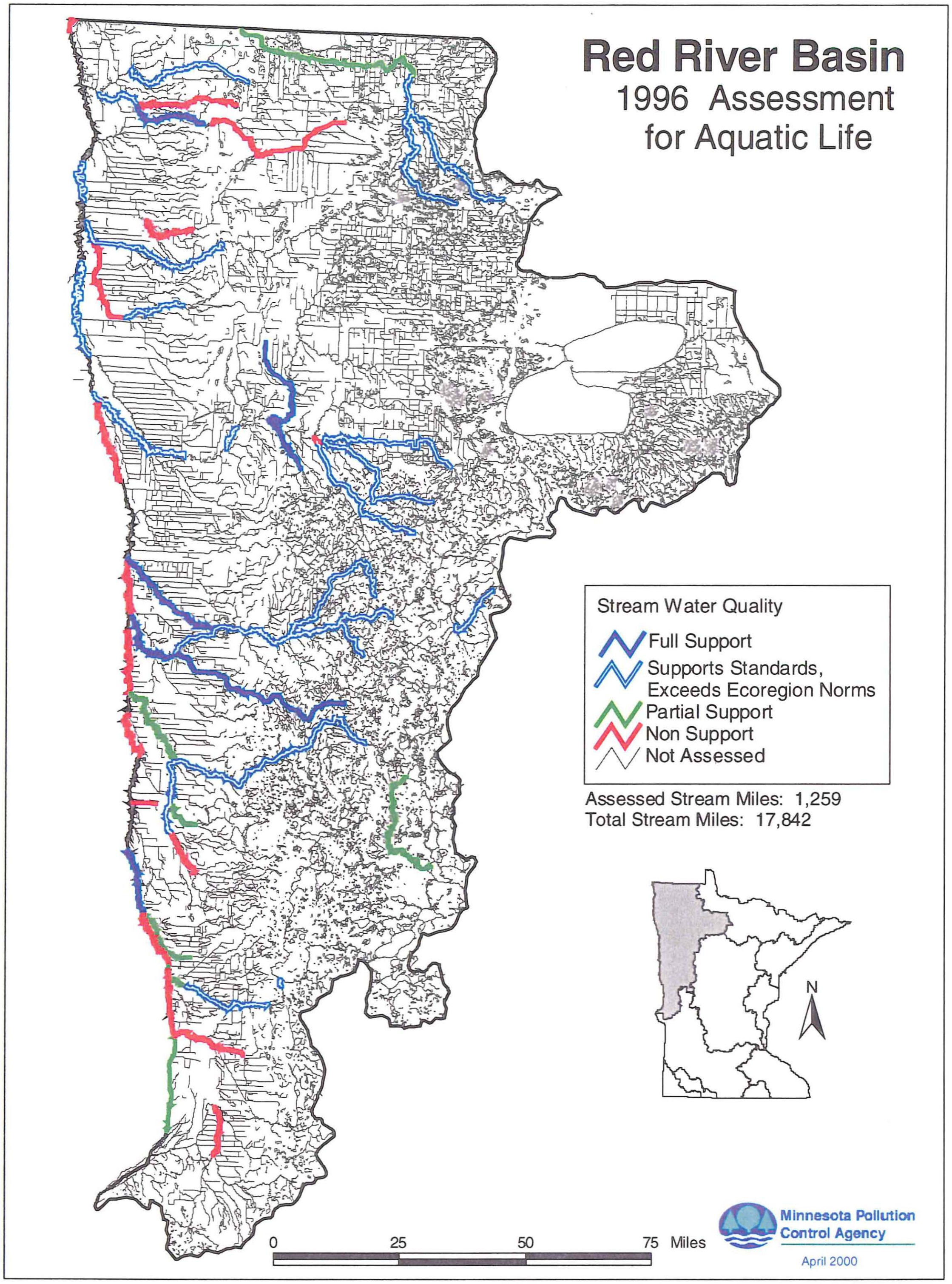



Missouri River Basin
2000 Lake Water
Quality Assessment
Lake Water Quality
Full Support
Marginal Support
Partial Support
Non Support
Watershed
County Seat
County Boundary
Assessed Lake Acres: 3,950 (48%)
Total Lake Acres: 8,205
Total Assessed Lakes: 6
Lincoln
Pipestone
Pipestone
Murray
Rock
Luverne
Nobles
Jackson
N
0
10
20
30 Miles
Minnesota Pollution Control Agency
April 2000

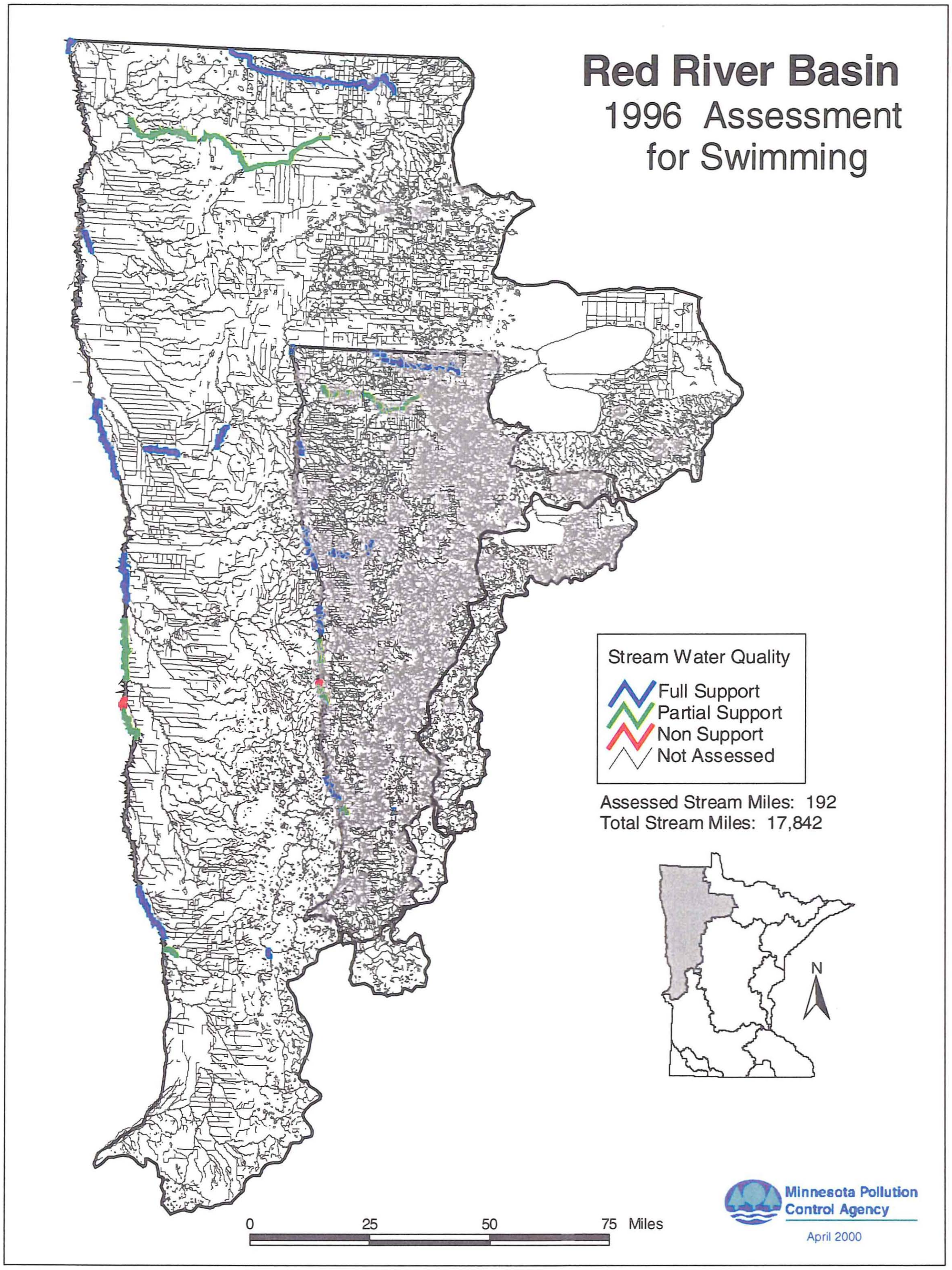

Rainy River Basin
2000 Assessment for Aquatic Life
Stream Water Quality
Full Support
Supports Standards, Exceeds Ecoregion Norms
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 235
Total Stream Miles: 10,583
N
0 10 20 30 40 Miles
Minnesota Pollution Control Agency
April 2000


Rainy River Basin
2000 Assessment for Swimming
Stream Water Quality
Full Support
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 222
Total Stream Miles: 10,583
N
0 10 20 30 40 Miles
Minnesota Pollution Control Agency
April 2000

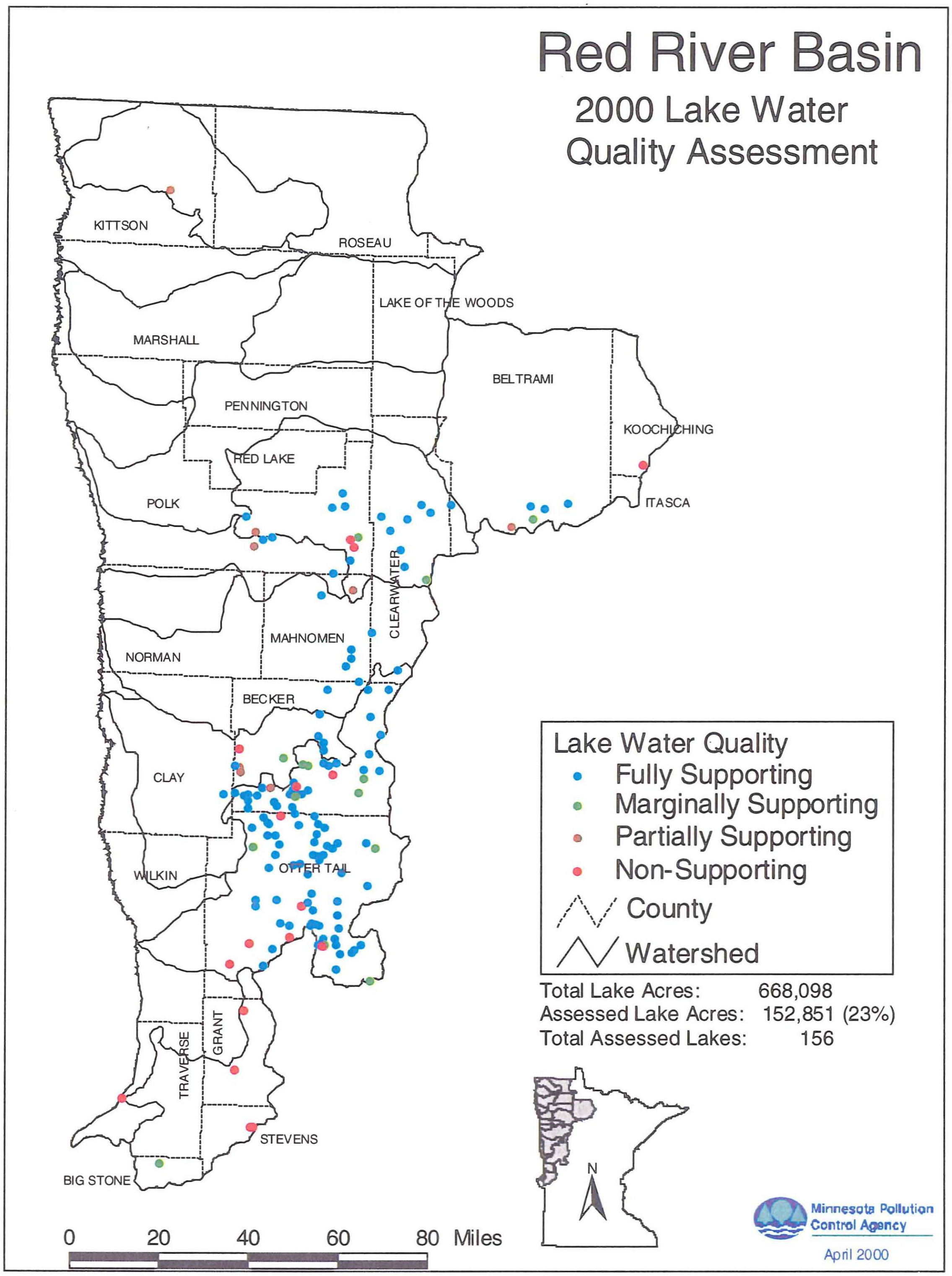

Rainy River Basin
2000 Lake Water Quality Assessment
Lake Water Quality
Full Support
Marginal Support
Partial Support
Non Support
Watershed
County Seat
County Boundary
Assessed Lake Acres: 937,849 (92%)
Total Lake Acres: 1,022,784
Total Assessed Lakes: 376
Roseau
Baudette
Lake of the Woods
International Falls
Beltrami
Koochiching
Itasca
St. Louis
Lake
Cook
N
0 20 40 60 80 Miles
Minnesota Pollution Control Agency
April 2000

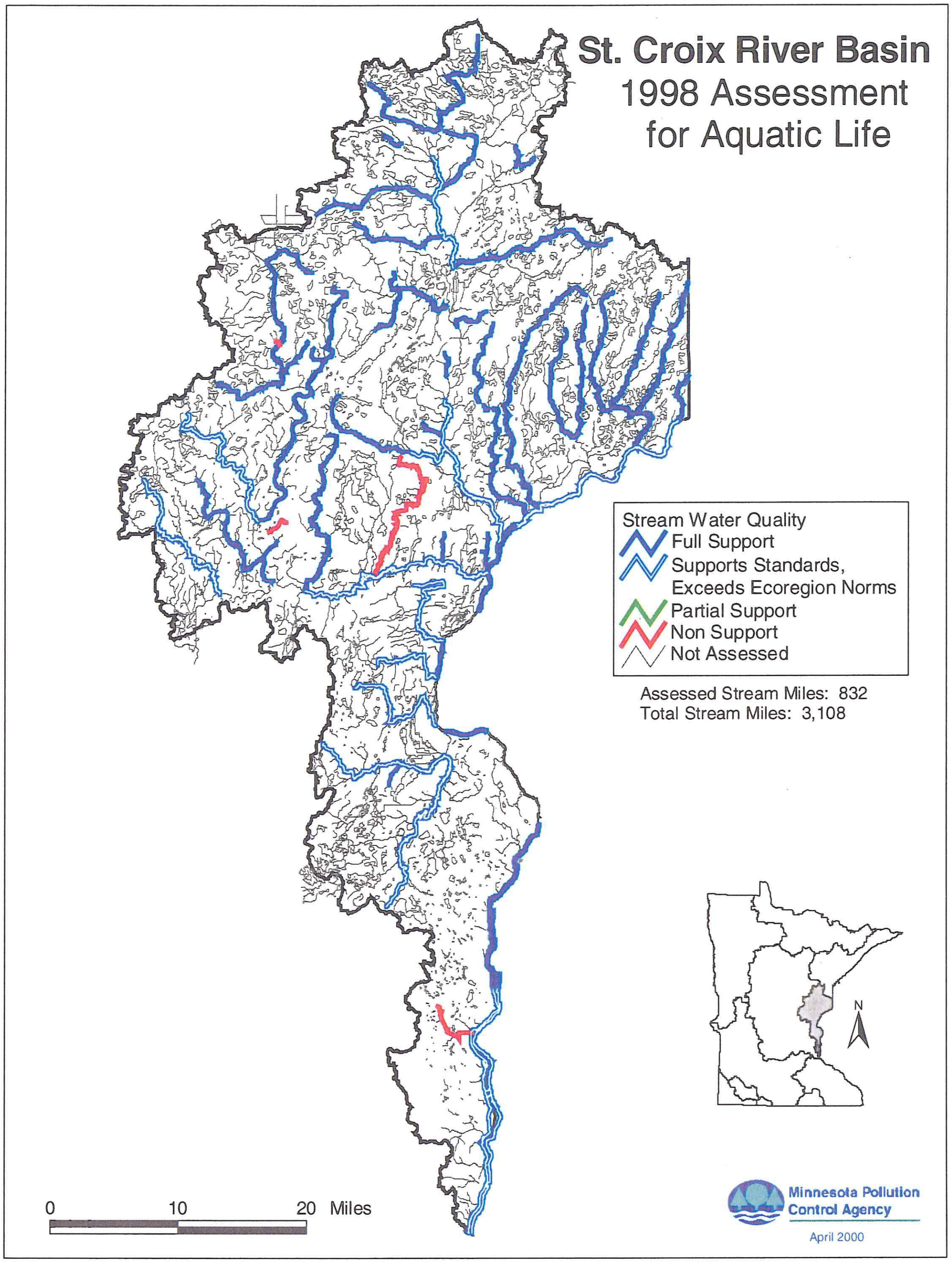


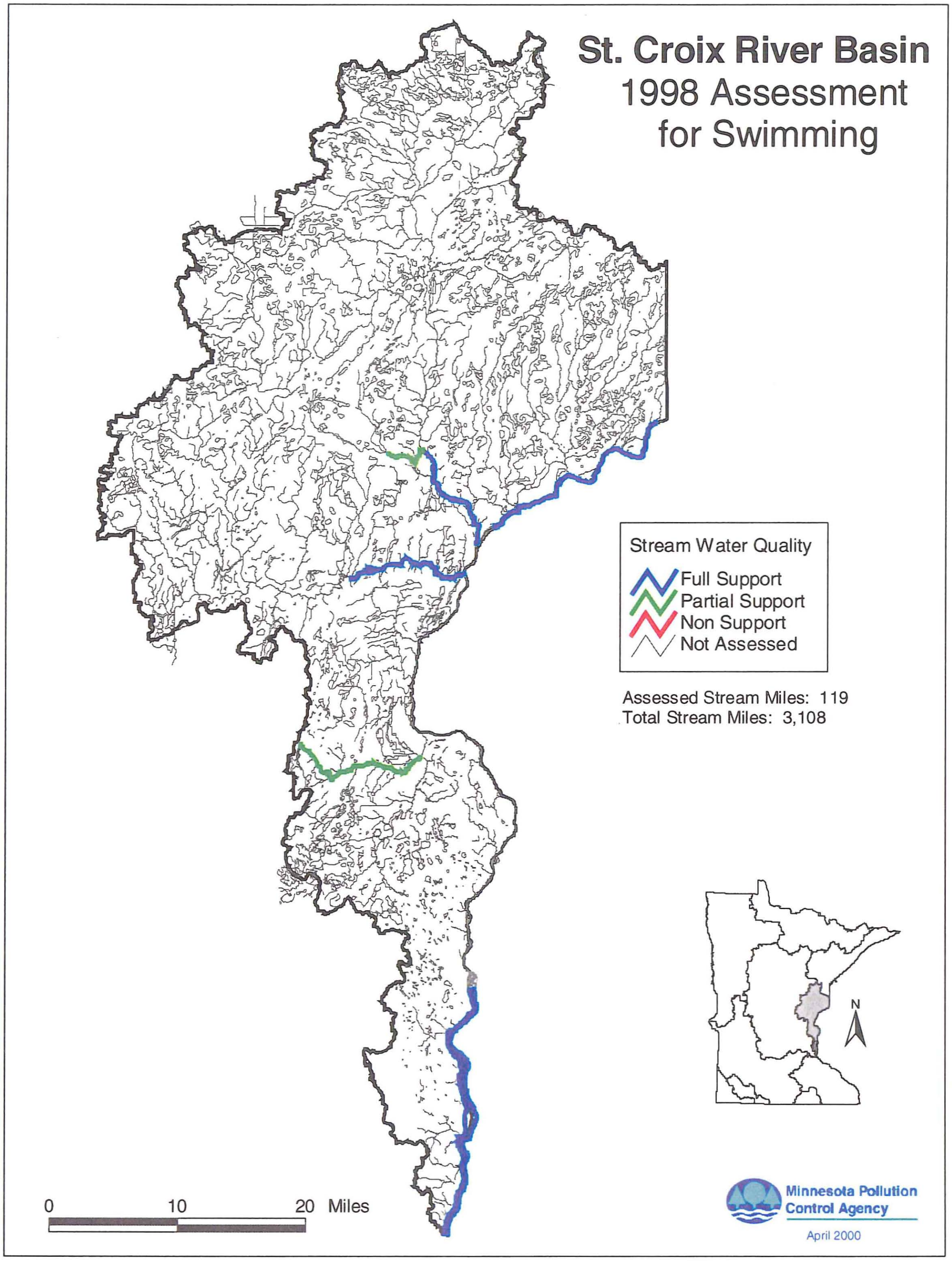
Red River Basin
1996 Assessment
for Aquatic Life
Stream Water Quality
Full Support
Supports Standards, Exceeds Ecoregion Norms
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 1,259
Total Stream Miles: 17,842
N
0
25
50
75 Miles
Minnesota Pollution Control Agency
April 2000

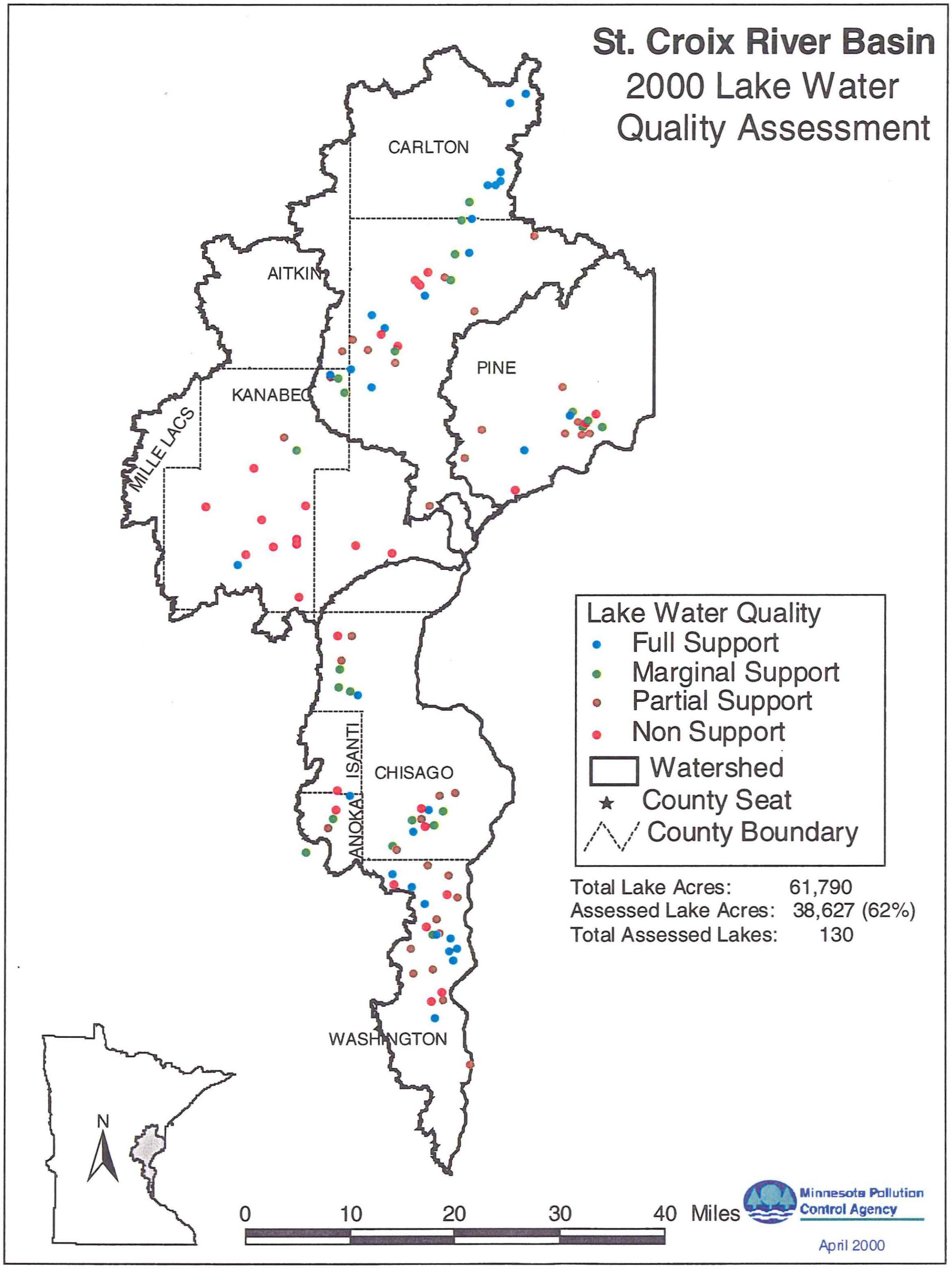


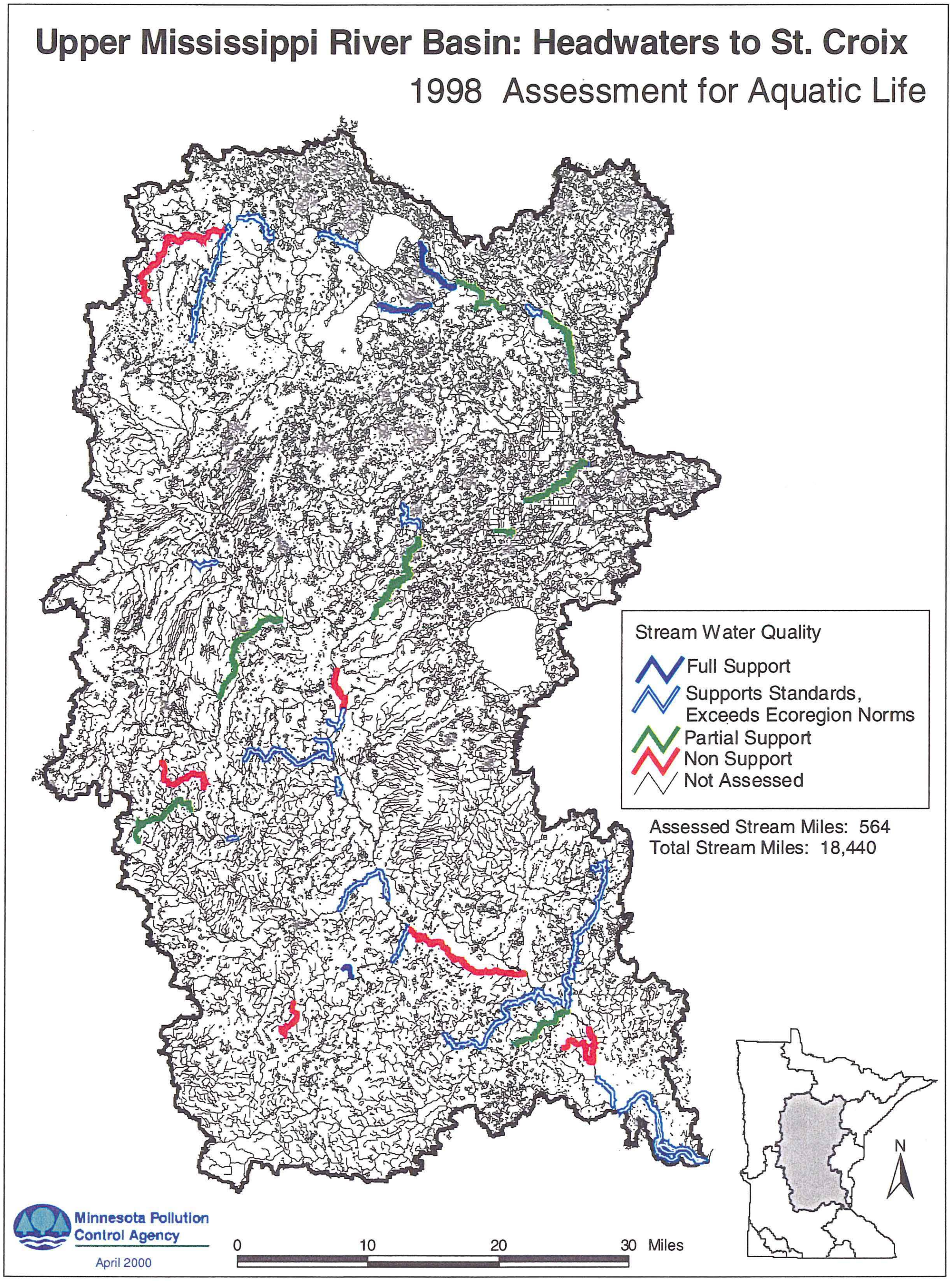
Red River Basin
1996 Assessment
for Swimming
Stream Water Quality
Full Support
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 192
Total Stream Miles: 17,842
N
0
25
50
75 Miles
Minnesota Pollution Control Agency
April 2000


Red River Basin
2000 Lake Water Quality Assessment
KITTSON
ROSEAU
LAKE OF THE WOODS
MARSHALL
BELTRAMI
PENNINGTON
KOOCHICHING
RED LAKE
ITASCA
POLK
CLEARWATER
MAHNOMEN
NORMAN
BECKER
CLAY
WILKIN
OTTER TAIL
GRANT
TRAVERSE
STEVENS
BIG STONE
Lake Water Quality
Fully Supporting
Marginally Supporting
Partially Supporting
Non-Supporting
County
Watershed
Total Lake Acres: 668,098
Assessed Lake Acres: 152,851 (23%)
Total Assessed Lakes: 156
N
0 20 40 60 80 Miles
Minnesota Pollution Control Agency
April 2000


St. Croix River Basin
1998 Assessment
for Aquatic Life
Stream Water Quality
Full Support
Supports Standards,
Exceeds Ecoregion Norms
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 832
Total Stream Miles: 3,108
N
0
10
20 Miles
Minnesota Pollution
Control Agency
April 2000

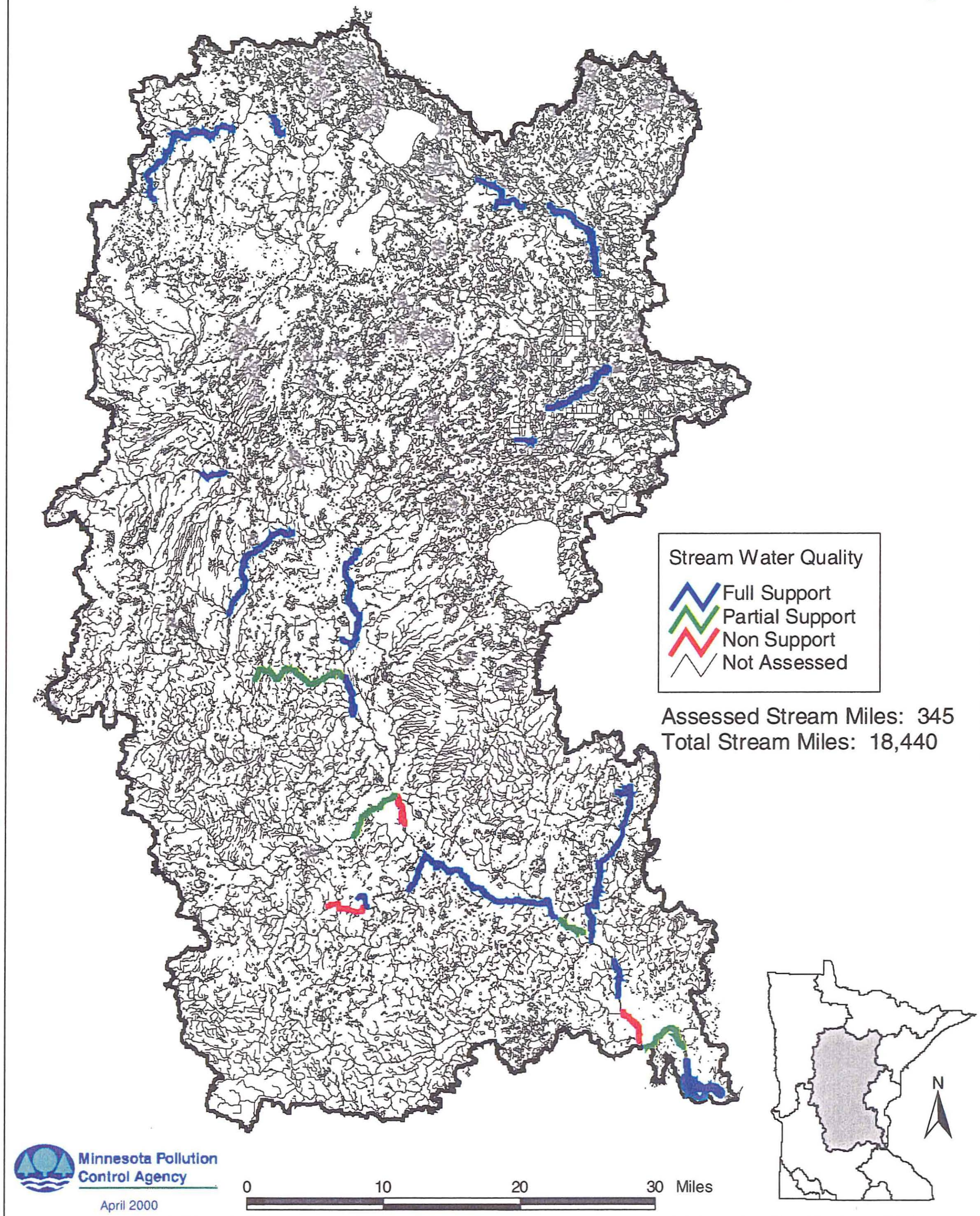

St. Croix River Basin
1998 Assessment
for Swimming
Stream Water Quality
Full Support
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 119
Total Stream Miles: 3,108
0
10
20 Miles
N
Minnesota Pollution Control Agency
April 2000

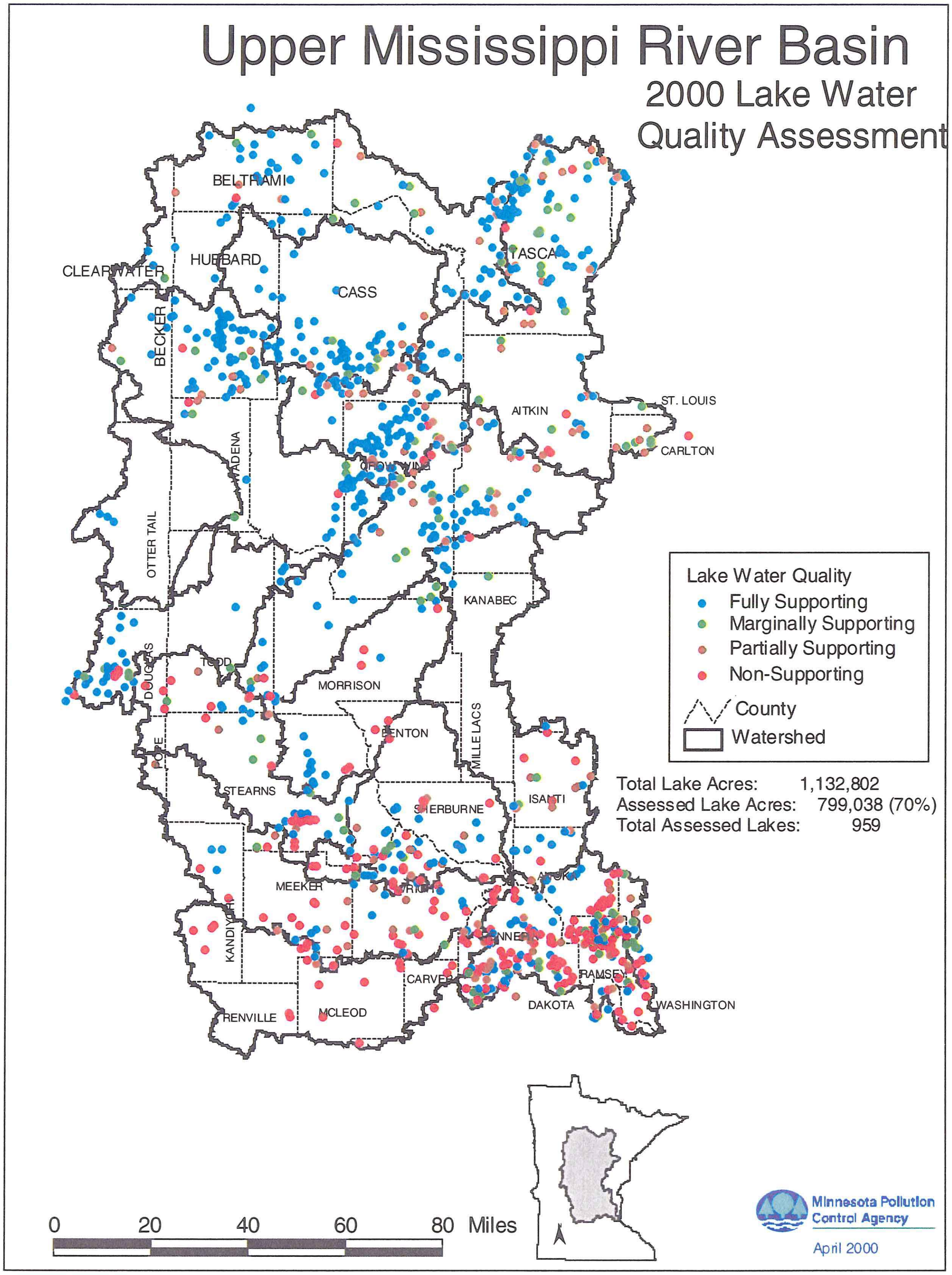

St. Croix River Basin
2000 Lake Water
Quality Assessment
CARLTON
AITKIN
PINE
KANABEC
MILLE LACS
ISANTI
CHISAGO
ANOKA
WASHINGTON
Lake Water Quality
Full Support
Marginal Support
Partial Support
Non Support
Watershed
County Seat
County Boundary
Total Lake Acres: 61,790
Assessed Lake Acres: 38,627 (62%)
Total Assessed Lakes: 130
N
0 10 20 30 40 Miles
Minnesota Pollution Control Agency
April 2000


Upper Mississippi River Basin: Headwaters to St. Croix
1998 Assessment for Aquatic Life
Stream Water Quality
Full Support
Supports Standards, Exceeds Ecoregion Norms
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 564
Total Stream Miles: 18,440
Minnesota Pollution Control Agency
April 2000
0
10
20
30 Miles
N

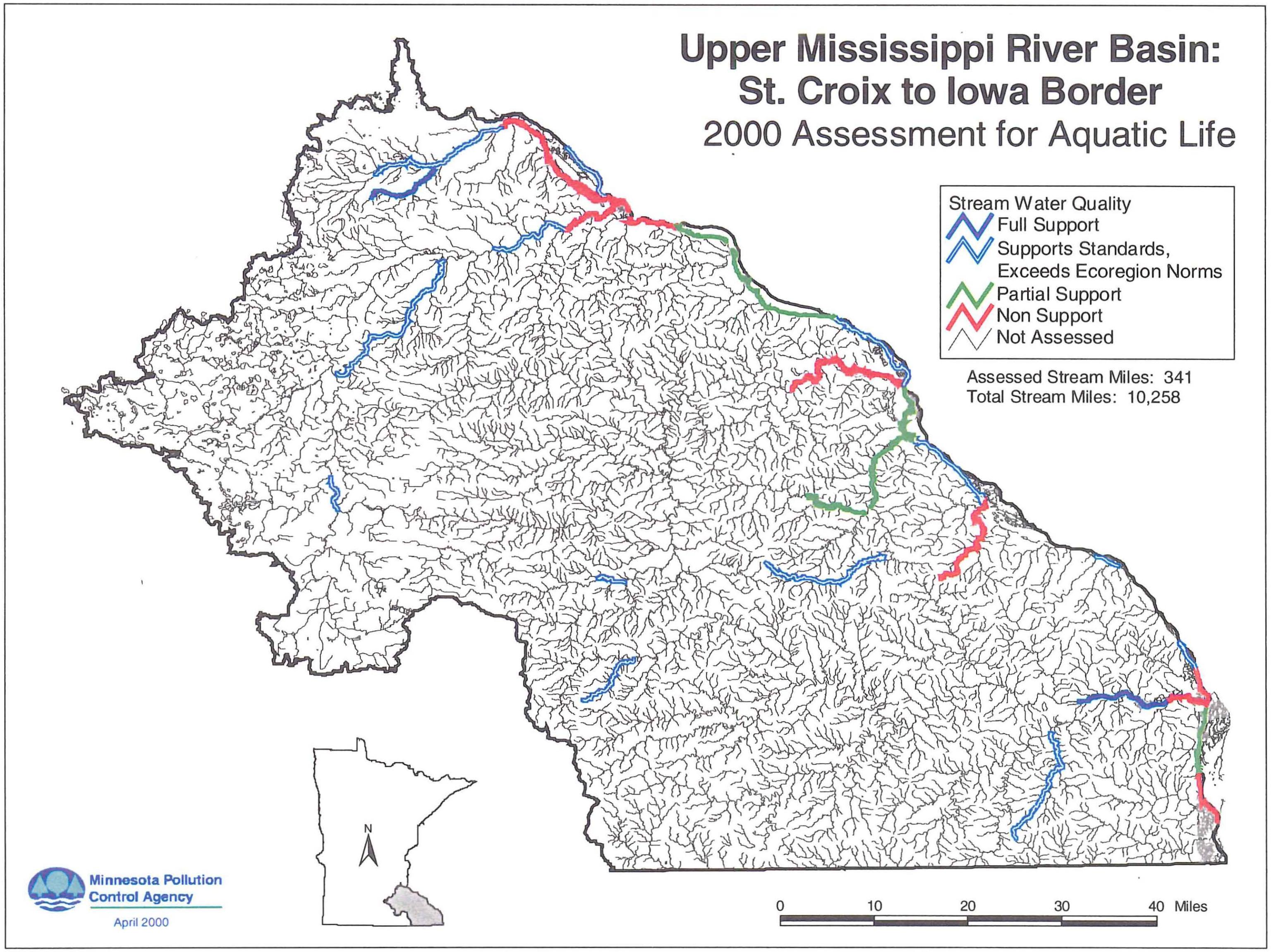
Upper Mississippi River Basin: Headwaters to St. Croix

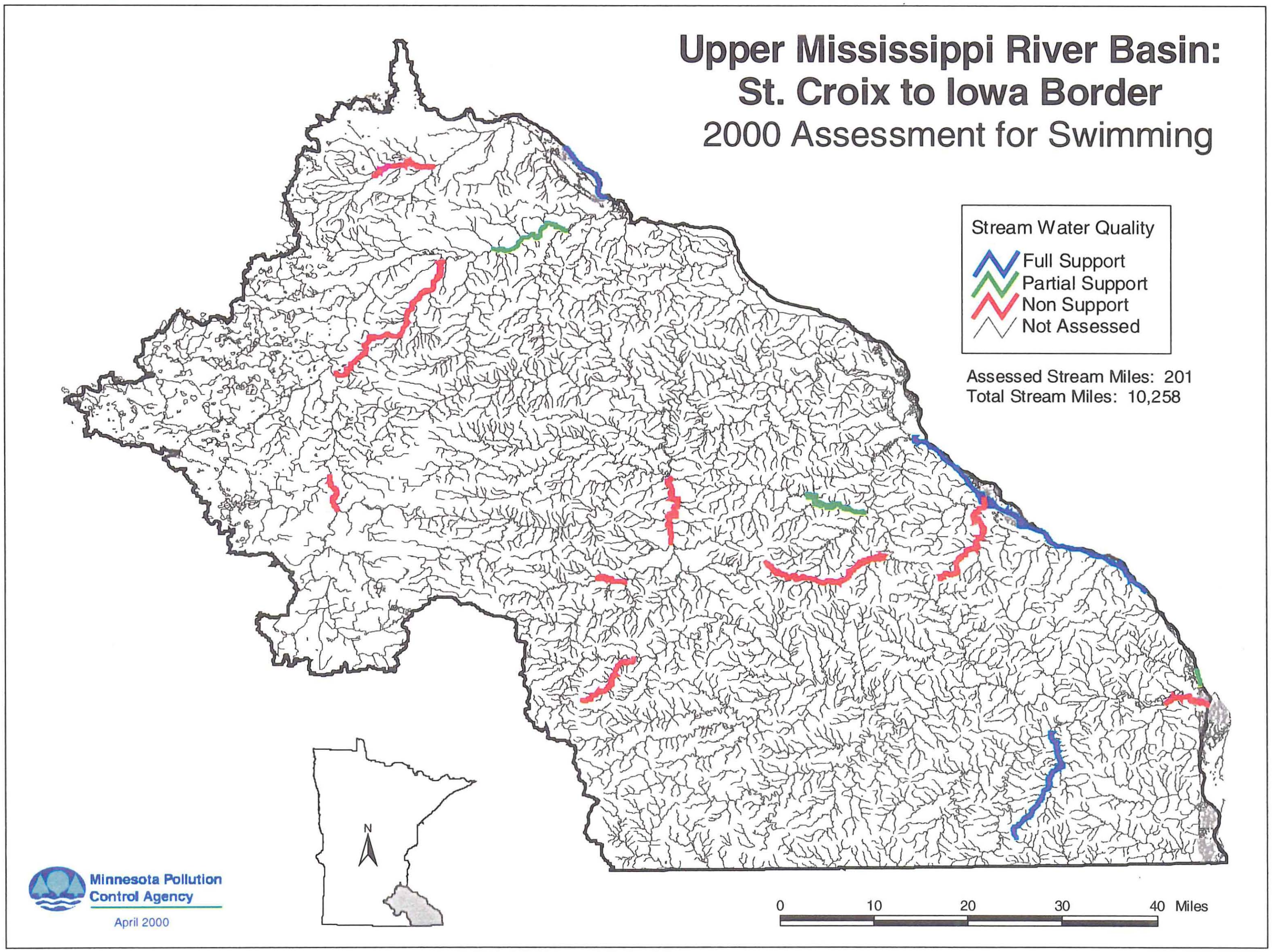
1998 Assessment for Swimming



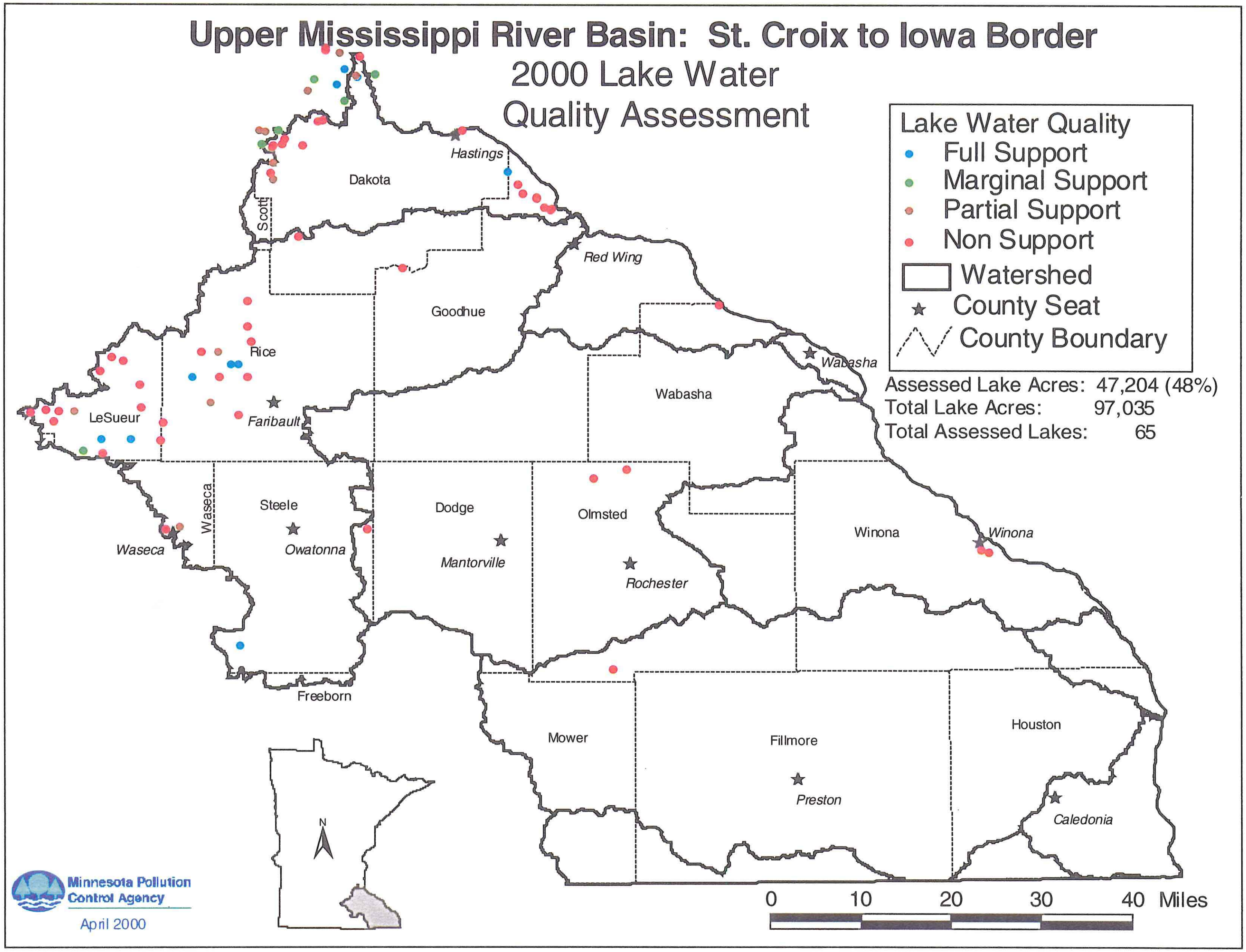


Upper Mississippi River Basin
2000 Lake Water Quality Assessment
BELTRAMI
CLEARWATER
HUBBARD
CASS
ITASCA
BECKER
ST. LOUIS
AITKIN
CARLTON
WADENA
CROW WING
OTTER TAIL
KANABEC
TODD
DOUGLAS
MORRISON
BENTON
MILLE LACS
POPE
STEARNS
SHERBURNE
ISANTI
ANOKA
MEEKER
WRIGHT
KANDIYOHI
HENNEPIN
RAMSEY
CARVER
WASHINGTON
DAKOTA
RENVILLE
MCLEOD
Lake Water Quality
Fully Supporting
Marginally Supporting
Partially Supporting
Non-Supporting
County
Watershed
Total Lake Acres: 1,132,802
Assessed Lake Acres: 799,038 (70%)
Total Assessed Lakes: 959
0 20 40 60 80 Miles
Minnesota Pollution Control Agency
April 2000


Upper Mississippi River Basin:
St. Croix to Iowa Border
2000 Assessment for Aquatic Life
Stream Water Quality
Full Support
Supports Standards, Exceeds Ecoregion Norms
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 341
Total Stream Miles: 10,258
N
0
10
20
30
40 Miles
Minnesota Pollution Control Agency
April 2000



Upper Mississippi River Basin:
St. Croix to Iowa Border
2000 Assessment for Swimming
Stream Water Quality
Full Support
Partial Support
Non Support
Not Assessed
Assessed Stream Miles: 201
Total Stream Miles: 10,258
N
0 10 20 30 40 Miles
Minnesota Pollution Control Agency
April 2000


Upper Mississippi River Basin: St. Croix to Iowa Border
2000 Lake Water
Quality Assessment
Lake Water Quality
Full Support
Marginal Support
Partial Support
Non Support
Watershed
County Seat
County Boundary
Assessed Lake Acres: 47,204 (48%)
Total Lake Acres: 97,035
Total Assessed Lakes: 65
Dakota
Hastings
Scott
Red Wing
Goodhue
Rice
Wabasha
Wabasha
LeSueur
Faribault
Waseca
Waseca
Steele
Owatonna
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Minnesota Pollution Control Agency
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Chapter 2 Programs and Funding for Implementing NPS Program

Technical Committee Members

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Introduction

We are only just beginning to understand the true enormity of the nonpoint source (NPS) pollution problem. The diffuse nature of NPS pollution makes it very expensive to abate. Insufficient funds are the most frequently noted barrier to implementing comprehensive NPS management programs. Amassing enough money to deal with NPS pollution comprehensively even in one small area is a daunting task.

As noted earlier in this document, water quality degradation from point sources has been largely remediated. This remediation was accomplished however, with substantial financial support over a long period of time. From 1972-1987, the federal government alone invested over $50 billion to help local communities construct secondary wastewater treatment plants to meet Clean Water Act (CWA) requirements. In contrast, the total Section 319 appropriation for NPS pollution for the past six federal fiscal years was $805 million.

Historically, both state and federal funding for NPS water pollution has been sporadic and inadequate. In Minnesota, the primary funding sources for NPS activities have been the federal Section 319 grants, state Revolving Fund (SRF) loan dollars and grant funds dedicated to Clean Water Partnership projects. There are state funds, allocated to programs that have a secondary benefit to water quality even though they may not focus directly on NPS pollution control. Some of the lake surveys and wildlife management programs administered by the Minnesota Department of Natural Resources (MDNR) fit into this category. All of these sources of funding will remain critical in the future, and in fact have grown, but full implementation of this NPS Management Program Plan will require significant additional support.

Potential state and federal sources of funding for improving water quality through NPS pollution controls are summarized in Table 1. The primary NPS funding sources, those where significant funding is allocated to activities focused on NPS abatement, are described in more detail below.

Primary Federal Funding Sources

Section 106 Water Pollution Control Program Grants

Section 106 of the Clean Water Act authorizes the United States Environmental Protection Agency (USEPA) to provide Federal assistance to states (including territories, the District of Columbia, and Indian Tribes) and interstate agencies to establish and implement ongoing water pollution control programs. Prevention and control measures supported by state water quality management programs include permitting, pollution control activities, surveillance, monitoring, enforcement; advice and assistance to local agencies; and the providing training and public service. Increasingly, USEPA and states are working together to develop basin wide approaches to water quality management. The Section 106 program is helping to foster a watershed protection approach at the state level by looking at states' water quality problems holistically, and targeting the use of limited finances available for effective program management.

Section 104(b)(3) Water Quality Cooperative Agreements

Under authority of Section 104(b)(3) of the Clean Water Act, USEPA makes grants to state water pollution control agencies, interstate agencies, and other nonprofit institutions, organizations, and individuals to promote the coordination of environmentally beneficial activities. These activities include storm water control, sludge management, and pretreatment. Among the efforts that are eligible for funding are research, investigations, experiments, training, environmental technology demonstrations, surveys, and studies related to the causes, effects, extent, and prevention of pollution. Minnesota uses a watershed based approach to both point and nonpoint source projects that are funded through this program.

Section 319 Funding

In 1987 the Clean Water Act was amended to include Section 319, a new section which authorized federal assistance for implementing NPS programs. Of the $805 million appropriated by congress to the USEPA for 319 activities, the state of Minnesota has received over $27 million from 1995 through 2000.

USEPA has granted Section 319 funds by first establishing a base funding level for each state to institutionalize the program over the long term. Distribution of funding is done through a national budget formula. The formula is based on population and other factors related to NPS pollution. As an example, in 1998, USEPA Region 5 allocated 19 percent of the total amount they received to Minnesota. Individual states determine how much to spend on their base programs (e.g. staff, etc.) and projects.

From 1995 through 1998, Minnesota received approximately $3.5 million per year. In 1999 the allocation was increased to over $6.9 million with the addition of money for the Clean Water Action Plan (CWAP). Although Section 319 funding has not come close to meeting the need, it has been increasing slightly until 1999 when the addition the CWAP money significantly increased the appropriation. National appropriations for each federal fiscal year to date are as follows:

1995 $100 million appropriated
1996 $100 million appropriated
1997 $100 million appropriated
1998 $105 million appropriated
1999 $200 million appropriated
2000 $200 million appropriated

Project funding is available to all state agencies or local entities that meet USEPA match requirements and USEPA/MPCA funding criteria. Project funds are awarded competitively based upon project merit and consistency with Section 319 program requirements and priorities. A group of representatives from some 20 different state, local, federal and Tribal agencies, called the Project Coordination Team (PCT), assists the MPCA in ranking and choosing the projects to be funded each year. More recently the PCT has taken a more active role in setting policy and direction for the various state and federal NPS funding programs within the MPCA. The PCT has served as a useful touchstone for the MPCA because the members can bring a wider perspective from their programs.

Project funding has been widely distributed each year among Minnesota entities. The following is a sampling and not a comprehensive list:

- University of Minnesota
- MN Extension Service
- MN Planning - Office of Strategic and Long-range Planning
- Minnesota Department of Agriculture
- Minnesota Department of Natural Resources - Waters Division
- Minnesota Department of Natural Resources - Minerals Division
- Metropolitan Council

- Minnesota Department of Health
- Minnesota Board of Water and Soil Resources
- Minnesota Pollution Control Agency
- Minnesota Alliance for Conservation and Resource Management
- Stearns County Soil and Water Conservation District (SWCD)
- Chippewa County Extension Service
- City of Duluth
- Kandiyohi SWCD
- USDA-NRCS

Some examples of the kinds of activities that have been funded to date include:

- Technical assistance to the Minnesota River Project
- Support for local Clean Water Partnership (CWP) implementation projects, including Phase II projects at: Lake Superior, the Redwood River, Lake Pokegama, Rice Lake and Lake Koronis
- Accelerated water quality improvement
- Alternative waste water demonstration projects
- Biological monitoring in the Whitewater watershed project
- Buffering drainage ditches in Iosoco Creek
- Shoreland vegetation best management practices (BMPs) to reduce erosion and runoff (including development and production of educational materials)
- Research on the benefits and impacts of chemical treatment of lake inflows
- Lakeshed erosion control costshare program
- 1998 Minnesota comprehensive local water planners conference

Clean Water Action Plan (CWAP)

This program, started in 1998, provides new federal resources for protecting the nation's waters and a new approach for doing so. These are 319 funds, which are currently being tracked separately. Based on a broad vision of cooperative watershed protection, it integrates new protections for our water resources and associated natural resources. The watershed scale focus creates opportunities for comprehensive solutions to problems in specific geographic areas.

In May of 1998, the CWAP Planning Committee, composed of staff from 25 tribal, federal, state, and local units of government, met to do a Unified Watershed Assessment (UWA). The group created a sub-team to gather available information and recommend categories of high, medium or low priority for each of Minnesota's 84 major watersheds. While the process had serious limitations, mainly due to time constraints, the classifications provided a starting point. The team was able to agree on the appropriate categories and priority rankings for the watersheds. Many of the limitations of the first assessment, including better characterization of watersheds in need of protection, will be addressed in future UWA's.

MPCA staff was under the impression that the new incremental 319 funds could only be used for restoration work, rather than protection work. According to USEPA staff in the Region 5 office this is incorrect. "The incremental section 319 funds are primarily aimed at restoration work, but can be used for planning and even protection work within watersheds that were described as "Category 1" by states in their Unified Watershed Assessments (UWAs). Keeping in mind that restoration is the primary goal, any work funded by these funds needs to be identified in a Watershed Restoration Action Strategy, which does not preclude protection work" (comment letter, January 8, 2001, Region 5).

Section 319 funding provides valuable support, but federal funds cover only a fraction of the work that needs to be done. It is uncertain how reauthorization of the Clean Water Act will affect Section 319 funding, but regardless of the outcome, it is clear that long term stable funding is needed to implement a successful program. Responsibility for future financial incentives will fall largely on state and local governments. Minnesota will need creative new ways to fund NPS controls. Examples of creative funding mechanisms used in Minnesota and other states for funding NPS programs include cost sharing, taxes (property, sales, or cigarette), user fees, utility districts (storm water or septic system), and permit development.

Environmental Quality Incentives Program (EQIP)

This program replaces the Agricultural Conservation Program, but like that program offers cost sharing for soil, water, and forestry practices of long-term benefit. The Natural Resource Conservation Service (NRCS) of the U.S. Department of Agriculture (USDA) administers the program. The NRCS, through the local soil conservation districts, provides technical assistance in determining where soil and water conservation practices are needed and feasible, preparing farm conservation plans, and designing specific best management practices. NRCS also supervises and certifies the proper installation of some of these practices.

Cost sharing of up to 75 percent of the total cost is available under five or ten-year contracts with farmers or ranchers on eligible land for the installation of practices designed to solve resource conservation and agricultural pollution problems. In recent years, an emphasis on water pollution control has led to the use of some of the EQIP funding for specific NPS water quality projects. The maximum cost share amount of any one contract is $50,000 and only one contract is allowed on the same piece of land at any one time.

Wellhead Protection Program

The 1986 Amendments to the Safe Drinking Water Act (SDWA) require states to develop and implement wellhead protection programs. Minnesota's wellhead protection program was approved by USEPA in March 1996 and the state wellhead protection rules were promulgated in November 1997. Although Congress authorized funding for state wellhead protection programs in the 1996 amendments to the SDWA, no funding has been appropriated. Therefore, no federal grants or loans are available through the SDWA to support the development and implementation of wellhead protection plans. The most appropriate use of federal and state funds for controlling NPS contamination in wellhead protection areas is to support local NPS pollution controls that are specified in wellhead protection plans that are approved by the Minnesota Department of Health.

US Geological Survey Cooperative Money

The US Geological Survey (USGS) has a long-term involvement with various MPCA and other state and federal projects. Ongoing USGS research projects conducted in Minnesota include those found on the following web sites:
http://mn.water.usgs.gov/active_projects/

The USGS also heads up the Interdisciplinary Research Initiative (IRI). IRI is research of lakes, wetlands and streams from a scientifically panoramic perspective. It consists of scientists from the USGS and professors and students from universities in Minnesota, North Dakota, Michigan, Maine and California. Information can be found at this web page:
http://wwwbrr.cr.usgs.gov/projects/IRI/

Coastal Zone Management Funding

The Coastal Zone Management (CZM) program assists states in implementing and enhancing CZM programs that have been approved by the Secretary of Commerce. Funds are available for projects in areas such as coastal wetlands management and protection, natural hazards management, public access improvements, reduction of marine debris, assessment of impacts of coastal growth and development, special area management planning, regional management issues, and demonstration projects with potential to improve coastal zone management.

Minnesota's Coastal Nonpoint Source Pollution Program

The Coastal Nonpoint Pollution Program is designed to reduce NPS pollution in the

Lake Superior Basin. It is being developed as part of both the Lake Superior Basin Plan, (which is being facilitated by the MPCA), and Minnesota's Lake Superior Coastal Program, (which is being facilitated by the Minnesota Department of Natural Resources (MDNR)). The Coastal Nonpoint Program is being co-facilitated by both the MPCA and MDNR. Numerous partners are involved in this effort, including state, federal, tribal and local governments, agencies, and citizens.

The Coastal Nonpoint Program Document summarizes Minnesota's existing nonpoint pollution programs and policies. This will let us see how they compare to the guidelines suggested by the USEPA and the National Oceanic and Atmospheric Administration (NOAA).

Benefits of the Program

The Coastal Program and Coastal Nonpoint Program provide opportunities for securing federal funding and technical assistance in order to protect and enhance local natural resources and support community goals. Program development also encourages cooperation and improves efficiency among partners managing natural resource programs. As a result we can better prevent erosion and stop polluted runoff from reaching the many high quality waters of Minnesota's Lake Superior Basin.

Background Information

Minnesota's Lake Superior Shore became part of the national Coastal Management Program after receiving federal approval in July 1999. Upon acceptance to the national coastal program, the State of Minnesota has 30 months to produce a nonpoint pollution prevention program that will be equivalent to the federal guidance for addressing nonpoint issues in the coastal basin or watershed.

Final approval of the Coastal Nonpoint Program will come when NOAA and USEPA determine that Minnesota's program is the equivalent of the federal nonpoint pollution management measures.

Public Review

A Coastal Nonpoint Program Document is being developed in stages:

- The Scoping Document consists of two existing documents: a 1995 summary of state NPS pollution programs and enforceable policies, and the 1996 federal response. The Scoping Document was available for public review August 28 - October 6, 2000.
- Comments received on the Scoping document have been incorporated into the Draft Coastal Nonpoint Program Document, which was out for public review March 10 - April 13, 2001.
- After incorporating comments received on the Draft Coastal Nonpoint Program Document, a Final Draft will be prepared. It will go out for review in July - August, 2001.
- After the final revisions are made, and the state agencies sign off on the Program Document, it will be submitted to NOAA and USEPA in July 2001.

Wetland Reserve Program

This voluntary program provides landowners with financial incentives to restore and protect wetlands in exchange for retiring marginal agricultural land. Landowners may sell a conservation easement or enter into a cost share restoration agreement. Landowners voluntarily limit future use of the land, but retain private ownership. Landowners and the NRCS develop a plan for the restoration and maintenance of the wetland.

Conservation Reserve Program

The Conservation Reserve Program (CRP) is a voluntary program that offers long-term rental payments and cost share assistance to establish long-term, resource-conserving cover on environmentally sensitive cropland or, in some cases, marginal pastureland. The protective cover reduces soil erosion, improves water quality, and enhances or establishes wildlife habitat. Increased rental payments are available on certain land areas (e.g., land within a wellhead protection area may receive an additional 10 percent payment.)

The Conservation Reserve Enhancement Program

The Conservation Reserve Enhancement Program (CREP) is a unique opportunity for Minnesota to dramatically improve the quality of water in the Minnesota River...with the federal government picking up most of the cost.

The program allows Minnesota to match federal dollars to put conservation easements on up to 100,000 acres in the 37-county Minnesota River Basin. Approximately $30 million in state funds have been appropriated to date and have been matched by approximately $65 million in federal funds. Approximately $98 million in federal funds are available until September 2002.

To fully fund the program and leverage the remaining federal funds, CREP needs a state appropriation in 2001 of approximately $51.4 million to complete the effort. Here's a closer look at the funding needs:

1) $43 million for CREP easement purchase (that triggers approximately $98 million in federal funds for easement payments); and

2) approximately $8.4 million for CREP implementation.

As of March 29, 2001 there are 930 easements recorded for a total of 34,228 acres.

Wildlife Habitat Incentives Program

The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat on private lands. It provides both technical assistance and cost sharing to help establish and improve fish and wildlife habitat. Participants worked with USDA's NRCS to prepare a wildlife habitat development plan in consultation with a local conservation district. The plan describes the landowner's goals for improving wildlife habitat, includes a list of practices and a schedule for installing them, and details the steps necessary to maintain the habitat for the life of the agreement.

PRIMARY STATE FUNDING SOURCES

The following state funding programs are the major sources, or most stable sources of state funding for NPS pollution abatement. They are not the only funding programs.

Clean Water Partnership

The Clean Water Partnership (CWP) Program was created in 1987 specifically to address nonpoint sources of pollution The program provides local governments, citizen groups, county water resources staff, and environmental groups with financial and technical resources to protect and improve lakes, streams and ground water. CWP funding for local water quality projects is awarded in two phases. In the first phase of a project, called a resource investigation, the local sponsors work with the MPCA to collect data and information on the watershed and water resource. The information is used to identify nonpoint sources of pollution and define water quality goals and objectives. The final step of the resource investigation phase is to develop an implementation plan that identifies the combination of education, best management practices (BMP) and other activities to protect or restore water quality.

The second phase involves implementing the BMPs and other activities identified in the diagnostic study. Projects can be done without CWP funding, but in order to be eligible for CWP funds for later phases the project must meet program requirements. Financial assistance available through the program falls into two categories: grants and State Revolving Fund (SRF) low interest loans. CWP grant funds are available for up to 50 percent of the project costs. Loans can be used for the implementation phase and can cover the entire cost of implementation or supplement a grant.

CWP/319 Combined Grant Round

For fiscal year 2001, the MPCA administratively combined the Clean Water Partnership Program and the Section 319 program. The application periods were run concurrently and all applications were considered for both funding sources, if eligible. The single application made applying for funding easier. More importantly, this was the first step in integrating the various NPS funding programs and is intended to move towards a more cohesive, focused and holistic approach to water quality protection and improvement. This first step will be followed by adding other funding programs within the MPCA, and ultimately, other funding programs from other agencies.

State Revolving Fund (SRF) Initiative

One of the more significant funding sources in Minnesota is the State Revolving Fund (SRF). Minnesota has been using SRF as part of its NPS management program since 1995. The program uses existing state delivery systems already servicing targeted clientele.

Minnesota's Public Facilities Authority (PFA) currently receives the State's capitalization grant from the USEPA for the SRF. Until 1995, the SRF had been used exclusively for municipal wastewater treatment projects. Under the SRF, NPS pollution initiative, the PFA has negotiated with the lead agencies to establish funding for their respective programs. Projects receiving NPS SRF funding are required to meet requirements of the Federal Clean Water Act, Title 3, Section 319. In addition, funds spent on NPS projects are noted in the Intended Use Plan (IUP), which the MPCA submits annually to the USEPA. The NPS projects are not part of the point source ranking in the IUP. Minnesota's NPS pollution initiative provides an innovative and flexible approach for local governments, farmers, individual homeowners, and businesses to access low-interest, environmentally directed loans.

In the past ten years, there has been a tremendous surge in interest of local governments to improve water resources degraded by nonpoint sources of pollution. The Minnesota River Assessment Project (MRAP) and the recently completed Red River Basin Plan reflects strong local interest in addressing NPS pollution. Local interest is further demonstrated through Local Water Plans that establish a list of projects the communities want to carry out.

Identified problems are varied: runoff from agricultural land, pesticides and fertilizers, feedlots, urban runoff from streets, yards, and construction sites, leachate from septic systems, forestry and mining activities, highway de-icing chemicals, dredging and drainage activities, and the impacts from loss of wetlands. Solutions include BMPs for urban, forest and agricultural areas; storm water control; erosion control; buffer zones; animal waste management systems; proper individual sewage treatment systems (ISTS) installation and maintenance; construction site management; well sealing; preservation of wetlands; and education.

Local project sponsors with approved implementation plans, who through public information and awareness have mobilized their communities for action, are placed in the unenviable position of having to wait because funds are not available. In many cases, a community has the opportunity to start projects with low interest SRF loans and 20-year repayment periods. Loan funds have been used to implement BMPs including: sedimentation basins for urban runoff and suburban areas; lakeshore landscaping for erosion control and stabilization; streambank stabilization; in-stream and in-lake chemical treatment and aeration; feedlot improvements; upgrades of individual sewage treatment systems; BMPs for ground water aquifer recharge areas; and education and outreach activities.

The SRF loan program has been integrated with several existing programs so clients can work within familiar systems. Clients are varied, (individual farmers to watershed districts), so the delivery system must be flexible. For example, farmers apply for SRF loans through the agriculture BMP Program at the Minnesota Department of Agriculture. Watershed districts or other units of government can obtain SRF loans through the CWP Program, thereby leveraging limited grant funds. This multi-agency approach provides service delivery as close as possible to the client.

The SRF nonpoint loan program is a cohesive and comprehensive approach that uses existing state agency delivery systems to leverage grant and loan funds for maximum environmental benefits. In addition, the development and support of an expanding local watershed management "infrastructure" will have positive long-term effects.

The SRF Nonpoint Source Pollution Initiative contains three components, two of which are funded, and a third program that was ended after one funding cycle:

1) Agriculture and Rural Nonpoint Source Pollution

Agriculture Best Management Practices Loan Program:

Lead Agency: Minnesota Department of Agriculture (MDA)
Estimated Annual Allocation: $10 million

MDA and the Board of Water and Soil Resources (BWSR) has developed and implemented systems for delivering SRF loan funds to individual land owners for agricultural and rural NPS projects. The counties have been the major vehicles in coordinating applicants' requests with existing grants and technical capabilities. MDA has identified existing agricultural lending entities to administer individual SRF loans.

2) Watershed Management:

Watershed management is a comprehensive, coordinated approach, which targets the restoration and protection of a specific water resource.

Lead Agency: Minnesota Pollution Control Agency (MPCA)
Estimated Annual Allocation: $3 million

Resource based, locally sponsored, nonpoint source projects done through the MPCA CWP program are the targeted clientele for the SRF loan program. CWP is the vehicle for delivering SRF loans that have enabled following activities:

a) Projects with approved implementation plans which have not received grant funds are able to initiate implementation with loan dollars;
b) Projects waiting for additional funding have been able to accelerate implementation;
c) Communities planning environmentally beneficial activities that are better suited for loan funds, such as individual sewage treatment systems; and
d) Communities have used SRF as match funds to help finance the local share of CWP grant projects.

Individual Sewage Treatment (Septic) Systems (ISTS)

During one funding cycle, some SRF money was loaned for ISTS upgrades through the Small Cities Development Program at the Department of Trade and Economic Development (DTED). Five loans were made. At that point, with the ISTS loan programs at the Department of Agriculture and the MPCA CWP program, the program at DTED was deemed to be duplicative and was ended.

Metropolitan NPS Grant Program

Background

In 1993 the Metropolitan Council entered into a Memorandum of Understanding (MOU) with the MPCA to resolve past wastewater permit violations. The MOU specified, among other requirements, that the Council, and the wastewater treatment section of the Council (Metropolitan Council Environmental Services, MCES) jointly adopt an administrative process and eligibility criterion for projects that were to be funded under the financial assistance program established by the MOU. About $10 million was provided by the MCES over a period of five years toward this financial assistance program.

The MOU also required the Council to develop an annual work program that lists NPS activities to be carried out by the Council. The MOU also identified nonpoint source abatement projects, which should be priorities for that portion of the Minnesota River that flows through the Twin Cities Metropolitan Area.

The program was set to end in 1998. However, the program was seen as so successful, and the need for nonpoint source pollution abatement seen as so critical, that the program was re-authorized in November of 1998. The Council entered into a new MOU with the Minnesota Center for Environmental Advocacy, a non-profit group, for an additional five-year commitment. The first round of grants was awarded in 1999. This program is seen as a successful complement to the 319 and CWP programs for those projects within the seven county metropolitan area.

Summary of Eligibility Criteria and Administrative Process

The Council established eligibility criteria and an administrative process which are in large part identical to the criteria and process established by the Minnesota Legislature and the MPCA for the Minnesota Clean Water Partnership Grant Program. The Council has had the flexibility to revise the criteria or process as needed.

There are, however, some significant differences between the two programs. Unlike CWP, in addition to any public entity, a trade and professional association, or public school may apply for, and receive a grant for a nonpoint source pollution-related project. <u>The Council itself is not eligible for a grant.</u> The geographic area of the project must be wholly or partly within the seven county metropolitan area. The project must be completed within three years. The maximum grant that can be awarded to a project is set at $100,000 and requires a 25 percent local match. Ten percent of the total amount available for grant during a grant award period will be set aside for special projects for which matching funds will be required.

Board of Water and Soil Resources Challenge Grant

The Board of Water and Soil Resources (BWSR) is a state agency dedicated to helping local units of government manage natural resources. BWSR aims to improve local capacity through providing technical, financial, and administrative assistance. They administer a number of grant programs all aimed at NPS pollution abatement including a block grant program, feedlot water quality management, nonpoint engineering, wetland conservation, lakeshore easement programs and special project grants. Most of the grant programs requires a 50% match. The programs cover a wide range of activities including education and information, monitoring, planning and environmental controls, and land and water treatment. For specific information about the applications and eligibility please see their website at: <u>www.bwsr.state.mn.us</u>.

ADDITIONAL IMPLEMENTATION SUPPORT

Besides financial support, state and local governments must take advantage of the many beneficial services provided by citizens and volunteers. Concerned people and organizations like Lake Associations, Boy Scouts, high school students, recreational organizations, historical preservationists, and university programs are continually seeking opportunities to get involved and improve their environment in a tangible way.

Watershed awareness has significantly increased citizen participation in cleanup, preservation and restoration activities. Just getting local residents out on a river in a canoe, rivers they have lived near all their lives, has had a profound effect on how they view their watersheds.

One example from the Clean Water Partnership Program is the Minneapolis Chain of Lakes project. They recently held their annual Earth Day 2000 cleanup of the lakes and adjoining parks. They had food and entertainment for all the participants. Approximately 2,000 people participated, the highest number yet. Besides restoring the chain of lakes, the CWP project increased awareness and concern for one of Minneapolis' most used resources.

Summary of Potential Nonpoint Source State and Federal Funding Sources

Additional state and federal funding sources that could potentially be used to accomplish some of the objectives laid out in this Management Program are summarized in Tables 1 and 2. Along with those funding sources, programs and their relevant elements can be found in Tables 1 and 2. In addition, programs that play a role in the control of NPS pollution are cited throughout this document, with specific programs and authorities described in appropriate chapters.

Summary of Eligible and Ineligible Expenses Under the Section 319 and Clean Water Partnership Programs

Table 3 sets out a list of activities and whether they would be eligible or not for funding under the rules governing CWP and guidance from USEPA. The Project Coordination Team and MPCA decided on the eligibility of certain items as a matter of policy even if funding was allowed under the Clean Water Act. This list is evolving and thus is subject to change. Please check with the MPCA 319 and CWP managers for the most current information.

TABLE 1
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State: Water Quality Focused Programs

Program	Lead Agency	Funding Source	Program Focus							Water Resources						NPS Category								Program Description
			Water Quality	Wetlands	Fish and Wildlife	Erosion Control	Shoreland	Habitat Rehab.	Conservation	Streams/Rivers	Lakes	Ground Water	Watershed	Great Lakes	Wetlands	Agriculture	Forestry	Mining	On-Site	Construction	Hydraulic Modification	Highway	Urban Stormwater	
Ambient Ground Water Quality Monitoring	MPCA	General Fund	X									X												The Ground Water Monitoring and Assessment Program (GWMAP) is currently focused on monitoring the effects of nonpoint source pollution on ground water and drinking water supplies. Current projects include sampling 25 domestic wells in each of 10 metro area communities in conjunction with Metropolitan Council to evaluate how residential areas serviced by ISTS's are impacting ground water quality. Also, we are evaluating how effective certain permitted manure containment systems statewide are at protecting shallow ground water. GWMAP has also looked at the impacts of different land uses on ground water quality in two studies. Additionally, monitoring of agricultural BMP's and their impacts on ground water quality in two wellhead protection areas in southwestern MN are ongoing. GWMAP is currently working on establishing a statewide nitrate monitoring project. Additional networks might be added in the future to address other contaminants, as resources are available

State: Water Quality Focused Programs

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Program	Lead Agency	Funding Source	Water Quality	Wetlands	Fish and Wildlife	Erosion Control	Shoreland	Habitat Rehab.	Conservation	Streams/Rivers	Lakes	Ground Water	Watershed	Great Lakes	Wetlands	Agriculture	Forestry	Mining	On-Site	Construction	Hydraulic Modification	Highway	Urban Stormwater	Program Description
Ambient Surface Water Quality Monitoring	MPCA	General Fund, Federal 100	X							X	X		X											Routine monitoring provides background water quality data necessary for several Agency water programs and for responses to requests from individuals and groups interested in water quality. Water samples are analyzed for a variety of chemical, physical, a
Citizens Lake Monitoring Program	MPCA	General Fund, SRF loan program	X								X													Volunteers assist in the assessment of water quality by measuring the clarity of lakes using Secchi discs.
Clean Water Partnership Program	MPCA	Federal 319 Grants, General Fund	X							X	X	X	X		X	X	X	X	X	X	X	X	X	The program provides financial assistance through matching grants and technical assistance to local governments to lead water resource restoration and protection projects with an emphasis on watersheds.
Feedlot Program	MPCA	Federal 106, Federal 319, general funds	X							X	X	X			X	X								Any facility that meets the definition of feedlot with greater than 1,000 animal units (AU) needs an NPDES permit. Any new facility greater than 300 AU needs an NPDES permit. In addition, any facility that is creating a pollution hazard may be required to get a permit. NOTE: Section 319 funding cannot be used to fund feedlots that are required to have an NPDES permit.

State: Water Quality Focused Programs

Program	Lead Agency	Funding Source	Program Focus: Water Quality	Wetlands	Fish and Wildlife	Erosion Control	Shoreland	Habitat Rehab.	Conservation	Water Resources: Streams/Rivers	Lakes	Ground Water	Watershed	Great Lakes	Wetlands	NPS Category: Agriculture	Forestry	Mining	On-Site	Construction	Hydraulic Modification	Highway	Urban Stormwater	Program Description
Individual Sewage Treatment System	MPCA	General Fund	X									X							X					MPCA has minimum standards and criteria for the design, location, installation, and the use and maintenance of Individual Sewage Treatment Systems. The Agency, along with the U of M conducts training workshops, based on these minimum criteria, to assist those involved in construction and servicing these systems.
Intensive Surveys Program	MPCA	General Fund, Federal 106	X							X	X													Intensive surveys are conducted on streams/rivers/ditches receiving discharges from municipal wastewater treatment plants where stream flows are considered inadequate to protect water quality standards. Data collected from the surveys is used to determine appropriated effluent limits so that water quality standards are maintained and the designated uses of a particular water area protected.
Lake Assessment Program	MPCA	EPA Lake Assessment Grants	X							X	X		X			X	X	X	X	X	X	X	X	The program is a cooperative study of a lake involving MPCA staff and local citizens. The studies characterize a lake's condition and provide some basic information regarding the interaction of the lake and its watershed.
Lake Studies Program	MPCA	General Fund	X								X													The program inventories the physical, chemical and biological characteristics of Minnesota's lakes for informed decision making of state fisheries and lake management programs.

State: Water Quality Focused Programs

Program	Lead Agency	Funding Source	Program Focus: Water Quality	Wetlands	Fish and Wildlife	Erosion Control	Shoreland	Habitat Rehab.	Conservation	Water Resources: Streams/Rivers	Lakes	Ground Water	Watershed	Great Lakes	Wetlands	NPS Category: Agriculture	Forestry	Mining	On-Site	Construction	Hydraulic Modification	Highway	Urban Stormwater	Program Description
SDS Permit Program	MPCA	General Fund, Permit Fees	X							X	X	X				X			X					This program regulates the land application of sludge. Some municipal sewage, sewage sludge, and industrial wastes are disposed of by land application such as spray irrigation. The SDS permits generally require permit holders to monitor ground water at sites where the waste is applied and to submit quarterly or annual reports.
Underground Disposal Control Program	MPCA	General Fund	X							X	X	X							X				X	The UDCP works to limit or eliminate disposal of industrial and other nondomestic wastewater in on-site septic systems. This currently under-development program will serve as a corollary to the EPA Underground Injection Control Program.
Individual Sewage Treatment System Installer/ Maintenance Certification, training, and assistance	MPCA	License fee, general funds	X							X	X	X	X		X			X						Certification is required for those who install and maintain ISTS. Certification is obtained through a combination of past experience and by passing a written examination. Training is provided by the MPCA and the University of Minnesota.
Individual Sewage Treatment System Grant Program	MPCA	General Fund	X							X	X	X	X		X				X	X				Provides a 50% match grant to low income communities for the installation of ISTS and small cluster systems

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State: Water Quality Focused Programs

			Program Focus								Water Resources							NPS Category								
Program	Lead Agency	Funding Source	Water Quality	Wetlands	Fish and Wildlife	Erosion Control	Shoreland	Habitat Rehab.	Conservation		Streams/Rivers	Lakes	Ground Water	Watershed	Great Lakes	Wetlands		Agriculture	Forestry	Mining	On-Site	Construction	Hydraulic Modification	Highway	Urban Stormwater		Program Description
Water Quality Certification Program	MPCA	General Fund, Federal 106	X										X			X						X	X	X			Any applicant for a federal permit or license for a project that has the potential to affect water quality must obtain a certification from MPCA that water quality standards will be met before the license or permit may be granted.
Lake Sampling Program	Metropolitan Council	General Fund	X									X										X	X		X		The Metropolitan Council has undertaken a lake sampling program since 1980 in the Metro area. This program is used to assess the quality of area lakes. This assessment is used to both establish policies and in reviews of local comprehensive plans.
MN Water Well Construction Code	MDH	Regulatory Fees	X										X									X			X		The program sees to the proper construction and sealing of wells and borings including water supply wells, monitoring wells, environmental bore holes, and mineral exploration drill holes. Proper location, construction, and maintenance of wells and borings can reduce the potential for ground water contamination.
Public Water Supply Program	MDH	Regulatory Fees	X										X					X							X		The Minnesota Department of Health regulates public drinking water supplies for the purpose of protecting public health. MDH has the authority under the federal and state Safe Drinking Water Act to set maximum contaminant levels and monitoring frequencies for over 10,000 public water systems in the state.

State: Water Quality Focused Programs

Program	Lead Agency	Funding Source	Program Focus: Water Quality	Wetlands	Fish and Wildlife	Erosion Control	Shoreland	Habitat Rehab.	Conservation	Water Resources: Streams/Rivers	Lakes	Ground Water	Watershed	Great Lakes	Wetlands	NPS Category: Agriculture	Forestry	Mining	On-Site	Construction	Hydraulic Modification	Highway	Urban Stormwater	Program Description
Wellhead Protection Program	MDH	General Fund, Well Fortification Filling and Permit Fees, Clean Water Act 106 & 319	X									X	X			X		X	X			X	X	The program, which is currently under development, will be designed to protect public wellhead areas from contaminates that may adversely affect human health. Public water suppliers will be required to delineate public wellhead areas, investigate a potential contaminate source, and develop a program for managing these sources.
Cost-Share Program	BWSR	General Fund	X			X				X	X				X	X				X				The purpose of this program is to provide financial assistance to landowners and operators for installation of erosion, sediment, and water quality control projects. Wetlands being enhanced or restored for the purpose of water quality protection may be eligible for this program.
Local Water Resources Protection and Management Program	BWSR	General Fund ($2.5 million)	X	X						X	X					X	X	X	X	X	X	X	X	The purpose of this program is to provide grants to counties to assist in administration and implementation of approved and locally adopted local water plans. An inventory of wetlands is an eligible use of these grant funds.
Aquatic Plant Management Program	DNR	Game and Fish Funds, Federal Cost Share	X								X					X								The program issues permits to lake property owners to kill aquatic vegetation on their property, using herbicides or mechanical removal.
Fish Contaminant Monitoring Program	DNR	RIM Funds	X							X	X							X				X	X	Data is collected from fish in lakes statewide to monitor levels of PCBs and mercury. The data is then provided to the Minnesota Department of Health, which issues fish consumption advisories.

TABLE 1
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State: Water Quality Focused Programs

			Program Focus							Water Resources						NPS Category								
Program	Lead Agency	Funding Source	Water Quality	Wetlands	Fish and Wildlife	Erosion Control	Shoreland	Habitat Rehab.	Conservation	Streams/Rivers	Lakes	Ground Water	Watershed	Great Lakes	Wetlands	Agriculture	Forestry	Mining	On-Site	Construction	Hydraulic Modification	Highway	Urban Stormwater	Program Description
Flood Plain Management Program	DNR	General Fund, FEMA Cap Funds	X	X			X		X	X	X		X	X	X					X				Standards provide for identifying floodplains, floodways, and flood fringe areas. Standards describe flood protection measures for new construction in the flood fringe. Standards require that only open space uses are to be allowed in floodway areas.
Regulation of Fertilizers, Soil & Plant Amendments	MDA	Tonnage Fees on Fertilizer	X							X	X	X	X		X	X								The program sets out the strategy through which the state agencies will promote BMPs. The program also describes the framework through which action will be taken in the case of ground water degradation by incorrect fertilizer application.
MN Pesticide Control Act	MDA	Regulatory Fees	X									X				X								The program is intended to regulate pesticide use in the state of Minnesota.

TABLE 2
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State: Water Quality Focused Programs

Program	Lead Agency	Funding Source	Program Focus: Water Quality	Program Focus: Wetlands	Program Focus: Fish and Wildlife	Program Focus: Erosion Control	Program Focus: Shoreland	Program Focus: Habitat Rehab.	Program Focus: Conservation	Water Resources: Streams/Rivers	Water Resources: Lakes	Water Resources: Ground Water	Water Resources: Watershed	Water Resources: Great Lakes	Water Resources: Wetlands	NPS Category: Agriculture	NPS Category: Forestry	NPS Category: Mining	NPS Category: On-Site	NPS Category: Construction	NPS Category: Hydraulic Modification	NPS Category: Highway	NPS Category: Urban Stormwater	Program Description
Streambank, Lakeshore & Restoration Program	BWSR	General Fund				X										X				X		X		The purpose of this program is to provide financial assistance to local units of government, although private landowners control problems on these sites. Priority is given to projects eligible for federal matching funds.
Wetland Establishment & Restoration Program	BWSR	General Fund		X									X		X						X			The purpose of this program is to allow landowners to apply to a county watershed management organization for assistance to restore or enhance a wetland in identified high priority areas.
Wetlands Biological Assessment	MPCA	LCMR		X											X									This two-year research project is in response to the U.S. EPA's request that states begin developing biological criteria for assessing water quality. The project consists of selection of least disturbed reference wetland sites, use of standardized sampling procedures, and assessment of diverse parameters. The results will be the basis for development of practical criteria for making decisions about impacts to high quality wetlands.
National Resources Parks Program	Metropolitan Council	Appropria-tions from the State Legislature							X	X	X									X			X	The program provides funding to the regional park agencies for the operation, maintenance, development, and acquisition for the parks in the metropolitan area.
National Resources Planning Program	Metropolitan Council	Ad Valorem Tax Levy, Chargebacks to Regional Agencies							X				X										X	The Metropolitan Council reviews and comments on local government Comprehensive Plans. If the Council determines that the local Comprehensive Plan will impact on the metropolitan systems, the Council can require the local plan be modified to be consistent with Council planning.

State: Water Quality Focused Programs

TABLE 2
Page 2

Program	Lead Agency	Funding Source	Program Focus: Water Quality	Program Focus: Wetlands	Program Focus: Fish and Wildlife	Program Focus: Erosion Control	Program Focus: Shoreland	Program Focus: Habitat Rehab.	Program Focus: Conservation	Water Resources: Streams/Rivers	Water Resources: Lakes	Water Resources: Ground Water	Water Resources: Watershed	Water Resources: Great Lakes	Water Resources: Wetlands	NPS Category: Agriculture	NPS Category: Forestry	NPS Category: Mining	NPS Category: On-Site	NPS Category: Construction	NPS Category: Hydraulic Modification	NPS Category: Highway	NPS Category: Urban Stormwater	Program Description
Aeration Program	DNR	Game and Fish Funds, Federal Cost Share		X							X													The program issues permits to operate aeration systems in public waters to prevent winter fish kills.
Aquatic Exotics Program	DNR	Water Recreation Account, Boat Licenses, Surcharge Fees						X		X	X			X										The program includes the inventory, monitoring, and control of infestations of purple loosestrife, millfoil, and zebra muscles. It also provides public education information, and conducts research on control and eradication of exotics.
Aquatic Management Areas	DNR	State Bonding, License Fees, Sport Fish Restoration Funds			X			X			X													Easement acquisition along lakeshore to provide corridors for angler access, riparian protection, habitat improvement or rehabilitation, or fish structure/barriers.
Creel Surveys (Study IV Surveys)	DNR	General Fund			X					X	X													Ten fish creel surveys are completed annually on lakes and rivers. The program monitors fishing pressure, harvest, and catch and recreational use parameters. It is then combined with other surveys to estimate impacts of fishing on fish populations.
Fish Kill Investigations Program	DNR	Game & Fish Funds, Federal Cost Sharing			X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	Investigations of pollutants that cause fish and wildlife kills. When the problem is found, the pollutant is traced to the discharger, and damages are assessed based on damage to fish and wildlife.

State: Water Quality Focused Programs

TABLE 2
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Program	Lead Agency	Funding Source	Program Focus: Water Quality	Program Focus: Wetlands	Program Focus: Fish and Wildlife	Program Focus: Erosion Control	Program Focus: Shoreland	Program Focus: Habitat Rehab.	Program Focus: Conservation	Water Resources: Streams/Rivers	Water Resources: Lakes	Water Resources: Ground Water	Water Resources: Watershed	Water Resources: Great Lakes	Water Resources: Wetlands	NPS Category: Agriculture	NPS Category: Forestry	NPS Category: Mining	NPS Category: On-Site	NPS Category: Construction	NPS Category: Hydraulic Modification	NPS Category: Highway	NPS Category: Urban Stormwater	Program Description
Fisheries Research Program	DNR	Dedicated Fund Appropriation to Section of Fisheries (most work is 75% reimbursable)			X					X	X													The program includes a large number of research projects studying a variety of fish populations and water bodies throughout Minnesota. The goal of the research is to develop tools to better manage fisheries within the state.
Flood Damage Reduction Program	DNR	General Funds, State Bonding		X				X		X	X		X	X	X					X	X			The program provides matching grants to Local Units of Government to implement flood damage reduction projects. Some projects have created or enhanced wetlands for flood water storage areas.
Game Lake Inventory	DNR	General Fund						X			X				X									The program is a survey of shallow lakes and wetlands to inventory plants, water quality, and wildlife habitat.
Habitat Management on Public Lands	DNR	RIM, Deer Hunting License Fees, Pheasant Stamp Funds			X			X					X											The program includes the maintenance and development of grasslands, woody cover, food plots, forest stands, forest openings and improvement of prescribed burns to improve wildlife habitat on public lands.
Lake Habitat Improvement	DNR	Fishing License Revenues, Partially Reimbursed by Sport Fish Restoration Funds			X			X			X										X			The program includes a variety of methods to manage lake communities and improve or maintain angling opportunities. These may include shoreline stabilization, vegetative restoration or improvement of development of fish spawning habitat.

State: Water Quality Focused Programs

TABLE 2
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Program	Lead Agency	Funding Source	Program Focus: Water Quality	Wetlands	Fish and Wildlife	Erosion Control	Shoreland	Habitat Rehab.	Conservation	Water Resources: Streams/Rivers	Lakes	Ground Water	Watershed	Great Lakes	Wetlands	NPS Category: Agriculture	Forestry	Mining	On-Site	Construction	Hydraulic Modification	Highway	Urban Stormwater	Program Description
Lake Reclamation	DNR	Fishing License Revenues, Partially Reimbursed by Sport Fish Restoration Funds			X			X			X													This intensive habitat improvement program includes use of chemicals to effect fish kills and reclaim lakes for desired sport fish populations.
Lake Survey Program	DNR	State Fish & Game Fund, Reimbursed by Sport Fish Restoration Fund			X						X													An annual survey of 600 lakes, including fish populations, water quality and habitat conditions. The monitoring effort tracks long-term trends in fish resources and habitat conditions.
Large Lake Program	DNR	State Fish & Game Fund, Reimbursed by Sport Fish Restoration Fund			X						X			X										This intensive annual sampling of the state's 11 largest lakes for detailed fish population, water quality and habitat data.
MinnAqua	DNR	RIM General Funds, LCMR, Non-Game Fund Check-Off						X		X	X													The program includes Urban Angling and Volunteer Instructor Training programs to teach people about lake and stream ecology by teaching them to fish.
Northern Pike Spawning Area Development	DNR	Fishing License Fees, Federal Aid, RIM			X						X				X						X			The purpose of this program is to develop controlled Type II wetlands adjacent to lakes and streams to function as northern pike spawning and nursery habitat. Sties are selected where natural spawning habitat is limited or lost to drainage or shoreland development. Ponds are developed by diking a site and manipulating water levels with a control structure. Most sites are less than 15 acres.

State: Water Quality Focused Programs

TABLE 2
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			Program Focus							Water Resources						NPS Category								
Program	Lead Agency	Funding Source	Water Quality	Wetlands	Fish and Wildlife	Erosion Control	Shoreland	Habitat Rehab.	Conservation	Streams/Rivers	Lakes	Ground Water	Watershed	Great Lakes	Wetlands	Agriculture	Forestry	Mining	On-Site	Construction	Hydraulic Modification	Highway	Urban Stormwater	Program Description
Other Study IV Surveys	DNR	State Fish & Game Funds Partially Reimbursed by USF&WS Sport Fishing Restoration Fund			X					X	X													The program includes a variety of special investigations to assess particular fish populations and characteristics, such as the effects of bass tournaments on populations, etc. The program is targeted to particular research issues.
Protected Waters & Wetland Inventory	DNR	LCMR		X											X						X			DNR has created an inventory of waters and wetlands for which permits are required. Inventory consists of hard copy maps on county highway maps base, and legal description for each protected lake, stream, and wetland. DNR is in the process of digitizing the protected water inventory on the computerized National Wetlands Inventory map base.
Protected Waters & Wetland Permit Program	DNR	General Fund, Permit Fees		X						X	X			X	X	X				X	X	X	X	Program provides for orderly and consistent review of permit applications in order to conserve and utilize the water resources of the state. A protected water permit is needed to do any work which will change or diminish the course, current, or cross-section of any lake, marsh or stream that is designated as a protected water or wetland by the DNR.
Shoreland Management & Wild Scenic Rivers Program	DNR	General Fund					X			X	X					X		X	X			X	X	Standards have been established for development of shoreland areas; land within 300 ft. of a stream or 1000 ft. of a lake or wetland, or extent of the floodplain. Standards address subdivision of land, structure setbacks, vegetative management, land alterations, agricultural activities, and sewage treatment.

TABLE 2
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State: Water Quality Focused Programs

Program	Lead Agency	Funding Source	Program Focus: Water Quality	Wetlands	Fish and Wildlife	Erosion Control	Shoreland	Habitat Rehab.	Conservation	Water Resources: Streams/Rivers	Lakes	Ground Water	Watershed	Great Lakes	Wetlands	NPS Category: Agriculture	Forestry	Mining	On-Site	Construction	Hydraulic Modification	Highway	Urban Stormwater	Program Description
Stream Flow Data	DNR	General Fund							X	X			X											A stream flow summary is produced weekly by the Division of Waters from March to September. The summary contains current flow data, trends, low flow, and flood flow warnings. The summary was developed to identify watersheds where flows were below critical levels and water appropriation permits should be suspended.
Water Appropriation Permit Program	DNR	General Fund, Permit Fees	X		X					X	X	X			X	X	X	X		X				Permits are required for appropriations of surface or ground water exceeding 10,000 gallons per day or 1 million gallons per year.

TABLE 3 ELIGIBLE AND INELEGIBLE EXPENSES FOR FISCAL YEAR 01 (to be annually reviewed and amended as necessary)

Activities	**Fundable with 319 Program Grants**	**Fundable with CWP Grants**	**Fundable with CWP Loans**
In-lake treatment	#Yes	* No	*Yes
Dredging	#Yes	* No	*Yes
Phase I resource investigation	#No	*Yes	* No
ISTS	No, only match money may be used	* No	*Yes
"Sewage treatment system upgrades"	#Yes	* No	*Yes
Feedlot BMP'S if not part of enforcement	#Yes	*Yes	*Yes
Activities started before G/L agreement is signed	#No	* No	* No
O & M of BMP'S	#Yes (limited)	* No	* No
Commercial operations (except farms)	#No	* No	* No
Mining activities	#Yes	* No	* No
Building and utility construction	#No	* No	* No
Highway and road construction	#No	* No	* No
Activities primarily for flood control	#No	* No	* No
Monitoring, data & information collection & analysis	#Yes, up to 20 %	*Yes	*Yes
Fiscal and management activities	#Yes, up to 10%	*Yes	*Yes
Development, review, selection, design, installation of BMP'S	Yes	*Yes	*Yes
Development & implementation of educational materials	Yes	*Yes	*Yes
Development & implementation of official controls (ordinances)	Yes	*Yes	*Yes
Acquisition of easements and property	Only with match money	*Yes	*Yes
Other activities determined to be necessary to carry out the project	Yes	*Yes	*Yes
Activities related to federal and state pollution control statutes such as CERCLA, RCRA, ECLA, and CLA.	No	*No	*No
Activities regulated by the NPDES permit program except costs	No	*No	*No
Activities regulated by solid or hazardous waste permit or rules	No	*No	*No
Publicly owned treatment works	#No	*No	*No
Regulated practices to control spills	No	*No	*No
Regulated practices to manage toxic or hazardous materials	No	*No	*No
Activities that violate state, local, & federal rules, statutes & regs.	No	*No	*No

* Set out in CWP rules
# Set out in the Clean Water Act, or EPA guidance

Chapter 3 Minnesota's Watershed Planning and Management Framework

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Introduction

In Minnesota, water planning is performed on many different scales, from statewide plans to local plans. These major efforts include the:

- Minnesota 2001 Nonpoint Source Management Program Plan (NSMPP),
- Minnesota State Water Plan 2000,
- development of basin plans for the 10 major drainage basins of the state under the facilitation of the MPCA,
- watershed planning efforts by groups representing major and minor watersheds in many areas of the state,
- county water plans, and
- watershed district and watershed management organization planning concentrated in the Red River Valley and Twin Cities Metro Area.

Though each level of planning has its purpose, significant workload issues at both the local government and state agency levels can arise if local and state task force members and staff are expected to participate in these multiple water related planning efforts at the same time. In addition to the potential for the timeframes for many of these planning efforts to overlap, there is also some lack of understanding by some as to what the purpose of each of the planning efforts is and how they all fit together.

The purpose of this chapter is twofold:

1) to identify the overall water planning framework currently in place in Minnesota, and how the different levels of planning interact and influence each other.
2) to identify the current status of planning activities in the state's major drainage basins.

WATER PLANNING AND MANAGEMENT FRAMEWORK IN MINNESOTA

At first glance to the casual observer the water planning framework in Minnesota probably seems awkward and cumbersome. In reality this framework, which has developed in Minnesota over the past 40 years, reflects the complex nature of both water management and the institutions that are in place to manage it. There are a number of ways in which the state's framework for water planning can be viewed. In this chapter, the framework is presented in a hierarchical model, with each level being impacted or influenced by the other.

Minnesota Water Plan 2000

The State Water Plan is a 10-year framework that will include broad goals, objectives and targets to measure the results of state and local policies and programs on a statewide level and by drainage basins. The plan is as broad as possible in scope, addressing all aspects of water resource management. The four broad goal areas of the plan include surface and ground water quality and quantity issues, ecosystem diversity as related to water resources, and water recreation issues.

State Water Plan 2000 is prepared under the direction of the MN Planning, Environmental Quality Board. It is a legislatively mandated report that is also a major component of the Governor's Executive Order calling for a Water Management Unification Initiative. The Initiative includes the focusing of efforts on major drainage basins in order to recognize and act on the differences in water resources and management choices throughout the state, the unification of water management through interagency teams in each basin working with local resource managers and citizens, and measuring results by developing and tracking progress toward a statewide framework of goals and objectives adapted to each basin.

As a statewide plan, Water Plan 2000 will guide state lawmakers and agencies by:

- providing policy direction for the legislature
- identifying funding initiatives
- giving direction to agency efforts and resource allocations
- measuring the state's progress in meeting environmental goals

While a statewide plan, State Water Plan 2000 recognizes and respects the individual basin efforts underway, and includes basin-specific sections that bring better specificity to planning at the more focused (though still geographically large) basin level.

The first phase of the Water Plan, called "Minnesota Watermarks: Gauging the Flow of Progress 2000-2010" was completed in September 2000. The second phase will be developed over the course of the next two years and will track progress toward the goals and objectives, set 10-year targets, evaluate whether existing programs are meeting needs, and decide key strategies and related responsibilities.

Minnesota 2001 Nonpoint Source Management Program Plan (NSMPP)

This plan is another statewide plan, but is more focused in the scope of issues it addresses than State Water Plan 2000. While the state water plan includes all water quality and quantity, ecosystem health, and recreation issues related to water resources, the MN 2001 NSMPP focuses on nonpoint source (NPS) water pollution and its impact on water quality. As nonpoint source pollution has such a major impact on water quality and comes from such diverse and widespread sources, this NSMPP or NPS plan is an important component of the state's water planning framework.

While the state is definitely advancing the basin planning approach, it is recognized that there is also a need for statewide plans and approaches on specific issues. This NSMPP or state NPS plan promotes statewide approaches on managing water resources through the strategies for lakes, ground water, streams, and wetlands. These statewide resource specific strategies provide a baseline framework for water resource managers to work from, to apply, and to enhance and provide more specific local detail to through basin and watershed planning. Likewise, this plan provides the statewide framework for addressing potential NPS pollution sources, such as feedlots, individual sewage treatment systems (ISTS), agricultural nutrients and pesticides, storm water, etc. The basic programs, rules, and approaches for these sources are spelled out in this plan, and should be utilized and enhanced to fit local conditions in basin and watershed planning and management.

Basin Planning

Basin plans provide a more geographically focused level of water planning, and typically will focus more on water quality issues. Basin water quality planning in Minnesota is being done under the direction of the Minnesota Pollution Control Agency. It is a geographically-based approach to water quality protection and restoration. The approach focuses on the state's 10 major drainage basins and is designed to 1) identify water quality problems, 2) work with local governments to establish shared goals and priorities, and 3) develop pollutant reduction strategies. The focus of this level of planning is to:

- refine water quality related state objectives
- set basin level water quality priorities
- define priority water quality pollutants & problem areas
- identify actions and projects to be performed to address the identified goals, objectives, priorities, and targets
- serve as a mechanism to help secure funding for implementation of the plans

Basin plans are intended to be five-year plans, continuously updated every five years. The goals, objectives, and targets they specify are to be at least partially achievable within the five-year life span of the plan.

To date, only one basin plan is completed – the Red River Basin Plan. The plan is very comprehensive and includes:

- ➢ issues, goals, priorities, and strategies and priority waters for each of the 4 geographic committees of the basin and the overall basin committee
- ➢ a basin wide projects list
- ➢ an overall plan time line

As most of the projects proposed in the plan are dependent upon funding from financial assistance programs, they do not include timelines.

This plan can be viewed on the Internet at: http://www.pca.state.mn.us/water/basins/redriver/wqplan/index.html.

All basin plans are scheduled to be completed by the end of 2003. Being so heavily focused on NPS water pollution issues, the basin plans are incorporated by reference into the substance of this NSMP plan.

Basin plans are intended to help focus attention and funding on particular watershed planning and management efforts that will advance the goals of the basin plan to protect and improve water quality of the basin.

The status of specific basin planning efforts is discussed later in this chapter. A schedule for basin plan development, and other information on the basin planning and management program can be found on the Internet at: http://www.pca.state.mn.us/water/basins/index.html.

Major Watershed Plans

Major watersheds are the next hydrologic division down in scale from the 10 Basins of Minnesota. They are watersheds at the 8-digit hydrologic unit code level. There are 81 ~~84~~ major watersheds delineated in Minnesota. Minor watersheds are a further subdivision of the major watersheds. There are about 5,600 minor watersheds in Minnesota.

The planning that is being done at this level is by various groups, including watershed districts, joint power entities, or organized citizen groups. The focus of this level of planning is to:

- Create sub-basin plans, typically at a major or minor watershed level
- Establish specific water related goals, objectives & priorities for:
  - individual environmental pollutants (i.e. phosphorous, sediment, etc.)
  - flood damage reduction
  - natural resources management
  - restoration, enhancement, or protection areas
- Implementation of watershed plans

There is no timeframe spelled out on a statewide basis for development of all major watershed plans as there is for basin plans. In cases of watershed districts that encompass entire major watersheds, they are required to develop watershed plans every 10 years. Otherwise, major watershed planning efforts are being done as possible through financial assistance programs and encouragement by basin planning efforts.

The draft Minnesota River Basin Plan states that by 2004, 11 of the 13 major watershed teams will have completed a water quality assessment and develop comprehensive implementation plans, and that all of the 13 major watershed partnership plans will be in some stage of implementation by 2005.

Funding Watershed Planning and Management

Many of these watershed-planning efforts, particularly those being managed by ad hoc groups, are funded through state and federal grant and cost-share programs. Local contributions of matching funds and in-kind services are typically a component of watershed projects as well. The Clean Water Partnership (CWP) Program administered by the MPCA has the ability to provide funding for watershed coordinators or other staff to facilitate these efforts, and has provided this type of support to many projects over the last decade. The BWSR Challenge Grants program has also provided similar funding. The funding programs identified in Chapter 2 "Programs and Funding for Implementing NPS Program" provide funding for implementation of watershed plans, such as Best Management Practices (BMP) and information and education programs. Please see Chapter 2 for more specific information on how CWP, Challenge Grants, and other funding programs operate and advance the watershed approach.

There is growing interest in exploring the concept of allocating portions of the funding available for watershed projects to specific basins to support basin and watershed planning and put more control over resource allocation in the hands of basin resource managers. Much discussion and evaluation still need to occur on this issue, but many see this as a way to support and implement basin and watershed planning and management.

In 1999, Minnesota became part of the Coastal Zone Management Program. Established by Congress in 1972, the Coastal Zone Management Act (CZMA) makes states and territories along the coasts of the Atlantic and Pacific oceans, the Gulf of Mexico, and the Great Lakes eligible to participate in the Coastal Zone Management Program. The CZMA affirms a national commitment to the effective protection and rational development of coastal areas, by providing assistance and encouragement to coastal states to voluntarily develop and implement management programs for their coastal areas. The goal of the Coastal Zone Management Program is to preserve, protect, develop, and where possible, restore and enhance coastal resources for present and future generations.

Responsibility for administering the national program rests with the Office of Ocean and Coastal Resource Management, which is part of the National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Responsibility for administering the state program rests with the Department of Natural Resources.

Direct benefits to states that participate in the program include:

- Financial Assistance - Approximately $600,000 per year to implement Minnesota's Lake Superior Coastal Program.
- Technical Assistance - Workshops and training coordinated with other state, federal, and local agencies and organizations to address common coastal issues and data and research information through NOAA's National Ocean Service.
- Federal Consistency - This component requires that actions of federal agencies be consistent with approved state coastal management programs.

Indirect benefits include participation in a program that provides a network of resource and business professionals nationwide that together work to solve problems common to coastal areas.

Other Watershed Based Programs

Minnesota Department of Natural Resources (MDNR) Watershed Management Initiative

The MDNR comprehensive watershed initiative is designed to integrate management efforts across discipline lines using the watershed as a geographical boundary. This effort is intended to capitalize on current interest in managing on a watershed basis and to foster cooperative ventures among the many units of government and private citizens who have a role in managing land and water resources.

This program uses a watershed based approach to address land and water resource issues. To accomplish this, the program:

1. Identifies means by which MDNR can be more involved in county local water planning;
2. Provides a MDNR point of contact for watershed based projects;
3. Identifies other state and federal resource agencies, local governments, and organizations with which the MDNR could be partnered;
4. Examines ways in which the MDNR organizational structure could be changed to more effectively work with the external environment of land and water resource decision makers;
5. Works with the private sector to set up a land trust to compliment MDNR acquisition programs; and
6. Inform and educate MDNR personnel about a watershed based approach to land and water resource management.

Five of eight identified prototype watershed projects have received funding and had project coordinators assigned to them. Projects in the Red River Basin, the Leech and Niemackl lakes, and the Wells Creek watershed are now underway. These projects are in various stages of planning and/or implementation.

All of these projects revolve around water quality concerns. All of these projects have tremendous potential to improve and/or preserve water quality by merging local interest and energy with an array of government agency programs intended to remedy water quality problems. It is anticipated that the prototype watershed management projects will serve as testimonies to manage natural resources from a watershed perspective. They will also serve as pilot projects to document successful processes and procedures needing further refinement. It is expected that these prototype projects will generate proposals for additional watershed management planning and implementation activity at locations throughout Minnesota.

- Minnesota Department of Natural Resources Metro Trout Stream Watershed Protection Initiative

The Metro Trout Stream Watershed Protection Initiative is a community-based, interdisciplinary approach to resource management. The initiative's focus is on protecting the region's last remaining high quality cold water resources; there are 15 trout streams in the seven-county metro area, and initiative staff work primarily on six high priority streams. Staff consists of two watershed coordinators, each focusing on three high-priority streams, and a stream habitat specialist, who works on all the streams.

Since the initiative began in 1997, staff have worked with over 60 different groups, including: state agencies, counties, cities and townships, federal agencies, watershed districts, watershed management organizations, citizen's advisory committees, schools, research institutions, conservation groups, non-profit organizations, local citizens, engineering firms and developers.

Since 1997, the program has leveraged around $2.5 million in funds spent on trout streams. This includes money that has been granted from both MDNR and outside sources. The vast majority of the money has been granted to collaborators, not to the initiative, per se. MDNR feels that were it not for the presence of the initiative, its collaborators may not have sought or been awarded these funds. MDNR has been able to influence the direction and focus of its collaborators towards trout stream protection where they may have spent their resources elsewhere in our absence.

Overall, the Metro Trout Stream Watershed Protection Initiative is a testimony on how cooperative efforts can result in more effective and efficient protection and enhancement of natural resources on a watershed scale.

Minnesota's Lake Superior Coastal Program

Minnesota's Lake Superior Coastal Program (MLSCP) is administered by the Minnesota Department of Natural Resources (MDNR). The MLSCP has several components:

- Section 306 of the CZMA established a grant program that makes funds available to governments, communities and organizations in the coastal area. MLSCP awarded its first grants in 2000.
- Section 309 of the CZMA established the Coastal Zone Enhancement Program, providing incentives to states and territories to periodically assess and address nine potentially significant areas: wetlands protection, coastal hazards, cumulative and secondary impacts of development, public access to the coast, special area management planning, marine debris, ocean (lake) resources, energy and government facility siting, and aquaculture. Minnesota submitted its first 309 assessment in 2001.
- Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) focused on nonpoint pollution. Section 6217 is different from sections 306 and 309 in two ways: (1) geographically, it is larger, encompassing Minnesota's entire Lake Superior Watershed, and (2) administratively, it is shared, with MDNR and MPCA serving as co-equal lead agencies. Minnesota will submit its initial Section 6217 (coastal nonpoint) program document in 2001.

Total Maximum Daily Loads (TMDL)

TMDLs have gained prominence over the last few years as a way to address impaired waterbodies. The state of Minnesota intends to address TMDLs using a watershed planning and management approach. This means TMDLs will be done by including the necessary components of developing a broad coalition of interest and involvement in development of the TMDLs, comprehensive watershed assessment, strategy development, and implementation, all in cooperation with local resource managers and stakeholders.

TMDLs are one tool in the basin and watershed management toolbox. A major component of basin management is prioritization - prioritization of issues to be addressed, waterbodies, watersheds, etc. The CWA Section 303d Minnesota TMDL list will be one factor that basin planning teams will use to help them set their priorities on what waters to address as priorities. Other factors than TMDLs will also be considered, including any special status waters may have (drinking water supplies, Outstanding Resource Value Waters, etc.), readiness for a local group to proceed on addressing a waterbody, availability of funding, and other considerations. By their nature, CWA Section 303d mandated TMDLs only address impaired waters, so cannot assist with protection of pristine waters or waters supporting designated uses. So, TMDLs are only a part of the basin management picture, and are not the main driver of basin management. At the same time, TMDLs do serve as a rallying point for local efforts to improve impaired waters. The MPCA intends to work with local resource managers and citizens to develop TMDLs, using a similar process to the watershed management approach that has been used successfully in the CWP Program. Thus, TMDLs will be a powerful mechanism for encouraging watershed and basin management.

For more information on TMDLs, including the state TMDL list and listing methodology, the TMDL development process framework, maps of impaired waters, and budget information, visit the MPCA website at http://www.pca.state.mn.us/water/tmdl/html

County Water Plans and Watershed Management Organization Plans

Implementation is the focus of this level of planning. Planning at this level is done by counties, watershed districts, and joint powers watershed management organizations. A major strength of this level of planning has been the strong support and participation from the state's resource agencies. All of these organizations have 1) a focus on implementation of programs and projects, 2) their own source of funding, and 3) some level of land use authority. The features of this level of planning are:

- County & minor watershed level plans that:
  - assess local resource conditions
  - set local priorities in context of watershed & basin plans
  - identify available fiscal & human resources
- Implementation focus
- Coordinate local activities of:
  - county
  - Soil and Water Conservation Districts (SWCD)
  - watershed organizations
  - extension office
  - municipalities
  - citizen organizations
- Identify opportunities for partnerships with state and federal agencies
- Track & report accomplishments in measurable terms

The Board of Water and Soil Resources (BWSR) oversees local water planning activities in coordination with other state agencies. In order for local government to respond and participate fully in the various water related planning that is being done in the state and to take advantage of the products produced at the state, basin and major watershed level, BWSR intends to pursue the following strategies for local water planning.

- Maintain maximum flexibility over water plan update deadlines. Water plans are required, by statute, to be updated on a regular basis. Statute also allows BWSR to grant up to a two-year extension for just cause. BWSR should grant extensions to those county's and watershed management organizations where the extension will allow them to fully participate in basin and major watershed level planning efforts. BWSR should also support counties in advancing their plan update deadline where opportunities exist to match up with current or planned water-related planning efforts.

- Endorse the participation of BWSR staff with local governments and state agencies to discuss and plan for an orderly water plan update process particularly in those areas where the potential for conflict between planning efforts has been determined to be high.

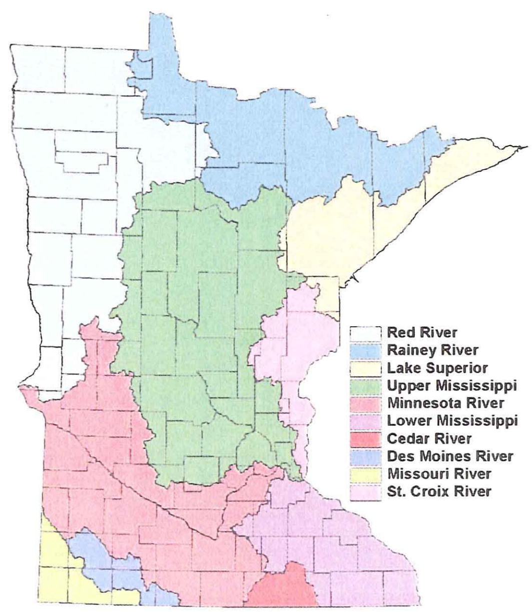
- Encourage the incorporation of relevant data, assessments, priority issues, target pollutants and watershed goals and objectives from statewide, basin, and watershed plans by reference into local water plans.

- Continue to endorse the concepts of local water plans, with a strong emphasis on implementation strategies and establishment of measurable outcomes. In some areas of the state this may lead to placing less emphasis on data collection and assessment and to a model which places greater emphasis on implementation. Historically considerable amounts of time were spent during a local water planning update, were spent on data collection and assessment of that data. The water planning framework, identified in this chapter, presents an opportunity to use the data collection, resource assessments, problem identification, and resource objectives established at the major watershed level, thereby reducing or eliminating the duplication of that by local governments. In turn this allows local governments in their next local water plan update or revision to focus more heavily on implementation, including 1) the development of specific implementation strategies to achieve watershed goals and objectives, 2) the allocation of limited human & fiscal resources, and 3) the use of existing programs and authorities and coordination with other local efforts and entities.

RIVER BASIN SPECIFIC EFFORTS

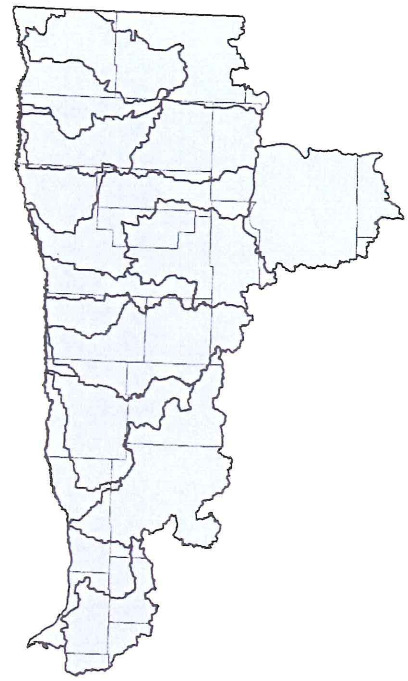
Minnesota is comprised of ten major river basins. Each river basin is made up of major and minor watersheds, which correspond to areas of land that drain to lakes, rivers, and streams.

This portion of this chapter will describe the status of planning efforts in the major basins in the state. The discussion that follows is not intended to be a detailed description of all of the water planning activities occurring in an area, instead it is intended to give the reader perspective on the scope and extent of activities that are occurring.



Red River of the North

Water planning activity in the Red River Basin has been high for many years. International coordination, severe and persistent flooding, and water supply concerns all contribute to a large amount of water planning activity.



Basin level planning activities

- MPCA, Basin Plan (completed 9/1999), Basin Information Document (completed 1997)
- Multiple Stakeholders, Flood Damage Reduction Agreement
- International Joint Commission (IJC) - Flooding task force strategy
- Red River Basin Board – International and interstate basin water plan

Minnesota Red River Basin Water Quality Plan – A Partnership Between Residents, Stakeholders, Local, State, and Federal Resource Managers of the Red River Basin – Though facilitated by the MPCA, the subtitle of this plan demonstrates the fact that this plan was a truly cooperative effort amongst all major water resource managers and stakeholders. The first basin plan to be completed, the Red River Basin Plan contains the goals and strategies to be implemented over the next 5 years. The plan is incorporated by reference into this NPS plan. It is scheduled to begin undergoing revision in 2004.

Focus now will be on implementing the strategies identified over the next several years. As planning has concluded, the challenge will be for state and local partners to put the plan into action.

Red River Basin Flood Damage Reduction Work Group Agreement – This agreement was the product of 8 months of consensus-based mediated negotiations. The agreement, which has basin wide planning applicability, established both flood damage reduction and natural resource goals for the basin. The agreement also included, 1) agreed to principles and strategies for future decision making by the nine watershed districts and the state agencies in the basin, 2) a new project review and permitting process, and 3) guidelines for a new comprehensive watershed planning process by the 9 watershed districts. One of the end results of this agreement will be preparation of major watershed level plans by the 9 watershed districts.

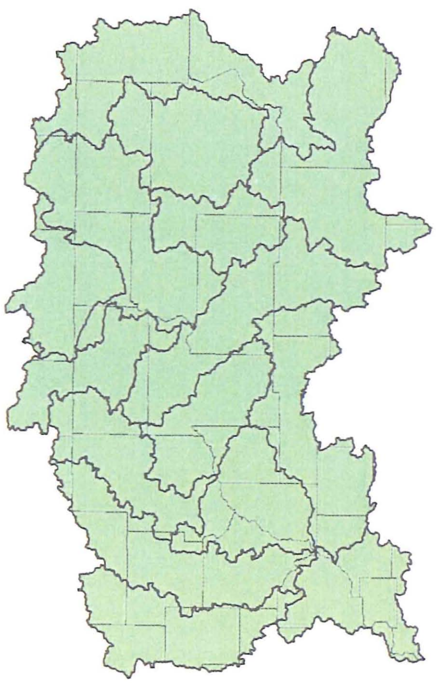
Major watershed level planning activities

- Watershed Districts – comprehensive plan revisions resulting from the mediation agreement (scheduled to be completed over the next 6 years – districts scheduled to begin in 2000 include Bois De Souix, Wild Rice, and Roseau River)
- Minnesota Department of Health – source water assessments (4 communities with surface water supplies – due 5/2003)
- Minnesota Department of Health – Consumer Confidence Reports (required in 2000 by all public water suppliers)
- Otter Tail River Plan (being completed by SWCD's anticipated completion 7/2001)

Local & minor watershed planning activities

- County Water Plan Updates – All counties have existing water plans. Four counties are scheduled to update in 2000, 5 in 2001, 9 in 2002, and 2 in 2003 or beyond.
- Pelican Lake, Lake Improvement District – Mapping and Hydrologic Study
- Red River mediation – Watershed Work Teams (problem area investigations – ongoing)
- Wellhead Protection Plans – required for all public water suppliers
- Pelican River Watershed District – plan completed
- Cormorant Lakes Watershed District – plan competed

Upper Mississippi River Basin



The Upper Mississippi River Basin is comprised of the Mississippi River and its tributaries north of its confluence with the St. Croix River on the Wisconsin border southeast of the Twin Cities. This basin is unique in that the condition of the waters in upper portions of the basin are generally thought of as in good condition while the southern portions of the basin the waters are considered more affected by nonpoint sources of pollution. Respectively, programs and activities by local government tend to be protection efforts in the north and restoration efforts in the south.

Basin level planning activities

- MPCA, Basin Information Document (completed 2000)
- MPCA, Basin Plan (scheduled completion in 2002). Basin planning activities will be organized into five geographic areas that have similar land uses and geomorphic characteristics, and existing political partnerships in place.
- US Geological Survey (USGS) Upper Mississippi River Basin National Water Quality Assessment Study
- Mississippi River Defense Network – river spill prevention and response plan, Source water protection assessment
- U. S. Army Corps of Engineers Reconnaissance Study

Major watershed level planning activities

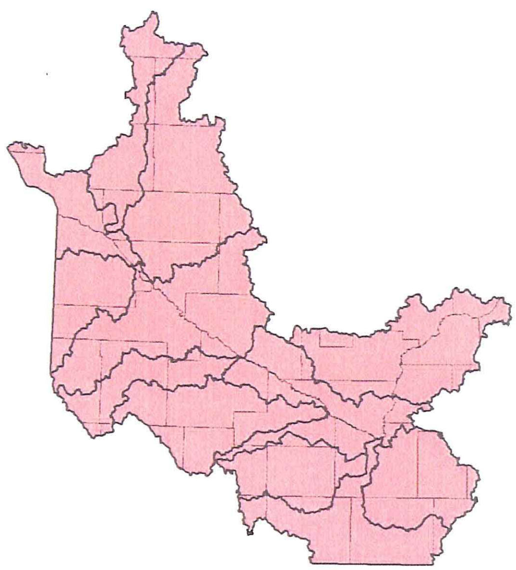
- Mississippi Headwater Board, Main Stem Corridor Plan for the northern stretch of the Mississippi River in the basin (scheduled for revision in 2000)
- Long Prairie River, TMDL establishment & Response Plan for documented water quality impairment, 2001 – 2003)
- Minnesota Department of Health - Source Water Assessment for St. Cloud water supply (surface water withdrawal from Mississippi)
- Sauk River Watershed District – comprehensive plan update in progress
- North Fork Crow River Watershed District
- Crow River Organized Waters (CROW) – joint powers agreement of 9 counties of the Crow River Watershed

Local & minor watershed planning activities

- County Water Plan Updates – All counties have existing plans. Ten counties are scheduled for updates in

2000, 2 in 2001, 5 in 2002, and 4 in 2005.
- Mille Lacs Lake Clean Water Partnership
- Wellhead Protection Plans, required for all public water supplies.
  - ➢ South Two River Watershed District
  - ➢ Clearwater River Watershed District
  - ➢ Thirty Lakes Watershed District
  - ➢ 18 watershed districts and joint powers Water Management Organizations (WMO) in Anoka, Carver, Hennepin and Ramsey Counties with tributaries to the Mississippi River

<u>Minnesota River Basin</u>



The Minnesota River Basin has had extensive experience with watershed planning. Basin planning and major watershed planning and implementation has been happening in the Minnesota River Basin since 1992. Much of the oversight of planning activity in the basin comes from the Minnesota River Basin Joint Powers Board (MRBJPB), made up of representatives from the counties covering the entire geographic area of the basin.

Basin level planning activities

- MN River Citizens Advisory Committee Report, Working Together – A Plan to Restore the Minnesota River (1994)
- MPCA, Basin Information Document (completed in 1997)
- MPCA, Basin Plan (scheduled completion in 2001)
- MDNR, Minnesota River Watershed Comprehensive Guidance Document (completed)
- BWSR, Conservation Reserve Enhancement Program (CREP), (completion 2002)
- 13 County Southcentral Water Planning Joint Powers Board

Major watershed level planning activities

- MPCA Clean Water Partnership Projects
  - ➢ Phase I Diagnostic Studies / Implementation Plans
    - * Redwood River watershed (completed)
    - * Yellow Medicine River watershed (completed)
    - * LeSueur River watershed (1999)
    - * Watonwan River watershed (1999)
    - * Blue Earth River watershed (1999)
    - * Chippewa River watershed (2000)
    - * Cottonwood River watershed (2000)
    - * Hawk Creek watershed (2001)
    - * High Island River watershed (in development)
    - * Lac Qui Parle River watershed (in development)
    - * Pomme De Terre River watershed (in development)
  - ➢ Phase II Implementation Projects
    - * Redwood River watershed (2001)
    - * Yellow Medicine River watershed (2006)
- ➢ Upper Minnesota Watershed District Comprehensive Plan update (draft stage)
- ➢ Buffalo Creek Watershed District
- ➢ High Island Watershed District

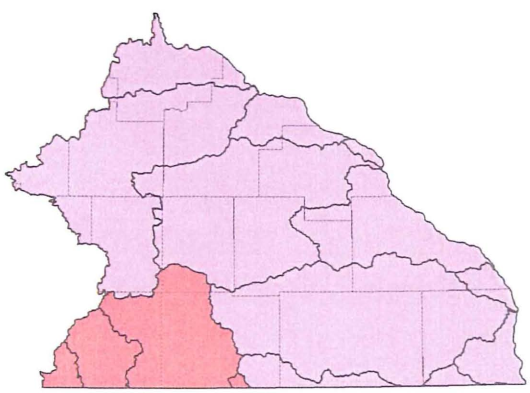
➢ Lac Qui Parle Yellow Bank Watershed District
➢ Yellow medicine River Watershed District

Local & minor watershed planning activities

- ➢ All counties currently have local water plans. Updates scheduled for 5 counties in 2000, 6 in 2001, 5 in 2002, 1 in 2003, 2 in 2005, 1 in 2006, and 4 in 2007
- ➢ Minnesota Department of Health, source water assessments for the surface water supplies for the communities of Fairmont and Mankato
- ➢ Minnesota Department of Health, wellhead protection plans for all public water suppliers
- ➢ 14 watershed districts and joint power WMO's in Carver, Dakota, Hennepin, and Scott counties that are tributary to the Minnesota river

Lower Mississippi River & Cedar River Basins

These river basins are located in southeastern Minnesota and occupy a part of the state with some of the greatest topographic relief. Water planning has been active for many years with its genesis in groundwater protection.



Late in 1999 an ad-hoc group of county, state and federal agency representatives started meeting to discuss the possibility of creating a basin plan for the Lower Mississippi River and Cedar River Basins in southeastern Minnesota. Shortly thereafter, Governor Jesse Ventura launched the Water Management Unification Initiative, as a result of which seven Basin Teams composed of state and federal agency representatives were appointed to assist in the development of the next state water plan. Thus two basin planning groups became established at roughly the same time in the Lower Mississippi and Cedar River Basins, with similar purposes and overlapping membership.

The Basin Team produced a report that was provided to Minnesota Planning - Office of Strategic and Long Range Planning in February 2000 for inclusion in Water Plan 2000. It focused on water quality goals, objectives and indicators for the basin. Water Plan 2000 was published in September 2000.

The ad-hoc basin-planning group contributed to the development of water quality and land use objectives in Water Plan 2000, and since February 2000 has been developing strategies by which these goals and objectives can be accomplished over the next decade. The planning group calls itself the Basin Alliance for the Lower Mississippi in Minnesota (BALMM). It meets monthly and is staffed informally by Mower Soil and Water Conservation District (chair), MPCA (basin coordinator) and BWSR (secretary). Membership includes most of those who belong to the Basin Team, in addition to representatives of many local, state, regional and federal agencies. BALMM is developing strategies for land-use, geographic management and monitoring for a Basin Plan Scoping Document that will be provided to the Basin Team for inclusion in the "Strategies" portion of Water Plan 2000. In addition, they will be further refined and developed by BALMM sub-teams and through interaction with basin citizens and stakeholders to develop a final Basin Plan by December 2003.

Strategies are being developed at the basin scale for use throughout the Lower Mississippi River Basin, with a view to making connections with land use planning activities at both smaller and larger geographic scales. Accordingly, goals and objectives from comprehensive local water plans from counties within the basin were collected, organized, and distributed to BALMM participants to help guide the development of strategies. Similarly, an attempt is being made to relate strategies developed for southeastern Minnesota to those being developed for the larger, 189,000 square mile Upper Mississippi River Basin, defined as the drainage area upstream of Cairo, Illinois, where the Ohio River joins the Mississippi River. Toward this end the Alliance has reviewed the recently published strategy by the Upper Mississippi River Conservation Committee, entitled "A River that Works and A Working River: A Strategy for the Natural Resources of the Upper Mississippi River System." This strategy lists nine objectives for the river system as a whole, which includes the drainage basin as well as the main channel and its floodplain. In particular, improving water quality for all uses (Objective 1), Reduction in erosion and sediment impacts (Objective 2), and Manage channel maintenance and disposal to support ecosystem objectives (Objective 7) are explicitly supported by the BALMM strategies. Other objectives, which deal with particular aspects of managing the Mississippi River and its floodplain, appear to be less directly related to the landuse management activities of local and state government participating in the Alliance.

In addition, the Alliance is keeping abreast of developments concerning hypoxia in the Gulf of Mexico, its relationship to nutrient inputs to the Mississippi River originating in Minnesota, and the "Draft Action Plan for Reducing, Mitigating and Controlling Hypoxia in the Northern Gulf of Mexico" that was developed by the Mississippi River/Gulf of Mexico Nutrient Task Force. Concern about nitrate-nitrogen contamination of ground water is high in southeastern Minnesota's karst region of fractured, porous bedrock. Because of the close interaction between surface water and ground water in karst geology, this concern extends to the trend of steadily increasing concentrations of nitrate-nitrogen in the region's rivers. Reversing this trend is a key water quality goal for the basin that is seen as supporting efforts to reduce nutrient loads to the Gulf of Mexico.

Basin level planning activities

- BALMM, Basin Plan Scoping Document (10/00)
- MPCA, Basin Information Document (scheduled to be completed 2/01)
- MPCA, Basin Plan (scheduled to be completed 12/03)
- SE Minnesota Water Resources Board (nine-county joint powers board)
- SE Minnesota SWCD Technical Support Joint Powers Board (11-SWCD board)
- Hiawatha Valley Resource Conservation and Development Area (11-county JPB)

Major watershed level planning efforts

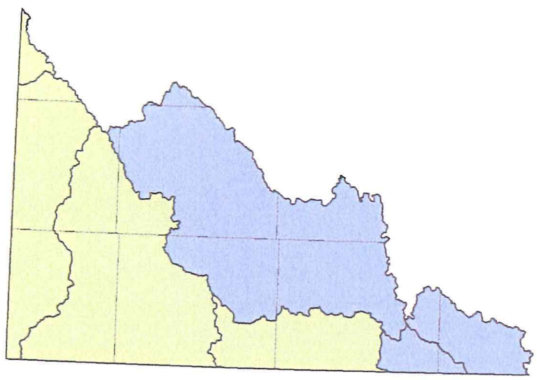
- Cannon River Watershed Partnership and the Cannon River Watershed Joint Powers Board
- Whitewater River Watershed project
- South Zumbro River Watershed project

Local & minor watershed planning activities

- All counties have existing local water plans. Updates are scheduled for 3 in 2000, 1 in 2001, 2 in 2002, 1 in 2003, 4 in 2005, and 1 in 2006.
- Minnesota Department of Health, Wellhead protection plans for the cities of Rushford, Preston and others
- Belle Creek Watershed District
- Bear Valley Watershed District
- Cooks Valley Watershed District
- Stockton-Rollingstone-Minnesota City Watershed District
- Crooked Creek Watershed District
- Turtle Creek Watershed District
- 3 joint powers WMO's in Dakota County which are tributary to the Lower Mississippi River

Opportunities exist in this basin to have counties do water plan updates at the same time as watershed planning efforts due to geographic proximity and the long history of cooperative efforts in this part of the state. MPCA Basin Planning is being closely coordinated with Water Plan 2000 basin planning activities as well as BALMM planning activities.

Missouri River and Des Moines River Basins



The Missouri River and Des Moines River basins are located in southwestern Minnesota. These areas represent very small portions of the Missouri and Des Moines watersheds which extend far beyond the boundaries of Minnesota. One of the major water resource issues facing this part of the state is the lack of abundant good quality groundwater supplies.

Basin level planning activities

- MPCA, Basin Information Document (completion scheduled in 2002)
- MPCA, Basin Plan (completion scheduled in 2003)

Major watershed level planning activities

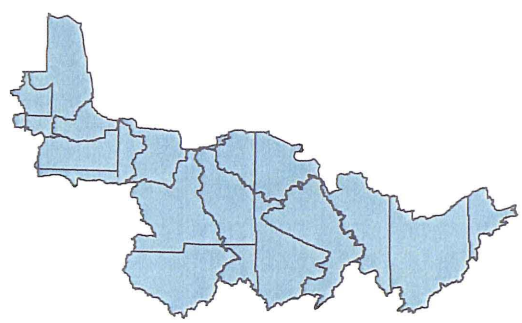
- Heron Lake Watershed District comprehensive plan update
- USGS, Des Moines River hydrologic investigation
- Heron Lake Watershed District
- Kanaranzi-Little Rock Watershed District
- Des Moines River TMDL

Local & minor watershed planning activities

- All counties have existing water plans. Updates are scheduled for 1 in 2002, 1 in 2005, 3 in 2006, and 2 in 2007.
- Heron Lake Watershed District, Heron Lake Clean Water Partnership
- Minnesota Department of Health, Lincoln-Pipestone and Red Rock Rural Water, wellhead protection plans
- Okabena-Ocheda Watershed District

Rainy River Basin

The Rainy River sits on Minnesota's border with Canada and is home to some of the state's finest forest and water resources. Voyageurs National Park and the Boundary Waters Canoe Area Wilderness are located within the Rainy River Basin, as are several of Minnesota's most famous walleye fisheries and many topnotch trout streams. Other prominent uses of natural resources in the basin are forestry, mining and various forms of recreation. Like the Red River Basin, waters from the Rainy River Basin flow north, eventually arriving in Hudson's Bay.



Basin level planning activities

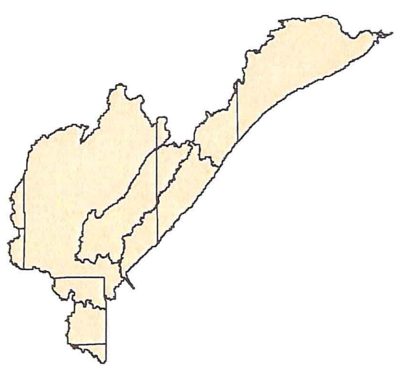
- International Joint Commission (IJC) – Presently considering combining the International Lake of the Woods Board of Water Level Control, International Rainy/Namakan Lake Board of Water Level Control and the International Rainy River Pollution Board into a single body. This would better integrate IJC activities and make it easier for residents and stakeholders to participate in IJC activities in the basin.

- MPCA – Basin Information Document (scheduled completion in 12/01)
- MPCA – Basin Plan (scheduled completion in 1/03)

Local and minor watershed planning activities

- Comprehensive Local Water Plans – Beltrami, Cook, Itasca, Koochiching, Lake, Lake of the Woods, Roseau and St. Louis Counties have existing plans.
- Jessie lakes Clean Water Partnership (Phase I)
- Big Fork River Plan (implementation)
- Little Fork River Plan (implementation)
- Rainy/Rapid River Plan (implementation)
- Voyageurs National Park – General Management plan & Visitor Use and Facilities Plan (draft, 6/00)
- Voyageurs National Park – Water Resources Management Plan (12/01)

Lake Superior Basin



Many issues of concern in the Lake Superior Basin are related to its physical characteristics, settlement patterns, and use of natural resources. Some areas in the southern part of the basin, such as the mouth of the St. Louis River, are living legacies from years of poor waste disposal and destructive natural resource practices. At the other extreme are coastal Lake Superior and the interior parts of the basin. This region contains scores of high quality trout streams, rivers, wetlands, and lakes. Consequently, protection and restoration programs are equally appropriate water resource management approaches.

Basin level planning activities:

Great Lakes Water Quality Agreement (1972)
North Shore Management Plan – (1988)
Lake Superior Basin Information Document – (1997)
Minnesota's Lake Superior Coastal Program – (1999)
Lakewide Area Management Plan – (2000) (Wisconsin, Minnesota, Michigan, and Ontario, Canada)
Inland Waterways Spill Response Atlas – Western Lake Superior Mapping Area (2000)
Lake Superior Coastal Nonpoint Program – (2001)
Lake Superior Basin Plan – (2001)
USEPA Five Year Great Lakes Strategy (Ongoing)

Minnesota's Lake Superior Coastal Nonpoint Pollution Control Program

The national Coastal Nonpoint Pollution Control Program ensures that coastal states have the tools to address polluted runoff. Specifically, this program:

- Establishes a consistent set of management measures for states to use in controlling polluted runoff.
- Focuses on pollution prevention, rather than just dealing with existing water quality problems.
- Encourages efforts at the local level that improve coastal water quality.
- Establishes shared responsibility for managing coastal water quality problems between state coastal management (CZM) and water quality (319) agencies.

Although states and territories participate voluntarily in the Coastal Program, the

Coastal Nonpoint component is required for all approved Coastal Program participants.

In Minnesota, responsibility for managing coastal water quality problems is shared between the DNR (the state's lead coastal management agency, with NOAA as the federal partner) and the MPCA (the state's lead water quality agency, with USEPA as the federal partner).

The Coastal Nonpoint Control Program is an outgrowth of the national Coastal Zone Management (CZM) Program. The CZM Program, which was established by the Coastal Zone Management Act of 1972, as amended, created incentives for coastal states and territories, including the Great Lakes states, to plan and manage their coastal resources. There are 33 approved plans (including Minnesota's), that cover more than 99% of the nation's shoreline. To address polluted runoff, the Coastal Nonpoint Pollution Control Program was created by the Coastal Zone Act Reauthorization Amendments of 1990. Eligible states and territories participate voluntarily in the Coastal Program. Those that choose to do so develop a Coastal Nonpoint Pollution Control Program as part of the process.

The Coastal Nonpoint Program Development Process

Program development involves assessing existing rules, regulations and programs that control nonpoint pollution in Minnesota's Lake Superior Basin. These are identified in a program document that lays out the most pressing coastal nonpoint issues and the tools available to address them. These tools include incentive-based programs and voluntary best management practices, as well as enforceable state authorities. The program document becomes the starting point for program implementation.

Minnesota's Coastal Nonpoint Program will be submitted to USEPA and NOAA in 2001. Program development involves a full range of players who assist in making nonpoint pollution programs effective. The State of Minnesota's position is that its existing enforceable policies and voluntary programs meet the federal guidelines. After program submission, the focus will turn to implementation. After receiving full approval, Minnesota will develop a 15-year program strategy, plus a five-year implementation plan that contains milestones and dates.

Assessing and Implementing Efforts to Control Nonpoint Pollution in the Lake Superior Watershed

The Coastal Nonpoint Program document identifies the environmental assessment and monitoring programs that are currently underway in the basin. Many of these efforts are being conducted by MPCA and other state agencies as part of their statewide efforts. In addition, MPCA is doing additional monitoring in the Lake Superior Basin with funding from Minnesota's Lake Superior Coastal Program. Additional studies, conducted by researchers from the University of Minnesota and the USEPA's Midcontinent Ecology Division in Duluth, have focused on the coastal area, as well. Summaries of these efforts are included in the program document, which is available on MPCA's Web site at: http://www.pca.state.mn.us/water/basins/superior/coastalnp.html.

Under Section 303(d) of the Clean Water Act, Minnesota has identified impaired waters. In 1998, for the Lake Superior Basin, 11 inland lakes and nine Lake Superior tributaries were listed as impaired. Because of this, the program document includes a section entitled "Additional Management Measures," and identifies a process for selecting and implementing additional management measures. The U.S. Congress has defined management measures as "economically achievable measures...which reflect the greatest degree of pollutant-reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods or other alternative."

As soon as Minnesota's Coastal Nonpoint Program has been submitted to NOAA and USEPA, the programmatic focus will shift to implementation, which will be done in conjunction with implementation of the Lake Superior Basin Plan.

Minnesota's Lake Superior Coastal Nonpoint Pollution Control Program is part of both Minnesota's Lake Superior Coastal Program, which is being led by the DNR, and Minnesota's Lake Superior Basin Plan, which is being facilitated by the MPCA (see below).

- The Basin Planning Process:

  The Coastal Nonpoint Pollution Control Program is being developed as part of the Lake Superior Basin Plan during 2001. An implementation strategy for the combined Lake Superior Basin Plan and Coastal Nonpoint Program will be developed during 2002.

  The Lake Superior Basin Plan will consist of recommendations for the protection of threatened waters, restoration strategies for impaired waters, and suggestions for institutional changes that improve regulation, management, and cooperation among agencies. Benefits of the plan include improved efficiency, increased effectiveness, greater consistency and improved public awareness and involvement in management in the basin's water quality resources. Integrating key programs that have been developed will also be part of the process. Programs already under way, such as the Coastal Nonpoint Program and Total Maximum Daily Load Programs, will be incorporated into the basin plan.

  The entire Lake Superior Basin Plan and Coastal Nonpoint Program development process has had a strong public participation component. The Programmatic Work Group (PWG) is an advisory committee that has played a key role in this process from the start. PWG members represent federal, state, county, municipal and tribal agencies and governments that manage ecosystems and land uses in the Lake Superior Basin. Public outreach activities include a Web site, information bulletins, fact sheets, comprehensive U.S. mail and e-mail distribution systems and public meetings.

- Major Watershed Level Planning Activities:

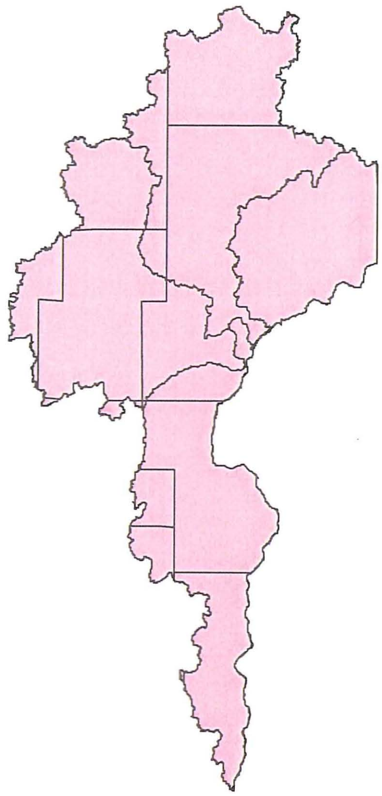
St. Louis River Remedial Action Plan (1992) (Minnesota and Wisconsin)
St. Louis River Management Plan (1994)
Nemadji River Basin Project (1998)
St. Louis River TMDL Watershed Partnership (2000-2015)

- Local and Minor Watershed Planning Activities:

All counties have existing water plans, which will be updated in the coming years: Pine County 2000, St. Louis County 2001, Aitkin County 2001, Carlton County 2001, Lake County 2002, Cook County 2003, and Itasca County 2005

North Shore Sewered Area Land Use Plan (2001)
Duluth Surface Water Assessment (2000)
Duluth Metropolitan Area Streams Snowmelt Runoff Project (2000)
Nonpoint Education for Municipal Officials (NEMO) Watershed Project (2001)
Stormwater Management Plan for Two Harbors (2001)
Stormwater Management Plan for Grand Marais (2001)
Oregon Creek Watershed Project (2001)
Skunk Creek Project (2000)
Midway River Watershed Restoration Project (2002)
Knife River Watershed Project (Ongoing)
Flute Reed River Watershed (Ongoing)
Miller Creek Clean Water Partnership

St. Croix River Basin



The St. Croix River Basin is a large watershed where most of the waters are of good to exceptional quality. So exceptional, in fact, all of the St. Croix River that borders Minnesota is federally designated under the National Wild and Scenic Rivers Act, recognized for its value to the nation as a whole. Some trends monitoring on the St. Croix has shown that the levels of some pollutants are improving. Everyone living, working, or recreating in the St. Croix Basin should be complimented on the improvements, since the water quality of the St. Croix River and all of its tributary streams, lakes, and wetlands is in large part a reflection of the activities of the people who use its land and water. But some contaminants have not been improving or have been increasing in the basin, and even those that show improving trends may not continue to do so under the pressure of increasing population and expanding businesses and recreation.

Basin level planning activities

- Minnesota/Wisconsin Boundary Area Commission
- St. Croix Interagency Water Resources Management Team (created by official agreement among the U.S. National Park Service, the Wisconsin Department of Natural Resources, and the Minnesota Department of Natural Resources and Minnesota Pollution Control Agency)
- MPCA – Basin Information Document (scheduled completion in 2002)
- MPCA – Basin Plan (scheduled completion in 2003)

Local and minor watershed planning activities

- All counties in the basin have an existing water plan.
- Lower St. Croix Planning Task Force
- Valley Branch, Browns Creek, and Carnelian Marine Watershed Districts
- Forest Lake, Sunrise River, Marine on St. Croix, Middle St. Croix River, and Lower St. Croix River Watershed Management Organizations
- Snake River Watershed Management Board

CONCLUSION

The water planning approaches that are being used in the State of Minnesota provides an orderly way of communicating water management goals and objectives between local and state government. The tiered approach recognizes the strengths of both statewide approaches and regional differences and capitalizes on the expertise of individuals at all levels. This is particularly evident in the area of resource assessments. In many instances the people best equipped to assess resource conditions are agency staff at the regional and state level. Utilizing these individuals' expertise to do resource assessments at the watershed level is far more efficient than having each local government doing them on their own.

The framework, in its purest sense allows each level to do what it is best at doing. In general, the different levels of planning result in:

1) **statewide plans**, with broad goals, objectives and indicators;
2) **major watershed plans**, which identify specific pollutants, reduction targets, and problem areas; and
3) **local plans** that are focused on implementation. This framework supports what local government is best at doing - focusing on implementation activities that work toward achieving the specific water-related objectives and standards set for each of the major watershed unit within their jurisdiction.

This framework makes the wisest use of the human resources, fiscal resources, programs, and authorities that exist at each level with the least amount of duplication.

Chapter 4 Overall Strategies for Each Water Resource

Specific Strategies

Chapter 4 consists of four separate strategies, each pertaining to a different water resource. Strategies include information on Nonpoint Source (NPS) issues specific to that water resource and recommended action steps for protection.

4.1 Ground Water Strategy
4.2 Lakes Strategy
4.3 Rivers and Streams Strategy
4.4 Wetlands Strategy

Hydro-modification

Hydro-modification is an issue relating to all four strategies of Chapter 4.

In Minnesota, it's estimated that hydro-modification is the second leading source of pollutants causing impairment of fresh waters. Activities used to assess and moderate impacts from hydro-modification are discussed below.

Projects involving channelization, channel modification, dams, streambanks and shoreline erosion are regulated by various local, state and federal programs in Minnesota. Programs are a combination of both regulatory and nonregulatory approaches to erosion and sediment control and water quality management.

Federal Level

The U.S. Army Corps of Engineers (USCOE), the U.S. Environmental Protection Agency (USEPA), and the U.S. Fish and Wildlife Service (USFWS) are the primary federal agencies involved with water resources protection and regulation in the state of Minnesota. The USCOE administers the 1899 Rivers and Harbors Act (Section 10) and the 1972 Clean Water Act (Section 404) permit programs for projects that affect Minnesota's waters. USEPA oversees the administration of the Clean Water Act (Section 404) and provides comment and oversight to the USCOE on Section 10 and Section 404 permit applications. The USFWS also provides review and comment to the USCOE on projects that will affect Minnesota's water resources. The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP) in Minnesota. Communities that participate in the NFIP must maintain the carrying capacity of altered watercourses to FEMA's satisfaction.

State Level

The primary state agencies involved in the protection and regulation of Minnesota's water resources are the Department of Natural Resources (DNR), Board of Water and Soil Resources (BWSR), Minnesota Pollution Control Agency (MPCA), Department of Agriculture (MDA), and Department of Health (MDH). The DNR administers the Protected Waters Permit Program for activities that will alter the course, current or cross-section of Minnesota's public waters and wetlands, and the Water Appropriation Permit Program for projects appropriating in excess of 10,000 gallons per day or one million gallons per year. Under the Wetland Conservation Act (WCA), BWSR oversees local government units (LGUs), which regulate wetland areas outside of the DNR's jurisdiction. Projects conducted under WCA require mitigation to compensate for wetland losses.

Local Level

At the local level, Soil and Water Conservation Districts (SWCDs), under Minn. Stat. ch. 103C, assist landowners in the implementation of plans to conserve and protect soil and water resources. SWCDs can provide cost-share assistance to landowners for implementing soil and erosion control best management practices and projects.

Counties (under Minn. Stat. ch. 394) and municipalities (under Minn. Stat. 462) have implemented shoreland, floodplain and wetland ordinances, in addition to their own building and zoning codes, to control development and protect the environment. An integral part of all local zoning regulations is the requirement for erosion and sediment control plans for construction and/or land disturbance activities, especially in shoreland district areas. The shoreland district, under local zoning authority, is defined as one thousand feet around lakes, and three hundred feet or the one hundred year flood plain, whichever is greater, for streams and rivers. Under Minn. Stat. 103F, DNR oversees the adoption of local controls and local zoning decisions within shoreland and floodplain areas. The authority for drainage and construction of drainage projects is found in Minn. Stat. ch. 103E.

Communities that have adopted state-approved floodplain management ordinances have provisions in place that maintain the conveyance capacity of altered watercourses as well as the receiving waterbody. Increased flood discharges and/or velocities will not be allowed that increase damages/losses in upstream, adjacent or downstream areas.

Existing regulatory and nonregulatory programs are tied together by Memoranda of Agreement (MOAs). Existing MOAs between the USCOE, DNR, MPCA, MDA, MDH and BWSR ensure coordination between state and federal permitting agencies. New MOAs can be implemented on an as-needed basis in areas that need more coordination.

Most programs administered by LGUs (e.g., shoreland and floodplain zoning, sanitary, septic and water supply, tanks and spills, etc.) have state agency oversight. Permit applicants for work that would alter the course, current or cross-section of protected waters or wetlands must complete the Combined Joint Notification form. This application form is accepted by local, state and federal agencies.

Chapter 4 Overall Strategies for Each Water Resource

4.1 Ground Water

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Introduction

Ground water supplies drinking water to almost 100 percent of the rural population of Minnesota and to 932 of 956 community water supply systems. Concerns over the impacts that land use and improper waste disposal practices have on ground water quality have resulted in broad-based ground water protection laws in Minnesota. The importance of potential ground water contamination through nonpoint source (NPS) activities is currently recognized in several Minnesota laws and programs (e.g., the 1989 Minnesota Ground Water Protection Act and the Clean Water Partnership Program).

Monitoring during the past two decades has indicated widespread contamination by improper management of nonpoint sources. For example, studies conducted by the Minnesota Department of Agriculture (MDA) and the Minnesota Department of Health (MDH) indicate that certain pesticides are present in Minnesota ground water, some in hydrogeologically sensitive areas. The Minnesota Pollution Control Agency (MPCA) and the MDA concluded from examination of nitrate data from over 25,000 Minnesota wells that nitrate contamination of ground water is clearly a problem in many areas of Minnesota.

On a statewide basis, potential NPS activity contributing to ground water contamination include:

1) nutrients and pesticides applied to agricultural fields and to turf;
2) feedlots and manure storage/spreading;
3) uncontrolled urban runoff;
4) construction activities;
5) on-site wastewater disposal systems,
6) illegal dumping;
7) road salt;
8) small generators of organic chemicals or metals in waste products; and
9) storm water retention or infiltration ponds.

At the local level, general awareness and understanding of NPS impacts on ground water is increasing through county level water planning efforts, local ground water protection efforts such as the Clean Water Partnership (CWP) program, and by increased education and outreach programs.

The Ground Water strategy presents:

1) A general review of how goals and action steps from the 1994 Nonpoint Source Management Program Plan (NSMPP) were addressed;

2) The basis for prioritizing NPS activities related to protecting or improving ground water quality;

3) Identification of high priority ground water protection activities needed to manage and minimize NPS pollution and;

4) Direction for coordinating the many agencies and programs associated with NPS ground water issues.

In particular, different levels of government can do a better job of coordinating efforts to 1) prioritize areas needing greater controls over nonpoint sources, and 2) implement nonpoint source control measures. In order to focus limited resources, further improvements to existing activities such as the CWP program, Wellhead Protection Program, and the Minnesota Nitrogen and Pesticide Management Plans are needed. These programs can focus on protecting a particular aquifer or recharge area through land use controls and implementation of best management practices (BMPs).

GENERAL APPROACH TO GROUND WATER ISSUES: CURRENT AND FUTURE

While Minnesota recognizes the critical need for adequate protection and management of all ground water resources in the state, it is clear that some regions of the state are more likely to have contamination problems. Overall, most ground water quality in the state is good at this time, but there are areas where contamination is a problem. Some of the poor quality ground water is contaminated with naturally occurring substances (e.g., iron, manganese, sulfates, radon, or arsenic), but there are also areas where ground water is contaminated through human activity, or is vulnerable to human-caused sources of contamination. Many of the human activities that can cause ground water contamination are considered NPS activities. Protection efforts in the state are already underway, and are steadily increasing. Some of these efforts are described below.

Local Government's Role is Critical

Local governments (county, city, etc.) have crucial roles in ground water protection. This is in part because of their authority to manage land use activity through planning and zoning restrictions, but also because ground water impacts are usually local in scope. Individuals need to understand how their behavior and activities impact their local ground water resources, and protection programs must continue to be developed at the appropriate local level.

The state has developed a number of programs to encourage local protection efforts, including local water planning (county-based comprehensive surface and ground water management in the 80 Greater Minnesota counties, and county-based ground water management in the 7 Metropolitan Area counties). These local plans are designed to be comprehensive in scope and most recognize the importance of managing nonpoint sources of contamination.

In order to assist local government and individuals, most state agencies already recognize that state resources and technical expertise must increasingly be available to local government programs. State assistance needs to be provided in the form of guidelines, technical and financial assistance, and sample regulations to assist local government efforts. Assistance must also be available through expanded and innovative means to fund local efforts, as well as the state programs that support local efforts.

Protection and Management Approaches

There are a number of tools already used to manage ground water protection. They include the following:

Land Use Planning: Land use restrictions are becoming recognized as a major tool for managing some categories of NPS contamination. Strong front-end land use planning, with environmental consideration included, is being increasingly used. Zoning and development restrictions, however, need to increasingly include consideration of the degree of environmental risk before decisions are made. In addition, effective local management tools need to be developed or improved by local governments.

Emphasis on Prevention and Use of a Hierarchy of Strategies: Minnesota recognizes that prevention is the best strategy for ground water quality protection. It is becoming increasingly clear both locally and nationally that ground water contamination is exceedingly difficult and expensive to correct, and sometimes impossible to accomplish. Minnesota's ground water prevention policy is articulated in Minn. Stat. § 103H.001, which states:

"It is the goal of the state that ground water be maintained in its natural condition, free from any degradation caused by human activity. It is recognized that for some human activities this degradation prevention goal cannot be practicably achieved. However, where prevention is practicable, it is intended that it be achieved. Where it is not currently practicable, the development of methods and technology that will make prevention practicable is encouraged."

In practical application, this policy means that:

1) All ground water is protected (not just current and future drinking water supplies);
2) The protection goal is to maintain natural quality where possible, and minimize impacts where not; and
3) Additional protective measures may need to be applied in sensitive areas.

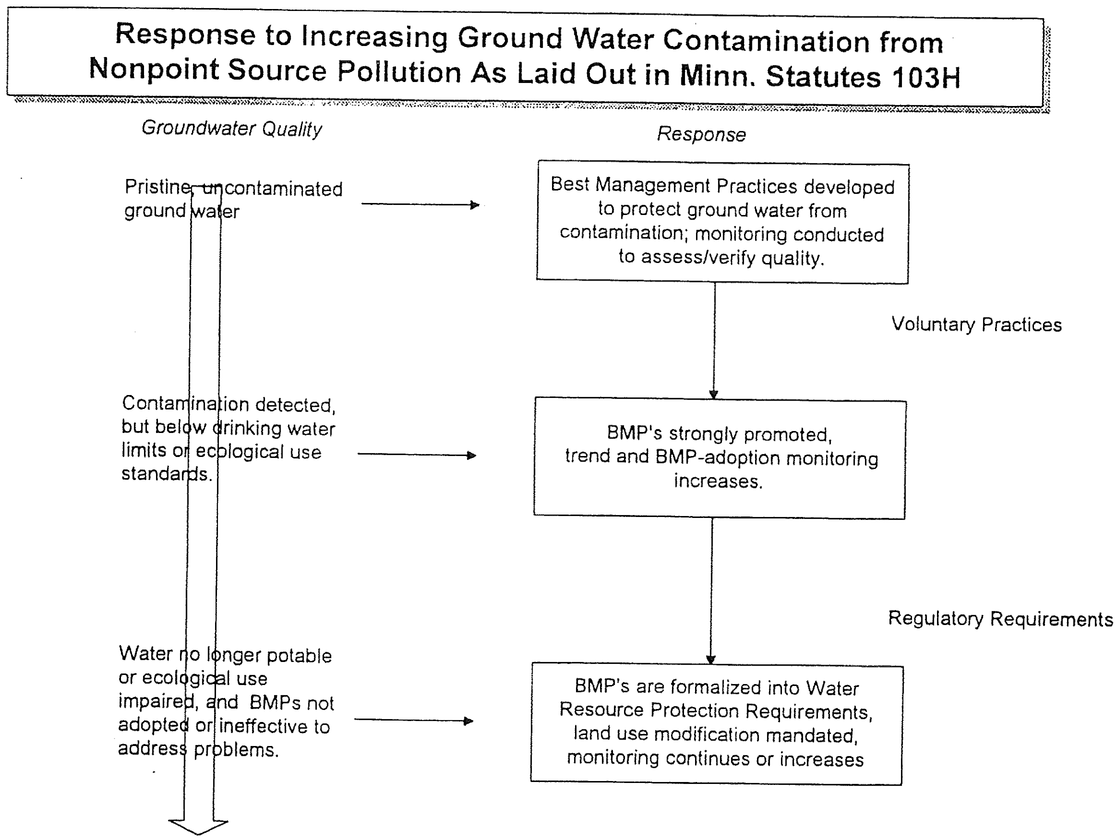
There is an increasing use of prevention-based controls for ground water contamination, including reducing or eliminating potential contaminant releases. A hierarchy of activities has been developed and needs to be expanded. The following description and accompanying diagram (Figure 4.1) describe the hierarchy of activities.

In The Absence Of Contamination: In order to protect existing good quality ground water, a variety of prevention and conservation strategies, including BMPs, are being or have been developed. More will continue to be developed, but it is important that those developed by different parties be consistent, and that all be implemented to the maximum extent possible. Implementation is likely to remain primarily voluntary. It is also imperative that local government is particularly diligent in protecting their currently pristine ground water, since many state efforts are currently directed toward preventing further contamination or remediating already impacted resources.

If Contamination Is Detected: The 1989 Minnesota Ground Water Protection Act describes an escalating level of effort, depending on existing conditions, which must be undertaken by state and/or local agencies if contamination is detected (Minn. Stat. § 103H.275). In order to prevent further contamination and potentially achieve a return to better quality ground water, a *"state agency or political subdivision that regulates an activity causing or potentially causing a contribution to the pollution identified shall promote implementation of BMPs to prevent or minimize the source of pollution to the extent practicable."* These BMPs are designed to be voluntary, so education of the land users is critical.

If Implementation Of The BMPs Is Proven Ineffective: The MPCA (for non-agricultural practices), or the MDA (for agricultural chemicals) may adopt mandatory requirements (called "water resource protection requirements") which are "designed to prevent and minimize the pollution to the extent practicable" and "to

Figure 4.1


Response to Increasing Ground Water Contamination from Nonpoint Source Pollution As Laid Out in Minn. Statutes 103H
Groundwater Quality
Response
Pristine, uncontaminated ground water
Best Management Practices developed to protect ground water from contamination; monitoring conducted to assess/verify quality.
Voluntary Practices
Contamination detected, but below drinking water limits or ecological use standards.
BMP's strongly promoted, trend and BMP-adoption monitoring increases.
Regulatory Requirements
Water no longer potable or ecological use impaired, and BMPs not adopted or ineffective to address problems.
BMP's are formalized into Water Resource Protection Requirements, land use modification mandated, monitoring continues or increases

prevent the pollution from exceeding the health risk limits." The health risk limits (also called HRLs) are drinking water based ground water limits promulgated by the MDH for substances found to be degrading Minnesota's ground water (Minn. Stat. § 103H.201).

A Balance of Regulatory and Nonregulatory Programs: State agencies recognize the need for nonregulatory programs to protect ground water, especially for addressing nonpoint sources of contamination. Regulatory programs are effective for point sources and some aspects of NPS controls, but many nonpoint sources are too diffuse and/or numerous to be easily regulated. A balance is needed between regulatory and nonregulatory approaches, including controlling contamination sources through permitting authorities, performance standards, enforcement and compliance activities, land-use regulations, facility siting restrictions, promotion of BMPs, incentives, educational programs, and promotion of water conservation.

Use Of Direct And Indirect Ground Water Protection Measures: Minnesota's NPS ground water protection efforts include formally adopted measures such as facility standards; ground water protection limits; HRLs; Water Resource Protection Requirements; water quality standards, and where public water supplies are potentially affected, federal Maximum Contaminant Levels. Indirect measures are also needed for their important role in NPS control, and these would include: BMPs, technology standards, conservation, siting criteria and construction standards.

Protection Efforts are Proactive and Long-term: Once water and any contaminants become part of the ground water system, removal of the contaminants can be difficult, if not impossible. Because of these potentially long-term impacts to Minnesota's ground water resources, protection efforts need to be proactive and far-reaching. They need to be based on long-term costs and benefits, not short-term demands and crises. Management needs to anticipate and address problems before widespread degradation occurs.

IDENTIFYING GROUND WATER RESOURCES THAT MAY BE IMPACTED BY NPS CONTAMINATION

The geologic materials comprising aquifers range from unconsolidated sand and gravel deposits to soluble carbonate rock and fractured bedrock. The distribution of these aquifers is not uniform across the state. These diverse geologic settings (along with precipitation gradients across the state and changing soil types and soil depths) influence the quality and quantity of Minnesota's ground water resources.

Identifying Geologically Sensitive Areas - Of particular importance for addressing NPS contamination is knowing where aquifers may be susceptible to contamination from land use practices. With respect to identifying ground water contamination susceptibility, three significant efforts are under way: 1) development of formal criteria for assessing geologic sensitivity and for mapping nitrate contamination of ground water resources, 2) mapping of geologically sensitive areas, and 3) mapping of areas where ground water used for drinking is being impacted by nitrate nitrogen.

The Minnesota Department of Natural Resources (MDNR) prepared criteria for assessing geologic sensitivity that all state agencies must use when addressing ground water contamination (Minn. Stat. ch. 103H). MDNR and Minnesota Geological Survey (MGS) staff provides technical assistance to county staff who is assessing the geologic sensitivity of local aquifers. The MDH convened an interagency advisory group in 1998 to prepare a methodology for mapping nitrate impacts on ground water that used the MDNR sensitivity criteria as a starting point. MDH staff provides technical assistance to county health and environmental staff to: 1) compile databases of nitrate and water well data, and 2) prepare maps showing where ground water used for drinking is being impacted by nitrate nitrogen. This information is available to the general public and MDH is moving ahead to serve it out using an Internet site.

County Geologic Atlases - In 1982, the first county geologic atlas was published by the Minnesota Geological Survey. A county geologic atlas is a systematic study of a county's geologic and ground water resources. Data pertinent to resource issues, including management of NPS contamination, are presented at a design scale of 1/100,000. This level of detail is sufficient to assist with regional planning, but is not sufficient for making site-specific decisions. However, the databases and geological expertise developed during the completion of an atlas can support local decision making.

Among the atlas plates is a map of the geologic sensitivity that is based on criteria developed by the MDNR. From 1989 to 1991 representatives from nine agencies developed criteria and guidelines for assessing geologic sensitivity in an effort to encourage a consistent approach to assessing geologic sensitivity in Minnesota. Geologic sensitivity is based on the potential for surface contamination to reach ground water resources due to the geologic characteristics of the overlying material.

To date, eleven county geologic atlases have been completed, four are nearing completion and a number of other counties are designated as priorities for future completion (see Figure 4.1). In addition, preliminary sensitivity ratings have been conducted for several counties and have been requested by several other counties. Completion of county-scale geologic sensitivity maps and their future update is critical for making land and water-use decisions, including targeting of NPS management activities. Ensuring and accelerating completion is therefore listed below as a priority under Goal 3.

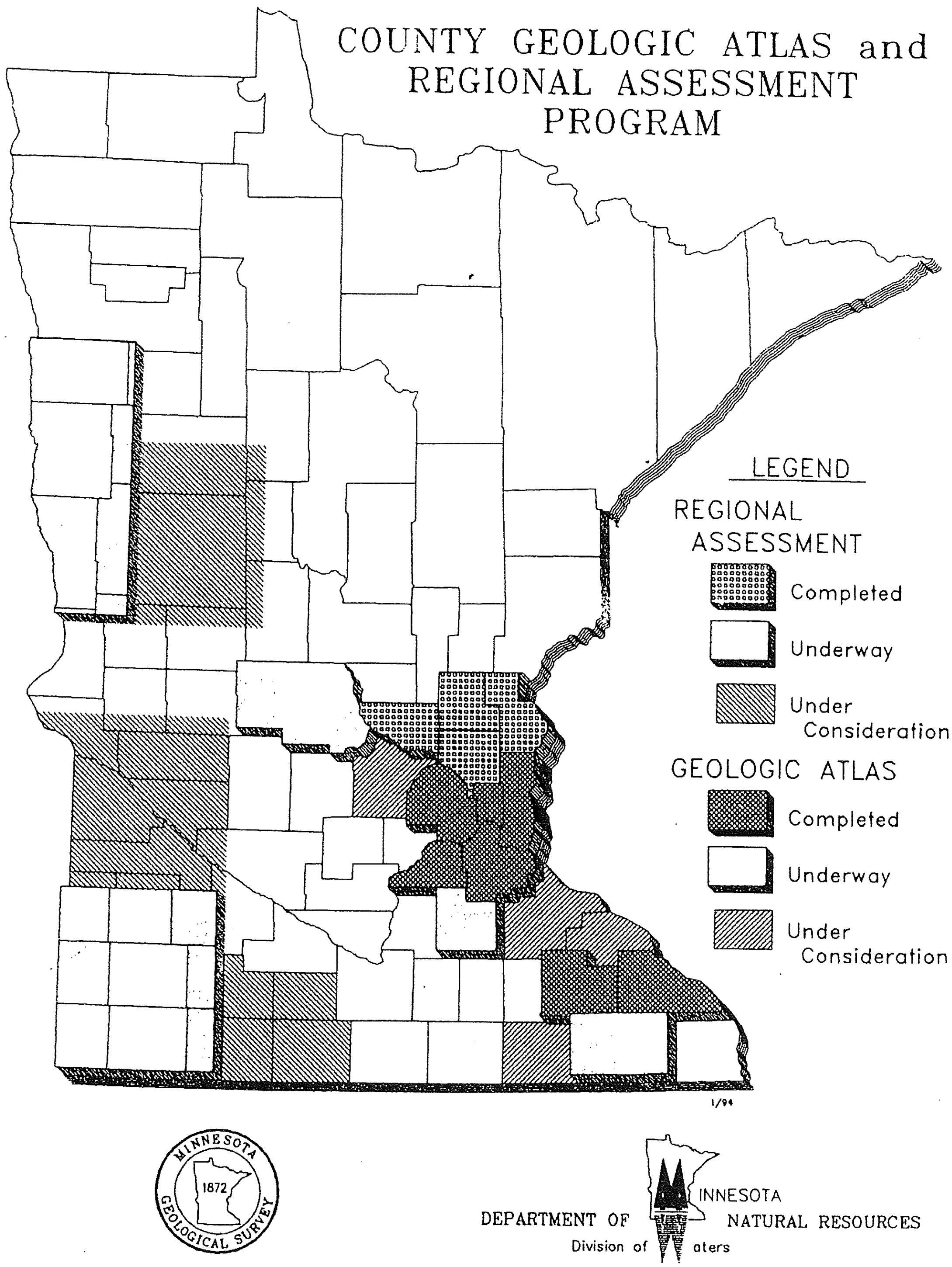
Regional Hydrogeologic Assessment Program - The Regional Hydrogeologic Assessment (RHA) Program complements the Geologic Atlas Program and is implemented through MDNR and MGS. An HRA is a less detailed, reconnaissance overview of near surface geologic and hydrologic conditions of a multiple county area, and includes a geologic sensitivity map. HRA mapping has been completed for the Anoka Sand Plain and the extreme southwestern part of the state. Four other areas are currently being mapped in the western half of the state (see Figure 4.2).

Mapping Nitrate Impacted Ground Water - The efforts noted above evaluate ground water sensitivity to contamination by focusing on the inherent characteristics of the aquifer itself and overlying geologic material (e.g., soil permeability, confining layers, etc.). Mapping of nitrate contamination potential enhances geologic sensitivity mapping by addressing land uses and uses nitrate nitrogen analyses from water wells as a calibration tool. MDH is preparing nitrate probability maps to address federal mandates to assess the vulnerability of public water supply wells. These maps can also be used to: 1) evaluate areas where NPS controls for addressing nitrate contamination should be stressed, and 2) identify areas where long-term monitoring of ground water is needed to determine their effectiveness.

MATCHING NPS CONTROLS TO NEEDS AND ASSESSING RESULTS

The variability of factors including hydrogeologic conditions, land uses, water use, existing NPS controls for protecting ground water, and the level of education regarding NPS impacts on ground water resources dictates that the approach to implementing and assessing NPS controls must be customized on a local basis. Although identifying where ground water resources may be susceptible to NPS contamination is a logical first step, several other factors must be considered when determining how to implement protection or remediation efforts.

Figure 4.2


COUNTY GEOLOGIC ATLAS and
REGIONAL ASSESSMENT
PROGRAM
LEGEND
REGIONAL
ASSESSMENT
Completed
Underway
Under
Consideration
GEOLOGIC ATLAS
Completed
Underway
Under
Consideration
1/94
MINNESOTA
1872
GEOLOGICAL SURVEY
DEPARTMENT OF
INNESOTA
NATURAL RESOURCES
Division of
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Prioritize Resources To Meet State-Wide Needs - It is anticipated that the resources available to implement NPS controls for protecting susceptible ground water resources will not be sufficient to meet local and state needs for 2001 - 2005. Therefore, criteria need to be developed for funding agencies to prioritize: 1) geographical areas for implementing NPS controls, 2) basic research needed to understand ground water resources and the effectiveness of NPS management measures, 3) education and outreach efforts that effectively communicate with land owners, and 4) data management efforts that will provide needed information in a reliable and cost effective manner. Developing such criteria is a high priority task that needs to be addressed early in the 2001 – 2005 Needs, Priorities and Milestones Action Steps table.

Evaluate The Effectiveness Of Existing NPS Controls To Meet Local Ground Water Protection Needs – Management practices have been developed that are often broad based and may not be an exact match for local geologic, soils, and land use conditions. It is very important to determine the technical merits of existing NPS controls so that: 1) resources are not wasted implementing ineffective NPS controls, 2) modifications to existing controls are made to meet local needs, and 3) realistic expectations over specific NPS control measures can be integrated into local and state NPS strategies for protecting ground water resources.

Increase Monitoring To Ensure That NPS Control Measures Are Having A Positive Impact On Protecting Or Remediating Susceptible Ground Water Resources - Monitoring the effectiveness of NPS control measures is essential to determining their worth. For example, the MESA studies conducted by the USGS indicate that BMPs were not effective in controlling nitrate nitrogen loading of ground water to levels below drinking water standards.

It is not a wise use of resources to promote the implementation of NPS controls without monitoring: 1) the degree to which land owners are implementing them, 2) long-term changes in ground water quality, and 3) the degree to which specific control measures are actually implemented. Monitoring is often viewed as a luxury but is as critical to ground water resources protection as implementing NPS control measures.

Support Research Needed To Understand The Impacts That NPS Contamination Have On Susceptible Ground Water Resources - It is not possible to adequately protect a resource that you do not understand. Funding must be made available to collect the basic information needed to understand local ground water resources and the impacts of NPS contamination on ground water quality. Also, resources must be available to integrate basic research to everyday applications once it's been proven effective.

Develop And Maintain Easily Accessible Data Systems - Many of the basic data management techniques have been developed to store ground water resource data and to track implementation of NPS controls. However, additional funding is needed to: 1) enter data, 2) make it accessible on the Internet, 3) integrate it with other state and local agency databases, 4) educate agency staff and the public regarding the uses and limitations of specific types of data, and 5) evaluate the cost effectiveness of data collection and storage methods. Criteria need to be developed to set standards for collecting data related to implementing NPS controls and tracking their effectiveness. This should receive a high priority and needs to be addressed early in the 2001 - 2005 Needs, Priorities and Milestones Action Steps table.

REVIEWING PROGRESS ACHIEVED FROM 1994 NSMPP

A great deal of effort was directed toward addressing NPS impacts on susceptible ground water resources during the past six years. The number of projects and the cooperation between federal, state, and local agencies on a wide variety of topical areas indicates the level of interest and dedication to protecting Minnesota's ground water resources (Figure 4.1). In addition to 319 funds from the federal Clean Water Act, support for these efforts came from local, state, and federal budgets. More detailed explanation about each effort can be obtained by contacting the lead agencies listed.

NEEDS, PRIORITIES, AND ACTION STEPS FOR 2001 - 2005

The five-year Action Plan provided below summarizes the goals and milestones which have been identified in the preceding sections. The work group felt that all of the following goals and action steps are needed to address NPS contamination of the state's ground water resources. Therefore, there is no priority given to the order in which they appear in this report. Projects being considered for Section 319 funding should be ranked by the number of action steps under this section that are included. It must be emphasized that many of the milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Goal 1: Continue the Coordination of NPS Activities with Existing and Planned Ground Water Protection Efforts in the State.

There was a great deal of progress achieved over the past six years regarding coordination between federal, state, and local agencies. New efforts for controlling NPS contamination came on line, such as the Environmental Quality Incentives Program and the Minnesota Pesticide Management Plan. Existing efforts such as the Clean Water Partnership (CWP) program and county level water planning expanded their roles to more closely address local NPS impacts on ground water resources. The Project Coordination Team chaired by the Minnesota Pollution Control Agency provided a means to focus inter-agency cooperation.

Although much progress has been achieved, there is still a need to improve inter-agency cooperation and understanding of each other's efforts. The NPS plan provides a mechanism to help ensure that this occurs and was a significant factor in the progress achieved over the previous six years. It cannot be overstated that ground water protection efforts are directly tied to NPS activities. These include the NPS Management Program, the Nitrogen Fertilizer Management Plan, the Pesticide Management Plan, and the CWP program. All of these programs need to be coordinated with each other, as well as with other more indirectly related programs occurring in the state. Some of those other efforts include the Comprehensive State Ground Water Protection Program, Wellhead Protection and Source Water Assessment programs, and basic research programs conducted by MDNR, MGS, and the U.S. Geological Survey. It is critical that efforts be consistent and coordinated to the extent possible.

In addition to coordination of programs that address different segments of the NPS spectrum, coordination is needed between government and non-government efforts. Although some coordination already exists, more partnerships must be formed to foster cooperation not only among all levels of government, but also with universities, the nonprofit sector, interest groups, industry, and business.

It is important to recognize the differences between NPS management efforts that are designed to protect surface waters and those which are designed to protect ground water because cross-media contamination needs to be prevented. Currently, some practices designed to minimize contamination of surface water may increase ground water contamination and vice versa. This needs to be recognized and prevented. Provisions need to be in place and implemented across programs to avoid cross-media contamination during management activities.

Action Steps

1) Integrate NPS control efforts with basin planning carried out under provisions of the federal Clean Water Act and the State Water Plan.

2) Integrate NPS related ground water protection efforts with county level water planning activities

3) Develop statewide priorities for funding NPS controls that are directed towards protecting or improving the quality of the state's most vulnerable ground water resources.

4) Ensure that NPS efforts to protect vulnerable ground water resources used for drinking water are reflected in wellhead protection plans prepared under the state's wellhead protection rules.

5) Develop technical criteria for evaluating the effectiveness of NPS controls directed towards protecting or improving the quality of the state's ground water resources.

6) Review the adequacy of local, state, and federal legal authorities and capabilities to implement NPS controls related to ground water protection or remediation efforts.

7) Integrate the implementation of NPS controls with federal, state, and local permitting and environmental review efforts.

Goal 2: Promote Education and Outreach Efforts for Implementing NPS Controls that Protect Ground Water Resources.

Involvement by Minnesota's citizens is vital to effective ground water protection and management efforts. However, because neither ground water nor the impacts to it can be easily observed, most citizens do not understand how ground water functions or how easily it can be impacted by their individual activities. Public education efforts must 1) help citizens understand how their individual behaviors and activities impact their local ground water resources, and 2) provide the information regarding management of those practices and activities which cause contamination.

There is a growing trend to focus educational efforts addressing NPS contamination of ground water resources on individuals. For example the FANMAP program implemented by the Minnesota Department of Agriculture provides individual analyses of farming practices for landowners. Nitrate clinics sponsored by counties and the Minnesota Department of Agriculture helps well owners recognize the degree to which local aquifers may be impacted by nitrate contamination. Children's ground water festivals provide an excellent opportunity for school age children to learn about NPS impacts on ground water and to take this knowledge back to their parents. Local wellhead protection teams learn from local and state staff about options for managing NPS sources that may impact community water supply wells. Internet sites such as those of the Minnesota Department of Natural Resources and the USGS provide a wealth of information about ground water resources that the public can easily access.

Although a great deal has been accomplished by a variety of education and outreach efforts over the previous six years, much more can be done. The following action steps focus on aspects of education and outreach that have not been adequately addressed to date.

Action Steps

1) Identify NPS controls and associated educational delivery mechanisms for specific audiences that are most cost effective for protecting or improving ground water quality.

2) Establish education and outreach approaches for specific audiences that are geared toward the NPS control needs identified by basin planning efforts.

3) Develop a statewide bibliography of educational materials and technical expertise that can be used at state and local levels to address NPS related ground water contamination.

4) Require that an evaluation of education and outreach efforts be incorporated into reporting how effective federal and state funding has been in implementing NPS controls.

5) Establish priorities for funding education and outreach efforts for controlling NPS impacts on the state's vulnerable ground water resources.

6) Encourage the participation of the widest possible range in special interest groups in developing approaches to implementing education and outreach efforts related to protecting vulnerable ground water resources.

7) Ensure that adequate delivery systems for disseminating information regarding the effectiveness of NPS controls are made available to local governments and to the general public.

Goal 3: Continue Identification of Geologically Sensitive Areas to Help Prioritize Protection Efforts Where Ground Water Resources are Most Susceptible to NPS Contamination.

The state has made substantial progress in mapping geologically sensitive areas since 1994, but many counties do not have sensitivity maps and regional hydrologic assessments that provide the detail for making countywide land and water-management decisions. Also, older county sensitivity maps need to be revised because new subsurface geological information is now available. Furthermore, knowledge regarding the composition and distribution of glacial deposits has steadily increased since 1994 and needs to be incorporated into assessing the effectiveness of best management practices. The availability of geologic sensitivity maps is an essential element of overall efforts to implement effective NPS controls for protecting the state's ground water resources.

Action Steps

1) Support basic research needed to identify areas where ground water resources are susceptible to NPS contamination.

2) Develop statewide criteria and a formal technical review process at the state level for identifying ground water resources that are susceptible to NPS contamination.

3) Identify priority areas for funding efforts to identify and map ground water resources that are susceptible to NPS contamination.

4) Establish a web site where the public can access information describing susceptible ground water areas.

5) Ensure that existing designations of susceptible areas are updated and refined as new information or techniques for mapping these areas become available.

6) Establish statewide criteria for identifying priority areas within susceptible areas where public health concerns will be most readily addressed through implementation of NPS controls.

Goal 4: Focus Resources on Areas Where Ground Water Protection Efforts Relating to NPS Contamination are Most Worthwhile.

Minnesota must expand prevention-based control of potential sources of ground water contamination, including reducing or eliminating potential environmental releases that may adversely impact ground water quality and increasing the use of BMPs. It is also important to recognize that current state law (Minn. Stat. ch. 103H) emphasizes state action where contamination is already known to occur.

Action Steps

1) Develop criteria for determining the merits of funding requests for implementing NPS controls related to ground water protection.

2) Ensure that state and federal agencies coordinate efforts to review and fund requests to implement NPS controls for protecting or improving ground water quality.

3) Develop criteria for identifying the types of NPS contamination that present the greatest threats to susceptible ground water resources at regional or county levels.

4) Integrate the results of mapping susceptible areas with allocating resources for implementing NPS controls for protecting or improving ground water quality.

Goal 5: Identify NPS Contamination Sources that are Not Being Adequately Addressed by Local, State, or Federal Efforts.

Because of the high cost and/or impossibility of ground water cleanup, protection and management needs must be anticipated and problems addressed before widespread degradation occurs. Efforts need to be developed to control sources of ground water contamination which are not addressed by 1) federal statute or regulations or 2) implementation of management controls such as best management practices.

For example, the effects that agricultural irrigation on ground water quality has not been adequately determined in all geologic settings, nor has the effectiveness of some best management practices for certain irrigated crops been established. The interconnection between surface water and ground water in some irrigated areas may result in potential negative impacts of agricultural irrigation being transferred from surface water to ground water and vice-versa.

Action Steps

1) Establish a mechanism for formal identification of NPS contamination sources that are not being adequately addressed.

2) Develop statewide criteria for evaluating whether a potential NPS contamination source or contaminant is not being adequately addressed.

3) Identify the parties responsible for developing NPS control measures or for implementing these measures to adequately address NPS contamination.

4) Integrate improperly addressed NPS contamination into setting statewide priorities for implementing NPS controls.

Goal 6: Promote Hydrologic Unit-Based Management where it Provides a Mechanism for Effectively Addressing NPS Contamination of Ground Water Resources.

Because actions at one site can locally affect a large part of an aquifer, aquifers and their recharge areas must be managed and protected as hydrologic units. Maps depicting several types of hydrologic units have been prepared and need to be assessed for their applicability in implementing NPS controls for protecting ground water resources.

Action Steps

1) Evaluate various approaches to designating hydrologic units to determine which make the most sense relative to: 1) evaluating NPS impacts on ground water resources, and 2) implementing effective NPS control measures.

2) Ensure that hydrologic unit-based management for controlling NPS impacts on ground water is integrated into basin and county level water planning efforts.

3) Identify hydrologic unit-based management areas that have the highest priority for receiving funding to implement appropriate NPS controls.

Goal 7: Assist Local Governments with Developing and Implementing Ground Water Protection Programs.

Participation by local governments is essential to achieving comprehensive implementation of NPS controls for protecting ground water. For example, as the state Wellhead Protection Program rule is promulgated by the MDH, local governments will need assistance with developing effective local programs. In addition to needing management tools, jurisdictional issues are likely to be a significant obstacle to public water supply managers who find that they have no authority to control land use around their wells (e.g., municipalities whose wells are located outside of city limits). Development of source management tools and model ordinances are needed to assist these local efforts, and address multi-jurisdictional issues. Many of the contaminant source management tools developed for use in wellhead protection areas can also be used to protect ground water resources elsewhere.

Action Steps

1) Recognize and support basin and county level water planning efforts to identify priority areas for implementing NPS controls that coincide with state criteria for defining these areas.

2) Recognize state approved wellhead protection plans that utilize NPS controls for protecting susceptible ground water resources used for drinking water.

3) Promote local implementation of NPS controls in areas where ground water resources are designated susceptible to NPS contamination.

4) Assist local governments with developing databases needed to track the effectiveness of NPS controls for protecting or improving ground water quality.

Goal 8: Implement Management Strategies for Controlling NPS Impacts on Ground Water.

The state needs to increase its emphasis and rate of progress on preventing impacts from pesticides and fertilizers, not only those used in agricultural practices but also those applied in residential lawn and gardens. One of the major tools used to prevent degradation of water quality from pesticide and fertilizer use is the use of BMPs. BMPs need to be written to protect both surface water and ground water from the impacts of these chemicals. (Also see Chapters 9 and 10 on Nutrient Management and Agricultural Pesticides.)

Action Steps

1) Ensure timely and impartial review of management strategies to ensure they are effective in minimizing NPS impacts on the state's ground water resources.

2) Develop effective NPS control measures that reflect the state's diversity in climatic, land use, ground water use, soils, and hydrogeologic conditions.

3) Ensure that state or federal funding reflects state criteria for priority setting and the technical merits of implementing these strategies.

4) Ensure accountability by anyone receiving funding to implement NPS strategies for addressing NPS impacts on ground water resources.

Goal 9: Define Measurable Objectives for Controlling NPS Impacts on Ground Water and Conduct Adequate Monitoring to Assess Results.

Programs aimed at prevention, control, and remediation of NPS contamination must have measurable objectives in order to monitor program success or failure. Monitoring needs to include appropriate ground water quality monitoring and, especially in the cases of voluntary management efforts, assessing the degree and extent of implementation of the management tools (i.e., implementation of BMPs). (Also see Chapter 5, Monitoring and Assessment.) Monitoring protocols need to ensure the long-term nature of response to BMPs and whether conditions are accounted for when monitoring success or failure of BMPs.

Action Steps

1) Develop statewide criteria for evaluating the impacts of NPS controls related to ground water protection.

2) Develop standards for determining the suitability of NPS controls relating to local hydrogeologic conditions.

3) Establish an interagency advisory group to provide guidance to local groups regarding the most effective NPS controls for addressing local ground water quality concerns.

4) Identify priority areas for allocating resources to implement NPS controls for protecting the state's ground water resources.

Goal 10: Provide Information Needed to Effectively Implement NPS Controls for Protecting or Remediating Susceptible Ground Water Resources.

Providing the information needed to understand the impacts that NPS contamination has on ground water quality is an important step in obtaining local acceptance for implementing controls. Also, data must be readily available to demonstrate the long-term benefits of implementing controls for decision-makers to support control efforts. Several significant trends in managing data have occurred since 1994 that must be recognized. First, individual computers now provide the storage and retrieval capabilities that large main frame computers had a decade ago. Second, the Internet provides a mechanism for anyone to access a variety of data sources without the need for a central clearinghouse. Third, geographic information system software has advanced to the point where the average person can combine spatially oriented data to meet individual needs. All of these advances in data management need to be considered when developing a strategy for managing data related to managing NPS contamination that may impact ground water.

Action Steps

1) Develop criteria for storing and sharing data generated by NPS-related projects funded using public money.

2) Establish a data standards group that reviews funding requests to ensure that data storage and sharing standards will be adequately addressed.

3) Identify existing data management systems and databases that can serve to store ground water data needed to support the implementation of NPS control measures. New data management systems and databases should be supported only if existing systems and databases are deemed inadequate by the data standards group.

Chapter 4 Overall Strategy for Each Water Resource
Strategy 4.1 Ground Water
Needs, Priorities and Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) 5-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Goal 1: Continue the Coordination of NPS Activities with Existing and Planned Ground Water Protection Efforts in the State.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Integrate NPS control efforts to protect ground water with basin planning carried out under provisions of the federal Clean Water Act and State Water Plan.	X	X	X	X		319, State, Safe Drinking Water Act	MPCA
2. Integrate NPS related ground water protection efforts with county level water planning activities.	X	X	X	X		319, State, local	BWSR
3. Develop statewide priorities for funding NPS controls directed towards protecting or improving the quality of the state's most vulnerable ground water resources.		X	X			319, State, Safe Drinking Water Act	MPCA
4. Ensure that NPS efforts to protect vulnerable ground water resources used for drinking water are reflected in wellhead protection plans prepared under the state wellhead protection rule	X	X	X	X	X	319, State, Safe Drinking Water Act	MDH
5. Develop technical criteria for evaluating the effectiveness of NPS controls directed towards protecting or improving the quality of the state's ground water resources.		X	X			319, State	MPCA, MDA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
6. Review the adequacy of local, state, and federal legal authorities and capabilities to implement NPS controls directed towards protecting or improving the quality of the state's ground water resources.			X	X	X	319, State, Local	EQB
7. Integrate implementation of NPS controls with federal, state, and local permitting and environmental review efforts.	X	X	X	X	X	319, State, Federal, Local	MPCA

Goal 2: Promote Education and Outreach Efforts for Implementing NPS Controls that Protect Ground Water Resources.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Identify NPS controls and associated educational delivery mechanisms for specific audiences that are most cost effective for protecting or improving ground water quality.			X	X	X	319, State, Federal	MPCA
2. Establish education and outreach approaches for specific audiences that are geared toward NPS control needs identified in basin planning efforts	X	X	X	X	X	319, State	MPCA
3. Develop a statewide bibliography of educational materials and technical expertise that can be used at state and local levels to address NPS related ground water contamination.		X	X	X		319, State	MES

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
4. Require that an evaluation of education and outreach efforts be incorporated into reporting how effective federal and state funding has been in implementing NPS controls		X	X	X	X	319, Other parts of the Clean Water Act, Safe Drinking Water Act, State	MPCA, EPA
5. Establish priorities for funding education and outreach efforts for controlling NPS impacts on the state's vulnerable ground water resources	X	X	X			319, State	Project Coordination Team, MPCA
6. Encourage participation of the widest range of special interest groups in developing approaches to implementing education and outreach efforts related to protecting vulnerable ground water resources.	X	X	X	X	X	State	MPCA
7. Ensure that adequate delivery systems for disseminating information regarding the effectiveness of NPS controls are made available to local governments and the general public.		X	X	X	X	319, State	MES

Goal 3: Continue Identification of Geologically Sensitive Areas to Help Prioritize Efforts on Areas Where Ground Water Resources are Most Susceptible to NPS Contamination.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Support basic research needed to identify where ground water resources are susceptible to NPS contamination.	X	X	X	X	X	319, Federal, State, Local, Private	Project Coordination Team, MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
2. Develop statewide criteria and a formal technical review process at the state level for identifying ground water resources that are susceptible to NPS contamination.		X	X			319, Safe Drinking Water Act, Federal, State	DNR
3. Identify priority areas for funding efforts to identify and map ground water resources that are susceptible to NPS contamination.		X	X			319, State	DNR
4. Establish a web site where the public can access information describing susceptible ground water areas.		X	X			319, State	DNR, MGS
5. Ensure that existing designations of susceptible areas are updated and refined as new information or techniques for mapping these areas become available.	X	X	X	X	X	319, State, Federal, Local	DNR, MGS
6. Establish statewide criteria for identifying priority areas within susceptible areas where public health concerns will be most readily addressed through implementation of NPS controls.		X	X			319, Safe Drinking Water Act, State	MDH

Goal 4: Focus Resources on Areas Where Ground Water Protection Efforts Relating to NPS Contamination Are Most Worthwhile.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop criteria for determining the merits of funding requests for implementing NPS controls related to ground water protection.		X	X	X		State	Project Coordination Team, MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
2. Ensure that state and federal agencies coordinate efforts to review and fund requests to implement NPS controls for protecting ground water quality.	X	X	X	X	X	319, State, Federal	Project Coordination Team, MPCA
3. Develop criteria for identifying the types of NPS contamination that present the greatest threats to susceptible ground water resources at regional and county levels.		X	X			319, State, Federal	MPCA, MDA
4. Integrate the results of mapping susceptible areas with allocating resources for implementing NPS controls for protecting or improving ground water quality.	X	X	X	X	X	319, Federal, State, Local	All agencies

Goal 5: Identify NPS Contamination Sources That are Not Being Adequately Addressed by Local, State, or Federal Efforts.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Establish a mechanism for formal identification of NPS contamination sources that are not being adequately addressed.		X	X			319, State	MPCA
2. Develop statewide criteria for evaluating whether a potential NPS contamination source or contaminant is not being adequately addressed			X	X		319, State	MPCA, MDA
3. Identify the parties responsible for developing NPS control measures or for implementing these measures to adequately address NPS contamination.			X	X		319, State, Federal	MPCA, MDA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
4. Integrate improperly addressed NPS contamination into setting statewide priorities for implementing NPS controls.				X	X	319, State, Federal	MPCA, MDA

Goal 6: Promote Hydrologic Unit-Based Management Where it Provides a Mechanism for Effectively Addressing NPS Contamination of Ground Water Resources.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Evaluate various approaches to designating hydrologic units to determine which make the most sense relative to 1) evaluating NPS impacts on ground water resources and 2) implementing effective NPS control measures.		X	X			319, State, Federal	MES
2. Ensure that hydrologic unit-based management for controlling NPS impacts on ground water is integrated into basin and county-level water planning efforts.		X	X	X	X	319, State, Federal, Local	MPCA, BWSR
3. Identify hydrologic unit-based management areas that have the highest priority for receiving funding to implement appropriate NPS controls.				X	X	319, Federal, State	Project Coordination Team, MPCA

Goal 7: Assist Local Governments with Developing and Implementing Ground Water Protection Programs.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Recognize and support basin and county level water planning efforts to identify priority areas for implementing NPS controls that coincide with state criteria for defining these areas.			X	X	X	319, State, Federal	MPCA, BWSR
2. Recognize state approved wellhead protection plans that utilize NPS controls for protecting susceptible ground water resources used for drinking.	X	X	X	X	X	319, Safe Drinking Water Act, State, Federal, Local	MDH
3. Promote local implementation of NPS controls in areas where ground water resources are designated susceptible to NPS contamination.	X	X	X	X	X	319, Federal, State	Project Coordination Team, MPCA
4. Assist local governments with developing databases needed to track the effectiveness of NPS controls for protecting or improving ground water quality.	X	X	X	X	X	319, Federal, State, Local	Project Coordination Team, MPCA

Goal 8: Implement Management Strategies for Controlling NPS Impacts on Ground Water.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Ensure timely and impartial review of management strategies to ensure they are effective in minimizing NPS impacts on the state's ground water resources.	X	X	X	X	X	319, Federal, State, Local	All agencies
2. Develop effective NPS control measures that reflect the state's diversity in climatic, land use, ground water use, soils, and hydrogeologic conditions.	X	X	X	X	X	319, Federal, State, Local	All agencies

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
3. Ensure that state or federal funding reflects state criteria for priority setting and technical merits for implementing these strategies.	X	X	X	X	X	319, Federal, State, Local	All agencies
4. Ensure accountability by anyone receiving funding to implement NPS strategies for addressing NPS impacts on ground water resources.	X	X	X	X	X	All funding sources	All agencies, but for 319 grants – MPCA

Goal 9: Define Measurable Objectives for Controlling NPS Impacts on Ground Water and Conduct Adequate Monitoring to Assess Results.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop statewide criteria for evaluating the impacts of NPS controls related to ground water protection.		X		X		319, State, Federal	MPCA
2. Develop standards for determining the suitability of NPS controls relating to local hydrogeologic conditions.		X		X		319, State, Federal, Local	MPCA, MDA
3. Establish and interagency advisory group to provide guidance to local groups regarding the most effective NPS controls for addressing local ground water quality concerns.		X	X	X	X	319, Federal, State	Project Coordination Team, MPCA
4. Identify priority areas for allocating resources to implement NPS controls for protecting the state's ground water resources.		X		X		319, Federal, State	Project Coordination Team, MPCA

Goal 10: Provide Information Needed to Effectively Implement NPS Controls for Protecting or Remediating Susceptible Ground Water Resources.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop criteria for storing and sharing data generated by NPS-related projects funded using public money.	X	X				319, State	MPCA
2. Establish a data standards group that reviews funding requests to ensure that data storage and sharing standards will be adequately addressed.		X				State	MPCA
3. Convene data standards group to review funding requests.			X	X	X	319, State	MPCA
4. Identify existing data management systems and databases that can serve to support the implementation of NPS control measures.		X	X	X	X	319, Federal, State	Project Coordination Team/MPCA

1994 NSMPP
Needs, Priorities and Milestones

The following Table provides the Goals and Action Steps included in the 1994 Nonpoint Source Management Program Plan (NSMPP). The Products, Services and Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps. Implementation of all action steps is contingent upon adequate funding and local involvement.

Goal 1: Expand Coordination of NPS Activities with Existing and Planned Ground Water Protection Efforts in the State.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Upper Mississippi Source Water Initiative.	State/Local	Cities of Minneapolis, St. Cloud, St. Paul	Coordination of efforts to protect public water supplies though out the Upper Mississippi River Basin.
2. Integrate management of non-point sources of contamination into local wellhead protection plans.	Federal/State/ Local, 319	Minnesota Department of Health	Management strategies for non-point sources in wellhead protection areas.
3. CRP set-aside priorities for wellhead protection areas.	Federal	Natural Resource Conservation Service	Reduce nutrient to vulnerable aquifer in wellhead protection areas.
4. Address agricultural and storm water drainage wells.	State	Minnesota Pollution Control Agency/Minnesota Dept. Health/Counties	Seal illegal drainage wells part of the 90,554 wells sealed from 1994 – 2000.
5. Studies of NPS impacts on groundwater based on land uses.	Federal and State, 319	USGS and Minnesota Pollution Control Agency	3 NAWQA studies, land use in Twin Cites and St. Cloud areas.
6. Storm Water Retention Manual.	Federal and State	Minnesota Pollution Control Agency	Published document (web accessible).

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
7.	Coordination of Permitting Groundwater Appropriations with Water Quality Concerns.	State	Minnesota Department of Natural Resources, local Soil and Water Conservation Districts	Quality concerns affected permitting decisions for about 300 permits annually with 5 permits annually forwarded to MDA for review.
8.	Efforts to seal unused wells on state property.	State	Minnesota Department of Natural Resources Minnesota Department of Transportation	Sealing of 750 wells according to State Well Code standards. As many as 400 still remain to be sealed.

Goal 2: Expand and Coordinate Education on Ground Water Protection and on Impacts Caused by Individual Land Use Choices and Actions.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1.	Children's Water Festivals.	Federal/State/ Local/Private	Counties	8 forums for children to learn about water resource and how to protect them.
2.	Use of Internet Sites.	Federal/State/ Local/Private	Varied	Provide free and easy access to educational materials.
3.	Nitrate Clinics.	State, 319	Minnesota Department of Agriculture and Counties	528 clinics that provided free nitrate testing of private well water to create awareness of non-point impacts on groundwater quality.
4.	Minnesota Water Forums.	Conference registration	University of Minnesota and sponsors	2 forums to present research, study results and finding, and discuss water resource protection issues.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
5.	Preparation and distribution of fact sheets, educational materials, groundwater models, demonstration projects.	Federal and State, 319	Federal and state agencies	Fact sheets regarding study results and general information regarding NPS contamination.
6.	USDA - EQIP: Educational demonstrations of Ag. Nutrient BMPs in wellhead protection areas.	Federal/ State/Local	Minnesota Department of Agriculture Natural Resources Conservation Service	Educational workshops, demonstration sites to show BMP effectiveness. Technical assistance
7.	Phase II Clean Water Partnership surveys and educational workshops.	Federal and State	Minnesota Pollution Control Agency, Minnesota Department of Agriculture	Baseline surveys of farm practices. Identification of NPS of groundwater contamination.
8.	Anoka Sand Plain Water Quality Demonstration Project.	Federal and State, 319	Natural Resources Conservation Service, Minnesota Extension Service	Studies of a unique hydrogeologic unit and demonstrations of BMPs.
9.	Management Systems Evaluation Area (MESA).	Federal and State, 319	University of Minnesota	BMPs for ridge-till corn-soybean rotation.
10.	Ag. Nutrient studies in sensitive groundwater areas.	State	Minnesota Department of Agriculture	Baseline surveys of farming practices; demonstration projects
11.	Washington County Quaternary Aquifer Study.	State, Local	Minnesota Geological Survey, Washington County	Maps, reports, workshops
12.	County Atlas workshops.	State	Minnesota Geological Survey	Education and outreach to county staff
13.	County Atlas Service Office.	State	Minnesota Geological Survey	Technical assistance

Goal 3: Accelerate Identification of Geologically Sensitive Areas, such as Through Special Studies, Regional Assessments, and Geologic Atlases.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1.	Completion of county atlases for Goodhue, Fillmore, Mower, Rice and Stearns Counties.	State and Local	Minnesota Department of Natural Resources, Minnesota Geological Survey	Groundwater sensitivity maps, supporting data bases, and staff expertise.
2.	Completion of regional assessment for Southwestern Minnesota.	State	Minnesota Department of Natural Resources, Minnesota Geological Survey	Regional assessment of water resources particularly, water table aquifers.
3.	Methodology for mapping nitrate impacted groundwater used for drinking.	Federal	Minnesota Department of Health	Protocol for mapping nitrate sensitivity that can be used for different levels of mapping
4.	Nitrate susceptibility map of Washington County.	Federal and State	Minnesota Department of Health	Assessment of nitrate vulnerability of the principle aquifer used in Washington County
5.	Land use studies in Metro, Anoka Sand Plain, and Ottertail County.	Federal, 319	USGS	Study results between land use and groundwater.
6.	Phase I Clean Water Partnership Projects.	Federal, State, and Local	Minnesota Pollution Control Agency	Identification of sensitive areas

Goal 4: Increase Emphasis on Prevention and Expand Use of a Hierarchy of Strategies.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1.	Environmental review requirements for animal feed operations.	State/Private	Minnesota Pollution Control Agency/ counties	Identify potential water resources impacts related to permitting of animal feedlots.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
2.	State wellhead protection rules	State/Local	Minnesota Department of Health /water utilities	Implementation of plans to protect public water supply wells from contamination
3.	Revision of county water plans.	State, Local, 319	Board of Soil and Water Resources, Counties	Integrate NPS issues into county comprehensive water resources protection plans.
4.	Establishment of Ag. BMPs in Special Protection Areas.	State	Minnesota Department of Agriculture	Technical assistance with BMPs
5.	Evaluation of Ag. Nutrient practices in wellhead protection areas.	State, 319	Minnesota Department of Agriculture	Incorporation of BMPs into local wellhead protection plans.
6.	USDA - EQUIP	Federal	Natural Resource Conservation Service	Well sealing on tribal lands, cost sharing for well sealing and sinkhole protection.

Goal 5: Increase Efforts to Evaluate the Impacts of Those Contaminant Sources Currently Lacking Attention through State or Federal Regulatory Frameworks.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1.	Assessment of 1991 state water plan.	State	Minnesota Environmental Quality Board	Report Soundings used to revise state water plan
2.	FANMAP studies of Agricultural areas.	State	Minnesota Department of Agriculture	Evaluation of nutrient management practices affecting groundwater quality
3.	NAWQA studies.	Federal	U.S. Geological Survey	Assessment of land and water-uses impacts on surface and groundwater throughout major river basins.
4.	Assessing the impacts of various types of land use on groundwater quality.	State	Minnesota Pollution Control Agency	Report of findings for the St. Cloud area

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
5.	BMPs for irrigated potatoes.	State, 319	University of Minnesota	BMPs
6.	Agricultural Pesticide and Nutrient Monitoring and Assessment Program.	State	Minnesota Department of Agriculture	State monitoring plan

Goal 6: Enhance and Promote Hydrologic Unit-Based Management.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1.	Project Coordination Team.	State, 319	Minnesota Pollution Control Agency	Provide guidance for allocating state and local funds for controlling non-point contamination.
2.	Geologic Mapping Advisory Committee.	State/Federal	Minnesota Geological Survey	Target geologic mapping on areas where groundwater resource management is of concern
3.	Mapping of karst springsheds in Fillmore County and Mower County.	State	Minnesota Department of Natural Resources, Fillmore County, Mower County, U of Minnesota	Maps of recharge areas to springs in a county dominated by karst terrains.
4.	Preparation of basin plans for the Minnesota River and the Red River.	State/Local	Minnesota Pollution Control Agency/local governments/citizen groups	Basin-wide plan with priorities for protecting surface water and groundwater resources.
5.	Initiate planning for Rainy, St. Croix, Lower Des Moines, Lower Mississippi, Upper Mississippi, and Missouri River Basins.	State/local,/federal	Headed by Minnesota Pollution Control Agency	Organizational efforts to begin basin planning.
6.	Establishment and study of Ag. Ecoregions.	Federal and state	Local agencies, University of Minnesota	Designate of Ag. Ecoregions throughout the state.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
7. Establishment of USDA - EQUIP Priority Areas.	Federal and State	Natural Resource Conservation Service, local governments	Priority areas for funding EQUIP BMPs.
8. Olmsted County Hydrologic Unit Area Project.	Federal, State, Local, 319	Natural Resource Conservation Service, Minnesota Extension, local	Installation of BMPs
9. USGS regional aquifer studies.	Federal, State, Local	USGS, Minnesota Department of Natural Resources	Reports, studies, maps, educational materials
10. Special geological studies pertinent to NPS effects on groundwater.	Federal, State, Local	Minnesota Geological Survey	Reports, maps

Goal 7: Assist Local Governments with Developing Wellhead Protection and Other Ground Water Protection Programs.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Establish local wellhead protection teams.	State/local/federal	Minnesota Department of Health Minnesota Rural Water Association	Groups assist communities with preparing and implementing wellhead protection plans
2. Place planning staff in regional offices to assist local governments and public water suppliers.	State	Minnesota Department of Health	Direct assistance to public water suppliers and local governments.
3. Develop GIS-based information regarding potential contamination sources.	State/Federal	Minnesota Department of Health	Provide local wellhead protection planning teams with information needed to formulate protection plans.
4. Provide training and educational materials needed to support wellhead protection program implementation.	State/Federal	Minnesota Department of Health	Education materials and workshops needed to support involvement by local governments.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
5.	Development of wellhead protection plans on tribal lands.	Federal/Tribes	USGS	Wellhead Protection Areas for Prairie Island and Shakopee Bands.

Goal 8: Improve Pesticide and Fertilizer Management.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1.	State Pesticide Management Plan.	State/Federal	Minnesota Department of Agriculture	State plan for pesticide management approved by EPA.
2.	Soil Testing Laboratory Cert. Program.	State	Minnesota Department of Agriculture	Standardize testing and reporting to predict crop nutrient needs.
3.	Manure Testing Laboratory Cert. Program.	State	Minnesota Department of Agriculture	Standardize testing and reporting to predict crop nutrient needs.
4.	Tools for Assessing Pesticide Runoff and Leaching.	Federal, non-profit, 319	Natural Resource Conservation Service, Institute for Agriculture and Trade Policy, University of Minnesota	Software
5.	Nutrient Management Software Development.	Federal, state, 319	Natural Resource Conservation Service, U of Minnesota	Software
6.	Nutrient Management Expertise to Farmers.	Federal, 319	Natural Resource Conservation Service, U of Minnesota	3 positions to provide technical assistance to farmers

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
7. USDA-EQIP: Incentive Payments for Improved Pesticide and Nutrient Management.	Federal	Natural Resource Conservation Service, FSA	Financial and technical assistance to farmers.

Also refer to Chapters 9 & 10 for additional information regarding management goals and milestones relating to pesticide and nutrient management.

Goal 9: Expand Use of Measurable Objectives for NPS and Provide Adequate Monitoring.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Develop county capabilities to collect and interpret well water quality data.	State/federal	Minnesota Department of Health	Provide training, equipment, and support to county health agencies.
2. Interagency monitoring team.	State	Minnesota Pollution Control Agency	Interagency coordination of groundwater monitoring and sharing of results
3. Evaluation of BMPs for soils in SW Minnesota.	State	Minnesota Department of Agriculture, Minnesota Extension Service	Revision of existing BMPs to reflect increased knowledge of how farming practices affect groundwater in SW Minnesota
4. Interagency Monitoring Initiative.	State	Minnesota legislature, State agencies	Provided funding to enhance the state's ability to identify natural groundwater quality and assess the impacts of land uses on groundwater quality.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
5. NAWQA monitoring efforts.	Federal	USGS	Interagency monitoring of surface and ground waters relative to NPS contamination.

Goal 10: Improve Data Management.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Revision of state well record data base.	State	Minnesota Department of Health, Minnesota Geological Survey	Upgrade the state's ability to store and retrieve well logs and groundwater quality data.
2. Web sites for public access to state/federal data bases.	State/Federal	State agencies/U.S. Geological Survey	Web sites for pubic access to maps, reports, and data.
3. State GIS coordination team.	State	Environmental Quality Board	Governor's Council on GIS to set standards for data collection and sharing.
4. USGS data base revisions.	Federal	USGS	Web access to USGS data base information.

Goal 11: Develop and Distribute a Method for Identifying NPS Controls Needed to Protect Ground Water on a Project-Specific Basis.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Wellhead protection planning.	State/lLocal	Minnesota Department of Health, Public water suppliers	Identify management strategies for reducing NPS impacts on public water supply wells.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
2.	Ag. Management strategies for wellhead protection areas.	Federal, State, Local	Minnesota Department of Health, Minnesota Department of Agriculture	BMPs for wellhead protection areas
3.	Implementing the Federal Ground Water Rule.	Federal, State, 319	Minnesota Department of Health	Report on viral occurrence in groundwater, age dating
4.	Age dating Anoka Sand Plain	Federal, State, 319	USGS, Minnesota Pollution Control Agency	Age dating of groundwater.

Chapter 4 Overall Strategies for Each Water Resource
4.2 Lakes Strategy

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Introduction

Preserving Minnesota's over 12,000 lakes from nonpoint source pollution requires a balanced approach of protection and restoration, using a variety of management strategies, within a structure that recognizes regional differences in lake ecology and landuse. Restoring lakes with impaired uses or degraded water quality or habitat has been the major focus of management efforts in the past. This strategy identifies assessment and protection of unimpaired lakes as a higher priority. Management strategies include regulations, incentives, education, planning, and acquisition.

Lake condition and lake-basin characteristics vary between regions - from the small, deep lakes of northeastern Minnesota, to the large, shallow lakes of the south. The *ecoregion framework* can serve as a basis for evaluating lake condition and setting preliminary water quality goals. Ecoregions, areas where the land use and water resources are similar, have been mapped by the US Environmental Protection Agency (USEPA) for the lower 48 states based on overlaying maps of land form, soil type, land use, and potential natural vegetation (Omernik, 1987). Minnesota is characterized by seven ecoregions, four of which contain 98 percent of Minnesota's lakes (Figure 1). These four are the 1) Northern Lakes and Forests, 2) North Central Hardwood Forests, 3) Western Corn Belt Plains, and 4) Northern Glaciated Plains. Several papers have been written which describe similarities and differences between the lakes in the different ecoregions (e.g., Heiskary et al. 1987) and the development of ecoregion-based phosphorus criteria (Heiskary and Wilson, 1989). In addition to these methods of classification, there are numerous other systems that are based on hydrology (drainage, seepage), biological communities (Schupps Index), and human uses (drinking water, recreation, general development).

Assessing trends in water quality or the status of individual lakes is difficult because only a small percentage of Minnesota's over 12,000 lakes have been monitored or evaluated. However, intensive monitoring of representative lakes, reviews by professionals, and surveys of lake users indicate that water quality in Minnesota is declining due to agricultural land use practices, urbanization, atmospheric deposition, increased shoreland development pressures, and recreational demands. Nutrients (Nitrogen, Phosphorus), sediment, bacteria, and toxics (mercury and PCBs) present the greatest threats to Minnesota's lakes by promoting eutrophication, degrading habitat, diminishing recreational opportunities, and accumulation in the food chain.

Limited funds are available from federal, state, and local sources to address the existing and potential impacts of nonpoint pollution on lakes. To improve the effective use of those funds, this strategy identifies and prioritizes a variety of management approaches. The merits of protecting resources, currently in good condition, will be evaluated relative to rehabilitating resources that are severely degraded. This will be described in the context of most sensitive uses and in terms of overall ecological health.

Background

DESIRED USES

Minn. R. ch. 7050 (1994) designates five classes of water use for which water quality standards have been established: 1) domestic consumption, 2) aquatic life and recreation, 3) industrial consumption, 4) agriculture and wildlife, and 5) aesthetic enjoyment and navigation.

To meet the goals of the Clean Water Act (CWA), the MPCA focuses on whether lakes meet *swimmable* or *fishable* uses. Lakes in Minnesota may be unsuitable for swimming because of cultural eutrophication that may cause nuisance blooms of algae and reduced transparency or bacterial contamination that may directly affect human health. Fishability of lakes may be diminished because of degraded habitat or the presence of toxic pollutants that bioaccumulate in the food chain resulting in fish consumption advisories for human consumers or posing a threat to fish-eating wildlife. In addition about 1.5 million people in Minnesota receive their drinking water from a surface water source (lake or river). Source water protection is critical to ensure safe drinking water supplies and minimize the expense of treatment technologies. Sediment and excess nutrients can interfere with navigational or industrial use and impair aquatic life, wildlife, recreation, and aesthetic enjoyment.

As noted previously lake conditions and lake-basin characteristics vary between regions—from the small, deep lakes of the Northern Lakes and Forests to the large, shallow lakes of the Western Corn Belt Plains and Northern Glaciated Plains. Results of lake observer surveys indicate that the perceptions of what constitute high transparency or severe algal blooms also vary by region. In general, lake users in northern Minnesota are less tolerant of reduced transparency and algal blooms than are those in southern Minnesota. Several reference lakes (least impacted lakes in the ecoregion) were selected in each ecoregion and monitored over two to three summers. Data from these lakes, along with user perception information derived from the Citizen Lake-Monitoring Program (CLMP), an extensive review of the literature, and a review by an expert panel led to the development of phosphorus criteria for the "most sensitive uses" within each ecoregion (Table 1). The uses addressed include drinking water, cold water fisheries and primary contact recreation. Since their establishment in 1988, the phosphorus criteria have served as a basis for assessing swimmable use, developing priorities, and setting water quality goals.

Minnesota's phosphorus criteria provide a sound basis for determining a lake's ability to support swimmable uses. For the purposes of Minnesota's 305(b) reports to Congress, the phosphorus criteria in conjunction with Carlson's Trophic State Index (TSI; Carlson, 1977) was used as a means to classify lakes relative to support of swimmable use. Swimmable use support is categorized as follows: *full-support (FS)* - few algal blooms and adequately high transparency exist throughout summer to support swimming; *marginal support (MS)* - swimmable use is still fully supported, but lake is near the phosphorus limit for its ecoregion and small increases in in-lake phosphorus could result in increased algal blooms and perceptible decreases in transparency; *partial-support (PS)* - algal blooms and low transparency may

Figure 1. Minnesota's Seven Ecoregions

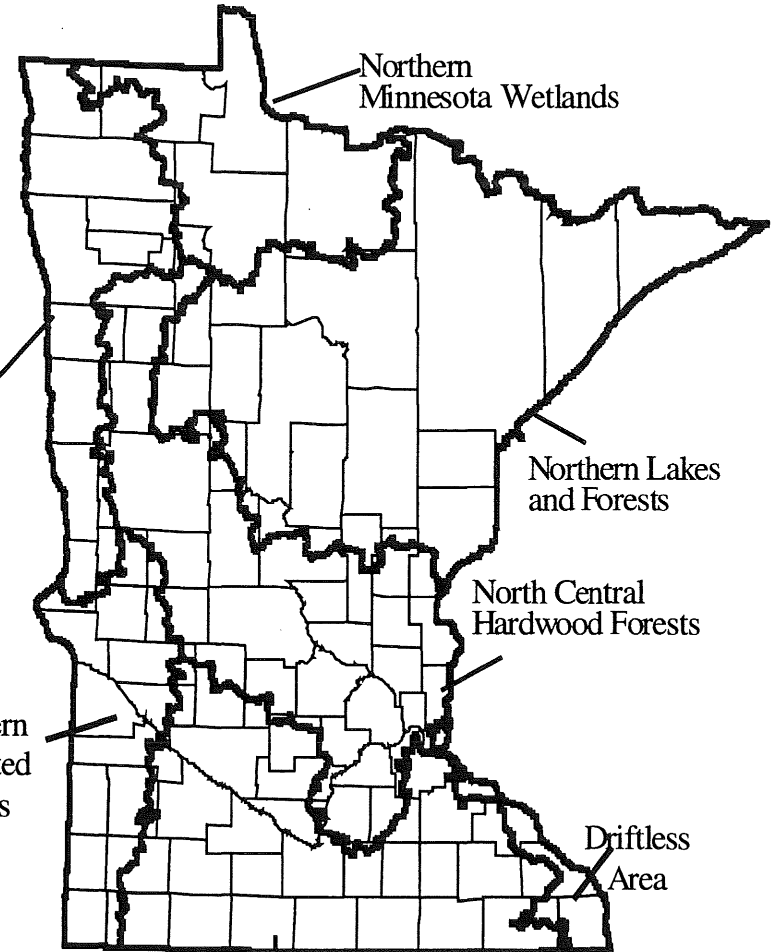
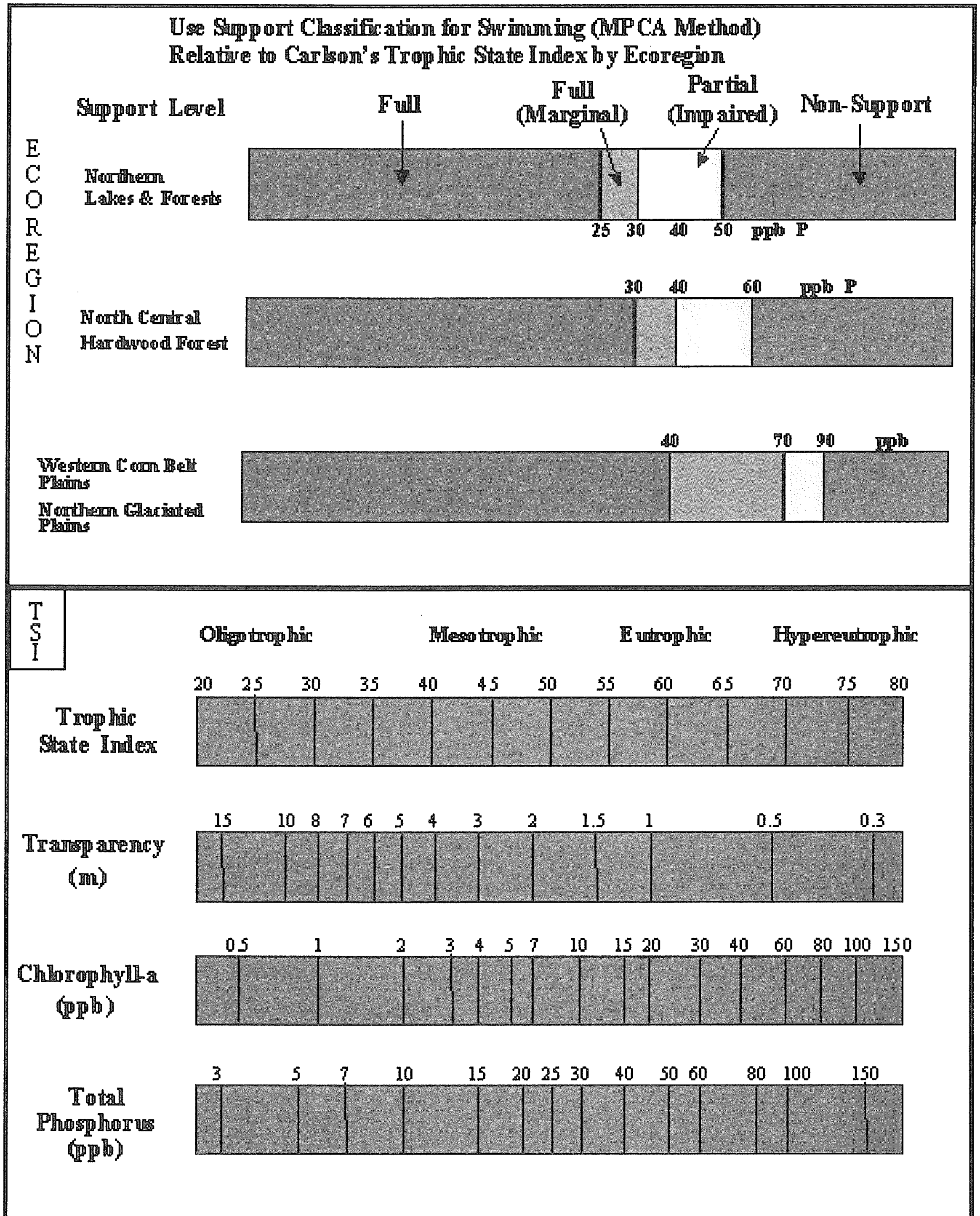


Table 1. Minnesota Lake Phosphorus Criteria (Heiskary and Wilson, 1988).

Micrograms Per Liter (ug/L)

Ecoregion	Most Sensitive Use	P Criteria
NORTHERN LAKES AND FORESTS	drinking water supply cold water fishery primary contact recreation and aesthetics	**< 15 μg/L** **< 15 μg/L** **< 30 μg/L**
NORTH CENTRAL HARDWOOD FORESTS	drinking water supply primary contact recreation and aesthetics	**< 30 μg/L** **< 40 μg/L**
WESTERN CORN BELT PLAINS	drinking water supply primary contact recreation (full support) (partial support)	**< 40 μg/L** **< 40 μg/L** **< 90 μg/L**
NORTHERN GLACIATED PLAINS	primary contact recreation and aesthetics (partial support)	**< 90 μg/L**

Figure 2. MPCA's Swimmable Use Support Classification Relative to Carlson's TSI.



After Moore, 1. And K. Thornton, [Ed.] 1988. Lake and Reservoir Restoration Guidance Manual. USEPA>EPA 440/5-88-002.

limit swimming for a significant portion of the summer; and *non-support (NS)* - severe and frequent algal blooms and low transparency will limit swimming for most of the summer. Use-support thresholds for each ecoregion are defined in Figure 2.

Drinking water supply is an important use as well and is acknowledged as a "most sensitive use" in the ecoregion-based phosphorus criteria. There are 24 community water supply systems and approximately 64 transient non-community water supply systems that use surface water sources in Minnesota (lakes, rivers, flooded mine pits). The types of surface water sources used by these public water supply systems and their geographic distribution is very diverse and presents a challenge for meaningful source water protection efforts.

The susceptibility of a surface water source to contamination is considered high because there is no practical means of preventing all potential contaminant releases into surface waters (in contrast to groundwater). In 1996 the federal Safe Drinking Water Act was amended to require states to conduct source water assessments for drinking water sources. The guidance document prepared by USEPA to assist states in developing source water assessment programs recognizes the importance of addressing nonpoint pollution sources during the assessment process. USEPA encouraged source water protection staff to work with their counterparts in the nonpoint source (NPS) pollution program to help ensure the NPS threats identified through source water assessments are acknowledges as concerns by both programs. Currently, there are very few source water assessments completed but they will all be completed by May 2003 because of federal deadlines.

Source water protection (SWP) represents a new focus and a major change in thought in protection of drinking water supplies. SWP is a part of a multiple barrier approach used to provide safe drinking water. The reliance on treatment alone can become a very costly alternative. The ecoregion-based phosphorus criteria recognize the need to attain/maintain relatively low phosphorus concentrations in source water supplies and that "reasonable goals" likely differ between ecoregions.

Many states, including Minnesota, have fish consumption advisories to inform people about how many meals of fish they can safely eat over a period of time. For most people, most fish caught while angling is safe to eat. Yet chemicals such as mercury, polychlorinated biphenyls (PCBs), toxaphene, and dioxin have been found in some fish from certain waters. The levels of these chemicals are usually low and in Minnesota there are no known cases of illness from these contaminants.

The MN Department of Natural Resources (MDNR), the Minnesota Pollution Control Agency (MPCA), and the Minnesota Department of Health (MDH) collaborate in producing the fish consumption advisory. Each year, the MDNR collects fish from lakes and rivers for testing. Minnesota has approximately 6000 fishable lakes. Fish from 856 lakes and 51 streams in Minnesota have been tested for contaminants. All waters from which fish have been tested are listed in the advisory - they are not necessarily more contaminated than those not tested. Waters are selected for sampling where angling is popular, where there is a known or suspected pollution source, or where fish contaminant trends are being tracked. Because some mercury is found in all fish tested from Minnesota lakes, a general guide is also available to choose which species to eat and how often to eat fish from lakes where fish have not been tested.

WATER QUALITY STATUS

The quality of many of Minnesota's lakes is impaired and designated uses are lost because of nutrients, sediment, bacteria, toxic contaminants, or hydrologic modifications. Increasing population, residential development, and recreational use cause many of the problems, but even remote lakes, protected in the Boundary Waters Canoe Area (BWCA) or Voyageur's National Park, show impacts from human activities, with elevated levels of atmospherically derived mercury, PCBs, and other organic contaminants. While these issues are all important, a primary emphasis of this chapter will be on the impact of excess nutrients, sediments, and land use activities in the shorelands and watersheds of Minnesota's lakes. From this priority issues, related NPS controls and management strategies, will be defined.

The swimmable use of many lakes is impaired as a result of cultural eutrophication. Reading from Minnesota's 1994 305 (b) Report to Congress *"....of lakes less than 5,000 acres (99 percent of Minnesota's lakes) only 51 percent fully support swimmable uses......Nutrients are the primary pollutants that degrade lake water quality below use thresholds and phosphorus (P) is the most significant of these."* That statement from Minnesota's 1994 305(b) report remains true today. In our most recent assessment (MPCA, 1999) approximately 2,245 lakes were assessed: 1,539 with "monitored" data (data collected from 1989-1998) and 706 with "evaluated" data (1970-1988).

Of the 2,245 lakes in the most recent assessment 1,206 (54%) fully-support swimmable use, 257 (11%) fully-support but are marginal, 316 (14%) partially-support, and 466 (21%) do not support swimmable uses. The relative percentage of lakes in each category varies between ecoregions and is summarized in Figure 3. In the Northern Lakes and Forests (NLF) ecoregion 81 percent of the assessed lakes fully-support swimmable use. In the Northern Central Hardwood Forest (NCHF) ecoregion 51% fully-support swimmable use. In the Western Corn Belt Plains (WCBP) and Northern Glaciated Plains (NGP) ecoregions the vast majority (76 and 74% respectively) do not support swimmable use.

Aquatic sediments contaminated with nutrients or toxic pollutants can contribute substantially to the impairment of designated uses of surface waters. Resuspended or resolubulized nutrients can contribute to excessive algae growth, low dissolved oxygen, and possibly, fish kills. Toxic pollutants can cause reproductive impairments, reduced growth, and even death to benthos. In addition, toxic chemicals can bioaccumulate in sediment based food chains contaminating fish and fish consumers. Fish consumption advisories are common in areas of known sediment contamination.

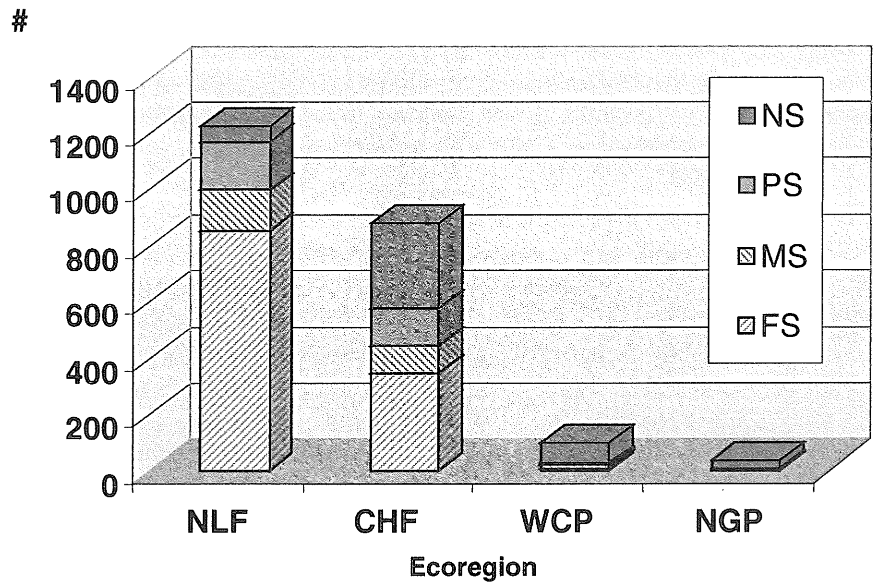
Nutrients (in particular phosphorus) may be stored in sediments long after point and nonpoint sources controls are implemented. Often, beneficial uses can not be fully restored in aquatic ecosystems until excess sediment-associated nutrients are identified and addressed through remedial actions.

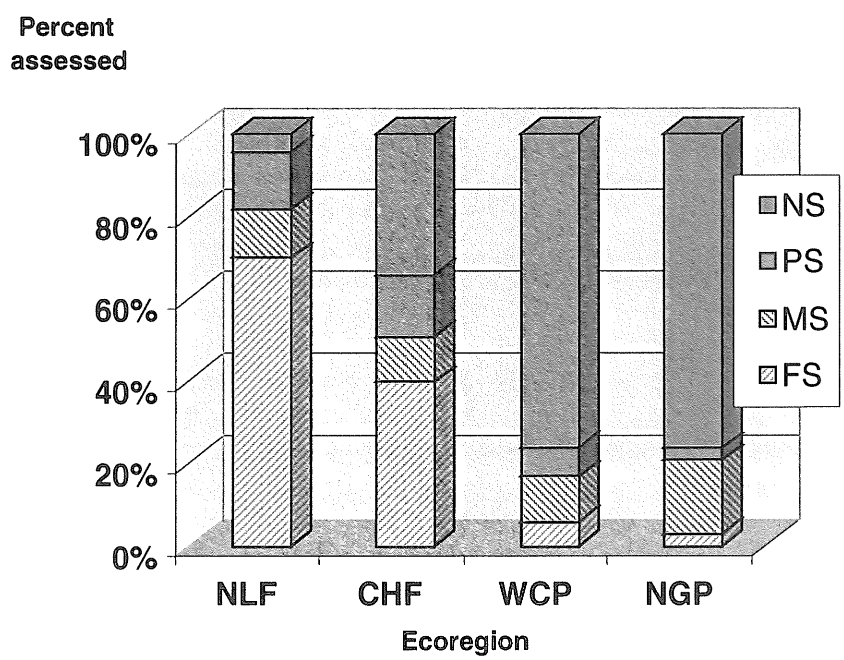
CURRENT THREATS AND SOURCES

Current land use practices, increased shoreline development, atmospheric deposition, inadequate wastewater treatment, and recreational demands are contributing: 1) nutrients (nitrogen, phosphorus), 2) sediment, 3) bacteria, and 4) toxics to lakes. Water levels are manipulated and natural waterways have been altered, exotics have been introduced, habitat is being lost or degraded, and biological communities are diminished. The relative importance of the sources of the four major pollutants varies regionally in relation to land use, ecoregion, and development pressure.

Sediment - Both external loading of sediment from watershed runoff and recycling of contaminants (primarily nutrients) from contaminated sediments contributes to in-lake water quality degradation. Watershed loading arises from agriculture, construction, and urban runoff. Shoreline erosion caused by a combination of wave action, hydrologic modification, and/or removal of aquatic and terrestrial vegetation can contribute excess sediment as well. These nearshore sources may affect fish spawning areas and habitat in general. Shallow lakes with large fetch are particularly susceptible to wind mixing and resuspension of sediment. Carp and other rough fish may also contribute to sediment resuspension. Impacts from sediment

Figure 3. Swimmable Use Support.
Number of assessed lakes and relative proportion by ecoregion.





delivered to lakes may include: filling (navigation), burial of existing substrate (habitat), reduction in transparency, impairment of industrial and drinking water uses, and as a carrier for adsorbed contaminants.

Perhaps the single greatest threat to Minnesota lakes from sediment is as a carrier for phosphorus to the lake.

Nutrients - Phosphorus (P) and nitrogen (N) are the nutrients of primary concern. However, because most Minnesota lakes are phosphorus-limited, and phosphorus arising from NPS is more readily controlled than N (which has a gaseous phase and is highly soluble), the primary focus will be on P rather than N. Sources of P are intrinsically tied to sources of sediment and, as such, land use practices that allow excess sediment to be exported off the land will typically export high amounts of P as well.

Phosphorus export, expressed as mass per unit watershed area (e.g., kg P/hectare), is one basis for comparing relative contributions from different land use types or watersheds. In predominantly forested watersheds, P export is typically low (Figure 4) and in-lake total phosphorus concentrations are typically low. Because of limited disturbance associated with forest soils and vegetation, minimal amounts of P move from the landscape to lakes and streams. However, lakes in the forested regions are very sensitive to additional inputs of P. (*Sources*: silviculture activities, road building, shoreland development.)

Phosphorus export from agricultural watersheds is often high relative to other land uses (Figure 4). P export varies substantially based on the intensity of the particular agricultural land use and opportunities for erosion and loss of P-bearing soil. Grasslands, typical of Conservation Reserve Program (CRP) plots or idle pastures, exhibit higher P export than forested lands but substantially lower P exports than intensive row crop agriculture or lands where excess amount of biosolids are applied to land or allowed to runoff from poorly managed feedlot or pasturing areas. *[Sources*: commercial fertilizer, manure management, tiling and drainage (delivery system), soil erosion, and wastewater.]

Phosphorus exports from urban watersheds rival that of agricultural watersheds (Figure 4). Impervious areas (roads, rooftops and parking lots) contribute to excessive runoff and transport of P-bearing soil and organic matter. Dealing with storm water from existing and future developments (residential, commercial and industrial) is the number one water pollution concern in urban and urbanizing watersheds. (*Sources*: lawn care - fertilizer, grass clippings, leaves, animal waste, construction sites, sediment, atmospheric deposition on impervious areas, and wastewater.)

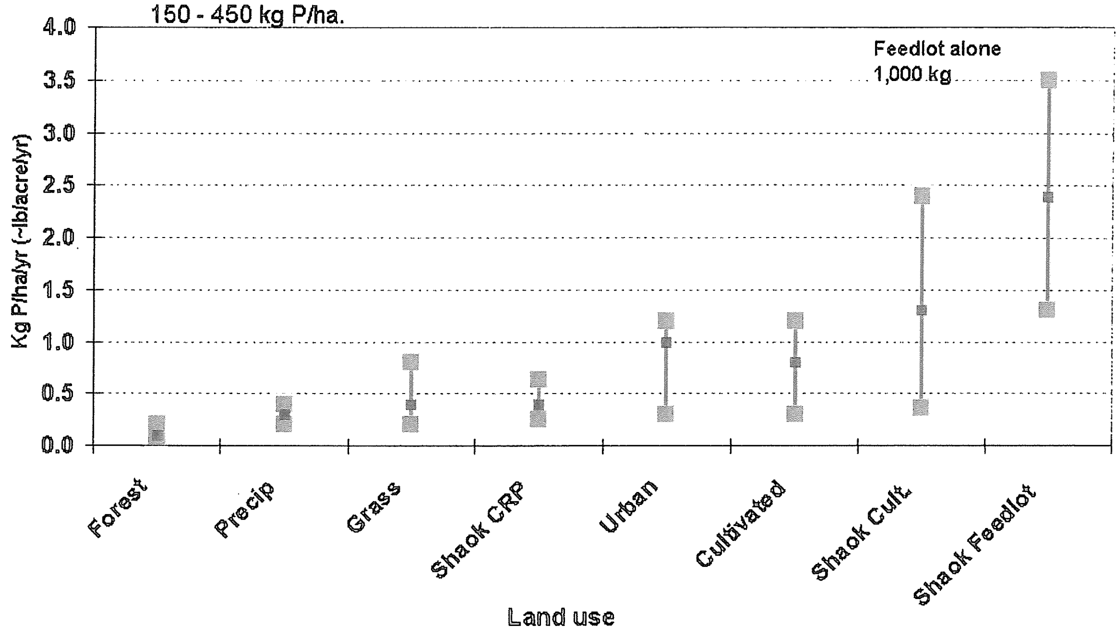
Activities in the immediate shoreland or riparian areas of lakes are an important part of the overall impact on the lake and its ecological integrity. [*Sources*: loss of shoreline vegetation (exacerbates), lawn care - fertilizer, grass clippings, burning leaves, storm water from shoreland development, and inadequate on-site wastewater systems.]

Excess nitrogen will also be transported to lakes from these land uses. Nitrogen (N) will enter attached to soil particles, as organic matter, or dissolved in the form of nitrite, nitrate, or ammonia – forms that are readily useable by algae and rooted plants. Concentrations of nitrite and nitrate N are often at or below detection in lakes in northern and central Minnesota – attesting to both lower inputs and rapid cycling (use) of these forms of N. This is in contrast to lakes in the agricultural portion of the state where these forms of N are routinely above detection limits in lakes. In agricultural areas N loading to surface waters is much higher than in the other parts of the state.

Bacteria – Bacteria have a direct impact on human and animal health via whole body contact or ingestion of the water. [*Sources*: inadequate wastewater treatment (on-sites & municipal); livestock manure management;

Figure 4

Phosphorus Export Coefficients. Estimated ranges from literaure and measured ranges from subwatersheds in Lake Shaokatan CWP Project (Schuler, 1992). Note: Literature estimates for feedlots, without containment, range from about 150 - 450 kg P/ha.



and other animal wastes arising from waterfowl, pets and other animals in the shoreland area.]

Toxics - Toxic pollutants may lead to direct toxicity (death) of aquatic organisms (in the case of chemical spills) or more commonly may bioaccumulate in the aquatic food chain and lead to health consumption advisories for humans and may impact fish eating wildlife (e.g., loons and raptors) as well. An emerging issue of concern is the influx of pharmaceutical contaminants to surface and groundwater from municipal and industrial discharges. Medicines and cosmetics from domestic health and wastewater provide estrogenic compounds, anti-bacterials, metals and other toxics that can impacts aquatic animals and present potential human health risk to populations using it as a drinking water source. [*Sources*: pesticides (agricultural, urban, forestry); atmospheric inputs (Hg, PCBs, polyaromatic hydrocarbons); transportation (road salt); improper disposal of hazardous household wastes; municipal and industrial discharges.]

Hydrologic modifications such as lake level alterations and/or land use changes in the watershed that result in changes in the timing and amount of the hydrologic load to lakes. Lake level alterations due to power generation, diversions, flood control, water supply and outlet modifications impact relatively few lakes in the state. However, impacts to these lakes have the potential to be dramatic. Much more common is the change in hydrologic load due to increased impervious surfaces, drainage, and stormwater management. Many lakes have been impacted in this manner with many that may be impacted in the future as watershed development occurs. Hydrologic modification has also been linked to increased mercury methylation when lakes flood surrounding terrestrial and wetland vegetation.

Shoreland development - Activities related to the construction and occupation of lakeshore homes, the management of lakeshore lots, and recreation in the adjacent waterbody can all contribute to problems in lakes. These impacts include: removal of native vegetation, construction activities, increased impervious area, addition of on-site septic systems, fertilizer and pesticide use, introduction of exotic species or replacement of native vegetation, and lake sediment disruption. A variety of processes can be altered, including: amount or timing of sediment/nutrients/water loading to lakes; the habitat types/microclimate conditions along the lakeshore, the relative proportion of groundwater: surface water inflow; the level of noise, etc. These practices have a high potential to degrade lakes because of the proximity of altered land use to the water - - there is little opportunity to minimize impact on the lake.

EXISTING ASSESSMENT TOOLS

Before prioritizing investment of resources to address nonpoint source pollution, there must be adequate evaluation of the current status of Minnesota's lakes. A variety of monitoring activities, qualitative assessments, modeling techniques, and new technologies are used at the local, regional, and state levels to help evaluate the status of lakes and trends in water quality. The ecoregion framework has been very useful for understanding and communicating between region differences in lake water quality, morphometry and watershed characteristics. For example, data from the ecoregion reference lakes has proven quite useful for evaluating the condition of other lakes in the same ecoregion. Table 2 represents the interquartile range in summer-means for various parameters by ecoregion. This provides a good basis for comparisons and can assist in the overall assessment of the lake.

Table 2. Ecoregion Lake Data Base Water Quality Summary
Summer Average Water Quality Characteristics for Lakes by Ecoregion.

Parameter	**Northern Lakes and Forests**	**North Central Hardwood Forests**	**Western Corn Belt Plains**	**Northern Glaciated Plains**
Total Phosphorus (ug/l)	**14 - 27**	**23 - 50**	**65 - 150**	**130 – 250**
Chlorophyll mean (ug/l)	**4 - 10**	**5 - 22**	**30 - 80**	**30 – 55**
Secchi Disk (feet) **(meters)**	**8 - 15** **(2.4 - 4.6)**	**4.9 - 10.5** **(1.5 - 3.2)**	**1.6 - 3.3** **(0.5 - 1.0)**	**1.0 - 3.3** **(0.3 - 1.0)**
Total Kjeldahl Nitrogen (mg/l)	**0.4 – 0.75**	**< 0.60 - 1.2**	**1.3 - 2.7**	**1.8 - 2.3**

MONITORING AND ASSESSMENT EFFORTS

There are an array of monitoring programs currently used in Minnesota. This summary presents these programs or efforts as tiers whereby lakes may move through the different tiers of monitoring based on data needs and/or the complexity of the problems being addressed. These tiers of effort are an important part of lake prioritization and protection efforts to be described later in this Strategy. Included among these are well-established techniques, such as use of Secchi disk, qualitative measures, and new evolving techniques.

Basic Volunteer Monitoring – MPCA's Citizens Lake Monitoring Program (CLMP) and Metropolitan Council's Citizen Assisted Monitoring Program (CAMP) are two examples of volunteer monitoring that can provide basic status and trend information for lakes. CLMP monitoring would be the first choice for any lake that does not have *current* data. The CLMP data will provide an improved basis for correctly classifying a lake and initial prioritization. Another advantage of the CLMP is that it comes at no cost to a local unit of government in terms of money or data management. Other volunteer monitoring programs, such as CAMP and local water plan trophic status monitoring, conducted in conjunction with coalitions of lake associations (COLAs), afford an opportunity for lake associations and interested citizens to gather additional data on their lakes. Whenever possible, data from these efforts are placed in STORET (USEPA's national water quality data bank) as well and thus can be combined with other sources of data to allow for trend assessment.

Lake Assessment Program (LAP) - This level of monitoring is the next step up. It considers not only the water quality of the lake but also watershed, fishery, and other pertinent characteristics. This type of monitoring is often most efficient and effective when done as collaboration between a lake association, local unit of government, and state resource managers. This level of monitoring does not usually provide enough information to diagnose all significant sources and develop feasible alternatives for addressing large-scale pollution problems in severely impacted lakes but may provide adequate information to further protection efforts on a lake. Additional details on this and different levels of monitoring (Appendix, Table 1) are provided in the Lake and Watershed Data Collection Manual (Heiskary et al., 1994).

Tributary Monitoring - If in-lake conditions have been adequately characterized it may be beneficial to monitor flow and Total Phosphorus (TP) from significant inflows to priority lakes. The purpose of this monitoring is to calculate flow-weighted mean TP concentrations for major tributaries (subwatersheds) to the lake and provide a basis for identifying which subwatersheds contribute the highest P loading. These loading estimates will also be valuable for modeling and goal setting purposes. In turn, these subwatersheds could be investigated in more detail for potential BMP implementation. Wilson and Schuler (1991) provide a good overview of stream sampling considerations.

Clean Water Partnership or Clean Lakes Programs - These types of studies, also referred to as "diagnostic-feasibility" studies, provide the level of resolution needed to accurately characterize in-lake conditions, determine accurate water and nutrient budgets, and determine appropriate sites for implementing BMPs and other pollution control measures. The studies in their initial phase, "Phase I" as they are commonly referred to, may cost anywhere from tens of thousands of dollars to over $100,000. These high project costs speak to the need to protect resources so that they do not become degraded to the point where these extensive projects are needed to restore or rehabilitate the systems.

Toxic Contaminants - *This* often involves fish tissue monitoring. Collections are targeted towards lakes with high fishing pressure. More recently the detection of trends in contaminant levels has become important. As such, strategies have been developed to monitor a select subset of lakes on a rotating basis to evaluate changes in contaminant levels over time. Another promising technique for evaluating contaminant levels is through the collection of sediment cores – both short and long cores. Short cores, that collect the upper few centimeters of sediment, can be used to establish current levels of contaminants. Long cores, that may be several meters in length can be sectioned and dated and be used to determine changes in contaminant loading over time.

The recycling of contaminants from lake sediments can be an important problem in the management of lake water quality. An MPCA report, "Lake Sediment Contaminant Levels in Minnesota Lakes" (Heiskary, 1996), provided an overview of contaminant concentrations found in the surficial sediments of lakes, with a primary focus on the lakes of the Western Corn Belt Plains (WCBP) and North Central Hardwoods Forests (NCHF). While the external (watershed) loading of TP is the most important source of phosphorus to most lakes, for others, the internal recycling of P may be a significant part of the overall P budget to a lake in some cases.

Qualitative Assessments – There are a variety of resource managers surveys and other more qualitative assessment tools used as a part of Minnesota's assessment process (e.g., 319 and 305(b)) and county assessments in support of local water plan development. These tools can be valuable and have their place in the overall assessment of lake and watershed condition. *Drinking water - source water assessments* completed by local teams offer a good opportunity to prioritize public water supply lakes that currently do not have monitoring efforts.

Modeling – Modeling can be helpful in assessment and prioritization as a diagnostic and predictive tool, particularly where we have limited current or historic data. Numerous complex mathematical models are available for estimating nutrient and water budgets for lakes. These models relate the flow of water and nutrient loads from a watershed to observed conditions in the lake. Alternatively, they may be used for estimating changes in the quality of the lake as a result of altering inputs to the lake (e.g., nutrient or water volume). The "Minnesota Lake Eutrophication Analysis Procedures" (MINLEAP) is a screening tool for estimating lake condition with minimal input data and is described in greater detail in Wilson and Walker (1989). BATHTUB and FLUX, developed for the US Army Corps of Engineers (US ACE) (Walker, 1987), are more advanced tools that are routinely used in Clean Water Partnership (CWP) studies in Minnesota.

New Technologies - There are numerous other technologies that hold promise for lake and watershed assessment, including the Geographic Information System (GIS) mapping technology and the use of remote sensing. While remote sensing has been used to assess lake condition periodically over the past two or three decades, advances in remote sensing technology, combined with increased availability of images and decreased cost to purchase images has renewed interest in this technique. This technique holds a lot of promise for counties with large numbers of lakes that have not been monitored or very large lakes that may exhibit extensive spatial variability in condition. Research is underway in the Twin Cities Metro Area (TCMA).

Satellite Remote Sensing - Regional lake monitoring is an important tool for making informed lake management decisions. Data from regional monitoring programs are frequently used to estimate expected ranges in water quality for unmonitored lakes (examine intra and inter-regional differences, and investigate the relationships between the landscape and water quality. A comprehensive, regional lake monitoring program should ensure adequate representation across both space and time. However, due to cost and logistical problems, ground-based monitoring programs usually sacrifice spatial coverage (fewer lakes) in favor of more frequent sampling. Satellite technology has potential to supplement existing (ground-based) monitoring and assessment programs. Assessment of lake water quality by satellite imagery requires the development of empirical relationships between satellite observations (generally spectral brightness or reflectance values in the visible to near-infrared region) and near-simultaneously collected ground measurements of water quality variables. In general, the relationships found between satellite data and water quality variables related to clarity, such as Secchi disk transparency (SDT) and total suspended solids (TSS), are strong; relationships for chlorophyll-a are moderately reliable; relationships for nutrients (e.g., total phosphorus concentrations) are poor.

Internet Data Access - Many water management agencies have, over the years, collected a considerable amount of water quality data. These data are stored and managed either in large, centralized, relational databases or in smaller PC-based spreadsheet files or paper in file cabinets. Both types of systems make widespread access to data difficult. Limited access to data means limited use of data and that in turn limits the full value of the data. The recent development of internet technology for data access holds significant promise for providing widespread, user- friendly access to water data. Many federal, state, and local agencies are providing more data on the internet all the time and a number of these agencies have significant projects to provide comprehensive access to agency-wide data.

Remote Data Acquisition Systems - Remote data acquisition systems gather, measure, analyze, chart, store and report water quality data. Data such as water temperature, dissolved oxygen, conductivity, salinity, pH, ORP, and turbidity can be collected at programmed time and depth intervals throughout the lake's water column. The collected data can then be downloaded via wireless a communication system utilizing either cellular or radio technology. This allows water resource managers and others to request immediate water quality information on the monitored lake and improves decision-making. One such system called the Remote Underwater Sampling Station (RUSS) is currently anchored in five lakes throughout Minnesota: Ice Lake (Grand Rapids), Grindstone Lake (Sandstone/Hinckley), Lake Independence (Maple Plain), and two contrasting bays in Lake Minnetonka (Minnetonka). Currently the RUSS units are linked to the "Water on the Web" (WOW) internet-based water quality monitoring project where real-time data are integrated into an educational curriculum.

Geographical Information Systems (GIS)
GIS are increasingly used to supply input to both simple and complex nonpoint source pollution models. The development and use of GIS can expedite data integration problems and the time-consuming process of synthesizing tremendous amounts of data for the spatial examination of nonpoint source pollution. A GIS, in which geographically referenced data can be inputted, manipulated, and analyzed, improves the decision making process and can contribute to lake management and protection efforts. GIS modeling applications may also be useful in incorporating geographically oriented layers of information in the analysis of lake and watershed data.

EXISTING MANAGEMENT APPROACHES

The state's current approach to managing nonpoint source impacts on lakes is implemented through a partnership of federal, state and local governments working in concert with local volunteers in lake associations or other organizations. The specific local government involved in this partnership varies across the state. Generally watershed management organizations are the lead local government in the Twin Cities Metropolitan Area (TCMA) with counties, Soil and Water Conservation Districts (SWCD) and/or watershed districts (WD) where they are formed being the lead local governmental units (LGUs) outside the TCMA. Notable exceptions exist where other local governments (e.g., city, park board, water utility) have a keen interest in specific lake resources and take the lead role. This approach reflects the overall responsibility and technical expertise of federal and state government and the overall authority of local governments in land use planning and management. In addition to the role of government, citizen participation often through lake association involvement is an important driving force in lake management.

Eutrophication is the top nonpoint source issue impacting lakes in Minnesota. Therefore, a large part of nonpoint source management for Minnesota lakes has been directed at phosphorus management. Management of nonpoint sources of phosphorus has included both statewide and watershed-wide approaches.

Bacteria is a nonpoint issue that has not been a high priority in Minnesota lakes and no statewide management strategy exists. Efforts to manage bacteria are primarily achieved through the control of discharges, requirements for wastewater treatment, fencing cattle out of watercourses, manure management, and limiting the access of waterfowl and domestic animals on beaches. Data collected at the local level are not compiled into a usable statewide database and there is no strategy to interpret data or pro-actively manage restrictions for body contact.

The primary control strategies for mercury (Hg) include a reduction in the use of Hg-bearing products, use of fossils fuels low in Hg and instituting limits on emissions from primary sources of Hg to the atmosphere such as coal-fired power plants. Recent research suggests that a large portion of the Hg that reaches lakes in central and southern Minnesota is a product of watershed loading and hence measures to reduce runoff and sediment loading in urban and agricultural watersheds should reduce the Hg burden as well. Site-specific strategies can also include assessing the affect hydro-modification (lake level management) may have on methyl mercury formation.

Source Water Protection: The preparation of source water protection plans is voluntary for the state's surface water-based public water supplier. Smaller public water suppliers (population served less than 3,300) would benefit from assistance by local units of government in plan development, preparation, and implementation. This could be another area for funding availability.

There are several existing efforts intended to address the impacts of shoreland development on the water quality and ecological integrity of the lake and shoreland area and are summarized as follows:

Shoreland Development Rules: On a broad scale, Minnesota has addressed the impacts of shoreland development through the establishment and implementation of the shoreland management rules. In some instances, LGUs have amended the shoreland rules to be more stringent than the state standard. In other instances there may be a need for lake-specific setback and development rules for land-locked lakes or other lakes which are prone to drastic lake level increases.

Acquisition of Critical Shoreland Areas: Various programs are already in place that acquire shoreland tracts to enhance resource value or improve resource management. For example, the Fisheries Section in the Department of Natural Resource acquires property adjacent to critical fish spawning areas to protect/enhance the fishing resource. Lake associations have also been instrumental in working with private shoreland owners to establish conservation easements of critical shoreland areas.

Shoreland Restoration/Protection: Nonpoint source impacts from shoreland development can be further reduced by initiating and promoting Best Management Practices (BMP's) that protect or restore shoreland buffers and minimize shoreland disturbances. Shoreland buffer strips reduce runoff, filter nutrients, stabilize shorelines, minimize wave damage and provide habitat.

Prioritization Schemes

PROTECTION VS. RESTORATION

In a world with unlimited dollars for monitoring lakes, restoring impaired lakes, and protecting high quality lakes there would also be little need to prioritize activities. However, since there is a limited amount of funding available at the national, state, and local levels, there is a need to ***prioritize*** the resources that are spent on these activities.

A ranking system that leads to a candidate pool of high-priority waters can simplify the task of selecting watersheds for focused management action (USEPA, 1993). Further, given the expense of restoration activities, typically measured in the hundreds of thousands of dollars per lake, it is wise to protect lake condition whenever possible. This applies not only to eutrophication, but can also apply to: shoreland vegetation and stabilization, sediment remediation, or toxic contaminant loading.

A primary goal of this strategy is to protect lakes that currently support swimmable and fishable uses, meet drinking water needs, and have natural shorelands. Thus an initial challenge is to identify impaired vs. unimpaired resources and from there determine strategies for protection and restoration. Minnesota has made extensive use of the ecoregion framework as a basis for understanding regional patterns in lake morphometry, quality and biology. Hence this framework will be a centerpiece of the following discussion. This should provide a reasonable metric for judging lake condition, setting goals and ultimately prioritizing activities. Implementation of these efforts will typically require a partnership between local citizens (e.g., lake associations), LGUs, landowners, and state and federal agencies.

PROPOSED ASSESSMENT APPROACHES

Following is a discussion of proposed approaches for assessing lake condition to identify the need for protection or restoration and resource prioritization. As noted previously the ecoregion framework, ecoregion-based P criteria, national nutrient criteria efforts and TMDL (303 (d) listing play a part in defining the need for protection vs. restoration and identifying priority waters and projects for 319 funding.

Nutrient Criteria Development

Reducing nutrient over-enrichment is one of the challenges posed in the Clean Water Action Plan (CWAP). A key action relative to this issue requires "EPA to establish nutrient criteria, by the year 2000, for nutrients that are tailored to reflect the different types of waterbodies and the different ecoregions of the country, and will assist states in adopting numeric water quality standards based on these criteria over the following three years (USEPA, 1998)." USEPA and the states are underway in this process. Guidance for developing lake nutrient criteria was published during the summer of 2000.

USEPA expects States and Tribes to use the guidance documents and nutrient target ranges as a guide in developing and adopting numeric levels for nutrients that support the designated uses of the waterbody as part of State water quality standards. USEPA will work with States to support and assist in this process. States should have adopted nutrient criteria that support State designated uses by the end of 2003. Once adopted as part of State or Tribal water quality standards, the nutrient criteria in State standards will become the basis for identifying waters where nutrients result in impairment of water quality and making many management decisions to reduce excessive nutrient levels in these waters.

The MPCA has developed ecoregion-based P criteria (Table 1) for lakes that will serve as a starting point for Minnesota's nutrient criteria development. In addition to Phosphorus (P) criteria, there will be total nitrogen (TKN), chlorophyll-a and Secchi criteria derived as well as a part of this process. These criteria, in combination with narrative language, will be promulgated into standards in a future standards revision and will play an important role in future TMDL listings and prioritization schemes.

Prioritization Based on Phosphorus Criteria

A prioritization scheme was developed for prioritizing management (monitoring, protection and restoration) of lakes for achieving (protecting) swimmable use. A decision tree approach was used as a means for conducting the prioritization (Figure 5). In this scheme an emphasis is placed on protecting lakes currently in good condition; i.e., those characterized as *full support* or *marginal support* based on their trophic status. This strategy assumes that protecting resources currently in good condition is a better investment and a higher priority than restoring resources that are highly impacted and which may or may not respond to reductions in nutrient loading. The factors used for the prioritization were: summer-mean P concentration, location of the lake (in terms of ecoregion and basin), and quality (age) of data. In the absence of P data use-support can be estimated based on Secchi or chlorophyll-a measures.

TMDLs and 303(d) Listing

Though Minnesota currently lacks eutrophication-specific, numeric standards, that typically would be used as a basis for determining whether lakes meet designated uses, a narrative standard in Minn. R. 7050.0211 subp.1 may provide an adequate basis for listing lakes when combined with our ecoregion-based P criteria. That portion of the rule reads as follows: "In addition, removal of nutrients from all wastes shall be provided to the fullest practicable extent whenever sources of nutrients are considered to be actually or potentially detrimental to the preservation and enhancement of designated water uses." This rule recognizes that excess nutrients may be detrimental to designated uses. The ecoregion-based in-lake P criteria provide an objective basis for determining whether nutrients (P specifically) are actually or potentially detrimental to designated uses. A methodology for listing nutrient-impaired lakes is currently under development.

The previously noted prioritization scheme (Figure 5) may work as well for prioritizing nutrient-based TMDLs efforts. Considerations in this process could be used as well for:
1) scheduling lakes for TMDL development following their listing on the TMDL list and;
2) to prioritize lakes for monitoring to evaluate whether they meet designated uses. For the former, the prioritization method (Heiskary, 1997) would suggest that lakes closest to the P criteria value be addressed first. This is based on the underlying concept that there is typically a greater likelihood of achieving water quality standards (use support) in a lake which partially-supports swimmable use in contrast to a lake which does not support swimmable use and may have watershed characteristics or morphometric constraints which may limit its ability to achieve water quality standards. This also should lead to more efficient use of TMDL funds (state and federal) and should provide an impetus to keep conditions from worsening in these partially supporting lakes.

Figure 5. Lake Prioritization—Swimmable Use Support

By ecoregion (all assessed lakes within a given basin, county, etc.)

(1.1) Lakes with Phosphorus (P) data

(1.2) **Protect** *Full Support (FS) or Marginal Support(MS)* — **Restore** *Partial Support (PS) or Non Support NS)*

(1.3) ---- **FS** ---- ------- **ST** ------ --------- **PS** ------ ------ **NS** -----

(1.4) current old old current current old old current

(1.5) **Protect** [2] **Monitor**[1] **Protect** [1] **Restore** [1] **Monitor**[2] **Restore** [2]

(1.6) **sort by size** (largest to smallest) largest lakes in highest priority in each category

(2.1) Lakes without P data (classify based on Secchi TSI) - need monitoring prior to developing protection programs

(2.2) **Protect** *Full Support (FS) or Marginal Support (MS)* — **Restore** *Partial Support (PS) or Non Support NS)*

(2.3) ------**FS**------- ------ **MS** ------ ------ **PS** ---- ------- **NS** ------

(2.4) current old old current current old old current

(2.5)**Monitor**[3] **Monitor**[1] **Monitor**[2] **Monitor**[2] **Monitor**[1] **Monitor**[3]

(2.6) **sort by size** (from largest to smallest) largest lakes highest priority in each category

Support Categories by ecoregion based on TP

Ecoregion	full support (FS)	marginal support (MS)	partial support (PS)	nonsupport (NS)
NLF	<25 ug/L	25 - 30 ug/L	30 - 50 ug/L	> 50 ug/l
NCHF	< 30 ug/L	30 - 40 ug/L	40 - 60 ug/L	> 60 ug/L
WCBP/NGP	< 40 ug/L	40 - 70 ug/L	70 - 90 ug/L	> 90 ug/L

Notes: Old = data > 10 years old, current = data <10 years old
Protect/Restore/Monitor - within category priority - 1= highest , 2 = secondary , etc.

Other strategies that could be considered in a prioritization process. Many of these considerations may be best implemented at a local level (e.g., local water plan). Some considerations are as follows:

Public Water Supply: Because of their inherent importance to a community and public health implications, lakes or reservoirs that serve as public water supplies should be a high priority for protection.

Economic Contribution: Certain lakes because of their size, depth, fishery and aesthetic values, or other characteristics may have a significant impact on a local or county economy. High resort usage, an abundance of public access, and/or a high tax base might reflect this. As a result, these lakes may be deemed a high priority for monitoring or protection.

Lake Depth: Lake depth is an important parameter to consider for further prioritization. Based on linear regressions of ecoregion reference lake data, mean depth is the single most important predictor of in-lake P (Heiskary and Wilson, 1988) and is a primary variable in most lake-eutrophication models. In general, deeper lakes, which stratify, tend to have lower P concentrations as compared to shallow lakes in the same region (Table 2). From a restoration perspective, deeper lakes should be prioritized higher than shallow lakes since they are more likely to respond favorably to reductions in nutrient loading, whereas shallow lakes may suffer from excess internal loading of P even after external P loads have been reduced. From a protection perspective, though, good quality shallow lakes might be considered a higher priority than deep lakes since small increases in P loading to a shallow lake may lead to rapid eutrophication, which may be difficult to reverse.

Watershed Size: Give lower priority to lakes with large watershed size as compared to lake surface area. Lakes with very large watershed-to-lake ratios (e.g., 100:1 or greater) often have very high NPS loads (MPCA, 1982), and it may be difficult to address enough sources of nutrients in their watersheds to exhibit visible improvement in lake quality.

Potential for Significant Changes in Land Use: Lakes classified as needing protection are often very susceptible to increased nutrient loading. One source of increased loading comes from dramatic changes in land use (e.g., urbanization of idle agricultural land or forestland). Lakes where these threats are currently occurring, or projected to occur in the near future, should be prioritized higher than those with threats anticipated in the distant future. For example, a high quality lake on the fringe of an urban area is more likely to have extensive development in its watershed in the near term than is a lake of similar quality, but very distant from a population center.

PROPOSED MANAGEMENT APPROACHES

Best Management Practices (BMP's) for Lakes (Lake Watersheds).

Much can be achieved in the prevention and abatement of nonpoint source pollution through appropriate planning in development and use of the landscape. Beyond good stewardship in planning, our management of resources within given land uses can have significant effect in the prevention or abatement of nonpoint source pollution. BMPs can be site specific voluntary practices that could applied following a hierarchical scheme:

1) Practices that avoid
2) Practices that control
3) Practices that contain
4) Practices that treat
5) Practices that mitigate

Further, BMPs can be viewed in a priority hierarchy to reduce NPS:

1) On-site
2) In transition from on-site to off site
3) Pre-discharge to a receiving water
4) In-situ (in the resource of concern, this would be an effort of last resort)

Projects or BMPs instituted as part of a protection project are not that much different than those that might be addressed in the course of a watershed-wide restoration (e.g., Case Study 4). One difference is the associated costs of doing a few projects to *protect* current in-lake conditions rather than numerous projects across large watersheds in an attempt to *improve* in-lake conditions (e.g., Case Studies 3 and 5). Some notes on potential management considerations and protection-related projects follow.

Developing Partnerships: Developing partnerships between local resource users, local units of government and state government are essential to successful watershed projects (e.g., Clean Water Partnership project). Minnesota Lakes Association (MLA), local water planners, COLAs, and lake associations routinely partner for monitoring and education efforts. The State complements these efforts by providing technical assistance. The Lake Forum, originally convened by the Freshwater Foundation in the early 1990s, was an attempt to bring a wide range of stakeholders together to share ideas on lake management in Minnesota (Freshwater Foundation, 1992). The Interagency Lakes Coordinating Committee reconvened this Forum in 2000 and MLA will revisit the issues brought up in the original forum. The Lake Forum could provide a continued means for addressing lake management issues and funding needs in Minnesota.

Lake Plan: In most instances, locally developed lake management plans will precede any meaningful protection efforts. The plans guide efforts and gain the buy-in of local government officials and state agencies. In this planning process, information on the lake and its watershed is assembled, goals for the lake and its watershed developed, and management options discussed. The MLA's Sustainable Lakes Planning Workbook will be a helpful resource in this regard.

Comprehensive Plans: Linking Minnesota's Nonpoint Source Management Program Plan (NSMPP) to local comprehensive plans and local water plans could improve implementation of the state's nonpoint source lake strategy. Local comprehensive plans form the legal basis for many of the land use decisions and controls that directly affect nonpoint source pollution, while local water plans will specifically address surface and groundwater management. These plans are particularly important for protecting lakes that are currently in good condition. Typical plans address a range of land use issues such as: urbanization, construction practices, septic system maintenance, wetland alteration, animal holding practices, and pesticide and herbicide application. The state should partner with and rely on local governments to implement the state's nonpoint source lake strategy and encourage the development of ordinances that might prevent problems before they occur.

Economics: Lakes are important to Minnesota's economy (Markuson, 1996). By establishing the *economic significance* of lakes in relationship to water quality, the need to protect or improve water quality will become readily evident and begin to justify the expenditure of funds for this purpose. For example, economic analyses in Maine and other locales associate the effects of water quality on lakeshore property prices (Michael et al., 1996). The Mississippi Headwater Board has an Legislative Commission on MN Resources (LCMR)-funded study underway which will attempt to apply these concepts in north central Minnesota.

Education: Education will be an important component of any protection or restoration strategy. Involving youth in these efforts targets the future beneficiaries of these efforts as well as future resource managers. The Lake Ecology curriculum, supported by MLA and local lake associations, is one example. Educational programs should deal with both the nature of specific threats to lake health and practical means for preventing damaging pollutant loadings from being exceeded (Case Study 1).

Urban/Residential Watershed Projects: Addressing storm water from existing and future developments is the number one water pollution concern in urban or urbanizing watersheds. The best opportunity to address storm water impacts, and protect a lake or stream, is when a parcel of land is under development. Other protective measures to consider include street sweeping, leaf litter control, stenciling of storm water drains (to discourage the introduction of pollutants), encouraging homeowners to use P-free fertilizers, and other educational opportunities intended to encourage BMPs throughout the watershed (Case Studies 1 and 2). As areas are re-developed this also affords an opportunity for BMP implementation. Properly developed and enforced ordinances may play an important role and help prevent problems before they occur.

Agricultural Watershed Projects: There are many opportunities to institute protection activities in the agricultural landscape. Projects of most significance, from a water quality protection standpoint, are those that minimize the amount of nutrients and sediments which move from the land to watercourses and ultimately to lakes in the watershed. Targeting lands adjacent to tributaries, ditches, or on the lakeshore may make the most sense where water flows are directly connected to the lake (Case Studies 3 and 4). Potential projects include: fencing livestock out of watercourses; ensuring that all livestock containment facilities in direct contact with a watercourse have adequate containment of wastes and adequate land to apply wastes; observing a setback when land-applying manure adjacent to streams, ditches and lakeshore areas; installation of vegetative buffer areas adjacent to watercourses [e.g., Conservation Reserve Program (CRP) Riparian Buffer Strips]; using BMPs on highly erodible lands; retirement (e.g., CRP or Reinvest in Minnesota) of highly erodible lands adjacent to or near watercourses; and restoring wetlands whenever possible.

Case Study 1. Lake Harriet Watershed Awareness Project: Making a Difference through Water Quality Education

The Lake Harriet project was a cooperative effort among the Minnesota Department of Agriculture, Minnesota Extension Service, and the Minneapolis Park and Recreation Board. It was a research project with two purposes: to inform homeowners about living in a watershed, and to help them learn how their lawn care habits can affect the quality of urban water. The project's goal was to improve water quality by reducing the quantity of pesticides and nutrients entering urban water.

The Lake Harriet watershed is a 1,139-acre area in a well-established residential neighborhood with almost 6,000 homeowners. The Lake Harriet study area is a 148-acre piece of the watershed. About 40% of the study area is covered with hard surfaces, like pavement and rooftops. About 700 homeowners live in the study area, most in single family houses built in the early 1900s. Lake Harriet is a source of year-round recreation for many Twin Cities residents.

This project monitored storm water, rainfall, and lake water to determine the levels of nonpoint source pollutants in Lake Harriet. Monitoring was done both before Lake Harriet residents received educational materials (1992-93) and after (1994-95).

There was a decrease in average pesticide loads between the earlier and later monitoring periods. The annual storm sewer runoff load of pesticides to Lake Harriet was reduced. The largest decreases came from four compounds: (MCPA 86%), Dicamba (59%), 2,4-D (58%), and MCPP (56%). The most prevalent pesticides found during monitoring were herbicides (weed killers). Eight herbicides accounted for 95% of all pesticide detections: MCPA,Dicamba, 2,4-D, MCPP, Alachlor, Atrazine, Cyanazine, and Metolachlor.

The four agricultural herbicides listed above - the only herbicides found in rainfall samples - were atmospherically deposited by wind and rainfall onto the watershed and the accompanying water bodies. Lawn herbicides were not detected in rainfall samples.

Analyses revealed that phosphorus in runoff peaks twice a year, in the spring and in the fall. In the spring, phosphorus is attached to tiny particles of grit, sand, and organic matter as it enters the storm sewers. In the fall, phosphorus in leaves, grass clippings, and other organic debris enters the storm sewers.

Lake Harriet project participants have concluded that educating homeowners living in the watershed is one of the best ways of reducing pollution in the lake. Many educational pieces were developed for the project including billboards, brochures and water bill inserts.

Case Study 2. Lake Protection Efforts: Lawn Fertilizers as a Source of Excess Nutrients in Urban Landscapes

Barten and Jahnke (1997), report that runoff from urban landscapes is a major source of nutrients, particularly phosphorus, entering lakes and streams in the Twin Cities Metropolitan Area (TCMA) of Minneapolis and St. Paul, MN. Furthermore, a potentially significant source of phosphorus to the urban runoff stream is from phosphorus fertilizer applied to lawns. In an effort to determine a direct relationship between stormwater runoff phosphorus levels and fertilizer application practices, a study by Barten and Jahnke, funded through the Minnesota Department of Natural Resources - Conservation Partners Grant Program, was undertaken in 1996 and 1997.

The study was initiated on 29 turf areas (separated into categories based on soil fertility level and the frequency of phosphorus fertilizer application) in the western TCMA. The objectives of the study were as follows; (a) determine if relationships exist between the fertility level of suburban lawns and the nutrient runoff from the lawn, and between the nutrient runoff from suburban lawns and the fertilizer application frequency to the lawns (b) determine if phosphorus fertilizer applied to lawns with high or very high phosphorus levels moves into the storm water stream; and (c) develop recommendations to minimize potential movement of nutrients from lawns to the storm water system.

Barten and Jahnke (1997) found that soil phosphorus fertility of lawns and phosphorus fertilizer applications were the two main factors responsible for transport of phosphorus from lawns into the stormwater stream. This suggests that much of the phosphorus fertilizer applied to lawns with very high levels of phosphorus is transported to the storm sewer system. Recommendations from the study included; (a) all lawns should be required to have a soil test prior to application of fertilizer; (b) municipalities and watershed management organizations should adopt phosphorus fertilizer bans prior to, or in addition to, implementing storm water BMPs for specific water quality programs; (c) retail fertilizer outlets should be encouraged or required to sell phosphorus free fertilizer; (d) municipalities should prohibit the application of phosphorus fertilizer by commercial lawn care companies; (e) the major fertilizer manufacturers should be contacted and encouraged to produce a phosphorus free product; and (f) municipalities should require tilling of the top five inches of soil after site grading prior to replacing topsoil

This study indicates that lawn fertilizers should be viewed as an important source of excess nutrients and should be addressed in any effort to protect or rehabilitate a lake in an urban area. It can also be used as one measure to protect lakes in non-urban areas with the focus being the lakeshore residents that surround the lake. In Minnesota several municipalities have instituted local ordinances addressing the use of P-bearing fertilizers. Also legislation was proposed during the 2000 legislative session to begin to address this source-category. Though it was unsuccessful that session, it is likely to return as an issue in future sessions.

Case Study 3. Rehabilitation of a Shallow Prairie Lake through Problem Identification and Implementation of Watershed Activities

Lake Shaokatan is a 995 acre lake located in the Northern Glaciated Plains ecoregion of southwest Minnesota in Lincoln County. With a maximum depth of about 12 feet and a predominately agricultural watershed it is fairly typical of lakes in this ecoregion. The lake has a history of water quality problems including severe nuisance blue-green blooms, summer and winter anoxia, and periodic fish kills. These problems were the result of excessive nutrient loading to the lake. A detailed Clean Water Partnership Phase I diagnostic study was initiated in 1989 and restoration efforts were underway by 1991. This detailed monitoring allowed for the characterization of phosphorus exports for several subwatersheds. Subwatershed land uses ranged from relatively low intensity land uses, such as Conservation Reserve Program (CRP) acres to high intensity uses such as row crop cultivation and feedlots. Phase II implementation included rehabilitation of three animal feedlots, four wetland areas, and shoreline septic systems.

1994 realized significant reductions in in-lake P with concentrations approaching the ecoregion-based P goal of 90 µg/L, in contrast to the 200 to 350 µg/L noted in previous summers. This resulted in reductions in the frequency and severity of nuisance algal blooms. Transparency has increased and anecdotal evidence suggests macrophyte populations are increasing. MDNR fishery survey report for 1996 indicates above average populations of walleye, perch, and black bullhead for a lake of its class. Good natural reproduction of walleye was noted as well. The Yellow Medicine River Watershed District and the local sportsman's club have continued limited monitoring and have indicated a willingness to expand post-restoration monitoring on this lake in collaboration with the MPCA and MDNR.

Continued vigilance is needed here however, if the quality of the lake is to be maintained or further improved. Watershed managers, agency staff, and lake users have noted several areas of concern: a) Portions of the upper watershed that were in CRP during the Phase I study have now since been put back into row-crop agriculture. While this portion of the watershed had been a minor contributor to the P loading reaching the lake it now could become a more important contributor if BMP's are not implemented that will minimize runoff and erosion from this hilly portion of the watershed. Monitoring has been instituted to try to evaluate post-CRP loading. b) Concerns have been expressed regarding the status and maintenance of septic systems in the shoreland area of the lake. Projects have been proposed to begin to address this issue. c) Poor operation and maintenance of feedlots near the lake resulted in huge quantities of P reaching the lake via tributaries adjacent to (or even in) the feedlot areas. There remain concerns that poor feedlot management in some portions of the watershed may continue to be a significant problem. d) Reductions in the frequency of algal blooms has allowed for increased transparency in the lake; however this increased transparency, combined with declining water levels, has contributed to extensive growth of macrophytes in the lake. While the macrophytes are important to the overall ecology of the lake they may also represent an internal load of P when they die-off in late summer. Water quality monitoring in 1999 revealed a late summer pulse in nutrients that could not be explained from watershed loading. This pulse of nutrients led to late season algal blooms.

This case study reveals both the success that can be attained through nonpoint source control -- especially where the "nonpoint" sources are related to animal agriculture and huge load reductions can be realized. However, it also reveals the need for continued vigilance through monitoring and observation in the watershed – both of which can target the need for additional work. It also indicates the complexity of trying to rehabilitate a shallow well-mixed prairie lake where not only external P loading but also internal loading may need be addressed.

Case Study 4. Protecting a High Quality Lake Resource through Small Preventative Projects

Lake Miltona is a 5,900 acre lake located just north of Alexandria in Douglas County. It is among the largest and deepest lakes in the state. A collaborative Lake Assessment Program (LAP) study of Miltona and its watershed was done by MPCA in 1990 in conjunction with the lake association, NRCS, Douglas County local water planner and MDNR. Land use in the watershed was a mixture of agricultural (43%) and forest, water, and marsh (55%) as is typical for lakes in the region.

The condition of the lake was found to be quite good; however the lake association and resort owners repeatedly expressed concern over pasturing operations that were located near the lake shore or on tributary streams. One such operation was about 50 yards upstream of the lake. Cattle routinely were in the stream, causing shoreline erosion and bank slumping, and had denuded vegetation in the shoreland area along the tributary. A resort with a swimming beach was located near the mouth of the tributary. These cattle contributed excess sediment and nutrients to the lake as well as a potential health hazard for users of the beach. In recognition of this problem, Douglas County NRCS and the lake association (they contributed landowners portion of cost-share) worked with the landowner to cost-share a project that fenced cattle out of the stream, placed a culvert in the stream and a bridge over the culvert that allowed access to the other side of the pasture. This project was initiated in the spring of 1995 and by mid-summer 1995 the former pasture and riparian area was fully vegetated and stabilized. Also in 1995 an erosion control project was put in place elsewhere along the lake. This project targeted some severe gully erosion that was occurring on a steep slope of the lake, resulting in a sand delta at the mouth of the gully. During the summer of 1999 another pasturing area on a tributary at the north shore of Miltona was addressed by NRCS. A buffer was installed along the tributary.

The LAP study and report, that had been conducted on the lake, was used as a basis for the justification of these projects and helped to secure matching funds at the county level. In each of these cases there was no detailed diagnostic work, nor would we ever be able to document improvements in the mid-lake water quality as a result of these projects. These projects could be considered low-cost common sense efforts intended to address obvious sources of pollution to the lake. These projects, applied in the watershed of a high quality lake, could truly be considered protective in nature and hence can be justified without the need for extensive diagnostic studies.

Protecting Shoreland Habitats:
Protecting shoreland habitats (terrestrial and aquatic) is important as well and presents some important challenges. The plants at the shore water interface provide important habitats for aquatic life and serve to protect shorelines from wind and wave erosion. There are a variety of manuals and handbooks that provide ideas on protection of enhancement of near-shore areas. Programs which encourage the reestablishment or maintenance of native plants along the lakeshore, that reduce the amount of control of aquatic plant communities in the lake, that decrease the amount of overland water flow and increase the amount of infiltration will help protect and restore Minnesota lakes. A wide variety of management approaches are available that might accomplish this goal. Projects, which meet the following criteria, should be given priority:

Results in nonpoint source reduction/ protection which provide the most significant improvement/the greatest degree of protection -- those that provide the "biggest bang for the buck". For example, priority should be given to projects on lakes where nutrients loads from shoreland areas is (or could) be a major contributor to the lake's nutrient budget.

Results in reduction/protection efforts that reach the largest number of people/impact the largest shoreline area. For example, while acquisition may provide complete protection/restoration of a particular parcel, its total impact to the lake may be limited by the cost of acquiring property.

Projects which integrate well with other existing programs/effort: In addition to these projects, private property owners should be provided with incentives to keep sensitive shoreland habitats from being developed via conservation easements, property tax incentives or other mechanism.

Permitting and ordinances: In addition to voluntary BMPs, education and other methods, there are "regulatory" approaches that can help to protect and improve lake water quality. National Pollutant Discharge Elimination System (NPDES) permits on upstream point sources play an important part in the management of nutrient loading to some reservoirs and lakes with upstream dischargers. However, these reductions often need to be complemented by nonpoint source control as well – especially during high flow years (Case Study 5). Some counties are beginning to use land-zoning authority to exclude intensive land uses such as livestock feedlots from locating within a lakeshore zone. Other measures include observing proper setbacks when developing lakeshore property, minimizing erosion during construction, and requiring individual sewage treatment systems (ISTS) systems to be in compliance with state and local codes. Increased attention has been placed on ISTS in recent years, and there is a great deal of interest on behalf of lake associations and others to bring systems in the shoreland areas up to code. Erosion control and stormwater ordinances, developed at the local level, may be helpful tools as well.

In-lake controls to address internal recycling of contaminants: Several waterways in Minnesota have benefited from nutrient control programs. Frequently, however, internal loading of phosphorus from the sediments slows the recovery of these systems. Remediation options are limited due to the expense of handling the sediment. This is especially true when high volumes of moderately contaminated sediments are present. Disposal costs often make dredging an unattractive option. With respect to internal recycling of phosphorus the most common method is the use of aluminum sulfate (alum) or ferric chloride that will tend to bind/inactivate phosphorus and provide somewhat of a seal to minimize the release from deeper sediments. In addition, aeration and related physical measures have also been used (with limited success) to create an oxygen-rich environment that discourages recycling. There is extensive research and documentation in the literature on the use of these and other techniques to minimize internal recycling. Longevity of these treatments is always a valid concern. In general these techniques often work better in deeper stratified lakes than in shallower well-mixed lakes.

Following are some examples of lakes that could benefit from reductions in internal loading of phosphorus. Some examples follow:

Trout Lake: Trout Lake is located in north central Minnesota. It received wastewater from the city of Bovey-Coleraine since the early 1900s and tailings from past mining activities. The wastewater discharged was removed from the lake in the late 1980s. Because of internal phosphorus loading and a very long water residence time recovery of the lake may be slow. A LAP study was conducted in 1987 and this was followed by a Clean Lakes study in the 1980s. The condition of the lake continues to be monitored and various solutions for speeding recovery have been proposed.

Case Study 5. Lake rehabilitation through point and nonpoint source control of nutrients

The Sauk River or Horseshoe Chain of Lakes, as they are referred to, is located in Stearns County near the mouth of the Sauk River. At about 3.7 square miles of surface area the Chain is rather small as compared to the entire drainage are of the Sauk River at about 940 square miles. The large watershed to lake ratio (104:1) translates to very high water and nutrient loading. As a result of high nutrient loading from both point and nonpoint sources the Chain has had a long history of poor water quality characterized by frequent and severe nuisance blooms of algae and low transparency. Given these characteristics the Chain would not be a good candidate for small protective measures – rather more drastic reductions in nutrient loading were required.

In this case an extensive study (Phase I – type study) was needed to fully characterize the in-lake water quality and create a water and nutrient budget over a range in flows. Much of this work was conducted by the MPCA in the mid-1980's. These studies indicated that although nonpoint source phosphorus loading was very high during high flow years, point sources were a significant contributor as well, especially during low flow. In fact it was estimated that the city of Melrose, which is approximately 40 miles upstream of the Chain contributed on the order of 50 percent of the phosphorus loading during low flow conditions. This finding led to a 1mg/L P limitation being placed on Melrose's discharge as a part of its NPDES permit. Several other municipal dischargers in the Sauk River watershed received effluent limitations as well in subsequent years.

Since Melrose was required to remove phosphorus, there has been an improvement in Horseshoe Lake water quality. Prior to P control at Melrose (1991) and the other facilities, Horseshoe Lake in-lake P ranged from 200 to 300 µg/L during high flow years and from 400 to over 600 µg/L in low flow years. Since that time in-lake P has ranged from about 100 to 150 µg/L during the high flow years that were characteristic of the 1990s. While there were no significant changes in the average transparency of the lake, there were measurable and perceptible reductions in the frequency and intensity of nuisance algal blooms.

The water quality of the Chain has further room for improvement though. With the reduction in the point source portion of the nutrient loading the stage has been set for nonpoint source control in the watershed. The MPCA through the Clean Water Partnership Program (and 319) has been actively involved with the Sauk River Watershed District, Stearns County Environmental Services, Stearns SWCD and others to address the numerous nonpoint source problems in this watershed. These problems range from issues associated with animal agriculture such as: land application of bio-solids, fencing of cattle out of waterways, feedlot permitting; to promotion of BMPs on cultivated lands; to wetland restoration; to addressing compliance with on-site septic system regulations. All these source-categories need to be addressed if there is to be further substantial improvement in the water quality of the Sauk River and the Chain of Lakes.

Fountain and Albert Lea lakes: Fountain and Albert Lea lakes are located in south central Minnesota. Phosphorus limitations have been implemented on point sources, however the lakes remain hypereutrophic. Discussions continue on the need to address sediment-related sources of P in these shallow lakes.

Shagawa Lake: The city of Ely has discharged to the lake for several decades. A strict phosphorus limitation was placed on the discharge in the 1970s. Lake quality has improved, however, internal phosphorus loading has slowed the recovery. Monitoring continues here to document changes over time as well as the influence of internal recycling.

Horseshoe Chain of Lakes (Case Study 5): Dramatic reductions in in-lake P have realized in this chain as a result of upstream point and NPS reductions. Internal recycling of P may slow the recovery of the lakes in this chain. During low flow summers this internal loading may be a particularly important part of the nutrient budget of these lakes. Further monitoring will serve to estimate the significance of this source.

CONTAMINATED SEDIMENT

Potential chemicals of concern can attach to suspended particulates in water and subsequently settle out to the bottom mud (sediment). Through complex chemical, physical and biological interactions, these pollutants may be further transported to other parts of the aquatic ecosystem. At elevated concentrations, contaminated sediments contribute to many impaired uses, including fish advisories, habitat impairments and restrictions on dredging. Additional information about contaminated sediments can be found on the MPCA Web Site at: http://www.pca.state.mn.us/water/sediments/index.html.

Chapter 4: Overall Strategy for Each Water Resource
Strategy 4.2 Lakes
Needs, Priorities, Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) 5-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement. (NOTE: Strategy 4.2 was not a part of the 1994 NSMPP. Therefore, no 1994 Needs, Priorities and Milestone Table is provided).

Goal 1: Work With USEPA on the Development of Ecoregion-Based Nutrient Criteria as a Part of the Clean Water Action Plan.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Participate in the Regional Technical Assistance Group to determine appropriate ranges of criteria.	X	X	X			USEPA, 104(b) 3	MPCA
2. Participate in National Nutrient Criteria Work Group.	X	X				USEPA	MPCA
3. Comment on national nutrient criteria ranges.	X					State General Funds	MPCA
4. Begin work on promulgation of nutrient standards for lakes and rivers.	X		X	X		State General Funds	MPCA
5. Complete promulgation of standards.					X	State General Funds	MPCA

Goal 2: Promote Lake Monitoring, Protection and Prioritization at the Local Level – Including Local Comprehensive Plan Development and Implementation and Source Water Protection.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Provide grants to local water plans for additional monitoring – leading to prioritization.	X	X	X			319, 314	BWSR, MDH, LGU
2. Collaborate on prioritization with local water plans – test cases.		X	X			319, 104(b)3	BWSR, LGU, MPCA
3. Test implementation of nutrient criteria.			X	X	X	104(b)3	MPCA
4. Link comp. Plans to NSMPP.		X				319	BWSR

Goal 3: Provide Funding and Technical Assistance to Lake Watershed Management Projects Where Lake and Watershed Evaluations Have Been Conducted and Lake Water Quality Improvements are Projected Based on Implementation of Specific Best Management Practices (With an Emphasis on Protection Whenever Possible).

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Support projects proposed through local water plan.	X	X	X	X	X	319, 314, CWP	BWSR, MPCA, LGU
2. Compile case studies on current and past projects (e.g. CWP) to evaluate success of projects.		X	X			319, 104(b)3	MPCA, BWSR
3. Evaluate success of new projects, solicit case studies.			X	X	X	State - CWP	MPCA
4. Integrate protection-oriented prioritization concepts into project selection.		X	X	X		319	MPCA, BWSR, LGU

4. Expand State's Lake Water Quality Database Via Conventional and New Technologies and Use of Citizen Volunteers. Focus on Those Lakes Most Likely to be Impacted by Development and Other Land Use Changes.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Conduct a targeted effort, in cooperation with local water plans and volunteers, to acquire trophic status data on all lakes of 100 acres or more.		X		X		319, 314	MPCA, local water plan, COLA
2. Increase amount of information in STORET, state water quality database and access to it.	X	X	X			State General Funds	MPCA, USEPA
3. Employ remote sensing and other techniques to improve characterization of state's lakes.			X		X	LCMR, 319	
4. Establish a set of trend and intensive study lakes.		X	X		X	319, LCMR	MPCA, MDNR
5. Report on status and trends, include intensive study lakes.		X		X		State General Funds	MPCA

Goal 5: Develop Incentives Program for Protection of Shoreland (Aquatic and Terrestrial) Vegetation and Broader Implementation of BMPs.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Fund projects through local water plan process.	X	X	X			319, state match	MDNR, Extension, LGU
2. Increase efforts to protect vegetation through easement and other incentives.	X	X	X			State General Funds	MDNR, Extension
3. Continue and expand education.	X	X	X	X	X	State General Funds	Extension, MDNR, MLA
4. Increase number of baseline GIS vegetation maps for trend assessment purposes.		X	X	X		LCMR	MDNR

Goal 6: Expand Information and Education on Appropriate BMPs, Ordinances and Strategies for Lake Protection.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Share experience of zoning administrators and provide training as needed for ordinance development and implementation.		X		X	X	319	MPCA, BWSR, Extension
2. Address growth-related issues as they relate to lake protection and responsibilities of LGU.		X		X		LCMR	State Plan, BWSR
3. Educate realtors and developers on lake-friendly techniques for development and maintenance.		X	X	X		319	Extension, BWSR, MLA
4. Reconvene the Lake Forum on a routine basis to address these issues at a statewide scale.		X		X		319, LCMR	ILCC, MLA
5. Promote P criteria as a means for prioritization.		X	X			State General Funds	MPCA, local water plan
6. Conduct outreach to local decision-makers on lake planning, shoreland BMP projects, etc.		X	X	X		319	BWSR, MLA, Extension

Goal 7: Evaluate Soil Phosphorus Fertility and Develop Management Strategies for Residential Turf, Recreational Turf (E.G. Golf Courses and Parkland) and Agricultural Lands.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Attain passage of legislation that restricts the use of phosphorus fertilizers on residential turf.	X	X				State General Funds	MDA, U of M Ext
2. Evaluate the soil phosphorus fertility and phosphorus use on recreational turf areas.	X	X				319	MDA
3. Develop management strategies for the use of phosphorus fertilizers on recreational turf areas.		X	X			319	MDA
4. Evaluate the soil phosphorus fertility and phosphorus use on agricultural lands.		X	X			319	MDA
5. Develop management strategies for the use of phosphorus fertilizers on agricultural lands.			X	X	X	319	MDA

Goal 8: Promote Monitoring and Compilation of Bacteria at Beaches.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop a comprehensive data base for compiling and reporting beach monitoring data.	X					319	MDH, LGU
2. Consider USEPA recommended changes to bacteria criteria in next rules revision.		X	X			State General Funds	MPCA
3. Assess beach data as a part of 305(b) swimmable use assessment.			X			305(b)	MPCA, MDH
4. Determine strategies for addressing beach bacteria problems.			X	X	X	State General Funds	MDH

Goal 9: Minimize the Impact of Urban Storm Water Runoff to Lakes.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Encourage the removal of grit, at a minimum, from stormwater inflows to lakes.	X	X				319	MPCA, LGU, Met Council
2. Ensure awareness of stormwater rules and regulations for communities outside Metro Area.	X	X	X			State General Funds	MPCA, LGU
3. Enforce stormwater rules as needed to ensure compliance with Phase II.		X	X	X	X	State General Funds	MPCA, LGU, Met Council
4. Encourage development of erosion control and stormwater ordinances to prevent problems.	X	X	X			State General Funds	BWSR, MPCA, LGU

Goal 10: Complete Analysis Of Sediment Core And Water Quality Data From The LCMR "Sediment Core Lakes Project." Augment Or Complement This Data As Necessary.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Further characterize regional patterns and data ranges. Incorporate into P criteria development	X	X				LCMR	MPCA, Science Museum
2. Augment database to provide yardsticking for sediment data and develop "clean-up goals."	X	X				104(b)3	MPCA
3. Conduct further sediment core analysis as needed to complement statewide data or specific projects		X	X	X	X	LCMR, CWP, 319	MPCA, LGU

Goal 11: Review Impacts To Lakes Caused By Ditch Projects And Clean-Outs.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop alternative designs for ditch projects that incorporate nutrient and sediment reduction strategies	X	X				319	MDA
2. Evaluate the significance of phosphorus loss from partially drained wetlands		X				LCMR	MDA MPCA,
3. Examine economic impact of ditching on lake water quality.			X	X	X	LCMR	MDA Extension
4. Develop and support drainage practices that reduce nutrient input to lakes.		X	X	X	X	State General Funds	MDA MPCA Extension, SWCDs

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Chapter 4 Overall Strategies for Each Water Resource
4.3 Rivers and Streams Strategy

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Introduction

Streams and rivers integrate aquatic and terrestrial conditions of the landscape. This interaction occurs along three measurable dimensions:

1. Physical - incorporating hydrologic and geomorphic processes, relating to the movement of water and its action on the channel, riparian area, and watershed,
2. Chemical - relating to the cycling of materials from the land through the water, and
3. Biological - relating to the processes that support plant and animal life in the stream and river and in its watershed (see Box 1).

To assure the health of streams and rivers, effective nonpoint source (NPS) pollution management strategies must recognize these processes and the interrelationship of these processes. Emphasizing one or the other will alleviate a symptom, but not remove a cause.

Since the passage of the national Clean Water Act (CWA) in 1973, pollution mitigation concentrated on measurement of the chemical processes of water quality, and consequently, regulated use of rivers according to measures of water chemistry, chiefly through the regulation of point source discharges to rivers. Today, resource managers recognize that they must pay attention to the movement of water through the river channel, the shape and breadth of the channel, and the biological processes it engenders, as well as its chemical composition, to understand if a river is healthy. Today, managers recognize that nonpoint source pollution results when a river's natural processes are disturbed.

Human activities degrade water resources by altering one or more of five groups of attributes:

1. Water quality – temperature, turbidity, dissolved oxygen, organic and inorganic chemicals, heavy metals, toxic substances.
2. Habitat structure – substrate type, water depth and current velocity, spatial and temporal complexity of physical habitat.
3. Flow regime – water volume, temporal distribution of flows.
4. Energy source – type, amount, and particle size of organic material entering stream, seasonal pattern of energy availability.
5. Biotic interactions – competition, predation, disease, parasitism.

The Rivers and Streams strategy will discuss briefly the status of nonpoint source issues in Minnesota's major river basins, and then examine the significant water quality disturbances linked to nonpoint source pollution in Minnesota, particularly, hydrologic modification, sedimentation, nutrient over-enrichment or eutrophication, and biotic impairment.

This strategy will provide some guidance for managers seeking to improve understanding of how nonpoint source pollution arises and how it can be managed, and then present goals, milestones and action steps to manage nonpoint source pollution in Minnesota's streams and rivers for the next five years.

Nonpoint source pollution is a critical issue for Minnesota's streams and rivers. Rivers and streams are important ecologically and economically to Minnesota and its residents. Here's a partial list of functions performed by rivers and streams that are important to Minnesotans:

- Flow of water;
- Storage of flood waters;
- Enrichment of the soil through sedimentation;
- Removal of pollutants through movement through riparian zones;
- Dilution and/or removal of wastes;
- Regulation of temperature;
- Cycling of oxygen, carbon, nitrogen and phosphorus;
- Export of organic and inorganic materials;
- Habitat for fish and game;
- Recreational use;
- Source of drinking water;
- Economic use through the capture and release of flow, and
- Economic uses through the storage and release of waters.

1. RESOURCE MANAGER'S GUIDE TO STREAM HEALTH

What questions does a resource manager need to answer in order to develop an integrated understanding of a stream's health? This list is taken from USDA Stream Corridor Restoration: Principles, Processes, and Practices, 1999, Chapter 1. This invaluable manual is available on-line at http://www.usda.gov/stream_restoration/

Hydrologic processes

- Where does the stream flow come from?
- What processes affect or are involved with stream flow?
- How fast, how much, how deep, how often and when does water flow?
- How is hydrology different in urban stream corridors?

Geomorphic processes

- What factors affect the channel cross section and channel profile?
- How are water and sediment related?
- Where does sediment come from and how is it transported downstream?
- What is an equilibrium channel?
- What should a channel look like in cross section and in profile?
- How do channel adjustments occur?
- What is the floodplain?
- Is there an important relationship between a stream and its floodplain?

Chemical characteristics

- What are the major chemical characteristics of the stream?
- What are the important relationships between physical habitat and key chemical parameters?
- How are the chemical and physical parameters critical to the aquatic life in a stream corridor?
- What are the natural chemical processes in a stream corridor and water column?
- How do disturbances in the stream corridor affect the chemical characteristics of stream water?

Biological community characteristics

- What are the important biological components of a stream corridor?
- What biological activities and organisms can be found within a stream corridor?
- How does the structure of stream corridors support various populations of organisms?
- What are the structural features of aquatic systems that contribute to the biological diversity of stream corridors?
- What are some important biological processes that occur within a stream corridor?
- What role do fish have in stream corridor restoration?

"A river and its basin is an ecological system, a set of processes that each contribute to its health. Nonpoint source pollution results when a river's natural processes are disturbed."

REVIEW OF CONDITIONS IN MINNESOTA'S MAJOR DRAINAGE BASINS

Minnesota's rivers and streams have been disturbed in many ways. Minnesota's nonpoint source pollution management plan for rivers and streams needs to begin with an assessment of the scope of the problems.

Minnesota has 10 major river systems – Red, Rainy, St. Louis-Superior, Upper Mississippi, the Lower Mississippi and its tributaries, the St. Croix, Minnesota, Cedar and Des Moines rivers. The Rainy and the Red Rivers, which drain the Canadian Shield and the Lake Agassiz Basin, flow northward toward Hudson Bay. Water from the St. Louis River and the many swift-flowing streams emptying into Lake Superior along its North Shore reaches the Atlantic Ocean via the Great Lakes and the St. Lawrence River. The Des Moines River, which drains a portion of southwestern Minnesota, enters the Missouri River, which eventually joins the Mississippi River. These rivers are significant sources of drinking water for approximately 11 cities, including the state's largest metropolitan areas. Rivers provide water for the state's energy industry. Rivers are the backbone of the state's significant game fishery.

A review of conditions in the state's major river basins helps to define the challenges facing nonpoint source pollution managers.

The **Red River Basin** lies on the remnants of Glacial Lake Agassiz. The basin is home to the world's most productive agricultural soils. The river valley is bounded to the east be a series of steep beach ridges defined by the glacial lake. The valley floor has almost no topographical relief. Most of this land is cultivated for agriculture. An extensive drainage system has been built from the beach ridge to the river channel. Nonpoint source pollution problems are significant in this basin. Examples of nonpoint source pollution in the Red River Basin are:

- Increased runoff
- Incised channels
- Increased erosion
- Impaired fish and wildlife habitat, less diversity and more pollution tolerant species
- Increased flooding
- Unsewered communities
- High background levels of carbon and mercury

The **Rainy River Basin** is relatively undeveloped, including lands lying within two national wildlife preserves: Voyageur's National Park and the Boundary Waters Canoe Area. Point sources of air and water pollution were significant before the passage of the Clean Water Act and other federal legislation, and have been largely remedied. Nonpoint source pollution problems are not significant in this basin. Issues of concern are:

- Recovery from industrial pollution
- Contaminated sediments
- Erosion from logging
- Unsewered communities

The **St. Louis/Superior Basin** is relatively healthy. Part of the basin lies within the Boundary Water Canoe Area. The St. Louis River has been the target of federal and state programs to reduce pollution to it, and these have been successful in improving water quality. However, contaminated sediment in the river and at its mouth to Lake Superior is a continuing issue. Nonpoint source pollution problems are not significant in this basin. Issues of concern are:

- Mercury
- Polluted sediments
- Shoreline development
- Noncompliant individual sewage treatment systems (ISTS)
- Vegetation removal and changes to stream watersheds
- Removal of wetlands
- Unsewered communities
- Erosion from logging

The **St. Croix Basin** is the least impacted of Minnesota's major drainage basins; it is also home to Minnesota's only National Wild and Scenic River. Nonpoint source pollution problems are not significant in this basin. Issues of concern are:

- Small municipal wastewater treatment plants
- Sprawl/urbanization pressures
- Recreational uses
- Nutrient management plan
- Unsewered communities
- Erosion from logging

The **Upper Mississippi River Basin** begins its course flowing through five state parks and the Chippewa National Forest. On the whole, the basin is relatively healthy. However, this basin is complicated, and its future should be closely monitored. A number of land uses that contribute to nonpoint source pollution converge in the greater St. Cloud area. These include animal agriculture, especially feedlots for poultry and cattle, urban growth and management of municipal wastewater treatment plans, suburban or "exurban" growth and the development of individual sewage treatment systems. Logging is a significant activity in the basin. Nonpoint source pollution problems are of concern in this basin. The following issues are critical:

- Loss of vegetation and hydrologic modifications
- Increasing runoff
- Sedimentation and erosion
- Eutrophication
- More contaminants
- Noncompliant ISTS
- Ground and surface water connections
- Nitrates in sand plain aquifers and alluvial outwash materials
- Contribution to hypoxic conditions in the downstream locations

The **Minnesota River Basin** has been significantly altered, with most of its land area converted from wetlands and shallow lakes to agriculture. The natural drainage system has been hydrologically modified to accelerate the flow of water to the Minnesota. The basin has been the target of intensive water quality diagnostic and remediation work. As a result, the point source of contribution of phosphorus has been significantly reduced. "River friendly" practices such as conservation tillage have been implemented throughout the basin, which have contributed to the reduction of sediment in the river. However, nonpoint source issues remain significant. Issues of concern are:

- Loss of wetlands and storage
- Increased volume of water flowing off the land
- Increased velocity of water flow
- Flooding
- Increased runoff
- Increased sediments and nutrients
- Increased fecal coliform bacteria
- Contribution from wastewater treatment plants
- Unsewered communities
- Noncompliant ISTS
- Contribution to hypoxic conditions in the downstream locations
- Feedlots

The **Lower Mississippi Basin** has been significantly altered, through logging and agriculture, industrialization and urbanization more recently. These changes introduced a variety of chemicals to the region. Land use changes, and the connection between ground and surface water, led to contamination of rivers and groundwater. Nonpoint source pollution is a concern in this basin, and significant issues are:

- Contribution from industry
- Contribution from wastewater treatment plants
- Unsewered communities
- Eutrophication
- Fecal coliform contamination
- Increased sediment
- Increased nutrients
- Impaired trout habitat

Disturbances to Streams that Cause Nonpoint Source Pollution

The Clean Water Act (CWA) is the keystone for surface water quality protection and restoration at the federal, state, and local levels. The CWA requires states to designate uses for all stream segments, called reaches. Designated uses for streams, lakes, and wetlands include, but are not limited to, fishing, swimming, aquatic plant and animal diversity, and drinking.

In CWA Section 303(c), and accompanying regulations and guidance, the CWA requires states to create water quality standards to protect designated uses. Water quality standards are both narrative and numeric. An example of a narrative water quality standards is chapter 7050.0222, subpart 4:

"The quality of Class 2B surface waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water sport or commercial fish and associated aquatic life, and their habitats. These waters shall be suitable for aquatic recreation of all kinds… ."

An example of a numeric water quality standard is un-ionized ammonia, which has a chronic water quality standard (WQS) of 40 micrograms nitrogen per liter.

Section 303(d) of the CWA and accompanying regulations and guidance requires states to monitor lakes and streams and list those waterbodies that are not fully supporting designated uses. Placement on the state's 303(D) list triggers the response of establishing a Total Maximum Daily Load, or TMDL, list of impaired waters. The state must study listed waterbodies and create pollution reduction budgets so that designated uses can be regained. In its current usage, the acronym TMDL can mean either a process to determine a pollution reduction budget or the pollution reduction load goal itself.

Minn. R. ch. 7050 (Chapter 7050) provides authority to the Minnesota Pollution Control Agency to set standards for allowable levels of chemical parameters depending on intended uses of the streams, rivers, wetlands or lakes. Chapter 7050 provides narrative standards protecting for biota and habitat as well. Chapter 7050 assigns multiple water use classifications to all surface waters of the state. These include: Class 1 Domestic Consumption; Class 2 Aquatic Life and Recreation; Class 3 Industrial Consumption; Class 4 Agriculture and Wildlife; Class 5 Aesthetic Enjoyment and Navigation; Class 6 Other Uses; and Class 7 Limited Resource Value Waters. While not all surface waters in Minnesota are specifically listed in Chapter 7050, all surface waters are classified with assigned uses.

As a simplified description, the State's multiple use classification system classifies all surface waters of the state Class 3 through 6. Depending on the existing and attainable uses of these waters (or certain reaches of these waters), they are then either designated as Class 2 aquatic life and recreation waters or as Class 7 limited resource value waters. In addition, certain waters may also be designated as Class 1 waters for drinking water purposes, and some are also designated separately for a higher level of nondegradation protection (i.e. Outstanding Resource Value Waters).

Class 7 limited resource value waters are primarily low flow streams and ditches where the stream flows are generally intermittent or have a flow at the once in ten year, seven day low flow (7Q10) of less than one cubic foot per second. Class 7 waters are protected for secondary water contact use by humans, for recharge of ground water for potable use, and for aesthetic qualities. As noted above, Class 7 waters are also assigned Class 3 through 6 uses. Effluent limits assigned to continuous discharges to Class 7 waters are often times less restrictive than those assigned to a Class 2 water of comparable size. All other things being equal, for low flow watercourses, a Class 7 discharger would likely be assigned a 15 milligrams per liter (mg/L) carbonaceous biological oxygen demand (CBOD5) effluent limit and a Class 2 discharger would likely be assigned a 5 mg/L CBOD5 effluent limit along with seasonal ammonia effluent limits.

Preventing or mitigating nonpoint source pollution in streams and rivers requires techniques that protect or support the key processes of streams and rivers, and consequently, protect or enhance the ecological goods and services of the river or stream. The key processes of rivers and streams change over time and space, which is a complicating factor for resource managers developing nonpoint source reduction plans.

For example, a river's water quality changes throughout the year. Water flow decreases in dry times and increases in wet times. A river's capacity to accommodate disturbances to its watershed changes from its headwaters, to its confluence's with tributaries, and at its mouth.

Development of the flood plain is another example of the cumulative effect of disturbances to a river system. A relatively stable river system uses the flood plain to relieve the energy during high flow events. When a river or stream is cut off from its flood plain through development, the channel itself must carry high flows. The channel now starts a long process to down cut, widen and recreate a floodplain to balance the energy at all flow regimes. However, as the floodplain becomes developed with impervious surfaces, more overland runoff will be carried directly into the channel rather than filtering through the vegetation and landforms of an undisturbed floodplain. Therefore, the loss of the floodplain increases the delivery of materials produced as byproducts of land uses in the watershed – sediment, nutrients, bacteria, toxic materials – to the river channel. River channels naturally incise. However, in many areas of Minnesota, especially the Minnesota and Red River basins, human actions have accelerated this process. Management of the floodplain and the stream channel as a unit could minimize loading rates or loss of assimilation capability.

The growing "dead zone" in the Gulf of Mexico illustrates that nonpoint source pollution has both a local and a cumulative effect. The dead zone results from the loss of oxygen (hypoxia), which has been determined to be largely the result of excess nitrogen. Minnesota contributes 8 percent of the nitrogen load, much of which has its origins in subsurface tiles in the Minnesota River Basin. It's an example of how an alteration to a stream's natural conditions – elevated nutrients – can grow from a local concern to a national one – threatening the fishery of the Gulf of Mexico, located more than 2,000 miles from the Minnesota farmland (see Box 2).

Minnesota's nonpoint source pollution problem has its origins in four types of disturbances:

1. Hydrologic modification of the stream's flow regime, including the size and shape of the channel, the flow of water from the watershed to the channel and the connection between the channel and its flood plain;
2. Sedimentation, which is associated with hydrologic modification, but also results from changes to land use in the watershed;
3. Nutrient enrichment, and
4. Impairment of biological conditions and the ability to support aquatic life.

Other issues are more localized in scope. These include bacteria, mercury, chlorides, floatable trash and the emerging issues of pharmaceuticals and pesticides in streams and rivers. To a large extent, addressing the first four issues will help resolve the critical local issues.

Hydrological Modification

The hydrologic cycle describes the movement of water from atmosphere to, over and through the ground and its return to atmosphere. Input of pollutants can take place at any point within the cycle.

2. HYPOXIA IN THE GULF OF MEXICO
(FROM http://www.epa.gov/msbasin/gulfmex.html)

On the Gulf of Mexico's Texas-Louisiana Shelf, an area of hypoxia (low dissolved oxygen levels) forms during the summer months. The area has been measured as large as 7,000 square miles; in Summer 2000, it was approximately 1,500 square miles in area. This condition is caused, in part, by a complicated interaction of excessive nutrients transported to the Gulf of Mexico by the Mississippi River. About two-thirds of the nitrogen load to the hypoxic zone comes from upstream agricultural land use. About 8 percent of that total nitrogen load comes from Minnesota's farmlands, chiefly via subsurface tile drainage. Other factors include physical changes to the river, such as channelization and loss of natural wetlands and vegetation along the banks; and the interaction of freshwater from the river with the saltwater of the Gulf.

The nature of the hypoxia problem is further complicated in that some nutrient load from the Mississippi River is vital to maintaining the productivity of the Gulf fisheries. However, too many nutrients can eventually adversely affect commercial and recreational fishing. Approximately 40 percent of the U.S. fisheries landings, including a substantial part of the Nation's most valuable fishery (shrimp), comes from this productive area. Commercial landings of all species in both 1995 and 1996 for Louisiana, Mississippi and Texas were 1.4 billion pounds, with 82% from Louisiana waters for both years.

Each element of the cycle (air, surface, and ground) is interconnected. For example, improper applications of pesticides on the land may be washed into ditches and streams. Flooding may then redistribute these pollutants across the floodplain with potential impact to the source water of public wells (ground water).

Nonpoint source (NPS) pollution is the accumulation of many sources within a watershed that drains to a waterbody. Best management practices (BMPs) must be designed on a case-by-case basis to prevent, capture and treat NPS pollution as close to the source as possible. The larger the watershed, the more complex and costly the treatment required to protect its water quality. The primary pollutants of concern are sediment, nutrients (nitrogen and phosphorus), pesticides and pathogens (virus, etc.).

To effectively control NPS pollution, it is necessary to address both the source reduction of the pollutants and the pathways/ mechanisms and quantities of flow which move and concentrate them.

Wind and water are the two major movers for NPS pollution with water usually being the primary factor. Moving water dislodges soil particles and mobilizes chemical compounds. Both the quantity and velocity of moving water affect the water quality.

Erosion and sediment transport are natural and continuing processes that can be accelerated by changes in the landscape resulting from population growth and changing land use patterns. These alter the pools and riffles of a natural stream system, washing out coarse bottom sediments (riffles) and filling in pools and interstices with finer sediment causing deterioration of the natural habitat and biota.

Minnesota's diverse climatic factors, land use, land cover, soil and geologic materials and topography all affect the shape, size, density and quality of its rivers and streams, lakes, wetlands and other land forms.

Hydrologic modification of the watershed can have the following cumulative effects:

- Increased runoff, increased peak stream flows and volumes of both high and low flow events occur with an increase in impervious surface;

- Increased pollutants occurring as increase in flows causes loading to the stream;
- Increased volume of stream flow resulting from changes in vegetative cover from perennial communities to annual crops;
- Loss of stability to stream channels as natural vegetation is removed (particularly, healthy riparian forest cover) along streambanks and within flood plains;
- Incising of stream channels and increased erosion as stream channel modifications steepen stream channel gradients increasing stream flow velocities and subsequent erosion;
- Increased volume and frequency of flood events occurs with drainage of wetlands, ditching and surface tile inlets.

The cumulative effects of these changes over space and time result in higher streamflow discharges and higher levels of export of sediment and nutrients from streams and rivers, accelerating their effects upon the land. Control of these effects is just as important as source reduction of pollutants. An effective NPS program must address both.

Stream channelization and drainage "improvements" disturb the dynamic equilibrium established by natural stream flow regime and sediment supply. These result in increased bank erosion, channel enlargement, downcutting above the project and increased frequency of overbank flows and elevation of stream bed below it. The resulting unstable flows and sediment regimes cause frequent short duration floods which can kill or flush fish eggs or fry out of the system. Heavy sediment loads also fill pools and interstitial spaces between rocks, which are important habitat for invertebrates, fish eggs and fry. Given time, streams and ditches slowly revert to a more sinuous, stable channel.

Restoration of stream channels to natural shape and function provide benefits of improved water quality, moderation of flood peaks, reduced erosion and enhanced fish & wildlife habitat. Ditches built with consideration of these hydrologic functions will require less maintenance. However, it is just as important that riparian vegetation be restored and maintained along with the channel.

Finally, removal of in stream impoundments also improves the health of a natural river system and increases its connectivity. Historically, Minnesota has more than 2,500 dams that have fragmented its rivers, blocked fish migration and disturbed natural flow and sediment regimes. The cost of removing unwanted, unused, unsafe dams is high, but the benefits of a healthier river system are even higher, in the long run. The construction of any new in stream impoundment should be closely scrutinized in light of these issues.

Sedimentation

Suspended sediment is a major water quality concern in several of Minnesota's major river basins. Erosion from construction sites is of concern in urban areas with rapid growth. Highway sanding and salting contributes annually to sediment pollutant loadings. Most of the intensively cultivated basins have fine-grained soils that are subject to erosion and once suspended are difficult to remove from the water column. Sediment concentrations, loads and yields increase substantially during runoff periods causing wide fluctuations in annual delivery. In the Minnesota River Basin, which drains about 20 percent of Minnesota, mean annual yield is about 74 tons per square mile (tons/mi2), but ranges from about 12 tons/mi2 to 240 tons/mi2 annually (Payne 1994). Another major basin, the Red River of the North, has a mean annual yield of about 24 tons/mi2 (Tornes and Brigham 1994).

Most of suspended sediment is fine grained silt and clay, and can be transported long distances before settling out. When deposited, it fills pools and backwaters, which limits the ecological processes and functions of the river system. Sediment also settles in portions of stream channels leading to deterioration of stream habitat.

Turbidity is the measure of the impact of fine-grained suspended sediment. Turbidity reduces light penetration causing a decline in desirable periphyton and thereby shifting stream primary productivity to undesirable phytoplankton species. High phytoplankton productivity also causes turbidity, resulting in streams that are turbid much of the time, even when inorganic sediment is not running off the landscape. The presence of sediment can increase stream temperature, as the particles absorb the sun's warmth. Increased temperature also reduces dissolved oxygen concentrations.

In addition to turbidity, suspended sediment transports attached phosphorus, often in concentrations that exceed 200 micrograms per liter (ug/L) (Payne 1994). Toxic substances also can be attached to sediment particles and thereby moved from source areas to become problematic in downstream reaches and accumulating in areas of sediment deposition. Mercury, for example, is strongly associated with suspended sediment transport, originating as atmospheric deposition on the landscape but subsequently transported to stream channels during runoff events.

Suspended sediment in stream and rivers results from erosion of upland landscape surfaces, or from erosion of stream banks and streambeds. Several of Minnesota's major river basins contain poorly drained, fine-grained soils that have been drained by an extensive system of ditches and subsurface tile. Tiles often have drop inlets that allow field-eroded soils to be transported to streams. Many of the ditches and channelized natural streams show evidence of bank and bed instability, either down cutting or meandering, which adds to the amount of sediment in transport. Some of the larger natural channels show evidence of down cutting to the extent that they are becoming isolated from their floodplains during annual floods.

Once isolated, these channels can no longer deposit a portion of their sediment load on the floodplain, and as a result carry most of their sediment loads downstream, becoming ever more sediment-laden as they accumulate loads from each of their tributaries. Part of the eroded bank material is sand-sized. The sand-sized material typically is transported as bed load, but can be part of the suspended load during high-magnitude flood events. When deposited in low-velocity river reaches, backwaters, and pools, this material also can degrade habitats and impede navigation. Bed load transport is not well quantified in Minnesota, but is evidenced by changes in channel depth and the presence of moving dunes at some locations.

Minnesota does not have a standard for total suspended sediment. However, the state has a turbidity standard, of 25 nephelometric turbidity (NTU)s for Class 2B waters and 10 NTUs for Class 2A waters. A correlation for total suspended sediment in mg/l and NTUs can be developed for a specific monitoring station.

Eutrophication

The presence of nutrients alters the aquatic environment. Changes can include:

- Depletion of dissolved oxygen (DO) concentrations,
- Increased plant growth,
- Warmer temperatures,
- Stress to aquatic life, including fish kills,
- Noxious taste and odor, affecting recreational use and drinking water supplies and
- Toxic effects to livestock, pets and people.

Reducing nutrient over-enrichment is a significant water quality goal for Minnesota. An important step toward achieving this goal is the development of nutrient criteria tailored to reflect the different types of waterbodies and the different ecoregions of the country. These ecoregion-based nutrient criteria will be used to assist states in adopting numeric water quality standards.

Nutrient enrichment is a significant issue for nonpoint source pollution, especially due to linkages between hydrologic modification and sedimentation and the cycling of nutrients through a stream system. For example, the U.S. Geological Survey (USGS) found that total phosphorus concentrations in agricultural streams were among the highest measured and generally correlated with nonpoint phosphorus inputs across the nation. In general the USGS found the phosphorus concentrations were highest where high concentrations of suspended sediment from erosion are common. Urban discharges of phosphorus are highest in densely populated areas. MPCA has developed ecoregion-based guidelines for phosphorus. Generally, background levels increase from the northeast to the southwest in the state, ranging from 0.052 milligrams per liter (mg/l) in the Northern Lakes and Forest ecoregion, to 0.340 mg/l for the Western Corn Belt ecoregion. Minnesota is participating in a national project, administered by U.S. Environmental Protection Agency (USEPA), to develop ecoregion-based nutrient criteria. These criteria will be used to develop numeric water quality standards by 2004.

Phosphorus

Phosphorus exists in the water column and landscape. Phosphorus contained in wastewater discharges is readily available to aquatic life in the receiving water. That is, up to 80 percent of the discharged phosphorus will be used in the stream or river. Conversely, most of the total phosphorus running off the landscape after storm events is sediment attached, and has to go through a biological process to be taken up in the aquatic environment.

Iron, aluminum and calcium content of soils naturally limits the biological cycling of phosphorus. However, the binding properties of soil are limited and can be broken down when too much fertilizer or manure is applied. The result is that phosphorus runs off the landscape and is not bound to the soil.

Chemical bonds are also broken down over time by several natural processes in the rivers, streams, wetlands and lakes present in the system. Algae and bacteria will liberate sediment-attached phosphorus for their use when other forms of phosphorus are less available. Under anoxic conditions, iron can be reduced and release phosphorus. pH determines the ability of aluminum and calcium in the soils to bind phosphorus. The setting and physical conditions of a river influence its capacity to assimilate or flush nutrients. For example, nutrients move quickly in high-gradient streams, but linger in the pools of meandering rivers.

Phosphorus enrichment is a process that occurs to the nutrients carried in runoff. A study under way by Dr. Dave Mulla and associates found that on average a typical field in the Minnesota River basin contains 1 to 1.25 pounds of phosphorus per ton of soil. The capacity of the soil particles to bind phosphorus varies with soil type. Silts and clays have more binding capacity than sands. Sands are more likely to be deposited while clay and silts are more likely to be carried. This natural sorting process contributes to phosphorus enrichment. According to Dr. Gyles Randall et. al. (1997), enrichment process may increase sediment phosphorus up to six times the original upland soil levels.

Minnesota does not have an ambient phosphorus standard in place. Therefore, limits of phosphorus in point sources are determined by assessing sensitivity of the receiving water. One mg/l is the typical limit applied to phosphorus sensitive waters, however, effluent limits as low as 0.3 mg/l have been required. Nonpoint source contributions of phosphorus can be managed by limiting the phosphorus content of soil in any source area, or by protecting soils from eroding or interrupting the transport process prior to delivery to the riverine system.

Nitrogen

Nitrogen exists in the environment in many forms and is far more soluble than phosphorus. Nitrite, nitrate, ammonia, N_2 gas are common forms that cycle through the air, water and soils in Minnesota. Nitrogen is most persistent in rivers and streams when in the form of nitrate nitrogen. The nitrogen cycle is complex in the soil and water, yet less complex than the phosphorus cycle.

There has been an increase in nitrate nitrogen in the recent decades, consistent with a national trend towards increased use of fertilizer. Rate, timing and type of nitrogen applications all affect the release of nitrogen into the environment. The University of Minnesota has developed regional nitrogen application rate and method/timing BMPs that provide effective guidelines for optimum crop or lawn productivity. They also minimize the release of nitrogen into the ground water or surface water.

Another factor in Minnesota is the growing use of subsurface tile drainage systems that intercept the infiltrating water and soluble nitrate and provide a direct pathway to the river, stream or ditch. This new pathway avoids or minimizes the time the groundwater is exposed to the denitrifying process.

There is no water quality standard for nitrogen. However there are water quality standards for nitrate and ammonia. Nitrate nitrogen has a standard for drinking water at 10 mg/l to protect infants from methemoglobinemia. The un-ionized ammonia chronic toxicity standard (protecting aquatic life from long term exposure) for Class 2b waters is 0.040 mg/l.

Nonpoint sources of nitrogen should be limited by practicing nutrient management on the upland areas and providing effective riparian zones to de-nitrify by using wetlands and aquatic plant life. In addition, denitrification can be enhanced by managing the time of release or reuse of the water using alternative designs of depth and spacing in subsurface tile drainage or controlled drainage. These methods have been shown to reduce nitrate releases to the hydrologic system by approximately half.

Biotic Impairment

Minnesota is home to over 150 species of fish and a large variety of aquatic invertebrates, the majority of which may be found in Minnesota's vast network of rivers and streams. Because each species requires specific physical and chemical conditions in order to survive they are excellent indicators of the state of our water resources. Stream systems that support well-balanced and adaptive aquatic communities are said to have a high degree of biological integrity.

Minnesota has been largely successful at control of point source discharges, and we are now beginning to understand and address nonpoint sources of pollution. The focus thus far has been on maintenance of resource quality by restricting and managing the influx of chemical pollutants into stream systems. However, biological integrity in rivers and streams is dependent on the protection of physical resource quality (i.e., instream habitat, hydrologic and geomorphic processes) as well as chemical quality.

Because of the diversity of Minnesota's rivers and streams, it is impossible to entirely characterize the wide range of naturally occurring stream habitats; however, there are certain characteristics that are found in almost all healthy stream systems throughout the state.

The vast majority of headwater streams in Minnesota are, or were at one time, influenced greatly by wetlands or lake systems. Headwater streams influenced by wetlands are naturally very stable and diverse. Wetland influenced streams are typically very low gradient meandering streams that are relatively deep and narrow. The stream bottom is typically composed of fine silts and detritus. Cover in the form of overhanging vegetation, undercut banks and woody debris is abundant. Wetlands in stream headwaters act as filters by removing pollutants before they reach the stream and also act as hydrologic buffers by moderating flow extremes. This unique environment provides excellent habitat for aquatic organisms including dragonfly and damselfly larvae and fish species such as the pearl dace, northern redbelly dace, and finescale dace.

The morphology of most streams can be characterized as a series of riffles, runs, and pools. Each one of these distinct habitat types provides a unique environment for specialized aquatic organisms. Riffles provide fast water, and course substrates for riffle fish species such as the longnose dace , and logperch as well as excellent habitat for caddisflies, mayflies, and stoneflies. The course substrates found in the fast flowing, oxygenated water of riffles provides suitable areas for feeding, reproduction, and shelter. Runs and pools provide slower, deeper areas that are used by pool dwelling species such as the smallmouth bass, bluegill, and channel catfish. The meanders that are so prevalent in natural streams help to slow down stream velocity and in the process, produce undercut banks and scour pools that act as cover and velocity shelters for fish and invertebrates. Silt and fine material in pools provide a suitable substrate for aquatic plants, which in turn provides both food and cover for fish and invertebrates. Pools are particularly important to the fry of many fish species whose survival depends on the prevalence of deep pools filled with aquatic vegetation.

Many land use practices negatively affect the quality of instream habitat. Anything that is done to alter the diversity and stability of naturally occurring stream habitats inevitably affects the aquatic community of organisms residing in streams. Also, because streams are flowing, interconnected systems, any alterations that occur in the upstream headwaters will eventually be reflected in the lower stream reaches. Stream habitat may be compromised by altering the streams natural morphology through ditching and channelization or through land use practices that occur outside of the stream channel such as removal of the riparian vegetation, drainage tiling, and residential development. Many land use practices alter the natural hydrologic cycle of streams so that water is removed faster from the landscape. However, in this process stream habitat diversity is seriously reduced. Water that was once slowed by bends, pools, and woody debris in the water column moves faster when the stream has been straightened. This faster flowing water carries with it an increased sediment load, some of which is deposited in the downstream reaches. Many fish and invertebrate species cannot use substrates that are laden with excessive silt for reproduction, feeding, or cover. Riffles and pools become scarce or absent as the stream is converted from riffle, run, pool sequences to long runs. Not only is habitat diversity affected, but the stream hydrology becomes inherently less stable. By removing water from the system faster the natural hydrologic timing is altered. The overall effect is an increase in the extremes of the high and low flow events. Streams in which the surrounding vegetation has been removed or altered are usually compromised by an increase in the amount of silt-laden runoff. Also, water temperatures within the stream may rise as the overhead canopy is removed exposing the stream to full sunlight.

When habitat alterations cause a loss of habitat diversity and stability the fish and invertebrate communities change in characteristic and predictable ways. Sensitive fish and invertebrate species are replaced by a few tolerant species such as the fathead minnow and brook stickleback. These tolerant species are able to take advantage of degraded habitat and out-compete the more intolerant members of the community. Species such as the creek chub and green sunfish may invade streams in which the stability of the habitat has become compromised. These species are known as pioneer species because they are the first to recolonize a stream after a catastrophic event such as a severe flood or drought. Darter and many other riffle dwelling species that depend on coarse substrates to reproduce may become scarce or absent. Stoneflies and dragonflies that rely on course substrates and woody debris on which to cling are forced out of their refuges by heavy silt loads that fill in the interstitial spaces surrounding course substrates and cover. Warmer water temperatures negatively influence cold water trout streams by forcing trout to seek colder water refuges and at the same time allowing the invasion of tolerant cool water fish species into the stream.

In summary, the biological integrity of rivers and streams is influenced by both the chemical and physical stream characteristics. Land use practices may alter the physical features of a stream so that the diversity and stability of instream habitat is reduced. Because aquatic communities depend on stable and heterogeneous habitats, there is often a reduction in biological integrity associated with many of these land use practices. Reduced biological integrity may be expressed in many ways including, but not limited to, a change in number of species found within the stream, a decrease in the number of sensitive or specialized species, or an increase in the number of tolerant and pioneering species.

Other Nonpoint Source Pollution Concerns

Oxygen depletion

The dissolved oxygen content of a river or stream is negatively impacted by several factors. A competitive environment for game fish can be reduced to one for rough fish or areas that have no life present at all. The total loss of dissolved oxygen across a reach will not only limit the presence of species in that reach of a river or stream but becomes an effective barrier to migration upstream of the reach as well. Presence of dissolved oxygen can be limited by chemical reactions in the water, including temperature increases that reduce the capacity of the water to hold oxygen, or by bacterial decay of organic matter in the water.

Oxygen depletion impairment has been identified as a parameter of concern on Minnesota's 303-(D) list. As a result of this listing, affected communities will work with the state to set Total Maximum Daily Loads (http://www.pca.state.mn.us/water/tmdl.html.) For instance, reaches on the Crow, Red, Minnesota and Mississippi rivers have been listed as impaired due to oxygen depletion. Standards for Class 2b (warm water fisheries) in Minnesota typically are to maintain a 5 mg/l level of dissolved oxygen. For Class 2a waters, cold water fisheries, the state has set an oxygen standard of 7 mg/l.

Bacteria

The state water quality standard for bacteria is 200 organisms per 100 milliliters (org/100ml) for fecal coliform bacteria. Fecal coliform is used as an indicator species for all potentially harmful waterborne bacteria. An indicator species is one which, if found in high concentration, "indicates" that there is a likelihood that other harmful bacteria are also present in concentrations high enough to be of a health concern.

Fecal coliform is found in the intestinal tract and, therefore, the feces of all warm-blooded animals. Common sources of bacteria contamination in our rivers and streams include; inadequately treated sewage from wastewater treatment facilities, direct discharges from septic systems, domestic animal manure, and wildlife.

In rural areas, nonpoint source pathways are non-compliant individual sewage treatment systems (ISTS), and surface runoff from fields with manure applications. A reduction in ISTS contributions could reduce that source down to zero if compliant systems were installed. Land application of manure BMP methods are set up be effective at minimizing the loading of oxygen depleting substances, nutrients and bacteria.

In urban areas, fecal coliform enter rivers and streams via storm water sewers. These connect impervious surfaces with the receiving rivers and streams directly. Urban storm water often contains high levels of bacteria. Sources include pet litter, animals such as raccoons and rats living in storm sewers or along conveyances and litter falling on impervious surfaces. Many of these sources are controllable and have programs set up to manage them. However, the standard is exceeded in many waterways in southern Minnesota.

Heavy Metals and Manmade Chemicals

Heavy metal and PCB pollution is typically highest in urban areas where there are more sources such as cars, pavement and buildings.

Heavy metal contamination is typically associated with industrial discharges of wastewater in most individuals' minds. However, the transport process associated with runoff affects the level of heavy metals entering into a river system. Many times the metals have an affinity for sediment and are transported with eroding soils. Another pathway is a source or work area exposed to precipitation. Metals like zinc or cadmium, originating from roofing material or car tires, are washed across impervious surfaces by precipitation and delivered to the river or stream.

More than 90 percent of the mercury in the state's waterways is contributed by atmospheric deposition. Mercury also enters fish through the biological process of methylation when wetland vegetation is inundated. Through exposure to the area and nutrients in the soil, mercury moves from an abiotic to a biologically available form.

Emerging Issues: Pesticides, Antibiotics and Endocrine Disrupters

Research conducted by the University of Minnesota and others confirms the presence of pesticides, antibiotics and endocrine disrupters in the state's rivers and streams. These chemicals include agents that give cleaning products a lemon fragrance, drugs prescribed to lower cholesterol, replace insulin, manage seizures and improve depression, to drugs that affect hormonal systems (so-called endocrine disrupters or EDCs), such as oral contraceptives. These chemicals enter the state's waters from wastewater treatment systems and overland runoff.

The presence of these chemicals in surface waters is of concern for the following reasons:

- These chemicals are discharged on a continuous basis via domestic or industrial wastewater treatment systems, or through surface runoff. That means that aquatic life is continually exposed to low doses, over many generations.
- Many of these chemicals do not biodegrade during traditional treatment processes, or they metabolize into other compounds.
- The possible actions and biochemical ramifications of these chemicals, or the metabolized forms of these drugs, are unknown, but may be cumulative.

The U.S. Geological Survey is implementing a national reconnaissance to provide baseline information on the potential occurrence of human and veterinary pharmaceuticals, industrial and household wastewater products and sex and steroidal hormones in streams. A network of 100 stream sites in 24 states, including Minnesota, was sampled last year. Further analysis is being conducted to test for the presence of antibiotics and prescription or over-the-counter drugs, such as ibuprofen.

Stream sampling locations selected for this reconnaissance are generally those expected to have a high susceptibility to environmental contamination by targeted compounds – such as downstream from human or industrial wastewater discharges, or intense animal feeding operations (since antibiotics are used throughout the feeding cycle of swine and poultry operations. This study will provide policy makers, industry, and the public scientific information on the potential for the targeted compounds to enter the environment, thus enabling informed decisions regarding environmental research priorities and chemical production and use.

This reconnaissance will provide:

1. The first nationwide assessment of the occurrence of these emerging environmental contaminants in streams;
2. A focal point for developing and testing of new laboratory analytical methods for measuring compounds in the environment at very low (sub parts per billion) levels; and
3. A basis for design of more systematic monitoring programs for emerging environmental contaminants.

Minnesota Department of Health is cooperating with USGS-Moundsview on a two-year reconnaissance study to characterize the presence and concentrations of these compounds in rivers directly upstream of drinking water inlets, water utility intake water, finished water, and downstream of major potential sources.

Chlorides

Road salt contributes to chloride levels in urban and highway runoff areas. The U.S. Geological Survey reports a correlation between chloride concentrations in surface waters and percent impervious surface. Ten sites were monitored ranging from less than five percent impervious surface up to 28 percent. The concentrations of chlorides ranged from a low of below 20 mg/l to over 120 mg/l during this study period. Sodium and chloride were also negatively correlated with fish specie diversity.

Road safety is dramatically increased during the winter months with the road salt program in Minnesota. However, the use of road salts may result in increased chloride concentrations. This can alter lake thermoclines by changing water density and increasing conductivity. Toxicity for aquatic life is also a concern.

Applying best management practices to salt and sand storage, snow stockpile storage, and street sweeping can minimize nonpoint source pollution impacts. The water quality standard for chloride is 230 mg/l for chronic toxicity.

Floatable Trash and Litter

Floatable trash and litter can be a nonpoint source problem for streams and rivers. There are many sources and modes of transport for these materials, but the problem is generally most serious within and downstream from urban, commercial, industrial and recreational land use areas. Trash can be directly deposited in the water or on streambanks by water users, flushed in through storm sewers or overland runoff and, in some cases, wind blown.

Many of these materials are nonbiodegradable and will persist in the environment for many decades until removed or in some cases buried through sedimentation processes within the floodplain. Flooding can increase the volume of litter. Trash and litter constitute a major impairment to the recreational use and esthetic appreciation of many reaches of the state's rivers and streams and can be hazardous to humans and wildlife.

GUIDANCE FOR MANAGERS

Managing nonpoint source pollution requires involving everyone whose land use activities affect the watershed. Some of these users are regulated, but many are not. The challenge is to help citizens and the public to understand the need for watershed stewardship, so that they can choose actions that promote, rather than impair water quality, and so that they can be an advocate within their community for public policies that promote watershed stewardship.

Water quality management need to incorporate a watershed perspective, develop a sound scientific basis for making decisions and include all stakeholders in the decisionmaking process. This shift has been encouraged by new mandates to the states from the federal government, including:

- Wellhead Protection
- Source Water Protection
- Impaired Waters Lists under 303(D) of the Clean Water Act and subsequent

development of Total Maximum Daily Loads (TMDLs)
- Clean Water Action Plan (CWAP).

These initiatives ask managers to assess and inventory all known sources of problems for a watershed. Developing remedies requires participation of all stakeholders. The USEPA provides thorough guidance to understanding and applying these concepts, including case studies of how communities and units of local government have engaged in watershed-based river management programs. These materials can be found at the following Internet address: http://www.epa.gov/owow/watershed/wacademy/acad2000.html. A summary of guidance available on the Web is provided in Box 4.

In Minnesota, the MPCA has developed a phosphorus strategy to guide regulation of point source discharges. Some dischargers will be required to develop phosphorus management plans as a condition of future renewal of permits.

The most effective nonpoint source pollution management plans are watershed-specific (see Box 3) and should incorporate the following elements:

1. Identification of the specific soil, landscape and climatic factors influencing water quality of a watershed;
2. Identification of sources and impact of nonpoint source pollution on the subject watershed;
3. Identification of a suite of cost effective practices that can reduce nonpoint source pollution;
4. Identification of water quality goals and a determination of the roles of each participant;

3: THE TARGETING DILEMMA

Everyone knows that watershed restoration efforts should be targeted to the most impaired regions first. Yet, identifying these regions is not easy. As an example, consider a large watershed with several tributaries that drain varied landscapes, and differ in stream gradient and stream flows.

For simplicity, consider two tributaries in the watershed. One of the tributaries drains steep landscapes, while another drains flat landscapes. The steeper tributary has sediment loads that are four times greater than the flatter tributary. The flatter tributary has nitrate loads that are twice as large as the nitrate loads from the steeper tributary. How do you decide which tributary is the most impaired? If your reference is purely local, you may be very sensitive to stream gradient, with low gradient tributaries seemingly more impaired than steep tributaries. Do you base it on downstream impacts as shown by water quality loads? If so, which pollutant is more important - sediment or nitrate?

This is an illustration of the dilemmas that watershed restoration managers often face. There is a great need to provide better guidance regarding the proper use of each watershed indicator, and its use in identifying impaired waters.

--David Mulla, Professor of Soil Science, University of Minnesota

4. GUIDANCE FROM THE WEB

Technical assistance required to developing effective nonpoint source pollution management plans is just a click of the browser away! Here are two excellent guides:

http://www.epa.gov/OWOW/NPS/Ecology/chap4.html

"Ecological Restoration: A Tool to Manage Stream Quality"

This chapter provides a conceptual framework for ecological restoration activities in water programs. Discussion focuses on important components and issues of decision-making for restoration, rather than a detailed step-by-step protocol for conducting ecological restoration. The decision-making guide is summarized in a series of nested flow charts.

http://www.usda.gov/stream_restoration/

"Stream Corridor Restoration: Principles, Processes and Practices"

The U.S. has 3.5 million miles of rivers. The 1992 National Water Quality Inventory of 642,881 miles of these rivers stated that only 56 percent fully supported multiple uses, including drinking water supply, fish and wildlife habitat, recreation, and agriculture, as well as flood prevention and erosion control. In the remaining 44 percent of stream miles inventoried, sedimentation and excess nutrients were the most significant causes of degradation. Sediment problems result from soil erosion from watersheds and streambanks.

Today, interest in restoring stream corridors is expanding nationally and internationally, as indicated by increasing numbers of case studies, published papers, technology exchanges, research projects, and symposia. Stream corridors are increasingly recognized as critical ecosystems supporting interdependent uses and values.

This document was produced by the collective experience, skills, and technology of 15 Federal agencies of the United States government. It is a benchmark document that is being used by these agencies, as well as many others who are interested in restoring the functions and values of the nation's stream corridors. Restoration practitioners share simultaneously in the good fortune and responsibility of participating in a new endeavor -- stepping beyond the current concept of natural resources conservation to a newer concept of restoring the living environment to an ecologically viable condition – to create places that improve rather than degrade over time. Oliver Wendell Holmes once said, "A mind stretched by a new idea can never go back to its original dimension."

-- From the Federal Interagency Stream Restoration Working Group
Understanding Stream Processes

5. Information about practices that mitigate nonpoint source pollution, and training to help citizens learn how to implement these practices, or teach them to others, and to implement at appropriate levels;
6. Long-term water quality monitoring, to diagnose problems, define trends in water quality and to measure success of measures to reduce nonpoint source pollution;
7. Information campaign plans, to help build dialogues among all who live in a watershed about stewardship, and to inform the public of status (and successes) of nonpoint source mitigation programs;
8. Funding to support the administration and management of local organizations, which should be raised from the community as much as possible, and
9. Funding to support technical work done by local organizations for health of the watershed, which should be supported by the State.

Role of Local Government

Generally, nonpoint source pollution is not subject to regulation, as are discharges to public waters. However, land use is managed and controlled by numerous local ordinances, which have been delegated by the state to the counties. These local land use controls can be the most effective management tools for the management of nonpoint source pollution. Examples of local land use controls that manage nonpoint source pollution are:

1. Shoreland rules, including setbacks and vegetation removal;
2. Subdivision rules;
3. Individual on-site sanitary treatment system rules;
4. Feedlot rules;
5. Land application of biosolids.

These regulatory programs are critical elements of any watershed's nonpoint source pollution management plan, since the administration of these rules is an opportunity to implement best management practices that will reduce nonpoint source pollution.

Incentives should be provided through current block grant funding programs from the state to local government to assure that nonpoint source issues and the watershed perspective are considered in the review and update of rules.

Local governments are critical players in the planning led by the state for nonpoint source pollution and other watershed management efforts. From the state level, the Minnesota Environmental Quality Board develops a state water plan every ten years, which is an overview of the state's goals for its water resources.

The MPCA develops basin plans for each of the state's major drainage basins. These build a coordinating structure for all water pollution programs, and link nonpoint source and point source programs.

Watershed districts develop five year plans to guide decision-making about water resources. The 80 rural counties develop comprehensive local water plans on a five to 10-year cycle, and a similar planning effort occurs in the seven-county metropolitan area.

Each of these plans, and the related planning effort, is an opportunity to educate stakeholders about nonpoint source pollution, and to establish local and regional goals and strategies to address nonpoint source problems. ***It is the recommendation of this section that the state use these planning and regulatory activities as an opportunity to deliver and achieve its nonpoint source pollution management plan.***

Citizens appointed by county commissioners make decisions about local ordinances. Therefore, a successful nonpoint source management program should provide training and information for elected and appointed decisionmakers.

Role of State and Federal Government

The state and federal government provides technical and financial support for the mitigation of nonpoint source pollution. These programs are available as funds authorized by the national Clean Water Act, and incentives provided through the National Resource Conservation Service. Moreover, both state and federal government are encouraging, indirectly, through services, and directly, through funding, management by major drainage basin.

Broad-scale public policy can have major effects on land use, and subsequently on the nonpoint pollution entering waterways. These effects may be direct or indirect and are sometimes unintended, but ultimately exert strong influence on the quality of aquatic and terrestrial habitats within watersheds and across the country. Current policy development processes that will be important for the state of Minnesota are the federal Farm Bill 2002, and the state Smart

Growth Initiative. It is the responsibility of state and federal government to provide balance in the formulation social, economic, and environmental goals, and to establish their compatibility through effective integration into policy.

The USEPA has published an "Inventory of Watershed Training Courses." This document provides one-page summaries of 180 watershed-related training courses offered by federal and state agencies, as well as resource professionals in the private sector. Below is the directory of courses covered in the inventory:

- General Watershed Courses (includes general survey or overview courses);
- Water Quality Courses (includes physical, chemical, geological processes);
- Ecosystem Management Courses (includes biological and habitat issues);
- Regulatory Courses (includes training to satisfy various regulatory needs);
- Data Collection and Management Courses (includes GIS and field sampling procedures);
- Outreach and Public Involvement Courses (includes outreach, stakeholder, partnership issues).

Role of the Private Sector

Minnesota has an active philanthropic community, as well as a tradition of individual giving. In 1997, the state's 871 private foundations, corporate giving programs and public foundations gave $613 million, of which 4 percent went to environmental programs (an increase over previous years). In the same year, Minnesotans claimed $2.3 billion in charitable contributions on income tax returns. Money from private foundations or corporate giving programs can be an opportunity to launch a community based watershed group. For example, the McKnight Foundation has dedicated $23 million between 1997 and 2002 to programs to reduce pollution in the Mississippi River's watershed.

Support from private foundations is less than five percent of overall charitable giving. Many communities are establishing local foundations that can provide ongoing support to local river groups. For example, the Grand Rapids Area Community Foundation which has established a Lakes and Rivers Fund among its endowed funds. A network of local funding will help assure the long-term success and viability of local watershed "watch" groups.

There are many nongovernment organizations that support nonpoint source management. Many of them are linked to the EPA's watersheds web site: www.epa.gov/OWOW.

SUMMARY AND CALL TO ACTION

Nonpoint source pollution management for Minnesota's streams and rivers is at a critical junction. The state has made great strides in reducing point source pollution. The state has launched effective nonpoint source pollution reduction strategies in the most disturbed river basins. However, the ability to continue this effort, and to expand it to all rivers, requires commitment to two basic principles: first, that we must address the ecological underpinnings of nonpoint source pollution problems in the state's rivers, and second, that we must support and encourage an infrastructure to guide management of rivers that is informed by the best science, provides meaningful and appropriate incentives, and has a decision-making structure accessible to all the residents of the watersheds of the state's rivers.

Finally, it is important to work to influence federal policies that affect nonpoint source pollution. Therefore, it is recommended that state agencies work together, with constituents and with the governor's office to provide effective input for drafting of the Farm Bill so that it encourages practices that are consistent with proper functioning streams, rivers and water bodies.

The following set of goals encourages that integration. The first four goals respond to the critical issues facing all rivers in the state. Addressing these issues by implementing milestones and action steps recommended in the accompanying matrix is a first step to solving any local impacts, ranging from bacteria to pharmaceuticals.

The final three goals recommend the systems that need to be built, encouraged and supported in order to fully develop a nonpoint source pollution management strategy for Minnesota's rivers.

Healthy Hydrological Regime

Promote hydrological management that enables rivers and streams to reach proper function conditions (as defined by the U.S. Bureau of Land Management). Characteristics of properly functioning hydrologic conditions include the presence of adequate runoff management, vegetation, land form and large woody debris to:

1. Dissipate stream energy associated with high water flows, thereby reducing erosion and improving water quality.
2. Filter sediment, capture bed load and aid flood plain development.
3. Improve floodwater retention and ground water storage.
4. Develop root masses that stabilize streambanks against cutting action.
5. Develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration and temperature necessary for fish production, waterfowl breeding and other uses.
6. Support biodiversity.

Allowing rivers and streams to function as nature intended with balanced or semi-balanced flow regimes, defined flood plains, meander belts and appropriate grades will improve the health and stability of the waterbody in addition to increasing the assimilation capacity of the resource. The hydrological conditions of a river's watershed can be measured using the following attributes: total (annual) discharge, seasonal (monthly) discharge, peak flows, minimum flows, annual flow duration, rainfall records, size and shape of the watershed. Channel processes that should be measured to assess this condition in streams are flow characteristics, channel dimensions, shape, profile and pattern, substrate composition, floodplain connectivity and evidence of entrenchment and/or deposition.

Healthy Sediment Budget

Promote practices that balance sediment size and quantity with stream flow and grade to restore or maintain an ecologically appropriate equilibrium. This balancing includes stabilizing the system's hydrology so that erosion and sedimentation are minimized, banks are vegetated and access between the flood plain and the river is maintained. The attributes of a healthy sediment regime in a watershed can be measured by the following attributes: watershed cover and soil health, presence of dams or in-stream impoundments, dominant erosion processes, rates of surface erosion and mass wasting, sediment delivery ratios, channel erosion processes and rates, and sediment transport functions. Sediment is the largest single pollutant problem our rivers and streams are facing in Minnesota and, therefore, requires special attention in the state's Nonpoint Source Management Program Plan (NSMPP). Sediment transports other pollutants – from nutrients to pharmaceuticals. Sediment transport changes create an imbalance in riverine systems that rivers respond to by aggrading or degrading to correct the imbalance. Therefore, assuring a healthy sediment budget in a river's watershed is the dominant step in addressing other nonpoint source pollution issues for rivers.

Healthy Nutrient Budget

Enrichment due to nutrients is a significant statewide issue for Minnesota's streams and rivers. The state is participating in a national nutrient criteria development project, which will inform development of future water quality standards. However, delivery of phosphorus and nitrogen to rivers and streams must be addressed as a statewide issue in Minnesota's NSMPP. The recognition that eutrophication occurs in our riverine systems as well as our lake environments is central to management of the biotic health and uses of our river systems. Many of the rivers and streams eutrophically impacted in Minnesota are phosphorus limited while others differ at different times between nitrogen and phosphorus. Downstream estuary impacts, such as hypoxia, are more related to nitrogen. Measurable attributes are color, temperature, dissolved oxygen, suspended sediment, total phosphorus, ortho phosphorus, ammonia, nitrate nitrogen.

Healthy Biological Communities

As river management is better informed by river science, we recognized that, "the most direct and effective measure of water body's integrity, and of its place in the water cycle, is the status of life in the water...Living communities reflect watershed conditions better than any chemical or physical measure because they respond to the entire range of biogeochemical factors in the environment." (James Karr and Ellen Chu, Hydrobiologia, in press). Researchers at Minnesota state agencies have been developing biological measures of stream health. It should be a critical goal of this nonpoint source management plan to encourage the completion of that effort, and to recommend strongly the application of the resulting measures. Measurable attributes are aquatic species of concern and associated habitats; riparian species of concern and associated habitats; native versus introduced species; threatened or endangered species, and benthic, macroinvertebrate or vertebrate indicator species.

Goals Setting

Proper goal setting at the watershed level starts with information gathering about the resource, identification of problems and opportunities, and identification of potential tools. Tools must be analyzed to determine which are appropriate, and then selected and applied. Applications must be evaluated for performance. This process of collection, review, application and evaluation includes political and social action. It is the agenda that brings together resource managers, users and citizens of the watershed. The list of issues given above must be defined and prioritized by the decision-makers involved in watershed management and land use management.

Infrastructure Support

This foundation goal encourages development of a proper supporting structure for government and citizen nonpoint source programs. This structure should incorporate several elements, including: development of a comprehensive planning structure that supports using a watershed and ecological approach to stream management; information programs targeted for decision-makers and elected officials about how to incorporate watershed-based goals in projects and planning; and an effective structure of citizen based organizations to assure participation in the decisionmaking and in implementation, such as through volunteer monitoring. This step also requires development of financial and material resources to support these tasks.

Research, Education and Demonstration

This foundation goal encourages development of comprehensive research and education activities for nonpoint source pollution management. The educational component includes the research needs, educational materials, training and demonstrations necessary to identify and promote effective changes in cultural and operational practices for the terrestrial, riparian and channel zones of the basin.

Successful nonpoint source pollution management is the result of good science and stakeholder-based decision-making. A solid research, education and demonstration program for the state is the critical link between science and stakeholders. Development of this step will assure that Minnesota can manage the hydraulic, chemical and biological functions of our streams and rivers.

CONTAMINATED SEDIMENT

Potential chemicals of concern can attach to suspended particulates in the water, and subsequently settle out to the bottom mud (sediment). Through complex chemical, physical and biological interactions, these pollutants may be further transformed and transported to other parts of the aquatic ecosystem. At elevated concentrations, contaminated sediments contribute to many impaired uses, including fish advisories, habitat impairments and restriction on dredging. Additional information about contaminated sediments can be found on the MPCA Web Site at: http://www.pca.state.mn.us/water/sediments/index.html

Chapter 4 Overall Strategy for Each Water Resource
Strategy 4.3 Rivers and Streams
Needs, Priorities, And Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) 5-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement. (NOTE: Strategy 4.3 was not included in the 1994 NSMPP and therefore, no 1994 Needs, Priorities and Milestone Table is provided).

Goal 1: Promote a Healthy Hydrological Regime for Minnesota's Streams and Rivers.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Promote a basic understanding of channel evolution, hydrology and available tools to use when making decisions at the LGU level and certain levels of Land management. Emphasize the connection between downstream effects and significantly increased hydrographs or shortening the return frequency of the event.	X	X	X	X	X	319 funds	MDNR, MPCA, NRCS, U of M
2. Develop/adopt a methodology for assessing hydrologic "health" for rivers, including hydraulic geometry regional curves.	X	X	X	X	X	319 funds, LCMR	MPCA, MDNR, NRCS, USGS
3. Assess Minnesota's major river systems to identify rivers unaltered and free-flowing and systems where the hydrologic regime has been disrupted.	X	X	X	X	X	319 funds	MPCA, USGS
4. Identify causes of disruptions to hydrologic regimes and determine which problems should be fixed first.	X	X	X	X	X	319 funds	USGS, MDNR, MPCA, U of M

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5. Promote stream restoration projects that restore connectivity between rivers and their flood plains. Remove artificial in-channel barriers (obsolete dams, etc.).	X	X	X	X	X	319 funds	MPCA, MDNR, Watershed District (WD)
6. Promote full funding for CREP and other programs that can provide mechanisms for restoring wetlands and reducing overland runoff.	X	X	X	X	X	319 funds	MPCA, MDNR, BWSR
7. Require the implementation of appropriate storm water management practices by local units of government		X	X	X	X	319 funds	USEPA, MPCA
8. Promote BMPs in upland areas which enhance water storage/hydrograph characteristics (e.g. controlled drainage, conservation tillage, surface tile intake alternatives).	X	X	X	X	X	319 funds EQIP	MPCA, BWSR, MDA, NRCS
9. Through and interagency work group develop training materials and provide training to policy makers, local governmental officials, etc. on incorporating hydrologic principles into local & state decision making.		X	X	X	X	319 funds EQIP	BWSR, MPCA, MDA, MDNR, NRCS
10. Prioritize rivers for restoration.		X	X	X	X	319 funds	MPCA, MDNR

Goal 2: Promote Healthy Sediment Regime for Minnesota's Streams and Rivers.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop/adopt a methodology for assessing sediment "health" for rivers.	X	X	X	X	X	319 funds	MPCA, MDNR, NRCS, USGS
2. Identify rivers with excessive sediment budgets (loads).	X	X	X	X	X	319 funds	USGS, MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
3. Establish sediment TMDLs for impaired rivers.		X	X	X	X	319 funds	MPCA
4. Identify and categorize causes of excessive sediment in affected rivers.	X	X	X	X	X	319 funds EQIP	NRCS, MPCA, U of M
5. Develop an interagency program to assess/control streambank erosion	X	X	X	X	X	319 funds EQIP	MPCA, MDNR, BWSR, MDA, NRCS
6. Promote CREP and CRP and similar programs.	X	X	X	X	X	319 funds EQIP	BWSR, MDNR, MPCA, MDA
7. Promote conservation tillage on steeper landscapes and vulnerable agroecoregions.	X	X	X	X	X	319 funds EQIP	NRCS, SWCD, U of M, MDA
8. Promote conversion of tile intakes to blind inlets.	X	X	X	X	X	319 funds EQIP	NRCS, SWCD, U of M, MDA, MPCA
9. Target restoration programs according to resources.	X	X	X	X	X	319 funds EQIP	MPCA, NRCS
10. Assemble inter-agency committee to study & report the effect and enforcement of mandatory vegetative buffer strips on protected waters (Shoreland Management) and public drainage ditch projects.	X	X				319 funds	MDNR, BWSR, MPCA, MDA, WD's
11. Utilizing the results of the study and a survey of how buffer strips have been used in other areas, develop recommendations on how they can be improved in Minnesota.		X	X			319 funds	MDNR, BWSR, MPCA, MDA, WD's, LGUs
12. Implement recommended changes. (Changes may include enhanced enforcement of existing controls, rule changes or other mechanisms identified by the committee).			X	X	X	319 funds	MDNR, BWSR, MPCA, MDA, WD's, LGUs

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
13. Monitor effectiveness of changes.				X	X	319 funds	MDNR, BWSR, MPCA, MDA, WD's, LGUs
14. Provide funding to the University of MN to conduct additional research, and to compile a synthesis of existing research on the effects of surface tile intakes.		X	X			319 funds LCMR	MPCA, USEPA
15. Establish an interagency work group to initiate the compilation of minimum performance standards (eg. conservation tillage) for agricultural operations.		X				319 funds	MPCA, MDNR, MDA, BWSR, NRCS
16. Enhance the understanding of sediment sources, by inventorying problems, surveying managers, and monitoring. Develop sediment budgets for select river segments, partitioning sediment by source categories and associated loads.		X	X	X	X	319 funds EQIP	NRCS, MPCA, BWSR

Goal 3: Promote Healthy Nutrient Regime for Minnesota's Streams and Rivers.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop/adopt a methodology for assessing nutrient regime "Health of a River."	X	X	X	X	X	319 funds	MPCA, UGSG, MDNR, NRCS
2. Identify rivers with unbalanced nutrient budgets (loads)	X	X	X	X	X	319 funds	MPCA, USGS
3. Identify sources of nutrients in affected rivers	X	X	X	X	X	319 funds, EQIP	MPCA, MDA, USGS, NRCS
4. Accelerate development of ecoregion specific nutrient standards, and minimum effluent requirements for nutrients			X	X	X	319 funds	MPCA, U of M

	2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5.	Develop/promote nutrient management planning tools and BMPs in affected river drainage areas.	X	X	X	X	X	319 funds	MPCA, NRCS, MDA, U of M
6.	Target restoration programs.	X	X	X	X	X	319 funds, EQIP	MPCA, NRCS, MDA, SWCDs

Goal 4: Promote Healthy Biological Communities for Minnesota's Streams and Rivers.

	2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1.	To the extent possible/ practical, ensure full funding for MPCA initiatives for establishing the Index of Biotic Integrity (IBI) for all river basins of the state, leading to biological criteria for water quality standards.	X	X	X	X	X	319 funds	MPCA
2.	Identify rivers with most unhealthy biological communities using IBI.	X	X	X	X	X	319 funds	MPCA, MDNR
3.	Identify causes of unhealthy biological communities in the most unhealthy rivers.	X	X	X	X	X	319 funds	MDNR, MPCA, U of M
4.	Develop manual for restoring healthy biological communities in each river basin.	X	X	X	X	X	319 funds	MPCA, MDNR
5.	Target restoration programs.	X	X	X	X	X	319 funds	MPCA

Goal 5: Promote Wise Goal-Setting For Citizens And Government

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Establish an interagency task force to work with the Governor's office to provide NPS guidance to the 2002 Farm Bill and other major policy initiatives.	X	X	X	X	X	319 funds	MPCA, MDNR, MDA, BWSR, NRCS, USGS, USFWS
2. Establish interagency tracking system linking implementation programs and funding to reductions in pollutant loads.	X	X	X	X		319 funds	BWSR, NRCS, MPCA, MDA
3. Develop review committees to oversee targeting and implementation strategies for all Clean Water Partnership projects.	X	X	X	X		319 funds	MPCA
4. Encourage incentives to incorporate river friendly practices in zoning ordinances, county local water plans, watershed district plans and ditch projects.	X	X	X	X	X	319 funds	MDNR, BWSR, LGUs, WDs, MPCA, U of M - Extension
5. Use MPCA basin plans to identify river friendly practices for each drainage basin.		X	X	X	X	319 funds	MPCA
6. Use comprehensive plans, watershed district plans and Local Water Planning to implement the goals and objectives of this plan.	X	X	X	X	X	319 funds	MPCA, BWSR, MDNR, WDs,

Goal 6: Support Infrastructure for Nonpoint Source Pollution Management That is Holistic, Comprehensive and Watershed-Based, and Provides Access to Decision-Making for all Residents and Users.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop instruction manual on procedures for targeting restoration efforts to most vulnerable locations in a watershed.	X	X	X	X	X	319 funds, EQIP	MPCA, U of M, NRCS
2. State agencies work together, with constituents and the governor's office to provide effective input for drafting of the Farm Bill.	X	X				319 funds	MPCA, MDNR, BWSR, MDA, Governor's Office

Goal 7: Research, Demonstration and Education That Encourages Understanding of Origin and Remedy for Nonpoint Source Pollution Problems.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Support river friendly farmer program.	X	X	X	X	X	319 funds	MDA, MPCA, BWSR, U of M
2. Develop instruction manual to identify most appropriate BMPs by basin, ecoregion, and agroecoregion.	X	X	X	X	X	319 funds	MDA, MPCA, U of M
3. Develop case studies on downstream impacts of nonpoint source pollution (Lake Pepin, Gulf of Mexico, etc).	X	X	X	X	X	319 funds	MPCA, U of M, MDA, NRCS
4. Establish paired watershed demonstration projects to illustrate impacts of BMPs on water quality and crop productivity.	X	X	X	X	X	319 funds	MDA, U of M, MPCA
5. Study and develop water quality standards for phosphorus in rivers, including the bioavailability of particulates.	X	X	X	X	X	319 funds	MPCA, U of M

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
6. Conduct watershed modeling studies to assist in targeting restoration efforts, evaluation of policy, and development of TMDLs.	X	X	X	X	X	319 funds, EQIP	NRCS, U of M, MPCA, USGS
7. Study potential for denitrification of tile drain effluent nitrate in ditches and wetlands.	X	X	X	X	X	319 funds	MPCA, U of M
8. Study the current relationship between cumulative drainage practices and downstream channel stability.	X	X	X	X	X	319 funds	U of M, NRCS, MPCA, USGS, MDNR
9. Study alternative drainage ditch designs.	X	X	X	X	X	319 funds	U of M
10. Study alternative tile drainage management systems.	X	X	X	X	X	319 funds	U of M
11. Evaluate assignment of a point source definition for surface tile intakes as part of the state water quality rule.		X	X			319 funds	MPCA
12. The Minnesota Department of Health and the USGS will conduct a two-year reconnaissance study to characterize the presence and concentrations of selected pesticides, antibiotics and endocrine disrupters. This work will be conducted upstream of drinking water inlets, water utility, intake water, finished water, and downstream major potential sources.	X	X				State funds, Federal funds	MDH, USGS

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
13. Provide funding for research and implementation of remedial source control and end-of-pipe measures to reduce the release of storm water transported trash and litter to waters of the state.	X	X	X			319 funds	MPCA
14. Asses urban/suburban channel stability in association with BMP implementation to protect water quality.				X	X	319 funds	MPCA

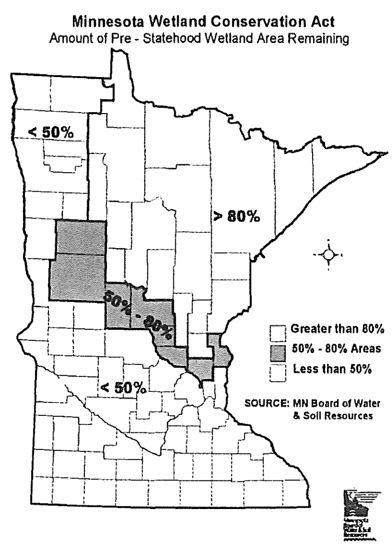
Chapter 4 Overall Strategies for Each Water Resource
4.4 Wetlands Strategy

Acknowledgments: Authorship of this strategy is partly the product of the Interagency Wetland Group (IWG). This workgroup meets approximately every month and many members are kept informed and correspond though email. Their primary responsibility is to initiate, review and facilitate policy directives relating to wetland protection in Minnesota. The membership is open to all that are interested, though as listed below most of the members represent federal, tribal, and state agencies. A few members represent local governments, private industry and nongovernmental organizations. Their comments and review of this document are appreciated. Development and oversight of the wetland strategy was co-chaired by John Jaschke from the Board of Water and Soil Resources and Mark Gernes from the Minnesota Pollution Control Agency.

MN Board of Water and Soil Resources
MN Department of Natural Resources
Fond du Lac Reservation
US Fish and Wildlife Service
MN Department of Agriculture
US Environmental Protection Agency
Mower County SWCD
Minnesota Power
MN Association of Watershed Districts
MN Pollution Control Agency
MN Department of Transportation
Red Lake DNR.
US Natural Resources Conservation Service
US Army Corps of Engineers
US Federal Highway Administration
St. Louis County Highway Department
National Wildlife Federation

Introduction

Minnesota supports one of the richest wetland heritages in the conterminous United States. From the bogs and peatlands of the north, to the prairie potholes of the central and western part of the state, wetlands are complex hydrologic systems with intrinsic values and functions. In general, Minnesota wetlands are recognized for their many utilitarian benefits such as improving and protecting the quality of surface and ground water by retaining storm water and filtering pollutants. Wetlands naturally retain water on the landscape. By storing water on the landscape wetlands can greatly reduce the damage from flooding in agricultural and urban watersheds. Intrinsically, wetlands also provide important recreational resources, essential habitat for many plants and animals, environmental learning opportunities and aesthetic open spaces.



Prior to the 1860s, about 18.6 million acres of wetland existed in Minnesota. Today, roughly half of Minnesota's original wetland acres remain, the other half have been drained or filled with most of the losses occurring in the southern and western regions of the state. Changes in public policy toward wetlands began in the 1950s and were slow to take hold, but in the last 10 years significant advances have been made toward keeping the remaining wetland resources on the landscape. Most notable are the Minnesota Wetland Conservation Act (WCA) of 1991, and implementation of section 404 of the federal Clean Water Act enacted in 1972. Both of these laws strive to achieve a no-net-loss of wetland acreage by requiring a sequencing process to first avoid and then minimize the loss of wetland areas, and if that is not possible then to mitigate the losses by restoring or creating wetlands with similar functions and values, generally within the same county or watershed.

While there is still a strong need to protect wetlands from draining and filling activities, the state of Minnesota is just beginning to initiate plans and responses to protecting the quality and integrity of natural and restored wetlands.

Current Efforts to Protect Wetland Quantity

As the public's awareness of wetland benefits has increased, various controls and programs have been put in place to limit the acres lost. In addition to protection efforts, a concerted effort by public and private groups has restored many acres of previously drained wetlands.

Protection of Wetland Quality

Wetland quality is a somewhat less familiar issue. As waters of the state and nation, all wetlands are included under the jurisdiction of the federal Clean Water Act, which intends to restore and maintain the chemical, physical and biological integrity of these waters. A primary focus of this plan is in restoring and maintaining wetland quality.

PHYSICAL LOSS: FEDERAL EFFORTS

1972 **The Federal Water Pollution Control Act** regulates the discharge of dredge and fill material into waters of the United States, including wetlands, under the section 404 permit program administered by the U.S. Army Corps of Engineers. Clean Water Act, 33 U.S.C. § 1344.

1985 **The Food Security Act** created the **"swampbuster"** provision, which denies USDA farm program benefits to farmers who plant annual crops on wetlands converted after 1985. 16 U.S.C.§ 3821 to 3824.

1990 **The Food, Agriculture, Conservation and Trade Act** created the **Wetlands Reserve Program** to restore and permanently protect wetlands, with a goal of enrolling one million acres of farmed wetlands, prior-converted wetlands, and adjacent upland by the year 2000. 16 U.S.C.§ 3821 to 3824.

1996 **The Federal Agriculture Improvement and Reform Act of 1996** continued the initiatives of the 1985 and 1990 legislation but removed some of the crop production limitations and established **"Freedom to Farm"** a seven year phase out for federal agricultural program benefits.

PHYSICAL LOSS: STATE OF MINNESOTA EFFORTS

1947 Chapter 142 declared "all waters providing substantial public use and that are navigable in fact" to be public waters. Drainage of public waters could occur only if they were deemed "non-public," or permission was acquired from the Commissioner of Conservation.

1951 The "Save the Wetlands" program was enacted, which used federal funds (Pittman-Robertson) to acquire wetlands for state wildlife management areas. A subsequent revision added a surcharge for acquisition in 1957. Later, in 1969 Wildlife Lake Designation began.

1976 Chapter 83 established a program to inventory and specify public waters once and for all, including wetlands. The state water bank program was created, where easements could compensate landowners that agreed to preserve their wetlands.

1979 Chapter 199 amended Chapter 83 to allow implementation of the Public Water Inventory Program and the State Water Bank Program.

1987 The Reinvest in Minnesota (RIM) Reserve Program was enacted with funds to secure conservation easements on private lands, including drained wetlands that would be restored.

1991 Chapter 354, the Wetland Conservation Act (WCA), created a "no net loss policy;" provided for mitigation of drained or filled wetlands; allowed local units of government administrative authority; and authorized the Board of Water and Soil Resources (BWSR) to adopt rules and acquire permanent easements for Types 1, 2 and 3 wetlands.

1991 Governor's Executive Order 91-03 established no-net-loss requirement for state agency operations.

1996 Chapter 462 amended the Wetland Conservation Act to provide a more streamlined notification process. Exemptions were also reformatted for easier interpretation, with expansion of exemptions covering agricultural land, individual sewage treatment systems, wildlife habitat improvement projects, drainage and de minims. The 1996 amendments provided that local governmental units may develop Local Comprehensive Wetland Protection and Management Plans as an alternative to the Rules, with flexibility in the application of sequencing standards, replacement standards and certain exemptions. 1996 changes also amended the requirements for public road project replacement, including the provision that the BWSR will replace wetlands drained or filled from the repair, reconstruction or rehabilitation for existing local government public roads.

2000 Chapter 382 integrated elements of the Wetland Conservation Act and the Department of Natural Resources Public Waters Regulatory Program.

2000 Governor's Executive Order 00-02 maintained a no-net-loss requirement for state agency operations.

PHYSICAL LOSS: LOCAL EFFORT

Many local land use plans and ordinances have provisions in place to protect wetland resources. Many of these plans and ordinances have included buffer or setback provisions and buffer plans. Though the majority of the local wetland plans and ordinances have been adopted within the metropolitan service area, there are several notable examples of local plans and ordinances outside the metropolitan service area.

WETLAND WATER QUALITY PROTECTION: WATER QUALITY RULES AND POLICIES

1994 Chapter 7001.1035 Storm-Water Permit [construction and industrial facilities] Following national regulations the MPCA adopted rules which required industrial activities with applicable Standardized Industrial Codes (SIC) and/or construction activities disturbing more than five acres to install and implement Best Management Practices (BMPs) to reduce storm event sedimentation and runoff into adjacent waters, including wetlands.

1994 Chapter 7050, State Water Quality Standards. These rules were revised to clarify the applicability of state water quality rules to wetlands. Specifically wetlands were defined and identified as waters of the state. Wetland water quality designated uses were defined, wetland narrative water quality criteria were included, as were narrative biological criteria for all waters including wetlands, and lastly the state antidegradation language and policy were specified for wetlands. The nondegradation language incorporated a definition and prohibition of wetland physical alteration by dredging, filling, draining or inundating wetlands, unless permitted through a 401 certification, or a state issued National Pollutant Discharge Elimination System (NPDES) permit or a state disposal permit. The 401 certification program is vital in helping to maintain wetland water quality in Minnesota.

1997 Minnesota Storm Water Advisory Group issued guidance applicable statewide for reducing storm water bounce effects and pollutant loading associated with storm water discharges to wetlands. Bounce criteria are based on the type of plant community associated with the wetland(s) of interest.

Comprehensive Wetland Planning

1997 The Minnesota Wetland Conservation Plan (MWCP) development began in 1994 and culminated with the publication of the MWCP in 1997. Numerous public and private interest groups provided input throughout development of the plan.

1998 The MWCP Action Planning Workbook was developed and released by the Minnesota Interagency Wetland Group (IWG). The Action Planning Workbook outlines the goals and tasks the five state agencies represented in the IWG intend to undertake to implement goals set forth in the Minnesota Wetland Conservation Plan.

Threats to Wetlands

PHYSICAL LOSS

Wetlands have been an issue throughout Minnesota's history. The debate over the value of wetlands, has been the paramount water issue since Minnesota statehood in 1858. Early water management in Minnesota consisted mainly of manipulating surface waters, attempting to make more land suitable for farming. Surface water was viewed as a "common enemy" and wide scale drainage was the order of the day early in the twentieth century. Wetlands were considered "undesirable wastelands."[1]

Towards the mid twentieth century the virtues of wetlands became more apparent and protection efforts were enacted at all levels of government. With many of the easily drained wetlands already converted, and protection regulations in place, the economic incentive for draining wetlands for agricultural purposes has become less appealing. Recently, the economy has escalated with resulting construction and development activities, including building and improving roads, increasing the loss of wetlands.

LOSS OF FUNCTION AND VALUE

Wetlands serve many functions. Minn. Stat. § 103B.3355 lists public values and functions of wetlands, and among them are:

1. **water quality** protection including filtering of pollutants to surface and ground water, assimilation of nutrients and trapping sediments;
2. **shoreline protection** resulting in reduced erosion and sedimentation;
3. **ground water recharge** to maintain shallow ground water resources and contribute to replenishing deeper aquifers used for drinking water;
4. **floodwater and storm water retention benefits**, reducing the potential for flooding and protecting the value of property subject to flooding;

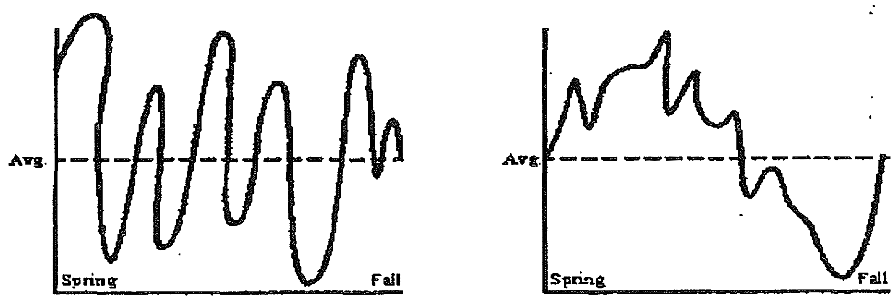
5. **public recreation and education**, including hunting and fishing areas, wildlife viewing areas, and nature areas;
6. **commercial uses**, including wild rice and cranberry growing and harvesting and aquaculture;
7. **habitats** for fish, wildlife, native plants and other aquatic life;
8. **low-flow augmentation**, sustaining aquatic life in streams during seasonally rain free periods; and
9. **other** public uses.

Many of these functions maintain natural processes of wetland ecological communities. These processes partially represent the ecological or intrinsic value of the wetland within its watershed. Other wetland functions, such as water quality protection, flood reduction or commercial uses, particularly when engineered to maximize the "reduction or production" benefits, can negatively impact the more intrinsic ecological values which in turn can detract from the aesthetic, education and recreational values associated with natural wetlands.

No research shows that indigenous wetland plants and other aquatic life *benefit* from an increase in water, sediment, nutrients or other pollutants delivered to the wetland. On the contrary, alterations to wetland hydrology and water chemistry have been documented by numerous researchers to degrade, and often destroy, the biological integrity of wetlands[2,3,4,5,6].

Introductions of exotic species such as purple loosestrife have resulted in significant alterations to the habitat function of many wetlands. Though biological systems are showing signs of promise in controlling the success of some of these exotic species such as purple loosestrife. Carp another exotic species, and other undesirable fish have gained access to wetlands through ditches and tile lines. The role of these benthic omnivores in promoting phytoplankton dominated systems with high phosphorus outputs rather than macrophyte dominated systems with relatively low phosphorus outputs is well documented

Example of Annual Hydrographs for Flood Management Wetland and for Natural Area Quality Wetlands



Altered Watershed Hydrology
- Unpredictable swings in water levels
- Creates biological instability
- Promotes habitats for weeds and poor aesthetics
- Promotes poor water quality

Naturalized Watershed Hydrology
- Annual seasonal high and low
- Predicable hydraulics and seasonal trajectory
- Promotes habitat for stable yet dynamic plant communities (diversity of plants and animals)

Hydrographs are from TSAC Technical Paper #1, An Overview of the Impacts of Water Level Dynamics ("Bounce") on Wetlands by ecologist Steven I. Apfelbaum with Applied Ecological Services, Inc. Brodhead, WI and Larry Lewis with Morris Wetland Management District, MN. Information can be obtained from these authors.

ALTERED HYDROLOGY[7]

When a wetland's watershed is altered to accommodate agriculture, transportation or urbanization (housing, industry, and retail), its hydrology will be affected. Also, water level changes in the wetland become more frequent and prolonged. This is often referred to as "*bounce,*" which has been documented to:

1. shift plant communities from diverse native species to monocultures of species tolerant of unpredictable hydrologic conditions;
2. contribute to destabilized shoreline conditions favorable to weedy plant species;
3. increase suspended solids and turbidity;
4. alter water chemistry conditions;
5. impact wildlife populations, and
6. simplify the wetland invertebrate community.

Studies have shown that wetland hydrologic alterations, particularly those resulting in pronounced wet and dry cycles may contribute to mercury methylation and mobilization and thus enhanced biological availability of mercury in aquatic foodchains[8].

Altering the hydrology can also divert surface or groundwater from the wetland. Sometimes referred to as *dewatering,* projects in a wetland's watershed that reroute or redirect water from wetlands pose a serious threat to wetland resources.

WETLAND CONDITION OR QUALITY

Wetlands are unique in protection and conservation programs. The physical loss of wetlands occurs much more frequently than the physical loss of waterbody types, such as lakes and streams. Thus, retaining the physical presence of wetlands on the landscape has been the primary intent of most wetland protection efforts, including nonpoint source efforts. In contrast, nonpoint source protection efforts focused on other waterbody types usually attempt to maintain the waterbody quality or condition.

By definition, "pollution" results from changes, due to human activities, in the chemical, physical and/or biological integrity of waters including wetlands. No one knows how many wetlands have been polluted and still occur on the landscape. Like other water body types, wetland condition can unquestionably be impaired by discharges of excess nutrients and toxic materials including heavy metals and compounds such as polyaromatic hydrocarbons. Sedimentation and related changes in turbidity has also been shown to adversely affect wetland condition. Specific thresholds of ecological response or specific numeric standards for wetlands have yet to be developed and incorporated into Minnesota water quality standards. It will be difficult to develop such standards given the variety of wetlands and the dynamic nature of wetlands across the state.

ASSESSING WETLAND CONDITION

Pollutant loading and other disruptions to biological integrity can affect the quality or condition of wetlands. In 1995, the Minnesota Pollution Control Agency studied 27 depressional wetlands in the North Central Hardwood Forest Ecoregion (Figure A-1) with the goal of developing biological indexes for wetlands based on wetland vegetation and invertebrates. This study included both high quality wetlands (reference condition) and wetlands judged to be affected by storm water, and agricultural practices.

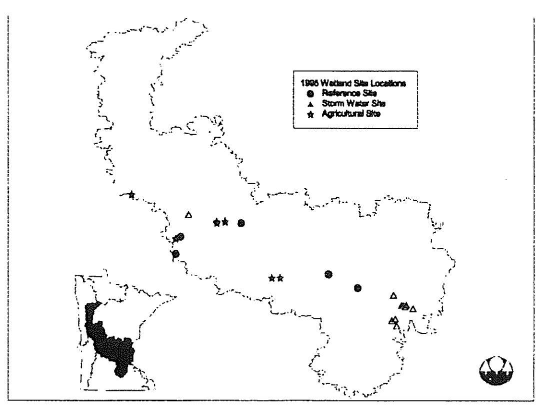


Figure A.1. Locations of the 27 Minnesota depressional wetlands in three study conditions: Reference, Agricultural and Storm water

These results showed that storm water wetlands had high concentrations of chloride compared with the reference wetlands. In addition, several heavy metals, particularly copper, zinc and lead were elevated in the sediments of the storm water influenced wetlands. The agricultural wetlands had the highest concentrations of phosphorus, nitrogen and total suspended solids in the water and phosphorus in the sediments.

Two multimetric biological indexes were developed for depressional wetlands in this part of the state. One of the indexes was developed based on the invertebrate community and the second index was based on the plant community. Both indexes have scoring criteria for 10 metrics and can be used to evaluate the biological integrity or "health" of depressional wetlands in this part of the state.

Functional Assessments

Wetland functional assessments evaluate the suitability and quality of the many functions ascribed to a given wetland. Functional assessments are typically applied to individual wetlands, often in conjunction with regulatory permit application(s), though they have also been applied in comprehensive local wetland plans. Several approaches to functional assessment have been developed and introduced in Minnesota. Two approaches or methods have received the most attention in recent years. The hydrogeomorphic method (HGM) evaluates several attributes, many of them physical factors, for the wetland being assessed and compares them to expectations of similar wetlands in the same geographic and hydrologic class. Regional guidebooks must first be developed before HGM assessments can be implemented. A guidebook for depressional wetlands in the Prairie Pothole region is under development and could be applied in Minnesota.

A second functional assessment method developed for use in Minnesota is the Minnesota Routine Assessment Method (MRAM). The MRAM was developed by the Minnesota Interagency Wetland Group. It is intended as an evaluation tool to document and organize field observations made by agency and local government field staff and environmental consulting professionals. The MRAM approach is not specific to particular wetland types or functional groups such as depressional or riverine wetlands, though the method does recommend applying reference standards by wetland type using accepted wetland classifications. MRAM can be applied to essentially any wetland type in the state.

The Minnesota Routine Assessment Method does not integrate the functional results into a single value or "score." Rather the result for each function is used relative to expectations for that function to make administrative decisions. MRAM results are intended to illustrate the consequences of proposed land use actions on individual functions.

Total Maximum Daily Loads (TMDLs)

A process for identifying wetland waters as polluted and in need of reductions in specific pollutant loads is under development in Minnesota. Though some wetland waters in Minnesota have been identified and are recognized as impaired based on various criteria used for other waters such as lakes and streams. Continuing work on wetland assessment methods and criteria is intended to be useful for the process under development to establish a TMDL listing process including wetlands.

Best Management Practices (BMPs)

Best management practices (BMP) are land management actions that can be implemented to protect wetlands from various nonpoint source pollutants. In general, they must be designed and often implemented to meet site specific needs. Typically, BMPs are chosen and implemented for their ability to treat or reduce sediment, nutrient removal and to reduce excess surface water from entering the wetland. The list provided below includes several BMPs often utilized to protect the biological integrity of wetlands. This list is not intended to be exhaustive and there are likely other recognized BMPs not listed here that can be useful in protecting wetlands.

One cautionary note about designing and applying wetland BMPs. The BMP should not be installed within the wetland, such that it will threaten the integrity of the wetland. Natural wetlands should not be used as part of a BMP system.

Cropping System Measures:
- Conservation Cropping Systems
- Conservation Tillage
- Crop Residue Use
- Cultural Control of Pests
- Soil Testing and Plant Analysis
- Timing and Placement of Fertilizers

Structural Measures:
- Concrete Grid and Modular Pavement
- Detention Basins
- Diversions or Terraces
- Exfiltration Trenches
- Grade Stabilization Structure
- Grassed Waterway or Outlet
- Gravel Inlet Filter
- Outlet Protection
- Porous Pavement
- Retention Basins
- Rooftop Runoff Disposal
- Silt Fence
- Storage/Treatment Facilities
- Storm Drain Inlet Protection
- Storm Water Conveyance Channel
- Underdrain Storm Water Filter Systems

Vegetative Measures:
- Critical Area Planting
- Construction Road Stabilization
- Mulching
- Riparian Buffer
- Vegetative Filter Strip
- Vegetation Establishment
- Water and Sediment Control Basin

Other
- Outlet designs that prevent entry of undesirable fish
- Livestock exclusion
- Street Cleaning
- Permeable surfaces or "grassed" overflow parking areas.

This list has been derived from recognized BMP information sources[9,10]. Consult these and other sources to obtain more detailed descriptions and specifications of BMPs and their application to wetlands.

CONTAMINATED SEDIMENT

Potential chemicals of concern can be transported and settle into the sediments of wetland areas. At elevated concentrations, contaminated sediments may contribute to habitat impairments. Additional information about contaminated sediments can be found on the MPCA Web Site at: http://www.pca.state.mn.us/water/sediments/index.html.

Needs, Priorities and Milestones: 2001-2005

As wetlands disappeared from the landscape, the quality of adjacent waters has suffered. The ability of wetlands to filter pollutants has provided a strong basis for their protection from drainage and filling. Though, viewing wetlands strictly as storm water retention areas presents a narrow view of wetland uses. Wetland biological communities provide many intrinsic values that are at least as important as the often-cited wetland water purification functions.

Not all wetlands are equal in their biodiversity, habitat and aesthetic values. Likewise, not all wetlands are equal in terms of the water quality benefits they provide. To make wise resource management decisions regarding individual wetlands and associated resources, land managers must have the appropriate tools and information necessary to help make wise decisions for the benefit of the community. The overall goals of this wetland strategy are to protect the quantity and quality of wetland resources across the state and endorse the following:

Informed local wetland management **-** Support efforts to inform and sensitize land use decision-makers concerning the need and practices to protect wetlands chemical, biological and hydrological integrity in addition to the physical quantity of wetlands.

Wetland related inventories **-** Support inventory and access to information describing the location of existing and restorable wetlands, including the type and extent of the wetland.

Monitoring and assessment – Support efforts to identify the quality and integrity of wetlands and provide status and trends of wetland condition. To provide estimates of wetland functional capacity.

Promote understanding and response to agricultural practice effects on wetlands **-** Reduce effects on wetlands of tillage and agricultural chemical uses. Facilitate local government opportunities to improve ecological wetland management decisions in agricultural landscapes.

Improve wetland restoration **–** Improve wetland restorations, creations, and promote efforts to recover lost wetland integrity and better management practices of natural wetlands.

Wetland education and outreach **–** Support efforts to improve the understanding and communication between individual and cumulative actions and their effects on wetlands.

Improved storm water management and planning **–** Promote wise storm water management to maintain wetland integrity. Local and state governments must strive to carry out desired actions and discourage undesirable storm water effects on wetlands.

Promote understanding of wetland responses to pollutants **–** support efforts to reduce the harmful effects of pollution on wetlands.

Wetland research **–** Work to enable better linkages between scientific studies and wetland management decisions.

Chapter 4 Overall Strategy for Each Water Resource
Strategy 4.4 Wetlands
Needs, Priorities and Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) 5-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement. (NOTE: Strategy 4.4 was not included in the 1994 NSMPP and, therefore, no 1994 Needs, Priorities and Milestone Table is provided.)

Whenever possible and appropriate these goals have been developed from other plans such as the State Comprehensive Wetland Plan and the Coastal Zone Management Plan[11].

Goal 1: Support Local Government Wetland Management and Protection Efforts.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Provide incentives to local governmental units (LGUs) to develop local wetland management plans that include priority wetland designations.		X	X	X	X	319, other Federal, State and Local sources	BWSR.
2. Draft model language for local plans (e.g., comprehensive, zoning) that protects the biological integrity of wetlands, including fringe/buffer areas.	X	X	X	X	X	319, other Federal and State sources (funding may not be necessary)	Interagency wetland group, BWSR, MPCA.
3. Increase financial assistance to local governments to enforce the Wetland Conservation Act and local wetland protection ordinances.	X	X	X	X	X	319, other Federal and State sources	BWSR.
4. Educate LGUs about how they can use incentives and zoning to discourage land use activity in wetland buffer (fringe) areas that would negatively impact wetlands.	X	X	X	X	X	319, other Federal and State sources	BWSR, MPCA, DNR.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5. Research and develop improved guidance for buffer widths and quality criteria in concert with similar research for rivers and lakes in urban landscapes.			X	X	X	319, other Federal and State sources	MPCA, DNR, MCEA, LGUs.
6. Develop linkages between local nonpoint source problem responses in the Lake Superior drainage to the Coastal Zone Plan outcomes.	X	X	X	X	X	319, other Federal and State sources	MPCA, DNR, BWSR.
7. Develop guidelines concerning the impact of undesirable fish in wetlands.	X	X	X			319, other Federal and State sources	DNR, USFWS, MPCA.
8. Research and present findings regarding how agricultural land preservation programs affect wetland values and functions.	X	X	X	X	X	319, other Federal and State sources	DNR, BWSR, MDA, NRCS.

Goal 2: Complete or Update Wetland and Related Inventories.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Update the National Wetland Inventory.			X	X	X	319, other Federal and State sources	DNR, LMIC, BWSR, USFWS.
2. Develop a comprehensive inventory of cropped, drained and restorable wetland sites.	X	X	X	X		319, other Federal, State, Local and Private sources	BWSR, DNR, COE, LMIC, LGUs.
3. Complete wetland and restoration opportunities at the county, municipal, township and/or watershed level.	X	X	X	X	X	319, other Federal, State and Local sources	BWSR, LGUs, DNR, USFWS.
4. Compile wetland and potential restoration inventories by major watershed.		X	X	X	X	319, other Federal and State sources	BWSR, DNR.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5. Produce and distribute digitized inventories of resources such as soil surveys and hydrologic maps.	X	X	X	X	X	319, other Federal and State sources	LMIC, DNR, BWSR.
6. Promote and expand the use of remote sensing methods for underground tile lines to develop regional inventories.		X	X	X	X	319, other Federal and State sources	BWSR, MDA, MPCA, DNR, U of M.
7. Develop a statewide inventory of public drainage systems.		X	X	X		319, other Federal and State sources	BWSR, MDA, MPCA, DNR, LGUs.
8. Promote the development of consistent statewide digital coverage of hydric soils.	X	X	X	X	X	319, other Federal and State sources	LMIC, BWSR, DNR.

Goal 3: Monitoring and Evaluation of Wetland Resources at the State and Local Level.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop a comprehensive strategy for wetland monitoring and assessment.		X	X			319, other Federal and State sources	Interagency Wetland Group, MPCA, DNR, BWSR.
2. Develop pilot wetland status and trends areas Suggested priority areas: • Twin Cities Metropolitan Area • Agricultural areas • Northern Minnesota Forested areas.		X	X	X	X	319, other Federal and State sources	MPCA, DNR, FWS, COE, BWSR.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
3. Evaluate the utility and intent of the Index of Biotic Integrity (IBI), MN Routine Assessment Method (MNRAM) and the Hydrogeomorphic Method (HGM) and identify other assessment tools useful in wetland management. Determine the level of support and applicability of each method.		X	X			319, other Federal and State sources (funding may not be needed)	Interagency Wetland Group, BWSR, MPCA.
4. Complete remote sensing of wetlands to document the loss of wetland quality due to shifts in phytoplankton dominated systems.	X	X	X	X	X	319, other Federal and State sources	DNR, USFWS, U of M.
5. To the extent funding and resources are available, complete IBI work in preparation for assessment implementation;	X					319, other Federal and State sources	MPCA, EPA, Tribes, DNR, Cooperation with academics and neighboring states.
a. Complete guidance modules for EPA national IBI workgroup	X						
b. large depressional wetlands (small lakes)	X						
c. Riparian wetlands			X				
d. Initiate fen and seasonal wetland IBI work		X					
e. Validate invertebrate and IBIs in different geographies within MN				X			
f. Pilot wetland assessment at the 14-digit HUC minor watershed scale.							
6. Develop indicators and methods to evaluate progress toward goals set forth within the Minnesota Wetland Conservation Plan.	X	X	X			319, funding may not be necessary	Interagency Wetland Group

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
7. Revise the citizen version of the IBI and develop improved guidance and training for local governmental units (LGUs) and other users.	X	X				319, funding provided by 104(b)3 wetland grant	MPCA
8. Evaluate and revise the Minnesota Routine Assessment Method as necessary.		X				319, other Federal and State sources (funding may not be necessary)	BWSR DNR, Interagency Wetland Group,
9. Evaluate and develop wetlands functional assessment methods for use in Minnesota, for example the Hydrogeomorphic methods.		X	X	X	X	319, other Federal and State sources	COE, NRCS, BWSR, DNR.
10. Train local governmental units to conduct functional assessments as part of "local water planning."		X	X	X	X	319, other Federal and State sources	BWSR, COE.
11. Initiate a review of local government wetland planning efforts and consider whether goals within the MWCP have been incorporated.		X	X	X		319, other Federal and State source	BWSR, DNR, MPCA.

Goal 4: Support Improvements in the Understanding and Response to Agricultural Practices on Wetlands.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Provide support and financial assistance to local governments to pilot comprehensive wetland decision-making in agricultural regions.		X	X	X	X	319, other Federal and State sources	MASWCD, BWSR, NRCS, MDA.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
2. Promote a better understanding of how adjacent agricultural practices affect the integrity of wetlands, including seasonal wetlands.		X	X	X	X	319, other Federal and State sources	BWSR, MPCA, DNR, NRCS, MDA.
3. Develop a better understanding of how shifts in agricultural land-use to residential or commercial development affect wetland quality.			X	X	X	319, other Federal and State sources	BWSR, MDA, MCEA, MPCA, LMIC.
4. Study the effect of aquaculture on wetland quality.		X	X	X	X	319, other Federal and State sources	DNR, MPCA, MDA.
5. Study the relationship between watershed hydrologic alterations and infestations by undesirable fish.		X	X	X	X	319, other Federal and State sources	DNR, LMIC, NRCS, USFWS.
6. Improve the process for inventory of wetland resources to include cropped and agriculturally converted wetlands.		X	X	X		319, other Federal and State sources	DNR, LMIC, NRCS, BWSR, MDA.
7. Establish a demonstration program of financial incentives to protect and preserve cropped wetlands from future cropping practices.		X	X	X	X	319, other Federal and State sources	NRCS, BWSR, MASWCD,
8. Develop an improved inventory of cropped wetlands.	X	X	X	X		319, other Federal, State and Local sources,	NRCS, BWSR, MDA, MACD.
9. Research and develop improved guidance for buffer widths and quality criteria in agricultural/rural landscapes.			X	X	X	319, other Federal and State sources	MPCA, DNR, MCEA, LGUs.

Goal 5: Improving Wetland Restoration Efforts.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Facilitate the use of the Minnesota Wetlands Conservation Plan (MWCP) regional geographic recommendations for siting wetland restorations.	X					319	DNR, BWSR, MPCA, COE, USFWS.
2. Link wetland restoration opportunities to specific identified priority locations by watershed. Priority locations may be determined by availability and modeling.	X	X	X	X	X	319, other federal, state, local and private funding sources, including WRP-NRCS	BWSR, DNR, MPCA, LGUs, NGO, NRCS.
3. Encourage wetland managers in their restorations to install fish barriers when appropriate to prevent harmful infestation by undesirable fish.		X	X	X		319, other federal and state sources	DNR, COE, BWSR, USFWS.
4. Develop improved guidelines and criteria, including vegetative coverage and diversity to evaluate restoration success.	X	X	X	X	X	319, other federal and state sources	BWSR, DNR, COE, U of M.
5. Facilitate ongoing gap analysis studies at the appropriate scale to identify critical discontinuities in wildlife habitat and ecological benefit. Provide this information to local governments.	X	X	X	X	X	319, other federal and state sources	DNR, USFWS.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
6. Identify high priority sites for wetland restoration or creation that most effectively fit into watershed needs. Sites should be indexed and included in local water management plans. Their anticipated benefits and priority should be determined.	X	X	X	X	X	319, other federal, state and local sources, WRP-NRCS	BWSR, DNR, MPCA, NRCS.
7. Establish and maintain a central database of wetland restoration activities in the state. The Database should include information from local, state and federal government projects and from private and nongovernmental projects.		X	X	X	X	319, other federal, state and private sources	BWSR, DNR, COE, NRCS, USFWS, NGOs.

Goal 6: Wetland Education and Outreach.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Promote and expand local government sponsored volunteer monitoring efforts similar to the "Dakota County Wetland Health Evaluation Project."	X	X	X	X	X	319, other federal, state and local sources	MPCA, BWSR, DNR, LGUs.
2. Provide training workshops for LGU and state and federal wetland staff. Topics to include both introductory and advanced wetland ecology, hydrology, soils, botany, classification, functional assessment and condition assessment		X		X		319, other federal and state sources	BWSR, DNR, MPCA, COE, University educators.

	2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
3.	Provide wetland "essentials" training for Realtors, contractors, developers and other development professionals.	X	X	X	X	X	319, other Federal and State sources	BWSR, DNR, MPCA, Builders Assoc, Realtors Assoc.
4.	Promote local and regional field tours of wetlands for local officials.	X		X		X	319, other Federal and State sources	BWSR, DNR, MPCA, LGUs.
5.	Create guidance for local officials on evaluating wetland values based on local and regional issues.		X	X	X	X	319, other Federal and State sources	BWSR, DNR, MPCA.
6.	Create a set of model local wetland management Plans to assist local government units.	X	X	X			319, other Federal and State sources	BWSR, MPCA, DNR.
7.	Create a series of professionally produced guidebooks for landowners focused on "discovering or gaining the most from your wetland" and similar management or appreciation topics. Include regional examples.		X	X	X		319, other Federal and State sources	BWSR, DNR, MDA, MPCA.
8.	Find effective ways to communicate wetland benefits, flooding and storm water processes, alternative runoff management, cumulative impacts of land use decisions and smart growth.		X	X	X	X	319, other Federal, State, Local and NGO sources	Many
9.	Produce outreach materials, public field tours, or other forums to promote exchange of views regarding wetland and watershed protection, land use planning and sustainable development.	X	X	X	X	X	319, other Federal, State, Local and NGO sources	Many

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
10. Promote dissemination of wetland professional expertise and contact through speakers list, written materials, AV materials and volunteer opportunities.	X	X	X	X	X	319, other Federal, State, Local and NGO sources	Many
11. Develop and promote use of quality wetland related video and technology materials for use by K-12 educators.		X	X	X	X	319, other Federal, State, Local and NGO sources	Various agencies and school districts.
12. Promote and develop interactive wetland educational programs like "WOW" and "Project WET" to provide preK-12 students a personal experience with wetlands.	X	X	X	X	X	319, other Federal, State, Local and NGO sources	Various Agencies and school districts.
13. Promote implementation of education and outreach to producers and landowners as outlined in the Green Print, Minnesota's State Plan for Environmental Education.		X	X	X	X	319, other Federal, State, Local and NGO sources	Various Agencies, Nongovernmental organizations and school districts.
14. Promote wetland-related activities curriculums, games or studies such as are developed for school events and school science fairs and incorporate them into Sharing Environmental Education Knowledge (SEEK).	X	X	X	X	X	319, other Federal, State, Local and NGO sources	Various Agencies and school districts.
15. Develop and promote a voluntary registry for unique and vulnerable wetlands such as seasonal wetlands and calcareous fens.	X	X	X	X		319, other Federal, State, Local and NGO sources	MPCA, BWSR, DNR, NGOs.

Goal 7: Support Improvement in Storm Water Management and Planning.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Complete revisions to urban BMP manual.	X					319, other Federal and State sources (funding may not be needed)	MPCA
2. Revise wetland storm water and snow melt runoff guidance to consider acute and chronic effects.		X	X			319, other Federal and State sources (funding may not be needed)	MPCA, Interagency work groups.
3. Promote wise management of storm water effects on wetlands through local water planning and zoning efforts. For more information see Chapter 11, Urban Runoff.	X	X	X	X	X	319, other Federal and State sources	MPCA, BWSR, LGUs, MCEA.
4. Implement the next stage of storm water construction and municipal permit compliance. Projects exposing 1-acre of soil or communities of 10,000 and greater must comply with the respective storm water permit provisions.		X	X	X	X	Various Federal and State sources [not including 319, for which this milestone would be ineligible]	MPCA

Goal 8: Promote Understanding of Wetland Responses to Pollutants.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Promote control measures for spread of exotic/invasive species in wetlands.	X	X	X	X	X	319, other Federal, State, and Local sources	DNR, MDA, LGUs.
2. Research the process of mercury methylation processes in different wetland types and hydrologic regimes.	X	X	X	X	X	319, other Federal and State sources	MPCA, USGS, Academic Institutions, EPA, COE.
3. Facilitate the adoption of nutrient control measures for wetlands.			X	X	X	319, other Federal and State sources	MPCA, EPA.

	2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
4.	Develop process for identifying, listing and responding to impaired wetland waters, i.e. total maximum daily loads (TMDLs).	X	X	X	X	X	319, other Federal, State, and Local sources	MPCA, LGUs, NGOs.
5.	Evaluate the role of human induced "bounce" and pollutant loading on wetland plant, invertebrate and wildlife populations.	X	X	X	X	X	319, other Federal and State sources	DNR, MPCA, LGUs, Academic researchers.

Goal 9: Wetland Research Needs.

	2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	**Lead Agency(ies)
1.	Research the role of wetlands within systems such as hydrologic systems or ecosystems.	X	X	X	X	X	319, other Federal and State sources	Agencies & Academic Researchers.
2.	Improve methods to determine wetland water budgets and groundwater recharge contribution of individual wetland basins or complexes and map important regional recharge zones.		X	X	X	X	319, other Federal and State sources	DNR, MPCA, MDH, USGS, Academic Researchers.
3.	Research the optimal width and characteristics of buffers adjacent to wetlands or tile discharges to wetlands. Work should be done in concert with other surface water buffer studies.		X	X	X	X	319, other Federal and State sources	MDH, DNR, MPCA, BWSR, NRCS, Academic Researchers.
4.	Research the water quality impacts of different grazing systems.	X	X	X	X	X	319, other Federal and State sources	Agencies & Academic Researchers.
5.	Research response thresholds of individual plant or invertebrate or vertebrate taxa to general classes of stress or pollutants.		X	X	X	X	319, other Federal and State sources	Academic Researchers.

	2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
6.	Research the need for and ecological/hydrological benefits of eliminating non-functional ditches in peatlands.		X	X	X	X	319, other Federal and State sources	DNR, USDA, Academic researchers.
7.	Evaluate methods for restoring wetlands on mine tailing sites, abandoned gravel pits and peat mining sites.	X	X	X	X	X	319, other Federal and State sources	DNR, USGS, Academic Researchers, Tribes.
8.	Research the methods and effectiveness for controlling undesirable fish using pheromones as attractants.		X	X	X	X	319, other Federal and State sources	DNR, USGS, Academic researchers.
9.	Continue research on the most effective methods for remote sensing techniques to determine wetland quality.	X	X	X	X	X	319, other Federal and State sources	DNR, USFWS, COE, MPCA, Academic researchers.
10.	Research the social and economic benefits along with the cost of maintaining or restoring wetlands.		X	X	X	X	319, other Federal and State sources	Agency & Academic Researchers.
11.	Evaluate how the property tax system influences local government and landowner decisions about natural resource management, with particular focus on wetlands.		X	X	X		319, other Federal and State sources	Academic Researchers.
12.	Identify all benefits and costs associated with wetland conversion, compared to alternative land uses.	X	X	X	X	X	319, other Federal and State sources	Academic Researchers.
13.	Research the success and benefits of different restoration techniques.	X	X	X	X	X	319, other Federal and State sources	Agency and academic researchers.

	2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
14.	Research techniques for better wetland creations and creating wetlands with targeted functions.	X	X	X	X	X	319, other Federal, State and LGU sources	Agency, LGUs and Academic Researchers.
15.	Research techniques for enhancement and restoration of natural wetlands dominated by invasive exotics.		X	X	X	X	319, other Federal, State and LGU sources	Academic researchers and LGUs.
16.	Research to determine the best approaches, techniques or processes to accomplish the previous goals and associated milestones.	X	X	X	X	X	319, other Federal, State and LGU Sources	Agency, LGUs and Academic researchers.

ACRONYMS AND AGENCY NAMES

DNR	Minnesota Department of Natural Resources
MDH	Minnesota Department of Health
MPCA	Minnesota Pollution Control Agency
BWSR	Minnesota Board of Water and Soil Resources
LGU	Local Government Unit
NRCS	Federal Natural Resources Conservation Service
USDA	United States Department of Agriculture
MDA	Minnesota Department of Agriculture
EPA	Federal Environmental Protection Agency
NGO	Nongovernmental organizations
USFWS	United States Fish and Wildlife Service
COE	Federal Corps of Engineers
MCEA	Metropolitan Council Environmental Affairs
LMIC	Minnesota Land Management Information Center
MASWCD	Minnesota Association of Soil and Water Conservation Districts
USGS	United States Geological Survey
MWCP	Minnesota Wetland Conservation Plan

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Chapter 5 Monitoring

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Introduction

WHY MONITOR

Water monitoring provides the information necessary to determine whether the quality and quantity of water are adequate for the many uses that water serves. Water monitoring specific to nonpoint source (NPS) pollution is necessary for determining what contaminants are generated from NPS activities, as well as evaluating which efforts used to manage NPS are successful in restoring or maintaining the physical, chemical, and biological integrity of the state's waters. This strategy will review past and present types of monitoring activities, and will make recommendations for future directions. This monitoring strategy has been developed to be consistent with "The Minnesota Water Monitoring Plan" prepared under the auspices of the Minnesota Environmental Quality Board in April 1992. Excerpts from that document have been included in this strategy. This strategy differs from that document, however, in that it focuses on monitoring activities with a direct relationship to NPS pollution management.

History and Background

Monitoring of water quality and water quantity in Minnesota had its beginning nearly a century ago. The collection of stream flow data under the US Geological Survey (USGS) - State of Minnesota cooperative agreement began in 1909. Additionally, as part of this cooperative program, ground water level readings were initiated in 1948, and surface water quality monitoring began in 1952. This cooperative program peaked in the 1979-1980 biennium. It has diminished in recent years, however, due to state and federal funding reductions. While the Minnesota Department of Natural Resources (MDNR) and the Minnesota Department of Transportation (MnDOT) were the primary state agencies involved in these early efforts, several local agencies, as well as the US Army Corps of Engineers, also participate in this program.

In addition to the USGS - State Cooperative Program, a number of water quality monitoring programs were established for specific purposes. These programs include the following:

1) The MDNR has surveyed shallow lakes and larger wetlands since the late 1940s, to provide an inventory of physical and

biological characteristics of these waterbodies for wildlife management, historical information and resource protection. Most of the 2,000 surveys were performed during the 1960s.

2) From 1954 to the present, the MDNR has conducted over 12,000 surveys, re-surveys and special assessments on 3,700 lakes and streams, using standardized procedures to inventory physical, chemical and biological characteristics of these waterbodies. These surveys aid informed decision making of state fisheries and management programs.

3) The MDNR was initially responsible for a fish contaminant monitoring program starting in 1969. The Minnesota Pollution Control Agency (MPCA) did most of the monitoring from 1975 to 1989. In 1989, DNR obtained Reinvest in Minnesota (RIM) funds to continue this work. To date, this program has provided for the collection of mercury (Hg), PCBs, dioxin or pesticide data on 800 to 900 lakes, rivers and streams. Approximately 2,000-3,000 fish from 70 to 80 lakes and 5 to 10 rivers are sampled annually.

4) The Minnesota Department of Health (MDH) has maintained a surveillance program for public water supplies since the earliest days of the department. Early emphasis was placed on detecting microbiological contamination. However, over time, the emphasis has shifted to chemical contaminants, many of which are human-made. Passage of the federal Safe Water Drinking Act (SWDA) amendments of 1986 has greatly expanded the requirements of public water suppliers and subsequently, the workload of MDH's public water supply program.

5) The MPCA's ambient stream monitoring program began in 1953 (under the Water Pollution Control Commission, 1953-1967) and it provides the largest source of computerized long-term water quality information in the state. The MPCA currently monitors conventional pollutants at 80 sites throughout the state. Sites in each basin are sampled two years out of five once a month for 10 months of the year. This program has served many purposes and MPCA has changed sites for many reasons. Still, there are 42 routine monitoring sites for which there are more than 22 years of data in the last 44 years.

6) The Citizen Lake Monitoring Program (CLMP), administered by the MPCA, started in 1973 at the University of Minnesota with 74 lakes. In 1999, there are approximately 1098 CLMP volunteers who take Secchi disk transparency readings and record their perceptions of physical appearance and recreational suitability. In 1985, the MPCA began a monitoring effort to better understand ecoregion patterns in lake conditions. In 1985, the Lake Assessment Program (LAP) was begun. A LAP study is a cooperative effort by the MPCA staff and local citizens. Since 1985, over 160 LAP studies have been conducted.

7) The MPCA began the process of developing biological criteria in the Minnesota River basin in 1990 with the development of a fish based Index of Biological Integrity (IBI) for rivers and streams. Since that initial effort the biological criteria program has expanded to include invertebrate and plant based indices in streams, rivers and wetlands throughout Minnesota. The rivers and streams program is currently developing IBI's using fish and macroinvertebrate communities to evaluate water quality within each major river basin of Minnesota. Biosurvey techniques are also being developed.

8) Since 1996, MPCA and MDNR have cooperated to monitor rivers and streams using a statistically based integrated water quality monitoring approach that is designed to provide a more holistic picture of riverine water quality in a basin. The term "integrated" refers to the use of biological, physical, and chemical indicators of water quality. Sites are chosen randomly using guidance from USEPA Environmental Monitoring and Assessment Program (EMAP).

9) The MPCA began monitoring ground water in 1978, using a statewide ambient monitoring network designed by the USGS. During the first 10 years of the program, the MPCA collected no more than 3 samples from any station. Several stations lacked sufficient well construction information to be able to adequately interpret the data. In 1990-91, program goals and objectives were reviewed and the program was re-designed to include three major components: the statewide baseline network, a trends analysis component, and regional monitoring cooperatives. These three components comprise the Ground Water Monitoring and Assessment Program (GWMAP).

10) Metropolitan Council Environmental Services (MCES) has been conducting ambient water quality monitoring of the major rivers in the seven-county Metropolitan Area since 1976. On a weekly or biweekly basis, samples are obtained at 22 sites and analyzed for a wide variety of conventional pollutants. Monitoring of toxic substances (metals and organics) in water and sediment at 14 sites has been conducted since 1981. Biological monitoring (periphyton, phytoplankton, zooplankton, and macroinvertebrates) has been conducted at 14 sites since 1979. Recent additions to the river monitoring program (1998-1999) are toxicity-testing, biological monitoring, and toxics characterization of sediments in the Mississippi, Minnesota and St. Croix Rivers.

11) In 1998, MCES established a stream monitoring program on Minnesota River tributaries, to determine the extent to which these streams are contributing NPS pollutants to the Minnesota River. Monitoring stations have been established at seven sites on six tributaries, for continuous measurement of stream flow, and automated samples collection during runoff events. Runoff samples are analyzed for a wide variety of conventional and toxic NPS pollutants. With flow and water quality data available, annual NPS pollutant loads can be determined for each stream. Possible sources of NPS pollutants can be identified by examining land use practices within each watershed.

Since 1995, MCES has greatly expanded the Metropolitan Area stream monitoring program, which now includes 28 automated monitoring stations on Mississippi, Minnesota, and St. Croix River tributaries. The MCES has also established six additional automated monitoring sites in the Middle Minnesota River Watershed, for identification of mercury and PCB sources contributing to fish consumption advisories in the Minnesota and Mississippi Rivers.

To address a need for increased citizen involvement in stream monitoring in the Metropolitan Area, MCES provided a $35,000 grant to WaterShed Partners in 1999, for development of a strategic plan. Implementation of the WaterShed Partners Volunteer Stream Monitoring Program is anticipated.

12) MCES has been conducting water quality monitoring of lakes since 1980, to provide baseline water quality and trend information, and to enhance management decision-making. In 1992,

a Citizen Assisted Monitoring Program, CAMP, was initiated to involve citizens, lake associations, and local watershed districts in the MCES lake monitoring effort. Citizen participation has enabled MCES to greatly expand the number of lakes monitored in the Metropolitan Area, to 120 lakes in 1999.

13) The USGS has conducted National Water Quality Assessment (NAWQA) Program studies in two river basins that include Minnesota. They are the Red River Basin in Minnesota and North Dakota and the Upper Mississippi River Basin in Minnesota and Wisconsin. These studies include collection of both water quality (chemistry) and aquatic-biological samples. They are designed to provide a comprehensive description of water quality conditions, to identify trends and to determine the factors that affect existing conditions.

Monitoring Types

It will be useful to categorize monitoring activities according to those purposes that can support NPS pollution management planning. Monitoring activities can be categorized to reflect the purpose for which the monitoring was initiated, that is, the intended use of the information collected. Three general categories of water quality monitoring include condition monitoring, problem investigation monitoring, and effectiveness monitoring. Other types or subcategories of monitoring are noted within the discussion of these three general categories.

Condition monitoring addresses the question "How good is the quality of water for its intended uses?" Condition monitoring generally requires a comparison of observed water quality conditions with desired water quality, expressed as reference conditions, criteria, or standards. Condition monitoring may be done either on a network of waterbodies designed to represent an area or on waterbodies of specific interest. Condition monitoring is often done at the state or regional level, but can also be done at a set of targeted sites. The data acquired for condition monitoring can be applied toward evaluating trends. Trend assessment considers whether, and in what direction, water quality is changing over time, in a particular context. The data acquired for condition monitoring may also be used to identify waterbodies or areas with problems. Using existing compliance data in connection with ambient data, there may be a preliminary determination of whether the problem is primarily due to point sources, nonpoint sources or both. The data could be used to determine spatial patterns.

Problem investigation monitoring focuses on a waterbody or an area that has either:

1) been identified as a problem, or;

2) is of special interest because of how the water is used, such as an aquifer that is a source of drinking water or a lake that is heavily fished.

Problem investigation monitoring is more intensive than condition monitoring. Sometimes neither the cause nor the source is known, and the investigation must determine what they are. It does not just identify a problem, but provides a more complete description of the problem and source(s) of the problem. Often it will be done to follow up on a specific source or sources. Both ambient data and compliance data will be collected and used to determine the relative contributions of various causes and sources of impairment and the expected impact of specific resource management decisions. Problem investigation monitoring is project specific.

Effectiveness monitoring is designed to measure the actual impact of resource management decisions, such as implementation of best management practices. Effectiveness monitoring involves monitoring both before and after implementation, and may involve a paired watershed design. The monitoring is done in specific locations and provides a measure of whether, and to what extent, responses to a problem were successful.

Chemical water quality monitoring may be done to determine loads or concentrations or both. Conventional NPS pollutants, such as nutrients and sediments, are often expressed as loads, since the amount of a pollutant delivered to a downstream confluence is of interest. Pollutants whose concentrations directly affect aquatic biota are usually expressed as concentrations.

Some types of water monitoring will not be addressed in this strategy. Compliance monitoring, which reflects compliance with certain regulations, will not be included. This strategy is to support NPS pollution management and most NPS controls are non-regulatory. Two areas, which do have regulations, are feedlots and individual sewage treatment systems (ISTS), or on-site septic systems. Monitoring associated with these potential pollution sources will be addressed in Chapters 7 and 14.1, which deal specifically with feedlots and with ISTS. Chapter 8 on Agricultural Erosion and Chapter 9 on Agricultural Nutrient Management also discuss specific monitoring related to those sources. Compliance monitoring is not specifically addressed in this chapter. However, the results of compliance monitoring will be used in connection with the results of ambient monitoring to determine the relative contributions of both point sources and nonpoint sources. This is done to some extent with data from condition monitoring and to a greater extent, using data from problem investigation monitoring. This strategy will also not address short-term research or special studies. These studies could involve any of the three types of monitoring listed above - condition monitoring, problem investigation, or effectiveness monitoring. They are distinguished by a short-term focus and by a focus on a specific issue or concern, not necessarily a specific site or sites.

Roles and Responsibilities of Each Agency

Several agencies have responsibility for various aspects of water monitoring. Local, regional, state and federal governments all monitor water resources in Minnesota. Private interests also do a significant amount of monitoring, either because of regulatory requirements, or simply due to an interest to understand the resource better. The USGS, since the 1930s, has maintained a set of flow gaging stations. They also have monitored for chemical constituents in ground water and surface water. In 1991, they began implementing a National Water Quality Assessment (NAWQA) program to collect nationally consistent information in 60 study units or basins across the United States. The Red River of the North Basin in Minnesota and North Dakota was one of the 60 study units chosen. The Red River study has been completed Another NAWQA study area is the Upper Mississippi, which also includes the St. Croix and a small part of the Minnesota Basin. The first phase of this study has been completed. NAWQA is designed to monitor water quality conditions and trends and identify and characterize problem areas.

The MDNR has responsibilities in the area of resource management. Water monitoring done by this agency is designed to inform resource management. Lake surveys and stream surveys are conducted which inventory the physical, chemical and biological characteristics of these waterbodies and changes in these characteristics over time. Larger wetlands and shallow lakes are surveyed for physical and biological characteristics. The Instream Flow program monitors stream flow, lake level, and habitat information in order to develop biologically valid recommendations for protected levels. In a cooperative program with the MDH and the MPCA, the

MDNR collects fish that are then analyzed for contaminants in their tissue.

The MDNR's Stream Flow Unit produces a weekly report that reflects stream flow conditions in all 84 major watersheds. This report uses data from the USGS River Gaging Program, the National Weather Service (NWS) Flood Forecasting Network and MDNR gages. Thirty-eight new flood-warning gages have been added to the NWS network and are maintained by both the NWS and MDNR's Stream Flow Unit. The MDNR Lake Hydrology Unit also is responsible for lake level monitoring at 900 sites in Minnesota ("Lake Level Minnesota"). Citizen volunteers or local organizations read gages on a weekly basis during the open water season and report readings to the MDNR. Data and more information are available on the DNR Web site.

A statewide network of approximately 700 water level observation wells (obwells) are monitored for the MDNR predominantly by Soil and Water Conservation District (SWCD) personnel. The MDNR obwell network was developed to record background water levels in areas of present or expected ground water use. The data are used to assess ground water resources, interpret impacts of pumping and climate, plan for water conservation, evaluate complaints, and otherwise provide for management of the resource.

The MDH maintains a surveillance program for public water supplies. Currently, 1,000 community (cities and mobile home parks), 900 nontransient non-community (schools and industries) and 9,600 transient non-community (restaurants, gas stations, parks) public water supplies are regulated. Community and nontransient non-community supplies must be monitored for as many as 83 contaminants. The frequency and number of contaminants monitored is determined by an assessment of the vulnerability of the water source(s) for each individual supply. Transient non-community supplies must monitor only for coliform bacteria and nitrates.

MDH administers the state's programs for:

1. licensing well, exploration, and drilling contractors; and

2. inspecting the construction of wells, test/exploration holes, elevator shafts, and heat loops. An analysis for coliform bacteria and nitrate nitrogen is required for all new potable water supply wells. Also, special well construction advisories are issued by the MDH where ground water contamination presents a threat to public health.

MDH is the lead agency for implementing the state's source water wellhead protection program. Monitoring for the impacts that nonpoint sources of contamination may have on public water supplies will be an integral part of source water wellhead protection efforts. The degree to which NPS controls will be required for specific public water supply wells will rely heavily on monitoring results.

A relatively new program being administered by the MDH estimates the susceptibility of aquifers to nitrate contamination. These assessments rely on partnerships with local governmental units for sharing and archiving data on chemical analyses and well locations. The end product of this type of assessment is a nitrate probability map. These are generally completed on a county-wide basis.

The MPCA has the responsibility of controlling pollution and protecting the water quality of lakes, streams, wetlands and aquifers. In addition to routine ambient stream monitoring and routine lake monitoring, the MPCA also engages in special studies associated with specific areas of interest or types of sources. Surveys are conducted on streams and rivers receiving discharges from wastewater treatment plants where stream flows are considered inadequate to protect water quality standards. Data collected from these surveys are used to determine the necessary level of treatment required to maintain water quality standards and protect the designated uses of a particular water. LAP projects are done in cooperation with local units of government. Clean Water Partnership (CWP) projects involve monitoring conducted by local units of government with technical assistance and oversight by the MPCA. Total Maximum Daily Loads (TMDL) projects involve monitoring of waters that are impaired, to determine the relative contribution of various point and nonpoint sources of impairment. These projects are conducted by local units of government, or other local organizations or consultants, with oversight by the MPCA. The scale at which these projects are conducted will depend on the nature and extent of the impairment. Possible project scales may be subwatershed, watershed, or multi-watershed. The MPCA also administers the CLMP. CLMP volunteers take transparency measurements and record perceptions of physical appearance and recreational suitability of the lake. With approximately 900 lakes in the CLMP program, it provides the only monitoring data for many lakes. In 1998, the MPCA established a Citizen Stream Monitoring Program (CSMP). Volunteers take transparency tube and rainfall measurements as well as recording perceptions of physical appearance, recreational suitability and stream stage. At the end of 1999, there were 239 volunteers enrolled.

It is the responsibility of the MPCA to develop biological criteria that are used as measures of water quality for given habitats in given regions. In a cooperative program with MDNR, the MPCA conducts statistically based integrated monitoring, using biological, physical and chemical measures of water quality. This monitoring is designed to provide a more holistic picture of riverine water quality in a basin.

It is also the responsibility of the MPCA to monitor for pollutants in ground water. The GWMAP involves a statewide baseline network, a trends analysis component, and regional monitoring cooperatives. The goal of the program is to identify regional variations in the quality of aquifers across the state, and to evaluate trends in the aquifers at greatest risk of contamination.

It is the responsibility of MDA to provide information on pesticide contamination of ground water and surface water. The MDA monitors wells throughout the state, concentrating on areas that are suspected to be problem areas and also including "background" or "check" wells. The MDA also monitors pesticide concentration in precipitation, and in cooperation with the MPCA , MDNR and local units of government, monitors pesticides in surface water and ground water.

The MCES has responsibility for facilitating water resource planning in the seven-county Minneapolis/St. Paul metropolitan area, and for developing and implementing regional plans to control water pollution, for managing wastewater treatment, and for characterizing the condition of Metropolitan Area waters.

In support of these responsibilities, MCES conducts extensive monitoring of Metropolitan Area rivers, streams, lakes, and wastewater treatment plants. MCES monitoring of rivers, streams, and lakes is described on page 5-3.

The MCES wastewater treatment plant monitoring program evaluates the effectiveness of wastewater treatment at nine MCES facilities. Acute and chronic whole effluent toxicity-testing has been conducted at MCES treatment plants since 1982, and toxics monitoring has been conducted at the Metropolitan Plant since 1994.

MCES also conducts special studies of rivers, streams, and lakes, to investigate local and regional water quality problems, to assess the relative importance of point and nonpoint sources of water quality impairment, and to address needs for wastewater treatment plant improvements.

Many local units of government conduct monitoring of lakes, streams, or ground water as part of the Local Comprehensive Water Management Planning process.

MONITORING DATA MANAGEMENT

Many of the agencies involved in water monitoring have been updating their own data management systems. There have also been various efforts to promote integrated data management. The MPCA is currently in the process of transitioning to the modernized STORET system. Monitoring data collected by MPCA staff, data collected by local projects funded by MPCA, and data collected by other projects or agencies that choose to do so are submitted for entry into STORET. The MDH has recently modernized and updated its Well Records Database. The MCES is developing an information system that integrates data from all of their monitoring programs and allows easy access through a GIS interface to various levels of monitoring data and information.

Integrated water information systems, such as the Ground Water Clearinghouse and the Stream and Watershed Information System that compile water and GIS data across agency lines, are maintained at Minnesota Planning. However, because of the difficulty with keeping the data complete and up-to-date in these systems, Minnesota Planning now recommends linking Web sites with related information rather than developing and updating integrated databases. All agencies have made significant progress in recent years with providing more data and information on their Web sites. There are a number of direct links between related MDNR and MPCA sites.

The Local Government Annual Reporting System (LARS), housed at BWSR, is used for tracking BMPs implemented by local governments and funded by a variety of state and federal programs. The MDH has provided training in many counties for local health agencies to interpret well-water quality data. Local water planners have become a primary user of data from state agencies. There are other examples of sharing data among agencies for specific purposes, but there is no organized process for doing so on a regular basis.

Four interagency groups meet on a regular basis and share information about each other's monitoring activities. They are the Interagency Lakes Coordinating Committee, the Interagency Surface Water Monitoring Coordination Group, the Interagency Ground Water Monitoring Coordination Group, and the Combined GW-SW Group. A subcommittee of the Combined Group has identified the most critical gaps in the state's monitoring programs. It was agreed that the most important of these needs is integrated access to data. This would greatly enhance the state's ability to share information across agencies and with its citizens. An approach to doing so, including linking databases and making use of new Internet tools, would need to be developed. At the present time, there are no resources for doing so.

NEW DIRECTIONS IN MONITORING

Monitoring of water quality and water quantity in Minnesota has provided useful information for several decades. However, current monitoring programs do not adequately address the resource management issues of today. Changes that are needed include:

- All monitoring activities should have a clearly defined purpose, based on specific information needs. For any monitoring activity, a design document, or information protocol, should be prepared which describes the information goals and provides the details for data collection, data handling and storage, data analyses, reporting and use of the information.

- Design of monitoring to characterize NPS contributions. A primary goal for NPS monitoring is the development of an understanding of the effects of the watershed on the water quality of a water resource. To do this, monitoring must characterize the movement of pollutants from the land to the water. The spatial and temporal variability present in the transport of the pollutants often makes NPS monitoring more complex and time-consuming than point source monitoring.

- Water quality samples should be taken over the range of flows and seasons. At high flow, it is particularly important to note the position of flow on the hydrograph. Flow data needs to be collected at the sampling site in order to determine loads and yields. Evaluation and assessment of NPS pollution requires that water quality monitoring should be weighted toward high flow seasons such as snowmelt and storm runoff events, because the vast majority (50-90 percent) of the total NPS pollution loading occurs during these events. Most NPS pollutants are mobilized and transported into water systems during these runoff periods. If these events are not adequately monitored, estimates of the pollutant loads are likely to be grossly underestimated.

- There is also a need for increased biological monitoring and sediment sampling (bed loads), because of the ability of biota and sediment to reflect water conditions over a period of time.

- Development of baseline data to establish good status and trend information and development of reference conditions for rivers and wetlands, where such baseline data and such references do not currently exist.

- Ground water monitoring at the landscape level, as opposed to the traditional "contaminated site" model. Landscape level monitoring will help determine impacts of land use on vulnerable aquifers and help local units of government make good land-use choices.

- Improvement of communication linkages among agencies involved in water monitoring for the purposes of expanding the statewide database and improving accessibility to it.

- Designing monitoring to meet explicitly stated purposes for identified geographic areas or issues of concern, to address management information needs. The information will then be used to guide resource management decision making, and to measure the effectiveness of actions taken.

Chapter 5 Monitoring
Needs, Priorities and Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) 5-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

See Minnesota's new Coastal Nonpoint Pollution Program Document for information on Lake Superior.

Goal 1: Develop Baseline Data Necessary to Allow Establishment of Good Status and Trend Information Relative to Surface Water and Ground Water at the state/regional level.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. For lakes: Continue to increase network of citizen lake monitoring volunteers and lake level volunteers by actively promoting programs, especially where volunteers are lacking in southern Minnesota. Also promote use of lake monitoring volunteers in all special projects (i.e., CWP,CL), as well as on reference lakes.	X	X	X	X	X	State General Fund, *Continuing effort*	MPCA, MCES, MDNR.
2. Lakes: Establish a set of trend and intensive study lakes. Report on status and trends, including intensive study lakes.	X	X	X	X	X	State Funds, *Continuing effort*	MPCA, MDNR.
3. Ground Water: Expand the State Well Records Database to include all well records and obtain accurate locations for these wells.	X	X	X	X	X	State Funds, Federal SDWA, *Continuing effort*	MDH
4. Ground water: Develop a network of observation wells to be monitored regularly to determine the degree of NPS contamination of the state's vulnerable aquifers.	X	X	X	X	X	State General Fund, *Continuing effort*	MDA, MPCA.

	2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5.	Ground water: Continue to conduct baseline assessments of the residence times of Minnesota's ground waters to use in identifying aquifers that may be susceptible to contamination.	X	X	X	X	X	State General Fund, *Continuing effort*	MDNR, MGS, MDH.
6.	Ground water: Continue to incorporate determination of gradient (direction of ground water movement) in ground water monitoring programs.	X	X	X	X	X	State Funds, Federal SDWA, *Continuing effort*	MDH
7.	Ground water: Determine trends in ground water quality statewide and trends associated with land use changes.	X	X	X	X	X	*Continuing effort*	MPCA
8.	Rivers: Continue to design the statistically based network of river sites for those basins for which it has not yet been done. When complete, this will allow for making statistically valid evaluations about statewide water quality and trends.	X	X	X	X	X	State General Fund, Technical assistance from EPA, EMAP for site selection, *Continuing effort*	MPCA
9.	Rivers: Maintain the established long-term monitoring sites to allow for determination of long-term trends at a set of specific sites. Conduct further analyses and presentation of trends.	X	X	X	X	X	*Continuing effort*	MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
10. Rivers: Partner with other local, state and federal agencies (MCES, BWSR, MPCA, USACE, USGS) in Minnesota to determine the priority of long-term gage sites and guarantee funding by way of legislative appropriation.	X	X	X	X	X	Possible State General Fund, Possible fees on dischargers, *New effort, but build on existing network*	MDNR
11. Rivers: Continue to increase network of Citizen Stream Monitoring Program (CSMP) volunteers. Continue analyses of CSMP data and other measures to determine use of CSMP for use-support assessments and other purposes. Continue to provide support for volunteer monitoring coordination efforts, such as Metro Monitoring Partners. Provide technical assistance to other volunteer monitoring programs, as resources permit.	X	X	X	X	X	State General Fund *Continuing effort*	MPCA, MCES, MDNR.
12. Explore the use of remote sensing monitoring capabilities to greatly increase the number of waterbodies monitored.	X	X	X	X	X	319	MPCA

Goal 2: Establish Reference Conditions, Criteria or Standards for Those Waterbody Types or Types of Measurement for Which Such References Do Not Currently Exist.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop biological criteria for watersheds where such criteria do not currently exist. Develop IBIs for the Upper Mississippi, Lake Superior, Rainy, Missouri, Cedar, DesMoines and Lower Mississippi Basins. Longer term; plan to incorporate numerical biological criteria into the state water quality standards rules.	X	X	X	X	X	State General Fund, Federal 106, Federal 319, *Continuing effort*	MPCA
2. Wetland water quality criteria development: Extend IBI development work to other types of wetlands including ephemeral wetlands, bogs, and fens.	X	X	X	X	X	Federal grants, *Continuing effort*	MPCA
3. Work with EPA on development of ecoregion-based nutrient criteria for lakes and rivers.	X	X	X	X	X	State General Fund, Federal grants, *Continuing effort*	MPCA
4. Identify other measurements important for NPS impacts for which standards or references do not currently exist.		X	X	X	X	319, State General Fund, *New effort*	MPCA
5. Define relationships among water quality parameters and the movement of various parameters through the system.		X	X	X	X	319, State General Fund, *Primarily new effort*	MPCA

Goal 3: Improve Monitoring Designed to Characterize NPS Contributions to Water Quality Problems.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Increase the amount of nutrient monitoring on lakes to provide data at a level of intensity needed to guide resource managers.	X	X	X	X	X	Federal 319, State Clean Water Partnerships, *Continuing effort*	MPCA
2. Expand database of flow information, both by increasing number of monitoring stations where flow can be obtained and by redesigning type of information obtained from existing stations. Identify gaps in continuous record data gathering in major watersheds and support the effort to create new or reinstall old USGS gage sites where warranted.	X	X	X	X	X	State General Fund, State Fees, *Continuing effort*	MDNR
3. Obtain more quantitative assessment of NPS loadings by: a. Through basin planning, secure cooperation, or new funding where necessary, to collect high flow event sampling, either manual or automated, as appropriate to specific sites.	X	X	X	X	X	State General Fund, State Clean Water Partnerships, Federal 319, *Primarily new effort*	MPCA
b. Combine planning for long-term flow monitoring (Goal 3-2) with basin plans for pollutant concentrations sampling to identify locations best monitored with automated equipment.	X	X	X	X	X	State General Fund, State Clean Water Partnerships, Federal 319, *Primarily new effort*	MPCA
c. Develop monitoring and assessment to characterize point and nonpoint source contributions over a range of hydrologic conditions.	X	X	X	X	X	State General Fund, State Clean Water Partnerships, Federal 319, *Primarily new effort*	MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
4. Develop monitoring to support individual TMDL projects, which combines quantitative assessments of both point source and nonpoint source pollution. Continue to identify sources of readily available good quality monitoring data to use in TMDL listing. Continue to conduct TMDL studies as indicated in TMDL listing schedule.	X	X	X	X	X	Much is new, some is continuing.	MPCA, many local partners.
5. Develop capacity to monitor emerging contaminant issues, including pesticide metabolites, pharmaceuticals, and pathogenic microorganisms. (See Chapter 10).						*New effort*	MDA
6. Continue to incorporate these three components in aquifer or wellhead protection projects: a. contaminant source investigation b. hydrogeologic assessment, and c. ground water/surface water interaction.	X	X	X	X	X	Federal SDWA, *Continuing effort*	MDH, MDNR.
7. Develop a monitoring scheme that characterizes the extent, impacts and sources of erosion, sedimentation, and nutrient loading on lake and stream water quality. Incorporate these monitoring procedures into existing programs and into new projects.		X	X	X	X	319, *Primarily new effort*	MPCA, MDNR.
8. Revise field-monitoring protocols to incorporate information on the contribution of specific land use practices, such as feedlot runoff, tile lines, etc. Also see Chapter 9.		X	X	X	X	319, *Primarily new effort*	MPCA, MDNR, MDA.

Goal 4: Promote Effective Use of BMP's Through Assessing the Improvement in Water Quality Relative to Specific NPS Reduction Actions.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Target geographic areas where a monitoring regime such as paired watershed monitoring would best be used to determine effectiveness of NPS control measures.		X	X	X	X	319, *New effort*	MPCA
2. Compile and evaluate monitoring results that show direct relationship of using BMP controls and improvement of water quality. Any evaluation of BMPs would need to take into account changes in weather /precipitation/flow. Use this documentation to encourage use of BMPs with proven track records and to support recommendations for BMPs in future watershed projects.	X	X	X	X	X	Some continuing, *Primarily new effort*	MDH, MPCA, BWSR, MDA.
3. Define cause and effect relationship by project level monitoring, establish numeric goals and track performance and stream/lake restoration or degradation trends	X	X	X	X	X	Clean Water Partnerships, TMDL funds, *Some continuing, some new*	MPCA
4. Review data from Phase I and II CWP projects—relate land use to pollutant effort rates.	X	X	X	X	X	*Primarily new effort*	MPCA
5. Design a model, or adopt existing models, that are able to predict changes in water quality due to changes in land use practices.		X	X	X	X	*New effort*	MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
6. Conduct long-term water quality monitoring via the NPS National Monitoring Program to provide the information needed to evaluate the effectiveness of BMP implementation in improving the water quality within the Whitewater Watershed Project. Use the results to document the effectiveness of NPS pollution controls in water quality improvement and protection.	X	X	X	X	X	*Continuing effort*	MPCA
7. Upgrade program effectiveness monitoring to answer questions such as effectiveness and efficiency of CREP or ISTS implementation.		X	X	X	X	319, *New effort*	MPCA

Goal 5: Design Monitoring Programs to Meet Management Information Needs Concerning Identified Geographic Areas or Issues of Concern, then Use Information Obtained for Resource Management Decision-Making

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Design and implement effectiveness monitoring in the Minnesota River Basin to demonstrate progress towards load reductions overall, and, where possible, progress resulting from particular management efforts.	X	X	X	X	X	State Funding *Some continuing, some new effort.*	MPCA
2. Evaluate relative contributions of pollutants (e.g., TSS, TP), under different flow regimes and their impact on water quality. Use results to determine necessity for point/NPS controls.	X	X	X	X	X	*New effort*	MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
3. Continue research on nutrient impacts in streams with intention of being ready to promulgate nutrient standards by the end of 2003.	X	X	X			Grants from EPA, State funding, *Continuing effort*	MPCA
4. Incorporate the collection or use of ancillary data such as land use, pesticide use, cropping histories, and pesticide application practices to allow meaningful interpretation of monitoring results. Continue to include habitat assessments as part of IBI development.	X	X	X	X	X	State General Fund, Federal Grants, *Some continuing, primarily new effort.*	MPCA
5. Integrate ground water and surface water monitoring results with health-based contaminant levels to support public health protection. Use health risk limits determined by the Minnesota Department of Health to focus contaminant source control efforts.		X	X	X	X	State General Fund, Federal SDWA, *New effort*	MDH
6. Develop guidance document designed to interpret standards and provide uniform procedures for analyzing ground water monitoring data.			X	X	X	State General Fund, *New effort*	MDNR, MDH, MPCA.

Goal 6: Improve Communication Linkages Both Between State and Local Resource Managers, as well as Among the Various Local, State and Federal Agencies Within the State for Purposes of Expanding the Water Quality Monitoring Database and Enhancing Accessibility to it.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Continue to update, improve and distribute NPS assessment maps. Redesign NPS survey of local resource managers to improve validity and reliability.	X	X	X	X	X	State General Fund, Federal 106, Federal 319, Continuing effort, new effort.	MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
2. Work closely with LMIC to complete statewide mapping efforts and ensure the GIS system will meet the various agencies' future needs.	X	X	X	X	X	*Continuing effort*	MN Planning, MDNR, MDA, MPCA, MDH, Met Council, USGS, BWSR.
3. Continue to enhance exchange of information between state and local government through local water planning. Provide training and assistance, when needed.	X	X	X	X	X	*Continuing effort*	MDH, BWSR, MPCA.
4. Maintain interagency monitoring coordination groups. Increase interagency coordination of monitoring planning and monitoring implementation activities.	X	X	X	X	X	*Continuing effort*	MDNR, MN Planning, MDA, MPCA, MDH, Met Council, USGS, BWSR.
5. Increase use of global positioning tools to provide locational data for all monitoring sites.	X	X	X	X	X	State General Funds, Federal Grants, *Continuing effort*	MDH, MPCA, others.
6. Review previously developed monitoring guidebooks for both ground water and surface water and refine the information to reflect current knowledge and needs.			X	X	X	State General Fund, *New effort*	MDNR, MPCA, MDH, MDA, USGS.
7. Make information more readily accessible across state and local agencies and to the public via the Web. Provide links among sites with related information. Increase the direct sharing of pertinent data between agencies via searchable Internet web sites.	X	X	X	X	X	*Continuing effort*	MDNR, MDA, MPCA, MDH, Met Council, BWSR.
8. Work with communities to implement ground water monitoring networks to address their needs, assist in making sure networks are properly designed and samples properly taken.			X	X	X	State General Fund, *New effort*	MDNR, MDA, MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
9. Assist county and local government units to develop county and statewide composite databases for nitrate and other water quality information.	X	X	X	X	X	State General Funds, Federal Grants, *New effort*	MDH
10. Work with local government units and volunteer organizations to set up inventory data on subjects such as streambank erosion, ISTS compliance critical area mapping, to facilitate the TMDL corrective action processes.			X	X	X	Federal 106, Federal 319, *New effort*	BWSR, MPCA, MDNR, MDA, Met Council.

1994 NSMPP
Needs, Priorities and Milestones

The following Table provides the Goals and Action Steps included in the 1994 NSMPP. The Products, Services and Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps. Implementation of all action steps is contingent upon adequate funding and local involvement

Goal 1: Develop Baseline Data Necessary To Allow Establishment Of Good Status And Trend Information Relative To Surface Water And Ground Water.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products Services & Outcomes
1. For lakes: Increase network of citizen lake monitoring volunteers by actively promoting program, especially where volunteers are lacking (e.g., WCBP/NGP ecoregions) in southern Minnesota. Also promote use of lake monitoring volunteers in all special projects (i.e., CWP, CL), as well as on reference lakes.	State General Fund—specific appropriation	MPCA, MCES, MDNR.	• Number of CLMP volunteers increased from 750 in 1993 to 1098 in 1999(MPCA) • CAMP now monitors 75-100 lakes in Metro Area (MCES) • Number of Lake Level volunteers increased from 700 in 1993 to 900 in 1999 (MDNR) • See notes at end of table.
2. Ground water: Develop a network of observation wells to be monitored regularly to determine the degree of NPS contamination of the state's vulnerable aquifers.	State General Fund, Pesticide Registration Fees	MDA, MPCA.	• MDA has 20-year agreements with 12 counties in glacial outwash sand area to monitor almost 200 wells for pesticides and nutrients. • MPCA monitors 50 wells in sand plain aquifer in one county to assess NPS impacts of 6 different land uses.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products Services & Outcomes
3. Ground water: Conduct a baseline assessment of the residence times of Minnesota's ground waters to use in identifying aquifers that may be susceptible to contamination.	State General Fund	MDNR, MGS, MDH.	• (MDNR, MGS) Ten County Geologic Atlases (CGAs) have been produced (with 5 more underway) • (MDNR, MGS) Two Regional Hydrogeologic Assessments (RHAs) have been completed (with another 3 underway) • MDH routinely samples public supply wells for tritium to determine susceptibility • See notes at end of table.
4. Ground water: Incorporate determination of gradient (direction of ground water movement) in ground water monitoring programs.	MDH	MDH	• MDH incorporates flow field in wellhead protection monitoring studies.
5. Rivers: Design a network of monitoring locations selected in a way which will allow for making statistically valid evaluations about statewide water quality and trends.	State General Fund, Technical assistance from EPA EMAP for site selection.	MPCA	• MPCA has completed statistically based stream monitoring in the St. Croix, Lake Superior and Upper Mississippi basins.
6. Rivers: Maintain the established long-term monitoring sites to allow for determination of long-term trends at a set of specific sites.	State General Fund, Federal 106	MPCA, MDNR.	• MPCA continues to maintain long-term chemistry monitoring sites • In 1999, trends over time at these sites were determined for six pollutants • Attempts are being made by various agencies to prioritize gage sites statewide, and secure funding to maintain them • See notes at end of table.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products Services & Outcomes
7. Structure volunteer monitoring programs to incorporate parameters needed by each respective program. Assist in design of monitoring programs, sampling protocols and ways of using information collected.	State General Fund	MPCA, MDNR, MCES.	• MPCA has developed guidelines for citizen collected data for use in use-support assessments. • MPCA provides guidance to external local programs for sampling protocol. • MPCA has analyzed relationships between Citizen Stream Monitoring Program (CSMP) data and other monitoring data to determine usefulness for use-support assessments. • MCES provides data management and some funding for Metro Monitoring Partners. MCES, MDNR, MPCA serve on Steering Committee.

Goal 2: Establish Reference Conditions, Criteria Or Standards For Those Waterbody Types Or Types Of Measurement For Which Such References Do Not Currently Exist.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products Services & Outcomes
1. Develop biological criteria for watersheds where such criteria do not currently exist.	State General Fund, Federal 106, Federal 319.	MPCA	• Fish IBIs developed for Minnesota, Red River of the North, and St. Croix Basins. • Others under development—see below. • 319 funding used for biological database development, to accelerate criteria development • See notes at end of table.
2. Evaluate the potential use of wetland reference sites as a basis for assessing wetlands statewide.	Federal grants	MPCA	• IBIs, using macroinvertebrates and macrophytes, have been developed for large depressional wetlands and for riparian wetlands.

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products Services & Outcomes
3. Expand monitoring which can aid in the development of region-specific standards for phosphorus in lakes. Periodically resample reference lakes and add new reference lakes as needed.	State General Fund	MPCA	This work has continued, but has not been expanded.
4. Identify measurements important for NPS impacts for which standards or references do not currently exist.	No Funding Received 1994 – 2000	MPCA	See Goal 2, Milestone 4 in 2001 – 2005 Table.

Goal 3: Improve Monitoring Designed To Characterize NPS Contributions To Water Quality Problems.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Increase the amount of nutrient monitoring on lakes to provide data at a level of intensity needed to guide resource managers.	State General Fund, State Clean Water Partnership.	MPCA, local partners.	Since 1994, nutrient monitoring on about 150 lakes.
2. Expand database of flow information, both by increasing number of monitoring stations where flow can be obtained and by redesigning type of information obtained from existing stations (explore use of partnerships with USGS).	FEMA Hazard Mitigation Grant, State Clean Water Partnership, State General Fund, Federal State TMDL, Federal 319.	MDNR, MPCA, local partners.	• 38 new continuous record flood-warning gages statewide • 5 USGS gages upgraded (telemetry) • MDNR established rating curves at 12 MPCA sites • MDNR established water level measuring points at 80 MPCA sites (319) • About 75 Clean Water Partnership stream gaging sites per year • About 27 basin stream gaging sites • 5 TMDL sites (2000) • 5 319 sites (2000) • See notes at end of table

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Obtain more quantitative assessment of NPS loadings by: a. increasing event based sampling, and b. identifying streams and rivers for long-term automatic monitoring of solids, nutrients, pesticides and flow.	No Funding Received 1994 - 2000	MPCA	See Goal 3, Milestone 3 in the 2001-2005 table.
4. Develop monitoring to support TMDL process, which combines quantitative assessments of both point source and nonpoint source pollution.	Federal TMDL, Federal 319, State TMDL.	MPCA, local partners.	• Year 2000 draft list incorporates monitoring data from more sources than previous lists • TMDL list influences lake monitoring—focus on lakes near criteria level • Twenty-four TMDL projects have begun.
5. Improve aquifer or wellhead protection projects by incorporating the three components: a. contaminant source investigation, b. hydrogeologic assessment, and c. ground water/surface water interaction.	Federal SDWA	MDH	• MDH incorporates these components routinely in wellhead protection investigations.
6. Develop a monitoring scheme that characterizes the extent, impacts and sources of erosion, sedimentation, and nutrient loading on lake and stream water quality. Incorporate these monitoring procedures into existing programs and into new projects.	No Funding Received 1994-2000.	MPCA, MDNR.	See Goal 3, Milestone 7 in the 2001-2005 table.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
7. Revise field-monitoring protocols to incorporate information on the contribution of specific land use practices, such as feedlot runoff, tile lines, etc.	No Funding Received 1994-2000.	MPCA	See Goal 3, Milestone 8 in the 2001-2005 table.

Goal 4: Promote Effective Use Of BMPs Through Assessing The Improvement In Water Quality Relative To Specific NPS Reduction Actions.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Target geographic areas where a monitoring regime such as paired watershed monitoring would best be used to determine effectiveness of NPS control measures.	No Funding Received 1994-2000.	MPCA	See Goal 4, Milestone 1 in the 2001-2005 table.
2. Compile and evaluate monitoring results that show direct relation- ship of using BMP controls and improvement of water quality. Any evaluation of BMPs would need to take into account changes in weather/ precipitation/flow. Use this documentation to encourage use of BMPs with proven track records and to support recommendations for BMPs in future watershed projects.	Public Water Supply Service Connection Fees	MDH	MDH tracking effect of BMPs on NO3 at some wellhead protection sites.
3. Review data from Phase I and II CWP projects – relate land use to pollutant effort rates.	No Funding Received 1994-2000.	MPCA	See Goal 4, Milestone 4 in the 2001-2005 table.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
4. Design a model, or adopt existing models, that are able to predict changes in water quality due to changes in land use practices.	No Funding Received 1994-2000.	MPCA	See Goal 4, Milestone 5 in the 2001-2005 table.
5. Conduct long-term water quality monitoring via the NPS National Monitoring Program to provide the information needed to evaluate the effectiveness of BMP implementation in improving the water quality within the Whitewater Watershed Project. Use the results to document the effectiveness of NPS pollution controls in water quality improvement and protection.	State Funding, 319	MPCA	See Goal 4, Milestone 6 in the 2001-2005 table.

Goal 5: *Design Monitoring Programs To Meet Management Information Needs Concerning Identified Geographic Areas Or Issues Of Concern, Then Use Information Obtained For Resource Management Decision-Making.*

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Use data from Minnesota River assessment to promote revision of water quality management activities in this area.	State Funding	MPCA	• Citizen advisory group • High participation in CREP • Permit limits on phosphorus • Point-nonpoint trading • Upgrading septic systems • See notes on page 5-29 and 5-30.
2. Evaluate relative contributions of pollutants (e.g., TSS, TP, under different flow regimes and their impact on water quality. Use results to determine necessity for point/NPS controls.	State Funding	MPCA	• Permit limits on phosphorus

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Incorporate new information concerning phosphorus-loading impacts on river water quality into management and policy decisions.	State General Fund, EPA Nutrient Criteria Development Grant.	MPCA	• Research in support of nutrient criteria development • Seven-point phosphorus strategy with focus on NPDES discharges—impact on rivers.
4. Incorporate the collection or use of ancillary data such as land use, pesticide use, cropping histories, and pesticides application practices to allow meaningful interpretation of monitoring results.	State General Fund, Federal Grants.	MPCA	• IBI development includes habitat assessment at all sites, so degree and nature of human impact can be assessed.
5. Integrate ground water and surface water monitoring results with health-based contaminant levels to support public health protection. Use health risk limits determined by the Minnesota Department of Health to focus contaminant source control efforts.	No Funding Received 1994-2000.	MDH, MPCA.	See Goal 5, Milestone 5 in the 2001-2005 table.
6. Develop guidance document designed to interpret standards and provide uniform procedures for analyzing ground water monitoring data.	No Funding Received 1994-2000.	MDH, MPCA.	See Goal 5, Milestone 6 in the 2001-2005 table.

Goal 6: Improve Communication Linkages Both Between State And Local Resource Managers, As Well As Among The Various Local, State And Federal Agencies Within The State For Purposes Of Expanding The Water Quality Monitoring Database And Enhancing Accessibility To It.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Update, improve and distribute both NPS assessment maps and NPS survey information to help focus local planning efforts.	State General Fund, Federal 106.	MPCA	• Assessment maps updated as part of the basin planning process • Assessment maps on the Web • Nonpoint survey of local resource managers not yet updated
2. Work closely with LMIC to complete statewide mapping efforts and ensure the GIS system will meet the various agencies' future needs.	State	BWSR, MPCA, MDH.	See Goal 6, Milestone 2 in the 2001-2005 table.
3. Encourage state-local communication linkage through active participation in upcoming revisions to local water plans (i.e., prepare guidance documents, provide training sessions, QA/QC).	State General Fund	BWSR, MPCA, MDH.	State agency assistance and data provided to local water planners.
4. Establish ongoing interagency task force to: a. evaluate and refine needs identified in this plan, and b. develop coordinated strategies for meeting the specific needs.	State General Fund	MDNR, MN Planning, MPCA, MDH, Met Council, USGS, MDA, BWSR.	• Interagency Lakes Coordinating Committee • Interagency Surface Water Monitoring Coordination Group • Interagency Ground Water Monitoring Coordination Group • Combined GW-SW Group.
5. Increase use of global positioning tools to obtain accurate locational data.	State General Funds, Federal Grants.	MDH, MPCA.	• MDH uses GPS equipment routinely for well locating • MPCA has used GPS for locating most, but not all monitoring sites.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
6. Review previously developed monitoring guidebooks for both ground water and surface water and refine the information to reflect current knowledge and needs.	No Funding Received 1994-2000.	State Agencies	See Goal 6, Milestone 6 in the 2001-2005 table.
7. Maintain and enhance integrated water information systems such as the Ground Water Clearinghouse and the Stream and Watershed Information System which compile water and GIS data across agency lines.	State General Fund	MN Planning	See Goal 6, Milestone 7 in the 2001-2005 table. MN Planning recommends linking Web sites with related information rather than developing and updating integrated systems.
8. Work with communities to implement ground water monitoring networks to address their needs; assist in making sure networks are properly designed and samples properly taken.	No Funding Received 1994-2000.	MDH, MPCA.	See Goal 6, Milestone 8 in the 2001-2005 table.

Additional notes on some of the Milestones

Goal 1, Milestone 1
As of 1998, monitoring data coordinators located in 3 non-Metro offices have as one of their responsibilities, promoting citizen monitoring in their geographic areas.

Goal 1, Milestone 3
The CGA/RHA program uses ground water residence times along with other considerations to produce plates that indicate the vulnerability of ground water to contamination from surface pollutants. Additionally, plates are produced that show potentiometric surfaces and direction of ground water flow.

Goal 1, Milestone 6
Agencies that use the information from gage sites prioritize sites reflecting their purposes, and attempt to seek funding to insure that the sites will be maintained. An interagency committee is also involved in seeking funding.

Goal 2, Milestone 1
A fish IBI is under development for the Upper Mississippi Basin. Sampling has been completed in the Lake Superior Basin. A macroinvertebrate IBI is under development for the St. Croix Basin. Macroinvertebrate sampling has been completed in the Lake Superior Basin.

Goal 3, Milestone 2
The 5 USGS gages were upgraded to provide flow information in areas that did not have it previously. The 12 MPCA sites at which MDNR established rating curves enable conversion of stage information collected by MPCA to discharge for future sampling.

Goal 5, Milestone 1
The Minnesota River Assessment Project (MRAP), particularly low IBI scores, provided the impetus for the citizen advisory group, which fostered political acceptance of resource management changes, and the high participation rates in the CREP. The assessment was the basis for the recognition that phosphorus loads have impacts on streams, leading to permit limitations for phosphorus and point-nonpoint trading.

In addition, fecal coliform monitoring that was initiated in the MRAP, was used effectively in the before and after study of the effectiveness of upgrading septic systems in a small unsewered community. The results support policies encouraging adequate individual sewage treatment.

Chapter 6 Information and Education

> *"We need an effective educational program because none of our other programs will work correctly without it." Susan Alexander, 1996.*

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Highlights

- Nonpoint source (NPS) water pollution issues are at the pre-peak and peak levels of public concern.
- NPS education is about 25 percent complete for the three main NPS pollutants (nutrients, sediments, and bacteria) suggesting that Minnesotans are aware of the nature of NPS water pollution.
- Lawn fertilizer management and precision farming are two NPS pollution emerging education issues in 60 percent of Minnesota counties. More than half of the counties have not yet begun an educational program dealing with these issues.
- After considering different approaches for the NPS Information and Education Strategy, 6 major educational goals are set for 2001 through 2005 to address the remaining 75 percent of topics identified in the strategy. They are:
  - ➢ Raising awareness of emerging or pre-peak NPS water pollution issues
  - ➢ Promoting local stewardship
  - ➢ Improving the outreach network
  - ➢ Coordination among agencies
  - ➢ Early NPS information and education
  - ➢ Measurable and statistically based program outcome evaluation
- Expanded use of the Internet as an educational medium.

Chapter Organization

The introductory section of this chapter will discuss the overall view of the information and education program. Section two discusses the findings of the most recent NPS strategic planning effort. Section three summarizes the needs, priorities, and milestones for 2001 through 2005. The information and education strategy chapter concludes by summarizing the needs, priorities and milestones from Minnesota's 1994 Nonpoint Source Management Program Plan (NSMPP).

Introduction

Investment in education must be considered an essential and integral part of every step in the 2001 NSMPP. Education cannot be a viewed as a minor component of the NSMPP, but one of the many steps that must be taken to meet the management plan's goals. In almost every other chapter of this management plan, education is recognized as an important means for effecting change with respect to NPS water pollution problems.

The information and education program includes community analysis, planning, instruction, promotion, evaluation and reporting as outlined by Boyle (1981). Over the years, most of the programs funded with section 319(h) funds and state Clean Water Partnership (CWP) funds relied on voluntary participation. For the last ten years, about 25 percent of the Section 319(h) funded projects had an educational emphasis. To paraphrase Alexander (1996) Minnesota's NSMPP is, in a sense, implementing a huge number of education programs. Furthermore, as the clean water program moves to a watershed approach with a commitment to identify and address the remaining water quality problem areas, good information about the condition of waters and the health of aquatic systems on a watershed scale is absolutely critical (Key Principle 9. "Improve Water Information and Citizen's Right to Know", CWAP, 1998). The new Total Maximum Daily Load (TMDL) rules call for measures to be taken toward mitigating NPS pollution but neither state nor federal agencies have the authority to regulate activities that lead to such pollution. Mitigation measures will consist of education and pollution reduction incentives. Alexander (1996) makes the case that "...one effort builds upon the other and education is the glue or mortar that enables the plan to be completed."

Findings from the Nonpoint Source Strategic Planning Effort

The decisions and actions of many people contribute to the level of NPS pollution in our water resources. The role of information and education in Minnesota's 1994 NPS Information and Education Strategy was to increase overall awareness of the NPS pollution issue, increase the knowledge base of individuals regarding NPS pollution, and move targeted groups of individuals towards action or behavior change.

The statewide NPS information and education strategy was updated using information from ongoing and Phase 2 Clean Water Partnership projects and Local County Water Planning. The purpose of the updated strategic planning effort was to establish specific educational requirements for the 2001 NSMPP. The idea that this strategy gets its direction from local NPS educational needs is a powerful one. Respondents to the Minnesota River Education Initiative focus groups said that educators do not listen to landowners enough to find out what will and what will not work. Local coalitions and participatory processes are vital to motivate local governments and citizens, and the recommended action steps laid out in this strategy focuses on this concept. It is much easier to build public consensus for action when people feel they are protecting a particular water resource--especially one that they care deeply about. Local educational activities should be planned with participants and partners whose mutual intent is achieving outcomes that have impacts.

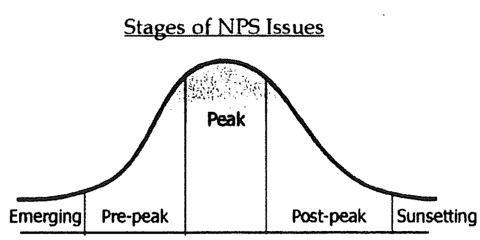
For the most part, the current information and education strategy keeps the same goals that were set in Minnesota's 1994 NSMPP Information and Education Strategy with two revisions. First, we expand our goals to emphasize evaluation of outcomes and impacts, which are reported to those that want or need to know what happened as a result of the investment in the educational program. Evaluation activities (especially Goal 6) over the time period of this management plan will complement the other needs, goals and priorities identified in section three of this chapter. For instance, the statistically based results of the goal 6 milestones will be used to measure the baseline levels of citizen awareness and participation of the other goals and objectives.

Secondly, traditional educational methods are increasingly being replaced by the expanded use of the internet as an educational medium. Recently, the U.S. Commerce Department found that access to computers and the internet have grown dramatically, with computers now in more than half of all households. The number of households with internet access grew from 19 percent in 1998 to 41.5 percent in 2000 (Associated Press, 2000).

METHOD

Representatives of the University of the Minnesota Extension Service and the Minnesota Pollution Control Agency recommended "program mapping" as the method to formulate the NPS Information and Education strategy. In formulating the strategy, local county water planners, regional MPCA staff and University of Minnesota Extension Educators were asked questions about the life line of NPS issues and the completeness of educational activities for several of the main contributors to nutrient, sediment and bacterial water pollutants.

Figure 1 shows the lifeline of a NPS issue. The first stage in the lifeline of a NPS issue is the emerging stage. Emerging issues are just coming into prominence in the local county water plan. The second stage is the pre-peak stage when the issue is gaining local concern. The third stage is the peak stage, when the issue is at its maximum level of concern in the local county water plan. The fourth stage is the post-peak stage when the level of prominence is subsiding. The last stage in the lifeline of a NPS issue is the sunsetting stage. An issue is sunsetting when it is no longer an important issue in the county water plan.



In mapping the issue lifeline, respondents were asked at which stage (emerging, pre-peak, peak, post-peak, sunsetting or not applicable) the issues were in their respective local county water plans. Likewise, the respondents were asked to judge the percentage of completeness (0%, 25%, 50%, 75%, 100%, or not applicable) of educational activities for each of the issues in their respective local county water plans. Although the topic of hypoxia in the Gulf of Mexico was not addresses *per se*, the issue maps include the main nonpoint sources affecting nutrient loadings to the Mississippi River. The NPS Information and Education Coordinator carried out the "program mapping."

Eighty-five of Minnesota's 87 counties are represented in this planning effort. For those counties in more than one basin, the basin of the majority of land was assigned to the county. For example, even though Otter Tail County lies in the Minnesota, Upper Mississippi and Red River Basins, most of the land in Otter Tail County lies in Red River Basin.

Within each basin, program mapping questions were repeated to validate the reliability of individual responses. The overall repeatability (as measured by the intraclass correlation[1]) was 57 percent. Because the needs and degree of completeness vary widely across basins, the results are summarized for the whole state and by hydrologic basin. Even though the Cedar and Des Moines River basins are not contiguous, they were combined in this strategy planning effort because of their sizes. The frequency distributions in Tables 6.2 through 6.19 were used to rank the top emerging and pre-peak NPS issues and the degree of completeness of educational activities. The levels of concern were ranked in descending order by the percentage of responses indicating the contributing sources were emerging or pre-peak issues. Likewise the levels of completeness were ranked in descending order by the percentage of responses that were least complete. For instance, in Table 6.2, lawn and turf fertilizer management is the top ranking issue because all counties identified it as an emerging or pre-peak NPS

[1] Intraclass correlation = σ^2 between responses/(σ^2 between responses + σ^2 within responses)

issue. In Table 6.3 lawn and turf fertilizer management is the top ranking NPS educational need because it was the issue that the counties viewed as least complete.

In the subsections that follow, the program map results are summarized for the state and then for each basin. Within each basin, the results are first summarized by pollutant type and then by each contributing nonpoint source.

STATEWIDE

All three major NPS pollutants (nutrients, sediments, and bacteria) appear to be at the pre-peak or peak stage of public concern in the CWP program and approaching the peak level of concern in Local County Water Plans. Educational programming is about 25 percent complete, suggesting that Minnesotans are aware of water quality issues (see Table 6.1). Lawn fertilizer management and precision farming are two NPS pollution emerging education issues in 60 percent of the counties surveyed. More than half of the counties have not yet begun an educational program dealing with these issues. Concern about feedlots and manure management is re-emerging as a result of recent revision in Minn. R. ch. 7020 relating to animal feedlots and utilization of animal manure. Educational activities, for these issues are just under way.

Respondents indicate that conservation tillage, the Conservation Reserve Program (CRP) and Reinvest in Minnesota (RIM) are sunsetting issues, and that most NPS educational activities for these issues are considered complete. However, the state's efforts to enroll 100,000 acres of Minnesota River riparian land in the Conservation Reserve Enhancement Program (CREP) by September 2002 is the most intensive conservation outreach program ever initiated. Using data from this needs assessment, counties were clustered on the basis of water quality issues and the degree of completeness of educational activities to maximize the cross use of developed educational programs.

Table 6.1. Nonpoint source issue stages and percent of educational activities completed (by basin).

	Nutrients		Sediments		Bacteria	
Basin or Statewide	Stage	Complete (%)	Stage	Complete (%)	Stage	Complete (%)
State	Pre-Peak	24	Peak	28	Pre-Peak	27
Cedar Des Moines	Peak	27	Peak	28	Peak	29
Lake Superior	Peak	9	Pre-Peak	11	Peak	20
Lower Mississippi	Pre-Peak	25	Peak	26	Peak	30
Minnesota River	Pre-Peak	24	Pre-Peak	27	Pre-Peak	24
Missouri River	Peak	18	Pre-Peak	25	Pre-Peak	27
Rainy River	Pre-Peak	15	Pre-Peak	19	Pre-Peak	27
Red River	Pre-Peak	25	Pre-Peak	29	Pre-Peak	26
St. Croix River	Peak	30	Peak	34	Pre-Peak	27
Upper Mississippi	Peak	26	Peak	30	Peak	31

CEDAR AND DES MOINES RIVER BASINS

The Cedar and Des Moines River Basins drain about 1,100 square miles of southern Minnesota (U.S. Geologic Survey, Minnesota Department of Transportation and University of Minnesota). All three major NPS water pollutants (nutrients, sediments, and bacteria) appear to be at the peak stage of public concern in the Cedar and Des Moines River Basins. Education programming is 27 percent complete for nutrients, 28 percent complete for sediments and 29 percent complete for bacterial pollutants. Fecal coliform bacteria and turbidity are the predominant pollutants affecting use in the water bodies assessed in this basin [Minnesota 2000 CWA Section 303(d) list]. Tables 6.2 and 6.3 show the stages of NPS issues and completeness of educational activities in the Cedar and Des Moines River Basins. The highest ranking emerging and pre-peak NPS issues in these basins are lawn and turf fertilizer management and precision agriculture which affect nutrient pollutants and stream bank erosion and urban storm water management which affect sediment delivery to water resources. NPS educational activities on lawn and turf fertilizer management and precision agriculture are just beginning. Educational activities on how feedlots and manure management affect bacterial loading and how drainage affects sedimentation problems are also in the early stages of completion.

Table 6.2. Stage of NSP Issues in County Water Plans in the Cedar Des Moines Basin[1] (%).

		Number	**Stage of Issues in County Water Plans**						Rank[2]
		Responses	Emerging	Pre-Peak	Peak	Post Peak	Sunsetting	Not Applic	
Nutrients	Lawn & Turf Fertilizer Mgt.	5	80	20	0	0	0	0	1
Nutrients	Precision Agriculture	4	75	25	0	0	0	0	1
Sediments	Stream Bank Erosion	5	60	40	0	0	0	0	1
Sediments	Urban Storm Water Mgt.	5	40	60	0	0	0	0	1
Bacteria	Feedlots	5	0	80	20	0	0	0	2
Bacteria	Manure	5	0	80	20	0	0	0	2
Sediments	Tile Inlets	5	0	60	0	40	0	0	3
Sediments	Buffer Strips	5	0	40	40	20	0	0	4
Nutrients	Drainage	5	0	20	20	40	20	0	5
Nutrients	Waste Water Treatment	5	0	20	20	60	0	0	5
Sediments	Drainage	5	0	20	60	0	0	20	5
Sediments	CRP-RIM	5	0	20	20	60	0	0	5
Bacteria	Septic Systems	5	20	0	80	0	0	0	5
Bacteria	Waste Water Treatment	5	0	20	40	40	0	0	5
Nutrients	Cropland Fertilizer Mgt.	5	0	0	60	20	20	0	6
Nutrients	Wetlands	5	0	0	40	60	0	0	6
Nutrients	Feedlots	5	0	0	80	20	0	0	6
Nutrients	Manure Management	4	0	0	100	0	0	0	6
Sediments	Conservation Tillage	5	0	0	40	40	20	0	6
Sediments	Wetlands	5	0	0	40	60	0	0	6

[1]Cedar and Des Moines Basins includes Jackson, Mower, Murray and Freeborn counties with one repeated response from MPCA staff.

[2]Ranked in descending order of percent emerging and pre-peak.

Table 6.3. Completeness of NSP Educational Activities in County Water Plans in the Cedar Des Moines Basin[1] (%).

		Number	**Completeness of Educational Activities in County Water Plans**						
		Responses	0%	25%	50%	75%	100%	Not Applic	Rank[2]
Nutrients	Lawn & Turf Fertilizer Mgt.	5	20	80	0	0	0	0	1
Nutrients	Precision Agriculture	4	50	50	0	0	0	0	1
Sediments	Stream Bank Erosion	5	0	80	0	0	20	0	2
Sediments	Tile Inlets	5	0	80	0	20	0	0	2
Sediments	Urban Storm Water Mgt.	5	40	40	0	20	0	0	2
Bacteria	Feedlots	5	0	80	20	0	0	0	2
Bacteria	Manure	5	0	80	20	0	0	0	2
Sediments	Drainage	5	20	20	40	0	0	20	3
Sediments	Buffer Strips	5	0	60	20	20	0	0	3
Nutrients	Drainage	5	0	40	20	20	20	0	4
Nutrients	Manure Management	5	0	40	60	0	0	0	4
Bacteria	Septic Systems	5	0	40	40	20	0	0	4
Nutrients	Feedlots	5	0	20	40	40	0	0	5
Nutrients	Waste Water Treatment	5	0	20	40	40	0	0	5
Sediments	Wetlands	5	0	20	40	20	20	0	5
Sediments	CRP-RIM	5	0	20	20	60	0	0	5
Bacteria	Waste Water Treatment	5	0	20	40	40	0	0	5
Nutrients	Cropland Fertilizer Mgt.	5	0	0	20	80	0	0	6
Nutrients	Wetlands	5	0	0	40	40	20	0	6
Sediments	Conservation Tillage	5	0	0	0	60	40	0	6

[1]Cedar and Des Moines Basins includes Jackson, Mower, Murray and Freeborn counties with one repeated response from MPCA staff.
[2]Rank in descending order of percent least complete.

LAKE SUPERIOR BASIN

The Lake Superior Basin drains over 6,150 square miles. In 1998, 208,740 Minnesotans resided in this basin (Minnesota Environmental Quality Board, 2000). In the Lake Superior Basin nutrients and bacteria are at the peak level of concern. Sedimentation problems are at the pre-peak level. Educational programming dealing with nutrients are only nine percent complete, 11 complete for sediments and 20 percent complete for bacteria. Table 6.4 shows the issue stages of NPS issues in the Lake Superior Basin. Buffer strips are the top ranking NPS emerging or pre-peak issue in three out of four counties in the Lake Superior Basin. Sixty percent of the responses identified feedlots and urban storm water management as emerging or pre-peak NPS issues. Cropland fertilizer management, precision agriculture, conservation tillage, tile inlets and CRP-RIM are not important NPS issues in the Lake Superior Basin. Mercury is the most commonly identified pollutant in the waters listed in the Lake Superior Basin [Minnesota 2000 CWA Section 303(d) list]. Table 6.5 indicates that essentially all of the educational activities related to sediment pollutants are just beginning while educational programming dealing with wetlands is more complete in this basin than other basins across the state.

Table 6.4. Stage of NPS Issues in County Water Plans in the Lake Superior Basin[1] (%).

		Number	Stage of Issues in County Water Plans						
		Responses	Emerging	Pre-Peak	Peak	Post Peak	Sunsetting	Not Applic	Rank[2]
Sediments	Buffer Strips	4	0	75	0	25	0	0	1
Nutrients	Feedlots	5	20	40	0	0	20	20	2
Sediments	Urban Storm Water Mgt.	5	40	20	0	40	0	0	2
Nutrients	Manure Management	4	50	0	0	0	0	50	3
Sediments	Drainage	4	50	0	0	0	0	50	3
Bacteria	Feedlots	4	25	25	0	0	25	25	3
Nutrients	Lawn & Turf Fertilizer Mgt.	5	20	20	0	20	0	40	4
Sediments	Stream Bank Erosion	5	0	40	20	40	0	0	4
Bacteria	Manure	3	33	0	0	0	33	33	5
Sediments	Wetlands	4	25	0	25	25	0	25	6
Bacteria	Waste Water Treatment	4	25	0	25	25	25	0	6
Nutrients	Drainage	5	0	20	20	20	0	40	7
Nutrients	Wetlands	5	0	20	20	20	0	40	7
Nutrients	Waste Water Treatment	5	0	20	20	60	0	0	7
Bacteria	Septic Systems	5	20	0	60	20	0	0	7
Nutrients	Cropland Fertilizer Mgt.	5	0	0	0	0	0	100	0
Nutrients	Precision Agriculture	4	0	0	0	0	0	100	0
Sediments	Conservation Tillage	4	0	0	0	0	0	100	0
Sediments	Tile Inlets	4	0	0	0	0	0	100	0
Sediments	CRP-RIM	4	0	0	0	0	0	100	0

[1]Lake Superior Basin includes Carlton, Cook and St Louis counties with two repeated responses from MPCA staff.
[2]Ranked in descending order of percent emerging and pre-peak.

Table 6.5. Completeness of NPS Educational Activities in County Water Plans in the Lake Superior Basin[1] (%).

		Number	Completeness of Educational Activities in County Water Plans						
		Responses	0%	25%	50%	75%	100%	Not Applic	Rank[2]
Nutrients	Lawn & Turf Fertilizer Mgt.	5	0	60	0	0	0	40	1
Nutrients	Drainage	5	20	40	0	0	0	40	1
Nutrients	Manure Management	3	100	0	0	0	0	0	1
Sediments	Drainage	4	25	25	0	0	0	50	1
Nutrients	Feedlots	5	40	40	0	20	0	0	2
Bacteria	Feedlots	4	25	50	0	25	0	0	3
Bacteria	Manure	3	33	33	0	33	0	0	4
Nutrients	Wetlands	5	0	20	0	40	0	40	5
Sediments	Urban Storm Water Mgt.	5	40	20	40	0	0	0	5
Sediments	Wetlands	4	0	25	0	50	0	25	6
Bacteria	Waste Water Treatment	4	25	25	25	25	0	0	6
Sediments	Stream Bank Erosion	5	0	40	40	20	0	0	7
Sediments	Buffer Strips	5	20	20	20	40	0	0	7
Nutrients	Waste Water Treatment	5	20	0	20	60	0	0	8
Bacteria	Septic Systems	5	0	0	80	20	0	0	9
Nutrients	Cropland Fertilizer Mgt.	5	20	0	0	0	0	80	0
Nutrients	Precision Agriculture	4	25	0	0	0	0	75	0
Sediments	Conservation Tillage	4	25	0	0	0	0	75	0
Sediments	Tile Inlets	4	25	0	0	0	0	75	0
Sediments	CRP-RIM	4	25	0	0	0	0	75	0

[1]Lake Superior Basin includes Carlton, Cook and St Louis counties with two repeated responses from MPCA staff.
[2]Rank in descending order of percent least complete.

LOWER MISSISSIPPI RIVER BASIN

The Lower Mississippi River Basin drains over 7,345 square miles of southeast Minnesota (U.S. Geological Survey, Minnesota Department of Transportation and University of Minnesota, 2000). More than three-quarters of the land in the basin are in crops and grass. From 1990, the population increased about 12 percent to 604,000. The population increase occurred in four urban and suburban counties (Minnesota Environmental Quality Board, 2000). The karst landscapes in the ten counties of the Lower Mississippi River Basin are extremely vulnerable to both ground water and surface water pollution. Concern about nutrients is at the pre-peak level while sediments and bacteria are at the peak level. Clean Water Partnership projects and Local County Water Plans report educational activities related to nutrients to be 25 percent complete, 26 percent complete for sediments, and 30 percent complete for bacteria. Nearly 90 percent of the respondent identified lawn and turf fertilizer management as the leading emerging NPS issue in this basin. Urban storm water management, feedlots and manure were frequently identified as emerging or pre-peak issues. Excess nutrients, fecal coliform bacteria and turbidity are the main pollutants identified in this basin [Minnesota 2000 CWA Section 303(d) list]. Because of the susceptibility of ground water pollution, animal waste storage structures associated with concentrated animal feeding facilities are a matter of intense public concern[2,3] and recent legislative action[4]. Urban storm water's effect on sediment problems is also an important emerging NPS issue. How feedlots and manure contribute to bacterial pollution problems is an educational programming area that has just begun.

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[2] State of Minnesota District Court County of Fillmore Third Judicial District File No. CX-00-306. Order and Memorandum of Law. Fillmore County Residents vs. Minnesota Pollution Control Agency and Reiland Farms.

[3] State of Minnesota District Court County of Waseca Third Judicial District, Citizens for Waseca County vs. Minnesota Pollution Control Agency and Peter and Paul Zimmerman.

[4] Laws of Minnesota 2000. Chapter 435 Sect. 13, effective April 25, 2000.

Table 6.6. Stage of NSP Issues in County Water Plans in the Lower Mississippi River Basin[1] (%).

		Number	Stage of Issues in County Water Plans						
		Responses	Emerging	Pre-Peak	Peak	Post Peak	Sunsetting	Not Applic	Rank[2]
Nutrients	Lawn & Turf Fertilizer Mgt.	19	47	42	0	5	0	5	1
Sediments	Urban Storm Water Mgt.	19	21	63	16	0	0	0	2
Bacteria	Feedlots	19	5	79	16	0	0	0	2
Bacteria	Manure	19	5	79	16	0	0	0	2
Nutrients	Precision Agriculture	14	43	36	0	7	0	14	3
Sediments	Stream Bank Erosion	19	16	47	26	11	0	0	4
Nutrients	Drainage	18	11	39	0	11	0	39	5
Sediments	Wetlands	18	17	33	44	6	0	0	5
Nutrients	Wetlands	19	16	32	47	5	0	0	6
Nutrients	Manure Management	19	0	47	53	0	0	0	7
Sediments	Tile Inlets	18	22	22	17	0	0	39	8
Nutrients	Feedlots	19	0	42	47	11	0	0	9
Sediments	Buffer Strips	19	16	26	42	16	0	0	9
Sediments	Drainage	19	11	26	11	11	0	42	10
Nutrients	Cropland Fertilizer Mgt.	19	5	26	21	42	5	0	11
Bacteria	Septic Systems	19	0	26	58	16	0	0	12
Bacteria	Waste Water Treatment	19	5	21	42	16	11	5	12
Nutrients	Waste Water Treatment	19	11	11	26	47	5	0	13
Sediments	Conservation Tillage	19	0	21	26	47	5	0	14
Sediments	CRP-RIM	18	0	17	50	28	6	0	15

[1]Lower Mississippi River Basin includes Dakota, Dodge, Fillmore, Goodhue, Houston, Olmsted, Rice, Steele, Wabasha and Winona counties with eight repeated responses fromMPCA and Extension staff.

[2]Ranked in descending order of percent emerging and pre-peak.

Table 6.7. Completeness of NSP Educational Activities in County Water Plans in the Lower Mississippi River Basin[1] (%).

			Completeness of Educational Activities in County Water Plans						
		Responses	0%	25%	50%	75%	100%	Not Applic	Rank[2]
Sediments	Tile Inlets	19	16	42	5	0	0	37	1
Nutrients	Precision Agriculture	14	71	7	0	7	0	14	2
Nutrients	Drainage	18	6	44	0	11	0	39	3
Sediments	Drainage	19	11	32	11	5	0	42	4
Sediments	Urban Storm Water Mgt.	19	5	79	11	5	0	0	4
Sediments	Stream Bank Erosion	19	5	74	16	5	0	0	5
Bacteria	Feedlots	19	0	79	21	0	0	0	5
Bacteria	Manure	19	0	79	21	0	0	0	5
Nutrients	Lawn & Turf Fertilizer Mgt.	19	11	68	11	11	0	0	6
Nutrients	Manure Management	19	0	53	42	5	0	0	7
Sediments	Buffer Strips	19	5	47	32	16	0	0	8
Nutrients	Feedlots	19	0	42	47	11	0	0	9
Nutrients	Wetlands	19	0	37	58	5	0	0	10
Sediments	Wetlands	19	5	32	63	0	0	0	10
Bacteria	Waste Water Treatment	19	16	5	37	26	0	16	10
Nutrients	Waste Water Treatment	19	5	21	42	26	0	5	11
Sediments	CRP-RIM	19	0	21	32	42	5	0	12
Nutrients	Cropland Fertilizer Mgt.	19	0	16	32	53	0	0	13
Bacteria	Septic Systems	19	0	11	63	26	0	0	14
Sediments	Conservation Tillage	19	0	5	32	58	5	0	15

[1]Lower Mississippi River Basin includes Dakota, Dodge, Fillmore, Goodhue, Houston, Olmsted, Rice, Steele, Wabasha and Winona counties with eight repeated responses fromMPCA and Extension staff.

[2]Rank in descending order of percent least complete.

MINNESOTA RIVER BASIN

The Minnesota River Basin drains about 17,000 square miles of Minnesota (U.S. Geological Survey, Minnesota Department of Transportation and University of Minnesota, 2000). All three major NPS water pollutants (nutrients, sediments, and bacteria) appear to be at the pre-peak stage of public concern in the Minnesota River Basin. Educational activities are 24 percent complete for nutrients and bacteria and 27 percent complete for sediments. Table 6.8 and 6.9 show the stages of NPS issues and degree of completeness of educational activities in the Minnesota River Basin. The top ranking emerging NPS issues in the Minnesota River Basin is lawn and turf fertilizer management. Precision agriculture, urban storm water and wastewater treatment are the next highest-ranking emerging or pre-peak issues. Educational programming on these issues is in the early stages of completion. Over 70 percent of the respondents identified tile inlets as an emerging or pre-peak level of concern. Educational activities on tile inlets and wetlands effect on suspended solids loading are in the early stages of completion. Excess nutrients, fecal coliform bacteria and turbidity are the predominant pollutants affecting use in the waters of the Minnesota River Basin [Minnesota 2000 CWA Section 303(d) list].

Table 6.8. Stage of NSP Issues in County Water Plans in the Minnesota River Basin[1] (%).

		Number	Stage of Issues in County Water Plans						
		Responses	Emerging	Pre-Peak	Peak	Post Peak	Sunsetting	Not Applic	Rank[2]
Nutrients	Lawn & Turf Fertilizer Mgt.	29	69	21	0	3	0	7	1
Nutrients	Precision Agriculture	29	52	31	3	7	0	7	2
Sediments	Urban Storm Water Mgt.	29	34	45	3	10	0	7	3
Bacteria	Waste Water Treatment	28	18	61	4	14	4	0	3
Sediments	Stream Bank Erosion	28	25	46	25	4	0	0	4
Sediments	Tile Inlets	28	25	46	21	7	0	0	4
Bacteria	Manure	28	21	43	29	7	0	0	5
Bacteria	Feedlots	27	30	33	30	7	0	0	6
Nutrients	Cropland Fertilizer Mgt.	29	17	41	14	28	0	0	7
Sediments	Buffer Strips	28	18	36	36	11	0	0	8
Bacteria	Septic Systems	28	14	39	39	7	0	0	9
Nutrients	Waste Water Treatment	29	10	41	21	21	3	3	10
Sediments	Drainage	28	14	36	29	11	4	7	11
Nutrients	Manure Management	29	14	31	55	0	0	0	12
Sediments	Wetlands	28	4	36	54	7	0	0	13
Nutrients	Wetlands	28	11	25	57	7	0	0	14
Nutrients	Feedlots	29	7	28	48	17	0	0	15
Sediments	Conservation Tillage	29	3	31	41	21	3	0	16
Nutrients	Drainage	28	21	4	61	14	0	0	17
Sediments	CRP-RIM	28	0	21	43	36	0	0	18

[1]Minnesota River Basin includes Big Stone, Blue Earth, Brown, Carver, Cottonwood, Faribault, Kandiyohi, Lac qui Parle, LeSeuer, Lincoln, Lyon, Martin, Nicollet, Pope, Renville, Scott, Sibley, Stevens, Swift Waseca, Watonwan, Yellow Medicine, Chippewa and Redwood counties with five repeated responses from MPCA and Extension staff.
[2]Ranked in descending order of percent emerging or pre-peak.

Table 6.9. Completeness of NPS Educational Activities in County Water Plans in the Minnesota River Basin[1] (%).

		Number	**Completeness of Educational Activities in County Water Plans**						
		Responses	0%	25%	50%	75%	100%	Not Applic	Rank[2]
Nutrients	Lawn & Turf Fertilizer Mgt.	29	21	62	10	7	0	0	1
Sediments	Tile Inlets	29	14	66	10	10	0	0	2
Nutrients	Precision Agriculture	29	48	24	14	7	0	7	3
Bacteria	Waste Water Treatment	28	18	61	4	14	4	0	4
Sediments	Stream Bank Erosion	29	14	62	10	14	0	0	5
Sediments	Urban Storm Water Mgt.	29	24	52	14	7	3	0	5
Sediments	Drainage	29	14	45	17	17	0	7	6
Nutrients	Drainage	29	10	48	28	14	0	0	7
Sediments	Buffer Strips	29	10	45	17	28	0	0	8
Nutrients	Manure Management	29	0	52	31	17	0	0	9
Nutrients	Waste Water Treatment	29	3	45	31	17	0	3	9
Sediments	Wetlands	29	7	45	38	7	3	0	9
Bacteria	Septic Systems	27	0	52	19	30	0	0	10
Bacteria	Feedlots	28	4	46	29	21	0	0	11
Bacteria	Manure	28	4	46	32	18	0	0	11
Nutrients	Wetlands	29	7	38	38	17	0	0	12
Nutrients	Feedlots	29	0	38	28	34	0	0	13
Nutrients	Cropland Fertilizer Mgt.	29	3	24	34	38	0	0	14
Sediments	CRP-RIM	29	3	17	48	14	17	0	15
Sediments	Conservation Tillage	29	3	14	34	41	7	0	16

[1]Minnesota River Basin includes Big Stone, Blue Earth, Brown, Carver, Cottonwood, Faribault, Kandiyohi, Lac qui Parle, LeSeuer, Lincoln, Lyon, Martin, Nicollet, Pope, Renville, Scott, Sibley, Stevens, Swift Waseca, Watonwan, Yellow Medicine, Chippewa and Redwood counties with five repeated responses from MPCA and Extension staff.
[2]Rank in descending order of percent least complete.

MISSOURI RIVER BASIN

The Missouri River basin drains 1,740 square miles of southwest Minnesota (U.S. Geological Survey, Minnesota Department of Transportation and University of Minnesota, 2000). Nutrient pollutants are at the peak level of concern in the Missouri River Basin. Sediment and bacterial pollutants are at the pre-peak level of concern. Educational activities are 18 percent complete for nutrients, 25 percent complete for sediments and 27 percent complete for bacterial pollutants. Excess nutrients, fecal coliform bacteria and turbidity are the predominant NPS pollutants affecting use in the waters of the Missouri River Basin [Minnesota 2000 CWA Section 303(d) list]. Table 6.10 shows the stages of NPS issues in the three counties of the Missouri River Basin. Wastewater treatment is the leading issue related to nutrient water pollutants. Stream bank erosion, buffer strips and urban storm water management and septic systems are the top ranking issues affecting sediment loading. Septic systems and wastewater treatment are top ranking issues affecting bacterial loadings. Table 6.11 shows that educational activities on the top ranking issues are also those that are least complete.

Table 6.10. Stage of NSP Issues in County Water Plans in the Missouri River Basin[1] (%).

		Number	Stage of Issues in County Water Plans						
		Responses	Emerging	Pre-Peak	Peak	Post Peak	Sunsetting	Not Applic	Rank[2]
Nutrients	Waste Water Treatment	3	0	100	0	0	0	0	1
Sediments	Stream Bank Erosion	3	33	67	0	0	0	0	1
Sediments	Buffer Strips	3	0	100	0	0	0	0	1
Sediments	Urban Storm Water Mgt.	3	100	0	0	0	0	0	1
Bacteria	Septic Systems	3	67	33	0	0	0	0	1
Bacteria	Waste Water Treatment	3	33	67	0	0	0	0	1
Nutrients	Lawn & Turf Fertilizer Mgt.	3	67	0	0	0	0	33	2
Nutrients	Cropland Fertilizer Mgt.	3	0	67	33	0	0	0	2
Nutrients	Feedlots	3	0	67	0	33	0	0	2
Nutrients	Manure Management	3	0	67	0	33	0	0	2
Nutrients	Precision Agriculture	3	67	0	0	33	0	0	2
Sediments	Tile Inlets	3	67	0	0	33	0	0	2
Bacteria	Manure	3	0	67	33	0	0	0	2
Sediments	Wetlands	3	33	33	0	33	0	0	2
Sediments	Conservation Tillage	3	0	33	67	0	0	0	3
Sediments	Drainage	3	0	33	33	33	0	0	3
Sediments	CRP-RIM	3	0	33	0	67	0	0	3
Bacteria	Feedlots	3	0	33	67	0	0	0	3
Nutrients	Drainage	3	0	0	33	67	0	0	4
Nutrients	Wetlands	3	0	0	33	33	33	0	4

[1]Missouri River Basin includes Nobles, Pipestone, and Rock counties.
[2]Ranked in descending order of percent emerging or pre-peak.

Table 6.11. Completeness of NSP Educational Activities in County Water Plans in the Missouri River Basin[1] (%).

		Number	Completeness of Educational Activities in County Water Plans						
		Responses	0%	25%	50%	75%	100%	Not Applic	Rank[2]
Nutrients	Lawn & Turf Fertilizer Mgt.	3	33	67	0	0	0	0	1
Nutrients	Waste Water Treatment	3	0	100	0	0	0	0	1
Nutrients	Precision Agriculture	2	50	50	0	0	0	0	1
Sediments	Stream Bank Erosion	3	33	67	0	0	0	0	1
Sediments	Urban Storm Water Mgt.	3	67	33	0	0	0	0	1
Bacteria	Septic Systems	3	33	67	0	0	0	0	1
Bacteria	Waste Water Treatment	3	33	67	0	0	0	0	1
Nutrients	Cropland Fertilizer Mgt.	3	0	67	33	0	0	0	2
Sediments	Tile Inlets	3	33	33	0	0	33	0	2
Bacteria	Manure	3	0	67	33	0	0	0	2
Nutrients	Feedlots	3	0	33	33	33	0	0	3
Nutrients	Manure Management	3	0	33	33	33	0	0	3
Sediments	Buffer Strips	3	0	33	33	33	0	0	3
Sediments	Drainage	3	0	33	0	33	33	0	3
Sediments	CRP-RIM	3	0	33	33	33	0	0	3
Nutrients	Drainage	3	0	33	0	67	0	0	3
Sediments	Conservation Tillage	3	0	33	0	67	0	0	3
Bacteria	Feedlots	3	0	33	67	0	0	0	3
Nutrients	Wetlands	3	0	0	33	67	0	0	4
Sediments	Wetlands	3	0	0	67	33	0	0	4

[1]Missouri River Basin includes Nobles, Pipestone, and Rock counties.
[2]Rank in descending order of percent least complete.

RAINY RIVER BASIN

The Rainy River basin drains over 11,238 square miles. The population of 55,640 grew two percent from the 1990. Over 94 percent of the Rainy River Basin is forest or wetlands (Minnesota Environmental Quality Board, 2000). All three major NPS water pollutants (nutrients, sediments, and bacteria) appear to be at the pre-peak stage of public concern in the three counties of the Rainy River Basin. Educational programs dealing with nutrients are 15 percent complete, 19 percent complete for sediments and 27 percent complete for bacteria. Tables 6.12 and 6.13 show the stages of NPS issues and degree of completeness of educational activities in the three counties in the Rainy River Basin. Stream bank erosion and buffer strips were identified as the leading emerging NPS issues. Except for precision agriculture, topics dealing with nutrient pollution problems were the next most important group of emerging issues. Educational programming for all issues is in the very early stages of completion. It should be noted that many of the issues listed in the program map are not applicable to the forested areas of the Rainy River Basin.

Table 6.12. Stage of NSP Issues in County Water Plans in the Rainy River Basin[1] (%).

		Number	**Stage of Issues in County Water Plans**						
		Responses	Emerging	Pre-Peak	Peak	Post Peak	Sunsetting	Not Applic	Rank[2]
Sediments	Stream Bank Erosion	4	25	75	0	0	0	0	1
Sediments	Buffer Strips	4	25	75	0	0	0	0	1
Nutrients	Cropland Fertilizer Mgt.	4	50	25	0	0	0	25	2
Nutrients	Drainage	4	50	25	0	0	0	25	2
Nutrients	Manure Management	4	25	50	0	0	0	25	2
Nutrients	Waste Water Treatment	4	25	50	0	0	0	25	2
Sediments	Wetlands	4	75	0	0	0	0	25	2
Bacteria	Manure	4	25	50	0	0	0	25	2
Nutrients	Lawn & Turf Fertilizer Mgt.	4	25	25	0	0	0	50	3
Nutrients	Wetlands	4	50	0	25	0	0	25	3
Nutrients	Feedlots	4	25	25	0	0	0	50	3
Sediments	Drainage	4	50	0	25	0	0	25	3
Bacteria	Feedlots	4	25	25	0	0	0	50	3
Bacteria	Septic Systems	4	0	50	25	25	0	0	3
Bacteria	Waste Water Treatment	4	0	50	0	25	0	25	3
Sediments	Conservation Tillage	4	25	0	0	25	0	50	4
Sediments	Tile Inlets	4	25	0	0	0	0	75	4
Sediments	CRP-RIM	4	25	0	25	0	0	50	4
Sediments	Urban Storm Water Mgt.	4	25	0	0	25	0	50	4
Nutrients	Precision Agriculture	3	0	0	0	0	0	100	0

[1]Rainy River Basin includes Koochiching, Lake and Lake of the Woods counties with one repeated response from MPCA staff.
[2]Ranked in descending order of percent emerging or pre-peak.

Table 6.13. Completeness of NSP Educational Activities in County Water Plans in the Rainy River Basin[1] (%).

		Number	Completeness of Educational Activities in County Water Plans						
		Responses	0%	25%	50%	75%	100%	Not Applic	Rank[2]
Nutrients	Feedlots	4	0	50	0	0	0	50	1
Nutrients	Manure Management	4	0	75	0	0	0	25	1
Sediments	Tile Inlets	4	25	0	0	0	0	75	0
Sediments	Urban Storm Water Mgt.	4	25	25	0	0	0	50	1
Bacteria	Feedlots	4	0	50	0	0	0	50	1
Bacteria	Manure	4	0	75	0	0	0	25	1
Nutrients	Lawn & Turf Fertilizer Mgt.	4	25	25	0	25	0	25	2
Nutrients	Cropland Fertilizer Mgt.	4	25	25	0	25	0	25	2
Nutrients	Drainage	4	0	50	0	25	0	25	2
Nutrients	Wetlands	4	25	25	0	25	0	25	2
Sediments	Stream Bank Erosion	4	0	75	0	25	0	0	2
Sediments	Conservation Tillage	4	50	0	0	0	25	25	2
Sediments	Buffer Strips	4	25	50	0	25	0	0	2
Sediments	Drainage	4	25	25	25	0	0	25	2
Sediments	Wetlands	4	50	25	25	0	0	0	2
Bacteria	Waste Water Treatment	4	0	50	25	0	0	25	2
Nutrients	Waste Water Treatment	3	0	67	0	33	0	0	3
Sediments	CRP-RIM	4	25	0	0	25	25	25	4
Bacteria	Septic Systems	4	0	50	25	25	0	0	4
Nutrients	Precision Agriculture	3	0	0	0	0	0	100	0

[1]Rainy River Basin includes Koochiching, Lake and Lake of the Woods counties with one repeated response from MPCA staff.
[2]Rank in descending order of percent least complete.

RED RIVER BASIN

The Red River of the North drains over 17, 743 square miles. Its population of 244,102 increased about three percent from 1990. Cropland constitutes about 45 percent of the Red River Basin land use (Minnesota Environmental Quality Board, 2000). All three major NPS water pollutants (nutrients, sediments, and bacteria) are at the pre-peak stage of public concern in the 16 counties in the Red River Basin. Completion rates of educational programming for nutrients, sediments and bacteria are 25, 29 and 26 percent, respectively. Fecal coliform bacteria and turbidity are the predominant NPS pollutants in the waters of the Red River Basin [Minnesota 2000 CWA Section 303(d) list]. Tables 6.14 and 6.15 show the top ranking NPS issues and degree of completeness of NPS educational activities in the Red River Basin. The effect of manure on nutrient and bacterial loading is the top emerging NPS issues in the Red River Basin. Over 60 percent of the responses indicate that educational activities dealing with manure management is less than 50 percent complete. Educational programs dealing with precision agriculture, tile inlets and manure are the topic which are in the earliest stages of completion in the Red River Basin. However, about half of the counties in the Red River Basin indicate that precision agriculture and tile inlets are NPS issues not applicable these counties.

Table 6.14. Stage of NSP Issues in County Water Plans in the Red River Basin[1] (%).

		Number	Stage of Issues in County Water Plans						
		Responses	Emerging	Pre-Peak	Peak	Post Peak	Sunsetting	Not Applic	Rank[2]
Nutrients	Manure Management	17	29	59	12	0	0	0	1
Bacteria	Manure	17	41	47	0	6	0	6	1
Sediments	Buffer Strips	16	38	44	13	6	0	0	2
Bacteria	Septic Systems	17	18	59	18	0	0	6	3
Nutrients	Feedlots	17	24	47	18	12	0	0	4
Sediments	Stream Bank Erosion	17	47	24	24	6	0	0	4
Nutrients	Lawn & Turf Fertilizer Mgt.	17	41	29	0	0	0	29	5
Bacteria	Feedlots	17	41	29	18	6	0	6	5
Nutrients	Cropland Fertilizer Mgt.	17	18	41	18	18	6	0	6
Nutrients	Waste Water Treatment	17	12	47	0	12	12	18	6
Sediments	Urban Storm Water Mgt.	15	33	20	13	7	0	27	7
Nutrients	Precision Agriculture	17	41	6	6	0	0	47	8
Sediments	Tile Inlets	17	18	29	0	0	0	53	8
Sediments	Wetlands	16	13	31	31	19	6	0	9
Sediments	Drainage	16	19	19	44	13	0	6	10
Nutrients	Drainage	17	6	29	41	12	12	0	11
Nutrients	Wetlands	17	6	29	35	29	0	0	11
Bacteria	Waste Water Treatment	17	29	6	12	12	18	24	11
Sediments	Conservation Tillage	17	0	29	18	35	12	6	12
Sediments	CRP-RIM	16	6	13	25	50	6	0	13

[1]Red River Basin includes Becker, Beltrami, Clay, Clearwater, Grant, Kittson, Mahnomen, Marshall, Norman, Otter Tail, Pennington, Polk, Red Lake, Roseau, Traverse, and Wilkin counties with one repeated response from Extension staff.
[2]Ranked in descending order of percent emerging or pre-peak.

Table 6.15. Completeness of NSP Educational Activities in County Water Plans in the Red River Basin[1] (%).

		Number	Completeness of Educational Activities in County Water Plans						
		Responses	0%	25%	50%	75%	100%	Not Applic	Rank[2]
Nutrients	Precision Agriculture	17	18	35	6	0	0	41	1
Sediments	Tile Inlets	16	19	19	6	0	0	56	1
Nutrients	Lawn & Turf Fertilizer Mgt.	17	12	53	6	6	0	24	2
Sediments	Buffer Strips	16	13	69	13	0	6	0	3
Sediments	Urban Storm Water Mgt.	15	27	20	27	0	7	20	4
Nutrients	Manure Management	16	19	44	31	6	0	0	5
Bacteria	Manure	16	31	25	38	0	0	6	6
Nutrients	Waste Water Treatment	16	19	25	13	25	6	13	7
Sediments	Stream Bank Erosion	16	25	31	38	6	0	0	7
Bacteria	Waste Water Treatment	16	19	19	19	19	6	19	7
Bacteria	Feedlots	16	31	19	38	13	0	0	8
Nutrients	Feedlots	16	19	25	31	25	0	0	9
Bacteria	Septic Systems	16	13	31	44	13	0	0	10
Nutrients	Cropland Fertilizer Mgt.	16	0	38	25	31	6	0	11
Nutrients	Drainage	16	6	31	31	31	0	0	11
Sediments	Drainage	16	13	19	38	19	6	6	12
Nutrients	Wetlands	16	6	25	63	6	0	0	13
Sediments	Wetlands	16	6	19	44	31	0	0	14
Sediments	Conservation Tillage	16	0	19	25	38	19	0	15
Sediments	CRP-RIM	16	6	0	25	50	19	0	16

[1]Red River Basin includes Becker, Beltrami, Clay, Clearwater, Grant, Kittson, Mahnomen, Marshall, Norman, Otter Tail, Pennington, Polk, Red Lake, Roseau, Traverse, and Wilkin countieswith one repeated response from Extension staff.
[2]Rank in descending order of percent least complete.

ST. CROIX RIVER BASIN

The St. Croix River Basin drains 3,529 square miles of east central Minnesota. The population of 198,917 increased about 24 percent from 1990 with the largest increases in Washington and Chisago counties. Nearly forty percent of the basin is forest (Minnesota Environmental Quality Board, 2000). Nutrients and sediment pollutants are at the peak level of concern in the four counties in the St. Croix River Basin. Educational programming is 30 percent complete for nutrients, 34 percent complete for sediments, and 27 percent complete for bacteria. As shown in Table 6.16 the most important emerging issues in the suburbanizing counties of the St. Croix River Basin are residential NPS issues, i.e., lawn and turf fertilizer management and septic systems. Table 6.17 shows that educational programs on CRP and RIM programs, cropland fertilizer management and conservation tillage are the topics most completed while lawn and turf fertilizer management, drainage and urban storm water management are the issues in the early stages of completion. Half of the responses indicate that precision agriculture, drainage, and wastewater treatment are issues that are not applicable to the St. Croix River Basin. Excess nutrients are the main NPS pollutant of the waters of the St. Croix Basin [Minnesota 2000 CWA Section 303(d) list].

Table 6.16. Stage of NSP Issues in County Water Plans in the St. Croix River Basin[1] (%).

		Number	Stage of Issues in County Water Plans						
		Responses	Emerging	Pre-Peak	Peak	Post Peak	Sunsetting	Not Applic	Rank[2]
Nutrients	Lawn & Turf Fertilizer Mgt.	4	75	25	0	0	0	0	1
Bacteria	Septic Systems	4	25	75	0	0	0	0	1
Sediments	Stream Bank Erosion	4	0	75	0	25	0	0	2
Sediments	Wetlands	4	0	75	0	25	0	0	2
Sediments	Urban Storm Water Mgt.	4	25	50	0	0	0	25	2
Bacteria	Feedlots	4	50	25	0	25	0	0	2
Bacteria	Manure	4	25	50	0	25	0	0	2
Nutrients	Cropland Fertilizer Mgt.	4	50	0	0	50	0	0	3
Nutrients	Wetlands	4	25	25	25	0	25	0	3
Nutrients	Feedlots	4	25	25	0	50	0	0	3
Nutrients	Manure Management	4	25	25	25	25	0	0	3
Nutrients	Waste Water Treatment	4	0	50	0	0	0	50	3
Sediments	Buffer Strips	4	0	50	0	25	25	0	3
Nutrients	Drainage	4	0	25	25	0	0	50	4
Sediments	Conservation Tillage	4	25	0	0	75	0	0	4
Sediments	Drainage	4	0	25	0	25	0	50	4
Bacteria	Waste Water Treatment	4	25	0	0	25	0	50	4
Nutrients	Precision Agriculture	4	0	0	0	25	0	75	0
Sediments	Tile Inlets	4	0	0	0	50	25	25	5
Sediments	CRP-RIM	4	0	0	0	50	25	25	5

[1]St. Croix River Basin includes Chisago, Kanabec, Pine and Washington counties.
[2]Ranked in descending order of percent emerging or pre-peak.

Table 6.17. Completeness of NSP Educational Activities in County Water Plans in the St. Croix River Basin[1] (%).

		Number	**Completeness of Educational Activities in County Water Plans**						
		Responses	0%	25%	50%	75%	100%	Not Applic	Rank[2]
Nutrients	Drainage	4	0	50	0	0	0	50	1
Sediments	Urban Storm Water Mgt.	4	0	75	0	0	0	25	1
Nutrients	Lawn & Turf Fertilizer Mgt.	4	50	25	25	0	0	0	2
Nutrients	Feedlots	4	25	50	0	25	0	0	2
Nutrients	Precision Agriculture	4	0	0	0	25	0	75	0
Sediments	Drainage	4	0	25	0	0	25	50	2
Bacteria	Waste Water Treatment	4	50	0	0	0	25	25	2
Sediments	Stream Bank Erosion	3	0	67	0	33	0	0	3
Nutrients	Cropland Fertilizer Mgt.	4	25	25	0	25	25	0	4
Nutrients	Manure Management	4	0	50	25	0	25	0	4
Nutrients	Waste Water Treatment	4	0	0	25	0	25	50	4
Sediments	Conservation Tillage	4	25	25	0	25	25	0	4
Sediments	Buffer Strips	4	0	25	25	25	0	25	4
Sediments	Tile Inlets	4	0	0	0	25	25	50	4
Sediments	Wetlands	4	0	50	25	25	0	0	4
Bacteria	Feedlots	4	50	0	25	0	25	0	4
Bacteria	Manure	4	25	25	25	25	0	0	4
Bacteria	Septic Systems	4	25	25	25	25	0	0	4
Nutrients	Wetlands	4	25	0	50	25	0	0	5
Sediments	CRP-RIM	4	0	0	0	50	25	25	5

[1]St. Croix River Basin includes Chisago, Kanabec, Pine and Washington counties.
[2]Rank in descending order of percent least complete.

UPPER MISSISSIPPI RIVER BASIN

The Upper Mississippi River Basin is the largest basin in Minnesota, draining over 20,089 square miles. The basin's 1998 population of over 2.54 million people grew about nine percent since 1990 (Minnesota Environmental Quality Board, 2000). All three major NPS water pollutants (nutrients, sediments, and bacteria) appear to be at the peak stage of public concern in the 18 counties in the Upper Mississippi River Basin. Educational programs dealing with nutrients are 26 percent complete, 30 percent complete for sediments and 31 percent complete for bacteria. Table 6.18 shows that the top emerging issues in the Upper Mississippi River Basin are lawn and turf fertilizer management and urban storm water management. Conservation tillage, drainage and CRP and RIM are most completed topics while precision agriculture is an issue for future educational programming. Excess nutrients is the predominant NPS pollutant in the waters of the Upper Mississippi River Basin [Minnesota 2000 CWA Section 303(d) list].

Table 6.18. Stage of NSP Issues in County Water Plans in the Upper Mississippi River Basin[1] (%).

		Number	Stage of Issues in County Water Plans						
		Responses	Emerging	Pre-Peak	Peak	Post Peak	Sunsetting	Not Applic	Rank[2]
Nutrients	Lawn & Turf Fertilizer Mgt.	20	35	30	15	10	0	10	1
Sediments	Urban Storm Water Mgt.	20	15	50	5	10	10	10	1
Nutrients	Cropland Fertilizer Mgt.	20	15	45	10	20	5	5	2
Nutrients	Feedlots	20	25	30	25	10	5	5	3
Nutrients	Manure Management	20	10	45	5	25	5	10	3
Nutrients	Precision Agriculture	20	30	25	0	5	5	35	3
Bacteria	Manure	20	20	35	20	10	5	10	3
Sediments	Buffer Strips	19	11	42	5	32	0	11	4
Sediments	Stream Bank Erosion	20	15	35	15	25	5	5	5
Bacteria	Feedlots	19	16	26	32	5	5	16	6
Bacteria	Septic Systems	20	5	35	45	10	5	0	7
Nutrients	Drainage	19	16	21	16	21	16	11	8
Bacteria	Waste Water Treatment	20	15	20	20	40	5	0	9
Nutrients	Wetlands	19	11	21	26	37	0	5	10
Nutrients	Waste Water Treatment	20	15	15	35	25	5	5	11
Sediments	Conservation Tillage	20	10	20	5	35	15	15	11
Sediments	Wetlands	19	16	11	37	26	5	5	12
Sediments	CRP-RIM	20	5	20	10	30	25	10	13
Sediments	Tile Inlets	19	5	16	5	21	16	37	14
Sediments	Drainage	19	5	5	26	26	16	21	15

[1]Upper Mississippi River Basin includes Aitkin, Benton, Cass, Crow Wing, Douglas, Hennepin, Hubbard, Isanti, Itasca, McLeod, Mille Lacs, Morrison, Pope, Ramsey, Sherburne, Stearns,Wadena and Wright counties with two repeated responses from MPCA and Extension staff.
[2]Ranked in descending order of percent emerging or pre-peak.

Table 6.19. Completeness of NSP Educational Activities in County Water Plans in the Upper Mississippi River Basin[1] (%).

		Number	Completeness of Educational Activities in County Water Plans						
		Responses	0%	25%	50%	75%	100%	Not Applic	Rank[2]
Nutrients	Precision Agriculture	19	26	32	5	0	0	37	1
Nutrients	Feedlots	19	11	53	16	11	5	5	2
Bacteria	Feedlots	20	15	35	20	10	5	15	3
Sediments	Tile Inlets	19	11	21	11	11	16	32	4
Bacteria	Manure	20	10	40	30	5	5	10	5
Bacteria	Waste Water Treatment	20	20	40	25	10	5	0	5
Nutrients	Manure Management	19	0	47	26	11	5	11	6
Nutrients	Lawn & Turf Fertilizer Mgt.	20	0	55	20	25	0	0	7
Sediments	Urban Storm Water Mgt.	18	11	33	17	17	11	11	7
Nutrients	Drainage	20	15	25	10	25	15	10	8
Nutrients	Waste Water Treatment	20	15	30	25	20	5	5	8
Sediments	Stream Bank Erosion	19	16	26	26	26	0	5	9
Sediments	Buffer Strips	19	16	16	21	37	0	11	10
Sediments	Drainage	19	16	11	21	16	21	16	10
Sediments	Wetlands	19	11	26	37	16	5	5	10
Nutrients	Cropland Fertilizer Mgt.	20	10	25	35	20	5	5	11
Sediments	CRP-RIM	20	0	30	20	25	15	10	11
Sediments	Conservation Tillage	19	5	16	16	37	11	16	12
Nutrients	Wetlands	20	5	25	30	35	0	5	13
Bacteria	Septic Systems	20	5	30	45	15	5	0	13

[1]Upper Mississippi River Basin includes Aitkin, Benton, Cass, Crow Wing, Douglas, Hennepin, Hubbard, Isanti, Itasca, McLeod, Mille Lacs, Morrison, Pope, Ramsey, Sherburne, Stearns, Wadena and Wright counties with two repeated responses from MPCA and Extension staff.
[2]Rank in descending order of percent least complete.

Chapter 6 Information and Education
Needs, Priorities and Milestones, 2001-2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) 5-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Goal 1: Raise Awareness of the General Public with Respect to the Nature of NPS Pollution, How Communities and Individuals Contribute to it, and what Governmental Organizations and Individuals are Doing About It.

Objectives:

- Increase overall citizen awareness by 20 percent by 2005 of the ways in which urban runoff water and home lawn-care and recreational activities affect water quality of nearby water bodies.
- Increase overall citizen awareness by 20 percent by 2005 of the ways in which livestock and crop systems and farm-management practices affect water quality of water bodies.
- Assure that current educational materials and delivery systems are coordinated and managed to reach the maximum number of Minnesotans in ways they understand and at times and locations where they will be most receptive.
- Actively promote increased media coverage of the nature of NPS pollution in Minnesota and of those activities that help to control it.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop and coordinate a statewide, multi-agency media campaign concerning NPS issues directed at urban and rural audiences.	X	X	X	X	X	319	MPCA and UMES
2. Develop a Powerpoint presentation on the general nature of NPS pollution that state and local resource managers can download from the Internet and tailor to their individual audiences, using elements from the file.	X					319	MPCA and UMES
3. Support 10 NPS presentations per year to special interest groups on how to set up action oriented local water quality programs.	X	X	X	X	X	319	UMES and MPCA, and others as appropriate
4. Conduct a statewide NPS awareness campaign that provides broad-based messages on emerging issues to the general public.	X	X	X	X	X	Twin Cities Water Quality Initiative, 319	BWSR, WaterShed Partners

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5. Improve utilization of involved agencies' public information offices as a mechanism for disseminating NPS news items	X	X	X	X	X	All involved agencies	All

Goal 2: Promote Stewardship and Active Citizen Involvement by Focusing NPS Information and Education Efforts on the Natural Resources in Which Local Audiences Have a Stake.

Objectives:

- Emphasize the watershed approach into new information and education programs to provide a common basis for citizen support and active citizen involvement.
- Strengthen the sense of local stewardship by using key regional and community people and programs as vehicles for delivering NPS educational activities.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Clarify and ensure the information and education roles of regional offices of involved state agencies.	X					319	MPCA
2. Offer centralized development of education programs of multi-county interest.	X	X	X	X	X	319	UMES and BWSR
3. Publicize lessons learned from 319 and CWP funded demonstration projects through a website, newsletters newspaper articles.	X	X	X	X	X	319	UMES and MPCA
4. Provide support for education programs aligned with each region's basin planning alliances, e.g. The Karst Campaign for the Basin Alliance of the Lower Mississippi of Minnesota.	X	X	X			319	USDA-Extension Water Quality and 319

Goal 3: Improve Information and Education Outreach Network for Local Officials and Resource Managers.

Objectives:
- Build capacity for Local Water Planners on the roles and components of effective NPS education programs
- Provide NPS education leadership on topics of broad-based statewide concern.
- Support NPS educational efforts outlined in county local water plans.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Utilize local water planners' electronic newsletters to share information about BMPs that have been successfully used in Minnesota.	X	X	X	X	X	BWSR and 319	BWSR and UMES
2. Initiate, develop and implement an education program for municipal officials tailored to Minnesota patterned after the existing NEMO (Nonpoint Education for Municipal Officials).		X	X			319 and USDA Extension Water Quality	UMES and MPCA
3. Continue sponsoring the multi-state Upper Midwest, such as the 1993 and 1996 LaCrosse conferences focused on "New Approaches to Rural NPS Pollution: What Makes Them Work."	X			X		Many	MPCA, WDNR, IDNR, NRCS-USDA, USDA-ARS-MSA, UMES, MDA, MDNR and US EPA-Region 5
4. Provide training support to local water planners and NPS educators.	X	X	X	X	X	319, BWSR grants, and UMES grants	BWSR and UMES
5. Provide information and materials support to local water planners and NPS educators	X	X	X	X	X	319, BWSR grants, and UMES grants	UMES, MPCA and BWSR
6. Provide educational program support on NPS educational issues of regional importance	X	X	X	X	X	319, BWSR grants, and UMES grants	All

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
7. Provide better follow-up documentation to local officials, including distribution of NPS Annual Reports, matrices of existing programs and funding sources, and follow-up summaries of survey information.	X	X	X	X	X	319	MPCA and UMES
8. Assist local water planners in review, assessment, and improvement of NPS educational plans.	X	X	X	X	X	BWSR County Local Water Planning Grants	BWSR and UMES
9. Present methods and examples of effective NPS education programming at annual Water Planner Conferences	X	X	X	X	X	BWSR Challenge Grants, 319	BWSR and UMES

Goal 4: Foster Coordination and Cooperation Between Governmental Agencies and Private, Nonprofit and Other Organizations to Carry Out Information and Education Efforts.

Objectives:

- Create a searchable, Internet-based database of NPS information and educational materials available from governmental agencies; educational institutions; and private, nonprofit and other organizations.
- Encourage the cross-use of lessons learned through NPS projects.
- Promote information exchange and coordination through a statewide Information and Education clearinghouse.
- Effectively utilize and coordinate existing Information and Education programs, and ensure that new programs are coordinated with and responsive to the established Information and Education roles and responsibilities.
- Establish a mechanism for ensuring the work efforts recommended in the strategy are coordinated and implemented, with progress reported back to the Project Coordination Team.
- Encourage partnerships and opportunities for education of professionals whose occupations are linked to NPS water pollution.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Continue support for coordinator position to lead and facilitate implementation of the overall information and education strategy. The coordinator will be responsible for ensuring work educational efforts within the strategy are implemented and reported back to the Project Coordination Team.	X	X	X	X	X	319	UMES and MPCA
2. Evaluate suitability of the Office of Environmental Assistance (OEA) SEEK database for including NPS educational materials for target audiences. Modify audience and key word search capabilities if necessary. If SEEK database is not suitable or cannot be adapted, establish searchable, Web-based database that uses SEEK software.	X					319 and OEA	MPCA, OEA and UMES
3. Foster the sharing of available resource materials by expanding SEEK website to include materials for a broader audience than children and teachers.	X	X	X	X	X	319	MPCA, OEA, and UMES
4. Update and formalize the roles and responsibilities of agencies involved in Information and Education for water quality through Memorandum of Understanding.	X					None Required	MPCA and UMES
5. Work with local governments in updating local water plans to incorporate the goals of the statewide Information and Education Strategy.	X	X	X	X	X	Local County Water Planning Grants and 319	BWSR, MPCA and UMES

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
6. Integrate elements of the NPS Information and Education strategy into the collaborative work efforts began with the WaterShed Partners.	X	X	X	X	X	319 and Metro Council Water Quality Initiative Grants	WaterShed Partners, UMES and MPCA
7. Provide a series of two technical forums per year where professionals can exchange information and gain information on government programs related to their field.	X	X	X	X	X	319 and UMES Funding	MPCA and UMES

Goal 5: Initiate Long-Term Early Education Programs that Focus On Water Quality Protection through NPS Controls.

An important long-term goal of NPS education efforts is to educate young people about NPS pollution and what can be done to address the problem.

Objectives:

- Ensure that curriculum materials for Minnesota 4-H Science and Animal Science projects discuss NPS pollution problem and inform members about what they can do to address it.
- Ensure that Minnesota vocational agriculture curricula cover the NPS pollution problem and inform students about what they can do to address it.
- Increase content of NPS educational messages into academic curriculums.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Obtain and review Crop Sciences, Lawn and Landscape Design, Plant and Soil Science, Beef, Dairy, Horse, and Sheep project guides. If needed, enlist guide developers' cooperation in adjusting the project guides to include information about NPS pollution and what 4-H'ers can do to avoid it.	X	X				USDA Extension Water Quality Grants, Extension Director's Grants319	UMES

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
2. Obtain and review Minnesota Vocational Agriculture course materials for crop and livestock enterprises. If needed, enlist curriculum developers' cooperation in adjusting course materials to include information about NPS pollution and how farmers can avoid it.	X	X				USDA Extension Water Quality Grants, Extension Director Grants, 319	UMES
3. Increase the content of NPS educational messages in K-12 academic curriculums employing programs such as ArtStart and the Children's Water Festival.	X	X	X	X	X	OEA, EPA education grants, 319	Many
4. Increase the content of NPS educational messages in technical school curriculums.	X	X	X	X	X	EPA education grants, 319	Many
5. Increase the number of NPS educational messages in continuing professional education programs	X	X	X	X	X	EPA education grants, 319	UMES, OEA

Goal 6: Improve the Ability to Effectively Evaluate NPS Information and Education Activities.

Objectives:

- Develop a method for evaluation of the effectiveness of the Information and Education program elements.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Utilize the survey group from the Minnesota Center for Survey Research to develop suitable questions to be used in statistically-based surveys of public awareness, and knowledge about NPS pollution and what can be done to address the problem.	X	X	X	X	X	319	MPCA and UMES

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
2. Utilize the statewide and Twin Cities metro area Minnesota Surveys to measure changes in attitudes and action over each year of the management plan.	X	X	X	X	X	319	MPCA and UMES
3. Develop and institute a standardized format to measure participation in educational programs of Section 319 and Clean Water Partnership programs.	X	X				319 and CWP	MPCA
4. Pull together other data sources reflecting behavioral changes of Minnesotans with respect to NPS pollution.	X	X	X	X	X	319	MPCA and UMES

1994 NSMPP
Needs, Priorities and Milestones

The following Table provides the Goals and Action Steps included in the 1994 NSMPP. The Products, Services & Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps. Implementation of all action steps is contingent upon adequate funding and local involvement

Goal 1: To Raise The Awareness Of The General Public With Respect To The Nature Of NPS Pollution, How Individuals Contribute, And What Government Is Doing About It.

Objectives:

- Increase overall citizen awareness of the way in which urban runoff water, lawn care, and recreational activities affect water quality of nearby urban waterbodies, and of the way in which livestock systems and farm management practices affect water quality of nearby rural waterbodies.
- Develop an educational materials package and a delivery system that will reach the maximum number of individuals in ways they understand and at times and locations where they will be the most receptive.
- Actively promote stronger media coverage of the nature of NPS in Minnesota and of those activities that help to control NPS pollution.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Develop, or compile, a series of camera ready visuals about NPS issues, and actively promote this information to a wide base of media representatives (newspaper, radio, public television, trade journals, etc.).	319	UMES & MPCA	Developed an information series about NPS issues that were publicized by radio spots on 13 radio program broadcasts throughout Minnesota.
2. Develop a NPS presentation, including slide show, poster boards, and handouts to take on the road and present at local workshops, state fairs, county fairs and water-related conferences.	319	UMES & MPCA	NPS educational presentations, videos, poster boards, and handouts were presented at local workshops, state fairs, and public television programming, and state and national water-related conferences.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Promote and encourage NPS presentations to special interest groups.	319	UMES, & MPCA	NPS educational presentations, videos, poster boards, and handouts were presented at local workshops, state fairs, and public television programming, and state and national water-related conferences.

Goal 2: Promote Stewardship and Active Citizen Involvement by Focusing NPS Information and Education Efforts on the Natural Resources in Which Local Audiences Have A Stake.

Objectives:

- Implement new I & E programs with a focus on a watershed approach designed to provide a common basis for citizen support and active citizen involvement (such as Clean Water Partnership, Clean Lakes, Minnesota River Project, and Lake Advocate programs).
- Strengthen the sense of local stewardship by using key regional and community people and programs as the vehicles for delivering NPS educational efforts.
- Implement a network whereby technological information on specific local concerns can be efficiently transferred from state and federal agencies to local audiences, and whereby local audiences can effectively voice and document their concerns and priorities back to state and federal agencies.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(is)	Products, Services, Outcomes
1. Compile comprehensive database of local target audiences and set up series of regionalized training workshops.	319	UMES and MPCA	Two separate educational programming needs assessments were conducted in 1996, 1997, and 1998.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
2.	Identify and document the I & E role of the regional offices of the involved state agencies.	319	UMES and MPCA	An e-mail network for interagency NPS workers spans across agencies, linking 500 e-mail addresses (56 committee members from the NSPMPP (1994) chapters; 414 local resource managers from MPCA, MES, SWCD, MDA, NRCS, DNR and BWSR; and 31 NPS Administrators).
3.	Develop process for locals to identify NPS concerns at the local level.	319	UMES and MPCA	NPS pollutants programming needs assessments were conducted in 1996, 1997 and 1998.
4.	Produce a series of fact sheets or brochures targeted to the issues within specific regional watersheds (such as the brochure for the Minnesota River).	UMES Extension Water Quality Program, 319	UMES	A series of fact sheets targeted to the issues within specific regional watersheds (Great Lakes, Minnesota River) have been prepared. A series of Water Quality Impact Statements have been prepared through the UMES Water Quality Leadership Team and distributed to County extension offices and distributed to Clean Water Partnership project managers.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
5. Publish newsletter or series of local newspaper articles focused on NPS issues within the specific watersheds.	BWSR and Twin Cities Water Quality Initiative	BWSR and Watershed Partners	Responsibility in research of Metro Area NSP Pollution Education Campaign coordinated by WaterShed Partners and BWSR in coordinating NPS information, in 1997. A multi-year public awareness campaign.
6. Provide information and training to local citizen groups on how to set up action-oriented local water quality programs (such as water watch). Develop criteria for Water Watch contributions to water quality assessments.	319	UMES	Provided information and training to local citizen groups and township officers on how to set up action-oriented local water quality programs (such as the nationally recognized River Friendly Farmer program). The overall result of this effort was that the number of River Friendly Farmers increased 73 percent from 1996.

Goal 3: Improve Information and Education Outreach Network for Local Officials and Resource Managers.

Local governments have the capability of exercising significant control over land development activities, zoning, planning and enforcement. Local government and resource managers are also going to play an active role in storm water and wetlands management in the near future. Because of these critical roles, educating local officials and managers in the benefits of NPS controls is an important component of an overall NPS education strategy.

Objectives:

- Establish on-the-ground contacts and interactions between the involved state agencies and local officials.

- Identify the specific areas of technical information, which are most needed and desired from the various local governments, and design a technology transfer program that will work to meet these needs.
- Enhance local governments' ability to implement NPS controls by providing a more reliable and comprehensive information base of state/federal programs and available funding sources.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Sponsor Upper Midwest conference focused on rural NPS solutions that feature local-level initiatives and partnerships.	Many	MPCA, WDNR, IDNR, NRCS-USDA, USDA-ARS-MSA, UMES, MDA, MDNR and US EPA-Region 5	Sponsored "New Approaches to Rural Nonpoint Source Pollution: What Makes Them Work" A highly successful conference held on September 16-18, 1996, in LaCrosse, Wisconsin. Three hundred thirty-four farmers, state, and federal resource managers attended the conference, sponsored by MPCA, WDNR, IDNR, NRCS-USDA, USDA-ARS, University of Minnesota Center for Agricultural Impacts on Water Quality, MDA, MDNR, U.S. EPA Region 5.
2. Survey local governments on their technical I & E needs.	319	UMES and MPCA	Two separate educational programming needs assessments were conducted in 1996, 1997, and 1998.
3. Provide better follow-up documentation to local officials, including distribution of NPS Annual Reports, matrices of existing programs and funding sources, and follow-up summaries of survey information.	319, CWP	MPCA and UMES	This milestone is on going and listed in the Needs, Priorities and Milestones 2001-2005 as Goal 3, Milestone 1, p. 6-18.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
4. Prepare and distribute newsletter to local entities on sharing BMPs that have been successfully used in Minnesota.	319	UMES and MPCA	Presented and Published "319 BMP Demonstration Projects" to PCT in 1998.
5. Use the ordinance reference document to increase the state's level of effort with local governments in developing NPS ordinances.	Not funded	MPCA	None – not undertaken.

Goal 4: Foster Coordination and Cooperation between Government Agencies, Private, Nonprofit and Other Organizations to Carry out Information and Education Efforts.

Objectives:

- Promote information exchange and coordination through a statewide I & E clearinghouse.
- Effectively utilize and coordinate existing I & E programs, and ensure that new programs are coordinated with and responsive to established I & E roles and responsibilities.
- Establish a mechanism for ensuring the work efforts recommended in the strategy are coordinated and implemented, with progress reported back to the Project Coordination Team.
- Encourage partnerships and opportunities for education of professionals whose occupations are linked to NPS.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Establish a short-term (2-3 year) coordinator position to lead and facilitate implementation of the overall strategy. The Coordinator would be responsible for ensuring work efforts within the strategy are implemented and reported back to the Project Coordination Team.	319	UMES	Program Coordinator was hired by Minnesota Extension Service (MES) and officed at Minnesota Pollution Control Agency (MPCA

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
2. Pull together agency representatives responsible for coordinating or implementing I & E activities within the various regions of the state, for purposes of clarifying and documenting the water quality educational roles of each coordinator. Hold regular meetings of this group focused on coordination of efforts and exchange of the information gained in implementing I & E efforts within various regions.	319 and UMES	UMES and UM Ag Expt. Station.	Activated and continue to coordinate the Feedlot & Manure Management Information and Training Subcommittee NSMPP (1994) with UMES Extension Service and MPCA staff.
3. Formalize the roles and responsibilities of the agencies involved in I & E for water quality through a Memorandum of Understanding.	Not Funded	MPCA	Memorandum of Understanding was established in 1991 and re-established in 1995.
4. Produce a comprehensive inventory of NPS adult educational materials and distribute to libraries and local government offices. Integrate the inventory into the statewide electronic bulletin board, and establish a mechanism for keeping it updated.	319	UMES and MPCA	• "An Annotated Inventory of Nonpoint Source Educational Materials" was prepared and distributed in the spring of 1997. • The annotated bibliography includes about 645 educational reference materials catalogued according to NPS, i.e., chapter headings of Minnesota's 1994 Nonpoint Source Management Plan.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
5.	Work with local governments in updating local water plans to incorporate goals of the statewide strategy.	BWSR and MPCA	BWSR and MPCA	Ongoing Local County Water Planning and Basin Management and Scoping Documents
6.	Develop a statewide database of agricultural survey information.	USDA and National Agricultural Statistics Service	MDA and USDA	Agricultural Statistics and National Agricultural Statistics Service
7.	Encourage local water planning entities to lead and coordinate NPS information and education planning efforts at the county and community level.	319	UMES and MPCA	Several presentations at the County Water Planners Conferences in 1996, 1997, 1998.
8.	Prepare an evaluation of the statewide I & E inventory to identify gaps and overlaps in the existing information, to check for accuracy and reliability of the information, and to modify the format based on user comments.	319	UMES and MPCA	Published and distributed "An Annotated Inventory of Nonpoint Source Educational Materials, Spring 1997
9.	Develop a format and prepare a series of "success stories" which demonstrate water quality improvement through NPS controls.	319 and MPCA base funds	MPCA	Minnesota section (p.65) in Section 319 Success Stories (1994) and pps. 90,91 in Section 319 Success Stories Volume II (1997)
10.	The interagency subcommittee formed for updating the NPS Management Program will develop implementation plans for information and education efforts specific to the major source areas of Forestry, Agriculture, Hydromodification, Urban, etc.	319	UMES and MPCA	Collected, analyzed and formulated and published "issue maps" used in the Findings from the Nonpoint Source Strategic Planning Effort section of this chapter.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
11. Develop method for evaluation of the effectiveness of the I & E program elements.	319	UMES and MPCA	This milestone is listed in the Needs, Priorities and Milestones 2001-2005 as Goal 6, Milestone 1 to 4, p, 6-22.
12. Provide a series of technical forums where professionals can exchange information and gain information on government programs related to their field.	UMES	UMES	Four NPS/Water Quality in-service training opportunities for 182 University of Minnesota Extension Educators, selected personnel from state and federal agencies and public officials were developed and carried out in 1995 and 1996.

Goal 5: Initiate long-term early Education Programs Focused on Water Quality Protection through NPS Controls.

Objectives:
- Inventory the training programs already available, and identify new or improved materials.
- Establish a liaison with the Office of Environmental Education.
- Set up regional workshops for local teachers to assist in developing curriculum and training programs.

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Chapter 7 Feedlots

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Description of Current Issues in Minnesota

The animal production industry is an extremely important component of Minnesota's economy. Farm marketing cash receipts for livestock were $4.3 billion in 1997. Total farm cash receipts were $8.5 billion (Minnesota Agricultural Statistics 2000). In a series of University of Minnesota papers focusing on the importance of Minnesota' livestock industry, UM economists determined that the poultry, dairy, and pork industries alone support 108,000 jobs in the state in production, processing, supply, distribution, and retailing (1996-1997 data). The same studies attribute $4.3 billion in total income for those three industries *(G. W. Morse and W. Lazarus, Dept. Applied Economics, University of Minnesota).* Table 7.1 illustrates the importance of Minnesota production nationally in 1999.

TABLE 7.1 Minnesota's Rank Among States - Livestock, Dairy, and Poultry Production - (From "Minnesota Agriculture Statistics 2000," Minnesota Agricultural Statistics Service)

Type of Production	Rank Nationally
Turkeys raised, 1999	2nd
Hogs Marketed, 1999	3rd
Total Cheese Produced, 1999	4th
Milk Production, 1999	5th
Red Meat Production, 1999	7th
Eggs produced, Dec. 1998-Nov. 1999	9th
Cattle/calves on Feed, Jan. 1, 2000	10th

Despite Minnesota's role as a leader in agricultural production, some producers of farm products face difficult financial challenges. For example, a survey of farm financial records volunteered by participants in the Minnesota State Colleges and Universities' farm business management program and farm business management associations for 1999 was conducted. The farm operations surveyed had cash farm income (including government payments) of $306,474. Net farm income was $48,183, of which all but $7,630 was accounted for by government payments, which are not likely to continue at this level. While this information cannot be generalized because the survey was not a representative sample of Minnesota farmers, it does illustrate the slim profit margins facing some producers. Slim profits tend to make new capital investments (e.g. for pollution abatement systems) very difficult. Therefore, it will be a challenge to provide economical, environmentally sound alternatives to these producers for storing and managing the manure produced by their operations.

Animal manure, when properly used as fertilizer, is a useful resource. It contains valuable nutrients such as nitrogen, phosphorus and potassium. It can improve soil quality, including aggregate stability, infiltration, water holding capacity, aeration, soil organic matter levels, and earthworm activity. However, animal manure improperly stored, handled, disposed of and allowed to leach or run off into surface or ground waters can create serious water pollution hazards. These hazards include excess nitrogen, excess phosphorus, pathogens, hormones, or trace metals. The impacts of this pollution can be felt locally, regionally, or nationally, as in the issue of hypoxia in the Gulf of Mexico. A study prepared by the Minnesota Nitrogen Task Force (funded by the Minnesota State Legislature) has indicated that although Minnesota farmers are doing a good job of managing nutrients applied in commercial fertilizers, often inputs of nutrients from other sources such as manure are not credited accurately.

Results from numerous Minnesota Department of Agriculture (MDA) studies conclude that Minnesota producers are generally managing commercial nitrogen inputs successfully in non-legume cropping systems. However, in the areas studied so far, most producers significantly under-estimate the nitrogen (N) credits associated with manure and legume inputs. Although the overall N contributions are typically minor in relationship to commercial fertilizer, the lack of proper crediting can result in significant over-applications of commercial fertilizer, particularly when manure is applied to previous legume crops (see Chapter 9 Agricultural Nutrients for additional details on these studies).

Nutrients in manure, useful on cropland, can promote algae and weed growth in surface waters like lakes and rivers. Manure and runoff from animal confinement and manure storage areas may also contain (1) substances that deplete oxygen in surface waters, (2) materials, such as ammonia, that in high concentrations can be toxic to aquatic life, and (3) disease-causing organisms. Manure solids and soils disturbed by animal traffic on open lots may increase sediment loadings in surface waters.

Ground water concerns include potential human and animal health effects from nitrates and pathogens. Potential pathways for these pollutants to enter ground water include leakage from earthen storage basins, access through improperly constructed drinking water wells, and recharge from polluted surface water bodies.

This chapter will primarily address impacts from animal confinement and manure storage facilities. Please refer to the Agricultural Nutrient Management Chapter (Chapter 9) of this document for various water quality impacts of manure management on cropland. Hazards or potential effects of animal confinement and manure storage facilities are discussed in greater detail within this chapter.

PHOSPHORUS

Phosphorus typically does not leach through soils in large quantities. However, phosphorus from animal manure can be a significant pollutant if runoff-containing manure is allowed to enter a surface water. Phosphorus is usually the limiting nutrient in lakes. Therefore, if animal manure or feedlot runoff is allowed to enter a lake, it can lead to nuisance weed and algae growth. One pound of phosphorus will produce approximately 500 pounds of weeds or algae growth in a lake.

ORGANIC MATTER

Animal manure also includes organic materials, which may be used by microorganisms as a food source. If this decomposition occurs in surface waters, these microorganisms can deplete oxygen in the water. The lack of oxygen can kill fish or degrade the water quality to the point that no fish or only less desirable rough fish can survive. Many fish kills are the result of excess organic materials being allowed to enter surface waters. Animal manure and feedlot runoff are relatively concentrated sources of these pollutants.

PATHOGENS

Animal manure can also include potential pathogens (disease-causing micro-organisms). If carried in either surface or ground water, these can spread disease to other animals, and to humans as well.

NITROGEN

Manure can create ground water pollution if it is improperly stored, is washed off a feedlot into a low area where it seeps into the ground, or if it is improperly land applied. Ground water pollution resulting from animal manure is typically in the form of nitrate nitrogen, but can also be in the form of ammonia nitrogen. Nitrogen in the form of ammonia can also be toxic to aquatic life if manure runs off into surface water.

PRODUCTION FACILITIES

Animal confinement facilities may be grouped into three general types: (1) total confinement, where animals are indoors at all times; (2) partial confinement, where animals are either indoors or in a "lot" open to the air and precipitation at various times; and (3) open lots or pens, where there are no roofed areas.

Animal pastures, in contrast, do not involve confinement. Ideally, animals on pasture are either given sufficient space or regularly rotated so that ground cover is maintained on the pasture. Animals are not allowed continuous access to surface water so that the impact on water bodies is minimized. However, animal-grazing systems, if poorly managed, can lead to water quality problems. These problems typically occur in pastures where animals are allowed continuous access to adjacent streams and lakes, resulting in direct deposit of manure and urine in the water body. This can be minimized by rotational grazing with access to water bodies limited to brief periods of time.

Manure may be stored in a solid, semi-solid, or liquid form in constructed storage facilities, or stockpiled in solid form on soil. In general, the likelihood of water pollution caused by these facilities increases with proximity to surface waters like lakes, streams or waterways, or in areas with shallow aquifers easily contaminated by seepage of pollutants from the surface.

Total confinement facilities, when properly designed and managed, present minimal hazard to surface waters, since all manure is under roof and cannot be carried away in runoff from rain or snowmelt. Partial confinement facilities and open lots have areas where precipitation can come into contact with manure. Runoff may carry manure away to surface waters, or seep into the soil.

Manure is sometimes stored in areas where runoff to surface waters or seepage to ground water may occur. This poses the same types of hazards to water quality as animal confinement areas.

How many feedlots are there in Minnesota? MPCA believes that the figure is in the neighborhood of 33-34 thousand that are greater than 10 animal units (AU), with another 2-3 thousand more if you factored in all animal numbers. This figure includes beef, dairy, swine, turkeys, chickens, sheep and some horses. These numbers are estimates, based on best information and then rounded to an appropriate level of accuracy. As more counties conduct inventories, and individual feedlot owners register their sites, there will be a much more accurate picture of the numbers. Registration is due to be completed by January 1, 2002. An animal unit is a unit of measurement that allows comparison of manure production by different types of livestock or poultry. A 1,000 lb. steer is the equivalent of one animal unit.

A 1979 survey conducted by the Minnesota Pollution Control Agency (MPCA) showed that about 10-15% of all feedlots was estimated to be located in shoreland areas. More than 5,000 feedlots in shoreland areas were surveyed in more detail. Analysis of the information collected indicated that virtually all feedlots located in shoreland were pollution hazards. Specifically, only 4.9 percent of feedlots surveyed did not discharge pollutants during a 25-yr/24-hr rainstorm—the "design storm" established by federal and state standards to define "potential pollution hazards" on feedlots.

Data are available from a few Minnesota counties that have conducted feedlot inventories recently. Blue Earth County estimates it has 886 feedlots currently in operation. The primary pollution hazards found by Blue Earth County are unlined earthen basins for hogs. Pollution hazards include unpermitted basins, tile inlet discharges to ditches, overflowing pits or basins, open lot runoff, manure storage in flood plains, unpermitted construction, land application runoff, pumping from basins to surface waters, manure over-application to land, and stockpile runoff. This, as well as surveys of surface waters impaired or threatened by pollution from animal confinement facilities, described further in the Assessment Chapter (Chapter 1) of this document, imply that there are still a substantial number of facilities that pose water quality hazards in Minnesota. The new registration and revised permitting processes under the newly revised state feedlot rules will provide an improved estimate of numbers of feedlots with a pollution potential.

DEVELOPMENTS

Issues related to feedlots and the animal production industry has received much attention in Minnesota recently. Concerns over surface and ground water impairment due to various nonpoint pollution sources, including animal confinement and manure storage facilities, as well as concerns about odors produced by large livestock and poultry confinement and manure storage areas have resulted in considerable press coverage and public interest in these issues.

In 1999, the United States Environmental Protection Agency (USEPA) and the United States Department of Agriculture (USDA) issued a unified strategy for dealing with Concentrated Animal Feeding Operations (CAFO). This strategy sets out goals for increasing compliance and reducing environmental impacts. Regulatory revisions are being proposed by USEPA in the winter of 2000-2001, which will help implement the strategy.

The MPCA Feedlot Rules (Minn. R. ch. 7020) have undergone major revisions, effective October 23, 2000. Major areas of the rule that were changed include:

- a new provision requiring registration of all feedlots over 50 animal units (10 animal units in shoreland),
- inclusion of clear technical standards for feedlots, manure storage, and land application of manure which apply to all facilities (not just those which go through permitting),
- modifications to the permitting process,
- strengthened and clarified requirements for delegated county feedlot programs, and
- a phased-in compliance period for controlling open lot runoff at feedlots less than 300 animal units in size.

In some ways, this rule is not as stringent environmentally as the previous rule had been. The phased-in compliance period for open lots is a loosening of requirements. Also, state permits will not be required for facilities less than 300 animal units, which is different from current practice. However, the total package of the new rule is stronger than the past rule due to strong, clear technical requirements for all sites (whether permitted or not) and the registration program. The technical standards will help ensure that new facilities are built to a higher standard than in the past and the registration requirement will identify existing facilities with pollution hazards and move them toward compliance in a planned and systematic way.

It should be noted that state statutory requirements passed in 2000 made changes to MPCA's authorities, resulting in some program areas that are not consistent with federal rule. Among these provisions are redefinition of animal units, a sixty-day permitting issuance requirement, and a prohibition of special requirements in permits. MPCA has been working with EPA to determine whether these changes are so detrimental that the program no longer meets EPA requirements. No ruling has been reached as of March 19, 2001.

In 1994, legislation established an advisory group called the Feedlot Manure Management and Advisory Committee (FMMAC). This group, comprised of producer groups, environmental groups and manure experts, has advised MPCA on the technical and policy aspects of the rule. FMMAC also has statutory duties to advise MDA and MPCA on research priorities, and has formed several subcommittees to deal with various issues. An example of a subcommittee that did strong work supporting the rule was the land application group. This group made recommendations that were incorporated into the rule and that made the rule much stronger in the areas of protection of surface and ground water. Current work of this group includes advising MPCA on development of a general National Pollutant Discharge Elimination System (NPDES) permit for animal feedlots.

Another directive of the state legislature in 1997 was for the Minnesota Environmental Quality Board to conduct a generic Environmental Impact Statement on Animal Agriculture. This effort, now in its third year, is looking at very big-picture issues relating to livestock production types and their relative environmental, societal, economic and human health impacts. Completion is scheduled for January 2002.

The Minnesota Nonpoint Source Management Program Plan (NSMPP) (1988) describes the requirements for an effective system to address pollution related to animal confinement facilities (feedlots) as follows:

"For the feedlot permit program to be effective, it requires not only good county-state cooperation, but also close coordination between other state and federal agencies involved in feedlot pollution control. The USDA-Farm Service Agency (FSA), USDA-Natural Resources Conservation Service (NRCS), Board of Water and Soil Resources (BWSR), and

MPCA coordinate their animal waste control programs so that federal and state cost-share funds, technical assistance programs, and the state permit program will work together efficiently. The NRCS and BWSR each have cost-share programs to provide incentives to install pollution control practices for animal waste management. The NRCS and Soil and Water Conservation Districts (SWCD) provide technical assistance. The MPCA permit program acts as a catalyst to bring farmers into these programs by establishing a regulatory incentive."

It should also be noted that the MPCA and the Minnesota Department of Natural Resources (MDNR) have entered into a Memorandum of Understanding concerning pollution enforcement. The Minnesota Pollution Control Agency (MPCA) is responsible for regulation of pollution caused by animal confinement facilities in Minnesota, through Minn. R. ch. 7020 and the federal National Pollutant Discharge Elimination System program. Criminal law enforcement investigation authority regarding water pollution and other environmental violations rests with MDNR Conservation Officers, and the Memorandum of Understanding clarifies how they will be used in feedlot enforcement.

Finally, there is a high level of communications between government agencies, research and extension staff, producer groups, and environmental groups in Minnesota. This is due in large part to advisory groups like FMMAC, multi-agency cooperation on projects such as development of uniform recommendations for manure nutrient management, and producer group interest in development of guidance for their members. It is imperative that these lines of communication remain open and are encouraged.

Geographic Areas of the State where Animal Production Issues are of Particular Concern

Minnesota has a number of regions where livestock and poultry production activities are creating, or have the potential to create, significant water quality hazards.
A number of maps of Minnesota have been prepared and will be referred to below:

Figure 7.1 - Ground Water Sensitivity - Susceptibility to Contamination
Figure 7.2 - Livestock Manure - Annual Nitrogen Production, by County
Figure 7.3 – Key Regions of Water Quality Concern – Eastern Minnesota River watersheds, Coteau and Inner Coteàu, Anoka Sandplain, Alluvial and Outwash region, and Karst Region
Figure 7.4 – Major Hydrologic Basins

In general, the highest densities of livestock and poultry are in the southern half of the state (see Figure 7.2). These areas include portions of the Upper Mississippi, Minnesota, Missouri, Des Moines, and Lower Mississippi River watersheds (Figure 7.4). They also include the driftless area characterized by Karst topography, and the Anoka Sand Plain (Figure 7.3).
The Red River, Rainy River, Lake Superior, and the northern half of the Upper Mississippi River watersheds are relatively low in livestock densities, as may be noted by comparison of Figures 7.2 and 7.4.

Runoff from animal confinement or manure storage areas is a potential pollution hazard to surface waters as described in the first Section of this Chapter.

Animal confinement and manure storage areas also have the potential to pollute ground water. The report "Nitrogen in Minnesota Ground Water," 1991, prepared by the MPCA and Minnesota Department of Agriculture (MDA) indicates that there are

Groundwater Contamination Susceptibility (July 1989)

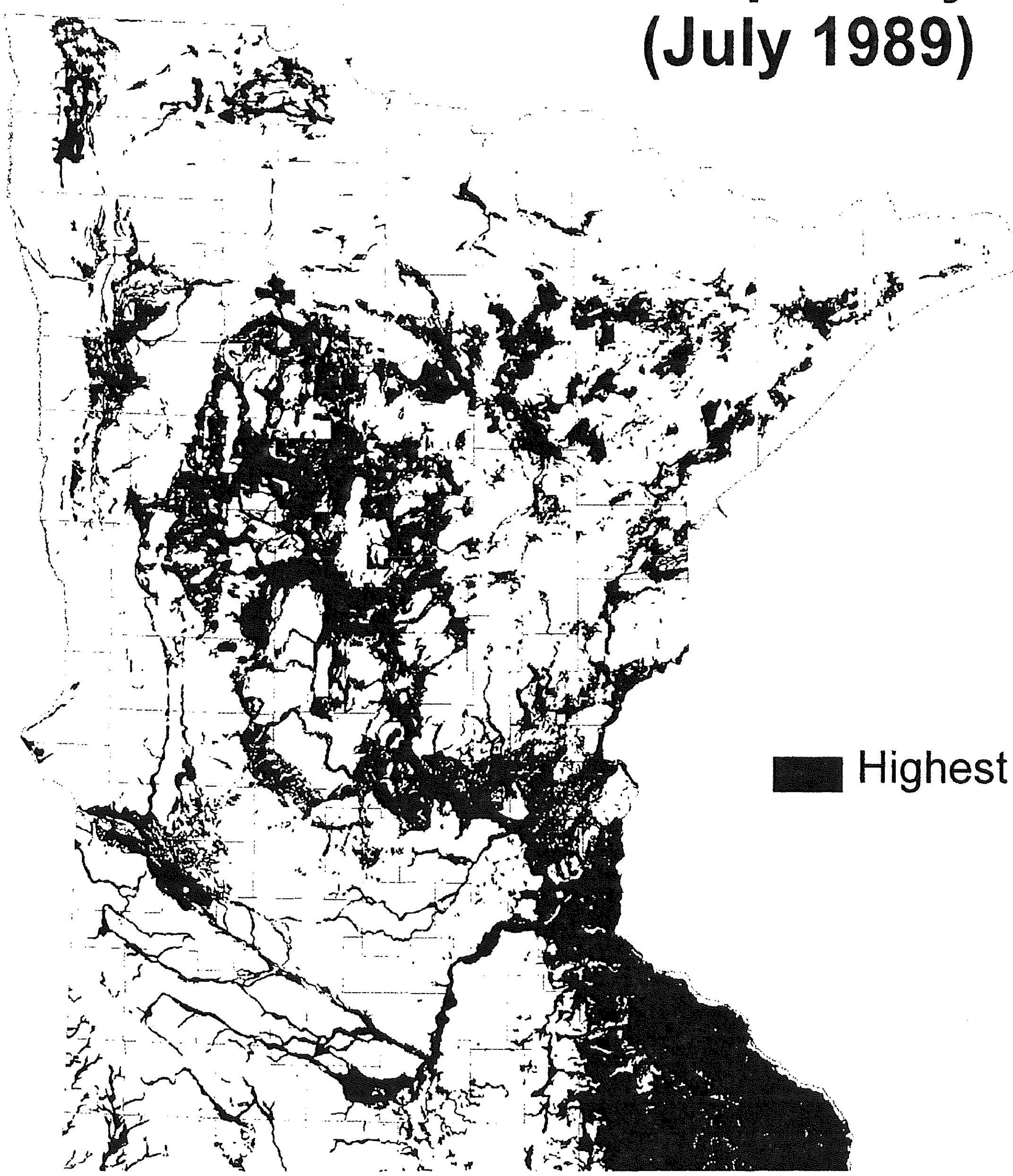

Figure 7.1

Livestock Manure - Annual Nitrogen Production per County

(Beef, Dairy, Hogs, Poultry)
(1997)

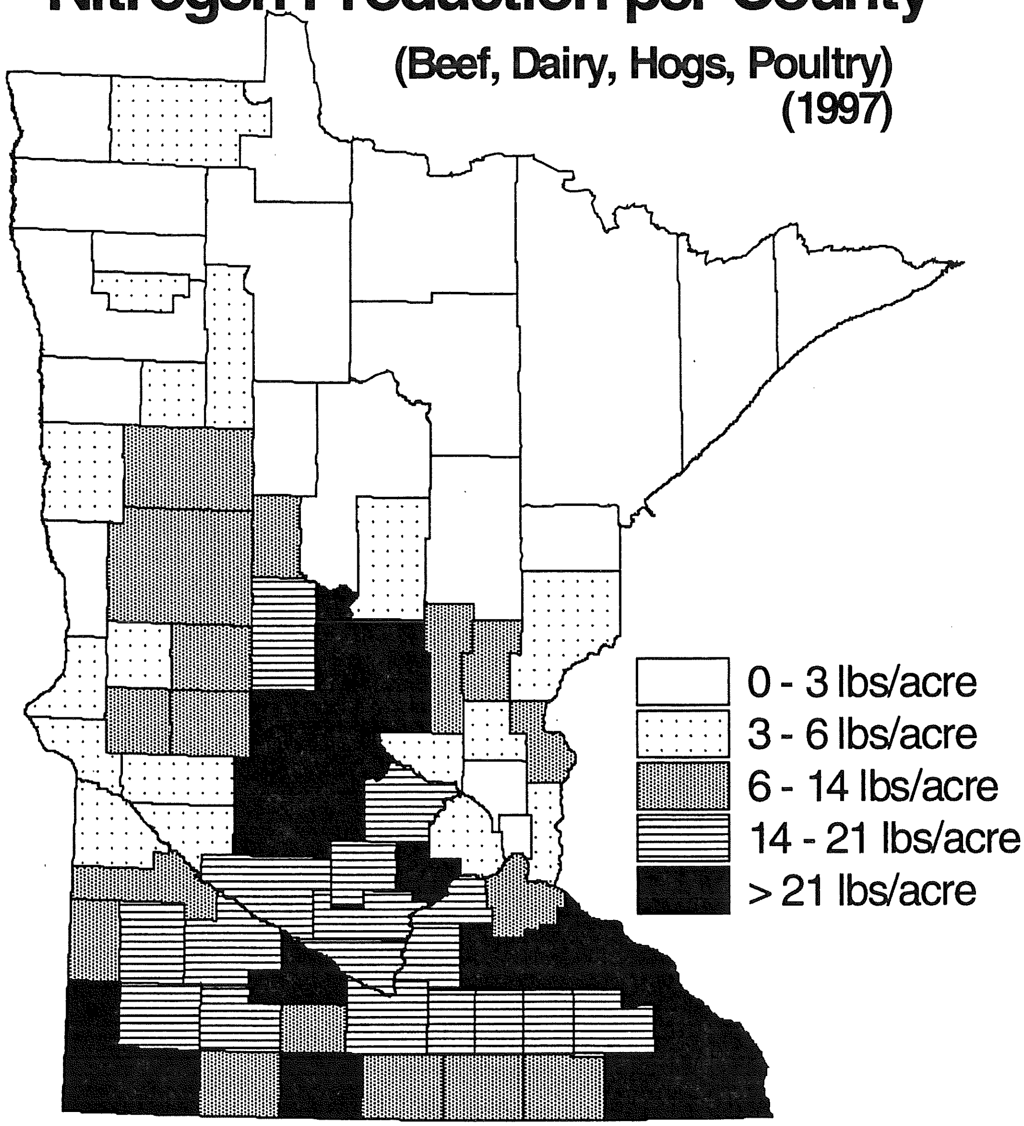

Figure 7.2

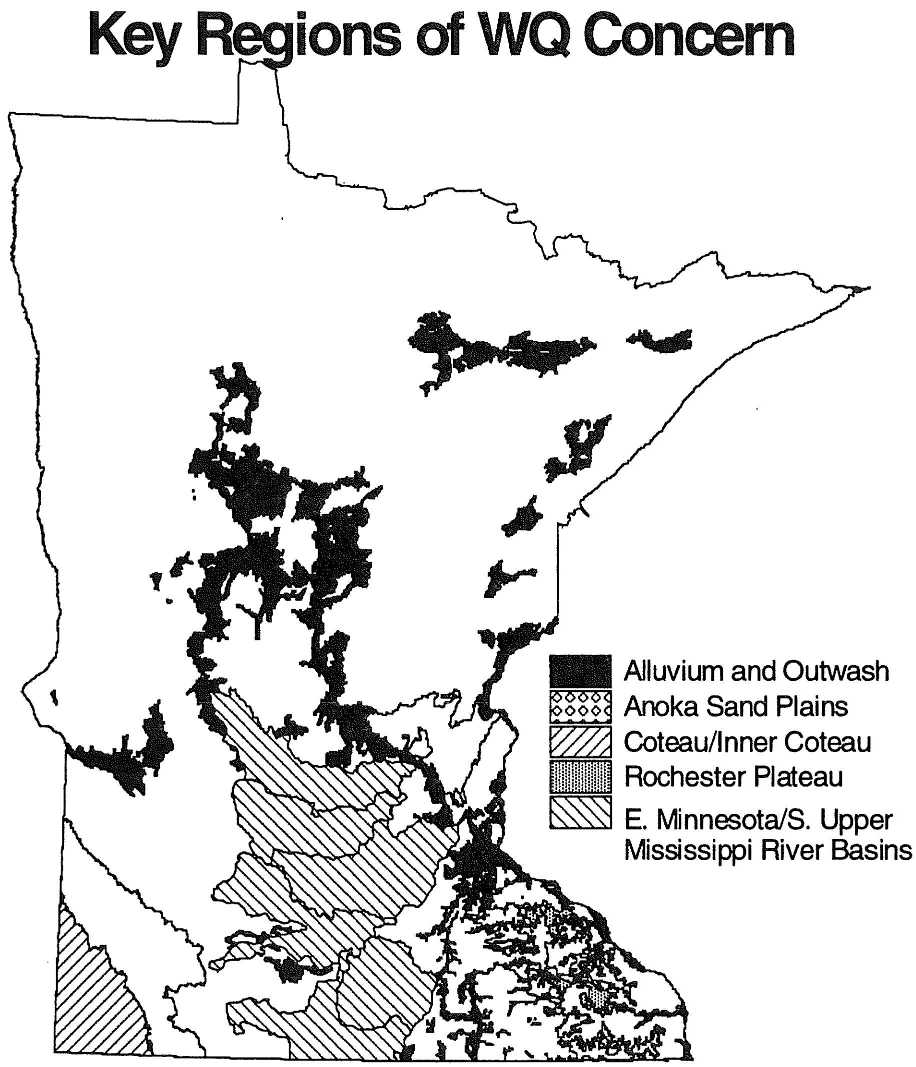
Key Regions of WQ Concern
Alluvium and Outwash
Anoka Sand Plains
Coteau/Inner Coteau
Rochester Plateau
E. Minnesota/S. Upper Mississippi River Basins

Figure 7.3

Major Hydrologic Basins

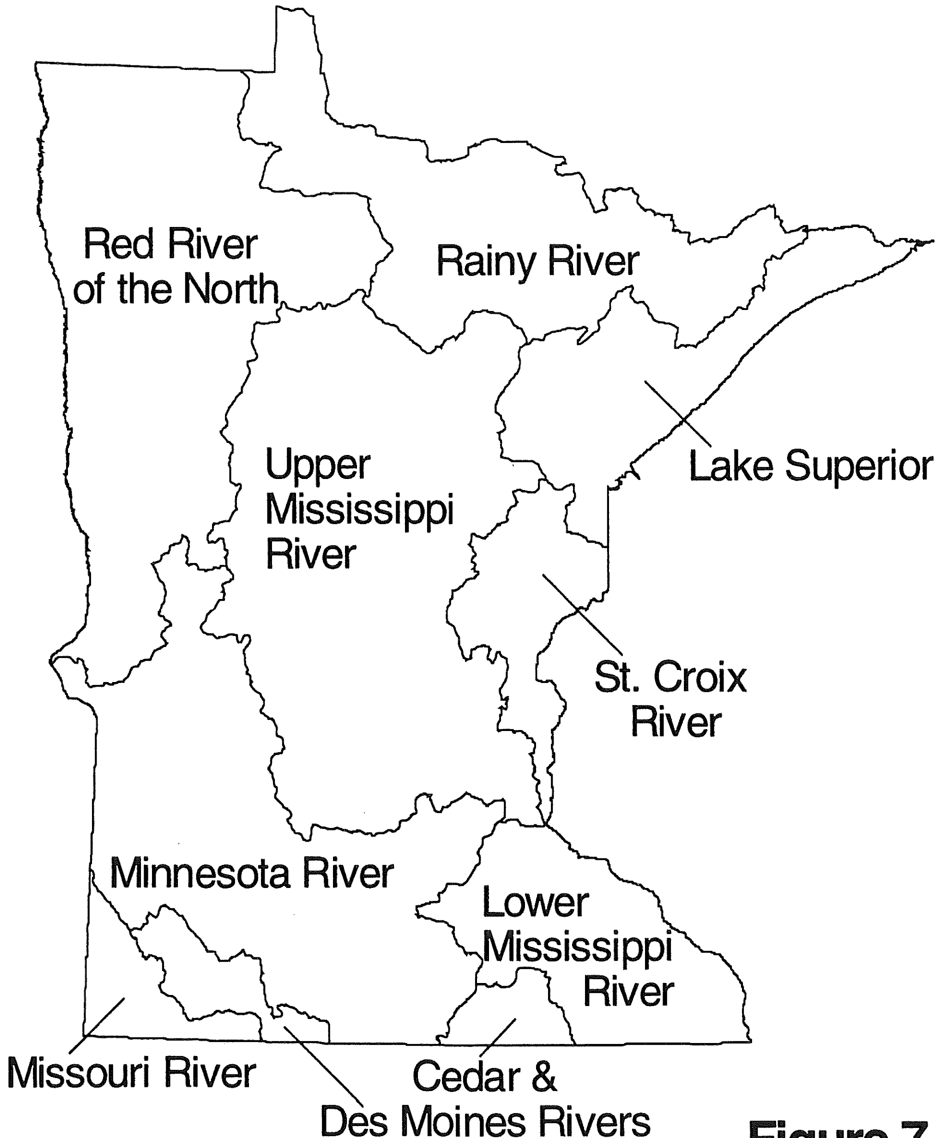

Figure 7.4

many areas of Minnesota where use of ground water as drinking water is impaired by high concentrations of nitrates. Nitrates may come from many sources, among them animal confinement and manure storage areas. This can be seen in a comparison of Figures 7.1 and 7.2, animal density and zones of ground water sensitivity. Some of areas of the state where highest concentrations of animals occur are also in the areas most sensitive to ground water pollution.

Examples of major regions of particular concern in regard to ground and/or surface water pollution are given below. These regions are shown on Figure 7.3.

1. Karst Region - Southeastern Minnesota has many areas that have fractured bedrock within a few feet of the surface. These shallow bedrock layers may serve as aquifers and surface activities, such as livestock production and improper manure management, along with other land management activities, may present pollutants that can be carried quickly through the fractured bedrock from the surface to the aquifer. This area is particularly sensitive in terms of ground water pollution, although the presence of short steep slopes in many areas where livestock are present also presents significant potential for surface water impacts.

2. Anoka Sand Plain - The Anoka Sand Plain, beginning near the northwest corner of the Minneapolis-St. Paul metropolitan area and extending into Stearns, Benton and Sherburne Counties, is characterized by coarse soils and shallow aquifers. These aquifers are easily affected by pollutants leaching from the surface. A number of activities may provide such pollutants, including livestock production and manure management. Over-application of crop nutrients (in particular nitrogen) has been implicated in ground water pollution.

2. Eastern portion of the Minnesota River Watershed and the North and South Fork of the Crow River - Land use in these watersheds is predominantly agricultural. Topography is flat to rolling, and most soils are thick glacial tills and moraines or lacustrine sediments. Heavy precipitation leads to large amounts of runoff or drainage. Runoff from animal production facilities, cropland, and discharge from agricultural drainage tiles, as well as discharge from industrial and municipal treatment plants and improperly constructed septic systems, have negative effects on the river water quality.

3. Coteau and Inner Coteau regions – Southwestern Minnesota has shallow bedrock overlain by soil developed from glacial moraines. Ground water wells installed in shallow alluvial material or the Sioux Quartzite aquifer using poor construction methods are at risk for ground water contamination from surface runoff.

Alluvial and Outwash sediments in Central Minnesota – Drinking water wells overlain by coarse textured soils or in alluvial sediment along river channels in the Upper Mississippi River Basin are vulnerable to leaching of nitrate to ground water.

Currently Applied Best Management Practices (BMPs) and Associated Challenges

The primary potential hazards to water quality associated with animal confinement, manure storage and manure application are:

1. Snowmelt or precipitation runoff carrying both dissolved and particulate material from areas where animals are confined, manure is stored or manure is land applied.

2. Leaching of pollutants into groundwater from areas where animals are confined, or manure is stored or land applied.

Currently applied BMPs to bring feedlots with an existing pollution hazard into compliance with state and federal water quality protection requirements include:

1. Clean water diversions (e.g. rain gutters, waterways and/or roofs).

2. Resizing and management of open lots via fencing and livestock use control.

3. Livestock exclusion from surface water via fencing, prescribed grazing and alternative watering sources.

4. Vegetated buffer areas or vegetated filter strips, often including solids settling and runoff management from open lots.

5. Collection and storage systems for manure and feedlot runoff (e.g. concrete tanks, earthen basins lined with clay and/or man-made liner material, anaerobic manure methane digestion systems, composting or stacking areas for solid manure).

6. Nutrient management for increased profitability and reduced runoff or leaching of nutrients from land where manure is applied.

7. Feedlot relocation.

There are numerous challenges associated with application of these BMPs, including:

1. Maintaining federal, state and local regulations that are effective, workable, compatible, predictable and well understood by the farmers and all those involved with feedlots and water quality protection.

2. Maintaining consistency in the application of regulations and BMPs, while providing appropriate flexibility for site-specific applications. This is primarily a challenge of training and coordination for regulators and technical assistance providers, which involves numerous federal, state and local government staff, as well as private consultants.

3. The vast majority of feedlots with existing pollution hazards are small to medium sized, located in riparian areas and operated by farmers with very limited financial resources. Feedlot pollution abatement often requires substantial capital investment and significant technical expertise. Therefore, there is a great need for technical and financial assistance for application of feedlot BMPs.

4. Identification and application of cost effective alternatives to achieve feedlot pollution abatement, with due consideration of site sensitivity. This challenge involves further development of low cost alternatives, the expertise to know where and how to apply them and the expertise to effectively operate and maintain them.

5. Adoption of more effective procedures, methods, and alternatives to use manure on farms where manure is land applied. Manure is a very good source of nutrients for crop production and organic matter for soil quality improvement. However, effective crop nutrient management using manure as a primary source of nutrients requires a higher level of testing and management than use of commercial fertilizer alone. This challenge involves further research and development of effective nutrient management tools, effective and workable regulations, education to develop understanding and commitment and training to develop the associated expertise of producers, consultants (both public and private) and regulators. The fundamental desired outcome is

more effective use of manure nutrients, which implies reduced use of commercial fertilizer on fields where manure is land applied. Because private crop consultants are key players in this regard, it is desirable to promote the sale of more technical assistance and less commercial fertilizer by crop consultants.

Responsibilities, Roles and Programs

Responsibilities for feedlot-related issues fall into five primary categories – 1) research and technical evaluation, 2) information/training and education, 3) technical assistance, 4) financial assistance, and 5) regulation. The following list outlines the current relevant federal, state, and local programs and authorities.

AGENCY RESPONSIBILITIES

1) Research And Technical Evaluation
Federal: USDA-ARS
State: MN Agricultural Experiment Station
Minnesota Department of Agriculture
Minnesota Extension Service
Minnesota Pollution Control Agency
Minnesota Environmental Quality Board

2) Information/Training/Education
Federal: Natural Resources Conservation Service
State: Minnesota Extension Service
Board of Water & Soil Resources
Minnesota Department of Agriculture
Minnesota Pollution Control Agency
Local: Soil and Water Conservation Districts
Watershed Districts

3) Technical Assistance
Federal: Natural Resources Conservation Service
State: Board of Water & Soil Resources,
MN Department of Agriculture
Local: Soil and Water Conservation Districts
Watershed Districts
Counties

4) Financial Assistance
Federal: Farm Service Agency/Natural Resources Conservation Service
State: Board of Water & Soil Resources
Minnesota Department of Agriculture
Local: Clean Water Partnership Projects

5) Regulation
Federal: Environmental Protection Agency
National Oceanic and Atmospheric Administration
State: Minnesota Pollution Control Agency
Minnesota Department of Natural Resources - Conservation Officers
Local: County Feedlot Programs
County Law Enforcement

AGENCY ROLES

Minnesota Agricultural Experiment Station
- Conduct needed research as identified by industry and agencies to provide an adequate scientific base for proper feedlot siting.
- Provide research that contributes to a reduction of the pollution potential of livestock manure.
- Incorporate livestock issues in farming system and sustainable agriculture research.

Minnesota Extension Service
- Provide leadership to implement educational programs related to feedlots and manure management.
- Cooperate with state and federal agencies in distributing information relating to feedlots through use of the

existing Minnesota Extension Service network.

- Conduct applied research to evaluate and adapt existing and new technologies.
- Cooperate in providing training for local governmental officials that results in a consistent interpretation and application of criteria to evaluate feedlot impacts.

Minnesota Board of Water and Soil Resources

Enable local government units to provide educational, technical and financial assistance to livestock producers for feedlot pollution abatement and proper manure management. Specifically:

- Serve as the administrative agency for the statewide Local Water Planning Program, which is key to definition of local water priorities and integration of local, state and federal water quality programs at the local level.
- Administer state cost-share programs, including feedlot water quality management and other cost-share grants to SWCDs for feedlot pollution abatement. These grants are for both technical and financial assistance.
- Administer the state Nonpoint Engineering Assistance Program, which provides grants to SWCDs for approximately 22 engineers and technicians to provide technical assistance for feedlot pollution abatement and other conservation practices.
- Develop and/or disseminate information and education materials.
- Provide technical and administrative training and assistance to local government units and other partners.
- Coordinate with local government units, other involved state and federal agencies, the University of Minnesota and others to help ensure effective and efficient delivery of education, training and technical and financial assistance.
- Provide a forum for coordination and policy development that fosters effective water and soil resource management through local units of government.
- Provide dispute resolution services for certain state water management laws and programs.

Minnesota Department of Agriculture

- Provide support to, and request the Feedlot and Manure Management Advisory Committee (FMMAC) to serve as a forum to provide stakeholder input into policies for animal agriculture in Minnesota.
- Develop and disseminate information and education materials statewide and participate in multi-agency efforts to provide effective delivery of information and technical resources to livestock producers.
- Assist in the environmental prioritization of targeting state and local funds for environmental upgrades to feedlots.
- Assist producers in the assessment of their environmental, economic and business options during their decision-making process of deciding how to respond to, or comply with state and federal feedlot regulations and programs.
- Conduct research on economically and environmentally viable options for producers to manage livestock waste.
- Develop, evaluate, improve and refine best management practices.
- Provide assistance to local governments in developing local ordinances for feedlots and integrating feedlot planning into local comprehensive plans.
- Where appropriate, working with the MPCA and local governments, deliver information to producers through the MDA Milk Inspectors.
- Provide information and data to assist producers and local governments in the siting of livestock facilities.
- Assist and educate local government units to use and intrepret livestock inventory information.

- Provide education and financial assistance for sustainable agriculture practices such as manure composting.
- Provide financial assistance for animal waste control structures, manure management equipment, abandoned well sealing, and other work that mitigates or prevents nonpoint source pollution.

Minnesota Department of Natural Resources

- Provide enforcement backup through Conservation Officers, including assisting in on-site investigations with uncooperative operators. Criminal law enforcement investigation authority regarding water pollution and other environmental violations rests with MDNR Conservation Officers.
- Investigate fish kills, working with MPCA on kills that involve feedlots.

Minnesota Environmental Quality Board (EQB)

The EQB has been designated the responsible governmental unit for development of a generic environmental impact statement on animal agriculture. This GEIS is to identify the environmental, social, and economic impacts of the evolving animal agriculture industry in Minnesota. In the course of this work, research needs were identified and priorities were set. Research for some of the priorities was funded and others are awaiting funding. The full set of recommendations will be considered by the legislature in the 2002 session.

Farm Service Agency

The Farm Service Agency (FSA), of the U.S. Department of Agriculture (USDA), administers various farm commodity, conservation and environmental protection and emergency programs. The USDA-Natural Resources Conservation Service (NRCS), local Soil and Water Conservation Districts (SWCD), the Forest Service, and State Forest agencies provide technical program guidance to FSA. The University of Minnesota Cooperative Extension Service also provides educational support and planning assistance. FSA provides various forms of payments under several conservation programs. Cost-share and incentive payments are available under the Environmental Quality Incentives Program (EQIP).

Soil and Water Conservation Districts

Enable agricultural producers and other private landowners to be more effective stewards of water and soil resources, including feedlot runoff control and manure management. Specifically:

- Work directly with producers to identify feedlot and manure management problems and potential solutions.
- Provide information and education to producers regarding feedlot best management practices.
- Serve as the employer and local administrator for engineers and technicians employed via the state Nonpoint Engineering Assistance Program.
- Provide technical and administrative assistance to producers for conservation practice design and implementation.
- Coordinate financial assistance for eligible feedlot pollution abatement and manure management practices, including local administration of state cost-share programs and the Agricultural BMP Loan Program.
- Review and determine eligibility and amount of financial assistance for remediation projects under some financial assistance programs.
- Provide construction inspection assistance for practice implementation.
- Periodically monitor operation and maintenance of practices installed with state cost-share.
- Provide advice and assistance to local governments, state agencies, and federal agencies to develop and implement effective environmental programs.

County Feedlot Officer

- Assist the livestock producers with registration and completion of the MPCA feedlot permit application.
- Assist the MPCA with public education on requirements within the livestock industry and to be the contact for the livestock producers and the MPCA.
- Direct producers to potential cost-share programs.
- May develop official controls for manure utilization, application, incorporation, and establish setbacks from potential sources of contamination of manure disposal and the location of feedlots from other land uses where those uses may not be compatible. These controls must be as stringent as the state standards and may impose additional requirements.
- Determine that all state and federal permits have been applied for.
- Conduct inspections, respond to complaints and take appropriate actions to ensure compliance with rules.

Minnesota Pollution Control Agency

- Administer rules regulating animal confinement facilities, including both Minnesota state rules and NPDES permit program. Conduct inspections, respond to complaints and take appropriate actions to ensure compliance with rules.
- Set state standards for control of potential pollution hazards from feedlots.
- Provide technical assistance to county feedlot officers with administration of county feedlot program.
- Provide information, education and technical assistance to producers, consultants, government agency staff and the public.
- Evaluate technical information related to water quality impacts of animal confinement and manure storage facilities.
- Adopt appropriate technical standards for manure storage facility construction and manure nutrient management.
- Maintain records of facilities reviewed for potential pollution hazards.

Natural Resources Conservation Service-USDA

- Provide technical assistance for the planning, investigation, design, and construction of feedlot pollution abatement systems.
- Prepare manure management plans for cooperators.
- With input from others, prepare and maintain technical standards for conservation practices, including pollution abatement components.
- Responsible for certifying the need for and completion of conservation practices for federal cost sharing.
- Provide technical assistance for planning and application of conservation practices for erosion control and water quality improvement on agricultural lands, including practices for pasture and streambank management.
- Administer the Environmental Quality Incentives Program (EQIP). EQIP provides up to 75% cost-share payments ($50,000 limit) to farmers for installation of conservation practices, including animal waste storage structures.

AGENCY PROGRAMS AND ACTIVITIES

Research and Technical Evaluation

Technical expertise to conduct research on manure management and feedlot issues is available at the University of Minnesota, College of Agricultural, Food, and Environmental Sciences, and the Minnesota Agricultural Experiment Station. Technical evaluation is conducted by UM Extension Service faculty and other state and federal staff.

Since 1994, the Feedlot and Manure Management Advisory Committee (FMMAC) has been providing advice on the issues and priorities for research needs on manure management and odor and air quality measurement and mitigation. In 1998, as a result of recommendations from FMMAC members and others, a Generic Environmental Impact Statement (GEIS) on animal agriculture was funded by the state legislature. The GEIS study is continuing.

Areas of priority research needs at the present time are:

- assessment of current practices and problems,
- effectiveness of earthen storage basins to contain liquid manure,
- evaluation of land application practices for crop growth,
- assessment of phosphorus movement under these practices,
- evaluation of health impacts from, measurement of, and mitigation of odor and air quality properties of emissions from feedlots and manure storage areas.
- evaluation of socioeconomic impacts of animal agriculture,
- methodology to site feedlot operations,
- development of additional BMPs to manage and utilize manure,
- evaluation of alternative treatment methods.

Results will be incorporated into future standards and specifications for construction, operation and maintenance of feedlot facilities. It will be important that the research priorities be set on the basis of interaction with local officials and planning staff, so that research can be brought to bear on the critical questions facing producers. The GEIS should provide significant information regarding animal agriculture issues. The FMMAC should continue to carry out its statutory charge to make recommendations on feedlot and manure management research needs.

<u>Information And Education</u>

All federal, state and local government units, and the Minnesota Extension Service have a role in information and education efforts. Training and education to meet these various needs should be carried out in a number of ways, ranging from the development of fliers, information sheets, and/or video tapes, to workshops, seminars, and demonstration projects, and one-on-one contacts between livestock producers and staff from state and local governments. Modular displays for county fairs, local meetings, or other gatherings can be used to communicate on a grass roots level.

The MPCA and MDA are developing a Memorandum of Agreement to guide MDA milk inspectors to help provide information to producers.

Computer programs to assist in the development of manure management plans will assist local conservation officials and will be a direct benefit to producers who have computers available to them. The Minnesota Extension Service should have the leadership role in development of decision aids and educational programming on management and utilization of manure. The development of decision aids and educational programming on management and utilization of manure should include input from producers and other private and public agricultural professionals.

Prevention of pollution from animal manure requires not only appropriate pollution control facilities, but good management as well. Many of the practices that prevent pollution from animal manure also maximize its value as fertilizer and provide a financial benefit to the producer. Further education and training is needed for producers to increase the implementation of such practices.

County Feedlot Officers, zoning officials, water planning staff, and other local officials could benefit from additional training to identify feedlot pollution problems and to be able to effectively administer programs and projects designed to control nonpoint source (NPS) pollution from animal feedlots. In addition, private crop consultants who work with livestock producers must be knowledgeable about the utilization of manure for its nutrient value.

There is also a need for farmers, farm lenders, realtors and others involved in agriculture to become more knowledgeable of the MPCA Feedlot Permit requirements. The rule revisions change the requirements for permitting significantly, and producers need to be aware of what types of activities require permits. Agencies should also consult with producers, custom applicators, contractors, and other private professionals that work closely with producers.

Technical Assistance

Technical assistance is provided for application of feedlot pollution control systems (e.g. structural and management practices) at the county level and technical training and support at the regional and state level. Those currently providing assistance at the county level are the NRCS, SWCD's and UM Extension. Assistance provided at the county level consists of:

1) inventory and evaluation,
2) planning for structural and management practices,
3) site inspections,
4) design,
5) implementation, and
6) operations and management follow-up.

At the regional or state level, assistance provided by the support staffs include training, development of standards and technical aids, direct assistance for complex problems, technical review and approval of designs.

Manure storage structures must be designed by a professional engineer or designed under the NRCS Engineering Job Approval Authority. The State of Minnesota Board of Architecture, Engineering, Land Surveyors and Landscape Architects regulates this. NRCS may not delegate that authority to non-NRCS employees. However, a registered professional engineer who works for other agencies or as a consultant can do this design work. Consultants can do work under the EQIP Program with NRCS review. Interest in this work by engineers outside NRCS has not been widespread in the past, but is increasing.

At the present time, the demand for technical assistance for the design of animal manure pollution control facilities and manure utilization planning exceeds the capacity of the agencies involved. With an increase in environmental awareness, it is expected that the demand for technical assistance on animal manure pollution control systems will remain at a high level.

NRCS is required to approve all designs for systems that are cost-shared through the EQIP program. A system that is not cost-shared does not require NRCS approval, and would be a lower priority for NRCS assistance than cost-shared systems and would not likely receive technical assistance. Technical assistance for systems may also be provided by professional engineers working for consultants or other agencies. When federal cost-share funds are involved, consultant-prepared plans must be reviewed by NRCS.

Program needs are staffing, training, design standards and methods, engineering supervision and approval, and technical assistance for non-cost-shared work.

Staffing levels need to be increased to match technical assistance needs. At this time, availability of technical assistance at the county level limits design and construction of feedlot pollution control systems. However, if staffing is increased at the county level, an increase at the regional and state levels will also be needed for training and technical support. Funding sources for increased technical assistance must be identified and developed. Funding for additional technical assistance should be directed to high priority areas of the state. The BWSR successfully sought a position (using funds from the USEPA Section 319 Program) to assist SWCD staff with training and technical support for design and construction of pollution abatement systems. Additional efforts such as these should be encouraged.

Training of both existing and new staff must be provided to make the most efficient use of limited technical and financial assistance. This training should be focused on both structural and management practices and be coordinated among all cooperating agencies.

Technical design standards and methods need to be developed and improved to more efficiently provide assistance to cooperators. NRCS standards need to be evaluated and updated to reflect current technology, and environmental concerns. Existing tools and models used to assess pollution potential from feedlots need to be reviewed and updated.

Current systems used to model potential pollution from livestock facilities do not provide an adequate assessment of potential ground water pollution. In addition, software to improve efficiency and uniformity of structural designs has been identified as a high priority need.

Technical decision aids are needed for the development of agricultural manure management plans. The Minnesota Extension Service, together with NRCS, BWSR, and MPCA developed a technical training manual on manure management that is accompanied by a computer program to assist in the development of these plans. By standardizing manure management recommendations between these various agencies in this way and by providing tools such as the computer program, staff time devoted to developing manure management plans and confusion on the part of producers has been reduced.

This computer program needs further development to make it easier to plan manure management over a number of years and a larger variety of field conditions.

Technical assistance for non-cost-shared work is almost nonexistent at this time. Improperly designed and constructed systems can present a serious pollution hazard. Additional guidance for consultants and contractors working on pollution abatement and manure storage and handling systems would be helpful. Minnesota Extension Service, in cooperation with other agencies, could provide training and support to these professionals.

Financial Assistance

The Environmental Quality Incentives Program (EQIP) provides financial assistance in the form of cost sharing and incentive payments to farmers for applying conservation practices on their land. At least half of this assistance must be targeted toward livestock related practices. These include waste management systems and grazing systems. Cost sharing is not available for operations of 1,000 animal units or larger. Contracts are awarded on a competitive basis and can result in the operator receiving up to 75% cost share, totaling up to $50,000 for the 5 to 10 year contract. Technical assistance on EQIP practices is provided by NRCS, SWCDs, MDNR, and the U.S. Forest Service.

The state cost-share programs administered by the BWSR provide financial assistance through local Soil and Water Conservation Districts (SWCD), including feedlot pollution abatement systems. Clean Water Partnership (CWP) grants from the MPCA may provide funding for correction of pollution problems associated with CWP projects.

The MDA's Energy and Sustainable Agriculture Program provides grants and loans on a competitive basis to support sustainable agriculture practices, such as alternative livestock production systems, on-farm composting, manure utilization, and testing. The grants are for up to $25,000 and the loans are up to $15,000 per farmer and up to $75,000 for groups of farmers.

These existing programs help pay part of the cost of pollution control facilities for livestock and poultry operations and have proven to be very successful. However, there appear to be some gaps in these programs. For instance, some livestock facilities are located at sites where the cost of correcting existing pollution problems exceeds the appraised value of the facility. In such cases, it may be most reasonable to have the state purchase the farm, or possibly purchase an easement restricting the use of the facilities to house livestock or poultry, rather than invest substantial amounts of public money in the corrective measures. However, there are no existing programs that would fund this option.

Another program that in the past provided valuable incentives for construction or purchase of pollution control facilities and equipment was a 10 percent state income tax credit on such expenditures. This program was eliminated. It had provided over $1,000,000 per year in assistance to farmers. Efforts should be made to either restore the program, or to replace the lost pollution control funds by increasing funds directed to state cost share programs.

The State Revolving Fund (SRF) program provides low interest financing through the MDA's Agricultural BMP Loan Program for installation of animal waste control facilities and manure management equipment for operations with less than 1,000 animal units. The Minnesota Legislature has also contributed additional funds for feedlot upgrades through this program. These funds are available through the local government or local Soil and Water Conservation District. The Rural Finance Authority can provide loans to qualifying individual for feedlot improvements.

Cost share funds are available through the PL-566 program to treat potential pollution problems related to feedlots and animal wastes. Animal waste problems and solutions would need to be identified in the approved watershed plan and funding would need to be received from USDA to implement these practices.

Regulation - Permitting and Enforcement

State rules regulating feedlots have been in effect since 1971, were revised in 1979 and again in 2000. These rules give authority to the MPCA to control pollution from livestock facilities, and to delegate authority to county government for non-NPDES permitting. NPDES permits are required for all facilities with 1000 or more animal units under state law; the others are regulated through state authorities and are considered to be nonpoint sources.

The purpose of the MPCA feedlot program is to review facilities for their potential water pollution hazards so that existing problems may be identified and corrected, or potential hazards with new facilities can be prevented prior to construction. Authority to administer this program for certain facilities can be delegated to county government.

In the process, producers must submit information regarding their livestock facilities and manure management. Both existing and proposed livestock facilities are reviewed for potential water pollution hazards. If pollution hazards are created by existing facilities, the MPCA requires that these hazards be corrected within twenty-four months of issuance of a MPCA interim permit, unless it is not possible for technical reasons to correct the pollution problem within this time. For more difficult problems, the MPCA may allow up to five years for correction using a State Disposal System (SDS) permit.

Existing facilities that meet the technical standards of the rule and do not propose to expand or change do not need permits, but they must register their operation with the state or delegated county. State permits are not required for construction or expansion of facilities with less than 300 animal units as long as the technical requirements of the rule are met. Correcting pollution hazards at these smaller sites may require an interim permit.

At present, there are an estimated 33,000 facilities regulated under the MPCA feedlot rules. Approximately 16,000 facilities have received permits or certificates issued by the MPCA or county feedlot officers since 1971. An average of 400 to 500 feedlot permit applications are received annually by the MPCA.

In the majority of cases where existing feedlot pollution problems must be corrected, producers work cooperatively with the MPCA, making use of cost-share and technical assistance programs through the SWCDs, BWSR and NRCS. This approach, and the availability of assistance programs, helps to make the correction of pollution problems relatively straightforward for the producer. However, enforcement tools are available to enforce state feedlot regulations should cooperative efforts fail to resolve a pollution problem.

Manure storage capability and having adequate land available to allow maximum utilization of nutrients need to be goals for livestock producers. Incorporation of these components in the planning and permitting process could provide management, economic and water quality benefits.

Participation of counties in the feedlot program through administration of the MPCA county feedlot program provides an excellent mechanism for the county to coordinate planning and zoning efforts with feedlot permit issuance. In addition, cost-share and technical assistance programs are administered at the county level, so local needs and efforts on feedlot pollution control may be efficiently administered through county staff coordination, reducing the number of agencies the producers must deal with.

There are two primary reasons why counties have chosen not to administer this program:

1) lack of funding for the required staff, and
2) lack of support from the county board to regulate agricultural practices. Education of local government staff, livestock owners and the general public on issues related to feedlot pollution problems may help resolve the lack of support for county feedlot programs. It is hoped that continued state funding for county programs will substantially increase the number of counties participating in the program. Currently, 54 counties are delegated.

Finally, USEPA's National Pollutant Discharge Elimination System Program for feedlots is administered by the MPCA, resulting in the requirement of all producers housing more than 1000 animal units to apply for a NPDES permit. Currently 26 Minnesota feedlots have NPDES permits. Under the revised program, up to 800 facilities may be required to obtain a NPDES permit. MPCA has developed a general permit for livestock production facilities. The general permit has been designed to cover most facilities with $\geq$1000 animal units that meet the standards of Minn. R. ch. 7020, except those with current discharges, past enforcement history and where special considerations result in additional conditions needed in the permit.

BEST MANAGEMENT PRACTICES (BMP)

The following Best Management Practices (BMP) are commonly used to reduce nonpoint source pollution from feedlots. This list is not comprehensive and does not suggest additional BMPs would have no benefit but, is provided to highlight the more common BMPs for feedlots.

Please refer to Part I Agricultural BMPs, Part II Erosion and Sedimentation BMPs and Part III Other Cultural and Structural BMPs included in Appendix B of this 2001 NSMPP for definitions of the following BMPs.

Part I Agricultural BMP's
8 Critical Area Planting
10 Deferred Grazing
11 Diversion and Terraces
12 Fencing
17 Grassed Waterway or Outlet
21 Lined Waterway or Outlet
22 Use Exclusion
23 Nutrient Management
25 Pasture and Hayland Management
26 Pasture and Hayland Planting
28 Prescribed Grazing
33 Riparian Buffer
34 Shade Areas
36 Soil Testing and Plant Analysis
41 Vegetative Filter Strip
42 Waste Management System
43 Waste Utilization
44 Water and Sediment Control Basin
45 Water/Feeder Location

Part II: Erosion and Sediment Control BMPs
8 Filter Strips
12 Level Spreader
24 Subsurface Drain
50 Rooftop Runoff Disposal
51 Storage/Treatment Facilities
52 Underdrain Storm Water Filter Systems

Part III: Other Cultural and Structural BMPs
55 Compost Production and Use
59 Lane Absorption Areas and Use of Natural Systems
60 Maintain Set Backs From Surface Waters

Chapter 7 Feedlots
Needs, Priorities and Milestones, 2001-2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) 5-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Goal 1: To Further Develop and Maintain Forums for Communication between Agencies and Groups with Interests and Responsibilities Related to Animal Production, Manure Management, And Related Aspects of Pollution Control.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. FMMAC meets on a regular basis to review rule changes and problems.	X	X	X	X	X	MPCA, MDA.	MDA, MPCA.
2. Continue use of task forces for review of specific issues as they arise, such as earthen basin standards, manure stockpiling issues, land application of manure, alternative methods of runoff treatment, and effects of turkey ranges on ground water.	X	X	X	X	X	MPCA, MDA.	MPCA
3. MDA, NRCS, UMES, others work with the NRCS CNMP and phosphorus task forces as policy recommendations are made.	X	X	X	X	X	NRCS, 319.	MPCA, MDA.

Goal 2: Establish, Maintain or Improve Effective Education and Technical Assistance Programs to Provide Consistent Information Regarding Water Quality Impacts from Animal Confinement and Manure Storage Facilities. Targeted Program Audiences would Include Producers; Contractors; Federal, State and Local Government Agency Staff; Educators and Consultants. Local Staff Include CFO's, Zoning Officials, Water Planning Staff, etc.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Distribute statewide guidance and information materials for producers regarding: - regulatory programs; - technical and financial assistance programs; - BMPs for water quality protection from animal production activities, such as filter strips and controlled grazing.	X	X	X	X	X	319, MDA.	MPCA, MDA, BWSR, NRCS, UMES.
2. Periodic (e.g. annual) training sessions for target audiences (including agency staff) on the issues such as: - regulatory programs; - financial and technical assistance programs; - BMPs for manure storage, treatment and land application; - assessment and inspections of animal confinement and manure storage facilities for potential pollution hazards; - strategies for resolution of pollution hazards; - design and construction of manure storage structures and pollution abatement systems; - alternative methods of pollution abatement or prevention; - relative costs of various types of pollution abatement and manure management systems.	X	X	X	X	X	319, MPCA.	MPCA, MDA, BWSR, NRCS, UMES.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
Commercial manure applicator certification program Audiences should include producers, federal, state and local government agency staff; lenders; realtors; equipment sales staff; consultants; extension service staff; contractors; and others interested in these issues.							
3. Coordinate preparation and development of guidance and information materials on manure management with ongoing committees and task forces.	X	X	X	X	X	MDA, NRCS.	MDA, MPCA, UMES, NRCS.
4. Develop and distribute guidance materials for local government on planning and zoning issues related to construction of animal production facilities.	X	X	X	X	X	MDA	MDA, UMES, BWSR, MPCA.
5. Develop process to evaluate effectiveness of feedlot education, information and technical assistance programs and activities.	X	X	X	X	X	319, BWSR, UMES.	MPCA, BWSR, UMES.
6. Provide private consultants with information about requirements for development of pollution abatement systems under federal and state cost-share programs and feedlot regulations.	X	X	X	X	X	319, MPCA, NRCS.	NRCS, FSA, UMES, BWSR, MPCA.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
7. Develop training programs for consultants and contractors on: - earthen basin design and construction - concrete pit design and construction - manure stockpile area design and construction; and - vegetated filter strip design and construction	X	X	X	X	X	319, MPCA.	MPCA, NRCS, UMES.
8. Identify and promote new partnerships and improved methods for delivery of technical assistance to producers	X	X	X	X	X	State	BWSR, MPCA, NRCS, MDA.
9. Evaluate need for and seek funding and approval for additional staff to provide technical assistance to producers in design of pollution abatement systems.	X	X	X	X	X	State, NRCS.	BWSR, MPCA, MDA, NRCS.
10. Promote use of alternative animal production methods as a means of pollution prevention such as controlled grazing of pastures.	X	X	X	X	X	State, NRCS, 319.	MDA, MPCA, NRCS, UMES, BWSR.

Goal 3: Increase and Improve the Information and Options Available for Design and Assessment of Animal Confinement and Manure Storage Areas to Minimize or Eliminate Impacts on Water Quality.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Research and evaluate ground and surface water effects of vegetated filter strips used for treatment of manure-polluted water.			X	X	X	NRCS, EPA, CSREES.	U of M, NRCS, MPCA, MDA.

	2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
2.	Research and evaluate effects of earthen basins and other types of manure storage structures or areas (e.g. concrete pits and stockpile areas) on ground and surface water.	X	X	X	X	X	NRCS, EPA, CSREES, USGS.	U of M, NRCS, MPCA, MDA, USGS.
3.	Evaluate the Feedlot Evaluation Model computer program as used in regulatory programs, and develop a more effective ground water evaluation component.		X	X			319	MPCA, BWSR, NRCS, U of M.
4.	Develop a survey of existing management practices and attitudes regarding animal manure collection, storage and utilization.	X	X	X	X	X	319	MDA, MPCA.
5.	Review standards and recommendations on animal waste management to ensure that these documents reflect current knowledge and research in Minnesota or areas similar to Minnesota.	X	X	X	X	X	EQB	MPCA, MDA, UMES, NRCS, BWSR.
6.	Research and evaluate alternative ways to treat manure, feedlot runoff and dead animals.	X	X	X	X	X	319	MDA, UMES, BWSR, MPCA.
7.	Develop software to improve efficiency and uniformity of structural designs for manure storage structures.		X	X			319	MPCA
8.	Compile an inventory of livestock and poultry facilities.		X				MPCA, 319.	MPCA
9.	Evaluate need for research on water quality impacts of abandoned feedlots and manure storage areas.	X	X	X	X	X	EQB, MPCA.	U of M, MDA, MPCA.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
10. Continue research on:							
-Precision manure application	X	X	X	X	X	MDA	U of M
-Alternative surface tile inlets	X	X	X	X	X	319	MPCA, MDA, UMES.
-Pathogen identification with biotechnology methods	X	X	X			LCMR, 319.	MPCA, U of M.
-Development of a phosphorus index	X	X	X	X	X	319, State, EPA, CSREES.	USDA, U of M, MDA, MPCA.
-Determine impacts of antibiotics, pharmaceuticals, and endocrine disrupters in surface waters.	X	X	X	X	X	NIH	NIH, U of M.

Goal 4: To Establish Flexible Programs for Financial Assistance Used to Correct Pollution Hazards from Animal Confinements and Manure Storage Areas

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Examine and develop sources of funding for: - installation of pollution control systems - relocation or retirement of facilities where correction of pollution hazards is not practical or economical - purchase of easements restricting use of facilities to prevent further pollution (with consent of landowner) (with consent of landowner)	X	X	X	X	X	319, EQIP, other state funding.	MDA, BWSR, NRCS.
2. Identify sources and increase funding used to provide technical assistance for design of pollution control facilities	X	X	X	X	X	319, State.	BWSR, MDA.
3. Assess and, if appropriate, develop programs to provide tax credits for installation and use of pollution control systems	X	X	X	X	X	State	MPCA, Minnesota Department of Commerce, legislature.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
4. Provide low cost loans to feedlot operators for pollution remediation through the AgBMP Loan Program with funds from the State Revolving Fund or from state appropriations.	X	X	X	X	X	State	MDA, MPCA.
5. Review and improve the delivery system of the AgBMP Loan Program.	X	X	X	X	X	State	MDA
6. Expand availability of loan programs to all facilities requiring remediation.	X	X	X	X	X	State	MDA, BWSR.
7. Examine other opportunities for financial, technical or business assistance.	X	X	X	X	X	EPA, USDA, State.	All Agencies.
8. Improve methods to prioritize utilization of financial assistance.	X	X	X	X	X	USDA, State.	MPCA, MDA, BWSR.

Goal 5: To Provide Clear, Consistent Guidance and Requirements Related to Control of Pollution from Animal Confinement and Manure Storage Facilities.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Assess and when necessary revise current standards for construction of manure storage facilities	X	X	X	X	X	State, NRCS.	MPCA, UMES, NRCS, BWSR.
Promote adoption of feedlot permit program; administration by counties with appropriate accountability for counties	X	X	X	X	X	MPCA	MPCA
3. Develop programs and formats to coordinate non-NPDES regulatory and enforcement activities among responsible agencies (e.g. MPCA, MDNR, counties).	X	X	X	X	X	MPCA, MDNR, MDA, 319.	MPCA, MDNR, MDA.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
4. Increase awareness of regulations and requirements through integration into information and education programs.	X	X	X	X	X	319	UMES, MPCA, MDA, NRCS, BWSR, MDNR.
5. Assess structure of delivery of MPCA feedlot permits, examining central and regional office roles and county staff responsibilities.	X	X	X	X	X	319	MPCA
6. Examine financial effects of regulatory programs and develop strategies to minimize financial impacts on producers.	X	X	X	X	X	319	MPCA, MDA, BWSR.
7. Assess need for change of environmental review process of animal confinement facilities by Environmental Quality Board and develop recommendations for improvement.	X	X				319	MPCA, EQB

Goal 6: To Develop Strategies and Plans for Program and Policy Development which Resolve Current Issues and Anticipate Future Issues Related to Pollution from Animal Production.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Assess impacts of large animal facilities on communities (e.g. greater than 1000 animal units).	X	X				319, EQB.	EQB, U of M, MDA, BWSR, MPCA.
2. Develop strategies to identify sites most suitable for animal agriculture and least environmentally sensitive.	X	X	X	X	X	319, EQB.	EQB, MDA, MPCA, BWSR, U of M.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
3. Identify strategies and options for addressing odors from animal production facilities, and evaluate the effectiveness of current state regulations on odors from animal production facilities and activities.	X	X	X	X	X	EQB, State.	EQB, MPCA, U of M, MDA.
4. Develop and distribute aids and guidance for local government to address planning and zoning issues related to animal production facilities.	X	X	X	X	X	MDA	MDA, EQB, U of M.

1994 NSMPP
Needs, Priorities and Milestones

The following Table provides the Goals and Action Steps included in the 1994 Nonpoint Source Management Program Plan (NSMPP). The Products, Services and Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps.

Goal 1: To Further Develop and Maintain Forums for Communication between Agencies and Groups with Interests and Responsibilities Related to Animal Production, Manure Management, And Related Aspects of Pollution Control.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Establish Feedlot and Manure Management Advisory Committee (FMMAC) in response to recent legislation. This committee will replace the informal advisory group known as the Feed Lot Advisory Group (FLAG). The primary purpose of this advisory committee is to receive input from affected parties outside of government regarding programs and policies related to feedlot and manure management. Meetings will likely be held quarterly or as needed.	MPCA, MDA.	MPCA, MDA, BWSR.	FMMAC was established in 1994 and meets regularly. The FMMAC has advised on improvements to the feedlot rules, research and strategies for odor measurement and mitigation and other research needs.
2. Continue use of task forces for review of specific issues as they arise, such as earthen basin standards, manure stockpiling issues, land application of manure, alternatives methods of runoff treatment, manure storage in karst areas, and effects of turkey ranges on ground water.	MPCA, MDA, BWSR, UMES.	MPCA, MDA, UMES.	Ongoing efforts of FMMAC and others.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Establish and formalize a Feedlot and Manure Management Coordinating Committee (FMMCC) to coordinate efforts of the various state and federal agencies involved in these issues.	MPCA	MPCA, MDA, BWSR.	This effort is done through FMMAC, with continued formal and informal coordination between agencies.
4. Develop a system of "one-stop shopping" for producers required to apply for permits for construction and operation of animal confinement facilities.	MPCA, MDA, BWSR.	MPCA, MDA, BWSR.	Revisions to MN Rule Chapter 7020 allow counties to handle all permitting activities up to 1000 animal units, making the delegated county a "one stop shop" for most of the feedlot permitting work in that county.

Goal 2: Establish, Maintain or Improve Effective Education and Technical Assistance Programs to Provide Consistent Information Regarding Water Quality Impacts from Animal Confinement and Manure Storage Facilities. Targeted Program Audiences would Include Producers; Contractors; Federal, State and Local Government Agency Staff; Educators and Consultants. Local Staff Include CFO's, Zoning Officials, Water Planning Staff, etc.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Distribute statewide guidance and information materials for producers regarding: - regulatory programs; - technical and financial assistance programs; - BMPs for water quality protection from animal production activities, such as filter strips and controlled grazing;	MPCA, MDA, BWSR, NRCS, UMES, 319.	MPCA, MDA, BWSR,	Ongoing. The Internet is a valuable tool for this sort of work, and is being used increasingly effectively.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
2.	Periodic (e.g. annual) training sessions for target audiences on the issues such as: - regulatory programs; - financial and technical assistance programs; - BMPs for manure storage, treatment and land application; - assessment and inspections of animal confinement and manure storage facilities for potential pollution hazards; - strategies for resolution of pollution hazards;	MPCA, MDA, BWSR, NRCS, UMES, 319.	MPCA	Ongoing. Training is a key component of rule revision implementation at MPCA. Recent 319 grant allows UMES to provide grants and training to local officials so they can put on county-based producer workshops to educate on the new requirements. Joint training for regulatory and technical assistance staff is ongoing.
	- design and construction of manure storage structures and pollution abatement systems; - alternative methods of pollution abatement or prevention; - relative costs of various types of pollution abatement and manure management systems. Audiences should include producers, federal, state and local government agency staff; lenders; realtors; equipment sales staff; consultants; extension service staff; contractors; and others interested in these issues.	MPCA, MDA, UMES, 319.	MPCA, MDA, BWSR.	
3.	Coordinate preparation and development of guidance and information materials on manure management with Agricultural Nutrient Management Team.	MDA	MDA, MPCA, UMES,	Not Done.
4.	Develop and distribute guidance materials for local government on planning and zoning issues related to construction of animal production facilities.	MDA, UMES, BWSR, 319.	MDA, MPCA, UMES, BWSR.	Ongoing.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
5. Develop process to evaluate effectiveness of feedlot education, information and technical assistance programs and activities.	BWSR, MDA, NRCS, 319.	BWSR, MDA, MPCA.	Not Done, but will be a key feature of the new MPCA feedlot program. MPCA staff has worked with consultants from the Green Mountain Institute to establish appropriate measures of effectiveness for the MPCA feedlot program as administered with their regulatory partners.
6. Provide private consultants with information about requirements for development of pollution abatement systems under federal and state cost-share programs.	MPCA, MDA, BWSR, UMES, NRCS, 319.	MPCA, MDA, BWSR, UMES, NRCS.	Ongoing.
7. Develop training programs for consultants and contractors on: - earthen basin design and construction; (Ongoing) - concrete pit design and construction;(Ongoing) - manure stockpile area design and construction; and - vegetated filter strip design and construction.	NRCS, FSA, UMES, BWSR, MPCA, 319.	MPCA, NRCS.	Earthen basin and concrete pit design and construction training programs are ongoing. Manure stockpile and some vegetated filter strip activities are not done. FLEVAL training addresses filter strip analysis.
8. Identify and promote new partnerships and improved methods for delivery of technical assistance to producers.	BWSR, UMES.	MPCA, BWSR, UMES, NRCS.	Ongoing (Joint Powers Engineers).

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
9. Evaluate need for and seek funding and approval for additional staff to provide technical assistance to producers in design of pollution abatement systems.	BWSR, MDA, UMES.	MPCA, MDA, BWSR, UMES.	Ongoing.
10. Promote use of alternative animal production methods as a means of pollution prevention such as controlled grazing of pastures.	MDA, MPCA, 319, NRCS, UMES, BWSR.	MDA, MPCA, BWSR, NRCS.	Ongoing.

Goal 3: Increase And Improve The Information And Options Available For Design And Assessment Of Animal Confinement And Manure Storage Areas To Minimize Or Eliminate Impacts On Water Quality.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Research and evaluate ground and surface water effects of vegetated filter strips used for treatment of manure-polluted water.	State (LCMR).	USGS	Draft report completed, with final report to be published by USGS.
2. Research and evaluate effects of earthen basins and other types of manure storage structures or areas (e.g. concrete pits and stockpile areas) on ground and surface water.	MDA, MPCA.	MPCA, USGS, U of M.	MPCA draft report, March 2001, "Effects of liquid manure storage systems on groundwater quality." USGS Water Resources Investigation Report 99-4206 (J. F. Ruhl), 1999, "Quantity and quality of seepage from two earthen basins used to store livestock waste."

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Evaluate the Feedlot Evaluation Model computer program for uses in regulatory programs, and develop a more effective ground water evaluation component.	MPCA, NRCS, 319.	MPCA	The Feedlot Evaluation Model has been evaluated for use in the recent rule revisions, but the ground water component has not been improved.
4. Develop a survey of existing management practices and attitudes regarding animal manure collection, storage and utilization.	MDA, UMES, 319.	MDA	FANMAP of MDA performs detailed, limited area surveys of nutrient management practices. A UM Extension survey reviewed manure management practices.
5. Review standards and recommendations on animal waste management to ensure that these documents reflect current knowledge and research in Minnesota or areas similar to Minnesota.	MDA, MPCA, UMES, 319.	MPCA, MDA, BWSR, UMES.	Ongoing: 7020 rules update, GEIS, NRCS standards update.
6. Research and evaluate alternative ways to treat manure feedlot runoff and dead animals.	MDA	MDA, U of M.	MDA animal mortality composting publication and demonstrations.
7. Develop software to improve efficiency and uniformity of structural designs for manure storage structures.	MPCA, 319.	MPCA	The MPCA has developed software on concrete manure pit design that can be used by regulators or designers.
8. Compile an inventory of livestock and poultry facilities.	MPCA, 319, EQB.	MPCA	Ongoing, both through the GEIS and in MPCA's registration program.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
9. Evaluate need for research on water quality impacts of abandoned feedlots and manure storage areas.	MPCA	MPCA, U of M.	Not done

Goal 4: To Establish Flexible Programs for Financial Assistance Used to Correct Pollution Hazards from Animal Confinement and Manure Storage Areas

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Examine and develop sources of funding for: - installation of pollution control systems - relocation or retirement of facilities where correction of pollution hazards is not practical or economical - purchase of easements restricting use of facilities to prevent further pollution (with consent of landowner).	MPCA, 319.	MDA, MPCA, BWSR.	Ongoing MDA and BWSR activities.
2. Identify sources and increase funding used to provide technical assistance for design of pollution control facilities	BWSR, MDA.	BWSR, MDA.	Joint Powers Engineers program.
3. Assess and, if appropriate, develop programs to provide tax credits for installation and use of pollution control systems	MPCA	MPCA	Not done
4. State Revolving Fund program of low-cost loans for manure management and feedlot pollution abatement practices.	State Revolving Fund (SRF).	MDA, MPCA.	In place and ongoing

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
5.	Implement grant program for administration of the feedlot permit program at the county level.	MPCA	MPCA	In place and ongoing
6.	Develop and improve methods to prioritize utilization of financial assistance.	MPCA	MPCA, MDA, BWSR.	Not done

Goal 5: To Provide Clear, Consistent Guidance and Requirements Related To Control Of Pollution from Animal Confinement and Manure Storage Facilities.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1.	Assess and when necessary revise current standards for construction of manure storage facilities.	MPCA, MDA, BWSR.	MPCA, MDA, BWSR, UMES.	Revisions to Minnesota Rule Chapter 7020, the feedlot rule, complete in October 2000.
2.	Promote adoption of feedlot permit program administration by counties with appropriate accountability for counties.	MPCA	MPCA	Ongoing. 54 counties delegated as of October 16, 2000.
3.	Develop programs and formats to coordinate regulatory and enforcement activities among responsible agencies (e.g. MPCA, MDNR, counties).	MPCA, MDNR, MDA, NRCS, UMES.	MPCA, MDA.	Meetings with County Feedlot Officers are held regularly. State agencies coordinate through informal meetings as needed, and in formal settings in FMMAC, EQIP meetings, and other. Ongoing.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
4.	Increase awareness of regulations and requirements through integration into information and education programs.	UMES, MPCA, MDA, BWSR, MDNR.	MPCA, BWSR, MDA, UMES.	Ongoing.
5.	Assess structure of delivery of MPCA feedlot permits, examining central and regional office roles and county staff responsibilities.	MPCA	MPCA	Ongoing.
6.	Examine and develop "affirmative defense" aspects for producers in compliance with regulations.	MPCA, EQB.	MPCA, EQB.	In law.
7.	Examine financial effects of regulatory programs and develop strategies to minimize financial impacts on producers. This could include recommendations for changes in current regulatory program.	MDA	MDA	Rules revision process.
8.	Assess and if necessary rewrite regulations on pollution control on animal confinement and manure storage areas.	MPCA	MPCA	Rules revision.
9.	Assess and if appropriate implement requirement for notification of MPCA at time of transfer of ownership of facilities, to assure application for feedlot permit.	MPCA	MPCA	In law.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
10. Develop and implement an appeal process for pollution assessments.	MPCA	MPCA	While a pollution assessment is not appealable, there are procedures in law for appeal of penalties assessed by MPCA.
11. Develop an operation and management component into regulatory program to allow greater flexibility in administration of rules and assessment of pollution hazards.	MPCA	MPCA	In the new feedlot 7020 rule the SDS permit is used as a flexible permitting tool for non-standard facilities.
12. Assess need for change of Environmental Review process of animal confinement facilities by Environmental Quality Board and develop recommendations for improvement.	EQB	EQB	Ongoing. Revisions to EQB rules for environmental review were completed in October 1999.

Goal 6: To Develop Strategies And Plans for Program and Policy Development which Resolve Current Issues and Anticipate Future Issues Related to Pollution from Animal Production.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Assess impacts of large animal facilities on communities (e.g., greater than 1,000 animal units).	State	EQB	GEIS is studying this issue.
2. Identify strategies and options for addressing odors from animal production facilities, and evaluate the effectiveness of current state regulations on odors from animal production facilities and activities.	State	EQB, MPCA, MDA, State.	Major emphasis by MDA, MPCA, U of MN on odor and air quality issues over the past five years.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Develop and distribute aids and guidance for local government to address planning and zoning issues related to animal production facilities.	State	MDA	MDA has prepared materials to aid local governments in dealing with feedlots. These are the MDA Feedlot Manuals and the MDA Planning and Zoning for Animal Agriculture Manual. MDA is developing a siting tool based on odor emissions in conjunction with the U of M.

Chapter 8 Agricultural Erosion

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Current Situation

ACTIVITIES ASSOCIATED WITH AGRICULTURAL EROSION

Soil is one of Minnesota's most valuable resources. Our fertile topsoil and skilled agricultural producers make Minnesota one of the outstanding crop producing regions in the world. Because our population and agricultural markets are becoming larger on a global basis, there is an expanding demand for the numerous products (e.g., food, clothing, and shelter) that come from the soil. It is important that this demand be translated into careful conservation and management of soil and not into exploitation. Minnesota's soil, and water resources, must be maintained as a permanent, useful resource because future needs for productive soil will be even greater than those of the present.

In 1998, Minnesota's agricultural production resulted in $2.28 billion in agricultural exports, which ranked the state seventh, nationally. Minnesota ranks sixth nationally for total crop production based on the strength of its feed gains, wheat, and soybeans and related products (Hunst, 2000). Minnesota's soil resources and climate provides the foundation for this agricultural abundance. While agricultural producers often lament they have no control over the weather, they do in fact have the ability to manage the soil resource to sustain this bountiful production as well as to assure the long-term productivity and quality of our state's irreplaceable soil and water resources.

There are approximately 21.4 million acres of cropland in Minnesota (NRCS 1992b). Pastureland accounts for an additional 3.3 million acres. Combined, these agricultural land uses reflect a majority (53 percent) of Minnesota's landscape. Consequently, it is appropriate to focus on this land use as a potential source of nonpoint source (NPS) pollution and to recommend strategies for the control of erosion and sediment from these lands. Erosion arising from forested agricultural lands, except for those that are grazed, is not discussed in this chapter. Silviculture is addressed in Chapter 12, Forestry.

POLLUTANTS AND IMPACTS

Soil and water quality problems caused by agricultural land uses are now recognized by society as a significant environmental concern. Sediments from eroded cropland interfere with the use of waterbodies for transportation; threaten investments made in dams, locks, reservoirs, and other developments, and degrade aquatic ecosystems. Sediments contain nutrients that accelerate the rate of eutrophication of lakes, streams and wetlands. Compaction and declining levels of organic matter in the soil are other forms of soil degradation that may result in accelerated erosion and greater sedimentation.

Storm water and snowmelt runoff from cropland and pastureland carry sediment nutrients, bacteria and organic contaminants into nearby lakes, streams and wetlands. Table 8.1 indicates the nonpoint source water quality impacts resulting from sediment and nutrients.

The U.S. Department of Agriculture indicates that the primary source of pollution to those rivers and lakes of the nation that are affected by nonpoint source pollution is agriculture. Specifically, 64 percent of the nation's affected rivers and 57 percent of the nation's affected lakes receive most of their pollution from agricultural sources. Sediments and nutrients combine for 60 percent and 81 percent respectively, of the primary type of pollutants to rivers and lakes. Sediment accounts for nearly half of all pollutant types in the nation's rivers and over one-fifth of all pollutants in the nation's lakes (Carey, 1991). Additional information regarding the impacts of sediment in Minnesota's waters is incorporated in Chapter 1, Updated NPS Assessment. This information is excerpted from Minnesota's 2000 National Water Quality Inventory (305(b)) Report.

Agricultural nutrient management is addressed in Chapter 9. For a broader review of the sources and impacts of nutrients on the quality of Minnesota's surface and ground waters, please refer to that chapter.

SEDIMENT AS A NPS POLLUTANT

Sediment is the single most significant water pollutant resulting most frequently from agricultural land uses, particularly cropland. Sediment that enters waterbodies and makes the water turbid is often referred to as suspended sediment. Suspended sediment discharge is the rate at which dry weight of sediment passes through a section of stream in a given time.

Suspended sediment yield is the suspended sediment load per unit of drainage area for a stream [(tons/day)/square mile]. Suspended sediment yields are greatest on intensively cropped clay and loessial soils of southern Minnesota.

Mallawantantri and Mulla (1998) estimated that annual sediment yields range widely in the Minnesota River Basin, from 471 metric tons per month in the Pomme De Terre watershed to 18,825 tons per month in the lower Minnesota River Watershed.

Meyer and Schellhaass (2000) report that climatic and landscape variability in watersheds make the prediction of sediment loadings very complex. However, all basins studied would benefit from stabilization of riparian areas and restoration of wetlands.

Table 8.2 contains estimated annual suspended sediment yields for selected watersheds in Minnesota including data from studies by Tornes (1986), Finley (1993), NRCS (1993, 1992a and 1987b), and Hawkins and Stewart (1990).

The above discussion focuses on suspended sediment. Another type of sediment is bedload. Bedload can cause the aggradation of the bed of streams and rivers, which can contribute to increased flood stages.

DRAINAGE AND STREAMBANK EROSION

Many wetlands have been drained to increase the acres of arable land. The drainage area of the Blue Earth River in the glaciated area of west-central Minnesota, for

TABLE 8.1
NPS WATER QUALITY IMPACTS

Pollutant	**Origins**	**Impacts on Water Quality and Associated Users**
Sediment	Agriculture, Urban Runoff, Construction, Mining, Forestry	Decrease in transmission of light through water • Decrease in primary productivity (aquatic plants and phytoplankton) upon which other species feed, causing decrease in food supply • Obscures sources of food, habitat, hiding places, nesting sites; also interferes with mating activities that rely on sight and delays reproduction timing Directly affects respiration and digestion of aquatic species (e.g., gill abrasion) Decreases viability of aquatic life; decreases survival rates of fish eggs and therefore size of fish population; affects species composition Increases temperature of surface layer of water; increases stratification and reduces oxygen-mixing lower layers, therefore decreasing oxygen supply for supporting aquatic life Decreases value for recreational and commercial activities • Reduces aesthetic value • Reduces sport and commercial fish populations • Decreases boating and swimming activities • Interferes with navigation
Nutrients (Phosphorus, Nitrogen)	Agriculture, Animal Feedlots, Urban Runoff, Construction, Forestry, Individual Sewage Treatment Systems (ISTS)	Promotes accelerated aging of lakes • Algal blooms and decay of organic materials create turbid conditions that eliminate submerged aquatic vegetation and destroy habitat and food for aquatic animals and waterfowl • Blooms of toxic algae can affect health of swimmers and aesthetic qualities of waterbodies (odor and murkiness) • Favors survival of less desirable fish species • Interferes with boating and fishing • Reduced dissolved oxygen levels can suffocate fish • Reduces waterfront property values Degradation of ground water quality • Reduces quality of drinking water • Nitrates can cause infant health problems

Source: Minnesota Pollution Control Agency, 1986; pages 7-8

TABLE 8.2
Summary of Suspended Sediment Yields for Selected Watersheds

Location	Drainage Area (sq. mile)	Average Annual Sediment Yield (T/sq.mi.)	Location	Drainage Area (sq. mile)	Average Annual Sediment Yield (T/sq. mile)
Baptism R., at Beaver Bay	140	14.2	Chippewa R., at Milan	1,870	5.8
St. Louis R., at Forbes	713	1.4	Redwood R., at Marshall	303[a] 73[b]	57.9
Deer Creek, at Holyoke	7.77	236	Redwood R., at Redwood Falls	697	17.6
Pelican R., at Fergus Falls	482	1	Minnesota R., at New Ulm	9,530	5.5
Buffalo R., at Hawley	322	5	Cottonwood R., at New Ulm	1,280	55.7
So. Branch Buffalo R., at Sabin	522	3.2	Watonwan R., at Garden City	812	54
Buffalo R., at Dilworth	1.040	4.5	Minnesota R., at Mankato	14,900	66.1
Wild Rice R., at Twin Valley	888	17.2	Straight R., at Faribault	442	44.1
Middle R., at Argyle	265	4.9	Zumbro R., at Zumbro Falls	1,130	49.3
Little Fork R., at Littlefork	1,730	33	Zumbro R., at Kellogg	1,400	104
Crow Wing R., at Nimrod	1,010	1.2	Whitewater R., at Beaver	271	260
Elk R., at Big Lake	615	2.2	Mississippi R., at Winona	59,200	5.1
Crow R., at Rockford	2,520	5.1	Root R., at Lanesboro	615	249
Mississippi R., at Anoka	19,100	8.1	Root R., at Houston	1,270	221
Whetstone R., at Big Stone City, SD	389	22.5	South Fork Root R., at Houston	275	173
Yellow Bank R., at Odessa	398	31.5	Cedar R., at Austin	425	30.9
Kanaranzi Creek/Little Rock R., Nobles-Rock Counties	310	103.2	Des Moines R., at Jackson	1,220	14
Upper North Branch Root R., at Lake Florence	119.4	385.3	Redwood R., above Lake Redwood	640	226
Middle Branch Whitewater R., Winona County	55	292.2	Clear Creek, at Seaforth	N/A	187
Three Mile Crk, at Green Vly	N/A	84			

<u>Sources</u>: Finley, 1993
Hawkins and Stewart, 1990
NRCS, 1992a and 1987b

[a] = Tornes, 1986
[b] = Finley, 1993

example, has almost doubled due to extensive tile drainage of depressional areas that formerly stored surface runoff. Studies to identify sources of sediment in this watershed have been made, and as a result, farmers have complied with reduced tillage and increased crop residue recommendations to help decrease the suspended sediment load in the river. Monitoring programs have, however, indicated that sediment problems have not been solved. Streambank and ditch bank erosion, not erosion from agricultural lands, is the major source of sediment in areas such as northwestern Minnesota, where low topographic relief contributes to reduced sediment yield. However, wind erosion--which is significant in northwestern Minnesota (Table 8.3) -- is believed to contribute significant sediment to drainage ditches and watercourses.

Geographic Areas of Concern

The highest suspended sediment yields in the state occurred in watersheds draining into the Mississippi River in southeast Minnesota. Adjacent watersheds of the Straight River and the upper reaches of the Zumbro River had similar average annual yields approaching 50 tons per square mile. The highest annual yields in the state were 260 tons per square mile, found on the main stem and South Fork of the Root River and Whitewater River (Tornes, 1986). Except in the situations noted earlier, stream bank erosion usually ranks behind upland areas as a sediment source to watercourses. Activities that increase or alter runoff patterns in the watershed , such as hydrologic modification, or alter nearbank vegetation can aggravate streambank erosion (NRCS, 1998).

Existing erosion rate and sediment yield data and water quality assessment inventories have been compiled on several geographic scales. For example, the National Resource Inventory (NRI) contains erosion data that have been compiled at the county level and also at the "major land resource area (MLRA) level. However, most water quality data cited within this chapter has either been compiled at a sub-watershed level or at the 4-digit hydrologic unit code (HUC) level. Still other water quality assessments have been done at the ecoregion level. Where possible, this chapter attempts to assemble erosion rate, sediment yield and water quality data on as similar a geographic basis as possible. The 4-digit HUC level was selected for the best overall representation since it directly corresponds to the water quality assessment inventories conducted by MPCA.

HIGH PRIORITY AGRICULTURAL EROSION AREAS

Since the principal source of nonpoint source pollution is agriculture and one of the primary types of pollutants is sediment, it is appropriate to address the geographic areas in the state where erosion results in off-site sedimentation. To do so, some generalizations and initial assumptions are in order:

- cultivated cropland is usually more susceptible to erosion than other agricultural land uses,
- cultivated cropland on rolling to steeply sloping topography usually contributes higher sheet and rill erosion rates than relatively level topography,
- typically, a greater potential exists for off-site deposition of sediment from lands where there are few swales and depressions for on-site deposition to occur - these areas are characteristically smaller watersheds with rolling to steeply sloping topography.
- In Minnesota, a small percentage of Minnesota croplands contributes proportionally higher loadings of sediment.

The previous generalizations are not intended to describe any specific geographic region or watershed. Rather, these generalizations help to explain some of the relative differences between such areas and watersheds that can contribute to the actual

TABLE 8.3
High Priority Agricultural Erosion Areas

1987 Cropland Sheet/Rill Erosion (tons/acre/year)	Major Land Resource Area (MLRA)	1992 Cropland Sheet/Rill Erosion (tons/acre/year)
5.8	105	5.3
5.1	102B	3.3
1987 Pastureland Sheet/Rill Erosion (tons/acre/year)	**Major Land Resource Area (MLRA)**	**1992 Pastureland Sheet/Rill Erosion (tons/acre/year)**
1.4	105	1.3
1.0	102A	0.4
1987 Cropland Wind (tons/acre/year)	**Major Land Resource Area (MLRA)**	**1992 Cropland Wind (tons/acre/year)**
8.5	56	12.6
7.6	88	6.6
6.7	57	6.0
6.1	91	5.3
5.4	102A	6.0

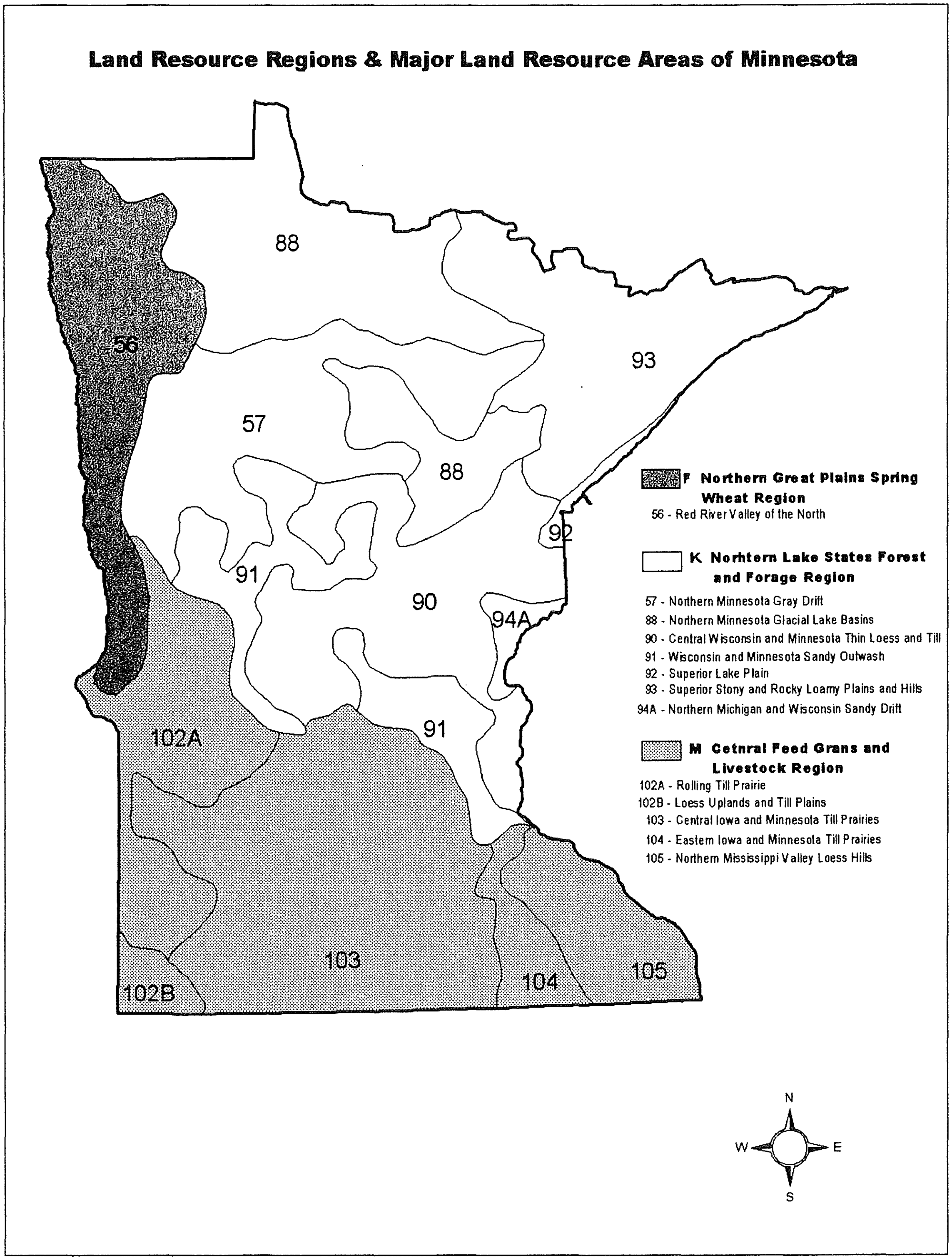
Source: (Soil Conservation Service, 1987a)
(SCS, 1992b)

or estimated erosion rates and suspended sediment yields in specific areas or watersheds that are observed.

Minnesota's land resources lie within parts of three land resource regions of the United States. The three regions are referred to as (1) the Northern Great Plains Spring Wheat Region (approximates the Red River valley of northwestern Minnesota), (2) the Northern Lake States Forest and Forage Region (approximates all of the forest and transitional areas of Minnesota), and (3) the Central Feed Grains and Livestock Region (approximates the prairie area of Minnesota, except for the Red River valley area). Major land resource areas (MLRAs) are smaller units covering several counties or parts of counties; thirteen MLRAs have been identified in Minnesota (Figure 8.1).

Average annual erosion rates for selected MLRAs and agricultural land uses are contained in Table 8. MLRA 105 exhibits the highest average annual sheet and rill erosion rate for both cropland and pastureland. This area is referred to as the Northern Mississippi Valley Loess Hills and covers most of six counties in extreme southeastern Minnesota. MLRA 56 exhibits the highest average annual wind erosion rate for cropland. This area is referred to as the Red River Valley of the North and covers most of nine counties in northwestern Minnesota. Most soil and water conservation districts (SWCDs) have also identified and may have delineated more localized high priority erosion and sedimentation areas within their comprehensive resource management plans. These plans are available for viewing at each local SWCD office.

Figure 8.1


Land Resource Regions & Major Land Resource Areas of Minnesota
88
56
93
57
88
92
91
90
94A
91
102A
103
104
105
102B
F Northern Great Plains Spring Wheat Region
56 - Red River Valley of the North
K Norhtern Lake States Forest and Forage Region
57 - Northern Minnesota Gray Drift
88 - Northern Minnesota Glacial Lake Basins
90 - Central Wisconsin and Minnesota Thin Loess and Till
91 - Wisconsin and Minnesota Sandy Outwash
92 - Superior Lake Plain
93 - Superior Stony and Rocky Loamy Plains and Hills
94A - Northern Michigan and Wisconsin Sandy Drift
M Cetnral Feed Grans and Livestock Region
102A - Rolling Till Prairie
102B - Loess Uplands and Till Plains
103 - Central Iowa and Minnesota Till Prairies
104 - Eastern Iowa and Minnesota Till Prairies
105 - Northern Mississippi Valley Loess Hills
N
W
E
S

WATER QUALITY IMPACTS FROM AGRICULTURAL EROSION IN MINNESOTA

Assessing the extent of nonpoint source pollution problems is very difficult because of the large number of pollutants that must be considered and the diversity of Minnesota's lakes, stream and ground water resources. The Minnesota Pollution Control Agency (MPCA) has facilitated a general assessment of nonpoint source pollution problems in Minnesota. That assessment addresses the state's ecoregions.

Ecoregions (Figure 8.2) are based on similarities of land use, soils, land surface form, and potential natural vegetation. Land use, topography, and water body characteristics of the ecoregions were reviewed to assess the nonpoint source pollution problems across the state. This review is compiled in MPCA (1986). The four ecoregions that correspond to the principal crop-producing area of the state show the greatest impact to each region's water resources. These ecoregions are referred to as (1) the Red River Valley, (2) the Northern Great Plains, (3) the Western Cornbelt Plains, and (4) the Driftless Area.

Trends in stream water quality have been monitored in these ecoregions during the period 1973 through 1985 by the MPCA and their compiled results are shown in Figure 8.3 (MPCA).

Data from many sources (see references) indicate that the greatest nonpoint source pollution impacts to Minnesota rivers results from agricultural sources, especially from croplands. Agricultural sources of nonpoint pollution also significantly impacts the state's lake resources, second only to the runoff and leachate resulting from on-site wastewater systems. However, nonpoint pollutants resulting from urban runoff provide a nearly equivalent degree of impact to Minnesota's lake resources as do agricultural sources. It is important to note that among the lake acres threatened by agricultural sources of nonpoint pollution one of the principle agricultural sources is pastureland.

Overall in Minnesota, especially given the extensive land area devoted to agricultural production, it is appropriate to focus on agricultural sources of nonpoint pollution, especially sediment resulting from erosion. Agricultural sources of nonpoint pollution are often identified in water quality assessments throughout the state. A compilation, from many sources, of agricultural sediment sources for selected major watersheds in Minnesota is presented as Table 8.4.

These data clearly indicate that the greatest degree of water quality impairment from cropland and pastureland occurs in the Minnesota River Watershed.

The Minnesota River and the Upper Mississippi River watersheds appear to be the most impacted by agricultural sources of nonpoint pollution of the nine major hydrologic sub-basins in the state.

Figure 8.2

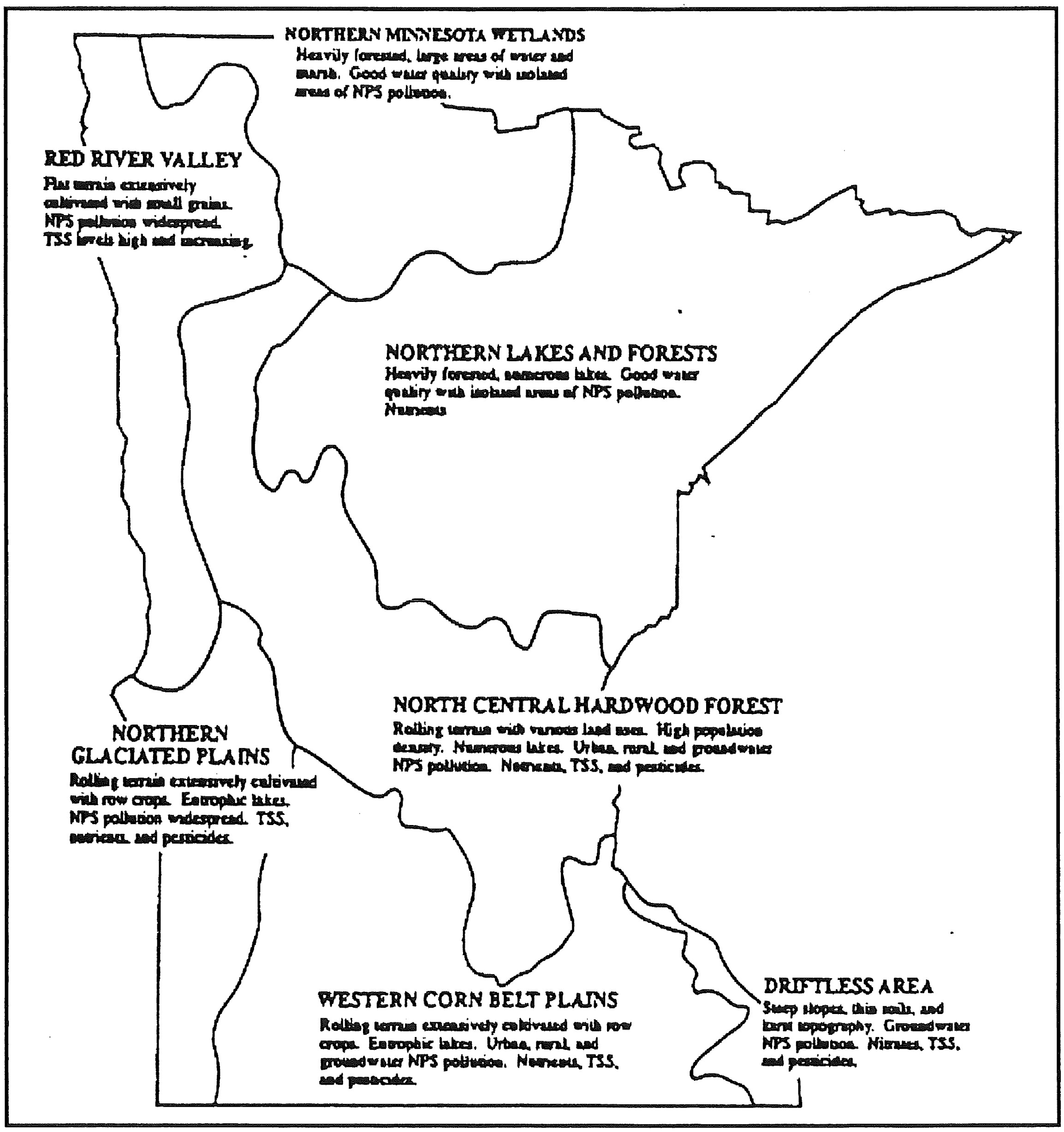

NORTHERN MINNESOTA WETLANDS
Heavily forested, large areas of water and marsh. Good water quality with isolated areas of NPS pollution.
RED RIVER VALLEY
Flat terrain extensively cultivated with small grains. NPS pollution widespread. TSS levels high and increasing.
NORTHERN LAKES AND FORESTS
Heavily forested, numerous lakes. Good water quality with isolated areas of NPS pollution. Nutrients
NORTH CENTRAL HARDWOOD FOREST
Rolling terrain with various land uses. High population density. Numerous lakes. Urban, rural, and groundwater NPS pollution. Nutrients, TSS, and pesticides.
NORTHERN GLACIATED PLAINS
Rolling terrain extensively cultivated with row crops. Eutrophic lakes. NPS pollution widespread. TSS, nutrients, and pesticides.
WESTERN CORN BELT PLAINS
Rolling terrain extensively cultivated with row crops. Eutrophic lakes. Urban, rural, and groundwater NPS pollution. Nutrients, TSS, and pesticides.
DRIFTLESS AREA
Steep slopes, thin soils, and karst topography. Groundwater NPS pollution. Nitrates, TSS, and pesticides.

Figure 8.3

FIGURE 8.3

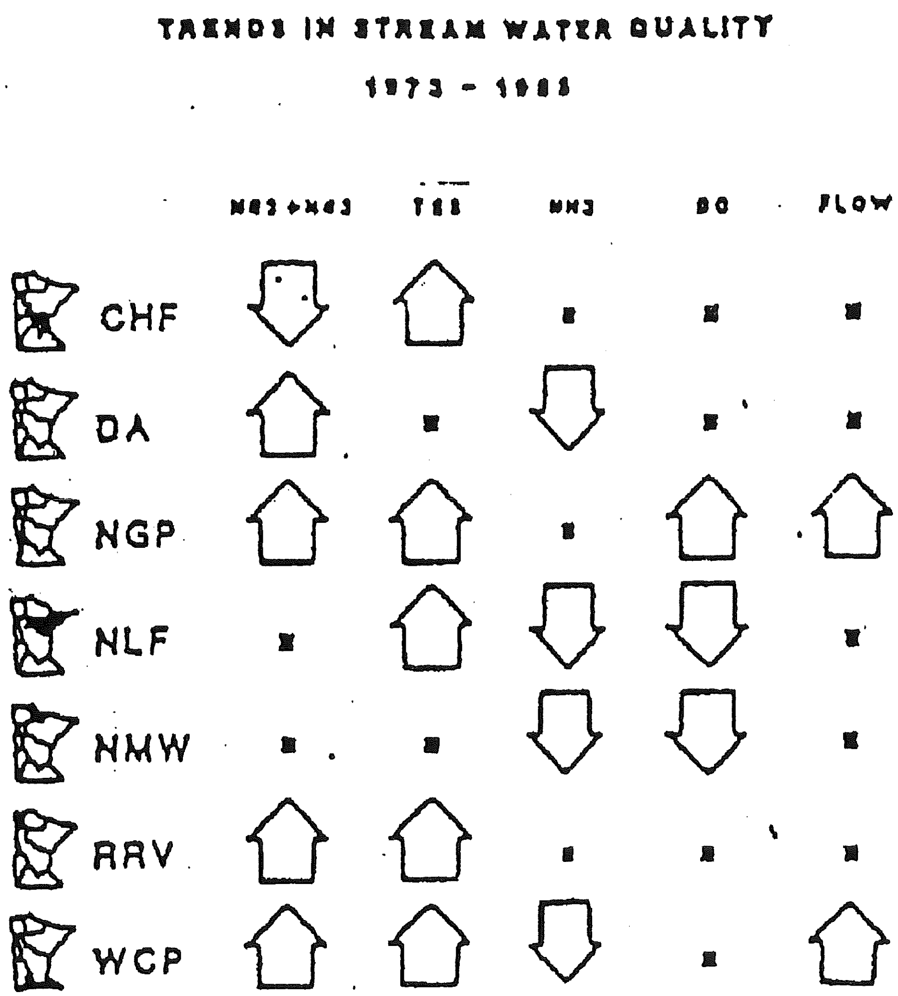


TABLE 8.4
Summary of Agricultural Sediment Sources for Selected Impacted Waters

Source of Sediment	Hydrologic Sub-Basin (Code # & Name)	IMPAIRED River Miles	IMPAIRED River Ranking	IMPAIRED Lake Acres	IMPAIRED Lake Ranking	THREATENED River Miles	THREATENED River Ranking	THREATENED Lake Acres	THREATENED Lake Ranking
Cropland: Non-irrigated	**0702: Minnesota River**	**2,397**	**1**	**133,791**	**1**	342	4	34,435	3
	0902: Red River	1,159	2	92,562	2	1,112	1	76,279	1
	0701: Upper Mississippi River	620	4	92,005	3	576	3	71,763	2
	0704: Lower Mississippi River	761	3	11,839	5	634	2	13,083	4
	0710/0708/0706: Cedar, etc.	220	5	18,185	4	191	6	7,876	6
	1017: Missouri River	194	6	504	7	244	5	10,105	5
	0903: Rainy River	91	7	0	N/A	75	7		
	0703: St. Croix River	0	N/A	10,551	6	56	8	1,939	7
	0401: Lake Superior, etc.	0	N/A	0	N/A	0	N/A	52	8
Cropland: Irrigated	**0702: Minnesota River**	**589**	**1**	**36,762**	**1**	46	4	5,182	2
	0701: Upper Mississippi River	435	2	27,730	2	**496**	**1**	4,659	3
	1017: Missouri River	194	3	504	4	33	5	0	N/A
	0704: Lower Mississippi River	83	4	448	5	19	6	0	N/A
	0710/0708/0706: Cedar, etc.	68	5	0	N/A	52	3	0	N/A
	0703: St. Croix River	0	N/A	5,018	3	0	N/A	387	4
	0902: Red River	0	N/A	0	N/A	235	2	**15,383**	**1**
	0903: Rainy River	0	N/A	0	N/A	0	N/A	0	N/A
	0401: Lake Superior, etc.	0	N/A	0	N/A	0	N/A	0	N/A
Pastureland	**0702: Minnesota River**	**692**	**1**	**80,221**	**1**	175	5	21,513	4
	0902: Red River	638	2	76,552	2	499	3	49,098	3
	0704: Lower Mississippi River	516	3	10,840	5	587	2	3,780	5
	0701: Upper Mississippi River	408	4	70,148	3	673	1	56,708	2
	1017: Missouri River	158	5	504	7	203	4	1,178	6
	0710/0708/0706: Cedar, etc.	151	6	9,013	6	141	6	776	7
	0401: Lake Superior, etc.	13	7	0	N/A	19	9	0	N/A
	0703: St. Croix River	0	N/A	12,355	4	56	8	601	8
	0903: Rainy River	0	N/A	0	N/A	115	7	220,800	1

NOTES:

Units of impaired and threatened river miles or lake acres are not additive since each unit may be impacted by more than one source of nonpoint pollutant.
"N/A" - not applicable.

In 1993, the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service, assessed the magnitude of nonpoint pollution sources in 10 agricultural sub-watersheds of the Blue Earth, Watonwan and LeSueur River watersheds of the Minnesota River sub-basin (HUC #0702). Figure 8.4 shows the locations of the 10 sub-watersheds within that portion of the Minnesota River sub-basin that was studied. Cropland comprised 86 percent of the area studied and 85 percent of the cropland was under a 2-year crop rotation of corn and soybeans. Table 8.5 includes the predicted annual suspended sediment yield for each of the 10 sub-watersheds.

Other recent studies have indicated similar annual suspended sediment yields for watersheds with a predominance of agricultural land use; those estimates are included in Table 8.2. For example, the NRCS studied watersheds in southeastern and southwestern portions (respectively) of the state; the former contained 85 percent cropland and 4 percent pastureland while the latter contained 88 percent cropland and 5 percent pastureland. While both watersheds yielded significant amounts of sediment, the southeastern Minnesota watershed contributed considerably more. This relative difference can be explained mostly by the obvious and considerable differences in topography and soils between the two watersheds. Nevertheless, each study indicates a significant loading of suspended sediment to the rivers and streams contained within each watershed.

TABLE 8.5

Priority Ranking of Selected Minnesota River Sub-Watersheds

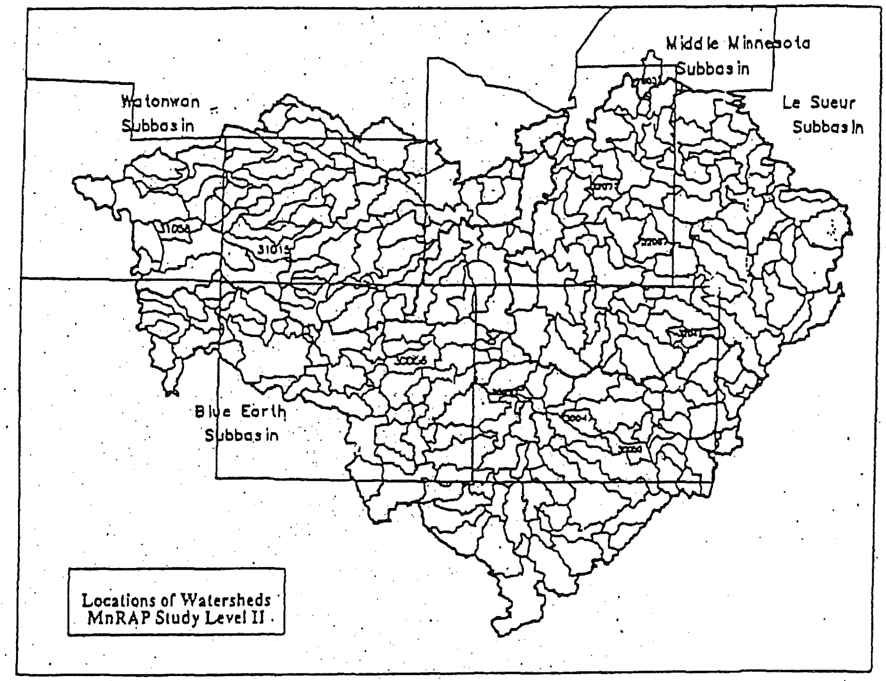
Sub-Watershed		Drainage Area (square miles)	*Watershed*		Annual Suspended Sediment Yield	SCS Ranking
Common Name	**Hydrologic ode***		**Common Name**	**Hydrologic Code***		
County Ditch #44	30050	10.6	Blue Earth River	07020009	707.5	1
County Ditch #60	30030	4.3	Blue Earth River	07020009	581.4	2
County Ditch #26	30047	10.3	Blue Earth River	07020009	524.3	3
Cobb River tributary	32073	8.8	LeSueur River	07020011	465.9	4
Judicial Ditch #3	30056	10.6	Blue Earth River	07020009	377.4	5
Maple River tributary	32042	908	LeSueur River	07020011	326.5	6***
County Ditch #5	32067	15.1	LeSueur River	07020011	344.4	7***
Mountain Lake	31058	10.3	Watonwan River	07020010	252.4	8
Duck Lake	28033	8.3	Middle Minnesota River	07020007	168.7	9
St. James Creek	31015	17.9	Watonwan River	07020010	134.1	10

* Indicates a code used by the Minnesota Department of Natural Resources.

** Indicates a code used by the USDA NRCS

*** NRCS (1993) ranked these watersheds as shown. As illustrated in this table, the ranking would be interchanged based on the computations of average annual sediment yield. The difference in ranking of these two sub-watersheds is due to rounding of numbers used in the computations.

Figure 8.4


Middle Minnesota
Subbasin
Le Sueur
Subbasin
Watonwan
Subbasin
Blue Earth
Subbasin
Locations of Watersheds
MnRAP Study Level II

In its study of the 10 agricultural sub-watersheds of the Minnesota River sub-basin SCS (1993) developed three strategies to address sedimentation. The three sediment management strategies that were developed included:

- (SED MGT-1) using whatever conservation tillage practices necessary to reduce sheet and rill erosion to soil loss tolerance levels;
- (SED MGT-2) using conservation tillage practices on all cropland in the ten watersheds; and
- (SED MGT-3) treating only those erosion areas located adjacent to drainage ditches, grass waterways, and streams downstream of large wetlands and lakes.

Table 8.6 illustrates the effectiveness of the three sediment management strategies. In its report SCS (1993) recommended that SED MGT- I be implemented first, followed by SED MGT-3, and then add SED MGT-2 until a desired goal is attained. Each strategy that reduced sediment yield by at least one ton per acre of treatment was highlighted on the table. In a similar study for the Upper Branch Root River in southeastern Minnesota, SCS (1992a) data suggest that each of two alternative management strategies would reduce sediment yield in that watershed by approximately 1.7-1.8 tons per acre treated.

Significant reductions in erosion and associated sediment from the application of best management practices has been identified as an effective land treatment strategy in the phosphorus reduction strategy of the MN River (MPCA, 2000).

Best Management Practices for Agricultural Erosion and Sediment Control

DESCRIPTION AND EFFECTIVENESS

Table 8.7 (Brach, 1991) indicates the types and effectiveness of best management practices often used to protect surface and groundwater from agricultural sources of nonpoint source pollution. For the purpose of this chapter, the principal focus of the selected BMPs is to address sedimentation into surface waters. Accordingly, it is evident that the most effective practices to control sediments are structural practices. Unfortunately, these practices often are relatively expensive to establish and maintain. However, the effective life of such practices (with proper maintenance) often exceeds 15 years whereas most vegetative and tillage practices established derive only annual benefits and must be reestablished each year. Consequently, vegetative and tillage practices are relatively inexpensive to establish, yet often require a greater degree of on-going management to fully realize the anticipated water quality benefits.

ON-GOING APPLICATION OF BMPS IN MINNESOTA

Table 8.8 illustrates the federal and state expenditures of cost-sharing programs and loan programs for the period of 1998 and 1999. These cost-share programs are administered by the NRCS (EQIP) and the Minnesota Board of Water and Soil Resources (which administers the Erosion Control and Water Quality Protection and Improvement Program). The agricultural BMP loan program is administered by the Minnesota Department of Agriculture.

Table 8.6

Effectiveness of Sediment Management Strategies for Selected Priority Sub-Watersheds

				Sediment Management Strategies								
		SUB-WATERSHED		**#1**			**#3**			**#2**		
SCS Ranking Of Annual Suspended Sediment Yield	Suspended Sediment Yield (T/yr./sq. mi.)	Common Name	Hydrological Code*	Annual Yield	% Reduced	Reduction Per Acre Treated	Annual Yield	% Reduced	Reduction Per Acre Treated	Annual Yield	% Reduced	Reduction Per Acre Treated
1	707.5	County Ditch #44	30050	424.5	40	**1.07 ton**	622.6	12	0.82 ton	367.9	48	0.62 ton
2	581.4	County Ditch #60	30030	488.4	16	**1.00 ton**	465.1	20	0.83 ton	325.6	44	0.46 ton
3	524.3	County Ditch #26	30047	291.3	44	**1.14 ton**	446.6	15	**2.00 ton**	223.3	57	0.52 ton
4	465.9	Cobb R. tributary	32073	329.5	29	**1.00 ton**	409.1	12	0.56 ton	261.4	44	0.35 ton
5	377.4	Judicial Ditch #3	30056	349.1	7	0.60 ton	311.2	18	0.64 ton	188.7	50	.033 ton
6**	326.5	Maple R. tributary	32042	295.9	9	**1.00 ton**	285.7	13	0.44 ton	224.5	31	0.33 ton
7**	344.4	County Ditch #5	32067	258.3	25	**1.08 ton**	304.6	12	**1.00 ton**	165.6	52	.038 ton
8	252.4	Mountain Lake	31058	223.3	12	0.60 ton	N/A	N/A	N/A	194.2	23	0.19 ton
9	168.7	Duck Lake	28033	144.6	14	0.25 ton	N/A	N/A	N/A	108.4	36	0.18 ton
10	134.1	St. James Creek	31015	122.9	8	0.50 ton	122.9	8	0.40 ton	83.8	38	0.10 ton

NOTES:
* Indicates a code used by the Minnesota Department of Natural Resources
"N/A" indicates not applicable.

** = SCS (1993) ranked those watersheds as shown. As illustrated in this table, the ranking would be interchanged based on the computations of average annual sediment yield. The differences in ranking of these two sub-watersheds is due to rounding of numbers used in the computations.

Table 8.7

Best Management Practices Summary Guide	Surface Water: Sediment	Surface Water: Soluble Nutrients	Surface Water: Adsorbed Nutrients	Surface Water: Soluble Pesticides	Surface Water: Adsorbed Pesticides	Surface Water: Oxygen-Demanding Substances	Surface Water: Bacteria	Ground Water: Nitrogen Loss to Grand Wtr.	Ground Water: Pesticide Loss to Ground Wtr.
I. MANAGEMENT PRACTICES									
1. Nutrient Management	±	●	●	±	±	±	±	●	±
2. Integrated Pest Management	±	±	±	●	●	±	±	±	●
3. Proper Pesticide Use	±	±	±	●	●	±	±	±	●
4. Irrigation Water Management	◆	◆	◆	◆	◆	±	±	◆	◆
II. VEGETATIVE AND TILLAGE PRACTICES									
5. Conservation Tillage	●	±	●	±	●	±	±	▲	▲
6. Contour Farming	●	◆	●	◆	●	◆	◆	▲	▲
7. Stripcropping	◆	◆	◆	◆	◆	◆	◆	±	±
8. Filter Strip	◆	±	◆	±	◆	◆	◆	±	±
9. Field Border	◆	±	◆	±	◆	◆	◆	±	±
10. Cover Crop	◆	◆	◆	◆	◆	±	±	◆	±
11. Crop Rotation	●	±	●	◆	●	±	±	±	◆
12. Field Windbreaks	◆	±	◆	±	◆	±	±	±	±
13. Pasture Management	◆	±	◆	±	±	◆	◆	±	±
III. STRUCTURAL PRACTICES									
14. Ag Waste Management System	●	●	●	±	±	●	●	●	±
15. Runoff Management System	●	●	●	±	±	●	●	●	±
16. Terrace	●	◆	●	◆	●	◆	◆	▲	▲
17. Water & Sediment Control Basin	●	±	●	±	●	◆	±	▲	▲
18. Diversion	◆	±	◆	±	◆	±	±	±	±
19. Livestock Exclusion (Fencing)	●	●	●	±	±	●	●	±	±
20. Grade Stabilization Structure	◆	±	◆	±	±	±	±	±	±
21. Grassed Waterway	◆	±	◆	±	◆	±	±	±	±
22. Streambank Protection	●	±	●	±	±	±	±	±	±
23. Wetland Development	●	◆	●	±	●	●	◆	±	±
IV. MISCELLANEOUS PRACTICES									
24. Sealing Abandoned Wells	±	◆	±	◆	±	±	±	●	●
25. Onsite Sewage Disposal System	±	●	±	±	±	●	●	●	±
26. Sinkhole Protection	±	±	±	±	±	±	±	●	●

± No control to low effectiveness

◆ Low to medium effectiveness

● Medium to high effectiveness

▲ May increase loading in some cases

Note: Because of the general nature of this chart, there may be situations where practices will not perform as indicated. Source: Brach, 1991

TABLE 8.8

PRACTICES APPLIED WITH COST SHARE, EQIP, AG BMP LOAN 1998-1999		
PROGRAM	TOTAL LOAN	TOTAL GRANT*
Critical Area Stabilization		$ 1,013,696
Diversions	$ 50,195	$ 320,633
Field Windbreaks	$ 5,219	$ 135,340
Grass Waterway	$ 472,185	$ 1,993,513
Riparian Buffer Strips	$ 1,676	$ 4,830
Sediment Retention, Erosion or Water Control		$ 1,556,752
Steambank, Shoreland and Roadside	$ 89,369	$ 835,307
Terraces	$ 178,657	$ 395,433
Waste Management	$ 13,740,864	$ 4,769,626
Conservation Tillage Equipment	$ 5,651,465	
	$ 20,189,630	**$ 11,025,130**

*Includes RIM and CREP Practices

Cost-share and loan programs are usually designed to provide financial assistance to landowners that voluntarily establish conservation practices that protect soil resources of productive agricultural lands and adjacent water resources. However, there are some marginal and environmentally sensitive agricultural lands that should be retired from agricultural use, particularly crop production. Landowners with marginal and environmentally sensitive lands have participated in land retirement programs such as the federal Conservation Reserve Program (CRP) and the BWSR conservation easement programs known as the Reinvest In Minnesota (RIM) Reserve and the Conservation Reserve Enhancement Program (CREP). CRP offers annual payments to landowners that enroll eligible lands under 10 to 15-year contracts and establish permanent vegetative cover. RIM Reserve offers a lump sum payment to landowners that enroll eligible lands under limited duration or perpetual conservation easements. CREP is a combination of RIM and CRP, which extends the benefits of CRP for a longer period of time, usually to perpetuity.

Approximately 1.65 million acres of cropland in Minnesota have been enrolled in the CRP for 10-15 year periods. Table 8.9 illustrates the acreage and type of conservation easements enrolled through 2000. These two land retirement programs offer an additional land management option for agricultural producers in Minnesota to address agricultural erosion and the associated impacts to water resources.

Finally, various conservation tillage practices also significantly contribute to the overall control of agricultural erosion and sediment. In fact, many agricultural producers have integrated some form of conservation tillage with most of their crop rotations.

Table 8.10 illustrates the use of conservation tillage in Minnesota for the years 1992 through 1998.

TABLE 8.9
Conservation Easements

EASEMENT TYPE	# OF EASEMENTS	ACRES
Marginal Ag Land		
Perpetual	445	11,069
Limited	152	2,649
WL* restoration	457	18,127
WRP**		
WL restoration	90	6,208
Sensitive groundwater		
Perpetual	29	999
Limited	7	135
Riparian land		
Perpetual	447	17,064
Limited	5	131
PWP*** perpetual	269	10,765
Other perpetual	104	3,542
CREP****		
WL restoration	181	9,344
Riparian	554	17,379
TOTAL	**2,740**	**97,412**

(as of October, 2000)

* Wetland
** Wetland Reserve Program
*** Permanent Wetland Preserves
**** Conservation Reserve Enhancement Program (limited to Minnesota River Basin)

TOTAL MAXIMUM DAILY LOADS (TMDLs)

Section 303(d) of the Clean Water Act requires states to publish a list of stream and lakes that do not meet their designated uses because of excess pollutants every two years. Minnesota's 1998 303(d) List identified stream reaches as being impaired based on a comparison of available water quality data with the state's Water Quality Standards for turbidity, fecal coliform, pH, un-ionized ammonia, dissolved oxygen, and mercury. Once specific stream reaches are identified as impaired, the Clean Water Act, Section 303(d), requires that a total maximum daily load (TMDL) be developed for those reaches.

Agricultural soil erosion and its subsequent transport into Minnesota's waterways directly influences turbidity in these waterways. As such, agricultural soil erosion will often be a major source of sediment in which TMDLs will develop local allocations designed for the attainment of water quality standards. In addition to the completion of individual TMDLs, work is needed to develop a process that adequately links turbidity to the biological responses in water system. The process also needs to provide an adequate link back to the watershed landscape (hydrology, soils, land use, etc.). Issues of scale in the application of TMDLs to watershed management in Minnesota also need to be addressed.

TABLE 8.10
Conservation Tillage for Selected Crops in Minnesota, 1998

Crop	Total Planted (acres)	No-Till (acres) [% of crop]	Ridge-Till (acres) [% of crop]	Mulch-Till (acres) [% of crop]	Total in Conserv. (acres) [% of crop]
Corn	7,229,253	102,806 1%	73,858 1%	938,270 13%	1,114,934 15%
Soybeans	6,864,262	415,215 6%	78,649 1%	2,089,934 30%	2,583,798 38%
Small Grains	3,048,975	23,730 1%	0%	527,539 17%	551,269 18%
All Crops	19,111,901	565,866 3%	153,107 1%	3,720,803 19%	4,439,776 23%

Conservation Tillage in Minnesota, 1992-1998 (All Crops)

Year	Total Planted (acres)	No-Till (acres) [% of crop]	Ridge-Till (acres) [% of crop]	Mulch-Till (acres) [% of crop]	Total in Conserv. (acres) [% of crop]
1992	18,297,222	531,027 3%	572,799 3%	2,971,651 16%	4,075,477 22%
1993	17,737,678	809,306 5%	569,097 3%	3,449,875 19%	4,828,278 27%
1994	18,947,223	718,290 4%	509,148 3%	3,312,928 17%	4,540,366 24%
1995	18,154,182	592,282 3%	361,933 2%	3,370,300 19%	4,324,515 24%
1996	18,892,324	613,812 3%	300,296 2%	4,004,202 21%	4,918,310 26%
1997	19,280,160	654,515 3%	311,278 2%	4,149,228 22%	5,115,021 27%
1998	19,111,901	565,866 3%	153,107 1%	3,720,803 19%	4,439,776 23%
Average	18,551,465	653,205 4%	437,425 2%	3,543,031 19%	4,633,661 25%

Source: Conservation Tillage Information Center (1998)

The water quality standard for turbidity in the Minnesota River is 25 Nephelometric Turbidity Units (NTU). The correlation between the concentration of total suspended solids (TSS) in the water and turbidity is fairly strong. As such, a link between the turbidity standard and TSS concentration may be made. In doing so, it appears that the turbidity standard is likely exceeded whenever flows are elevated due to storm events in agricultural watersheds. The development of suspended sediment-related standards must, in some way, accommodate both the actual conditions in the river and elevated turbidity levels from storm events. It must also account for differences in measurement techniques, specifically suspended sediment concentrations versus TSS concentrations and turbidity measurements.

Current Programs and Authorities

FEDERAL ACTIVITIES

Table 8.11 illustrates the federal agency activities in Minnesota to address agricultural erosion and sediment control. The principal technical assistance agency is the Natural Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), and the principal financial assistance agency is the Farm Services Agency (FSA), both within the U.S. Department of Agriculture.

STATE ACTIVITIES

Table 8.12 illustrates the state agency activities in Minnesota to address agricultural erosion and sediment control. The principal agency is the Board of Water and Soil Resources (BWSR) due to the focus of many of its land treatment programs to private lands and also because those programs are administered locally, through soil and water conservation districts (SWCDs). Other state agencies include the Minnesota Pollution Control Agency (MPCA), the Minnesota Department of Agriculture and the Minnesota Department of Natural Resources (MDNR).

To better correlate BMP installation with pollutant reductions, several state and federal agencies, led by BWSR, have developed a web-based interactive GIS system that integrates LARS (Local Government Annual Reporting System).

LOCAL ACTIVITIES

Table 8.12 illustrates local activities in Minnesota to address agricultural erosion and sediment control. The principal agency is the local SWCD due to its ability to provide technical assistance to private landowners and also because it locally administers land treatment programs offered by BWSR. The Metropolitan Council (Met Council) plays an active role in local activities in the Twin City metropolitan area and is also included in the following table.

Needs, Priorities and Milestones

Efforts to reduce and prevent water quality degradation from agricultural erosion must begin with soil and water resource management activities that protect and enhance soil quality. The quality of a soil depends on attributes such as texture, depth, permeability, biological activity, capacity to store water and nutrients, and the amount of organic matter contained in the soil. High-quality soils prevent water pollution by resisting erosion, absorbing and partitioning rainfall and snowmelt runoff, and degrading or immobilizing agricultural chemicals (National Research Council, 1993).

Table 8.13 illustrates the five-year action plan for years 2001 – 2005 for controlling sedimentation and associated nonpoint pollution resulting from agricultural erosion.

Table 8.14 is the Needs, Priorities and Milestones from the 1994 NSMPP. It is provided for comparison.

TABLE 8.11

Current Federal Activities in Agricultural Erosion & Sediment Control

Agency	Program	Program Delivery
NRCS	**Technical Assistance:** Assistance in planning and implementing practices on any land use for a wide variety of purposes including soil erosion, water conservation, water quality, gully control, soil productivity and animal waste management.	**District Conservationists** provide assistance to individuals, groups and governments as requested and as priorities allow. Contact county office to request technical assistance.
NRCS	**Cooperative River Basin Studies:** Efforts with other federal, state, and local agencies to appraise water and related resources and develop plans for conservation, use and development.	**Sponsors** of river basin projects requests assistance through Minnesota State Office.
NRCS	**Flood Plain Management Studies:** Provide assistance to local and state agencies for programs to reduce existing and future flood damages.	**Project sponsors** request assistance through Minnesota State Office.
NRCS	**Soil Survey Program:** Identifies, maps and interprets soils to assist users in understanding and using soil wisely.	**District Conservationists** provide assistance to any user upon request.
NRCS	**National Resource Inventories:** Collects data on land use, management, and conservation treatment needed to help public and private organizations, groups, and individuals make land use decisions.	**Inventory Specialist** provides inventory data to all users. **District Conservationists** provides county level data to local users.
NRCS FSA	**Sodbuster Program:** Determines if fields are highly erodible and have been broken out of native vegetation. Provides assistance to develop and implement conservation plans on highly erodible fields. Farm programs benefits denied by other federal agencies if violations occur.	**NRCS District Conservation** make technical determinations. **FSA County Executive Directors** oversee administration.
NRCS FSA	**Conservation Compliance:** Determines if cropland fields meet the highly erodible definition. Provide assistance to develop and implement conservation plans on highly erodible fields. Farm program benefits denied by other federal agencies if violations occur.	**NRCS District Conservationists** make technical determinations and assist preparation of conservation plans. **FSA County Executive Directors** oversee administration.
NRCS	**Environmental Quality Incentive Program:** Provides cost-sharing to agricultural producers for conservation practices that prevent soil erosion and water pollution, conserve water, preserve and develop wildlife habitat and encourage energy conservation.	**NRCS District Conservationists** accept applications, make technical determinations and provide technical assistance to install the desired practices.
FSA NRCS	**Conservation Reserve Program (CRP) and the Conservation Reserve Enhancement Program (CREP):** Provides annual rental payments to agricultural producers for 10 to 15-year retirement of certain cropland that is highly erodible or contributes to water quality problems. Also provides cost-sharing to establish necessary conservation practices.	**Local FSA offices** accept applications from producers; **Conservationists** assist preparation of conservation plans and installation of necessary practices.
NRCS	**Small Watershed Protection & Flood Prevention Program:** Assist local project sponsors to develop and implement watershed plans. Projects may include watershed protection, flood prevention, erosion and sediment control, or animal waste management.	**Sponsors** of watershed projects requests assistance through Minnesota State Office.

TABLE 8.12

Current State Activities in Agricultural Erosion & Sediment Control

Agency	Program	Program Delivery
BWSR	**General Services Grants**: Provides assistance to SWCDs to administer programs.	**Local SWCDs** provide technical assistance to individuals, groups and other local units of government as requested and as priorities allow. General services grant helps support these services.
MPCA	**Nonpoint Source Pollution Management Program**: Variety of activities to assess and reduce pollution of surface and ground water from nonpoint sources.	**MPCA Central Office and regional offices**, in cooperation with local governments and other state and federal agencies, implement the various management strategies.
BWSR	**Local Water Resources Protection and Management Program**: Provides grants to counties to assist in administration and implementation of approved and adopted local water plans. Inventorying, monitoring and data collection are allowed.	**BWSR administers the program through counties**. Local water planning task forces are often involved. Counties must have a state approved and locally adopted plan.
MPCA	**Clean Water Partnership Program**: Matching grants and technical assistance to local governments to conduct watershed management projects to protect and improve surface and ground water degraded by nonpoint pollutants. Pollution sources must be identified and assessed, and a watershed implementation plan that identifies best management practices must be implemented.	**Sponsors (local governments)** of projects request consideration through **MPCA Central Office.**
MPCA	**Clean Lakes Program**: Provide financial assistance through matching grants and technical assistance to local governments to lead lake restoration projects with an emphasis on watershed management. Data collection, problem identification, and a restoration plan must be implemented.	**Sponsors (local governments)** of projects request consideration through **MPCA Central Office.**
MPCA	**Minnesota River Projects:** Identifies, monitors and assesses nonpoint source pollutant loadings.	**MPCA Central Office** coordinates cooperating agencies and a Citizen Advisory Committee.
DNR	**Shoreland Management Program:** Establishes standards for development of shoreland areas including subdivisions, structure setbacks, vegetative management, land alterations, agricultural activities, and on-site wastewater systems.	**DNR** sets standards and local governments incorporate into their ordinances. **DNR** also reviews and comments on certain local zoning actions.

Agency	Program	Program Delivery
BWSR	**Erosion Control & Water Quality Protection and Improvement Cost-Share Program:** Provides financial assistance to landowners for installation of erosion and sediment control and water quality protection practices.	**BWSR administers the program through SWCDs.**
BWSR	**Reinvest in Minnesota (RIM) Reserve Program and CREP:** Retires marginal agricultural lands from crop production through conservation easements. Landowners are compensated for conveying limited duration or perpetual easements that prohibit cropping, grazing and drainage of the easement areas enrolled.	**BWSR administers the program through SWCDs.**
MDA	**The Agricultural Best Management Practices Loan Program (Ag BMP Program)** portion of the State Revolving Fund (SRF) may be used to purchase conservation tillage equipment, for streambank stabilization projects, terracing, and other erosion control measures. These loan funds will be used on their own, or to leverage projects funded by cost share and other sources of public and private funding.	MDA

Current Local Activities in Agricultural Erosion & Sediment Control

Agency	Program	Program Delivery
SWCD	**Technical assistance:** Assistance in planning and implementing practices on any land use for a wide variety of purposes including soil erosion, water conservation, water quality, gully control, soil productivity and animal waste management.	**SWCD staff** provide assistance to individuals, groups and governments as requested and as priorities allow.
County	**Local Comprehensive Water Plan:** Document is compilation of local water resources and related resources data which identifies, inventories, and assesses local natural resources. Also contains general and specific strategies that will be implemented by local units of government.	**County water plan coordinators** provide overall local coordination of implementation activities identified in the plan. Often **local SWCD** has a role in implementation.
Met Council	**Minnesota River Project:** Special funds that the Council can grant to local governments to implement nonpoint source pollution programs or other measures to protect and enhance the quality of the Minnesota River.	**Council and participating local governments** develop projects that are implemented at the local level.

BEST MANAGEMENT PRACTICES (BMPs)

The following Agricultural BMPs are commonly used to reduce nonpoint source pollution from agricultural erosion areas. This list is not comprehensive and does not suggest additional BMPs would have no benefit. Please refer to Part I Appendix B Best Management Practices of this 2001 NSMPP for definitions of the following BMPs.

Part I Agricultural BMPs

1 Access Road
4 Conservation Crop Rotation
5 Contour Farming
8 Critical Area Planting
11 Diversion and Terraces
12 Fencing
13 Field Border
14 Field Windbreak
16 Grade Stabilization Structure
17 Grassed Waterway or Outlet
20 Irrigation Water Management
21 Lined Waterway or Outlet
22 Use Exclusion
23 Mulching
25 Pasture and Hayland Management
26 Pasture and Hayland Planting
28 Prescribed Grazing
30 Residue Management (no till, strip till, mulch till and ridge till)
31 Residue Management-seasonal
33 Riparian Buffer
37 Streambank Protection
38 Stripcropping
40 Tree Planting
41 Vegetative Filter Strip
44 Water and Sediment Control Basin

Chapter 8 Agricultural Erosion
Needs, Priorities and Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) 5-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Goal 1: Improve Interagency Coordination in the Development and Implementation of Statewide Policies and Programs Concerning Agricultural Erosion and Sediment Control.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop and refine a comprehensive strategy for integrating federal farm policy and programs into state and local policy and programs.	X	X	X	X	X	State general fund	Board of Water and Soil Resources (BWSR) and the USDA State Technical Committee (STC)
2. Meet and confer on technical and policy issues, share relevant information, coordinate regulatory and other activities and collaborate on strategic and locally directed planning associated with agricultural erosion and sediment control.	X	X	X	X	X	State general fund	BWSR and the STC.

Goal 2: Improve Technical Assistance and Education Associated with the Application and Adoption of Best Management Practices (BMPs) for Agricultural Erosion and Sediment Control.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Identify needs and develop training programs for individuals planning and applying BMPs.	X	X	X	X	X	State general fund and fee supported.	BWSR and the Natural Resources Conservation Service (NRCS).
2. Develop and distribute informational materials and conduct associated workshops.	X	X	X	X	X	State general fund and fee supported.	University of Minnesota (U of M).
3. Develop and implement a process to evaluate the effectiveness of information and education programs.	X	X	X	X	X	State general fund.	U of M

Goal 3: Continue to Improve the Reliability and Accuracy of Decision-Making Tools Associated with Agricultural Erosion and Sediment Control.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Increase the level of associated technical evaluation and research.	X	X	X	X	X	State general fund.	U of M
2. Continue to promote and integrate the Local Annual Reporting System (LARS) with other agencies.	X	X	X	X	X	State general fund, 319.	BWSR, MPCA.
3. Evaluate the environmental and economic effectiveness and adoption rates of agricultural erosion and sediment control BMPs.	X	X	X	X	X	State general fund, 319.	BWSR, U of M and MPCA.
4. Investigate different techniques of gathering and displaying soils information.	X	X	X	X	X	State general fund.	BWSR, NRCS and U of M.
5. Develop and implement a technique for using satellite imagery to assess the level of crop residue.	X	X	X	X	X	State general fund.	U of M
6. Develop and implement a field-scale BMP audit component for LARS.	X	X	X	X	X	State general fund.	BWSR

Goal 4: Increase the Adoption and Effectiveness of Agricultural Erosion and Sediment Control BMPs.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop and implement demonstration projects to illustrate how agricultural erosion and sediment control BMPs can be integrated into different farm-scale production systems.	X	X	X	X	X	State general fund.	BWSR and U of M.
2. Promote the use of crop residue management.	X	X	X	X	X	State general fund and EQIP.	BWSR, NRCS and U of M.
3. Monitor, model and evaluate the effectiveness of BMPs at various watershed scales.	X	X	X	X	X	State general fund.	MPCA and U of M.
4. Conduct research for improved estimation of sediment loading from stream bank erosion.	X	X	X	X	X	State general fund.	U of M

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5. Develop and better understanding of the effect of sediment in water.	X	X	X	X	X	State general fund.	U of M and MPCA.

Goal 5: Focus Agricultural Erosion and Sediment Control Activities in Watersheds Contributing the Most Sediment.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Encourage state and local governments to use watershed assessment and planning techniques.	X	X	X	X	X	State general fund.	BWSR
2. Develop and distribute guidance for targeting agricultural erosion and sediment control BMPs at the sub-watershed or smaller scale.	X	X	X	X	X	State general fund.	U of M

1994 NSMPP
Needs, Priorities and Milestones

The following Table provides the Goals and Action Steps included in the 1994 NSMPP. The Products, Services and Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps. Implementation of all action steps is contingent upon adequate funding and local involvement.

Goal 1: Develop Long-term Consistent and Clear Statewide Policies on Agricultural Erosion and Sediment Control Issues through Improved Interagency Coordination.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Develop a comprehensive strategy for an agricultural erosion and sediment control program to address federal, state and local requirements.	None	BWSR, MPCA, MDA, NRCS.	Interagency topics are discussed on a continuous basis.
2. Establish long-term coordination committee to address programmatic issues, share technical information and improve strategic planning for implementation of agricultural erosion and sediment control measures. Needs with potential to be addressed by this group include: a. Clarify specific roles of the various state and local agencies, land users and their associations; b. Clarify how the various rules (e.g. federal farm policies) apply to specific situations (e.g., forestry activities within agricultural areas; riparian pasture management; etc.);	None	BWSR, MPCA, MDA.	Interagency topics are discussed on a continuous basis.
c. Develop process for coordinating and distributing BMP implementation and effectiveness information statewide;	319	BWSR, MPCA, MDA.	State Local Annual Reporting System (LARS)

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
d. Define the existing and future roles of local water planning to guiding federal and state priorities and programs; e. Provide forum on status and upcoming requirements of federal programs; and f. Examine role of each agency with respect to ensuring policies are consistent, and develop issue papers relating findings and identifying areas that need further coordination.	None	BWSR, MPCA.	Interagency topics are discussed continuously.
3. Develop coordinated federal, state, and local policies for consistent use of agricultural erosion and sediment control BMPs. Policies would address: a. Coordinate local water management planning and requirements with state and federal efforts; b. Develop approved water quality standards for NPS (i.e., agricultural erosion and sediment control); and c. Develop management strategy for agricultural erosion and sediment control with achieves compliance with federal programs.	None	BWSR, MPCA, MDA, NRCS.	Interagency topics are discussed continuously.
4. Develop a coordinated policy on how local, state and federal programs will be implemented. This policy would address ways to integrate local planning process and state programs so that local, state, and federal programs will be consistent.	None	BWSR, MPCA, MDA, NRCS.	Interagency topics are discussed continuously.

Goal 2: Establish an Effective Technical Assistance and Education Delivery System Focused on Improving Water Quality through Application of Agricultural Erosion and Sediment Control BMPs. To Achieve Maximum Effectiveness, Target Audiences for Education and Information Delivery Would Include Both Local Resource Managers and the General Public, Whereas Target Audiences for Technical Assistance Would Primarily Involve Local Resource Managers.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Reestablish a soil and water conservation specialist position within the Minnesota Extension Service of the University of Minnesota.	State general fund.	Board of Water and Soil Resources (BWSR) and University of Minnesota Extension Service.	A conservation agronomist was hired who conducts training for local government and is involved in many conservation tillage-oriented endeavors.
2. Accelerate availability of technical assistance to producers by increasing the number of technicians in local SWCD offices.	State general fund.	Board of Water and Soil Resources.	An additional 20 technicians were hired by SWCDs.
3. Evaluate the need for developing an erosion and sediment control specialist certification/training program to address contractors, administrators and installers/inspectors.	State general fund.	BWSR, Minnesota Pollution Control Agency (MPCA), USDA Natural Resources Conservation Service (NRCS) and the Minnesota Erosion Control Association.	The group has continued to refine the need for a certification program, including the need for staff. An effort is underway to finalize funding for a staff person.
4. Develop both informational materials and educational workshops related to development of integrated farm pollution prevention plans. Workshops would be targeted toward: a. providing technical assistance to landowners and landusers; and b. providing assistance to local governments for writing and interpreting guidance for the integrated farm pollution prevention plans.	State general fund.	BWSR, Minnesota Department of Agriculture, NRCS and MPCA.	Many workshops and training sessions were held as separate sessions and as integrated material within ongoing planned activities.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
5. Develop public education process for exchange of information between federal and state agencies, local governments, various researchers and landowners and landusers.	None	U of M	UM Extension is leading this effort and has produced workshops and publications.
6. Develop process to evaluate effectiveness of information and education programs and activities.	None	U of M	Work is on-going by Extension.
7. Evaluate proper utilization and combinations of agricultural erosion and sediment control measures for varying sets of circumstances within watersheds.	None	U of M, BWSR, MPCA, MDA, NRCS.	Has been integrated in watershed projects as components of the work plan.

Goal 3: To Improve the Reliability and Technical Accuracy of Future Decision-Making Capabilities by Increasing the Level of Technical Evaluation and Research, and Research, and by Focusing this Evaluation and Research on Minnesota's Most Pressing Agricultural Erosion and Sediment Control Issues.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Develop agricultural erosion and sediment control BMP auditing process to establish where BMPs are being implemented, if they are being installed correctly, and whether or not they are effective.	None	BWSR, MPCA, MDA.	MN LARS program records BMP location and environmental effectiveness.
2. Evaluate the cost effectiveness (i.e., agronomic and environmental considerations) of agricultural erosion and sediment control measures.	None	BWSR, MPCA, MDA.	Some work has been done, mostly in the Minnesota River Basin and through MN LARS program.
3. Evaluate long-term effectiveness and acceptance of agricultural erosion and sediment control BMPs, including: a. maintenance responsibilities; b. surface and ground water impacts; c. enhancement of soil quality; and d. enhancement of water quality.	None	BWSR, MPCA, MDA.	None

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
4. Soil surveys: a. preparation for all counties; b. update existing soil surveys; and c. accelerate digitization and automation of soil survey data.	USDA and county funding.	NRCS, U of M, BWSR.	54 of 87 counties will have initial soil surveys.
5. Research and develop soil erosion susceptibility and sediment potential maps.	USDA and county funding and State funding from the Legislative Commission on Minnesota Resources.	NRCS, University of Minnesota and BWSR.	10 of 87 counties will have initial soil surveys updated and about 50 of Minnesota' 87 counties have digital soils information suitable for GIS application.
6. Data coordination: a. Improve NPS assessment procedures; and b. Develop data management system for BMP implementation and effectiveness including a plan for entering monitoring data into computer systems, systematic analysis of data, and compilation of field-level BMP audits in priority areas. c. Develop a minimum data set of soil quality parameters as suggested by the national Academy of Science and ensure county-by-county coverage of soil conservation data items of high priority to the state for all future National Resources Inventories conducted by NRCS, beginning in 1997.	319	BWSR, MPCA.	MN LARS accomplishes some of these action steps.

Goal 4: Increase Adoption and Improve Appropriate Application of Agricultural Erosion and Sediment Control BMPs through Evaluation of Existing BMPs and Identification of New Types of BMPs Needed to Meet Water Quality Goals.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Develop guidance for targeting the physiographic features where certain agricultural erosion and sediment control BMPs (or combination of BMPs) would be most effective.	State general fund.	University of Minnesota and Minnesota Department of Agriculture.	Agriecoregion maps were developed.
2. Implement a demonstration project to illustrate the significance of agricultural erosion and to show the integration of water quality BMPs into several distinctly different agricultural production farms and use as statewide models.	None	BWSR, MPCA.	Demonstrations are part of many water quality projects and the White River Project is an example of a specific demonstration project.
3. Evaluate and develop hydrologic modification BMPs addressing the impacts of: a. drainage (subsurface and surface); b. effects on wetland habitats and flow; and c. effects on streambank and lakeshore stability.	None	U of M, BWSR, MPCA, NRCS.	Drainage research is being conducted jointly by Iowa State University and the University of Minnesota.
4. Evaluate ways to mitigate artificially extended "bankful" flow in developed areas of extensive drainage systems.	See 3. Above	See 3. Above	See 3. Above
5. Conduct a field-level audit of agricultural erosion and sediment control measures.	None	BWSR, MPCA, NRCS.	None

Goal 5: Improve Compatibility Between the Various Federal, State and Local Regulatory Programs so that There Is Consistency Between the Various Regulatory Requirements.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Identify and evaluate local, state and federal regulations relating to agricultural erosion and sediment control.	None	BWSR, MPCA, MDA.	None

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
2. Develop model ordinance for agricultural erosion and sediment control for local governments.	None	BWSR	None
3. Work with local governments to revise, upgrade, or develop agricultural erosion and sediment control ordinances.	None	BWSR, MPCA.	None
4. Improve enforcement efforts so that local, state and federal agencies are consistent.	None	None	None
5. Assess landowners' compliance with federal, state and local regulations for control of agricultural erosion and sedimentation.	None	None	None

Goal 6: Focus Agricultural Erosion and Sediment BMP Planning and Implementation Activities on a Watershed Basis to More Effectively Assess Water Quality Needs and Better Demonstrate Implementation Successes.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Model and evaluate potential impact of proposed BMPs for site specific watersheds and waterbodies.	None	BWSR, MPCA, MDA.	Work on-going statewide, especially in the Minnesota River Basin.
2. Assess ways to more effectively implement policies which avoid, minimize and mitigate the impacts of agricultural erosion and sedimentation, evaluating such methods as: a. permanent and long-term land retirement (where appropriate); b. alternative crops and crop management systems (including agro-forestry applications); c. monitoring of BMPs (funding and planning for follow-up to BMP installation); d. monitoring of impacts (ways to monitor and methods of finding out the impacts).	USDA and state general funds.	USDA, BWSR.	About 1.5 million acres of cropland is enrolled in the Conservation Reserve Program and approximately 115,000 acres of environmentally sensitive cropland has been enrolled in permanent conservation easements.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Examine local, state, federal and private funding mechanisms to identify ways of implementing programs. For example, provide guidance or position papers on: a. information sources and methods of funding; and b. assessment formulas and legitimate uses of funds.	None	U of M, BWSR, MPCA, MDA, NRCS.	Integrated in promotional material and program guidance for a host of federal and state programs.
4. For prioritized watersheds, encourage governments to use watershed assessment and planning to develop implementation approaches that address specific water quality improvement goals.	State general fund and local government funding.	BWSR and MPCA.	Watershed planning and assessment techniques were promoted by agencies in their ongoing land and water programs.

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Chapter 9 Agricultural Nutrients

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Health and Environmental Concerns Associated With Agricultural Nutrients

HUMAN HEALTH CONCERNS

Nitrogen (N) and phosphorus (P) are the primary nutrients posing the greatest environmental threat to Minnesota's surface and ground waters. Nitrogen effects on human, domestic animals and aquatic species have been summarized for Minnesota conditions in Nitrogen in Minnesota Ground Water (DeLuca, 1991) and recently in Generic Impact Statement on Animal Agriculture (Mulla et al., 1999). The principle human health concern associated with nitrate consumption (via drinking water or dietary intake) is methemoglobinemia, a condition that affects the respiratory system in infants. The most recent reported case of methemoglobinemia in Minnesota was a non-fatal case that occurred in 1979. However, it is highly probable that the numbers of reported cases are seriously underestimated since most states, including Minnesota, do not have an established methemoglobinemia medical registry. Little is known about the long-term impacts on adults. A limited number of recent studies suggest linkages between drinking-water nitrate and non-Hodgkin's lymphoma (Ward et al., 1996; National Cancer Institute, 1998) and stomach cancer (Freshwater Foundation, 1995).

Eutrophication in surface waters can be rapidly accelerated by phosphorus and nitrogen enrichment and the toxic breakdown chemicals from algae decomposition pose health concerns in drinking supplies (Sharpley et al., 1999). Recent outbreaks of Pfiesteria in the Chesapeake Bay area have also been linked to excess nutrient loading.

GROUND WATER CONCERNS

Approximately 73% of Minnesota's population relies on groundwater aquifers for its water supply. Ninety-nine percent of the state's 1,700 public supply systems[1] and an additional 450,000 private wells utilize groundwater aquifers as a primary source of drinking water. Less that 1% of the public

[1] MDH categorizes public water supplies into two broad groups: Community and Non-Community systems. Community (Residential) systems include 700 Municipal (Cities) and 300 Non-Municipal suppliers (mobile home parks, etc). Non-Community systems include 750 Non-transcient (schools, daycare centers, etc). See Mulla et al (1999) for additional details.

supplies exceed the 10 mg/Liter (mg/L) nitrate-N public health standard established by the U.S. Environmental Protection Agency (USEPA). A brief discussion on communities using water supplies that are impacted by agriculture will follow later in this chapter.

Estimates of the proportion of the state's private wells that exceed the health standard are considerably greater. Results vary drastically due to biases in the types of wells used in the analysis. The MN Department of Health (MDH) recently reported[2] that 7% of all public and private wells exceeded the health standard (Figure 1). This data set is dominated by the County Well Index (28,000 wells) but also includes MDH Public Water Suppliers (1,000), the Private Well Survey (750) by the Centers for Disease Control and Prevention along with the MDH, and the Minnesota Pollution Control Agency's (MPCA) Ground Water Monitoring and Assessment Program. This data set does not include any representation from the 8,000 non-community wells classified as transient (campgrounds, churches, etc). Private wells within this dataset are primarily those which incorporated the construction improvements required by the mid-1970's well code. Similar to public supply systems, these newer private wells tend to be deeper and fewer are completed in aquifers with known elevated nitrate levels. In some areas, such as the southeastern Karst region, new well construction in the shallower aquifers is prohibited.

Recent results based on 21,000 wells (1995-98) from the Minnesota Department of Agriculture's (MDA) Nitrate Water Testing Program (Gallus and Montgomery, 1999) suggest that 12 to 15% exceed the health standard. This data set is more inclusive of a broader age of wells and types of well construction (including sand points, dug wells and other non-approved construction methods) than the MDH data set. These results also represent a great deal of diversity in geologic conditions and land use since sixty to seventy counties participate in this program each year.

[2] Found in Mulla et al., 1999.

Clinics within each county tend to be located by local cooperators in the most problematic areas hence potentially skewing the data. Additionally, there are slight tendencies for wellowners with more vulnerable wells to participate in these voluntary clinics. However, based on the fact that 40-50% of the clinic participants have either never previously tested their drinking water supply or at least ten years have passed since their supply was last tested, this bias characteristic is probably minor.

SURFACE WATERS

Twenty-seven percent (1.2 million) of Minnesotans rely on surface waters for their drinking water supply. Although there are only approximately 24 communities (Figure 2) that use surface water supplies, these are very important systems since five of them deliver to large population bases (Twin Cities, Moorhead, St. Cloud, Mankato, and Duluth). The remaining systems serve small to medium-sized communities with many located along the Lake Superior shores.[3] Heiskary and Tomasek (2000) reported that there are also approximately 64 transient non-community water suppliers that use surface waters. Surface waters in Minnesota typically have low nitrate concentrations; this certainly holds true for supplies pumped from the Mississippi River and Lake Superior area suppliers. These community water suppliers are much more concerned about pathogens rather than nutrient concentrations.

The cities of Mankato and Fairmont are exceptions and have nutrient-related problems in their surface water supplies. Mankato, which draws a portion of its water supply from materials immediately below the Minnesota River, has a history of nitrate problems. Mulla (1997) reported that the nitrate-N levels exceeded 10 mg/L in the Minnesota River between St. Peter and Jordan ten percent of the sampling times during 1964 to 1994.

[3] Several communities in northeastern MN use abandon taconite mine pits for water supplies.

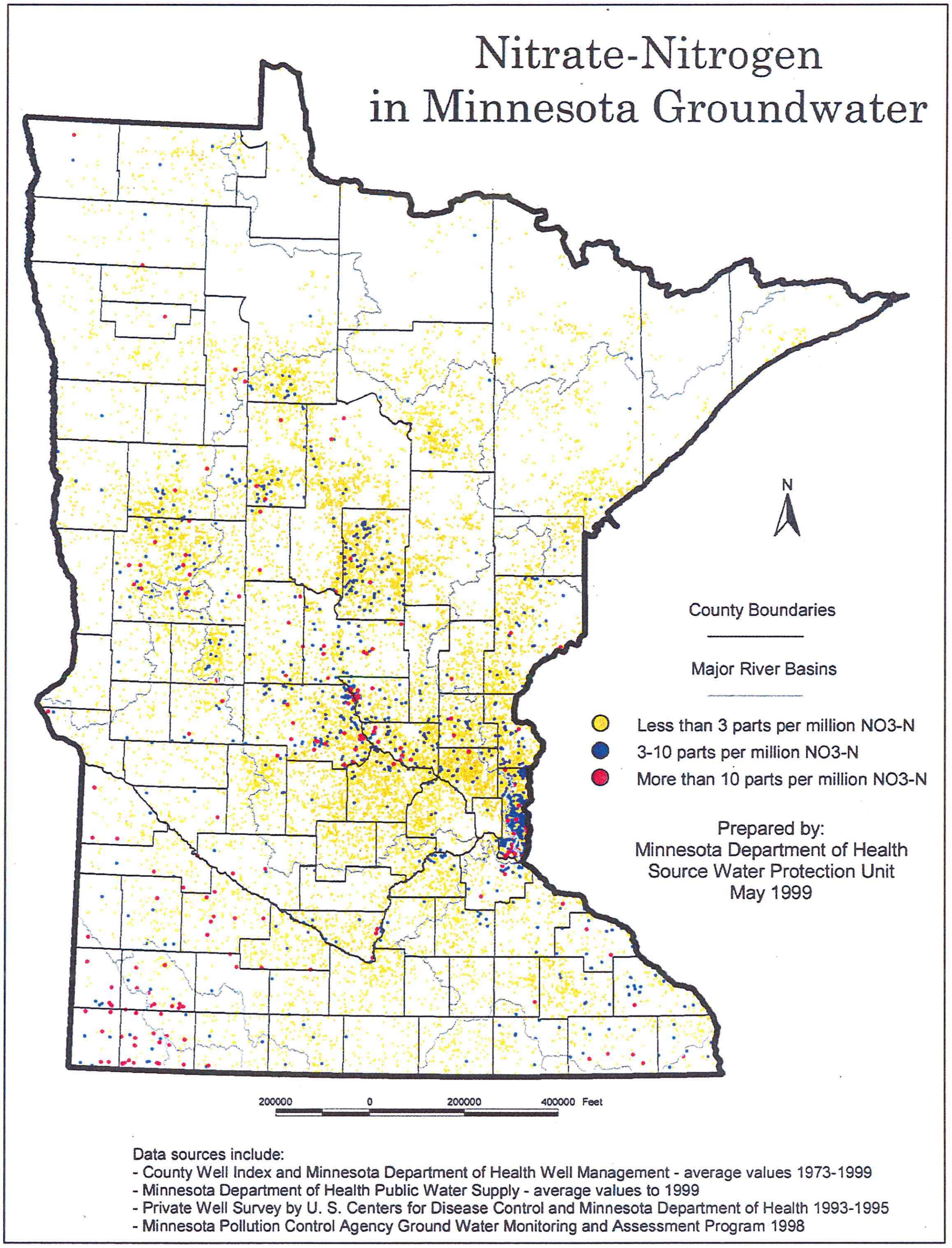


Figure 1. Nitrate-N concentrations from the County Well Index and various monitoring programs that have been operational since the 1970's. Data prepared by the MN Department of Health-Source Water Protection Unit, 1999.

Community Water Supplies Using Surface Water Supplies in Minnesota

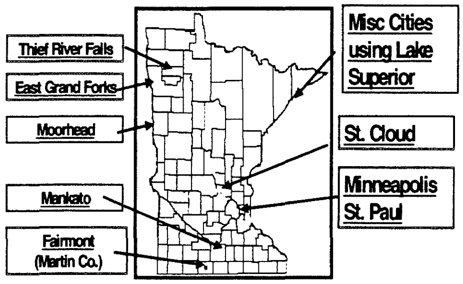


Figure 2. Locations of the approximately twenty-four community water supply systems that are reliant on surface waters for drinking water.

Fairmont is faced with high levels of trihalomethanes, a chemical byproduct induced by the aggressive chlorination dosages necessary to treat their drinking water supply. The Chain of Lakes, which the city is built around and serves as its drinking water source, is prone to prolific algae blooms resulting from heavy sediment, phosphorus and nitrate loadings that are due, in part, to surface runoff and tile-drainage waters from the surrounding farmland and animal feedlots.

NUTRIENT IMPACTS ON WATER RESOURCES

On a national level, the Environmental Protection Agency (EPA, 2000) estimates that about 90% of the nitrogen loading into water resources originates from non-point sources (65% from agricultural NPS and the remainder from other NPS). Also on a national level, it is estimated that 36% of rivers and streams and 39% of the nation's lakes are impaired[4] (Mulla et al., 1999). Agriculture was identified as the primary cause of impairment in 70% of the river and streams. In Minnesota, sixty percent (60%) of the surveyed rivers and streams and 17% of the surveyed lakes have been classified as impaired. Agriculture was identified as the cause of 90% of the impaired river miles and 64% of the impaired lake acres (Mulla et al., 1999). Most urban nonpoint studies, although limited in numbers, suggest that while pesticides, plant residue (primarily derived from grass clippings and leaf litter and leading to increased biological oxygen demand) and phosphorus loads can be significant, nitrogen contributions are relatively small (Heiskary and Tomasek, 2000; Montgomery, 1991a)

While nitrogen can have adverse effects on both surface and ground water, phosphorus problems are predominately associated with surface water. Erosion and runoff from watersheds are major pathways of phosphorus movement into surface waters. Surface tile intakes on drained farmland, particularly in south central Minnesota, are also a potentially large source of sediment-bound phosphorus to surface waters. Unlike nitrogen, significant P contributions can originate from urban landscapes and point sources such as municipal treatment plants.

Eutrophication is the most visible indicator of excessive nutrient loading in freshwater systems. Symptoms of eutrophication include algal blooms, algal mats, luxuriant development of selected aquatic macrophytes, and oxygen depletion. Generally phosphorus, rather than nitrogen, is considered the limiting growth factor in freshwater aquatic systems. However, excessive loading of nitrogen may, in certain cases, stimulate the growth of algae and contribute to eutrophication.

Recently there has been major national attention focused on the Gulf of Mexico hypoxic zone. This large area (7,000 square miles in 1997) on the northern end of the Gulf has been found to be deficient in dissolved oxygen supplies and dramatic ecological changes are occurring. The formation of the zone is strongly correlated with increasing levels (2 to 7 times) of nitrogen (N) loading over the past century

[4] Impairment is defined as water bodies that could not attain the goals and standards set forth in the Clean Water Act and state regulations.

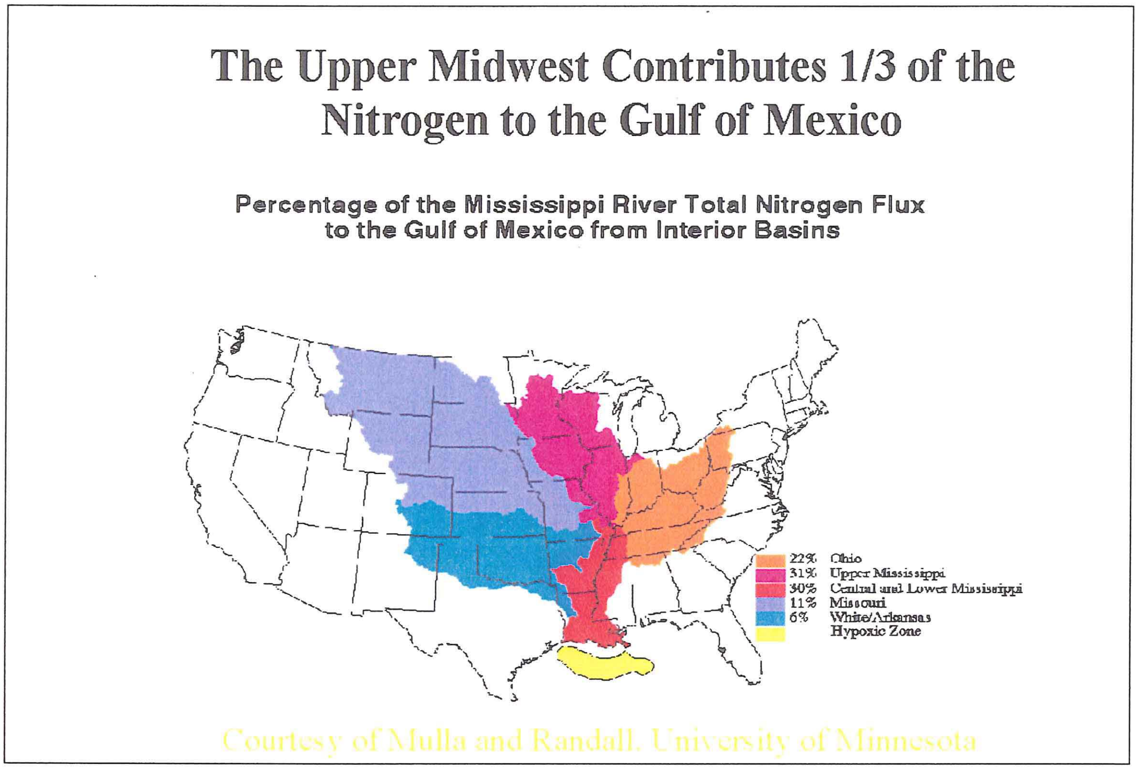


Figure 3. Percentages of total nitrogen flux to the Gulf of Mexico from the major interior basins of the Mississippi Watershed (Goolsby et al., 1999).

from the Mississippi River Basin. Changes in silicon (Si) and phosphorus (P) also play a role and the changing balances of N, Si and P can affect the marine food chains (CAST, 1999). A series of comprehensive national reports covering a multitude of hypoxia-related issues have recently been released (Brezonik et al., 1999; Goolsby, et al., 1999; Mitsch et al., 1999; and Rabalais et al., 1999).

Implications to the Corn Belt States could be very significant. It has been estimated that the upper Midwestern states (portions of Iowa, Illinois, Wisconsin and Minnesota) contribute over one-third of the nitrogen loading to the Gulf (Goolsby et al., 1999) (Figure 3). The Upper Mississippi Basin, which drains a large amount of Minnesota and western Wisconsin, accounts for approximately 10% of the nitrogen flux to the Gulf. The Minnesota River Basin contributes roughly two-thirds of the nitrogen exported from the state.

Sources of Agricultural Nutrients

Annual nitrogen input (plant available forms) on a statewide basis was originally estimated between 1.4 to 1.8 million tons (Montgomery, 1991b). The relative magnitude[5] of the various individual sources was also estimated; these estimates included contributions from soil organic matter, agricultural inputs, municipal treatment output and atmospheric deposition. Agricultural inputs from fertilizer, manure, and legume credits account for approximately half of the total statewide inputs. After excluding inputs over which there is little direct human control (atmospheric deposition and organic matter contributions), the reexamined budget loads

[5] The application of these estimates is only appropriate as a statewide overview with the recognition that the magnitude of an individual source is not necessarily directly related to the source's impact on water quality.

indicate that over 99% of the nitrogen added to the soil environment originates from agricultural sources. Estimates based upon the most recent agricultural census data (Department of Commerce, Census of Agriculture, 1997) project contributions from fertilizer, manures and legumes to be 73%, 12%[6] and 15%, respectively (Figure 4). These contributions, using similar assumptions and calculation methods, were very similar to the original calculations based on 1987 census figures (Montgomery, 1991b). The 1997 summation of these important N inputs is 973,000 tons which translates into an overall 90 lb/acre application rate across all of Minnesota's 20.4 million acres of cropland.

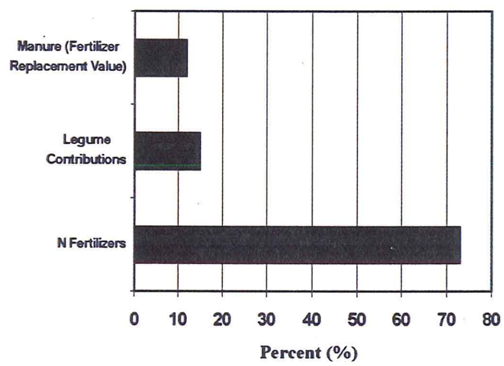


Figure 4. Comparison of the major agricultural nitrogen sources based upon the 1997 Census.

Nitrogen and phosphorus inputs to agricultural cropland, using the 1997 Census data, have been estimated on a county basis (Figures 5 and 6); values reflect the summation of fertilizer sales, manure[7] and legume inputs distributed evenly across all cropland regardless of the type of cropping system. Because the commercial fertilizer tonnages are based upon "point of sale" rather than the county where the product is actually used, this information is should only be used to provide the reader a method of comparing relative inputs on a cluster of counties rather than on an individual basis. The value of nutrient budgets for environmental implications is greatly enhanced when conducted on a localized level and budgets must consider a variety of factors such as yield goals, manure management techniques, timings and crop rotations.

Phosphorus can originate from a variety of sources including fertilizer and manure inputs, septage, and industrial wastes. Portions of the state (significant parts of the southeast, the Central Sands, and the seven county "Metro" area) have high native phosphorus levels due to the abundance of a mineral called apatite.

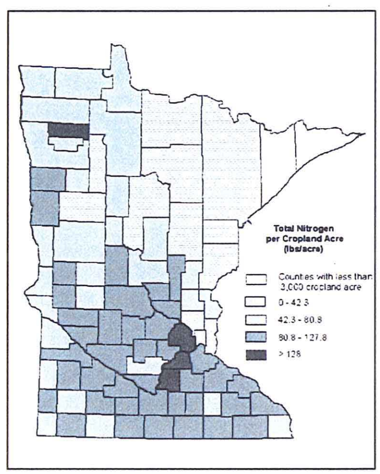


Figure 5. Nitrogen input estimates based on 1997 Census data for county nitrogen fertilizer sales, "fertilizer replacement" credits from manure and legume contributions. Inputs are averaged across all cropland acres within each county.

[6] Manure N contributions were calculated based upon the 1997 animal census for various species of livestock and poultry using nutrient output estimates from the Midwest Planner (Iowa State, 1985). Output numbers are then reduced by 50% recognizing that there are significant storage and application losses due to gas emission losses of ammonia, uncollected manure under pastured conditions and other losses. These adjusted values represent the land-applied portion of manure that ultimately becomes available for plant uptake and is referred to as the "fertilizer replacement value of manure".

[7] "Fertilizer replacement" value as previously defined for nitrogen. Phosphate contributions from manure are converted to replacement values by multiplying by 80%.

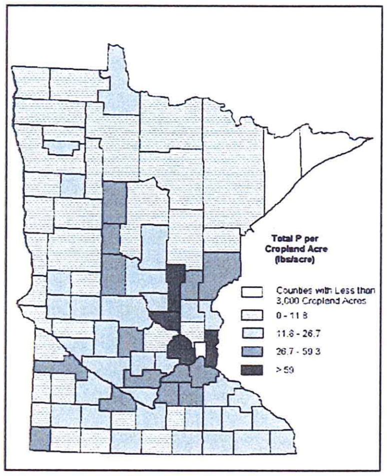


Figure 6. Phosphorus input estimates based on 1997 Census data for county fertilizer sales and "fertilizer replacement" values from manure contributions. Inputs are averaged across all cropland acres within each county.

COMMERCIAL FERTILIZER CONTRIBUTIONS

Like other Corn Belt states, Minnesota's dependence on commercial fertilizers during the past 40 years flourished as producers discovered the economic returns of fertility management, more productive corn hybrids were developed, and more land has been converted into annual crop production. Nitrogen fertilizer usage rapidly increased from approximately 40 pounds of nitrogen per acre from 1965 to 110 pounds/N/A in 1988 (Tennessee Valley Authority, 1988). Total annual nitrogen sales in Minnesota during the same time period increased from 100,000 to 600,000 tons.

Since the mid-1980's, sales have continued to slowly increase. Nitrogen fertilizer sales have increased 15-20% during the past 15 years (Figure 7). Annual nitrogen sales have averaged 678,000 tons over the past three cropping seasons. This upward trend in commercial sales is also observed in most of the neighboring states (Figure 8). Minnesota traditionally ranks sixth nationally in commercial nitrogen fertilizer sales following Iowa, Illinois, Texas, Nebraska and Kansas.

Despite the continued growth in fertilizer sales, there is little supporting data to indicate that these increases are due to increased application rates on a per-acre basis. The Minnesota Agricultural Statistics Service started reporting on fertilizer use in 1993. The average nitrogen application to corn during the period 1993 to 1999 was 112 pounds/acre with no significant increasing or decreasing trends.[8] Some of the increased sales can be explained by huge losses in small grain production; these acres are frequently replaced with corn, which requires greater N inputs (Figure 9). Less important, at least from a statewide perspective, is the increasing acreage of specialty crops such as potatoes, edible beans, and sugar beets.

Phosphate (P_2O_5) sales and inputs (per acre) have varied little since the 1960's. Annual sales range from 240,000 to 295,000 tons of phosphate per year (Figure 10). However despite the stable sales trends, there are significant concerns that these rates, along with manure contributions, have drastically altered the soil test P levels (Figure 11) (Randall et al., 1997).

[8] It is noted that the reported rates do not account for past cropping credits, manure applications, nor yield goal considerations

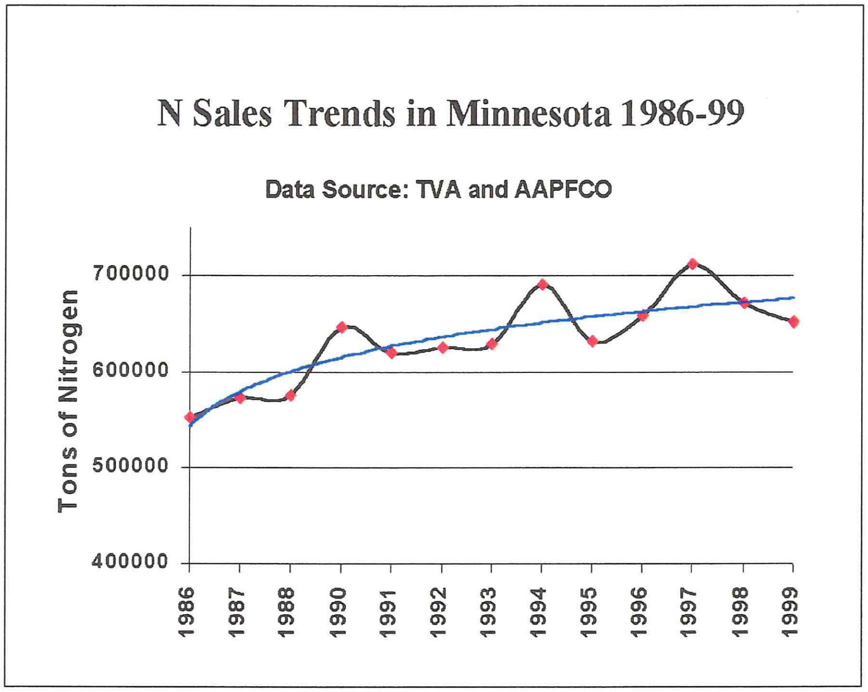


Figure 7. Minnesota's nitrogen fertilizer sales from 1986 to 1999.

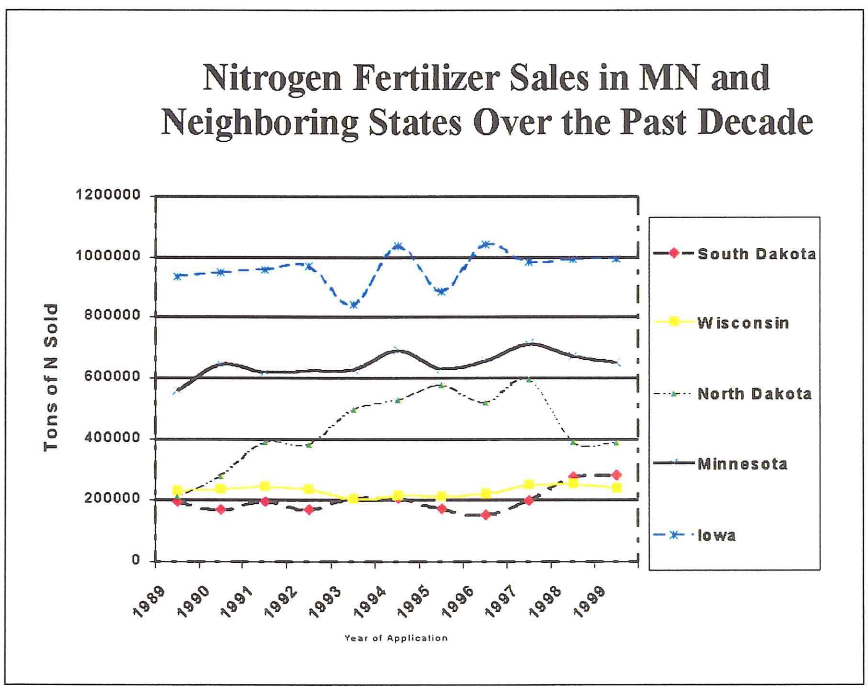


Figure 8. Trends in nitrogen fertilizer sales in Minnesota and its neighboring states over the past decade.

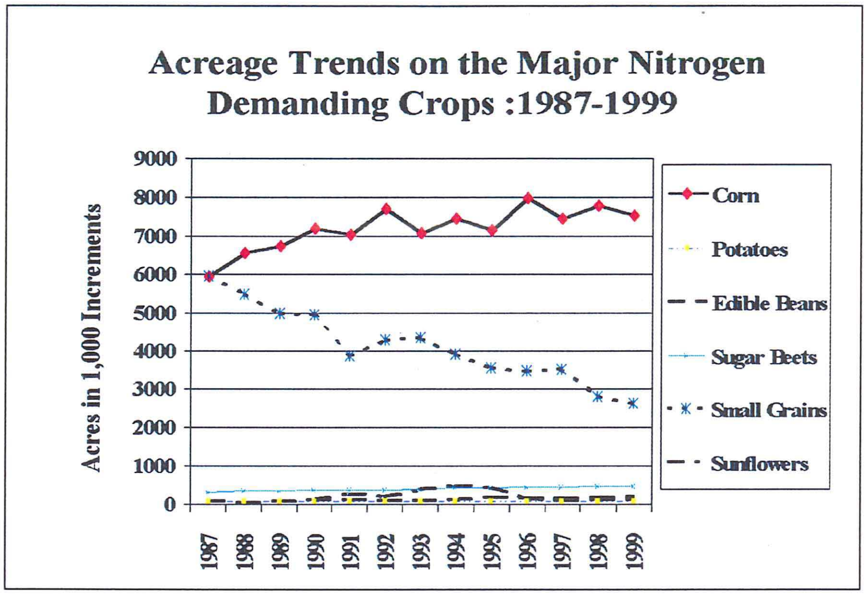


Figure 9. Acreage changes since 1986 on the major Minnesota crops that account of the majority of the state's nitrogen demand.

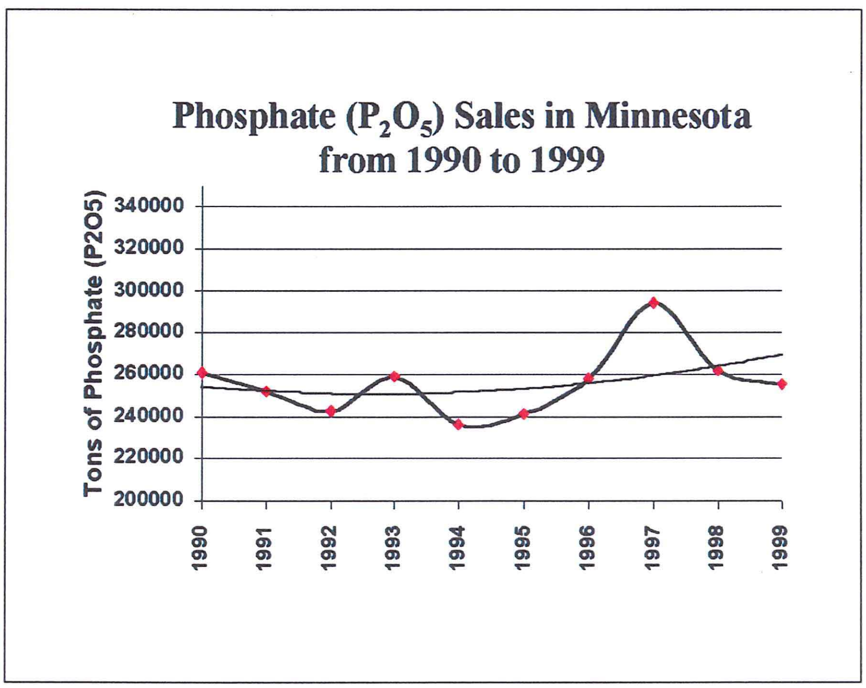
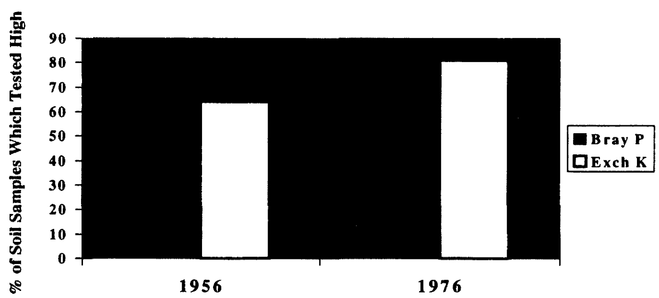


Figure 10. Phosphate fertilizer sales over the past decade.

Long-Term Soil Fertility Changes in Minnesota Soils



Definitions: High Bray P: 16-20 PPM

High K: 121-160 PPM

Figure 11. Changes in the soil test levels in phosphorus and potassium from 1956 to 1976. Taken from Randall et al., 1997.

MANURE CONTRIBUTIONS

This section and the subsequent "***Needs, Priorities, and Milestones: 2001-2005***" provides a brief overview of the relative importance of the nutrient contributions of manure from a land-application perspective and action steps to improve the management of this resource. Runoff and seepage problems associated directly feedlots and manure storage structures are addressed in Chapter 7.

Manure generated by Minnesota's livestock and poultry populations during the early 1990's produced 200,000 to 270,000 tons of total nitrogen per year (Schmitt and Rehm, 1993; Montgomery, 1991) and approximately 150,000 tons of phosphate per year (Schmitt and Rehm, 1993; Mulla, et al., 1999). For purposes of this report, the "nitrogen fertilizer replacement value" is considered to be approximately 50% due to storage and application losses. Based upon this assumption, the N contributions equivalent to commercial fertilizer was estimated between 100,000 to 135,000 tons/year. The "phosphate fertilizer replacement" value is frequently calculated as 80% of the total phosphate generated; the resulting phosphate contributions from manure were 120,000 tons/year. Fertilizer sales during this same time period ranged between 650,000-700,000 for nitrogen and 200,000-250,000 tons per year for phosphate. Using the 1997 Census animal populations and similar calculation methods as used in Schmitt and Rehm (1993), the most recent annual fertilizer contributions from manure are 120,000 tons of nitrogen and 130,000 tons of phosphate.

Animal populations, based upon animal units,[9] have decreased slightly since the mid-1960s (Figure 12). The most obvious changes over the past 30 years are the significant decreases in dairy numbers and increases in hog production. It is also worth noting that the number of livestock producers managing these important manure resources has decreased.

[9] For purposes of calculating relative manure production from a variety of different domesticated farm animals, state feedlot rules assume that manure production from one animal unit is equivalent to that produced by one mature cow (milked or dry) weighing less than 1000 pounds.

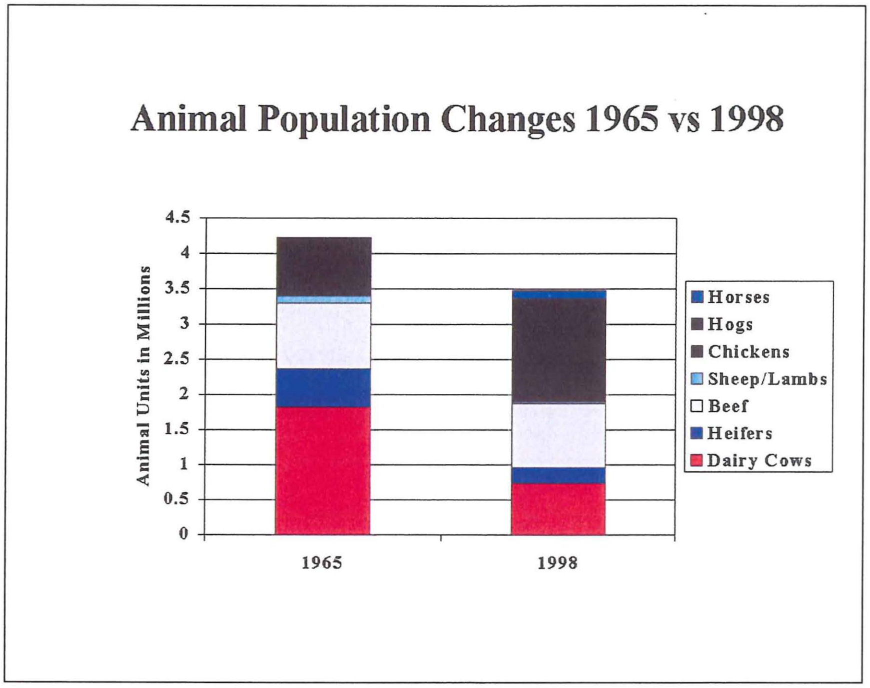


Figure 12. Comparison of animal units for the major domestic species from 1965 to 1998 (Data from Mulla et al., 1999).

Historically Minnesota has maintained high animal densities concentrated directly over portions of sensitive areas of the central portion of the state and the Southeast Karst area (Figure 13 a, b). Dairy is the most dominant animal industry in both of these regions; poultry is an additional important nutrient source in portions of the Central Sands. More recently, large increases in hog numbers have sparked numerous surface water concerns in heavier-textured soils that are drained with subsurface drainage systems and surface tile intakes.

Nitrogen fertilizer replacement contributions from manure vary greatly by county, ranging from 1 to 30 pounds per cropland acre (Figure 13a). Phosphorus contributions[10] across all cropland acres can be as high as 7-13 pound/A. While these numbers are relatively small in comparison to fertilizer inputs, manure applications tend to be concentrated on a small percentage of Minnesota's cropland.

What appears to be the overriding factor, regardless of the nutrient source, is how those resources are being managed (see next section).

LEGUME CONTRIBUTIONS

Subsequent nitrogen credits from past legume crops (primarily soybeans and alfalfa) contribute 15% of the current N agricultural inputs to Minnesota's cropland (Figure 4). Most producers can realize a 40 lb/acre reduction in commercial N fertilizer input requirements to corn following soybeans; producers on coarse-textured soils should realize a 20 lb/acre reduction under non-irrigated conditions (Rehm et al., 1994). Nitrogen credits for forage legumes are dependent upon the population density prior to termination and credits typically range from 75 to 150 lb/acre.

[10] Note that the units in Figure 13b are expressed in phosphorus units rather than phosphate. To convert from P to P_2O_5, multiply by 2.29.

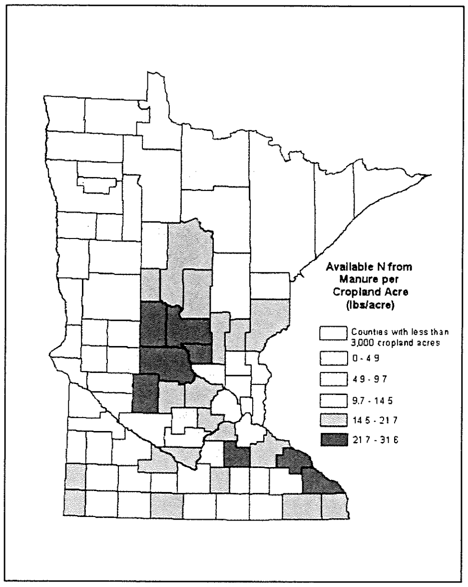


Figure 13a. Nitrogen "fertilizer replacement values" from manure based on animal populations from the 1997 Census. Inputs are averaged across all cropland acres within each county.

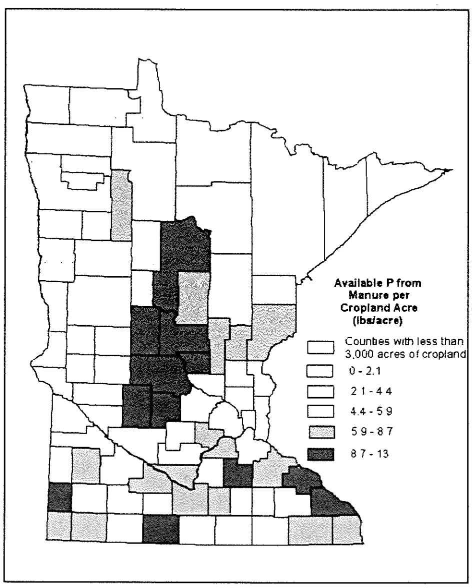


Figure 13b. Phosphorus "fertilizer replacement values" from manure based on animal populations from the 1997 Census. Inputs are averaged across all cropland acres within each county.

Soybean production has steadily risen since the early 1990's and annual production levels now total over six million acres (Figure 14). Increases in acreages have mirrored corn production (Figure 9) with a simultaneous drop in small grain production.

Hay (alfalfa and clover) production has also experienced some decreases in acreage. These reductions have occurred, in part, as a result of dairy losses in the southeast portion of the state. While the lack of proper crediting (see next section) of perennial forages once the crop is terminated can pose some problems, the overall benefits of these crops on water quality is well documented (Randall et al., 1997; Russelle et al., 2001).

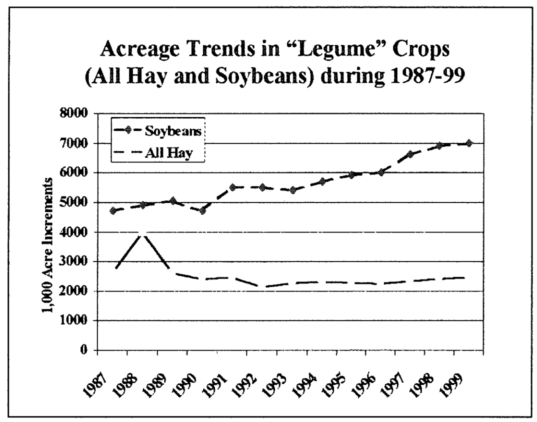


Figure 14. Acreage changes for soybeans and forage legume crops since 1987.

Nutrient Management Assessments

A key component in the Groundwater Protection Act is based upon the state's ability to assess the adoption of voluntary best management practices (BMP). If voluntary changes could be achieved through educational approaches, the state could avoid costly regulations. To assist the State in determining the success of adoption rates, the Minnesota Department of Agriculture developed a data collection tool in 1993 that eventually became known as the "**FA**rm **N**utrient **M**anagement **A**ssessment **P**rogram" or "**FANMAP.**" FANMAP was designed to determine current nutrient practices. This information has been used to design water quality curricula and will also serve as valuable baseline data to determine the effectiveness of nonpoint source pollution educational programs over time.

In the past seven years, over 500 farmers have volunteered two to four hours of their time to share information about their farming operations. Timing, rates, and method of applications are collected for all nitrogen (N), phosphate (P_2O_5), and potassium (K_2O) inputs (fertilizers, manures, and legumes) on a field-by-field basis for all acres on the entire farm. Results are then compared to the University of Minnesota's recommendations (numerous U of M documents listed in the Reference section). The collection of these assessments provides one of the most comprehensive studies on nutrient management behavior in the country.

NUTRIENT RATES AND ASSOCIATED CREDITING OF MANURES AND LEGUMES

Strong similarities exist in all existing FANMAP projects: a majority of producers are generally managing commercial N inputs successfully (although frequently using outdated recommendations) but continually underestimate the N credits associated with manure and legume inputs. Although the overall N amounts from manures and legumes are minor in relationship to commercial fertilizer, the lack of proper crediting can result in significant over-applications of commercial fertilizer, particularly when manure is applied to previous legume crops.

To illustrate this point, a series of FANMAP data sets for corn production[11] were collectively analyzed (Bruening, 1999, 1998, 1994). Locations of the regional sites and specific studies in Source Water Protection Areas are shown in Figure 15. Four different cropping scenarios are provided.

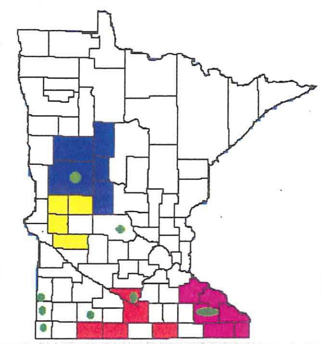


Figure 15. Locations of the regions and specific studies in Source Water Protection Areas included in the FANMAP summary.

Scenario 1: Corn production with commercial fertilizer inputs: no associated manure or legume crediting:

Under corn cropping systems where no manure or previous legume carryover credits confound the fertilizer recommendation process (this is usually a continuous corn rotation or corn following another non-legume crop), Minnesota producers apply commercial fertilizer-N rates that are typically in close agreement with U of M recommendations (Figure 16a). While there are a number of reasons why some minor discrepancies occur at a local level, it is worth noting that the U of M has made reductions in the recommendations over the past decade. These reductions are possible due to modifications in management strategies resulting in improved fertilizer use efficiencies. Also,

[11] Over 90% of the commercial N, manure, and legume credits go into Minnesota corn production

through years of continued research, the U of M has access to broader crop response datasets and continues to fine-tune the recommendations.

Scenario #1: Dependent on commercial fertilizer; no manure or legume credits.

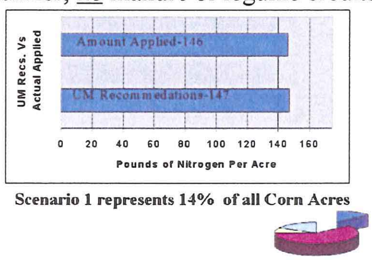


Figure 16a. Nitrogen balances comparing actual rates to U of M recommendations in Scenario 1.

Scenario 2: Corn production with N contributions from legume crediting and commercial fertilizer inputs:

Minnesota farmers could realize an average cost saving of \$8-\$9/acre by taking the full N credit contributions from soybeans and forage legumes. In this cropping scenario, representing over 60% of the corn acreage, producers are frequently applying 30-40 lb/A more than U of M recommendations (Figure 16b).

Scenario #2: Corn following a legume crop and no manure applied

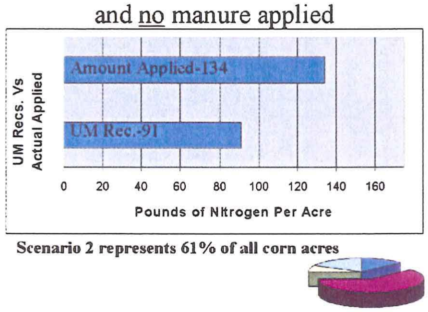


Figure 16b: Nitrogen balances comparing actual rates to U of M recommendations in Scenario 2.

Scenario 3: Corn production with N contributions from manure and commercial fertilizer inputs:

In cropping systems where manure is applied in a rotation without N "carry-over" from the previous crop (usually a continuous corn rotation), producers appear to be doing a very good job of taking the proper N credits based on their manure management and application methods (Figure 16c). This scenario is minor representing 8% of all corn acreage in the FANMAP data sets analyzed. Nitrogen efficiencies could be dramatically improved though changes in their application methods including proper incorporation techniques.

Scenario #3: Manured corn following a non-legume crop

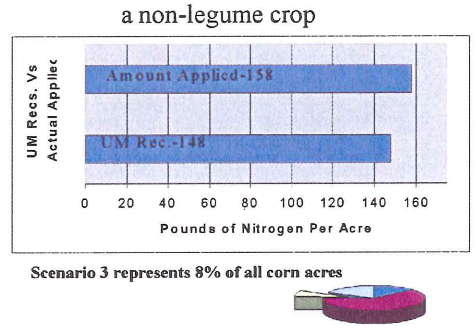


Figure 16 c. Nitrogen balances comparing actual rates to U of M recommendations in Scenario 3.

In some areas of the state, there are significant numbers of dairy farms without manure containment systems and these farms are unable to capitalize on much of the N credits due to high atmospheric losses from "daily scrape and haul" spreading techniques.

Scenario 4: Corn production with N contributions from manure, legumes, and commercial fertilizer inputs:

It is a common practice for livestock producers to apply manure to soybean stubble or forage legumes prior to seeding the following corn crop. In this cropping scenario, there are significant opportunities to reduce, if not completely eliminate, commercial N applications. On average, livestock producers could reduce inputs by 70 lb/acre (Figure 16d).

Scenario #4: Corn following a legume crop and received manure

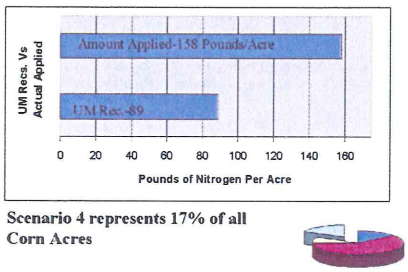


Figure 16 d. Nitrogen balances comparing actual rates to U of M Recommendations in Scenario 4.

When the four different scenarios are compared, N application contributions in excess of U of M Recommendation from Scenarios 1, 2, 3, and 4 are <1, 67, 2, and 30%. Future educational programs need to focus on legume and manure crediting particularly when both N sources need to be accounted for simultaneously.

TIMING, SOURCE SELECTIONS, AND OTHER BMPs

Proper selection of yield goals, nitrogen sources, timing of applications, and the use of nitrification inhibitors are just some of the other important management practices that producers integrate into their farming operations. Nitrogen management strategies vary across the state and are dependent on climatic, soils/geology, and cropping systems. Listed below is a series of general observations that characterize the present status of BMP adoption.

Yield goal selection: Based upon numerous FANMAP studies, producers are routinely within 3-10% of the U of M guidelines for selecting the proper yield goal.

Proper nitrogen timing in critical in the Karst regions of southeast Minnesota and fall application is not recommended (Randall and Schmitt, 1993). Area producers clearly understand the need for delaying applications until spring and Bruening (1998c, 1999a) found that 95-99% of the nitrogen was spring-applied.
Proper nitrogen timing and split applications are important management tools when farming both dryland and irrigated coarse-textured soils (Schmitt et al., 1993). Multiple N applications are common in irrigated potato and corn production. Additional information is provided later in this chapter (found in *Current Nitrogen Management Practices on the Outwash Sand Plains*).

In areas such as the Whitewater River Basin (Olmsted, Winona and Wabasha Counties) where accelerated educational programs and cost sharing has been focused on nutrient management, significant improvements in manure crediting and testing were obtained (Bruening, 1999a).

The practice of applying nitrogen in the fall on the fine-textured soils is common in south central, southwest, west central and northwestern portions of the state. Educational efforts need to be accelerated so that fall applications are delayed until the recommended soil temperatures are reached. In the south-central region (Randall and Schmitt, 1993), additional educational efforts need to be developed to encourage producers to convert to spring-applied programs.

While there are a growing number of livestock producers that now use manure testing to determine the nutrient value of the manure, educational programs need to be improved and accelerated to better incorporate the results into the nutrient management plan.

Producers need to be better informed on the management of UAN (28-0-0) and other soluble nitrogen forms as the popularity of these products increases.

Recent Advances in Technical Support and Financial Assistance

Numerous advancements have been made over the past decade related to BMP research, development and outreach, enhanced technical support of agricultural professionals through various certification programs, and accelerated BMP adoption and technical assistance through cost sharing opportunities. Very briefly, a select overview of advancements are highlighted below. These numerous accomplishments have been summarized in detail and can be found in the *1994 Needs, Priorities, and Milestones.*

BEST MANAGEMENT PRACTICES (BMPs) and RELATED RESEARCH

- An entire series of BMPs for nitrogen management BMPs were released through the U of M Extension Service in 1993. This included practices applicable for statewide, regional and special situations (irrigated coarse-textured soils). The design and content continues to be one of the comprehensive in the nation.

- Numerous advances in nutrient availability from manure, improved management tools and record keeping systems, and accelerated outreach programs associated with manure resources.

- BMPs for irrigated potato production (early, medium and late season varieties) were developed in 1996.

- A series of bulletins on phosphorus fertilizers and management were released by the U of M Extension Service in 1997.

- The U of M and the U of M Research and Outreach Centers, in cooperation with the MN Land Improvement Contractors and the MDA, have recently launch a series field-scale demonstration activities related to tile drainage design and wetland utilization on water quality.

COST SHARING, CONSERVATION RESERVE PROGRAM, and EQIP EDUCATIONAL PROGRAMS

- Since the USDA Natural Resources Conservation Service started the Environmental Quality Incentives Program (EQIP) in 1997, over 500 Minnesota farmers are now participating in nutrient management planning.[12] A majority of these farms are located in the most environmentally sensitive regions of the state.

- Over 1.65 million acres of sensitive farmland is enrolled to participate in the 2001 Conservation Reserve Program.[13]

- Successful implementation has occurred in counties that have made nutrient management a high priority. Stearns County for example, a county that historically maintains high animal densities (Figure 13 a,b), has successfully doubled the number of acres where nutrient management planning

[12] Personal communication with Jeff St. Ores, USDA Natural Resource Conservation Service.
[13] Personal communication with Greg Anderson, USDA Farm Services Agency.

activities have been employed since the early 1990's.[14]

- EQIP also provides small grants to local units of government for conducting nutrient management related demonstrations. Nitrogen rate demonstrations and follow-up winter educational program were conducted in Hubbard, Otter Tail, Martin and Nicollet Counties during 1999-2000. Additionally, demonstration sites were developed in Wadena, Hubbard and Otter Tail counties for irrigation and nitrogen timing/management on dry edible beans in 1998-99.

- The MN Association of Soil and Water Conservation Districts along with the county SWCD offices, with the financial assistance from 319 funds, are currently implementing nutrient management and technical assistance in Redwood, Renville, Goodhue and Rice counties.

CERTIFICATION PROGRAMS

- The number of agricultural crop retailers and other ag professionals which have obtained certification through the Certificated Crop Advisor (CCA) program has grown very rapidly since 1993[15] (Figure 17).

- MDA started the Manure Testing Laboratory Certification Program in 1996. The number of participating testing laboratories has quickly grown to 26 members with expected participation between 35-40 in 2001.[16]

- MDA started licensing commercial manure applicators in 2000. Currently over 160 businesses have obtained commercial animal waste technician licenses.

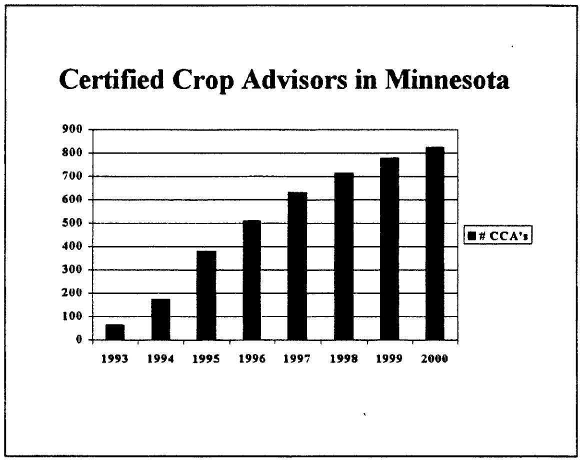


Figure 17. Growth in the number of CCA's in Minnesota since the program started in 1993.

Seriousness Of Agricultural Nutrient Impacts On Minnesota's Water Quality

GROUND WATER QUALITY

The direct relationships of land-applied agricultural inputs and groundwater quality are poorly understood. Interpretations are typically plagued with well construction problems, feedlot and septic tank issues and other sources of nitrogen contributions. Complicating matters even more, the "time lags" between initiating land use or management changes may take years to decades to ultimately impact ground water supplies. Additionally, it is uncommon to have an adequate water quality baseline established prior to any human-induced problems. Consequently there are few projects nationwide that have successfully demonstrated either the long-term impacts of existing practices or the potential benefits

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[14] Personal communication with Dennis Fuchs, Stearns Co. SWCD and Steve Sellnow, NRCS
[15] Personal communication with Bob Minks, Minnesota Crop Retailers Association.
[16] Personal communication with Jan Jarman, MDA

of implementing the wealth of agricultural management practices that have been developed over the past twenty years.

Currently the best "snapshot" of water quality conditions can be achieved through the wide array of existing monitoring networks, public and private well results. As mentioned previously, each collection of datasets contains strengths and biases in the attempt to answer the common questions posed by the general public regarding the future quality of Minnesota's water supplies.

Perhaps the most complete statewide assessment addressing the magnitude of nitrate contamination was reported by Wall (1991). The Nitrogen in Minnesota Ground Water Study provided a detailed analysis of sixteen existing data sets and monitoring efforts in Minnesota. This collection of data, which included numerous monitoring studies by several state and federal agencies as well as the majority of the County Well information available at that time, was summarized using 25,000 well observations. Due to inherent variability of the various efforts, absolute conclusions were difficult. However, the data clearly indicted that nitrate contamination of ground water in Minnesota occurs differentially in the state. Studies that targeted mostly shallow wells in geologically sensitive areas under agricultural production showed 27 to 44% of wells exceeded the drinking water standard.

Since the publication of that report, a significant number of private wells have been added to MDH's data sets and are included in Figure 1. Additionally, over 30,000 private wells (from 1993 to 2000) have been analyzed through the Minnesota Department of Agriculture's Nitrate Water Testing Program.[17] As discussed earlier in this chapter, results based upon 21,000 observations suggest that 12-15% of Minnesota's private wells exceeded health standards. Results from all clinics since the program started in 1993 through 1999 are summarized and illustrated in Figure 18.

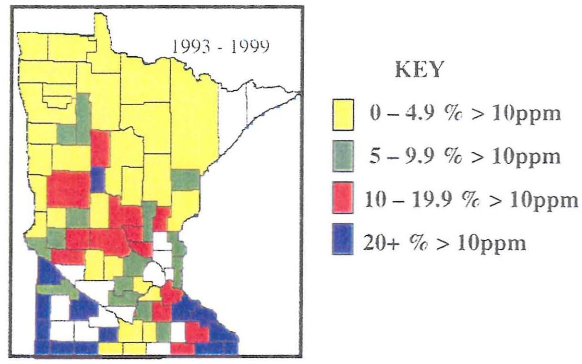

Figure 18. Results from the MDA's Nitrate Water Testing Program from 1993 to 1999 as expressed by the number of wells exceeding the 10 mg/Liter nitrate-N standard. (Counties in white did not participate in the program.)

Regardless of which datasets are used, it is obvious that there are some significant ambient problems on a regional scale[18] as well as on a local level to warrant significant concerns. Based solely upon the MDA program, the following areas have been identified a number of nitrate hotspots including impacted areas in southern Hubbard, eastern Otter Tail, southern Wadena, southern Washington County, and the entire Karst region. Many of the shallow alluvial aquifers in the southwestern portion of the state also contain elevated nitrate levels. Individual county maps from the Nitrate Water Testing Program are currently available from either the local cooperators or MDA staff. It is MDA's intent to have the county maps available through the agency's website (http://www.mda.state.mn.us) sometime in 2001. These maps should be valuable for targeting future groundwater monitoring and educational programs.

[17] Funded in part by the Legislative Commission on Minnesota Resources (1997-1999); EPA 319 (1997-2000) and the MDA Fertilizer Account.

[18] Examples: Southwest, Karst regions in Southeast MN, areas along the Mississippi River Corridor in Benton, Stearns, Sherburne and Morrison Counties, etc.

LAKE WATER QUALITY

Within this NSMPP, Heiskary and Tomasek (2000) provide an excellent overview of lake ecology and its relationship with various land uses. Sediment, due to the fact that it is the carrier for most phosphorus transport, was identified as the potential greatest single threat to the state's lakes. Both urban and agricultural exports can be significant. The reader is encouraged to review Chapter 4: Lakes Strategy 4.2.

STREAMS AND RIVER WATER QUALITY

Mulla et al. (1999) estimated that 5% and 1% of the national N loading into the Gulf of Mexico originated from the Minnesota and the Upper Mississippi Rivers (upstream from the Twin Cities), respectively. Minnesota also contributes approximately 4% of the total phosphorus flux to the Gulf. Earlier, Mulla (1997) determined that over 60% of the nitrogen loading originates in the Blue Earth, Watonwan and Le Sueur watersheds. The relative ranking of the 12 major watersheds was considerably different for phosphorus contributions.

There is also evidence that the streams and rivers from the southeast Karst regions can contain elevated nitrate levels. This is due to the hydraulic connections between surface and ground waters. For example, the Middle Branch of the Whitewater River has been reported to contain nitrate-N concentrations[19] between 7 to 8 mg/L during 1993-1999 (Wotzka and Bruening, 2000). Streams from this portion of the state contribute about 1% of the Gulf of Mexico nitrogen loading (Mulla et al., 1999).

Implementation strategies need to be targeted on basins and contaminates which will have the greatest impact on water quality. Again, the reader is encouraged to review Chapter 4.

[19] Reported as flow-weighted annual concentrations.

Targeting Impacted Agricultural Areas

SOURCE WATER PROTECTION AREAS

Various state and local agencies have worked jointly with the MDH in implementing federal and state Source Water Protection (SWP) programs as they relate to agricultural nutrients. A prioritization and ranking system for public water supplies (PWSs) has helped to focus interagency efforts on those geographical areas and Source Water Protection Areas (SWPAs) where nitrate concentrations in groundwater exceed or threaten to exceed the health standard. In addition to the formal PWS ranking process (driven by broad geologic mapping units, ambient groundwater data and potentially affected population), geographic areas of concern have also been identified through state and local activities (via Nitrate Water Testing Clinics or other monitoring efforts) or through the MDH (via SWPA contaminant source inventories or other monitoring efforts).

Educational efforts (including focused workshops, distribution of educational materials, and cooperative demonstration projects) have been initiated in or near SWPAs and have created awareness of potential crop production impacts on PWSs. Areas of critical concern where combined state and local efforts have been a major focus are illustrated in Figure 19.

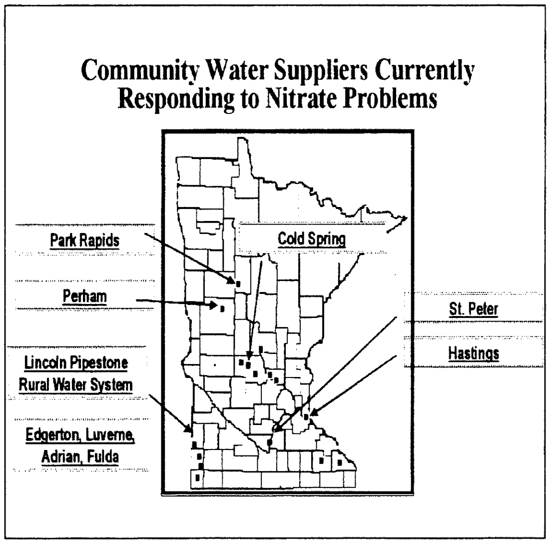

Figure 19. Locations of communities that have water supplies impacted by agriculture and are currently developing Source Water Protection Areas.

The goals of the SWP Program and the state's Nitrogen Fertilizer Management Plan have been combined in an effort to promote the adoption of University of Minnesota-developed nitrogen Best Management Practices (BMPs). The BMPs were developed on controlled experimental plots and are, by design, applicable to wide geographic areas of the state; therefore, they serve as a starting point for on-farm implementation. Local implementation of the BMPs is necessary in order to gauge their effectiveness on local landscapes, soils, crops, climatic patterns, irrigation and drainage practices and geology. Local implementation has been accomplished through the establishment of on-farm demonstration plots that incorporate the BMPs. We have discovered that the interests of crop producers, agricultural dealers and merchants, seasonal homeowners, city planners and residents are all at stake in such demonstrations, so it has been critical to obtain broad participation and understanding demonstration goals and anticipated outcomes.

The following summaries provide several examples of the kinds of educational and demonstration efforts being conducted in by PWSs responding to nitrate problems:

City of St. Peter SWPA: The City of St. Peter had observed long-term problems with nitrates in the city's water supply. This observation prompted the city to become one of the state's first to develop source water protection strategies. Local farmers, county health staff, extension agents, city water planners and state agencies, among others, came together to assess the problems and develop appropriate responses. The need for the development of nitrogen demonstration work and accelerated educational efforts were the result of these discussions.

A local farmer had an existing tile drainage system that was ideal for monitoring the water quality and quantities from two 30 acres parcels in a corn-soybean rotation. Nitrate concentration data have been collected since the 1995-cropping season. In 1996, MDA added a pesticide monitoring component. The site now provides continuous year-round monitoring for water flow, nitrate, and pesticides. One of the goals at this site is to validate a land use computer model with the data specific to local soils and weather patterns in order to assist land use discussions throughout the SWPA. Additional EQIP and 319 grants have allowed expanded outreach and nitrogen BMP demonstrations that include up to 30% of the cultivated acreage in the SWPA.

City of Perham SWPA: The MDA joined the East Ottertail SWCD in applying for an Environmental Quality Incentives Program (EQIP) grant from the Natural Resource Conservation Service (NRCS). An aid in securing funding was the results of the two MDA Farm Nutrient Management Assessment Program (FANMAP) surveys of farm practices within the WHP Area. The grant allows cooperators to work with farmers to set up nutrient demonstration plots on individual farms within the Perham SWPA. In addition to the demonstrations of BMPs, installation of suction tube lysimeters in the nutrient test plots is helping in the evaluation of appropriateness of BMPs on area soils under specific crops, rotations and irrigation practices. The grant also provided funding to conduct soil and manure sampling analysis for the development of nutrient management plans, and to conduct educational workshops and field days.

Lincoln-Pipestone Rural Water System SWPA: LPRWS manages the Verdi and Holland well fields, which are located in shallow aquifers in the southwestern portion of the state. Cooperating agencies have conducted several meetings with producers and dealers to promote the BMPs as a means of protecting the aquifers beneath area farms while protecting farm profitability. MDA staff conducted FANMAP surveys in the SWPA and made initial contacts with participating producers to conduct on-farm nutrient management demonstrations under an EQIP grant. Under a separate grant from the Legislative Commission on Minnesota Resources (LCMR), the University of Minnesota Extension Service established test plots to assess manure utilization, fertilizer formulation, application rates and timing. The USDA Agricultural Research Service is irrigating perennial forages using nitrate-contaminated groundwater as a fertilizer source. This process, referred to as "phytofiltration," might reduce the cost of expensive nitrate-removal treatment technologies for rural water suppliers.

IRRIGATED AND NON-IRRIGATED AGRICULTURE ON THE OUTWASH SAND PLAINS

There are considerable public concerns regarding agricultural activities on Minnesota's outwash sand plains. Concerns typically develop around any or all of the following subjects: irrigation and its associated higher fertilizer inputs; the rapid expansion of the potato production (Figure 20); spray drift or noise associated with crop dusting; water quantity supplies; and water quality. Manure application and/or fertilizer inputs to non-irrigated cropland are generally not perceived as an environmental threat.[20]

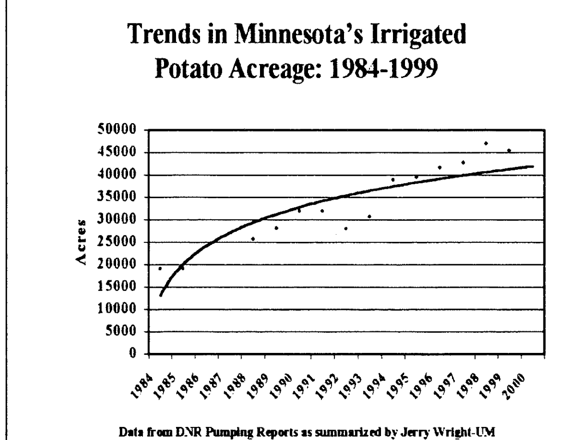

Figure 20. Irrigated potato acreage since 1984. Numbers are based upon the pumping reports submitted to the Department of Natural Resources (DNR). Data courtesy of Jerry Wright, U of M West Central Research and Outreach Center.

Based upon the 1997 DNR pumpage reports, approximately 2% of the cropland in Minnesota is irrigated (Wright, 1999). Fifty (50) percent of these acres are found in the following five counties: 1) Otter Tail;

[20] Comments based upon numerous public input and review during the development of an Environmental Assessment Worksheet (EAW) in Otter Tail County in 1997.

2) Pope; 3) Sherburne; 4) Dakota; and 5) Stearns. Statewide-irrigated acreage is between 417,000 (1999) and 428,000 (1998) acres although the number of permitted acres is closer to 550,000.[21] Corn, soybeans, potatoes, dry beans and canning crops account for 51, 19, 13, 12, and 5% of the row crop acreage.

The total number of acres increased rapidly during the 1970's and into the 1980's (Figure 21). Although the census numbers on irrigated acreage is not available for every year, it appears that the growth rate from 1985 to the present is approximately 20%. Based solely upon the number of new permits during 1998, it appears that the fastest growth is occurring in Otter Tail, Morrison, Stearns and Todd counties.

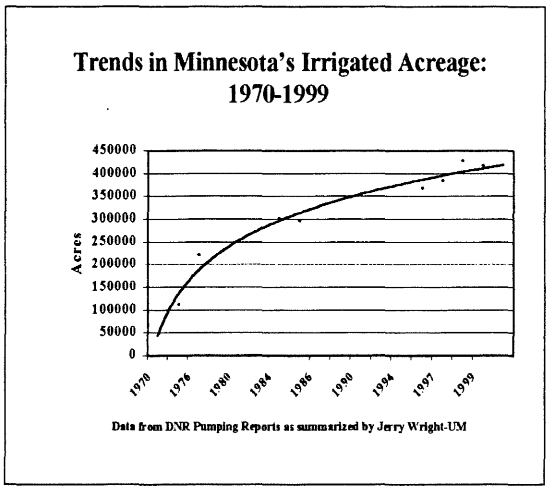

Figure 21. Irrigated acreage since 1970. Numbers are based upon the pumping reports submitted to the DNR. Data courtesy of Jerry Wright, U of M West Central Research and Outreach Center

[21] Permitted acres not receiving irrigation applications are typically in CRP or areas that receive adequate rainfall for that particular cropping season.

CURRENT NITROGEN MANAGEMENT PRACTICES ON THE OUTWASH SAND PLAINS

Extensive studies (Montgomery and Bruening, 1997) on nutrient management practices used on Minnesota's outwash sand plains have been conducted since 1992 with the FANMAP process previously described. This study identified three dominant but distinctly different types of agricultural cropping systems that coexist in this region. This study focused on: 1) irrigators primarily dependent on corn production and most were dairy operations; 2) non-irrigators dominantly dairy; and 3) irrigated potato producers. Nutrient inputs, yield and yield goals, and a variety of N management strategies were collected on a field-by-field basis covering 67,000 cropland acres involving 119 farms.

Commercial fertilizer rates on corn for both irrigated and dryland production were in excellent agreement with U of M recommendations. However, the crediting process under both cropping systems was seriously confounded by the addition of manure. Virtually no manure credits were accounted for resulting in over-applications of 60-70 pounds of N per acre across all manured corn acres. On the irrigated farms, 30% of the corn acres received manure yet this acreage contributed 90% of the N in excess of U of M recommendations. Acceptance of manure crediting on the outwash sands significantly lags behind other livestock regions of the state.

Timing and source selection of N fertilizers associated with potato production were also in excellent agreement with U of M recommendations. The concept of multiple N applications was widely accepted; the average potato field received 4 N applications per season. Over 50% of the growers were using petiole analysis for making real time N management decisions. Unlike the other two groups, existence of manure and legume credits was uncommon in this cropping sequence which greatly simplified N management. Across all potato acreage, N inputs averaged 34 pounds per acre more than U of M recommendations. Potato producers could also make significant environmental advances by reducing starter N by 35%.

In summary, it was determined that it is possible for irrigators to implement some of the most advanced nutrient management practices found in the state. While reductions can still be achieved, it is very obvious that this segment of agriculture, particularly the potato industry, has made some dramatic improvements in the last decade. Significant improvements need to be made in manure crediting under both irrigated and non-irrigated cropping systems.

Protection of the sensitive aquifers found in the outwash sands needs to be a shared responsibility of both dryland farmers and irrigators. Focusing environmental education on just irrigated production will not be sufficient and will only address about 25%[22] of the excess N put into these systems. Also, it is very evident that additional research on the long-term impacts of agriculture cropping systems needs to be conducted in outwash regions of the state. Even if BMPs are fully accepted and implemented, there are numerous public concerns that water quality for future generations is in jeopardy.

IMPACTS OF TILE DRAINAGE ON THE FINE-TEXTURED SOILS

Drainage of agricultural land to remove excess water stored in or on the soil through subsurface tile lines is common in large areas of highly productive but poorly drained soils in Minnesota. Drainage of agricultural land is a practice that has been used in Minnesota since the mid-1800's (Payne, 1994). Improved drainage is very important to the state's agricultural economy because it enables producers to raise crops in areas that would otherwise be marginal for crop production.

The installation of an agricultural drainage system results in potential advantages and disadvantages for both the producer and the environment. Potential benefits of agricultural drainage include increased soil aeration, increased soil temperature in spring, stabilized soil structure, improved trafficability, earlier planting dates, increased soil water storage, reduced peak discharge, and removal of soluble salts. Potential negative impacts of agricultural drainage include accelerated decomposition of soil organic matter, soil subsidence, increased peak flows, increased risk of drought, leaching of valuable nutrients, and potential environmental damage.

Nutrient composition of tile drainage reflects the nutrient losses from the field which are affected by weather, soil type, soil and nutrient management practices, and topographic location. Research has shown considerable amounts of sediment, nutrients, and detectable levels of pesticides are carried in tile drain discharge (Randall et al., 1997; Buhler et al., 1993; Kladivko et al., 1991). Tile drain discharge into ditches and surface waters can pose a serious threat to water quality. Nitrate-nitrogen (NO_3-N) loading from the Upper Midwest has been identified as a contributing factor to the hypoxic zone in the Gulf of Mexico. Nitrate losses through subsurface tile drainage under row crop systems often are in the range of <2 to >100 kg NO_3-N/ha in the Upper Midwest (Timmons and Dylla, 1981; Randall and Iragavarapu, 1995).

The University of Minnesota and the U of M Research and Outreach Centers provide expertise and leadership for nutrient management and tile drainage research. Agricultural drainage research to address current issues includes 1) impact of drainage system design on water quality and flow; 2) impacts of alternative surface inlet design

[22] Montgomery and Bruening, 1997. Unpublished data.

on water flow, crop yield, and water quality; 3) impact of storage basins, wetlands, and in-ditch treatment on water quality; and 4) wetland protection, restoration, construction, and mitigation.

Financial Assistance, Current Policies and Programs to Address Agricultural Nutrient Issues

Federal and State Incentive and Cost-Share Programs

Several grant and loan programs are being accessed to assist local units of government in improving and protecting water resources from nonpoint agricultural pollution.

Environmental Quality Incentives Program

The Environmental Quality Incentives (EQIP) Program administered by the USDA-Natural Resource Conservation Service (NRSC) and the state Board of Water and Soil Resources (BWSR) provides technical, financial and educational assistance related to cropping, tillage and nutrient management and environmental protection practices in designated priority areas. EQIP education grants have funded demonstration projects, workshops, farm surveys and cost-sharing grants are used to provide incentives to producers to implement environmentally beneficial improvements to infrastructure or for nutrient, pest and grazing land management plans and practices.

Clean Water Partnership and Section 319 Programs

The state Clean Water Partnership (CWP) Program, administered by the MPCA, will provide grants, loans, and technical assistance to local units of government to address agricultural nonpoint source pollution. CWP Phase I grants are awarded for diagnostic projects in which the type and extent of nonpoint source pollution in a lake, river or aquifer are determined and response/implementation plans are developed. CWP Phase II grants or loans are awarded to implement practices to improve or protect water resources identified in the CWP Phase I report or an equivalent diagnostic and planning process. The Section 319 Program has also been used to implement activities to reduce agricultural nonpoint source pollution. Grants have funded various implementation activities including development of specific farm surveys, interviews with producers, demonstration projects, other educational activities, and various agricultural BMPs. Funds have also been used to conduct monitoring that assesses the effectiveness of BMPs.

Agricultural BMP Loan Program

The MDA BMP Loan Program provides loans to counties, SWCDs and Joint Power Boards. These funds are provided for the implementation of select agricultural BMPs addressing infrastructure needs and certain farm management practices that reduce or prevent nonpoint environmental degradation from farm fields and farmyards. Funds are provided for agricultural waste management, structural erosion control measures, conservation tillage and manure handling equipment, on-farm individual sewage treatment system upgrading or replacement, and proper sealing of abandoned wells. The BMPs must be identified as priorities by local units of government in their water planning activities, including WHP plans.

Current Policies and Programs

Nitrogen Fertilizer Management Plan

Minnesota Statute 1989, Chapter 326, Article 6, Section 33, Subd. 2b, also known as the 1989 Comprehensive Groundwater Protection Act (the Act) directed a nitrogen fertilizer task force to develop recommendations for a Nitrogen Fertilizer Management Plan (NFMP) for the prevention, evaluation and mitigation of NPS occurrences of nitrogen fertilizer in waters of the State. The NFMP was finalized in August of 1990 and includes components that promote the prevention of contamination of water resources by inorganic nitrogen and responses to the detection of inorganic nitrogen from fertilizer sources in ground or surface water. Although the Act and the associated NFMP have laid the foundation for protection of the state's water resources from agricultural nonpoint source pollution, there was no related funding provided with enactment of the legislation, leaving state agencies to compete for limited federal funds and a variety of state funding programs originally designed for other environmental protection efforts.

The Act mandates that the NFMP contain both a voluntary Best Management Practice (BMP) component and a component that allows for regulatory action in the form of Water Resource Protection Requirements (WRPRs).

The *voluntary* BMPs, developed jointly by the University of Minnesota Extension Service and the MDA, were an outgrowth of the Act and were developed through public participation and notice in the state register. Statewide BMPs outline broad-based recommended practices, while regionally specific BMPs account for variable soil and climatic conditions. Special situation BMPs (e.g., for irrigated, coarse textured soils, and for potatoes) were developed based on emerging issues.

The NFMP structure for responding to nitrogen fertilizer nonpoint contamination is as follows:

<u>BMP Promotion Phase</u>: Promotion of voluntary adoption and implementation of BMPs. BMP development and promotion is considered an ongoing process;

<u>BMP Evaluation Phase</u>: Evaluation of the adoption and effectiveness of voluntary BMPs. The state is currently developing and implementing BMP evaluation efforts in a limited number of areas of critical concern (e.g., Source Water Protection Areas);

<u>Response Phase:</u> Response to instances wherein voluntary BMPs have not been adopted (despite promotion) or are ineffective at mitigating the occurrence of nitrate in local ground or surface water. The Response Phase is implemented when initial attempts to resolve nitrogen contamination problems through voluntary action fail. Regulation governing nitrogen fertilizer use in vulnerable areas is possible after a series of intense BMP and groundwater monitoring efforts justifies rule writing. The Response Phase (which incorporates additional BMP promotion and evaluation efforts) is comprised of the following steps:

<u>Special BMP Promotion Areas</u>: Before regulatory action can be taken at the local level, the MDA, SWCD and the county water planning authority must designate a localized Special BMP Promotion Area in which various evaluation efforts must occur. Time must be allotted for producers to implement the BMPs and then a reasonable amount of time needs to be factored in for observing potential water quality changes.

<u>Nitrogen Management District</u>: If, after the creation of the localized Special BMP Promotion Area, agricultural sources of nitrate in drinking water remain problematic for at least a four-year period, the area should be reclassified as a Nitrogen Management District. The establishment of the district initiates a process of change from a voluntary to a regulatory situation.

Water Resource Protection Requirements: If BMP adoption and water quality remain unacceptable in the Nitrogen Management District after annual reviews, the MDA shall commence the promulgation of localized Water Resource Protection Requirements through rule-making.

Details of the NFMP are provided in the "Recommendations of the Nitrogen Fertilizer Task Force on the Nitrogen Fertilizer Management Plan to the Minnesota Commissioner of Agriculture," August 1990, available from the MDA.

University of Minnesota and the University of Minnesota Extension Service

Research and Development: Technical expertise is available at the University of Minnesota within the College of Agriculture, Food, and Environmental Science and Minnesota Agricultural Experiment Station to conduct research on nutrient management issues as they relate to water quality and BMP issues. Other parts of the University are also involved with water quality research efforts. Scientists from the Colleges of Natural Resources and Biological Sciences also have roles to play in these research efforts.

University of Minnesota Extension Service: The U of M Extension Service has diverse educational and technical expertise with programs that address agricultural, forestry and urban nutrient management issues as they relate to water quality. Diverse educational programs on subjects ranging from Agricultural Nitrogen Best Management Practices to the proper location, construction, and maintenance of individual sewage treatment systems is the responsibility of the Minnesota Extension Service. There is an established infrastructure to provide such educational programs at both the state and local levels. This unique situation is an advantage since educational programs can get wide dissemination. Specific nonpoint pollution educational efforts are targeted to agricultural chemical dealers, consultants, local resource managers and producers. Areas of emphasis include soil and manure testing, BMPs for phosphorus, site specific management, proper credits for manure and legumes and successful approaches to promote BMPs.

Board Of Water And Soil Resources (BWSR), Soil and Water Conservation Districts (SWCDs), Local Water Planning Departments, and Local Offices of Environmental Services

BMPs are promoted through BWSR programs and its local government clientele, which includes Soil and Water Conservation Districts, county government, watershed districts, water management organizations and demonstration farms. The BWSR administers the comprehensive local water planning program, which includes components dedicated to the prevention of nonpoint source pollution from agricultural nutrients. The BWSR, the SWCDs and local units of government that directly or indirectly address nonpoint source pollution from agricultural nutrients through the following programs:

- Cost Share Programs to reduce soil erosion and sedimentation
- EQIP and the Conservation Reserve Program (CRP)
- Local Water Resources Protection and Management Program (which includes Local Water Planning Programs and associated challenge grant programs)
- The Permanent Wetland Preserves (PWP) Program
- The Reinvest in Minnesota (RIM) Reserve Program
- Conservation Reserve Enhancement Program (CREP)
- Feedlot Water Quality Management Program
- Non Point Engineering Assistance (NPEA) Program

Minnesota Department of Health (MDH) and the Source Water Protection Program

The federal Safe Drinking Water Act [CFR 40, Part 141, Section 1428] and the state Wellhead Protection Rule [Minn. Rules, §§ 4720.5100 to 4720.5590] jointly require that source water protection measures be established for all public water supply wells. Both programs are administered by the MDH. The MDA has developed a Memorandum of Understanding with the MDH to coordinate source water protection activities related to nonpoint source pollution from agricultural nutrients. The MDH also conducts its own monitoring and education programs related to nitrate contamination of public and private drinking water wells. Please refer to "Targeting Areas Where Agricultural Nutrient Issues are of Particular Concern," located elsewhere in this chapter, for an explanation of how state and local efforts in nutrient nonpoint source pollution prevention have been focused in source water protection areas.

Minnesota Pollution Control Agency (MPCA)

The MPCA is involved in the monitoring of lakes, streams and ground water and contributes to assessment of current conditions, trends and causative factors related to agricultural nutrients and nonpoint source pollution. Through recently revised Chapter 7020 Feedlot Rules, the MPCA evaluates and permits feedlot design and operation, including manure management plans. Through the Clean Water Partnership, Clean Lakes program and Minnesota River project, the MPCA facilitates the implementation of numerous projects striving to minimize agricultural nutrient transport to water resources. MPCA also serves as the lead state agency in the development of TMDL (Total Maximum Daily Load) criteria.

Soil Testing Lab Certification & Manure Testing Lab Certification Programs

The Soil Testing Lab Certification is a voluntary MDA program to ensure accurate and credible soil test results for Minnesota producers, and promotes use of soil testing and use of U of M fertilizer recommendations in nutrient management planning. Participating laboratories must maintain standards for equipment, facilities, personnel, record keeping, methods and procedures. Soil analysis must follow uniform reporting methods. Soil fertility recommendations made by the laboratory must include land grant university soil fertility recommendations as a basis for comparison by the crop producer.

The Manure Testing Laboratory program is similar to the soil testing laboratory certification program and was developed in response to economic and environmental concerns related to land application of animal manures. Despite increasing numbers of livestock in the state, most producers do not test their manure on a regular basis, in part due to concerns about the value of the testing. Use of MDA-certified laboratories will be required for development of manure management plans by certain livestock producers under provisions of the new state feedlot rules; however, testing is recommended regardless of whether a producer is required to conduct manure analysis.

Sustainable Agriculture Program

The MDA Energy and Sustainable Agriculture Program was established in 1987 in response to concerns over the impact of conventional agricultural practices on farm profitability, health and the environment, including nonpoint source pollution of surface and ground waters from agricultural nutrients. The purpose of the program is to demonstrate and promote alternative practices that are energy efficient, environmentally sound, and profitable, and which enhance the self-sufficiency of Minnesota farmers. The program's mission is to work toward the goal of sustainability for Minnesota agriculture by designing and implementing programs that meet the identified needs and support the creativity of Minnesota farmers.

MDA Groundwater and Surface Water Monitoring

The Monitoring and Assessment Unit of the MDA exists to conduct monitoring of the state's surface and ground waters for the presence of pesticides and agricultural nutrients. Pesticide monitoring has been conducted in support of the development of a state Pesticide Management Plan to address nonpoint pesticide concerns. The Unit has established memoranda of agreement (MOAs) with various organizations and local units of government. These MOAs are designed to be long-term cooperative monitoring agreements wherein MDA water monitoring programs provide technical assistance to nonpoint water quality monitoring projects that are funded, in part, by local entities through grants or other sources.

Feedlot and Manure Management Advisory Committee

The Feedlot and Manure Management Advisory Committee (FMMAC) was created during the 1994 legislative session (Minn. Stat. § 17.136) as an advisory body to the MDA and MPCA. FMMAC was established to identify needs, goals, and suggest policies for research, monitoring and regulatory activities regarding feedlot and manure management issues.

Commercial Animal Waste Technician Licensing Program

In response to requests from the professional associations representing commercial applicators of liquid and solid manure in Minnesota, the 1998 legislative session (Minn. Stat. § 18C.430) established a licensing program for Commercial Animal Waste Technicians. As of 2000, over 160 businesses are now licensed through the MDA.

BEST MANAGEMENT PRACTICES

The following general list of Agricultural Management Best Management Practices (BMPs) are commonly used to reduce nonpoint source pollution from use of agricultural nutrients. This list is not comprehensive and does not suggest additional BMPs would have no benefit. Please refer to Part I Agricultural BMPs and Part II Erosion and Sediment Control BMPs in Appendix A of this document for definitions of the following BMPs.

Part I Agricultural BMPs:

4 Conservation Crop Rotation
20 Irrigation Water Management
24 Nutrient Management
35 Slow Release Fertilizer
36 Soil Testing and Plant Analysis

Part II: Erosion and Sediment Control BMPs:

8 Filter Strips
38 Fertilizer Application Control

Chapter 9 Agricultural Nutrients
Needs, Priorities and Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) 5-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Goal 1: Accelerate and Enhance Educational Programs, Implementation of Nutrient Management Plans, and Affiliated Certification Programs Related to the Management of Fertilizers, Manure, and Organic Sources of Agricultural Nutrients. Targeted Audiences Should Include Farmers, Agricultural Crop Retailers, Consultants, Commercial Manure Applicators, Local and State Resource Managers and Affiliated Agricultural Services.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Continue to promote fundamental principles of sound nutrient management and the associated environmental/economic aspects. Review and update University of Minnesota (U of M) BMPs and Fertilizer Recommendations as needed and promote. Reaffirm credibility of existing U of M recommendations through cooperative validation projects with Ag information providers. Focus activities on documented issues such as lack of proper crediting (i.e. soybeans and manure), timing, and nitrogen source selection.	X	X	X	X	X	Rapid Response Fund (U of M), EQIP, 319, State, Private Contributions.	University of Minnesota (herein consider "U of M" notation inclusive for Extension Service, Research and Outreach Centers, and Main Campus activities).

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
2. Intensify educational efforts and affiliated demonstration sites related to manure management including nutrient availability, proper crediting, dietary/feed rationing impacts on nutrient output, exchange/transport opportunities, spreader calibration and uniformity, and nutrient availability interactions with storage/application methods. Incorporate recommendations resulting from the on-going GEIS for Animal Agriculture.	X	X	X	X	X	319, State, Local.	U of M, NRCS, SWCD, MDA, MPCA.
3. Provide tools and technical assistance to all Minnesota farmers for successful development/implementation of nutrient management plans and record keeping. Identify and implement ways to increase the number of plans developed, and to increase the number of individuals properly trained and certified to develop nutrient management plans.	X	X	X	X	X	State, 319, USDA EQIP, Ag BMP.	U of M, SWCD, NRCS.
4. Provide financial and technical assistance (for the development and implementation of nutrient management plans approved by NRCS or other certified entity) to producers operating in environmentally sensitive areas. Focus Minnesota's limited state and federal cost share dollars to areas	X	X	X	X	X	Federal Cost Share, Ag BMP, 319, State.	NRCS, SWCD, CWP Programs, MDA-FANMAP.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
most likely to yield maximized benefits. Determine long-term effectiveness of cost sharing after financial incentives are depleted. Use FANMAP[23] or other reliable techniques to develop baseline data to determine effectiveness of subsequent programs.							
5. Conduct targeted educational programming and implementation in strategic locations. Examples are Source Water Protection Areas (SWPA), Cleanwater Partnerships, and TMDL areas. Use computer simulation modeling techniques as a tool (educational and planning) for evaluating potential benefits of BMP implementation and alternative land management decisions.	X	X	X	X	X	State, 319, USDA EQIP, Educational Grants, Local.	SWCD/NRCS-EQIP Coord, MDH-SWPA delineations, MDA-SWPA Coordination of farmers and community, U of M-Computer Modeling Efforts.
6. Develop focused educational activities and demonstrations to address Gulf of Mexico hypoxia concerns. Implement educational recommendations as submitted to the Committee on Environmental and Natural Resources Hypoxia Work Group (CENR) including the following steps from the National Hypoxia Task Force:	X	X	X	X	X	319, Other Federal and State.	Multi-Agency U of M.

[23] Farm Nutrient Management Assessment Program. Developed by the MN Dept. of Agriculture.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
a) Increase federal cost share assistance for voluntary actions to restore, enhance, or create wetlands and buffers and	X	X					
b) Increase assistance to ag producers for BMP implementation.	X	X					
7. Intensify educational efforts and affiliated demonstration sites related to tile drainage designs (surface intakes and subsurface) and alternative water treatment systems (i.e. wetlands, riparian treatment, linear wetlands, control structures, etc) for reducing nutrient loading.	X	X	X	X	X	State, 319, MN Land Improvement Contractors Association.	U of M, MDA, BWSR.
8. Promotion of CRP,[24] CREP,[25] RIM,[26] riparian systems and alternative cropping systems (i.e. perennial forages, agroforestry) that demonstrate clear water quality benefits. Assist producers in establishing markets for alternative crops to insure success.	X	X	X			Various State and Federal Programs, Ag BMP, ESAP.	BWSR, NRCS.

[24] Conservation Reserve Program
[25] Conservation Reserve Enhancement Program
[26] Reinvest In Minnesota

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
9. Continue to promote principles of sound nutrient management in "Special Protection Areas" (SPAs) under Minnesota Rule 7020's land application provision and accelerate educational components related to the 2000 revised 7020 Rules.	X	X	X	X	X	State.	MPCA, U of M.
10. Continue improvements and promotion of MAP[27] software and related manure management tools/software for farmers and nutrient management plan writers.	X	X				319, State.	U of M.
11. Accelerate the promotion of Phosphorus BMPs in high loading areas. Use educational tools such as the "Phosphorus Index" in areas prone to sedimentation losses into surface waters.	X	X				319, State.	U of M.
12. Provide educational support to agricultural information and service providers (i.e. crop retailers and consultants) through programs such as the Certified Crop Advisors, the Commercial Manure Applicators, Certified Manure Testing Labs, and Certified Soil Testing Labs. Development of innovative interactive training techniques through the Internet, CD, and other "state-of-the-art" technology.	X	X				Various Public and Private Funds, 319.	Various Boards, University of Minnesota, MDA Certification Programs.

[27] Manure Application Planner. Developed by the U of M in cooperation with state and federal agencies.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
13. Maintain appropriate consistency in recommendations from manure and soil testing labs through approved laboratory methods, reporting units and subsequent fertilizer recommendations. Accelerate efforts in consolidating manure-testing programs on a national level to reduce conflicting individual state programs.	X	X				State, Federal Office of Water (Proposal submitted to EPA 4/2000 to set up a national manure testing certification program; status pending).	MDA, U of M.
14. General promotion of Site Specific Management (also called Precision Agriculture) in terms of increased fertilizer use efficiency and water quality benefits.	X	X				Funds for Rural America, 319.	U of M.
15. General promotion of Sustainable Farming, Rotational Grazing and Whole Farm Planning principles.	X	X	X	X	X	319, State, Ag BMP.	Land Stewardship, MDA Sustainable Ag.
16. Promotion of water scheduling and nutrient management for irrigated agriculture, particularly in SWPA and other areas with threatened drinking water supplies.	X	X				319, State.	U of M, SWCD, NRCS, MDA, DNR.
17. Transfer of educational programs and techniques from successful watershed or promotional area projects. Expand and promote water quality demonstrations such as the Red Top and Big Woods Farm Demonstration .	X	X	X	X	X	319, State.	Various Agencies, U of M.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
18. Continue nitrate water testing services and affiliated water quality education/outreach programs.	X	X				319, State.	MDA, MDH, SWCD, U of M.

Goal 2: Continual Research, Development and Refinement of Best Management Practices That Minimize Nutrient Losses from Agricultural Systems Via Leaching, Runoff and Atmospheric Emissions. Determine Long-Term Sustainability of BMPs on Minnesota's Water Resources and Provide Guidance and Management Tools to Resource Planners/Managers. Provide Guidance to the Agricultural Community for the Proper Selection of BMPs and Expected Performance/Outcomes.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop a framework and initiate the process of determining long-term impacts of agricultural BMPs on water quality. Develop subsequent management tools and information for resource managers. Techniques should include the use of validated computer simulation models, long-term demonstrations (via paired watersheds, drainage lysimeters, "model farm concepts") and other proven methods. Research should be evaluated on a field-scale basis when possible and targeted for environmentally sensitive agroecoregions (see also Chapter 5).	X	X	X	X	X	State	Various state, U of M, ARES, and other Federal Agencies.
2. Identification of barriers that impede economic, social, and technology transfer of existing BMPs/technologies. Develop appropriate responses.	X	X	X			319, State.	U of M, MDA.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
3. Conduct statewide or watershed scale feasibility studies on potential impacts of major policy initiatives to address nutrient issues such as Gulf Coast hypoxia and groundwater contamination. Include environment impacts as well as economic impacts on producers and the agricultural industry on banning/reducing fall N applications. Include issues such as lowering the nitrate-N standard for drinking water or for biological purposes in river systems CENR: Accelerated research/modeling.	X	X	X	X	X	319, State, Various Federal Region.	U of M, MDA, MPCA.
4. Conduct research related to manure management and associated animal agricultural issues as recommended by the GEIS[28] and CENR-Hypoxia Work Group. For example, the GEIS identified the following: 1) identification of BMPs and mitigation technologies to prevent against ground and surface water pollution from manure storage, handling and application and determine their effectiveness; 2) impacts of pastured animals to nearby surface waters; and 3) impacts of Minnesota's current/future animal densities on hypoxia and local water quality concern with emphasis on phosphorus issues.	X	X	X	X	X	319, State.	U of M, MPCA, MDA, EQB (Administrative oversight to GEIS).

[28] Generic Environmental Impact Statement for Animal Agriculture

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5. Development of regional Phosphorus BMPs and associated analytical tools ("P Index", simulation models, soil P test for environmental purposes, etc). Develop a better understanding of "bioavailable P" and its fate under various anaerobic/aerobic environments, pH levels and other physical/chemical conditions.	X	X				319, State.	U of M.
6. Conduct irrigated agricultural research needs including: 1) development of BMPs for edible beans and early season potatoes; 2) Long-term ramifications of crop rotational effects on groundwater; 3) Interactions between plant diseases/plant nutrition; 4) Efficacy of slow release Nitrogen formulations and other advanced methods for reducing N leaching loss.	X	X	X			State, Federal.	U of M, Central Lakes Ag Center.
7. Address research requirements for the development of BMPs related to tile drainage designs (surface intakes and subsurface) and alternative water treatment systems (i.e. wetlands, riparian treatment, linear wetlands, control structures, etc) for reducing nutrient loading.	X	X	X	X		State	U of M, MDA, BWSR.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
8. Development of BMPs for specific local conditions experiencing water quality problems such as SWPA's and customized BMPs for the Karst, Sand Plains and Alluvial Valleys (SW). BMPs need to reflect unique soil-geology-cropping conditions.	X	X	X	X	X	State, Federal.	U of M.
9. Target research/ development to keep pace with a dynamic marketplace and rapid scientific advances (i.e. Genetically Modified Organisms (GMOs), Precision Agriculture, dietary advancements, etc). Continue to strive for maximized fertilizer use efficiency, minimize environmental impacts and economically viability.	X	X	X	X	X	State, Federal.	U of M.
10. Research and development of biological freshwater quality standards (nitrogen, phosphorus, silica, etc) in response to Gulf Coast Hypoxia.			X	X	X	State, Federal.	MPCA, U of M.
11. Development of TMDLs which consider spatial variation in soil landscapes and ag management practices and temporal variation in climatic conditions in addition to feasibility of attaining TMDLs and economic viability of TMDL implementation.		X	X	X	X	State, Federal.	MPCA, U of M.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
12. Evaluate new tools (i.e. BMP insurance programs, innovative cost share/ incentives, etc.) for accelerating adoption rates. Determine long-term sustainability and likelihood of success.	X	X				State, Federal.	U of M, MDA.
13. Research and develop cost effective technology (i.e. phytofiltration, denitrification) for cleaning up existing impacted aquifers.	X	X	X			State, Federal.	ARS, U of M.

Goal 3: Provide Accurate Assessments of Adoption Rates of BMPs and Related Advancements, Establish a Framework of "Performance Indicators" for Gauging Future Trends, and Evaluate Subsequent Impacts on Minnesota's Natural Resources Through Surface and Groundwater Monitoring Programs.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Analyze human behavioral aspects of BMP adoption through rigorous evaluation of management practices currently used in Minnesota agriculture. Use FANMAP[29] or other reliable techniques to develop baseline data to determine effectiveness of subsequent programs. Target vulnerable agroecoregions, Source Water Protection Areas, and other potentially problematic areas. Reassess areas within established benchmarks. Identify social, economic, technology barriers and other factors impeding successful adoption.	X	X	X	X	X	State, 319.	MDA, U of M.

[29] FArm Nutrient Management Assessment Program. Developed by the MN Dept. of Agriculture.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
2. Establishment of a priority ranking system of Watersheds/ agroecoregions based on critical nutrients (N and P) and target subsequent monitoring and educational activities based on standardized criteria.	X	X	X			319, State, Federal.	U of M.
3. Determine effectiveness of previously implemented educational programs and cost share efforts. Conduct random audits on farms currently getting cost share funds to determine compliance.	X				X	State, Federal, 319.	NRCS, U of M, MDA.
4. Develop meaningful, cost effective "performance indicators" and maintain long-term data collection/analysis to evaluate future progress within the Ag community. Potential examples of "performance indicators": 1) Establish the statewide % of acres with high soil P tests; 2) Trends in % farmland tile-drained, irrigated, implementing CRP or other cost share measures; 3) % farms using soil or manure testing services, etc. Use existing data collection sources (MN Ag Stats, MDA sales data, etc) when possible.	X				X	State, Federal, 319.	U of M, MDA, MN Agricultural Statistics Service.
5. Develop a framework for maximizing specific water quality indicators.	X	X				State, Federal, 319.	MPCA.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
6. Maintain long-term water quality monitoring networks in vulnerable areas to understand trends, progress towards meeting the state's degradation prevention goals, and effectiveness of BMP/TMDL efforts.	X	X	X	X	X	State.	USGS, MDA, MDH, MPCA.
7. Development of a coordinated multi-agency approach in tracking BMP related activities and costs so that water quality achievements per unit cost can be determined.			X	X		State, Federal, 319.	MPCA, MDA, BWSR.
8. Identify areas and aquifers where nitrate concentrations exceed or approach standards in order to help set county priorities regarding nitrogen management, target areas for the Nitrogen Fertilizer Management Plan and Clean Water Partnerships, and related programs.	X	X	X			State, Federal, 319.	MDH, USGS, MDA, MPCA, SWCD.

Goal 4: Develop Effective Statewide Policies for Decreasing the Transport of Agricultural Nutrients to the State's Water Resources and Improve the Coordination Framework Necessary to Accomplish These Policies.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Determine feasibility of "nutrient user" fees on commercial product sales, animal/manure/feed, or other equitable means of distributing costs. Fees would fund legislative mandates provided in the 1989 Ground Water		X	X	X		State.	U of M, MDA.

2001 - 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
Protection Act such as research, enforcement, rule writing, and technical, financial, and educational support to the Ag community.							
2. Draft and implement rules for nitrogen management considering recommendations made in the state's Nitrogen Fertilizer Management Plan			X	X		State	MDA
3. Establish a multi-agency advisory group to determine criteria for classifying the severity of existing surface and groundwater nitrate problems and develop a prioritization plan.		X				State	Multi-Agency, LMIC.
4. Establish a multi-agency advisory group to determine criteria for classifying the severity of existing surface water/phosphorus problems and develop a prioritization plan.		X				State	Multi-Agency, LMIC.
5. Develop an institutional framework that clearly identifies the interrelating roles of various organizations and programs as they relate to the Nitrogen Fertilizer Management Plan.		X				State	

1994 NSMPP
Needs, Priorities, and Milestones

The following Table provides the Goals and Action Steps included in the 1994 Nonpoint Source Management Program Plan (NSMPP). The Products, Services and Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps. Implementation of all action steps is contingent upon adequate funding and local involvement.

Goal 1: Enhance The Education Delivery System For Nutrient And Crop Residue Best Management Practices And The Sensitivity Of Water Resources To Nutrient Contamination. Target Audiences For Education Should Include Agricultural Dealers, Consultants, Local Resource Managers And Farmers

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Develop an educational program to promote the use of newly developed soil nitrogen test in the humid (eastern) half of the state.	State	University of Minnesota	Successful promotion of nitrogen test for corn following corn. U of M Extension publication # 6514.
2. Intensify educational efforts in the areas of:			
• Soil and manure testing			
o Soil testing	State	University of Minnesota,	Increased use of soil testing services.[30]
		MN Dept. of Agriculture.	Standardize testing and reporting methods for soil sampling relative to predicting crop nutrient needs.
o Manure testing	State, Federal (319)	University of Minnesota,	Increased use of manure testing services.[31]
		MN Dept. of Agriculture.	Standardize testing and reporting methods for manure sampling relative to predicting crop nutrient needs.

[30] Personnel communications with the laboratories participating in MN's Soil Testing Certification program.
[31] Personnel communications with the laboratories participating in MN's Manure Testing Certification program.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
• Sensitivity of lakes and streams to nutrients.	319	MDA, U of M, SWCD.	Water Quality Workshop for Home & Cabin Owners (Otter Tail, Pope, and Dakota Counties).
• Best Management Practices for phosphorus.	State, Federal	University of Minnesota, MPCA.	Guidelines Land Application of Manure and Phosphorus; Publications (6288, 6797-B, 6796-B, 6795-B, and FO-7079-E); Low interest loans for BMP construction and equipment. Phosphorus Forum, 1998
• Provide assistance to farm operators to prepare nutrient management plans in cooperation with state resource agencies. Site specific assessments would be made for nutrient needs of crops and for on-farm sources of nutrients. Nutrient plans would consider soil type, soil test results, cropping history, previous crop cover, and realistic yield goals. Vulnerability of receiving waters and nutrient valve of various on-farm sources (animal manure, green manure, etc.).	Federal (319 and other), State, local	Various	Various groups promoting nutrient management plans. Nutrient Management Training Workshops 1995-96. Nutrient Management Planning Workshops for Ag Retailers-1996. Ag Chem Retailers Needs Assessment Survey-1996.
• USDA – EQIP: Educational demonstrations of ag nutrient Best Management Practices in wellhead protection areas.	Federal, State	SWCDs (Otter Tail, Hubbard, Martin and Nicollet Co), U of M, MDA	Technical assistance with demonstration planning, interpretation, outreach, education and distribution of results.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
• Economics of nutrient management Best Management Practices.	319, State.	U of M, MDA.	Various associated workshops, Dealer and farmer training sessions.
• Running yield goal for corn.	Federal, State.	University of Minnesota, MN Dept. of Agriculture, SWCD.	Federal EQIP projects and Red Top Demonstration Farm.
• Site specific management (Precision Agriculture).	State; Federal.	University of Minnesota.	Ongoing, international conferences and establishment of the Precision Agriculture Center in Rosemount.
• Manure application Best Management Practices.	Federal (319 and other), State, Local.	Various	Manure Management Workshops.
• Manure exchange and transport programs.	State	MPCA	Currently operating at the local level through the Minnesota Pollution Control feedlot permitting process.
• Successful approaches of local agencies to promote Best Management Practices.	Federal (319 and other); State; Local.	Natural Resources Conserva-tion Service; regional University of Minnesota, Soil and Water Conservation Districts; Clean Water Partnerships.	Promotion of Best Management Practices.
• Irrigated agriculture: Development of Best Management Practices for Potatoes.	State.	University of Minnesota; MN Dept. of Agriculture.	Management practices to minimize impact of irrigated potato farming on groundwater resources – Nitrogen BMPs for Irrigated Potatoes adopted 1996.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
• Irrigated agriculture: Development of BMPs for dry edible beans.	State, AURI, EQIP, North Harvest Bean Growers, Irrigators Ass. of MN.	University of Minnesota; SWCD (Hubbard, Otter Tail and Wadena).	U of M Ext. Bulleting BU-7397 IPM Control of White Mold in Irrigated Dry Beans, Meronuck et al., 1999.
• Licensing of commercial animal waste technicians.	State.	MN Dept. of Agriculture.	Rule enacted in 1998 requires licensing of Commercial Animal Waste Technicians Manuals completed in 1999 and examinations completed 2000.
• Feasibility study on the certification of non-commercial manure applicators.	State.	MN Dept. of Agriculture.	Statute enacted in 1998 to evaluate and determine feasibility of certification of non-commercial manure applicators Report delivered 1999.
• Phosphorus education forum.	State.	Minnesota River Basin Joint Powers Board.	Conferences in Mankato and Marshall.
• USDA – EQIP: Incentive payments for improved pesticide, nutrient and irrigation management.	Federal.	Natural Resources Conservation Service.	Incentive payments for farmers to adopt improved management practices.
• Sustainable agriculture promotion and teaching.	State.	MDA.	Establishment of MDA Sustainable Agricultural Outreach Program.
3. Develop an irrigation/nitrogen certification program; ideally administered through the irrigators themselves.	319, State.	MDA, U of M, SWCD.	Irrigation Issues Workshops.
4. Technically transfer the body of knowledge from successful watershed projects (e.g., the Clean Water Partnership projects, Clean Lakes Projects, Minnesota River Assessment and other special projects) regarding nutrient transport and loading.	Federal (319 and other), State, Local.	Various.	Participation by various groups in watershed projects.

Goal 2: Further Develop And Improve Best Management Practices That Minimize Nutrient Losses From Agricultural Fields And Obtain Information Needed To Understand Nutrient Transport To Water Resources And Ways Of Reducing Such Losses.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Conduct a demonstration project to promote the economic and environmental benefits resulting from realistic yield goal selection using the "running yield goal" concept.	Federal, State.	MN Dept. of Agriculture.	Anoka Sand Plains Project, Red Top Demonstration Farm and federal EQIP projects.
• Develop manure management plan format and software.	State.	University of Minnesota.	Manure Application Planner software and manual record keeping systems.
• DNA fingerprinting of manure sources.	State.	University of Minnesota.	Study to be completed by June 30, 2001.
2. Manure management research needs include:			
• Improve the techniques for predicting nitrogen availability from manure in the application year and subsequent years.	State.	University of Minnesota.	Funding from a state commission (93-95) resulted in updated U of M manure recommendations.
• Improve application equipment enabling more precise application rates and more uniform distribution.	Private Industry.	None.	Various technical advances in response to the need to improve manure application procedures.
• Explore the feasibility of manure exchange or transport programs for concentrated animal operation areas.	None.	MPCA.	Localized exchange based on feedlot permit needs.
• Gain a better understanding of how Minnesota farmers store, credit and apply their manure resources.	State, Local.	University of Minnesota, Blue Earth River Basin Implementation.	Manure management practice surveys for commodity groups in specific areas. #Inventory of feedlot data collected by county personnel.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Irrigated agriculture research needs include:			
• Develop localized crop coefficient curves so irrigators can make accurate estimates of crop water use and minimize percolation losses.	State, Irrigators Association of MN.	University of Minnesota, SWCD offices (Otter Tail, Hubbard, Wadena, and Anoka) Clear Lake Wellhead Project.	Development and promotion of local crop water use ET hotline and development of the Irrigation Scheduling-Checkbook Method into a computer spreadsheet program.
• Develop Best Management Practices specific for Minnesota's outwash sand regions incorporating nitrogen/irrigation interactions.	State, AURI, EQIP, Private Industry, North Harvest Bean Growers, MN Irrigators Association.	University of Minnesota	Development and promotion of BMPs for white mold control, N Timing and Irrigation scheduling. U of M Extension Bulletin BU-7397.
4. Determine extent of nutrient loading to surface water resulting from tile drainage and surface tile inlets and develop Best Management Practices to reduce nutrient inputs to surface and ground water from drainage activities.			
• Red Top Farm project.	State	MN Dept. of Agriculture, Various cooperators.	Farm demonstration project monitors tile water under Best Management Practices.
• Tile design research/demonstrations: Waseca and Lamberton.	State.	University of Minnesota, MDA, MN Land Improvement Assoc.	Various drainage practices installed in 1999 for research.
• Computer simulation (ADAPT) output of tile line management and design	State.	U of M.	Developed computer model based on lysimeter data from seventies and eighties.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
5. Conduct paleolimnological work to determine historical/background phosphorus levels in order to set attainable goals for surface water quality.	Not Available.	N/A	Task not undertaken.
6. Research and demonstrate the economic and environmental benefits of soil specific crop management.	State.	University of Minnesota.	Ongoing, international conferences and establishment of the Precision Agriculture Center in Rosemount.
7. Develop Best Management Practices for proper setback distances from surface water bodies that are needed to minimize cropland nutrient runoff (with and without filter strips).	State.	MPCA.	Guidelines (not official Best Management Practices) Land Application of Manure published in 1996.
8. Study how nitrogen affects algae and weed growth in Minnesota lakes and streams.	Not Available.	N/A	Task not undertaken.
9. Conduct research on phosphorus as recommended by the proposed phosphorus task force.	Not Available.	N/A	Task not undertaken.
10. Value of perennial forages for ground water protection.	State.	ARS, U of M, MN Dept. of Agriculture.	Study to be completed by June 30, 2001.
11. Management Systems Evaluation Area (MSEA) Northern Cornbelt Sand Plains project, Minnesota site.	Federal; State.	University of Minnesota.	Development of environmentally protective ridge-till corn-soybean rotation Best Management Practices.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
12. Establishment and study of agroecoregions.	Federal, State.	University of Minnesota.	Division of state into agroecoregions based on soil and hydrologic characteristics; management guidelines based on agroecoregions.
13. USDA – EQIP Conservation Priority Areas.	Federal, State, Local.	Natural Resources Conservation Service; local	Focused application of Best Management Practices.

Goal 3: To Improve Our Understanding Of The Adoption Of BMPs, Effectiveness Of BMPs, And To Identify Priority Areas Through Monitoring Of BMP Implementation, And Soil, Surface And Ground Water Nutrient Levels.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Agricultural Pesticide and Nutrient Monitoring and Assessment Program.	State	MN Dept. of Agriculture; MPCA; MN Department of Health; Clean Water Partnerships.	Develop monitoring network for data collection and analysis of ag chemical trends in groundwater.
2. Place planning *or technical* staff in regional *or field* offices to assist local governments and public water suppliers.	State.	MN Dept. of Health; and MN Dept. of Agriculture.	Direct assistance to public water suppliers, *ag producers* and local governments.
3. Establish a long-term monitoring network for nitrate in vulnerable aquifers throughout the state in order to better understand nitrate trends, progress towards meeting the state's degradation prevention goal, and the effectiveness of BMP promotion efforts.	Funds for a unified statewide monitoring network not available.	Localized networks via Clean Water Partnerships.	Not Completed.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
4.	Identify areas and aquifers where nitrate concentrations exceed or approach standards in order to help set county priorities regarding nitrogen management, target areas for the *Nitrogen Fertilizer Management Plan* and the Clean Water Partnership, and proved an increased level of drinking water protection for domestic water supply users.	Federal (319), State.	MN Dept. of Agriculture.	Annually test 6,000 to 8,000 private wells for nitrates. County level summaries available each year from MDA. Anticipate data will be Web accessible by the end of 2001.
5.	Monitor the adoption of nutrient management Best Management Practices by farmers in various areas in the state through surveys and interviews.	State.	MN Dept. of Agriculture, Clean Water Partnership.	Baseline surveys on 500 farms of farm practices. Anticipate data will be Web accessible by the end of 2001.
6.	Assemble and analyze soil test data to determine trends in soil phosphorus levels throughout the state.	State.	U of M.	For analysis of southern MN, see Randall et al., 1997.
7.	Monitor lakes, streams, soil water and ground water where Best Management Practices have been implemented through the Clean Lakes and the Clean Water Partnership Projects. Monitoring should be conducted for a period of at least six to ten years after BMP implementation.	State.	MPCA, MN Dept. of Agriculture, Clean Water Partnerships.	LCMR groundwater study in southwestern MN to be completed by June 30, 2001 with an extension likely. Numerous lake monitoring efforts. Whitewater River project.

Goal 4: To Develop Clear Statewide Policies for Decreasing Transport of Nutrients to the State's Water Resources and to Improve the Coordination Framework Necessary to Accomplish these Policies.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Analyze and document existing information related to phosphorus in Minnesota waters to support the development of best management practices to minimize phosphorus transport to water resources.	State.	University of Minnesota.	Phosphorus publications (6288, 6797-B, 6796-B, 6795-B, and FO-7079-E) published in 1997.
2. Draft and implement rules for nitrogen management Best Management Practices, considering recommendations made in the *Nitrogen Fertilizer Management Plan.*	Not Available.	Not Applicable	Task not undertaken.
3. Provide a forum among various state and federal agencies and local interest groups to discuss proposals for dealing with livestock exclusion along waterways, buffer strips along surface water resources, and surface tile inlets.	State.	MN Dept. of Agriculture; MPCA.	Establishment of Feedlot and Manure Management Advisory Committee and revised feedlot rules in 2000.
4. Establish a multi-agency advisory group to determine criteria for classifying the severity of existing ground water nitrate problems in townships throughout the state that would aid in state and local prioritization efforts.	Not Available.	Not Applicable	Task not undertaken.
5. Develop an institutional framework that clearly identifies the interrelating roles of various programs (Comprehensive Local Water Plan, The Clean Water Partnership and Wellhead Protection) as they relate to the *Nitrogen Fertilizer Management Plan.*	Not Available.	Not Applicable	Task not undertaken.

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Chapter 10 Agricultural Pesticides

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Introduction

Minnesota is a state rich in water resources, including lakes, river, wetlands and extensive underground aquifers. Minnesota is also the site of the headwaters of three major river systems: Hudson Bay, Lake Superior and the Mississippi River. As a headwater site three times over, our state is unique. Almost all surface water runs out of the state, so virtually any contamination we find in our water supplies (except for that brought by precipitation) is our own. We're in the enviable position of not being responsible for trying to prevent - or minimize - contamination caused by others.

For both urban and rural landowners, the term "pest" describes many different threats to our crops and lawns, including insects, rodents, weeds, and a variety of plant diseases. To manage this vast array of pests effectively, urban and rural landowners use a variety of pest control tools and management strategies. One strategy, known as integrated pest management (IPM), includes precise timing and application of pesticides, as well as crop rotations, adjustments of planting dates, weather monitoring, introducing natural enemies of particular pests, and the use of resistant varieties of plants and crops.

To protect farm fields and home lawns, landowners consider many different pest control options, and one of these options is the responsible use of pesticides. In rural areas, pesticides help protect crops and increase yields. In urban areas, pesticides help protect shrubs, trees, lawns and gardens.

Finding the balance between the responsible use of pesticides and the protection of our water resources is an ongoing challenge. While certain areas of the state - including the central sand plains and the karst regions of southeast Minnesota - are particularly vulnerable to ground water contamination, all of our surface water resources and ground water resources need to be protected from the potential risk of contamination by pesticides.

By finding the balance, we will be able to continue using pesticides as a tool for protecting our crops, shrubs, trees, lawns and gardens from pests. At the same time, we will be doing all we can to protect our water resources.

MINNESOTA PESTICIDE MANAGEMENT PLAN

Because of the direction provided in Minn. Stat. § 18B.045, Minnesota's approach to pesticide management starts with prevention efforts and water quality monitoring, then, if necessary, moves through voluntary measures and further monitoring prior to increased regulatory restrictions regarding potential problem pesticides. The Minnesota Commissioner of Agriculture also has the authority to deviate from this process and impose use and distribution restrictions on a pesticide if necessary to prevent unreasonable risk to humans and the environment.

The initial step in the process is promotion of management practices that are protective of the environment. Prevention of contamination is an underlying theme behind MDA's pesticide registration and certified applicator training programs, and is a key factor in the development of Best Management Practices (BMPs). These and other prevention activities are ongoing, and occur even if contamination is not detected in ground or surface water. The prevention goal of the Pesticide Management Plan (PMP) is to effectively manage pests while protecting water quality from degradation, economic profitability, and urban and rural beneficial uses of pesticides.

Within the prevention component, many activities take place including development and promotion of BMPs and vulnerability assessments. A specific chemical management plan will consider inclusion of a crop specific management plan. BMPs may be promoted both before pesticides are detected in water resources and in response to declaration of common detection or a requirement by U.S. Environmental Protection Agency (USEPA) to develop management plans for specific pesticides. Management plans may include or be coordinated with crop specific management plans. Completing a vulnerability assessment is a tool to help focus monitoring activities, tailor BMPs to meet local needs and target special promotion efforts to achieve the maximum protection of Minnesota's water resource.

Pesticide management plans may be designed for individual pesticides or multiple pesticides used in similar manners on one or more crops. The pesticide specific management plans may be promoted by or incorporated into crop specific management or conservation plans or approaches.

Independent of the pesticide management process, statewide water quality monitoring is conducted, including monitoring of ground water, drinking water supplies, and surface water. Monitoring of pesticide use practices and quantities used is also conducted.

The water quality monitoring data gathered is analyzed and summarized into a format from which decisions can be made. The data is managed in computerized databases maintained by the MDA's Monitoring Unit, and is available to the public upon request. The MDA is currently working with the U.S. EPA to put all data into STORET, a unified database with EPA-established quality assurance objectives. Once data is managed in STORET, it will be immediately accessible by interested parties through the Internet.

Data collected from these efforts is used by an MDA-facilitated multi-stakeholder committee in making regulatory decisions pertaining to pesticide use and water resource quality. The data is also used by local planners in the development of local water plans and source water protection activities, and by those engaged in the promotion of Integrated Pest Management programs.

Evaluation of water resources for common detection of pesticide impacts is a required step in the process of developing specific management plans, Best Management Practices, and more stringent, and possibly mandatory water resource protection requirements. In cases of ground water and surface water contamination resulting from use of a pesticide that is not due to misuse or unusual or unique circumstances, but is likely to be the result of normal use of a practice, the commissioner will review the available data for common detection status. In instances where extreme hazard is found (such as a hypothetical newly-registered pesticide which is widely found in ground or surface water after just a single year of use), the commissioner may apply the broad authorities of his office to cancel or restrict registration, without the need to evaluate for common detection. In instances where a pesticide is not in common detection status the commissioner may work with the registrant or interested commodity groups to develop a generic BMP promotion program.

An analysis of the benefit of registration of the pesticide to Minnesota agriculture in relation to measured or predicted environmental impacts may be recommended in cases when the presence and concentration of a pesticide declared common detection indicate an increased risk of harm to human health or the environment. The commissioner, based on this analysis and other information, will determine whether it is in the best interest of the state of Minnesota to develop a management plan for some or all uses of the specific pesticide. Various regulatory and non-regulatory options are available to the commissioner ranging from statewide prohibition of use to site specific pesticide management plans.

The evaluation goal of the PMP is to determine the validity and effectiveness of pesticide management strategies. To make sure that decisions are made based on accurate data, that BMPs are truly effective in addressing problems, that they don't cause other problems and that pesticide users actually are adopting the BMPs, an evaluation team will be convened with the responsibility of ensuring that management decisions are made through application of valid information.

The detection and concentration of pesticides in ground or surface water can be used to indicate the need to initiate best management practices or analysis of the effectiveness of these practices. In cases where the detection and concentration trends of a pesticide or other evaluation means, indicate that the best management practices are ineffective, water resource protection requirements may be implemented. Mitigation of the detection and concentration will be sought to minimize or eliminate unreasonable adverse effects on human health and the environment. The MDA will accomplish the mitigation goal through the convening of management teams that will be responsible for the development of pesticide specific management plans. To enhance resource utilization, a crop specific management plan may be similarly developed. The diversity of the water quality monitoring effort leads to a variety of water quality standards, which are applied. These include the application of Minnesota Health Risk Limits, federal Maximum Contaminant Levels, and surface water standards established by the Minnesota Pollution Control Agency.

PESTICIDE USE MONITORING IN MINNESOTA

Minn. Stat. § 18B.064 requires the Minnesota Department of Agriculture (MDA) monitor urban and rural use of pesticides on a biennial basis. Pesticides include a wide variety of diverse products such as structural insecticides, lawn care products, row crop herbicides and household disinfectants. Approximately 10,000 pesticide products are registered for use in Minnesota and they are used in most home, public places, and businesses in addition to agricultural and turf applications.

No single existing source of pesticide use data provides a comprehensive picture of pesticide use in Minnesota and it would take a significant commitment of resources to do so. However, there currently are several sources of pesticide use data in Minnesota. These sources are:

- Minnesota Agricultural Statistics Services (MASS) annual reports on Minnesota agriculture;
- MDA required reports of pesticide sales;
- Minnesota Pesticide Impact Assessment Program (MPIAP) reports on special surveys of "minor" crops and aerial applicators; and

- MDA Farm Nutrient Management Assessment Program (FANMAP) surveys of nutrient and pesticide use practices.

Most reports and data from the sources outlined above are available to the public. A brief summary and discussion of each of these sources of pesticide use data follows:

Minnesota Agricultural Statistics Service (MASS) Annual reports on Minnesota Agriculture

The MASS selects a set of pesticides for which information is needed each year by crop type. The MASS collected data on the use of specific pesticides prior to 1985 and starting again in 1996. The 11-year gap in data was the result of budget cuts. The following is a summary of the data. Combining the MASS data with information on report of sales, below, will provide a useful picture of major row crop pesticide use trends over time.

The MASS surveys, while not designed specifically to collect pesticide use information, ask for use data on a small number of specified herbicides selected by the USDA. The data is compiled and reported on a statewide basis. Given these restrictions one should be cautious about correctly interpreting the data. However, the data is useful for identifying major statewide trends in pesticide use for Minnesota's two primary crops, corn and soybeans.

For corn the pesticide compounds have remained fairly static since 1982 with the exception of acetochlor, which was first registered for use in 1994. The registration and use of acetochlor is concomitant with the decrease in the use of alachlor. A condition of acetochlor's federal registration was that the use of several other compounds must be reduced by a substantial amount across the United States. One of these was alachlor. The MASS data indicates that these six compounds alone represent pesticide use on over ten million acres of cropland in the state.

Imazethapyr was very popular following its initial introduction in Minnesota. Its use has since begun to decrease possibly as a result of increasing use of glyphosate as a result of increasing use of round-up ready soybean varieties or the appearance of resistant weed species. Data on the use of metribuzin and alachlor on soybeans was not collected by MASS in surveys during the 90's.

The MASS data indicate that the herbicides Methyl-4-chlorophenoxyacetic acid (MCPA) and 2,4-Dichlorophenoxyacetic acid (2,4-D) are used extensively in growing wheat. The use of MCPA showed a dramatic increase from 1984 to 1995 through 1998. The four compounds tracked account for over 2.5 million acres of cropland in 1998. Data on dicamba and trifluralin was not collected during the 1990s.

MDA Required Reports of Pesticide Sales

Pesticides must be registered in Minnesota to be sold here. The registration fee is based on total product sales from the previous year. Sales information for each pesticide product must be submitted to the MDA on an annual basis to determine these fees. The basic data collected consists of gross product sales in dollars for each registered product. This sales data can be used to estimate product use by active ingredient or category of use (crop type, turf, sanitizer, etc.).

It is important to recognize that converting sales data to another format requires a substantial effort and is vulnerable to errors. For example, to determine the total pounds of atrazine used in Minnesota would require a search for all products containing atrazine, estimating the cost, calculating the unit cost per pound of active ingredient, and then determining a rough estimate of pounds of atrazine for each product. Many common active ingredients are contained in dozens to hundreds of products. In addition, there is no guarantee that the product sold will be used in Minnesota or when it will be used. Nevertheless, the data is very useful as a reliable indicator of long term trends in product used.

The MDA has estimated total use (in pounds) from sales data for thirteen pesticide active ingredients. The pesticides selected are indicators of pesticide use patterns and trends in Minnesota and includes those pesticides of greatest concern with respect to the environment (as evidenced in water quality monitoring programs), human health or as indicators of trends in pesticide use.

Minnesota Pesticide Impact Assessment Program (MPIAP) Reports on Special Surveys of "Minor" Crops and Aerial Applicators

The University of Minnesota, Department of Entomology is the state liaison with the National Pesticide Impact Assessment Program. The program is known as the Minnesota Pesticide Impact Assessment Program (MPIAP). In Minnesota the MPIAP focuses its efforts on the collection of pest control information on specialty and "minor" crops, and the aerial application of pesticides. The information they collect includes pesticide use. In the past these surveys have collected or compiled very good information capable of providing a picture of use changes over time. MPIAP has conducted surveys of pesticide use on minor use crops for a number of years under the direction of USDA. The focus of these reports changes regularly in response to USDA instructions.

MDA Farm Nutrient Management Assessment Program (FANMAP) Surveys of Nutrient and Pesticide Use Practices.

FANMAP is a tool used by the MDA's fertilizer and manure management programs to assist in determining the status and needs of individual farms with respect to nutrient management. FANMAP is an on-farm personal visit by staff from the MDA for the purpose of filling out an extensive questionnaire on farming practices of selected farmers. As the name implies FANMAP has been used primarily for nutrient management. But in 1998 through a request from MDA's surface water monitoring program, FANMAP was specifically modified for the purpose of collecting pesticide use information in the middle branch of the Whitewater River watershed. This was the first in a series of planned FANMAP assessments for pesticides in seven additional watersheds where water quality monitoring is conducted. The result of each FANMAP assessment is a report detailing the information that was collected in the watersheds.

Planned Pesticide Use Monitoring Activities

In recent years the public's interest in pesticide use data appeared to be increasing while the available data remained limited. In response to this concern, the MDA entered into a contract with the MPIAP to review all previous pesticide use surveys conducted in the state, assess the types of information collected, the methods employed, and the adequacy of the various survey methods and information for the purposes of a biennial survey

MPIAP staff assigned to the project left employment there, and the project was never completed. The MDA conducted its own internal review of pesticide use and monitoring options and prepared a conceptual plan (outlined below) for ongoing monitoring activities. The MDA reviewed all its current and historical pesticide use monitoring options, and brainstormed other opportunities, including pesticide use monitoring activities in other states and actions that might capitalize on the current MDA "Project Unity" to upgrade the departments data management systems.

One obvious option that received careful consideration was a biennial pesticide use survey. The MDA conducted a prototype survey of 18,000 farmers in 1990, with funding through the Legislative Commission on Minnesota Resources (LCMR). Based on that experience, the MDA concluded that it would be both logistically and financially difficult to maintain such a rigorous survey effort on a biennial basis. More importantly it was also concluded that response to the surveys would likely drop precipitously each ensuing year because of the extensive nature of the questions asked.

Currently the MDA is planning actions to address pesticide use monitoring. The major parts of the plan, along with some additional considerations and discussion, are presented here.

1. **Hiring New Staff -** The department has hired an additional professional staff person whose responsibilities include pesticide use monitoring.

2. **Reports of Sales -** The department plans to continue to use sales data for two purposes. First, historical sales data suggests that typically less than a dozen pesticide active ingredients account for roughly 85% of total pesticide use in Minnesota. Therefore, the department will continue to use sales data to help prepare a short list of pesticides that are of primary environmental interest due to use. Second, the department staff will prepare an estimate of the total pounds of active ingredient sold in Minnesota for each of the active ingredients on the list.

   In the longer term the department plans on investigating options to make pesticide sales data available electronically to the general public. This will require significant changes to the current database and data tracking system. However, the department's data management systems are currently being upgraded which may provide an opportunity for needed modifications. A possible future approach will be to track pesticide sales by products and active ingredients, rather than just by products as is currently done. This could allow for sorting by pounds of active ingredient sold annually, possibly through an interactive web site (to be developed at a later date). Public access to some pesticide sales data may be limited by data privacy restrictions.

3. **Farm Surveys Through MASS -** As previously mentioned the Minnesota Agricultural Statistics Service (MASS) conducts ongoing statewide commodity surveying activities. The MDA and MASS have discussed incorporating additional pesticide use questions into the current MASS farm surveys. These could include a short list of perhaps 15-20 pesticides which are of greatest environmental concern based on volume of sales and detections from the MDA ground and surface water monitoring program. Questions regarding the use of these 15-20 products will be included in the MASS surveys. Survey data will be available on both a statewide and regional basis in accordance with the current MASS data analysis methods. Preliminary discussions with MASS indicate that any changes to the survey must be approved through the USDA central office and may take some time to implement. The MDA is moving forward with this option.

4. **FANMAP -** The department plans on integrating pesticide use questions into the current Farm Nutrient Management Assessment Program (FANMAP). The FANMAP approach is used primarily in areas with an identified ground water or surface water problem to evaluate existing practices, identify opportunities to improve practices, and as a reference point to determine if the adoption rate of agricultural best management practices varies over time. The primary advantage of the FANMAP approach is that it provides a highly detailed analysis of actual pesticide use. The weakness of this approach is that it requires extensive use of staff resources over a very limited area, generally a wellhead protection area or a small watershed. FANMAP activities are generally conducted in areas with surface water or ground water

monitoring in place. Despite the fact that FANMAP activities are resource intensive, their use as a "barometer" of pesticide use and BMP adoption is extremely beneficial. An analysis of FANMAP results can lead to more focused education and outreach efforts, which ultimately have tremendous potential to mitigate pesticide impacts to water resources.

5. **Limited Pesticide Use Surveys at Monitoring Sites** - The MDA's ground water monitoring program is focused around the central sand plain portion of the state where land use activities are more likely to impact ground water resources on a broad scale. The program has spent the last two years installing new monitoring wells in a 12 county region of the sand plains. Samples are collected from these wells to determine the impact that agricultural chemical use is having on the ground water. To aid in this assessment the landowners around each of the well sites voluntarily provide the department with their pesticide use information. This effort will use the FANMAP approach. The fieldwork would be conducted primarily through the assistance of local cooperators under the MDA ground water monitoring program.

6. **Other Opportunities** - In the short term the MDA plans on moving forward immediately with the pesticide use monitoring activities outlined above. After the new staff person is hired the department will also pursue two additional options. We hope to further evaluate these options.

   a. **Increased Coordination with MPIAP** - A recent discussion with MPIAP staff indicated that they are in a period of transition such that they would not be well positioned to take any potential additional commitments in the short term. However, both MDA and MPIAP felt there was an outstanding opportunity for long term coordination between programs.

   b. **Increased Coordination with Commodity and Industry Groups** - Much of the work currently planned will focus on major crops. There may be an excellent opportunity to collect pesticide use information on specialty applications and minor use crops directly from applicators affiliated with these groups. For example, structural, aquatic and mosquito control applications and some minor use crops such as sugar beets all have a relatively small group of applicators who are either closely regulated or have an active industry group to represent them. These groups may be easier to survey and willing to survey their members, creating a higher likelihood of response than random surveys conducted by a government agency.

PESTICIDE WATER QUALITY MONITORING IN MINNESOTA

Minnesota Department of Agriculture

Major recent projects included the installation of monitoring wells in the central sand plain region of the state, and the installation of automated surface water monitoring stations in the Minnesota River Basin. More than 100 wells were installed at 84 sites in the sand county area of the sand plains. In the surface water monitoring program three automated stations were installed in the middle Minnesota River Basin, one in the Des Moines River Basin, and another was installed in the lower Minnesota River Basin.

1. **Ground Water Program**

   During 1999, the ground water monitoring program focused on the installation of monitoring wells for the central sand plain monitoring cooperative. The Sand Plain Ground

Water Monitoring Cooperatives are for the development and installation of a long-term monitoring well network for the sand plain areas of the state. All interested agencies needing ground water quality or quantity data for the sand plain area will be allowed to use the wells if the data is not already being collected by another group.

This initiative will help provide answers to the region's agricultural water quality concerns including: what is the status and trends in pesticides and nutrients in the surficial aquifers of the sand plain region of Minnesota and what are the impacts of changes in management practices? Prior to the current network there was not a sufficiently constructed monitoring well network in the sand plain area of Minnesota to allow adequate collection of ground water quality or quantity data for decision and policy-making purposes. Wells consist of two inch PVC casing with four foot slotted screens. In order to detect changes in pesticide levels as soon as possible, each site has a well nest screened across the water table and one or more wells screened at greater depths. The sites will be sampled on a rotating basis every nine months resulting in one sample from each season every 27 months. The result is that approximately one-third of the total wells in each cooperative will be sampled every quarter. This will result in the ability to track trends in occurrence as well as concentration over time. This will also allow tracking long-term small magnitude trends in individual wells. Wells are located in the sand plain portions of 12 counties.

2. **Surface Water Program**

During 1999, the surface water monitoring program focused on the installation of five new automated surface water monitoring stations. Three stations are located in the Middle Minnesota River Basin, one in the Des Moines River Basin and one in the Lower Minnesota River Basin. Along with the addition of sites the program continued to operate automated sampling stations on the Middle Branch of the Whitewater River, Cascade Creek, Bent Creek, and jointly operated sites in the Minnesota River at Jordan, Sand Creek and Bevens Creek with the Metropolitan Council. The drain tile site at Red Top Farms was also maintained during the year with an additional tile system in a field across the road instrumented and monitored.

Three memorandums of agreement (MOAs) with other organizations were completed during the year. Two of the MOAs are long-term cooperative monitoring agreements that obligate the surface water monitoring program to lend its expertise to new water quality monitoring projects.

COMMON DETECTION ADVISORY COMMITTEE

The Common Detection Advisory Committee (CDAC) was created as an outcome of the Minnesota Department of Agriculture (MDA) Pesticide Management Plan (PMP) for the purpose of recommending to the Commissioner of Agriculture which pesticides should be considered for common detection status. Common detection, as defined under Minn. Stat. § 103H.005, means not being due to misuse or unusual or unique circumstances but due to normal use of a product or practice.

Based on the recommendations of the MDA, the CDAC evaluated five pesticides in ground water: atrazine, alachlor, cyanazine, metolachlor, and metribuzin. The CDAC acknowledged that atrazine was unofficially recognized in a common detection status for ground water in 1991, and in 1996 recommended that this status be officially confirmed. The CDAC concluded the detection of the other four pesticides in ground water was not a common occurrence and recommended that they not be placed in common detection status. The CDAC also commented on pesticide specific water quality concerns, monitoring needs, and the need for Health Standards and Water Quality Criteria for all pesticides being considered. The committee was complementary of the quality of the MDA ground water monitoring program and monitoring data.

Based on the recommendations of the MDA, the CDAC evaluated nine pesticides found in surface water: atrazine, acetochlor, alachlor, cyanazine, dicamba, MCPA, MCPP, metolachlor, and 2,4-D. After conducting an in-depth analysis of the monitoring data and reviewing the language contained in the PMP, the committee concluded that the definition of common detection contained in Minn. Stat. ch. 103H did not adequately address the issues relevant to surface waters. The committee recommended criteria specific to surface water for evaluating surface water monitoring data and this was incorporated into the Minnesota PMP.

In keeping with the intent and guidance in the PMP, the CDAC recommended development of generic (crop or region specific) surface water Best Management Practices (BMPs) for: atrazine, acetochlor, alachlor, cyanazine, metolachlor and 2,4-D.

The committee recommended development of lawn and turf surface water BMPs for: MCPA, Methyl-(4-chlorophenoxy) propionic acid (MCPP), and 2,4-D. The committee also prioritized the relative need for BMPs for each pesticide.

The committee was complementary of the quality of the MDA surface water monitoring program and data, but noted that the data are insufficient, on a scientific basis, to make a determination of the extent of surface water contamination across Minnesota. The committee also recommended that a clearinghouse for pesticide monitoring data be established to consolidate monitoring data from all sources, including other state agencies, into a central repository.

INTEGRATED PEST MANAGEMENT

Minnesota Department of Agriculture

The Integrated Pest Management (IPM) Program takes its authority from Minn. Stat. § 17.114, subd. 4.: *Integrated Pest Management* which states: "the state shall promote and facilitate the use of integrated pest management through education, technical or financial assistance, information and research". The Minnesota Department of Agriculture (MDA) develops and implements statewide strategies for the increased use of IPM on private and state managed lands. Some of the IPM program activities include generating IPM information via newsletters for growers, producers and land managers which inform them of relevant issues and can help them make alternative choices in their pest management decisions; developing an IPM in schools program to educate school districts on IPM and how to implement its use; providing funding for IPM research; and providing IPM information to the general public.

Fruit and Vegetable IPM - According to USDA statistics, fruits and vegetables (potatoes, sweet corn, peas, apples, carrots, onions, and small fruits) are produced on more than 3,000 Minnesota farms, covering more than 278,100 acres, with an annual farmgate value of over $222.5 million. The MDA, in cooperation with the University of Minnesota, is producing the *Minnesota Vegetable IPM Newsletter* which takes a comprehensive, multi-disciplinary approach in disseminating IPM strategies, educating producers, and communicating timely pest pressure and pest management information to growers. By anticipating pest problems in a proactive mode, decision making activities will go beyond merely scouting for a particular pest before making the decision of whether or not to apply a pesticide.

Weed IPM - The State of Minnesota manages about 5.5 million acres of land. This land has multiple uses, everything from prison perimeter security areas, to state parks, to college campuses. There are diverse types of vegetation, wildlife, and human uses that need varied approaches to environmentally sound management. There is growing consensus within the legislative and executive branches that state land management practices should protect the environment, provide habitat for native species and wildlife, and provide for present and future public use of the land.

Based on these expectations and the statutory requirements (MN Laws, Chapter 326 - Article 5, Section 18B.063 - State Uses of Pesticides and Nutrients) that "the state use integrated pest management techniques in its management of public lands, including roadside rights-of-way, parks, and forests; and use planting regimes that minimize the need for pesticides and added nutrients", the legislature asked for a management plan for state-owned lands that incorporates the principles of sustainable agriculture and integrated pest management. Thus, the "Integrated Pest Management and Sustainable Agriculture Plan for State-Owned Lands" was written and released in May, 1996.

The MDA and MDNR worked in partnership to produce this plan for integrating more environmentally sound and cost-effective practices into the management of state-owned lands. The plan inventories the management practices of various state agencies and provides a framework for the increased use of sustainable agriculture and IPM as part of local land management techniques. This provides the state with the opportunity to act as a model for private landowners who are being encouraged to implement similar practices.

In response to the report, and IPM working group on noxious weeds began meeting in 1998. Weeds of particular interest include, but are not limited to Canada thistle, leafy spurge, purple loose strife and buckthorn. Representatives include the MDA, MDNR, MnDOT, USDA-APHIS, USFWS, and the U of M. Discussions have centered on how IPM can be implemented with regard to weed control on state-owned land and serve as a model for private landowners. The group is preparing a survey for land managers and working on the first in a series of Weed IPM brochures. In addition, a bi-monthly multi-agency e-mail Weed IPM Newsletter for land managers is produced cooperatively by the agencies listed above with the MDA as the lead.

School IPM - Because of the interest expressed concerning IPM in K-12 schools, the MDA and the U of M jointly established a voluntary statewide IPM in K-12 Schools Working Group. The Working Group includes representatives from the MDA, U of M Extension Service, MN Office of Environmental Assistance, MN Department of Children, Families and Learning, MDH, and St. Paul Public Schools, all of whom have expertise in health, pollution prevention or pest and pesticide management issues in K-12 schools. Group members agree that there is a need to bring awareness to and work with pest control operators, school administrators, school health and safety staff, facility managers, maintenance staff, teachers, students, parents, school boards, and the general public regarding IPM and the safe and judicious use of pesticides both in and around school buildings.

The Working Group decided that a survey of pest management practices in Minnesota public and private K-12 schools was a good starting place to help identify current pest management practices because there was limited data on pest management practices in Minnesota K-12 schools. The MDA, with the support of the Working Group, sought and was awarded funding from the US EPA for a survey of pest management practices in Minnesota public and private K-12 schools. The survey was completed in early 2000. The USEPA provided a second round of funding which is being used to develop IPM pest fact sheets and IPM training workshops which will be held in several locations throughout Minnesota in early Fall 2000.

BEST MANAGEMENT PRACTICES (BMPS)

The following general list of Agricultural Management BMPs is commonly used to reduce nonpoint source pollution from use of agricultural pesticides. This list is not comprehensive and does not suggest additional BMPs would have no benefit.

Please refer to the Appendix B of this 2001 NSMPP for definitions of the following BMPs.

Part I Agricultural BMPs

2. Biological Control of Pests
4. Conservation Cropping System
6. Correct Application of Pesticides
7. Correct Pesticide Container Disposal
9. Cultural Control of Pests
19. Integrated Pest Management
27. Pesticide Selection
32. Resistant Crop Varieties

The MDA has adopted BMPs for Pest Control in Agronomic Crops. The complete set of 8 fact sheets can be found at: http://www. mda.state.mn.us/ APPD/BMPs/BMPs.htm

Chapter 10 Agricultural Pesticides
Needs, Priorities and Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) 5-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Goal 1: Improve Water Resource Protection Decisions through the Collection, Storage and Dissemination of Data Related to Pesticide Products, Environmental Persistence, Toxicology and Alternative Pest Management.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Expand the understanding of relationships between pesticides and their breakdown products in ground water by:						Federal, State	MDA, MPCA.
• Conducting a background search on existing pesticide breakdown product data;	X						
• Determining the contamination source where possible;		X					
• Comparing results from point source (e.g., spills and ag chem. facility losses) vs. nonpoint source contamination sites; and			X				
• Expanding analytical capabilities to include more breakdown products.				X			
2. Monitor scientific and toxicological research regarding parent pesticides and their breakdown products. Apply results toward updating drinking water exposure standards and monitoring regimes.	X	X	X	X	X	Federal, State	MDA, MDH.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
3. Evaluate ways in which research that is indirectly related to pest management and alternatives to pesticide use could be implemented by landowners to reduce chemical use.	X	X	X	X	X	Federal, State	MDA, U of M.
4. Update BMP manuals to include results of research efforts directed at non-traditional and non-chemical approaches to pest management.	X	X	X	X	X	Federal, State	MDA, U of M.
5. Complete Geologic Atlas series statewide.	X	X	X	X	X	Federal, State	MDNR

Goal 2: Develop and Document Measures of the Effectiveness of Pest Management Practices as They Relate to Water Quality.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop screening procedures for pesticides and field sites that likely could impact ground and surface water.	X	X				Federal, State	MDA
2. Periodically conduct surveys to update information on pesticide use practices in Minnesota.		X		X		Federal, State	MDA
3. Evaluate past monitoring efforts and target future efforts through application of GIS capabilities. GIS application would include mapping locations of MDA, MPCA, and MDH monitoring networks; analytical results from various sites; geographically sensitive areas; pesticide use and storage sites; public water supply wells; and Wellhead Protection Areas.	X	X	X	X	X	Federal, State	Interagency Monitoring Group.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
4. Incorporate pesticide breakdown products in analyses of well water monitoring results.	X	X	X	X	X	Federal, State	MDA
5. Consider the impacts on non-target organisms, including threatened or endangered species and native plant communities when developing recommendations for pesticide use.	X	X	X	X	X	Federal, State	MDA, DNR, USFWS.

Goal 3: Continue to Develop Effective Educational Tools and Campaigns to Educate the Public on Pesticide Management Practices as they Relate to Water Quality.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Incorporate results of BMP research into ongoing MDA certification training programs.	X	X	X	X	X	Federal, State	MDA, U of M.
2. Develop focused educational program for promoting use of pesticide specific BMPs. Design program to address three levels of effort:	X	X	X	X	X	Federal, State	MDA, U of M, MPCA.
i. identify the geographic areas of the state potentially at risk from specific pesticides and target these areas for BMP educational efforts;	X	X	X	X	X	Federal, State	MDA, U of M, MPCA.
ii. identify vulnerable areas of the state where specific pesticides are most widely used and target these areas for BMP promotion; and	X	X	X	X	X	Federal, State	MDA, U of M, MPCA.
iii. identify agricultural pesticide users and dealers/crop consultants for targeting specific training efforts.	X	X	X	X	X	Federal, State	MDA, U of M,

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
3. Develop targeted demonstration projects to show economic viability and water quality benefits of selected BMPs or alternative management practices.			X	X	X	Federal, State	MDA, U of M, MPCA.
4. Extend the pest management training programs to dealers, crop consultants, coop agronomists, Soil and Water Conservation District and NRCS staff and pesticide users.	X	X	X	X	X	Federal, State	MDA, U of M, NRCS.
5. Establish ground and surface water standards for pesticides declared Common Detection as defined in the Minnesota Pesticide Management Plan.	X					Federal, State	MDA, MPCA, MDH.
6. Implement recommendations of the Common Detection Advisory Committee.	X	X	X	X	X	Federal, State	MDA, U of M, other state agencies.

Goal 4: Improve the Coordination and Communication Linkages Between State and Local Resource Managers, as Well as Between the Various State Agencies.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Assist public water planners in developing an understanding of potential pesticide contamination of state and local water resources by:						Federal, State	MDA, MDH, MPCA.
i. coordinating monitoring well selection within select areas of benefit to both state and local planners;	X	X	X	X	X	Federal, State	MDA, MDH, MPCA.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
ii. developing GIS application designed to compare locations of community and non-community non-transient public water supply wells in Minnesota with areas where agricultural pesticides are being used and with locations of existing monitoring stations; and	X	X	X	X	X	Federal, State	MDA, MDH, MPCA.
iii. incorporating information on the development of Pesticide Management Plans and Pesticide Best Management Practices into public water planning documents such as basin plans, watershed plans, wellhead protection plans, and local water plans.	X	X	X	X	X	Federal, State	MDA, MDH, MPCA.
2. Encourage implementation of the Memorandum of Agreement between the MDA, MPCA, and MDH on issues related to pesticide nonpoint source pollution.	X	X	X	X	X	Federal, State	MDA, MDH, MPCA.
3. Review agricultural pesticide water quality sample data collected by public water suppliers for Wellhead Protection and use to augment existing MDA network.	X	X	X	X	X	Federal, State	MDA, MDH, MPCA.
4. Assure interagency cooperation on goals established as part of the comprehensive state ground water protection plan.	X	X	X	X	X	Federal, State	MDA, MDH, MPCA.

Goal 5: Provide Information and Education to all Minnesotans on Integrated Pest Management Practices that can Aid in the Reduction of Pesticide use and Positively Affect Water Quality.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Produce IPM information for growers and producers who can help them make alternative choices in their pest management decisions.	X	X	X	X	X	Federal, State	MDA, U of M.
2. Combine pest survey information for Minnesota commodities with IPM options, while expanding producer access to the information.	X	X	X	X	X	Federal, State	MDA, U of M.
3. Provide the general public with information on IPM and how its use combined with practicing the judicious use of pesticides can contribute to improving water quality.	X	X	X	X	X	Federal, State	MDA, U of M.
4. Increase research of IPM strategies for weed management and disseminate information to producers.	X	X	X	X	X	Federal, State	MDA, U of M.
5. Formalize a funding source for conducting research specifically targeting pest management strategies.				X	X	Federal, State	MDA, U of M.

Goal 6: Continue Working with Other State and Federal Agencies on the Implementation of IPM on State and Federally Owned Land, Particularly in the Area of Weed Management, so as to Increase its Use by Governmental Agencies thereby Aiding in their own Efforts to Positively Impact Water Quality.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Insure that discussion of and implementation of IPM practices continues in state agencies by holding meetings and sharing relevant IPM information.	X	X	X	X	X	Federal, State	MDA, U of M.
2. Coordinate the development of weed IPM fact sheets that will be produced for statewide distribution to state and federal land managers as well as private landowners.	X	X	X	X	X	Federal, State	MDA, U of M.
3. Use state or federal research and implementation sites as educational sites for private landowners.				X	X	Federal, State	MDA, U of M.
4. Establish a task force comprised of state and federal agencies with land management responsibilities and other interested parties to coordinate and advance IPM issues.	X	X	X	X	X	Federal, State	MDA, U of M.
5. Formalize a funding source for conducting research specifically targeting pest management priorities on public land.				X	X	Federal, State	MDA, U of M.

Goal 7: Increase the Understanding of IPM and its Environmental Benefits so that IPM is Incorporated into the Pest Management Plans of K-12 Schools in Minnesota.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Provide IPM training to appropriate school personnel so that they can begin to increase its use in their school or school district thus aiding in the understanding of how the use of a combination of pest management practices combined with the judicious use of pesticides can benefit water quality.	X	X	X	X	X	Federal, State	MDA, U of M.
2. Provide IPM information to K-12 students to complement the activities occurring in their schools and to encourage its use at home.	X	X	X	X	X	Federal, State	MDA, U of M.

1994 NSMPP
Needs, Priorities and Milestones

The following Table provides the Goals and Action Steps included in the 1994 NSMPP. The Products, Services & Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps. Implementation of all action steps is contingent upon adequate funding and local involvement

Goal 1: Increase the reliability and accuracy of future decision making through improvement of the current technical base.

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Expand the understanding of relationships between pesticides and their breakdown products in ground water by:			
i. conducting a background search on existing pesticide/breakdown product data;	Federal, State	MDA, MPCA	Incident response and monitoring programs.
ii. developing a sampling program for pesticides and their breakdown products; and determining the contamination source where possible and comparing results from point source vs. nonpoint source contamination sites.	Federal, State	MDA	Monitoring network installed 1999. Monitoring initiated in 2000.
2. Monitor scientific and toxicological research regarding parent pesticides and their breakdown products. Apply results toward updating drinking water exposure standards and monitoring regimes.	Federal, State	MDA, MDH	Lab capability developed at MDA for the MPCA Cottage Grove project. New methods developed for triazine and acentanilide degradates and for new imidazolinone and sulfonylurea parent compounds. Monitoring has been adjusted accordingly and new standards developed by MDH when possible.

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Evaluate ways in which research that is indirectly related to pest management and alternatives to pesticide use could be implemented by landowners to reduce chemical use (e.g. cover crops, alfalfa for biomass production, etc.)	Federal, State	MDA, U of M.	No evaluation of research occurred.
4. Update BMP manuals to include results of research efforts directed at non-traditional and non-chemical approaches to pest management.	Federal, State	MDA, U of M.	Nonpesticide BMPs developed.
5. Complete Geologic Atlas series statewide.	State	MDNR	Completed for many counties.

Goal 2: Improve the assessment and documentation of pest management practices and their impacts on Minnesota water quality.

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Develop screening procedures for pesticides and field sites that likely could impact ground and surface water.	Federal, State	MDA	Accomplished as part of redesign of ground water monitoring network.
2. Expand ground water monitoring efforts to incorporate parameters that could be indicators of pesticide contamination.	Federal, State	MDA	No indicators other than high nitrate-nitrogen have emerged as candidates for such activity.
3. Incorporate low geologic sensitivity settings and bedrock aquifers in the pesticide-monitoring network.	None	None	Program discontinued
4. Periodically conduct surveys to update information on pesticide use practices in Minnesota.	Federal, State, 319	MDA, U of M, MASS.	Lake Harriet Watershed Awareness Project.

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
5. Develop procedure and software that combines the Soil Pesticide Interaction Screening Procedure matrix system with information contained in the atlas series (for counties having the completed series). These procedures must be regionalized for Minnesota conditions.	None	MDA, U of M, MDNR.	Program Discontinued.
6. Evaluate past monitoring efforts and target future efforts through application of GIS capabilities. GIS application would include mapping locations of MDA, MPCA, and MDH monitoring networks; analytical results from various sites; geographically sensitive areas; pesticide use and storage sites; public water supply wells; and Wellhead Protection Areas.	Federal, State	Interagency monitoring groups.	Accomplished during the development of the new ground water monitoring network following the intent of the interagency water monitoring initiative.
7. Incorporate pesticide breakdown products in analyses of well water monitoring results.	Federal, State	MDA	Analyses
8. Develop procedures to track reduced chemical use or risk.	Federal, State	MDA, U of M.	Contracted with UMPIAP to research and develop procedures. Work is continuing with National Agricultural Statistics Service under special USEPA funding.
9. Consider the impacts on non-target organisms, including threatened or endangered species and native plant communities when developing recommendations for pesticide use.	Federal, State	MDA, MDNR, US FWS.	Contact was made and voluntary agreements were reached with individually affected landowners regarding pesticide use and the Endangered Species Protection Program.

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
10. Develop a comprehensive vulnerability assessment by:			
i. completing the Geologic Sensitivity mapping for all agricultural areas of Minnesota;	State	MDNR	Completed for many counties.
ii. combining Geological and Soils Sensitivity ratings for all mapped counties.	Not applicable	MDA, U of M.	Program Discontinued.
Iii. developing maps delineating High Risk Areas in Minnesota; and	Not applicable	MDA, U of M.	Program Discontinued.
iv. combining individual pesticide leaching ratings with High Risk Areas.	Not applicable	MDA, U of M.	Program Discontinued.
11. Develop and implement a strategy for obtaining and managing accurate information on current and future agricultural management practices.	Federal, State	MDA, U of M	Farm Nutrient Management Assessment Program.

Goal 3: Educate the public on pest management practices that reduce pesticide impacts on water quality.

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Incorporate results of BMP research into ongoing MDA certification training programs (e.g. Extension's short course training efforts and crop consultant certification program sponsored by the American Society of Agronomy).	Federal, State	MDA, U of M.	Certification programs.
2. Develop focused educational program for promoting use of pesticide specific BMPs. Design program to address three levels of effort:			

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
i. identify the geographic areas of the state potentially at risk from specific pesticides and target these areas for BMP educational efforts;	Federal, State	MDA, U of M, MPCA.	Common Detection Advisory Committee recommendations.
ii. identify vulnerable areas of the state where specific pesticides are most widely used and target these areas for BMP promotion; and	Federal, State	MDA, U of M, MPCA.	Common Detection Advisory Committee recommendations.
iii. identify agricultural pesticide users and dealers/crop consultants for targeting specific training efforts.	Federal, State	MDA, U of M.	Work accomplished via pesticide applicator certification programs.
3. Incorporate information on Wellhead Protection and BMPs when promoting both programs.	Federal, State	MDA, MDH, MPCA.	Development of guidance "Management Ideas for Wellhead Protection Programs: Agricultural Chemical Facilities and Applicators"
4. Develop targeted demonstration projects to show economic viability and water quality benefits of selected BMPs or alternative management practices.	Federal, State, 319 Funds	MDA, U of M	Lake Harriet Water Quality Awareness project, Lake Alimagnet Water Quality Awareness project.
5. Extend the pest management training programs to dealers, crop consultants, coop agronomists, Soil and Water Conservation District and SCS staff and pesticide users.	Federal, State	MDA, U of M, NRCS.	Work accomplished via pesticide applicator certification programs.

Goal 4: Establish statewide policies, standards, or criteria designed to reduce pesticide impacts on Minnesota's water resources.

	1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
1.	Incorporate ideas from the Consolidated State Ground Water Protection Plan Strategy Activity III. These include:	See 4.1 Ground Water Strategy.	See 4.1 Ground Water Strategy.	Action steps incorporated into Ground Water Strategy (4.1) and USEPA Approved State Wellhead Protection Program.
	i. expand the role of local government;	See 4.1 Ground Water	See 4.1 Ground Water	Same as above.
	ii. improve land use planning;	See 4.1 Ground Water	See 4.1 Ground Water	Same as above.
	iii. revise metro area water management;	See 4.1 Ground Water	See 4.1 Ground Water	Same as above.
	iv. resolve Wellhead Protection jurisdiction issues;	See 4.1 Ground Water	See 4.1 Ground Water	Same as above.
	v. improve state government programs; and	See 4.1 Ground Water	See 4.1 Ground Water	Same as above.
	vi. form advisory council.	See 4.1 Ground Water	See 4.1 Ground Water	Same as above.
2.	Establish ground and surface water standards for pesticides declared Common Detection as defined in the Minnesota PMP.		MDA, MPCA, MDH, U of M.	Common Detection Advisory Committee Recommendations.

Goal 5: Improve the coordination and communication linkages between state and local resource managers, as well as between the various state agencies.

	1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
1.	Assist public water suppliers in development of their Wellhead Protection plans by:	Federal, State	MDA, MDH, MPCA.	
	i. coordinating monitoring well selection with Wellhead Protection area monitoring needs; and	Federal, State	MDA, MDH, MPCA.	MDA's revised monitoring network.

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
ii. developing GIS application designed to compare locations of community and non-community non-transient public water supply wells in Minnesota with areas where agricultural pesticides are being used and with locations of existing monitoring stations.	Federal, State	MDA, MDH, MPCA.	In progress.
2. Encourage implementation of the recently completed Memorandum of Agreement between the MDA, MPCA, and MDH on Wellhead Protection.	Federal, State	MDA, MDH, MPCA.	Ongoing implementation of source water protection program.
3. Review monitoring data on agricultural pesticides collected by public water suppliers for Wellhead Protection and use to augment existing MDA network.	Federal, State	MDA, MDH, MPCA.	Common Detection Advisory Committee Recommendations.
4. Assure interagency cooperation on goals established as part of the comprehensive state ground water protection plan.	Federal, State	MDA, MDH, MPCA, MDNR.	Participated in Minnesota Ground Water Association multi-agency conference on fine tuning the Ground Water Protection Act. Continue to work cooperatively on Act provisions with other state agencies.
5. Establish a task force comprised of agencies, coalitions, chemical dealers, crop consultants, and pesticide users, to coordinate and advance Integrated Pest Management issues.	Federal, State	MDA, U of M.	IPM Task Force formed and meets periodically.

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
6. Develop a method of coordinating with other state task forces, working groups and agencies on standardizing data collection activities and in developing clearinghouse procedures for gathering and issuing data.	Federal, State	MDA, MDH, MPCA, MDNR.	In progress.
7. Formalize a funding source for conducting research specifically targeting pesticides, pest control, and soil/pesticide interactions.	Federal, State	MDA	Pesticide Regulatory Account.

Chapter 11 Urban Runoff

Technical Committee Members

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Busacker, Greg – MN Department of Transportation (MnDOT)
Frost, Jack- Metropolitan Council – Environmental Services (MCES)
Haertel, Jim – Board of Water and Soil Resources (BWSR)
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Introduction

Urban Runoff is runoff from developed or developing urban areas wherever they may be found in the state.

What are the issues and trends associated with urban runoff? Many reports by the Center for Watershed Protection, and others, have summarized the impacts of urbanization. The two main issues can be summarized as quantity and quality. The U.S. Environmental Protection Agency (USEPA), Metropolitan Council, the U.S. Geological Survey (USGS), the Minnesota Pollution Control Agency (MPCA) and others have documented the impacts of urbanization. Many of the issues described below are highlighted by the reports of these agencies.

ROLE OF THIS REPORT

The Section 319 Nonpoint Source Management Program Plan (NSMPP) is responsible for implementing programs for problems not covered by National Pollutant Discharge Elimination System (NPDES) storm water permits. Activities supported through Section 319 funding, therefore, should concentrate on issues and areas not covered by storm water permits. However, in order to support storm water permitting, Section 319 funds can be utilized to support innovative source control activities or practices that serve to educate others, even in areas covered by storm water permitting. Activities that would be eligible for Section 319 funding include:

- Technical support to storm water permit writers;
- Problem identification and quantification;
- Source control best management practices (BMPs) implementation (non-permit);
- Runoff control BMPs implementation (non-permit);
- Information and education programs; and
- Technology transfer and training.

USEPA

Water Quality

The latest USEPA 305b report for 1998 shows urban runoff as the third leading source of pollutants causing impairment of fresh waters behind agriculture and hydromodification:

Leading Pollutants and Sources* Causing Impairment in Assessed Rivers, Lakes, and Estuaries

	Rivers and Streams	Lakes, Ponds, and Reservoirs	Estuaries
Pollutants	Siltation	Nutrients	Pathogens (Bacteria)
	Pathogens (Bacteria)	Metals	Organic Enrichment/ Low Dissolved Oxygen
	Nutrients	Siltation	Metals
Sources	Agriculture	Agriculture	Municipal Point Sources
	Hydromodification	Hydromodification	Urban Runoff/Storm Sewers
	Urban Runoff/Storm Sewers	Urban Runoff/Storm Sewers	Atmospheric Deposition

*Excluding unknown, natural, and "other" sources.

Quality of Runoff

Urban surfaces are subject to the deposit of contaminants, which are then subject to wash-off by rainfall or snow melt. Typical contributors to pollutants in runoff include vehicular traffic, industry, power production, lawn care, pets, eroded sediments and vegetative litter.

The major urban runoff pollutants include sediment, nutrients, oxygen-demanding substances, toxic chemicals, chloride, bacteria and viruses, and temperature changes. Each of these pollutants is discussed below.

Sediment

Suspended sediment and bed load is made up of tiny soil particles from natural soils as well as metal particles from streets and parking lots as well as sand and grit associated with snowmelt. These particles are washed and blown into lakes and streams. Sediment is considered one of the more damaging pollutants in Minnesota, and it is the major pollutant by volume in the state's surface waters.

Nutrients: Phosphorus and Nitrogen

In Minnesota, the effects of nutrients are a major concern for surface water quality. Many naturally occurring materials — especially phosphorus and nitrogen — are essential for life, and are therefore termed "nutrients." However, an excess of some nutrients can lead to explosive growth of noxious life, such as algae, or can be toxic to some forms of aquatic life (as is the case with ammonia).

Nutrients can cause algal blooms and excessive aquatic plant growth. Of the two nutrients, phosphorus is usually the limiting nutrient that controls the growth of algae in lakes. As phosphorus loading rises, the potential for algae blooms and accelerated lake eutrophication also increases.

Of particular concern for receiving waters are nutrients that are increased in urban runoff from such sources as lawn care products, vegetative and animal debris, or automotive additives. Atmospheric deposition (wind erosion, industrial activity) is a concern in urban areas because it can easily be picked up by runoff from impervious surfaces. Nitrate nitrogen, most commonly from fertilizer overuse, can adversely impact ground water when concentrated to high-enough levels. Nitrate may also have toxic effects on some aquatic life such as mollusks.

Oxygen-Demanding Substances

While land animals extract oxygen from the air, aquatic life depends on oxygen dissolved in water. When aquatic microorganisms consume organic matter, dissolved oxygen is depleted. Following a rainfall, urban runoff can deposit large quantities of oxygen-demanding substances in lakes or streams. The biochemical oxygen demand (BOD) of typical urban runoff is about as large as that of effluent from an efficiently run secondary wastewater treatment plant (USEPA, December 1983). A "pulse" of high oxygen demand can be created during storm runoff that can totally deplete oxygen supplies in shallow, slow-moving or poorly flushed waters. Oxygen depletion is a common cause of fish kills. In urban areas, spills, pet wastes, street litter and organic matter are common sources of oxygen-demanding substances.

Toxic Chemicals

Many of the everyday activities in urban areas also contribute substantial amounts of toxic material to receiving waters. Essentially, anything that is applied to the land or emitted from fertilizer or pesticide applications, a smokestack or a vehicle's tailpipe can be deposited on, and washed off, impervious urban surfaces. Some of the toxics of concern are trace metals and hydrocarbons. Seventeen pesticides and five metabolites were detected at all monitored sites in a recent U.S. Geological Study (USGS) report (99-4247).

Chloride

In Minnesota, a tremendous amount of salt is used each year to melt ice from roads, parking lots and sidewalks. From 1984 to 1994 average salt usage was approximately 157,000 tons per year. Over 1989 to 1994 usage increased to an average of 181,000 tons per year. Because it is extremely soluble, almost all salt applied ends up in surface or ground water (Pitt, 1995). If the concentration of chloride becomes too high, it can be toxic to many freshwater organisms. There have been many cases of surface and ground water contamination caused by runoff from inadequately protected stockpiles of salt and sand-salt mixtures (Blaha, Cherryholmes, unpublished MPCA data).

Bacteria, Parasites and Viruses

High concentrations of many bacteria and viruses are found in urban runoff. The Nationwide Urban Runoff Program (NURP) study found that total coliform counts exceeded USEPA water quality criteria at almost every site and almost every time it rained (USEPA, 1983). Apparently, soil can act as a source of bacteria even when it is very unlikely that the high levels are of human origin or that they indicate significant human health risk (Barrett *et al.*, 1996). The coliform bacteria that are detected may not be a health risk in themselves, but are often associated with pathogens that are. The sources of pathogens can include sanitary sewer leaks, pets, vermin and discarded infected material. The result of contact with these pathogens can be disease.

Temperature Changes

Temperature changes, from sources such as impervious surfaces or even ponds, can significantly impact streams (especially trout streams). Various types of temperature criteria can affect the success and mortality of organisms in waterways. Temperature changes that occur over a short period can have a shock effect, resulting in their death. There can also be long-term temperature effects, which cause changes in the growth, reproduction or mortality of organisms. These mean and maximum temperature effect levels vary from organism to organism and can be different for even the same organism in a different waterway. In Minnesota, the water quality standards reflect daily maximum average temperatures for most waterways, or changes above the ambient which are limited to a few degrees on a monthly average basis (Minn. R. ch. 7050).

Floatable Trash and Litter

Many of the state's river and stream reaches are degraded to varying degrees by floatable trash and litter of anthropogenic origin. There are many sources and modes of transport for these materials, but the problem is generally most serious within and downstream from urban, commercial, and industrial land use types. Trash can be directly deposited in the water or on streambanks by water users, flushed in by storm sewers or overland runoff, and in some cases wind blown. Many of these materials are nonbiodegradable and will persist in the environment for many decades until removed or in some cases buried through sedimentation processes within the floodplain. In many areas, increasing volumes of litter are accumulating throughout riparian areas with annual highwater events. It is not a practical assumption to consider that clean-up volunteers can effectively address any more than the immediate stream corridor of a small percentage of Minnesota's 91,000 miles of river habitat. There are also serious ethical questions about shifting the responsibility for this problem to environmentally concerned citizens when education, enforcement, and structural source controls for abatement are deficient or absent. Trash and litter constitute a major impairment to the recreational use and esthetic appreciation of many reaches of the states rivers and streams and can be hazardous to humans and wildlife.

The issue of trash and litter defiling the nations waters has received surprisingly little attention from the responsible local, state, and federal agencies with mandates to protect these natural resources in the public interest. This is perhaps an artifact of the priorities established early in the process of implementing the intent of the federal Clean Water Act. In Minnesota, awareness of the problem resulted in a request for study by the MPCA and Department of Natural Resources in 1987. With a grant and coordination from the Local Road Research Board of the Department of Transportation, a consultant study was undertaken to attempt a characterization of the floatable trash and litter problem in the Mississippi River within the Minneapolis and St. Paul area. A principal focus was to gain some quantification of these materials that were delivered to the river by storm sewer systems. The study was limited in area and time but results are considered to be representative for this metropolitan area.

The study, conducted by a consulting firm, monitored four storm sewer networks with two being categorized as residential and two as a blend of commercial and industrial. Monitoring occurred during August and September 1987 and July through September of 1988. At the time and locations of this study, the residential areas contributed less litter to the system than the commercial and industrial, which had similar but variable volumes. The litter collection method employed plastic fencing with a 1.5x 3-inch mesh that extended one foot below the water surface. Materials smaller than the mesh dimension, and those with neutral or negative buoyancy were not likely included in the sampling results. Extrapolating the results of these representative areas to a 46 square mile area directly storm sewered to the river yielded 59 cubic feet of man-made floatable litter (MMFL). This calculation does not include the storm sewered area of St. Paul. The model calculations used a 0.42 in/hr rain event with seven days since the last storm.

In order to assess the relative contribution of storm sewers to the total amount of MMFL in the surveyed reach, actual river sampling was conducted with the collection point near downtown St. Paul. For the period following the same rain event used in the storm sewer model, 62 cu/ft of small MMFL (size restricted to that which could pass through the typical 4-6x24 inch street curb inlet design) was directly collected from the river. Considering that the model result (59 cu/ft.) did not include the city of St. Paul, there appears to be disparity between the model and actual river collected volumes of small MMFL. What is clear from the final study results is that small MMFL is the majority of the volume of total MMFL in the river and that storm sewers contribute most of that material.

It is reasonable to assume that this preliminary study has exhibited results that could be considered representative of similar storm sewer systems statewide. It is also apparent that results under estimated actual volumes due to information and sampling constraints. Nonetheless, it has been shown that a single rain event delivers large volumes of a persistent and objectionable class of pollutant to waters of the state.

Urbanization is Hydromodification

An emerging issue in water quality that needs to be addressed is that hydromodification, which involves changes in flow patterns in natural waterways such as rivers or streams and wetlands, is also one of the major urban runoff issues. As noted above, the latest USEPA 305b report, for 1998 shows hydromodification as the second leading cause of impairment of fresh waters.

The tools to address this issue are starting to be organized and applied at the source. The following text explains the changes taking place and some of the impacts:

While climate and rainfall patterns may or may not have been affected by human activity, it is clear that runoff has changed significantly with human development. In the presettlement Midwest, entire watersheds were in vegetative cover (*e.g.*, prairie, oak savanna), with maximum infiltration and minimum runoff. With the massive conversion of the landscape to agricultural and urban uses came substantial changes in runoff to wetlands, lakes and streams.

Removal of perennial vegetation led to a decrease in infiltration and an increase in the volume of runoff. Exposing soils to wind and water increased sediment loads carried by runoff. Impervious surfaces and artificial drainage systems increased the volume of runoff and accelerated the rate at which water was removed from the landscape. Impervious surfaces in urban areas also transported runoff more rapidly and in greater volumes than before development. Fertilizers, pesticides, automobile exhaust residues, animal waste and other sources greatly increase nutrient loading and contaminants carried by runoff.

There is an emerging understanding of the many ways that land use practices negatively affect the quality of instream habitat. Anything that is done to alter the diversity and stability of naturally occurring stream habitats inevitably affects the aquatic community of organisms residing in streams. Also, because streams are flowing, interconnected systems, any alterations that occur in the upstream headwaters will eventually be reflected in the lower stream reaches. Stream habitat may be compromised by altering the stream's natural morphology through ditching and channelization or through land use practices that occur outside of the stream channel, such as removal of the riparian vegetation, storm sewer drainage, and residential development.

Existing stream characteristics are a reflection of past conditions in the watershed. Urbanization will increase the runoff volume from each storm event, and may overload the natural drainage systems. The frequency of bank-full events increases with urbanization, causing the stream to enlarge its channel to reach a new equilibrium with the increased flows.

Increased flow volumes increase the erosive force of the flows in the channel and can significantly upset the sediment load equilibrium that was established over many years.

Base flow, or low flow, in streams is also affected by changes in hydrology from urbanization because a large part of base flow comes from shallow infiltration. Impervious cover reduces infiltration, reducing the volume of water available for base flow in streams. These changes in hydrology can have a dramatic effect on the ecosystem of urban streams and wetlands. Studies of streams affected by urbanization have shown that fish populations either disappear or are dominated by species that can tolerate a lower level of water quality (Klein, 1979).

Hydromodification can be a Pollutant

Minn. Stat. § 155.01, subd. 13 (b) define pollution of waters as "the alteration made or induced by human activity of the chemical, physical, biological, or radiological integrity of waters of the state". The basis for this statute is that human activity, such as hydromodification, affects these waters in many adverse ways.

Under natural conditions and at bank-full capacity, studies have shown that streams can handle a flow approximately equal to the 1.5- to 2-year frequency peak discharge within their banks (Rosgen, 1994; Leopold *et al.,* 1964). After urbanization, increased runoff can cause bank-full flow to be exceeded several times each year. In addition to increased flooding, this condition causes previously stable channels to erode and widen. Much of the eroded material becomes bed load and can smother bottom-dwelling organisms.

In this process, stream habitat diversity is damaged or lost. Water that was once slowed by bends, pools, and woody debris in the water column moves faster and with greater volume cutting into the bed and eroding the banks. This faster flowing water carries with it an increased sediment load, some of which is deposited in the downstream reaches. Many fish and invertebrate species cannot use substrates that are laden with excessive silt for reproduction, feeding, or cover. Riffles and pools become scarce or absent as the stream is converted from riffle, run, pool sequences to long runs or pipes. Not only is habitat diversity affected but the stream hydrology becomes inherently less stable. As water leaves the system faster, the natural hydrologic timing is altered. The overall effect is an increase in the intensity of the high flows and decreased duration of low flow events. If the water is stored to prevent increased peak flows, then the flow duration is extended. Streams in which the surrounding vegetation has been removed or altered are usually compromised by an increase in the amount of silt-laden runoff. Also, water temperatures within the stream may rise as the overhead canopy is removed exposing the stream to full sunlight.

Urbanization also changes the extent and duration of inundation in wetlands, which can modify the established wetland vegetation. Measures to control discharges to wetlands must control the peaks and volume of flow to wetlands, if they are to be protected. This also means that reduced surface and ground water flow caused by diversion to storm sewers is also an area of concern, especially for sensitive wetlands.

Hydromodification of Small Events

Urbanizing areas increase runoff from small events in greater proportion than large events. This is important because, in Minnesota, more than 90% of the precipitation events are less than 1.0 inch. These rainfall events also account for approximately 65% of the cumulative runoff quantity in urban areas and proportionately large amounts of the pollutant loading associated with these rainfall events (Pitt, 1998). While the significance of large flood events should not be underestimated, the smaller flows with an approximately nine-month to two-year return period frequency, are probably as important or more important to overall water quality. These flows can be very erosive and can be the major source of increased pollutant loading. Pollutant loading is more closely associated with total runoff volume than with peak runoff rates. Utilizing methods to maintain volumes and peaks closer to those that originally shaped the channel can reduce the channel reshaping process in a watershed. Examples of appropriate management techniques are the volume reduction that results from the use of swales instead of curb and gutter, reduced impervious surfaces or infiltration structures.

Wetland and upland vegetation can affect or be significantly affected by hydrologic changes. For example, drainage can obviously change the vegetation at a site, but increased water that drains from a project area into an off-site drainage basin can impact trees and other vegetation, including wetland vegetation. In such cases, water itself is the damaging agent even if it is clean. The increase in water level, both surface and subsurface, can result in the death of roots. Roots require oxygen from the air, and saturated soils create an anaerobic condition that will eventually kill the roots. A case in point is a tamarack swamp that receives water from several developments. As water levels increase through the swamp, the increased flow depth results in the death of many of the tamarack trees, even though they are tolerant of wet conditions. In Minnesota, we have several tree species that tolerate short periods of flooding, but we should be encouraging diversity and be mindful of sensitive areas downstream. Likewise vegetation in upland areas can change the infiltration capacity or evapotranspiration capacity of a watershed. By using native plantings that have denser canopies and/or deeper root networks the storage capacity of the upland areas are significantly increased reducing run-off volumes, especially in the smaller storms.

IMPLEMENTING URBAN RUNOFF CONTROLS

The above list of water quality impacts are reduced and minimized by effective implementation of management measures including regulatory and voluntary programs. Both regulatory and voluntary programs utilize the same basic BMPs, but differ in administrative opportunities and education efforts to protect the resources in Minnesota. The following text identifies how key programs or policies in Minnesota are implemented.

NPDES Program

In Minnesota, the primary regulatory program for storm water runoff is the NPDES storm water discharge program under Section 402 of the 1987 Clean Water Act. The MPCA is the state agency responsible for administering the storm water permit program in Minnesota. Storm water permitting will provide the focus and primary stimulus for urban storm water controls on larger sites (over 1 acre) or in urbanized areas with over a population of 10,000.

The USEPA regulations require some storm water discharges to be authorized under an NPDES/SDS (State Disposal System) Permit. These regulations required certain industries to obtain permits on a mandatory or discretionary basis based on Standard Industrial Codes (SICs). Cities and the State are required to obtain permits for some industrial and/or construction activities.

Under the phase I requirements of the Clean Water Act, USEPA was required to establish criteria for different types of industrial activities that would be covered under the storm water permit program Storm water permit applications currently required for phase I:

1) Large municipalities (cities with populations of 250,000 or more) and medium municipalities (cities with

populations of at least 100,000 but less than 250,000). In Minnesota this includes Minneapolis and St. Paul only;

2) Industrial activities, including manufacturing, mining, transportation, hazardous waste facilities, power plants, landfills, recycling facilities and wastewater treatment plants (2,020 permittees to-date);

3) Construction activities which disturb five acres, or more, of land (up to an estimated 1,200 permits per year) were identified by USEPA as requiring permits. Construction activities include clearing, grading, excavation, road building, demolition activity, and construction of residential houses, office buildings, commercial facilities and industrial buildings.

The final Storm Water Phase II rule, was signed on October 29, 1999, and published in the *Federal Register* on December 8, 1999 (63 FR 1536). It expanded the NPDES program to cover all small municipal separate storm sewer systems (MS4s) within urbanized areas (see attachment 1) as well as adding construction sites that disturb one to five acres. The Phase II rule also conditionally exempts industrial facilities in all 10 categories that have "no exposure" of industrial activities to storm water, thereby reducing application of the program to many industrial activities that had been covered by the program. These programs are being phased in over a period of three years. Contact the MPCA for the latest requirements.

The most critical need for this program during the current implementation phase is to provide clear expectations, good guidance and technical assistance to permittees.

Planning Requirements

The NPDES program is the statewide "regulatory" program addressing storm water runoff from urban, industrial and construction site activities. For nonpoint source activities, the local governments and watershed management organizations (WMO) are the primary implementing bodies. The Minnesota Board of Water and Soil Resources (BWSR) has the responsibility for overseeing the state water plans, utilizing Minn. Stat. ch. 103B (formerly 509) planning process. Local governments within the Metro Area have adopted regulatory controls under these plans for activities such as erosion from construction sites, and are responsible for implementing these regulatory controls.

Metropolitan Area

Currently, "first generation" State 103B watershed management plans have been adopted and are being implemented for essentially the entire Metro Area except for the international airport area. The area of the international airport should be under 103B planning in 2000. The planning has been done by watershed management organizations created either by a joint powers agreement under 103B or as a watershed district under 103B and 103D. As a result of the 103B planning effort in the Metro Area, in mid-2000 a total of 22 joint powers agreement WMOs and 14 watershed districts will exist. Essentially all WMOs have State approved first generation watershed management plans and 14 have second generation plans approved. Three WMOs have second generation plans pending approval.

Previously there were as many as 37 joint powers agreement WMOs. However, due to their lack of levying authority, levy limits placed on cities and other reasons, many joint powers agreement WMOs have dissolved and watershed districts have been formed or counties are conducting the water management planning. Two of the seven Metro Area counties have taken over the water management planning for all of the previously existing joint powers agreement WMOs in their respective counties. Another Metro Area county is in the process of consolidating four joint powers agreement WMOs and four watershed districts into three watershed districts. The lack of funding and administration has been the downfall of several joint powers agreement WMOs. A small geographic size and low tax base has been a contributing factor.

The content and implementation programs of the first generation plans varied in scope and content due to a number of variables, including but not limited to: development pressure, geographic size, funding, tax base, local administrative pressure and lack of comprehensive requirements for the plans. The cost of first generation plans varied, from $15,000 in rural areas to as high as $150,000 in urban areas, with the average costs from $50,000 to $60,000 in the urban areas.

The second generation plans are much more consistent and of higher quality than the first generation plans due to state rules (Minn. R. ch. 8410). Second generation plans require local controls to regulate erosion from construction sites per approved BMP manuals in use in the Metro Area. They also require standards for storm water design, must be consistent with state and regional water management goals, provide detailed accountability and establish measurable goals for a number of specific storm water management issues. Some second-generation plans have cost a quarter of a million dollars and the average is well over $100,000.

Outstate Area

Outside of the seven-county metropolitan area where watershed districts and joint powers watershed management organizations conduct water planning, each of the 80 remaining counties have adopted a comprehensive local water plan. Further, the state has approved each of these 80 county comprehensive local water plans.

Local water planning at the county level works because of funding, land use authority, local coordination and the state-local partnership. The state has continually appropriated funding for this effort. Often the state appropriation has been over five million dollars a year. The average annual state contribution is $30,000 per county and the average annual county contribution is $95,000. Additional funding and grants from various sources have also been utilized.

Local coordination and communication may be the most visible of the program's successes. In all 80 counties, the local task forces that formed to develop the plans continue to meet after plan approval to aid in plan implementation. These task forces ensure that the plans consistently reflect local priorities. In addition, frequent meetings provide a forum to coordinate the variety of resource-related activities that various levels of government and other groups may be performing, thus avoiding duplication.

Storm Water Management Plans

As local government develops their storm water management plans, in response to the state planning requirements, they must develop comprehensive programs to manage storm water for aesthetics, flood control, pollution control and all other appropriate purposes. Planning should involve public and intergovernmental participation. In developing local goals, local government should analyze the system-wide needs of the community, addressing the appropriate measures for the site, watershed, region or water body. Selection of the optimal mix of BMPs, including educational and structural measures such as storm water ponds, depends on the goals that are established for the system, the nature of the project site, the nature of the watershed, and the pollutants to be addressed.

Important factors to consider include, but are not limited to:

- **Environmental Goals**
  Pollutant-removal targets and levels of removal: phosphorus, total suspended solids, metals, sediments
  Temperature changes
  Channel erosion protection
  Wetland creation
  Wildlife habitat
  Aesthetics
  Swimmable waters
- **Community Acceptance**
  Safety risks
  Construction costs
  Maintenance costs
  Land-consumption costs
- **Nature of the Watershed**
  Developed: retrofit options
  Undeveloped: planning for future development
  Sensitive areas: special protection
- **Selection of Proper Prevention and Treatment System**
  Avoidance policies
  Selection of primary treatment systems
  Selection of associated BMPs

Resource-Protection Policies

Controlling storm water discharges to water bodies should be the primary objective of the comprehensive storm water and surface-water runoff-management plan developed by local units of government. Requirements of the Metropolitan Area Surface Water Management Act and other applicable planning requirements should form the basis for comprehensive review of storm water and water body plans. Future possible requirements of any Phase II NPDES permit requirements should also be anticipated and considered. As with all plans, the first step should be a survey of existing information, including mapping of all the water bodies in the watershed and associated normal flow paths.

Resource Inventory

It is recommended that the local unit of government complete the inventories of existing resources. Existing information, such as the Protected Waters Inventory (PWI/MDNR) and the National Wetland Inventory, U.S. Fish and Wildlife Service (NWI/USF&WLS) or the Watershed Heritage Program (WHP/MDNR) can be used as a starting point for these inventories. Any survey information must be field verified. Much of the original aerial photography was made over 10 years ago, so the surveys can be used only as a guide to field activities. Field visits will be necessary to verify NWI information. Wetlands should be identified in the inventory and classified according to their appropriate wetland sensitivity group (Eggers, 1997; Minnesota, State of, June 1997). The size should be estimated and the surface hydrologic connections should be recorded for each water body identified on the inventory.

Resource Quality and Condition

An assessment of water body quality and condition is probably best conducted using a methodology that evaluates the condition of the biological community. The functioning of many water body uses is directly related to the biological integrity, since the biota will reflect the overall health of the system. Therefore, an assessment of the condition of a water body is best based on an evaluation of the relative "biotic impoverishment" (such as provided by Karr, 1993).

Significant Resources

Water bodies that have been designated by local, state or federal action as providing unique qualities, such as recreational, scientific, educational or aesthetic uses, should be considered significant resources. Other significant water bodies should include those that have been restored for specific purposes, such as water quality improvement or wildlife, industrial or agricultural uses. Water bodies known to be important to local recreation activities, such as hunting, fishing or bird watching, and water bodies occurring within parks, shoreland areas and conservation corridors would also be considered to be significant resources. Forested areas may also be considered significant resources and should be designated for protection from destruction by removal, inundation and flooding.

Excellent-quality water bodies of all types are very rare and becoming more rare as time and development goes on. Every effort to protect these waterbodies should be made. Providing off-site compensation does not easily mitigate for destruction or degradation of these types of water bodies.

Sensitive water bodies should be protected. Highly sensitive water bodies, even of moderate quality, are a concern because of the care that must be taken to preserve them. Importantly, they often cannot be easily mitigated, restored or created due to their special nature.

Other water bodies

Because of their position in the watershed, morphology, surface-flow connections or other physical attributes, some waterbodies play an important role as part of a hydrological system. The role of the waterbody in the hydrologic or ecological system should be highlighted in the inventory when these functions are believed to be important.

Maintaining and improving public uses and values is a very important component of maintaining or improving the entire function of a watershed. Piecemeal destruction or alteration of minor water bodies and/or changes in the hydraulic regime can significantly damage the entire system through changes in hydrology, erosion, nutrients or other pollutant loading on the system.

Policies for Critical Areas

Avoidance policies

It is important to avoid impacts at the outset if at all possible. The best way to minimize adverse impacts of development on runoff and water quality is to develop policies that avoid any construction activity in the most sensitive areas. Given the open-space requirements found in most zoning codes, this is a real option which is still too often overlooked. Avoid:

- destruction of natural vegetation,
- siting improvements along the shoreline of lakes or streams,
- constructing in natural drainageways or
- areas dominated by steep slopes, dense vegetation or erodible soils.

Vegetation

Avoid the loss of vegetation whenever possible. Delineate important vegetation and protect it from development activities.

Shoreline

Runoff from construction close to the receiving waters is hard to clean up before it reaches the receiving water, making measures to reduce pollutant delivery much more difficult and expensive. Measures to avoid the runoff are the best choice. Vegetated shoreline is a critical part of nature's system for cleansing runoff water of pollutants. Also, once the vegetation is disturbed, shoreline erosion from running water and wave action is dramatically increased.

Natural Drainageways

Construction in natural drainageways destroys the natural vegetation that protects the soil from erosion and, with it, the filtering capacity of the vegetation. This type of vegetation is among the most difficult to reestablish. Natural drainageways contribute a large percentage of runoff going directly to receiving lakes or streams, and once disturbed, they become high-energy, high-volume conduits for moving massive amounts of pollutants to receiving waters. Site plans that disturb these areas result in much larger volumes of water to manage and treat (and much greater costs for pipes and BMPs) than would be required by using other areas of the site for the same purpose.

Steep Slopes

Generally, the steeper the slope, the greater the erosion hazard. This is because the angle of repose on steep slopes means it takes less energy for water to dislodge and transport soil particles. Development often results in making flat areas for such things as roads, buildings and lawns. Creating flat areas on steep slopes exposes more soil surface area to erosion during construction than the same action on flat slopes. Good site planning avoids placing buildings and roads on steep slopes.

Erodible Soils

When denuded of vegetation, areas with easily eroded soils yield greater volumes of transported soil than those with erosion-resistant soils. Proactive planning can avoid disturbing erodible soils in the land development process, so that erosion and sedimentation problems will be avoided.

POLICY ON IMPERVIOUS SURFACES

While population density is important for many planning and zoning regulations, imperviousness and the way impervious surfaces drain is the critical environmental planning consideration with reference to urban runoffs.

Impervious surface area is the portion of the land where water cannot infiltrate to the subsurface. Instead, water is conducted by gravity on the surface as overland flow. Impervious systems generally consist of roads, parking lots, sidewalks, rooftops and other impermeable surfaces of the urban landscape. While imperviousness is fairly easy to define, it may be hard to identify in practice. While asphalt and concrete are generally impervious, they have been found to allow infiltration under some conditions. Gravel surfaces can be pervious, but if they contain a high percentage of fines, they may become impervious. Lawns are considered pervious, but disturbed urban soils may allow only minimal infiltration (Pitt, 1994).

Imperviousness is still a very useful indicator by which to measure the impacts of land development on aquatic systems. Research conducted in many geographic areas and employing many different methods of analysis has led to similar conclusions regarding the nature of impervious surfaces and stream degradation: Stream degradation occurs at levels of imperviousness from approximately 10 to 20% of the watershed (Schueler, Fall 1994).

Traditional Zoning Methods

If municipalities have addressed the problem of impervious surface at all, they have often addressed it by setting the maximum density for an area based on building units. The transport component is generally not addressed. However, transport-related imperviousness often exerts a greater hydrological impact than building-related imperviousness. Runoff from rooftops can be spread over pervious areas, such as open fields and grassed waterways, whereas roads and parking lots are usually directly connected to the storm-drain system.

Not only are roads generally connected to the drainage system, they also have the effect of producing secondary development, with a multiplying effect on the impacts to the watershed system. Because impervious surfaces place greatly increased total flow and loadings on waterways and on aquatic systems, it is very difficult to eliminate the impacts of the impervious surfaces by BMPs. BMPs that provide stable channels, reduce pollutant loading and reduce impacts to benthic biota may raise the allowable imperviousness. However, even when effective practices are widely applied, the threshold of imperviousness is eventually crossed, which results in a degraded condition. It is, therefore, critical that local government units (LGUs) address the impacts of imperviousness very early on by aggressive land use policies.

There are many policies that can be adopted on a local level to reduce the impacts of imperviousness. Narrower streets, smaller parking requirements, swales instead of curb and gutter, and a host of other practices are outlined by documents from numerous centers, associations and agencies. One of the many growing practices is *"Cluster development."* This is defined as the grouping of all residential structures of a development on a portion of the available land, reserving a significant amount of the site as protected open space. Many communities in Minnesota and across the United States are updating their comprehensive plans and establishing ordinances to guide the development and construction of cluster developments. New ordinances are requiring design standards, and identifying open space and density standards. These key changes have prompted some communities to opt for more descriptive terminology, such as "open-space development" or "conservation subdivision design," instead of the more traditional "cluster development." While this use of different terminology has created some confusion, each still maintains the three basic goals of cluster development: (1) preserving open space, (2) protecting critical ecological habitat and (3) preserving agricultural land.

The useable open space created by a cluster development can serve to meet a number of community goals, such as the protection of critical ecological resources, protection of wooded areas or the preservation of farmland. Obviously, these goals overlap and have the potential to conflict with one another. For example, the protection of wildlife habitat may be incompatible with the preservation of agricultural land. However, the key benefit is the quality of life preserved by the availability of open space made possible through the clustering of units.

POLICIES TO PROTECT GROUND WATER

When development occurs, the problems of runoff need to be addressed; often this is by "management policies" or "infiltration devices." *Management policies*, in this context, means reducing impervious surfaces, discharging impervious surfaces over pervious areas, disconnecting roof drains from the storm water system or other measures. Management policies are encouraged and are essential; however, general policies may require special considerations in industrial areas or other unusual cases.

The other category of activity is called *infiltration devices*. This is everything from filter strips and swales to large infiltration ponds or infiltration trenches, tubes or other devices that conduct the runoff into the ground. In *most* cases the types of devices that are of most concern are devices that bypass the zone of aeration above the ground water table (vados zone) and conduct surface runoff directly into the ground. For example, swales and ditches are generally of less concern, while devices that conduct into deep aquifers are generally of greater concern. Note that these are generalizations that need to be evaluated on a site-specific basis. A site analysis should be conducted before implementing infiltration devices on project or in a community.

Infiltration devices, such as basins and trenches, are controversial as BMPs for storm water management. Literature indicates (e.g. see Pitt et al. January 1994) that operation of infiltration devices is a concern for two reasons: (1) failure to operate properly, (often due to maintenance) and (2) concerns for ground water contamination. These concerns are made greater or diminished depending on site circumstances, and must be compared to the benefits that infiltration can provide for reducing storm water flows in surface waters and replenishing ground water through recharge. Therefore, infiltration devices should be used only after thorough, site-specific evaluation of these concerns and of the pros and cons of other storm water management options. Infiltration should also be used in conjunction with other measures, such as avoidance and pretreatment practices to protect ground water quality to the maximum extent practicable, and to protect the function of the infiltration device. Sound judgment; good design, including a detailed site evaluation and proper construction techniques should alleviate the operational problems with these systems.

OTHER REQUIREMENTS

Class 5 Wells

Under federal laws, "Class 5 wells," which are essentially any storm water infiltration device that is deeper than it is wide, are required to be inventoried by reporting to the USEPA and the MPCA. There are no other regulations at the present time, but future regulation is anticipated.

Minn. R. ch. 7060

Minnesota state laws (Minn. R. ch. 7060) prohibit the direct discharge of untreated storm water to the saturated zone if the discharge threatens ground water from potential pollutants. There could be liability if it is determined that a discharge has introduced contaminants into ground water in violation of state law. Treatment before infiltration is a suggested means to discourage the possible introduction of pollutants into the ground water.

Wellhead and Source Water Protection Plans

For storm water systems located in defined wellhead and source water protection areas, the local unit of government must develop a "Wellhead or Source Water Protection Plan" in accordance with state laws and requirements. Special attention should be given to injection wells or infiltration basins and trenches which may pose a high risk to the wellhead, especially for drinking water wells classified by the Minnesota Department of Health as vulnerable to contamination.

SUMMARY OF AUTHORITIES AND PROGRAMS

In addition to the authorities listed above, many other state and local agencies have leadership responsibilities in storm water pollution control. The primary role of the involved agencies can be summarized as follows:

Minnesota Pollution Control Agency

- Administration and Enforcement of the NPDES storm water program, including Total Maximum Daily Loads (TMDLs)
- Apply effluent and water quality standards for storm water, erosion and sediment control where applicable
- Adopt and provide technical assistance on acceptable technical standards and BMPs as permit requirements and as accepted tools in nonpoint source (NPS) watershed programs
- Coordinate review and approval of local programs
- Provide technical assistance and administrative assistance for NPS watershed projects under the Clean Water Partnership (CWP) program

- Provide educational and technical assistance to locals developing pollution prevention plans for compliance with the state's storm water permitting program

- Provides water quality certification of 404 wetlands permits process and other federal permit certification

- Provides BMPs for urban areas including:

  Nonstructural BMPs focus on changing behavior and management. These measures can be described as "good common sense" and can include such practices as street cleaning, education on lawn and garden practices, moving materials inside to reduce exposure, prohibiting certain practices, training, and employing spill-prevention plans.

  Structural BMPs are measures that control or manage storm water runoff and drainage. Examples of structural BMPs include enclosures used for covering exposed significant materials, swales, dikes, or storm water treatment basins and wetland restoration.

- The MPCA also has many regulatory and pollution-prevention programs that can affect storm water, such as the hazardous waste program, the aboveground and underground tanks programs, spills response programs and even air quality rules. Many fact sheets have been developed to help individuals, industries and local governments to develop their pollution-prevention programs.

<u>Board of Water and Soil Resources (BWSR)</u>

- Review, comment, and approval of local comprehensive watershed planning
- Provide cost share funding for local water planning and plan implementation
- Oversee Minnesota's Wetlands Conservation Act
- Provide assistance to Local Governmental Units (LGUs) for complying with water planning laws
- Provide oversight for local watershed plan implementation
- Hear and rule on appeals alleging failure to implement local water management plans
- Periodically review and update rules relating to comprehensive local water planning
- Provide technical assistance

<u>BWSR and MPCA</u>

- Develop model ordinances
- Develop acceptable technical standards and Urban BMPs
- Ensure interagency coordination
- Provide information and education programs
- Review local programs

<u>Minnesota Department of Natural Resources</u>

- Provide technical assistance on storm water runoff control
- Enforce Protected Waters Permit regulations
- Enforce Shoreland Management Act provisions
- Has developed and led public awareness and cleanup programs such as the "Adopt A River Program"

<u>Metropolitan Council</u>

- Review water quality plans for the Metropolitan Area as mandated by USEPA through Clean Water Act (Section 208) and by the state legislature through Minn. Stat. ch. 473
- Implement a NPS control strategy through the local comprehensive plans of local units of government via the Metropolitan Land Use Planning Act

- Provide technical planning assistance to local units of government and watershed managers, and participate in multi-agency efforts to solve water quality problems
- Conduct research on the behavior and management of urban NPS pollution

Minnesota Department of Transportation

- Designs, builds and maintains storm water conveyance and treatment systems for transportation projects.
- Coordinates transportation project design with local units of government, WMOs, state and federal agencies.
- Provides standards and specifications for materials and techniques used in BMPs.
- Provides formal and informal testing of BMPs to control erosion from construction sites.
- Provides standards and specifications for integration of biological systems with engineering principles, leading to functional succession of altered landscapes.
- Provides continuous research and development of appropriate seed mixes reflecting Minnesota's ecological regions for vegetative establishment associated with transportation projects.
- Provides systematic life-cycling approaches for the use of new products, BMPs, and designs for reducing impacts of storm water.

Minnesota Department of Agriculture

- Coordinate the development of pesticide and fertilizer BMPs
- Assess current pesticide and fertilizer management practices
- Promote the use of BMPs and alternative management approaches for pesticides and fertilizers
- Provide direction/guidance in the development of local Integrated Pest Management (IPM) programs
- Enforce violations of state and federal pesticide and fertilizer laws

Minnesota Department of Health

- Responsible for drinking water issues

Local Governmental Units

- Adopt and implement local ordinances, including zoning
- Install, operate and maintain BMPs
- Administer and enforce local controls

Soil and Water Conservation Districts

- Act as technical resource to local government and perform inspections as requested
- Review and comment on local programs

PROGRESS TO-DATE

- Storm water program has issued more than 2,020 permits for industrial activities and about 1,200 permits per year for construction activities

- The municipal storm water permits have been drafted for the Cities of Minneapolis and St. Paul

- BMP manual has been revised and available for use in Minnesota and throughout the nation

- 103B and 110B plans are in the process of being revised

- Metropolitan Council-Interim Guidance on use of BMP handbook has been promulgated and implemented

Highlights of Innovative Urban Runoff Activities Happening in Minnesota

- **H.B. Fuller** has implemented parking lot runoff treatment by wetland swales and ponds for volume and quality controls as an innovative project.

- Communities throughout the state have adopted local water plans, and cities have addressed urban runoff in their comprehensive plans.

- The **Metropolitan Council** has given 8.8 million in grants through the Twin Cities Water Quality Initiative for educational and technical projects

- Many 319 projects for urban storm water runoff have been implemented, including:

  - **Maplewood** innovative storm water treatment program has been implemented and may be expanded. This project involves the use of rain garden and infiltration for storm water runoff.

  - **Fairfax** has installed a pond for rate and quality control of storm water runoff, combined with citywide BMPs for runoff control as a demonstration and implementation project.

  - **Minneapolis** has done extensive studies and implemented quality and quantity controls on its Chain of Lakes.

  - **Duluth**, with other agencies, has studied the Duluth-Superior harbor area and developed strategies for significant tributaries such as Miller Creek.

  - Many cities throughout the state have developed and encouraged public awareness by educational measures such as storm sewer stencils and other programs. They have also adopted Phosphorus Ordinances, sediment control ordinances, and other pollution prevention programs.

BEST MANAGEMENT PRACTICES (BMP)

The following Best Management Practices (BMP's) are commonly used to reduce nonpoint source pollution from Urban Runoff sources. This list is not comprehensive and does not suggest additional BMP's would have no benefit but, is provided to highlight the more common BMP's. For a more complete list of BMPs, see "Protecting Water Quality in Urban Areas" (which is incorporated by reference into this NSMPP) for BMPs dealing with storm water runoff from urban, suburban and developing areas of Minnesota. Also, please see Part II "Erosion and Sediment Control BMPs" and Part III "Other Cultural and Structural BMPs" in Appendix B of this 2001 NSMPP for definitions of the following BMPs.

Part II Erosion and Sediment Control BMPs.

1 Vegetation Establishment
2 Brush Barrier
3 Construction Road Stabilization
4 Check Dams
5 Critical Area Planting
6 Diversion
7 Dust Control
8 Filter Strips
9 Grade Stabilization Structures
10 Grassed Waterways or Outlets
11 Gravel Inlet Filter
12 Level Spreader
13 Mulching
14 Outlet Protection
15 Paved Flume
16 Permanent Seeding
17 Riprap
18 Silt Fence
19 Sodding
20 Sod Inlet Filter

21 Storm Drain Inlet Protection
22 Storm Water Conveyance Channel
23 Straw Bale Barrier
24 Subsurface Drain
25 Subsurface Roughening
27 Temporary Fill Division
28 Temporary Gravel Construction Entrance
29 Temporary Right-Of-Way Diversion
30 Temporary Sediment Basin
31 Temporary Sediment Trap
32 Temporary Seeding
33 Temporary Slope Drain
34 Topsoiling
35 Tree Preservation and Protection
36 Trees, Shrubs, Vines and Ground Covers
37 Waterway Drop Structure
38 Fertilizer Application Control
39 Pesticide Use Control
40 Solid Waste Collection and Disposal
41 Source Control on Construction Sites
42 Street Cleaning
43 Concrete Grid and Modular Pavement
44 Detention Basins
45 Exfiltration Trenches
46 Grassed Waterway (Swale)
47 Parking Lot Storage
49 Retention Basins
50 Rooftop Runoff Disposal
51 Storage/Treatment Facilities
52 Underdrain Storm Water Filter Systems

Part III Other Cultural and Structural BMPs

53 Adequate Containers for On-Site Solid Waste
56 Correct use of soils for septic systems
57 Dry Weather Flow Testing of Storm Sewers and Ditches
58 Increase Flow Distances
59 Lane Absorption Areas and Use of Natural Systems
60 Leash Laws and Clean Up After Your Pet Programs
61 Maintain Set Backs From Surface Waters
62 Maximum Recycling of Solid Waste
63 Prompt Clean-Up of Chemical Spills
64 Proper Installation of Septic Tanks and Drainfields
65 Proper Maintenance of Motorized Equipment
66 Routine Maintenance of Septic Tank Systems
67 Small Quantity Hazardous Waste Collection
68 Soil Testing and Plant Analysis
71 Waste Treatment System, Publicly Owned Treatment Works (POTWs)

Chapter 11 Urban Runoff
Needs, Priorities, and Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) 5-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Goal 1: The State Should Take the Lead Role in Developing Methods to assess the Reliability and Technical Accuracy of Technical Evaluation and Research, and in Focusing this Evaluation and Research on Minnesota's Most Pressing Urban Issues. The Following Milestones are Best done Sequentially.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Compile existing data on storm water runoff and BMPs.	X	X				319, State.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
2. Analyze the existing data for trends and conclusions.	X	X				319, State.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
3. Evaluation of cost effectiveness of urban BMPs.	X	X	X	X	X	319, State.	MPCA, MnDOT, BWSR.
4. Develop protocols and test methods for analyses and evaluation of storm water events, including: - toxics - bioaccumulation - compliance testing for effluents and WQ standards violations Develop new ways to assess impacts such as indices of biological integrity and habitat assessment.	X	X	X	X	X	319, State.	MPCA, MDNR, BWSR, MDH.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5. Develop urban BMP auditing (observing, monitoring and observation with analysis) process to establish where BMPs are being implemented, if they are being installed correctly and whether or not they are effective.			X	X	X	319, State.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.

Goal 2: Develop Consistent and Clear Statewide Policies on Urban Runoff Issues through Improved Interagency Coordination. These are Parallel Tasks Rather than Sequential.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Establish a long-term interagency urban runoff task force to address programmatic issues, share technical information and improve strategic planning for implementation of storm water BMPs for developed, and developing communities. Needs with potential to be addressed by this group include: -clarify specific roles of various state agencies and local entities; -clarify how the various rules apply to specific situations; -develop process for coordinating and distributing information statewide; -define the future role of local water planning; -provide forum to relay back storm water information gained on status and upcoming requirements of federal programs; -examine rules of each agency with respect to ensuring policies are consistent, and develop either MOA or issue papers relating findings and identifying areas that need further coordination.	X	X	X	X	X	319, State.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
2. Develop model development ordinances and coordinated development policies.	X	X	X	X	X	State, 319.	MPCA, BWSR.
3. Improve public information for litter control within watersheds of the state.	X	X	X	X	X	State, 319.	MPCA, MnDOT, MDNR, Met Council, BWSR.
4. Data coordination –assess existing data availability and usability and develop data management systems, including a plan for making data more widely available and directly accessible. – develop a data standard for collection, storage, retrieval and accessibility.	X	X	X	X	X	319, State.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
5. Develop coordinated federal, state and local policies for consistent application of urban management requirements. Policies would: - coordinate local water management planning and requirements with state and federal efforts; - develop approved water quality standards for NPS and storm water management; and - develop an enforcement policy for the storm water program and a strategy for addressing compliance.	X	X	X	X	X	319, State.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA, USEPA, CORPS.
6. Increase coordination and compliance monitoring for street sanitation and other practices of local governmental units. Increase enforcement of state and local litter laws including those pertaining to refuse hauling.	X	X	X	X	X	State, 319.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
7. Use the NPS Management Plan as a basis for initiating action strategies for incorporation into Storm Water Plans, Local Water Plans, and agency environmental review activities.	X	X	X	X	X	State, 319.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
8. All storm water detention facilities, public and private, should be designed and constructed or retrofit so that they prevent the release of floatable trash and litter. (319 would not be used to fund permit required facilities) Further review of curb inlet and other structures should be conducted to establish the efficacy of prevention methods for excluding these materials from storm sewers. Cage structures for storm sewer outlets may receive demonstration funding with ultimate O&M costs to be borne by the storm sewered municipalities.	X	X	X	X	X	State, 319.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
9. MDNR & MPCA need to examine all opportunities for addressing trash issues through permitting and BMP development. Hydroelectric facilities, water intakes, lock and dams etc. are collection points for large amounts of manmade trash, and BMP as well as permit requirements should assure the proper collection and recycling of these materials that have come under the control of these facilities.	X	X	X	X	X	State, 319.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
10.Develop a coordinated policy on how local, state and federal programs will be implemented. This policy would address: a) ways to integrate local planning process with state programs, especially phase II of the storm water program, and TMDLs b) guidance on urban storm water runoff, requirements so that local, state and federal programs will be consistent.		X	X	X	X	319, State.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.

Goal 3: Coordinate the Various Federal, State and Local Regulatory Programs so that there is Consistency Between the Various Regulatory Requirements. These are a Continuous Process.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop a comprehensive storm water program and a strategy for addressing consistent federal, state and local requirements.	X	X	X	X	X	319, State.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
2. Work with locals to revise, upgrade, or develop water plans, zoning ordinances that reduce impervious surfaces and erosion control ordinances.	X	X	X	X	X	319, State.	MPCA, BWSR.
3. Improve inspection and enforcement programs so that local, state and federal agencies are consistent.	X	X	X	X	X	319, State.	MPCA, BWSR.

Goal 4: Increase Adoption and Improve Appropriate Application of Urban BMPs through Evaluation of Existing BMPs and Identification of New Types of BMPs Needed to Meet Water Quality Goals in Urban Areas.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Evaluate, identify or develop BMPs oriented toward retrofitting controls in developed areas and planning efforts in developing areas.	X	X	X	X	X	319, Local.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
2. Evaluate, identify or develop BMPs that protect ground water where it may be detrimentally impacted.	X	X	X	X	X	State, 319.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
3. Evaluate, identify or develop hydrologic modification BMPs addressing the impacts of: - New impervious surfaces - Ditching - Channels - Drainage, and, Effects on wetland habitats.		X	X	X	X	State, 319.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
4. Evaluate, identify or develop BMPs ways to mitigate artificially extended "bankfull" flow in developed areas.		X	X	X	X	319, State.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
5. Develop and evaluate BMPs for trash prevention and removal from storm sewers and natural urban waterways.	X	X	X	X	X	State, 319.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
6. Continue to Revise the MPCA BMP manual to reflect the findings of studies and experience gained locally and throughout the nation. - Develop summaries of BMPs showing their applicability and effectiveness.	X	X	X	X	X	319	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.

Goal 5: Establish an Effective Technical Assistance and Education Delivery System Focused on Improving Urban Water Quality through Application of Urban Runoff Best Management Practices. To Achieve Maximum Effectiveness, Target Audiences for Technical Assistance, Education and Information Delivery as Appropriate for Local Resource Managers and/or the General Public.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Expand and develop certification/training programs to address contractors, administrators and installers/inspectors. (319 funds would not be used for actual inspections, but for training).	X		X	X	X	State, 319, federal.	MPCA, BWSR.
2. Expand and develop both informational materials and educational workshops related to pollution prevention plans for education about compliance with the NPDES storm water program. Workshops would be targeted toward providing technical assistance to NPDES industrial and construction permittees.	X	X	X	X	X	State, 319, federal.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
3. Provide education and technical assistance to MS4s for the phase II implementation plans by interpreting federal guidance, and providing information on state processes	X	X	X	X	X	State, 319, other federal.	MPCA
4. Hold statewide annual seminar (jointly sponsored between agencies) on urban issues.	X	X	X	X	X	State, 319, federal.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5. Improve public education efforts related to urban impacts through such delivery channels as brochures, pamphlets, public service announcements, newsletters, and videotapes. Initial areas of emphasis would include: - Lawn and garden chemical use, composting and debris disposal; - sewers (where they discharge to); - construction (BMPs and erosion control); - material handling (tanks, spills, hazardous materials solid waste, etc.); - animal waste; - public participation; - litter (source controls, collection and prevention); - Imperviousness and the; need to mitigate runoff by running water over pervious surfaces or other measures; - water collection and treatment system especially swales, sewers, & ponds.	X	X	X	X	X	State, 319, federal.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
6. Develop process to evaluate effectiveness of urban runoff Information and Education programs/activities.	X	X	X	X	X	319, State Federal.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.

Goal 6: To Focus BMP Planning and Implementation Activities on a Watershed Basis to More Effectively Assess the Specific Water Quality Needs and Better Demonstrate Implementation Successes.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Model and evaluate potential impacts of proposed BMPs for site specific watersheds, neighborhoods, and waterbodies.	X	X	X	X	X	319, Federal, CWP, Local.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
2. Assess ways to avoid, minimize and mitigate the impacts of development, evaluating such methods as: - layout, such as cluster development; - restrictive growth - smaller streets and parking lots; - removed substances (waste removals, street sweeping, dredged material disposal); - monitoring of BMPs (funding and planning for follow-up to BMP installation); - monitoring of impacts (ways to monitor and methods of finding out the impacts); - natural drainage feature avoidance (wetlands, drainageways swales, etc.).	X	X	X	X	X	319, State, Local , CWP	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
3. Examine and report on local, state and federal funding mechanisms to identify ways of implementing programs.	X	X	X	X	X	319, State.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
4. Evaluate erosion problems and develop guidance and policy on ways to avoid these impacts in areas with runoff affected by urban developments.		X	X			State, 319.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5. Evaluate long-term effectiveness and acceptance of urban BMPs, including: - maintenance and removed substance options; - air deposition sources and controls; - ground water contamination; - litter collection and source controls; - removal substance handling and disposal; - wetland treatment and pretreatment requirements.			X			State, 319.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
6. Develop guidance for targeting the physical setting in the watershed where certain urban runoff BMPs (or combination of urban BMPs) would be most effective.		X	X	X	X	State, 319.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
7. Implement a demonstration project to show the integration of water quality BMPs into existing storm water management requirements at the local level and use as a statewide educational model.		X	X	X	X	319, State, Local.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
8. Develop water quality standards for urban impacts, due to total suspended solids, phosphorus, flow changes, channelization.		X	X	X	X	319, State.	MPCA
9. Develop guidance options to allocate urban runoff inputs to water quality for Total Maximum Daily Loads (TMDLs).	X	X	X	X	X	319, State	MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
10. Evaluate proper utilization and combinations of urban BMPs as appropriate for varying sets of circumstances within watersheds, such as: - pond design; - outlet flow controls; - wetland pretreatment and use; - wetland construction; - housekeeping; - erosion controls.	X	X	X	X	X	319, State.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.

Goal 7: To Develop Policies, BMPs and Assess the Effectiveness of Housekeeping Practices of Business and Municipal Separate Storm Sewer Systems Related to Urban Runoff.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Evaluate policies on removed materials and develop recommendations and toxic assessment protocol for collected sediment, street sweeping, trash and other removed materials (policy development).	X	X	X	X	X	319, State, Federal.	MPCA
2. Assess the impacts of freezing, snow and snowmelt on the operation and effectiveness of existing and potential BMPs (BMP assessment).		X	X			319, State, Local.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.
3. Improve procedures for system maintenance, street sweeping, fertilizer, salt and pesticide use, as well as storage and handling of any potential polluting materials (BMP assessment and development).	X	X	X	X	X	319, State, Local.	MPCA, MnDOT, MDNR, Met Council, BWSR, MDH, MDA.

1994 NSMPP
Needs, Priorities, And Milestones

The following Table provides the Goals and Action Steps included in the 1994 NSMPP. The Products, Services and Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps. Implementation of all action steps is contingent upon adequate funding and local involvement

Goal 1: To Improve the Reliability and Technical Accuracy of Future Decision Making Capabilities by Increasing the Level of Technical Evaluation and Research, and by Focusing this Evaluation and Research *on Minnesota's Most Pressing Urban Issues*

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Develop urban BMP auditing process to establish where BMPs are being implemented. If they are being installed correctly, and whether or not they are effective.	State, 319.	MDNR	Methods of MDNR Forestry audits are products being used for urban and developing areas.
2. Evaluation of cost effectiveness of urban BMPs.	319, State.	MDNR	Methods of MDNR Forestry audits are products being used for urban and developing areas.
3. Develop protocols and test methods for analyses and evaluation of storm water events, including: - toxics; - bioaccumulation; - compliance testing for effluents and WQ standards.	Federal 319, MnDOT.	MnDOT, USGS.	MnDOT, Local Road Research Board, USGS roadway runoff study.
4. Research and evaluate the impacts to various types of wetlands due to inflow of storm water (quantity and quality).	State, 319, Federal.	MPCA	SWAG June 1997 publication resulted from these efforts.
5. Assess the impacts of snowmelt to evaluate the effectiveness of existing and potential BMPs.	319	USGS, Met Council,	USGS Met Council, Seminar with the Center for Watershed Protection.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
6. Evaluate long-term effectiveness and acceptance of urban BMPs, including: - maintenance and removed substance options; - air deposition sources and controls; - ground water contamination; - litter collection and source controls; - removal substance handling disposal and; - wetland treatment and pretreatment requirements.	State, 319.	Met Council, Local.	Met Council follow up to McCarrons Lake, Maplewood study of BMP acceptance.
7. Evaluate erosion flows and develop education and technical assistance on ways to avoid these impacts in areas with runoff affected by urban developments.	State	MPCA, MDNR, BWSR.	Seminars have expanded the knowledge of these issues.

Goal 2: Establish an Effective Technical Assistance and Education Delivery System Focused on Improving Water Quality through Application of Urban Runoff Best Management Practices. To Achieve Maximum Effectiveness, Target Audiences for Education and Information Delivery Would Include Both Local Resource Managers and the General Public, Whereas Target Audiences for Technical Assistance Would Primarily Involve Local Resource Managers.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Institute certification/ training program to address contractors, administrators and installers/inspectors.	Federal	MPCA	Construction certification program instituted in 1994.
2. Develop both informational materials and educational workshops related to development of pollution prevention plans for compliance with the NPDES storm water program. Workshops would be targeted toward: a) providing technical assistance to NPDES permittees and b) providing assistance to local governments for interpreting guidance for the pollution prevention plans.	Federal 319, Local.	MPCA, BWSR, Local.	Construction certification training, Team efforts on construction MPCA, BWSR, Counties, local.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Develop process for exchange of information between state agencies, local governments, various researchers and NPDES permittees.	319, State.	MPCA	Informally done by USWAG, NPDES Training.
4. Hold statewide annual seminar (jointly sponsored between agencies) on urban issues.	State, Local.	MPCA, U of M.	MECA, Water Resources Conferences.
5. Improve public education efforts related to urban impacts through such delivery channels as brochures, pamphlets, newsletters, and videotapes. Initial areas of emphasis would include: - fertilizer; - sewers (where they discharge to); - construction (BMP and erosion control); - material handling (tanks, spills, hazardous materials solid waste, etc.); - animal waste; - public participation; - litter (source controls, collection and prevention); - water collection and treatment system especially sewers, ponds.	State, Local, 319.	Met Council, MDNR, MPCA.	Storm sewer stencil program, adopt a river program, construction training programs, Met council major effort on information adds.
6. Develop process to evaluate effectiveness of urban runoff Information and Education programs/activities.	State, Local, 319.	Met Council	Follow up to Met Council efforts, City of Maplewood.
7. Evaluate proper utilization and combination of urban BMPs as appropriate for varying sets of circumstances within watersheds, such as: - pond design; - outlet flow controls; - wetland pretreatment and use; - wetland construction; - housekeeping; - erosion controls.	State, Local, 319.	MPCA, Local.	City of Minneapolis Lakes programs, Lake Harriet watershed awareness project, Lake Alimagnet watershed awareness project.

Goal 3:Develop Consistent and Clear Statewide Policies on Urban Runoff Issues Through Improved Interagency Coordination.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Establish long-term interagency coordination committee and urban runoff task force to address programmatic issues, share technical information and improve strategic planning for implementation of storm water BMPs. Needs with potential to be addressed by this group include: - clarify specific roles of the various state agencies and local entities; - clarify how the various rules apply to specific situations; - develop process for coordinating and distributing information statewide; - define the future role of local water planning; - provide forum to relay back storm water information gained on status and upcoming requirements of federal programs; - examine rules of each agency with respect to ensuring policies are consistent, and develop either MOA or issue papers relating findings and identifying areas that need further coordination.		MPCA	Urban Storm Water Advisory Group established in 1992.
2. Data coordination – a) Improve NPS assessment procedures b) develop data management system for NPDES enforcement procedures including a plan for entering of monitoring data into computer systems and systematic analysis of data.	State, federal (non-319)	MPCA	MPCA Waters permits entered into Delta

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Develop coordinated federal, state and local policies for consistent application of urban management requirements. Policies would address: - coordinate local water management planning and requirements with state and federal efforts; - development of approved water quality standards for NPS and storm water management; and - development of an enforcement policy for the storm water program and a strategy for addressing compliance.	State, Federal, Local.	BWSR, MPCA, Met Council.	New Storm Water Plans required since 1986.
4. Develop a coordinated policy on how local, state and federal programs will be implemented. This policy would address: a) ways to integrate local planning process with state programs and b) guidance on urban storm water runoff, wetland use and pretreatment requirements so that local, state and federal programs will be consistent.	State	BWSR, MPCA, Met Council.	New Storm Water Plans required since 1986.

Goal 4: Increase Adoption and Improve Appropriate Application of Urban BMPs through Evaluation of Existing BMPs and Identification of New Types of BMPs Needed to Meet Water Quality Goals in Urban Areas

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Develop guidance for targeting the physiographic type of area where certain urban runoff BMPs (or combination of urban BMPs) would be most effective.	319	MPCA	2000 BMP manual developed.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
2. Implement a demonstration project to show the integration of water quality BMPs into existing storm water management requirements at the local level and use as a statewide model.	319	MPCA, Local.	Fairfax, Maplewood, Minneapolis chain of lakes.
3. Identify and develop BMPs oriented toward retrofitting controls in developed areas.	Local, 319.	MPCA, Local.	Minneapolis chain of lakes.
4. Evaluate and identify those areas of the state where implementation of certain storm water BMPs that entail ponding and infiltration may detrimentally impact ground water (i.e., for potentially using hydrocarbon analysis).	Local	LGUs	South Washington County.
5. Revise the MPCA BMP manual to reflect the findings of studies and experience gained locally and throughout the nation.	319	MPCA	2000 BMP Manual.
6. Evaluate policies on removed materials and develop recommendations and toxic assessment protocol for collected sediment, street sweeping and other removal materials.	State	MPCA, Met Council.	Met Council Street sweepings study report, Nationwide Investigations conducted are reflected in the BMP manual.
7. Evaluate and develop hydrologic modification BMPs addressing the impacts of: - Ditching; - Channels; - Drainage; - Effects on wetland habitats and flow.	State	BWSR, MPCA, MDNR.	MPCA Ditch policy manual has been drafted.
8. Evaluate ways to mitigate artificially extended "bankfull" flow in developed areas.	319, State.	MPCA, MDNR, BWSR.	BMP manual, seminars have raised consciousness.

Goal 5: Improve Compatibility Between the Various Federal, State and Local Regulatory Programs so that there is Consistency Between the Various Regulatory Requirements.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Develop a comprehensive storm water program and a strategy for addressing consistent federal, state and local requirements.	State	MPCA	Plans, permits and BMPs all being worked on and developed.
2. Work with locals to revise, upgrade, or develop erosion control ordinances.	State and Local.	MPCA, BWSR, Local.	Model ordinances from BWSR and MPCA.
3. Improve inspection and enforcement programs so that local, state and federal agencies are consistent.	State, Local.	State, Local.	Construction E-team efforts local State cooperative efforts.
4. Develop ways to proportionately allocate NPS inputs to water quality for Total Maximum Daily Loads (TMDLs).	Federal	MPCA	In process.
5. Develop water quality standards for NPS issues, total suspended solids, phosphorus, flow changes, channelization.	State and Federal (non-319).	Federal, (non-319).	In process.

Goal 6: To Focus BMP Planning and Implementation Activities on a Watershed Basis to More Effectively Assess the Specific Water Quality Needs and Better Demonstrate Implementation Successes.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Model and evaluate potential impacts of proposed BMPs for site specific watersheds and waterbodies.	CWP, Local.	MPCA, LGUs.	CWP projects and pollutant trading have used model efforts.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
2. Assess ways to avoid, minimize and mitigate the impacts of development, evaluating such methods as: - Layouts; - restrictive growth; - removed substances (waste removals, street sweeping, dredged material disposal); - monitoring of BMPs (funding and planning for follow-up to BMP installation); - monitoring of impacts (ways to monitor and methods of finding out the impacts); - natural drainage feature avoidance (wetlands, drainageways, swales, etc.);	State, Local, CWP, 319.	MPCA	Reflected in BMP manual.
3. Examine local, state and federal funding mechanisms to identify ways of implementing programs.	CWP, 319, State Revolving Fund.	MPCA, BWSR, Met Council.	CWP projects have used watershed planning efforts.

Chapter 12 Forestry

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Introduction

Minnesota is blessed with vast acreages of forestland and an abundance of high quality water. Forest management activities are extensive in nature and often take place in close proximity to or adjacent to water resources, or in wetland areas. Sustainable forest management is only possible when all the needs of society are balanced against maintaining diverse, healthy forest ecosystems. Therefore, forest managers, landowners and operators must ensure that all forest management activities are accomplished in a manner that minimizes impacts to the environment and water quality.

The total land area of the state is 54 million acres). Of this total, 16.7 million acres are forested, most of which is contained in the northern half of the state. More than one million acres of forest are within scientific and natural areas or the Boundary Water Canoe Wilderness Area, where no harvesting is permitted. Another 800,000 acres are unproductive forestland (Figure 12.1). The remaining productive or commercial timberlands available for timber management totals 14.8 million acres.

More than twenty-seven percent of the state's timberland is wetland forest types (Table 12.1) such as ash-elm, black spruce, tamarack, and white cedar. Management activities in these types require extra caution to minimize impacts to their biologic and hydrologic functions.

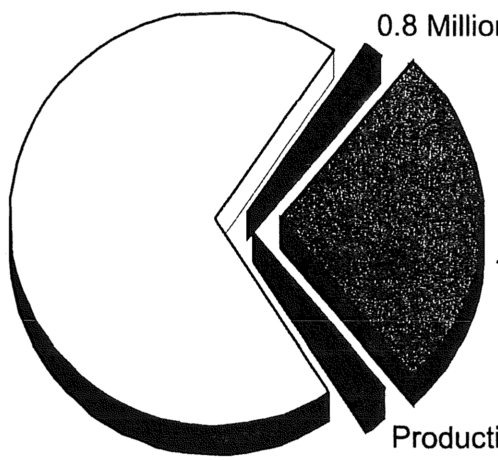
The aspen forest type covers the largest acreage, nearly thirty-five percent, and is where the most timber harvest activity has occurred over the last twenty years (Figures 12.2). In 1998 nearly sixty-one percent of the wood harvested in the Minnesota was aspen, primarily from the aspen type (Table 12.2). Prior to the 1970's the majority of the aspen type was nearly all the same age, having originated following the abandonment of unproductive farms in the late 1930s, 1940s, and early 1950s. These mature age classes (over age 50) will soon be depleted (Figure 12.3). With continuing and increasing demand harvest pressure has begun to shift to other upland hardwood types such as birch, oak and maple-basswood (20 percent of timberland). Demand has also been strong for upland conifers (11 percent timberland).

Public agency lands have provided the majority of timber harvested in Minnesota until recently, despite the fact that the largest acreage of forest types containing the species most in demand are located on Non-Industrial Private Forest (NIPF) lands (Figure 12.4). This was because:

- public forest management agencies are required to actively manage their lands on a sustainable basis,

FIGURE 12.1
MINNESOTA LAND USE

- Total of 54 Million Acres -



Source : Minnesota FIA 1990 Eastwide database provided by USFS N. Central F. Exp. Station

- demand for wood was well below the harvest levels these agencies identified as desirable in their management plans, and
- stumpage prices were too low to encourage NIPF landowners to market their wood.

As worldwide demand has increased, the state's forest industry has grown. The demand for several species, particularly aspen, now exceeds the volume available from public lands. As a result, harvest levels on NIPF lands now exceed that of public lands (Figure 12.5).

This shift of harvest to NIPF lands is a significant concern for the protection of water quality. Public agencies own and manage fifty-five percent of the commercially available forestland (Figure 12.6).

Table 12.1A
Area of Timberland in Minnesota by Forest Type -1990

FOREST TYPE	ACRES (000's)
Jack Pine	447.5
Red Pine	301.6
White Pine	63.2
Balsam Fir	734.3
White Spruce	93.8
Black Spruce	1,322.1
Cedar	680.5
Tamarack	705.1
Oak	1,184.3
Elm-Ash	1,291.5
Maple – Basswood	1,402.9
Aspen	5,114.2
Birch	835.8
Balm of Gilead	427.7
Non – Forest	168.9
Total All Types	1,4773.4

Source: Based on MN Forest Statistics, 1990, USDA Forest Service Resource Bulletin NC-141.

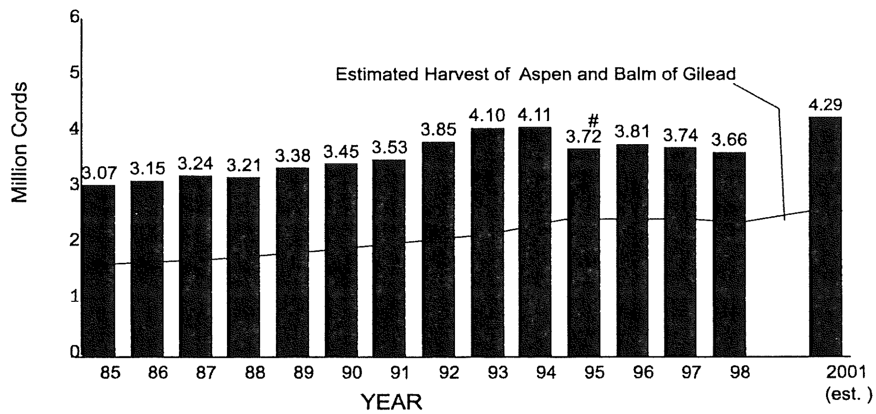
Table 12.1B
Current and Projected Wood Harvest from Timberland - Minnesota Statewide

	(In Thousand Cords)	
SPECIES	**1998**	**PROJECTED 2001***
Aspen/Balm of Gilead	2,361.7	2,535
Birch	226.1	377
Ash	30.6	30
Oak	192.0	190
Elm	10.3	15
Basswood	38.9	103
Maple	48.8	113
Cottonwood	11.7	10
Other Hardwoods	20.5	10
Pine	331.5	432
Spruce	166.2	201
Balsam	198.1	244
Tamarack	16.5	20
Cedar	8.3	6
Total	**3,661.2**	**4,286**

Source: 1998 Harvest Data compiled by NCFES and DNR.
Projected 2001 based on announced expansions and industry interviews.

*Adjustments due to:
Potlatch expansion of pulpmill at Cloquet
Potlatch rebuilds of OSB mill at Cook
Blandin's switch to more spruce/balsam
Potlatch additions to lumbermill
Closing of aspen sawmill
A portion of Boise Cascade proposed increase

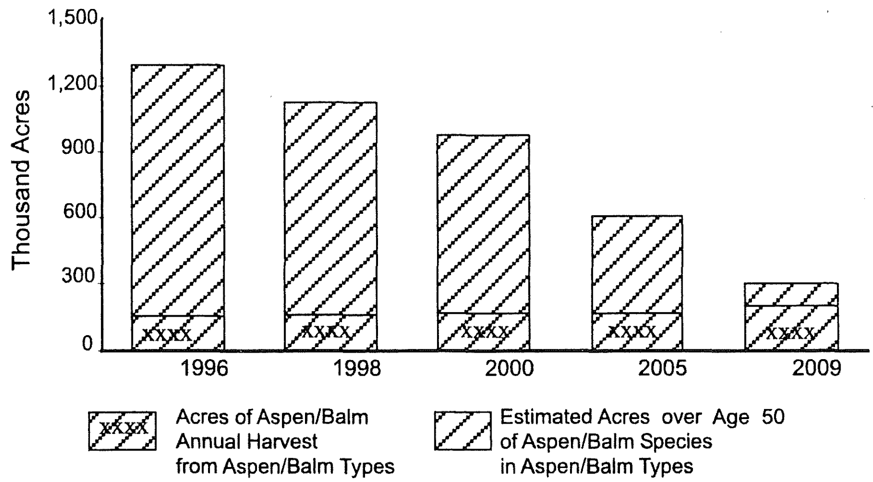
FIGURE 12.2
ACTUAL & PROJECTED TIMBER HARVEST in MINNESOTA
- from MN Timberland , all Ownerships, all Species -



Source : # 1995 adjustment due to decrease in fuelwood use since 1989/90
Harvest Data Compiled by NCFES and DNR.
1996 figures include a one time increase in pulpwood exported to Wisconsin.

12/99

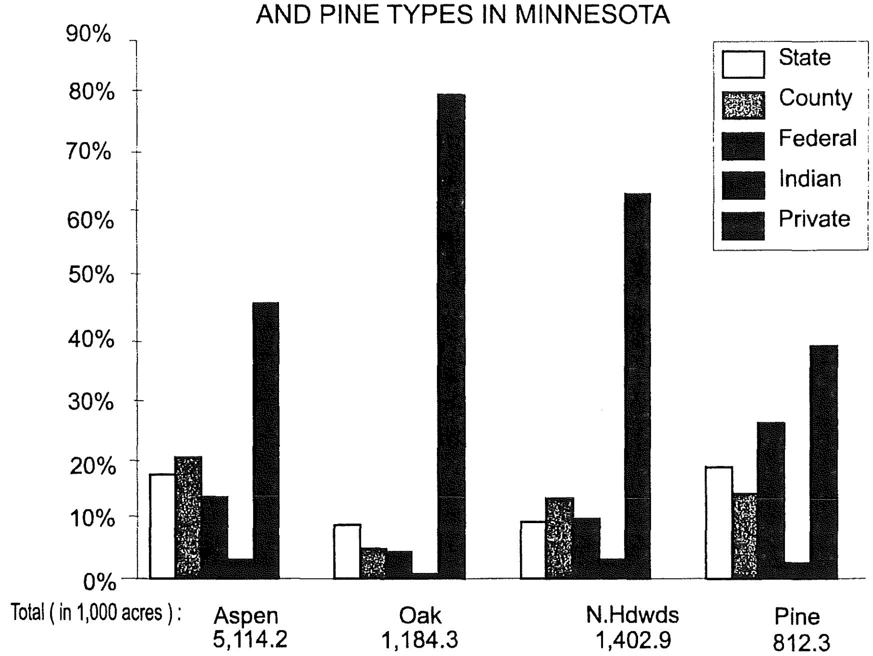
FIGURE 12.3
ASPEN TYPE: ANNUAL HARVEST VS ACRES over AGE 50
Minnesota Statewide
(includes Aspen & Balm of Gilead species in the Aspen & Balm of Gilead types only)



Source: NCFES & DNR Surveys

DNR 1/99

FIGURE 12.4
OWNERSHIP OF ASPEN, OAK, NORTHERN HARDWOOD, AND PINE TYPES IN MINNESOTA

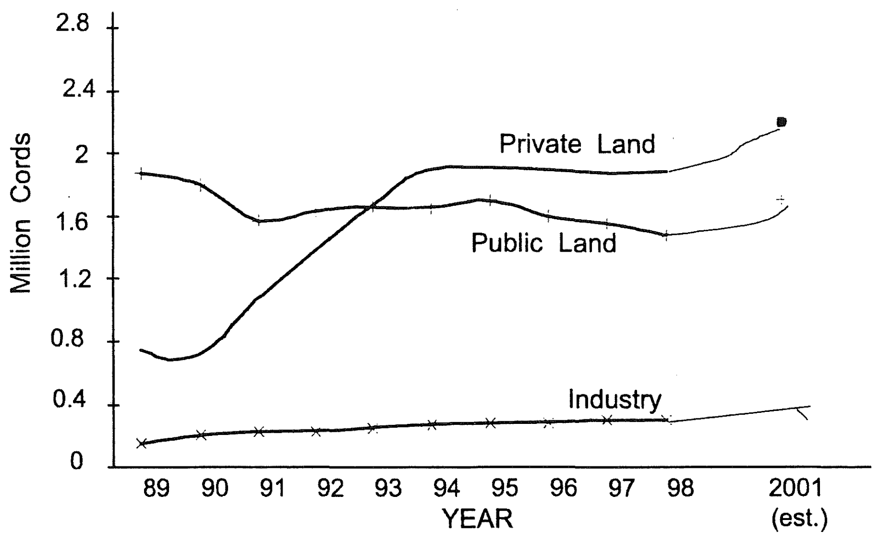


Source : Minnesota Forest Statistics, 1990 - USFS, Resource Bull. NC-141 (Table 8)

Aspen includes Aspen and Balm of Gilead cover types

Pine includes Jack pine, red pine, and white pine cover types

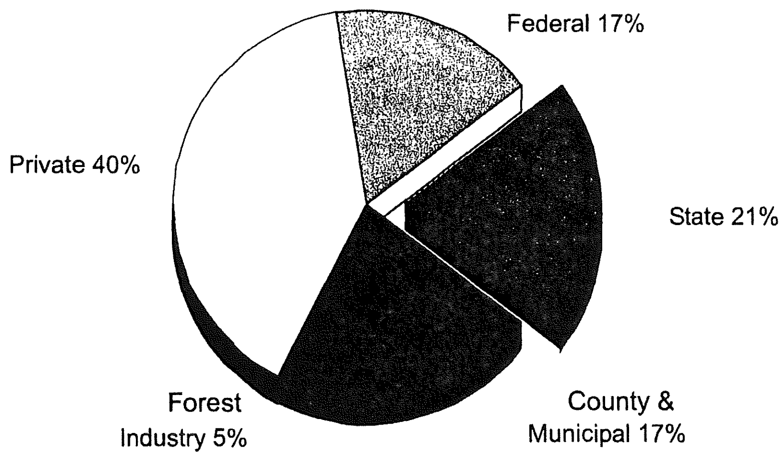
FIGURE 12.5
VOLUME of TIMBER SOLD by OWNERSHIP - MINNESOTA



Public Land : State, Chippewa & Superior Nat'l Forest, BIA, and 15 Counties.
Source : Volume of timber sold by public land agencies, DNR survey,
NCFES pulpwood use survey, MFI industry survey.
Estimated 2001 based on announced industry expansions.

DNR 3/00

FIGURE 12.6
MINNESOTA TIMBERLAND BY OWNERSHIP
- 14.8 Million Acres -



Source : Minnesota Forest Statistics, 1990 - USFS, Resource Bull. NC-141 (Table 2)

(Private includes tribal lands)

These agencies have foresters and other natural resource professionals on staff to address nonpoint source (NPS) pollution through the adoption of appropriate organizational policies and regulations. They are also subject to ongoing legislative and public scrutiny to assure they adhere to high standards of resource protection.

In contrast to public agencies, NIPF landowners, who control forty percent of Minnesota's timberland, often do not utilize professional natural resource assistance. Prior to 1990 the MDNR, Division of Forestry estimated that only about twenty percent of the estimated 139,000 NIPF landowners utilize a forestry professional to help plan their forest management activities. Developing incentives and an effective education program to encourage implementation of BMPs on NIPF lands has been a major challenge. To meet this challenge Minnesota's stewardship program has set a goal of providing written stewardship plans for fifty percent of the NIPF acreage by 2005. They have increased the acreage with plans to forty percent in the first five years of effort.

Geographic Areas of Concern

Much of Minnesota's forestland has gentle topography and stable soils where impacts to water quality from erosion and sedimentation attributed to silvicultural activities is generally not severe. It is important to recognize, however, that an extremely high proportion of high quality waters (e.g., designated trout streams, designated trout lakes, and Outstanding Resource Value Waters) occur or originate in the forested areas of Minnesota. Therefore, where poor management practices are applied, it is likely to degrade high quality resources.

Several forested areas of Minnesota are particularly susceptible to erosion and sedimentation. Additionally, NIPF landowners generally own small parcels of timberland, and have few constraints on their land-use practices. Because their timberlands are interspersed with public and forest industry lands, a complex mosaic of ownership exists that greatly complicates coordination of forest management on a landscape scale. Regional landscape planning committees, made up of stakeholders from all segments of the regions' population, are being established to begin addressing the complicated issues that this mosaic of ownership creates.

Based on the sensitive physical nature of some areas, the mosaic of public and private ownership, and the findings of the best management practices (BMPs) implementation monitoring, priority areas of the state for focusing water quality protection and improvement efforts include:

- The Nemadji River Basin in the northeast, which has erosion problems as the result of steep slopes of red clays underlain by course sand and gravel.
- The Root River Basin and other areas in the southeast, which have Karst topography with sinkholes, highly erodible loess soils, and steep slopes.

Currently Applied BMPs

Minnesota has had voluntary water quality best management practices (BMPs) to address nonpoint source pollution since 1990. These were revised in 1994 based on the results of implementation monitoring in 1991, 1992, and 1993. Wetland BMPs were incorporated at that time to better address the intent of the federal Clean Water and Coastal Zone Management Acts and to address the requirements of the state's new Wetland Conservation Act. Visual Quality BMPs were also developed in 1994 as a result of collaboration initiated by the resort and forest product industries of Minnesota. Implementation monitoring of the revised water quality and new wetland and visual quality BMPs was conducted in 1995 and 1997.

The focus of Minnesota's forestry BMPs has been, and continues to be, at the site level for all forest ownership across the state. These site level practices have been expanded and integrated with guidelines intended to enhance or minimize impacts to riparian areas, site-specific wildlife, soil productivity, and cultural and historic resources. These BMPs are now incorporated in the newly published, "Voluntary Site-Level Forest Management Guidelines, Sustaining Minnesota Forest Resources." The BMPs found in this manual are incorporated by reference into this Plan. Additional efforts are currently under way to address forest management issues at a landscape level. The entire program remains voluntary for the landowner/manager to the extent practical within the constraints of existing federal, state, and local laws and regulations. This provides important flexibility to meet variations across landscapes, in on-site conditions, available equipment and technology, and management goals.

The forestry BMP guidebook provides recommendations to protect water quality for the following activities:

1. General Practices:
   - fuel, lubricant and equipment management;
   - filter strips; and
   - follow-up evaluations.

2. Forest Roads:
   - design recommendations, considerations for alignment, water crossings, winter roads, and drainage;
   - construction recommendations for clearing, excavation, surfacing, drainage, and soil protection; and
   - maintenance recommendations activities for all roads in general, as well as specific considerations for active roads, and inactive roads.

3. Timber Harvest:
   - planning considerations for reconnaissance, timber sale plans, design and layout, harvesting and follow up, and shade trees.

4. Mechanical Site Preparation:
   - planning considerations; and
   - recommended prescriptions for shearing and raking, discing, patch and row scarification.

5. Pesticides:
   - planning considerations for integrated pest management, use of licensed pesticide applicators, pesticide selection, and response to spills; and
   - procedures for pesticide handling during transportation, storage, mixing
   - loading, application, equipment cleanup, and container and waste disposal.

6. Prescribed Burning:
   - planning considerations, recommended prescriptions, and maintenance after fire.

Additional guidelines for recreational trails and facilities are currently under development under the direction of the MN Forest Resources Council (MFRC).

WATERBODIES ADDRESSED

The wetland and water quality BMPs apply to all perennial and intermittent streams, lakes, open and non-open water wetlands, and ground water.

POLLUTANTS

Erosion and subsequent sedimentation is the principal water quality impairment associated with silvicultural practices in Minnesota (Generic Environmental Impact Statement, Draft, 1993). Other pollutants commonly associated with forest management activities include dissolved nutrients, organic debris, pesticides, petroleum products, and thermal effects. Changes in the pattern of water movement above and within the soil (hydrologic flow) is another potential impact that can affect water quality as well as biologic function at the site level and beyond. While some erosion and sedimentation within forested lands occurs naturally, most is attributable to poor design, placement, and maintenance of forest roads and trails. Other silvicultural activities that have the potential to generate these pollutants include:

- mechanical site preparation resulting in sedimentation and dissolved nutrient losses,
- soil compaction and rutting that results in increased surface flow of water off site or that interrupts normal lateral water movement in the soil,
- spills of fuel and lubricants due to breakdowns or during equipment maintenance,
- harvesting trees along the banks of waterbodies, resulting in increased water temperatures and reduced bank stability which can degrade the stream channel and increase long-term sedimentation,
- slash burning resulting in nutrient loading to streams,
- extensive clearcutting within a drainage basin which can result in increases in stream peak flows,
- regeneration and pest control activities that involve pesticide use or chemical management, and
- fire breaks resulting in sedimentation and dissolved nutrient losses.

Seasonal changes and fluctuating climatic conditions often complicate these activities.

PROGRAM DESCRIPTION:

Implementation of the forest management guidelines is monitored by field audits of a sample of recent forest management activities on all forested ownership in Minnesota. Information gained from the field audits is used to:

- evaluate the degree of implementation of the guidelines,
- identify needed modifications to guidelines, and
- focus technical assistance and education efforts on problem areas identified in the field audits.

Our goal has been, and continues to be, to sample 120 sites each year monitoring is done. This provides a sample adequate to statistically assess overall guideline implementation, but does not permit a statistically meaningful assessment of most subsets of the data. Our primary limitations are funding and design of a timely way to obtain an unbiased sample of forest management sites, particularly for NIPF ownership.

For the monitoring conducted from 1991 through 1997, minimal funding restricted us to requesting the cooperation of state, county, federal, forest industry, and tribal forestry organizations to identify sample sites. Each organization was asked to submit documentation of all sites on their ownership that met the following criteria:

- timber harvest, mechanical and chemical site preparation, and prescribed burn activities covering ten acres or more (5 acres in SE MN),
- located within 200 feet of open water, and
- completed within the previous two years.

We attempted to obtain the same information for NIPF lands, but were severely limited because less than 20% of such activity was accomplished with the assistance of a professional forester. No records were available for activities on the other 80%.

We have acknowledged from the start that both the self-selection process for public agencies and industry and the lack of an effective means of identifying the majority of activity on NIPF lands are significant limitations for the credibility of our monitoring results to date. Our greatest strength has been the multi-stakeholder teams we used to evaluate each site.

From 1991 through 1997, BMP monitoring utilized multi-stakeholder teams of six to eight people. These teams were composed of individuals with a broad range of expertise representing as many interest groups as possible. These teams worked by consensus to evaluate which BMPs were appropriate for each site, whether they were applied properly, and if they were functioning as intended.

We found that the interaction between team members was as important as the results of the audits. People of widely diverse backgrounds and opinions regarding environmental issues found they had common ground and built trust where they assumed they had would find conflict. These multi-stakeholder teams lent substantial credibility to the assessment of individual sites.

IMPROVEMENTS IN WATER QUALITY

Evaluating compliance with forestry guidelines on all forestland ownership, in combination with the use of the monitoring results to focus our training and technical assistance efforts on specific problem areas, continues to serve as the cornerstone for improving forest management practices. While the results of the initial implementation monitoring efforts do have scientific weaknesses, they do demonstrate progressive improvement in the application of the guidelines on the majority of forestland ownership. And the high level of logger, forester, public agency, and forest industry participation in the training programs demonstrates a strong commitment on the part of the entire forestry community to the voluntary process of our program.

Table 12.3: Minnesota Water Quality BMP Monitoring Results

Year	Number of Sites Monitored	Number of Practices Rated	Application	Effectiveness
			Meets or Exceed BMP	Adequate Protection
1991, 1992, 1993	261	5,707	84%	92%
1995	110	2,731	91%	95%
1997	120	2,062	92%	96%
Total	491	10,500	87%	93%

Table 12.4: Minnesota Wetland BMP Monitoring Results

Year	Number of Practices Rated	Application Meets or Exceeds BMP
1995	352	87%
1997	319	87%
Total	671	87%

Table 12.5: Minnesota Shade Strip BMP Monitoring Results

Year	Number of Practices Rated	Application Meets or Exceeds BMP
1995	76	80%
1997	60	88%
Total	136	84%

However, recruiting and training multi-stakeholder teams is very difficult and time consuming. It requires training eighty people to adequately staff three audit teams to evaluate 120 sites over a two and one-half month period each fall. The increased complexity of the expanded guidelines has made this approach to implementation monitoring unworkable.

For the year 2000 we have attempted to improve the credibility of our site selection process and resolve some of the staffing and logistical complexity of the monitoring effort. This includes:

- hiring biomatricians to design a statistically valid system of randomly selecting townships in the forested regions of the state, for which aerial photography was flown, as an unbiased way to identify a pool of sample sites,
- hiring a private contractor to audit the sites,
- instituting a quality control process to ensure the contractor accurately evaluates the sites, and
- initiating development of a computer program intended to permit entry of data in the field.

A variety of problems have arisen in our attempts to put this plan into operation. Efforts continue to solve these problems and refine the plan.

The expanded forest management guidelines have been adopted as operational policy on state, national forest, county, and industry forest lands. Members of the Minnesota Logger Education Program (MLEP) are required to take forest management guideline training and are encouraged to include compliance with the guidelines in their contracts with NIPF landowners. MLEP has nearly 400 member companies representing more than 70% of the timber harvested in Minnesota.

Minnesota's Stewardship Program, which extends professional assistance to NIPF landowners through consultants, industry foresters, Soil and Water Conservation District (SWCD) staffs, environmental groups, and state natural resource professionals, requires all individuals wishing to qualify as Stewardship plan writers to take forest guideline training. The plan writers are also required to incorporate the appropriate guidelines, including water quality protection strategies, in the plans they write for NIPF landowners. And the landowners are also required to utilize the guidelines for all projects involving cost-share funding.

SPECIFIC ACCOMPLISHMENTS

The Minnesota Forest Resources Council (MFRC) has published 5,000 copies of the new integrated forest management guidebook titled, "Voluntary Site-Level Forest Management Guidelines, Sustaining Minnesota Forest Resources." This incorporates and replaces, "Protecting Water Quality and Wetlands in Forest Management, Best Management Practices in Minnesota."

Guideline training for loggers and foresters was very limited in 1998 because an intensive program was planned to introduce the expanded guidelines in 1999. The 1999 training was an introductory program with a two-day format based on timber harvest. The first day was a full day classroom session offered at eight locations around the state. Fourteen sessions were held in the spring, with two make-up sessions in August. More than 1,200 loggers, foresters, wildlife managers, recreation specialists, hydrologists, and other natural resource managers attended. These same people attended fourteen field-training sessions, offered at six locations, in September and October to complete the 1999 introductory program. Three more sessions of the introductory program, attended by more than 250 people, have been held in 2000.

Additional, more specialized training on such subjects as recreational trails, road maintenance, and prescribed burning will be offered in the future. Training on the forest management guidelines has been given to more than 500 volunteer "woodland advisors." These are private individuals with an interest in forest and wildlife management that receive eighty hours of training on general forestry and wildlife topics and the types of professional services available to private landowners. These people then provide advice to their neighbors, and encourage them to seek appropriate assistance.

The MDNR, Division of Forestry has developed a set of standardized forest management regulations, including specific water quality guidelines that can be incorporated into timber sale and other forest management project contracts. This has been done to improve the consistency and clarity of the wording and make the regulations more easily enforced. This will also permit;

- identification of the types of problems that arise,
- evaluation of the appropriateness of project regulations, and
- comparison of agency results with the statewide monitoring results.

Field foresters will still have the flexibility to write project regulations customized to address unique site conditions.

Research efforts are being developed to evaluate the effectiveness, cost, and benefits of individual guidelines. Work is currently proceeding on impacts of a variety of harvest systems within riparian areas. This work is looking at a wide variety of aquatic factors, forest birds, associated vegetation, damage to residual trees, production, and operating costs. Additional studies will be developed as funding permits.

Substantial joint efforts are being made by local, state, and federal agencies to restore riparian vegetation, particularly forest cover, along some of Minnesota's most polluted waterbodies. The MDNR, Division of Forestry has hired three full-time foresters to accelerate this effort in the Minnesota River drainage area. They are working with a number of programs to provide incentives to farmers to take floodplain fields out of crop production and plant forest cover. One of the most important programs is the Conservation Reserve Enhancement Program (CREP), which allows a landowner to extend their Conservation Reserve Program (CRP) contract by five years if they plant trees.

A field demonstration of a variety of small-scale logging equipment was held in October 1998 to introduce loggers, foresters, and landowners to equipment options that may be better suited to thinnings or small acreages. The intent was to provide additional options for medium to small loggers that cannot afford the very high cost of new, full-sized, high-tech machines.

The field demonstration was a joint project of the Minnesota and Wisconsin Societies of American Foresters, each state's Divisions of Forestry, and the University of Minnesota Extension Service. Funding was provided by the US Forest Service, State and Private Forestry (S&PF). The field day was a great success. We had 15 vendors and more than 300 attendees. Every vendor sold equipment, and all comments were very positive. Several requests have been made for a repeat of this program in other parts of Minnesota.

A second workshop in June 2000 addressed the variety of options for cut-to-length systems (sizes and combinations of equipment, advantages and disadvantages, clearcut and thinnings, etc.). 200 loggers and foresters attended it. This program was also very well received and, at the request of loggers, has resulted in efforts to organize equipment operator training programs through one of the state technical colleges.

A representative from the state forester's office continues to work with the National Association of State Foresters (NASF) to develop a national forestry perspective on the Clean Water Act that will provide both protection to water quality and cost-effective management. The MDNR, Division of Forestry will also provide leadership in implementing the state's new Coastal Zone Management Plan guidance document and forestry management measures. We will also continue our efforts to ensure that cost sharing for water quality protection remains a high priority for stewardship.

GOALS FOR BEYOND 2000

The forestry community will continue to evaluate and improve education programs for loggers, landowners and resource managers. Education efforts will continue to target woodland advisory committees, woodland owner groups and other NIPF landowners.

The MDNR, Division of Forestry, Minnesota Extension Service, and USDA Forest Service are pursuing research funds to continue and expand research on light-on-the-land logging technologies and to expand the evaluation of the effectiveness, costs, and benefits of individual guidelines.

Under the state's Sustainable Forest Resources Act, Minnesota's forest management guidelines will remain a voluntary program for the landowner/ manager. The majority of public forest agencies and forest industry, as well as loggers and many NIPF landowners are strongly committed to the effective utilization of the guidelines. Evaluation and revision of the guidelines and the entire program remains a process involving multi-stakeholders and extensive scientific and public review.

Programs, Roles and Authorities

The Minnesota Department of Natural Resources, Division of Forestry is the lead agency for implementing the forestry section of the NPS Management Plan. The water quality agency, Minnesota Pollution Control Agency (MPCA), is the agency designated to implement Section 319 activities and will be involved in coordination of forestry NPS activities with the overall NPS Management Program. As needed, memoranda of agreements will be developed between implementing agencies. Other federal, state and local agencies and organizations and individuals, which have roles and programs, related to improving the water quality of Minnesota's forestlands through controlling silvicultural practices include:

- USDA/FSA/NRCS: Conservation Reserve Program
- USDA/FSA: Agricultural Conservation Program
- USDA: Stewardship Incentives Program
- NRCS/SWCDs: Preparation of conservation plans for erosion and sedimentation control (i.e., field windbreaks)
- USFS: NEPA - USFS: Forest Legacy

- USDA/FSA: Forestry Improvement Program
- MDNR: Private Forest Management/Stewardship Programs
- MES: General education for stewardship
- Private Industry: Provide forest stewardship planning to private landowners
- Consulting Foresters: Provide forest stewardship planning to private landowners

A more detailed description of these programs, including the major program components, the funding source, lead agency and resource information can be found in Chapter 2, Programs and Funding for Implementing NPS Program, of this 2001 Nonpoint Source Management Program Plan (NSMPP).

BEST MANAGEMENT PRACTICES (BMP)

The following guidelines are recommended to reduce nonpoint source pollution from Forestry activities. This list is not comprehensive and does not suggest additional measures would have no benefit but is provided to highlight commonly employed practices. Appendix B of this 2001 NSMPP provides definitions of best management practices for a broad range of NPS sources.

The forestry guideline book provides recommendations to protect wetlands and water quality for the following areas of concern:

1. General Practices:
   - timing of activities;
   - fuel, lubricants, and equipment management;
   - petroleum product spills;
   - filter strips and riparian management zones;
   - protection of normal hydrologic flow of streams and wetlands;
   - protecting wetland inclusions and seasonal ponds;
   - coarse woody debris; and
   - follow-up evaluations of sites.

2. Forest Roads:
   - location and alignment;
   - references back to general practices for protection of wetlands and open waterbodies;
   - design recommendations for:
     - season of required access, long term access needs, topography, soil type,
     - surface drainage erosion control,
     - approaches to and crossing of wetlands and open waterbodies;
   - construction recommendations for:
     - clearing and excavation,
     - soil stabilization, and disposal of clearing debris,
     - approaches to and crossing of wetlands and open waterbodies;
   - maintenance recommendations for roads while in use and when temporarily closed; and
   - recommendations for permanent closure of roads.

3. Timber Harvest:
   - utilization of aerial photography, topographic maps, wetland inventory maps, and other aids when planning and designing timber sales;
   - recommends field reconnaissance for preparation of harvest plans and prior to the start of harvest operations;
   - recommends a written harvest plan and on-site review of that plan with the logger prior to the start of operations;
   - location of landings and skid trails,
   - references back to general practices for protection of wetlands and open waterbodies; and
   - skid trail approaches to and crossing of wetlands and open waterbodies; and documentation, supervision, and follow-up evaluation of desired outcomes.

Chapter 12 Forestry
Needs, Priorities and Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 thorough December 31, 2005) 5-year Action Plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 – 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Goal 1: Education: Improve Adoption and Use of BMPs Through Effective Educational Programs.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Target outreach to NIPF landowners, -develop curriculums for local conditions (i.e. county woodland committees, woodland advisors).	X	X	X	X	X	General Fund (S), Stewardship Education Fund (S).	MDNR Forestry, MFA, U of M Extension.
2. Develop early education curriculum in cooperation with professional associations (i.e. Project Wet, Project Wild, Project Learning Tree, Natural Resources in the Classroom).	X	X	X	X	X	General Fund (S), Association Funds (P).	MDNR Forestry, MDNR Waters, Wildlife Society, Society of American Foresters, U of M Extension.
3. Document benefits of the guideline education programs based on evaluation of and landowner surveys - survey landowners with management plans to determine effectiveness.	X					LCMR (S), General Fund (S), Stewardship Education Fund (S).	MDNR Forestry, MFA, Uof M Extension.

(P) Private (S) State (F) Federal

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
4. Document benefits of the guideline education programs based on evaluation of implementation field monitoring results.	X	X	X	X	X	General Fund (S).	MDNR Forestry.
5. Develop demonstrations of practices and equipment to reduce impacts and improve the efficiency and cost effectiveness of forest operations.	X	X	X	X	X	General Fund (S), S&PF (F), Grants (P).	MDNR Forestry, U of M Extension.
6. Continue training programs for loggers and foresters and expand to include other natural resource professionals.	X	X	X	X	X	General Fund, (S), MLEP (P).	MFRC

Goal 2: Monitoring: Evaluate and Quantify Implementation of BMPs

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Continue guideline implementation monitoring.	X	X	X	X	X	General Fund (S)	MDNR Forestry
2. Improve implementation monitoring process design.	X	X	X	X	X	General Fund (S)	MFRC
3. Adequate sampling of critical activities.	X	X	X	X	X	General Fund (S)	MFRC
4. Identify meaningful sampling criteria.	X	X	X	X	X	General Fund (S)	MFRC
5. Streamline on-site evaluation.	X	X	X	X	X	General Fund (S)	MFRC
6. Expand implementation monitoring to include permanent forest management infrastructure; Roads Water crossings Trails.			X	X	X	General Fund (S)	MFRC

Goal 3: BMP Development and Implementation: Continue BMP Development and Implementation Efforts to Improve the Effectiveness and Use of BMPs and Expand the Protection of Resources.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Revise guidelines to reflect the results of monitoring and research.	X	X	X	X	X	General Fund (S)	MFRC
2. Prioritize assistance, education, and corrective actions to address those practices identified through implementation monitoring as poorly applied, inadequately utilized, or newly developed or revised.	X	X	X	X	X	General Fund (S), Stewardship Education Fund (S), Cost Share Programs (S) (F), MLEP (P), U of M Extension (F)	MFRC
3. Increase technical assistance to NIPF landowners.	X	X	X	X	X	General Fund (S), Stewardship Funds (S).	MDNR Forestry
4. Evaluate the need for tax credits as incentives for guideline implementation.	X	X	X	X	X	General Fund (S)	MFRC
5. Establish guideline implementation recognition programs for loggers, natural resource managers, landowners, and management agencies.	X	X	X	X	X	General Fund (S), Association Funds (5).	MFRC, SAF, MLEP, MFA.

Goal 4: Research: Target Research Efforts to Evaluate Costs and Benefits as well as Effectiveness of BMPs in Reducing Negative Impacts of Forest Management Practices

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Evaluate effectiveness of filter strips in reducing sediment movement to waterbodies and wetlands.	X	X	X	X	X	General Fund (S), S&PF (F), Grants (P).	MFRC, MDNR Forestry, U of M, NRRI, USFS, S&PF.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
2. Initiate long term research to determine the effectiveness of a variety RMZ configurations for; - thermal impacts - trapping sediments - capturing or trapping nutrients - providing critical habitats.	X	X	X	X	X	General Fund (S), S&PF (F), Grants (P) (F).	MFRC, MDNR Forestry, Uof M, NRRI, USFS S&PF.
3. Evaluate soil disturbance impacts and recovery rates; - erosion and channelization - infiltration - hydrologic regimes - site productivity.	X	X	X	X	X	General Fund (S), S&P (F), Grants (P) (F).	MFRC, MDNR Forestry, U of M, NRRI, USFS S&PF.
4. Evaluate alternative technologies to accomplish timber harvest and other forest management activities.	X	X	X	X	X	General Fund (S), S&PF (F), Grants (P) (F)	MFRC, MDNR Forestry, U of M, NRRI, USFS S&PF.

Goal 5: Restore Forest Vegetation on Riparian Areas Through Tree Planting to Improve Water Quality, Absorb Nutrients, Restore Habitat, Provide Alternative Crop, Improve Aesthetics, Slow Flood Discharge, and Trap Sediment.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Restore riparian forest cover to 2,000 to 6,000 acres per year utilizing native species and hybrid varieties of trees, with preference for native species.	X	X	X	X	X	RIM (S), CRP (F), CREP (F), MFA (P),	MDNR Forestry, MDNR Waters, MPCA.
2. Promote easement programs or tax incentives to promote riparian cropland to forest cover.	X	X	X	X	X	RIM (S), CRP (F), CREP (F), MFA (P),	BWSR, SWCD's.

1994 NSMPP
Needs, Priorities, and Milestones

The following Table provides the Goals and Action Steps included in the 1994 NSMPP. The Products, Services and Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps. Implementation of all action steps is contingent upon adequate funding and local involvement

Goal 1. Education: Improve Adoption and Use of BMPs through Effective Educational Programs.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Target outreach to NIPF landowners. • develop a system to identify private landowners so they can be effectively targeted for information distribution and educational opportunities; • develop curriculum for local coalitions (i.e., woodland advisory committees).	General Fund, (S) Stewardship Education Fund (S), Blandin Foundation (P), Northwest Area Foundation (P).	MDNR-Forestry, MFRC.	Forest Guideline Brochure, Stewardship 50% by 2005 program, Woodland Advisor Program.
2. Develop early education curriculum in cooperation with MN Association of Science Teachers and Project Learning Tree.	General Fund (S)	MDNR-Forestry, MN SAF.	PLT & MN SAF Natural Resources in the Classroom.
3. Document water quality benefits of the BMP educational program based on an evaluation of field audit results and further landowner surveys.	General Fund (S)	MDNR-Forestry, U of M Extension.	Accomplished & ongoing.
4. Continue logger training program.	LEAP (F), Rural Development Grant (F), USFS, State and Private Forestry (F), General Fund (S), U of M Extension (F), Forest Industry (P), MLEP (P).	MDNR-Forestry, U of M Extension, MLEP.	Over 30 workshops reaching producers of more than 80% of the timber harvested.
5. Develop logger recognition program.	General Fund (S)	----	Not accomplished.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
6. Improve coordination of education efforts among organizations and agencies.	General Fund (S), MLEP(P), MFRP U of M Extension (F).	MRFC, MDNR-Forestry, MLEP, U of M Extension.	Accomplished & ongoing.
7. Continue providing educational opportunities for forestry professionals.	General Fund (S) Forestry Industry (P).	MFRC, MDNR.	Over 90% of foresters trained.

Goal 2. Monitoring: Evaluate and Quantify Compliance with and Effectiveness of BMPs.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Continue BMP compliance monitoring effort on a biennial basis beginning in 1993 (with spot-checking in the off years).	General Fund (S)	MFRC, MDNR-Forestry.	Ongoing
2. Monitor and quantify the sediment and nutrient loads to waterbodies identified as priorities.	LCMR (S), Northwest Area Foundation (P), General Fund (S), U of M (S), NRRI (S), US Forest Service (F).	MFRC, MDNR-Forestry, U of M, NRRI, US Forest Service.	Research evaluating impacts of harvest practices in riparian areas began in 1997 & is ongoing.
3. Quantify real cost of BMP implementation and cost effectiveness.	LCMR (S), Council of Great Lakes Governors (S), Blandin Foundation (P), Northwest Area Foundation (P), Rural Development Grant (F), General Fund (S).	MFRC, US Forest Service, U of M.	Work began in 1997 and is ongoing.
4. Develop a revision system to revise the BMP handbook based on updated auditing information.	General Fund (S)	MFRC, MDNR-Forestry.	BMPs updated in 1994-95, expanded in 1997-98 & peer reviewed in 2000.
5. Incorporate water quality protection measures recommended in the timber harvesting GEIS into the forestry program.	LCMR (S), Special state appropriation (S), General Fund (S).	MFRC, MFRP.	MOU signed by most public forestry agencies & forest industries.

Goal 3. BMP Development and Implementation: Continue BMP Development and Implementation Efforts to Improve Adoption and Use of BMPs.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Establish 4-6 BMP demonstration sites on state land, one of which would focus on road installation in the Nemadji River watershed.	LCMR (S), Council of Great Lakes Governors (S), Blandin Foundation (P), Rural Development Grant (F), General Fund (S)*	MFRC, MFRP, MDNR Forestry, MLEP, U of M Extension.	A full day of field training on a demonstration site is a required part of logger & forester guideline training.
2. Establish ongoing equipment demonstration program to evaluate harvesting equipment and related technologies.	General Funds (S)*, USFS, State & Private* Forestry (F)* Private Industry (P)*	MDNR-Forestry, U of M Extension, US Forest Service.	Demonstrations & workshops held on high flotation tires, cable yarding on steep slopes, cable yarding on level ground, portable stream & wetland crossings, small-scale logging equipment & cut-to-length systems.
3. Revise BMP handbook to include:			Completed revision of the BMP handbook in 1995 and developed and published an expanded set of forest management guidelines in 1999. This expanded document includes guidelines for protecting water quality, wetlands, visual quality, cultural and historic resources, site-specific wildlife, soil productivity, and riparian management zones. The entire document has gone through pubic review and scientific peer review. The riparian and seasonal pond sections have gone through a second peer review. The entire document is to be revised in 2002.
• additional wetland BMPs for forestry,	General Fund (S)*	MDNR-Forestry,	
• developed visual quality BMPs,	General Fund (S)*	MDNR-Forestry,	
• expand BMPs to address riparian areas, soil productivity, cultural & historic resources, & site-specific wildlife & integrate all BMPs into a single document.	General Fund (S)*	MFRC, NFRP, MDNR-Forestry.	

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
4. Continue efforts to encourage NIPF landowners to get professionally prepared stewardship management plans written for their forestlands. The goal is to have 50% of the acreage of NIPF forestlands under stewardship plans by 2005.	General Fund (S), Stewardship Funds (S).	MDNR-Forestry, Forest Industry Consultants.	Ongoing
5. Improve cost share programs (i.e., MFIP and SIP) to ensure BMPs are a requirement.	General Fund (S), Stewardship Education Fund (F).	MDNR-Forestry	Ongoing
6. Identify and prioritize specific erosion problem areas to better focus assistance and corrective action efforts.	LCMR (S), Northwest Area Foundation (P).	MDNR-Forestry, U of M.	Ongoing
7. Modify language within timber harvesting contracts to require use of BMPs.	No cost	MFRC, MFRP.	MOU signed by most public forestry agencies & forest industries.
8. Evaluate need for increased technical assistance to private landowners.	General Fund (S)	MDNR Forestry	Ongoing
9. Evaluate need for tax credits as incentive for BMP adoption.	----	----	No action, is under consideration in the 2001 legislative session.

Goal 4. Research: Target Research Efforts to Evaluate Effectiveness of BMPs in Reducing Silvicultural NPS Pollution.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Evaluate effectiveness of filter strips in reducing sediment movement to streams.	LCMR (S), General Funds (S)*, U of M (S)*, NRRI (S)*, US Forest Service (F)*.	MFRC, MDNR-Forestry, U of M, NRRI, US Forestry Service.	Research on the impacts of harvest systems in riparian areas began in 1997 & is ongoing.
2. Evaluate fate and off-site movement of forest-use herbicides under Minnesota conditions.	LCMR (S), NAPIAP (F).	----	No action taken due to lack of funding and staff. This will not change for the foreseeable future.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Evaluate soil disturbance in coverage and severity from conventional and high flotation harvesting.	LCMR (S)*, Private Industry (P)*, Central MN Initiative Fund (S)*, US Forest Service (F),* General Fund (S)*.	MDNR-Forestry, US Forest Service, U of M.	Research has been done on high flotation tires, cable yarding on steep slopes & cable yarding compared to CTL & grapple skidding. Research continues on comparison of harvest systems in riparian areas.

Goal 5. Coordination: Increase Coordination Among Agencies and Organizations to Improve Effectiveness of BMP Implementation.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Establish federal/state water quality coordination committee.	General Fund (S)*	State legislature.	Established the MFRC & MFRP in 1995 & reauthorized in 1999.
2. Develop network with allied state, federal and local entities to promote water quality, share resources and take advantage of specialized expertise.	General Fund (S)*	MFRC, MFRP.	Accomplished & ongoing.

Goal 6. Restore Forest Vegetation on Riparian Areas Through Planting to Improve Water Quality (E.G. Absorb Nitrates, Slow Flood Discharge Provide "Benign" Floodplain, Trap Sediment Runoff, Restore Habitat/Ecosystems, Provide Alternative Crop, Improve Aesthetics).

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Plant 2,000 to 6,000 acres per year of bottomland tree species on converted agricultural fields in floodplain and other riparian areas.	ACP (F), FIP (F), SIP (F).	MDNR-Forestry	Substantially more acres planted each year than targeted. Three MDNR foresters hired to target riparian forest.
2. Provide training to field staff on identifying native vegetation communities needed for restoration.	General fund (S)*	MDNR-Forestry	158 MDNR foresters & 53 wildlife managers & county foresters trained in 1993 & 1994.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Identifying and prioritize specific sites for reforestation which best absorb excess nutrients and best prevent surface erosion.	ACP (F)	MDNR - Forestry	Minnesota River floodplain targeted.
4. Evaluate need for easement program or tax incentives to promote conversion of cropland to permanent cover.	----	----	No action

\# ACP = Agricultural Conservation Program
FIP = Forestry Incentives Program
SIP = Stewardship Incentives Program

* **Actual Sources of Funding Utilized**

Chapter 13 Mining

Technical Committee Members
Paul Eger, MN Department of Natural Resources (MDNR), Lands & Minerals, Co-Chair
Lyn Leopold, MN Department of Natural Resources (MDNR), Lands & Minerals, Co-Chair
Dick Clark, MN Pollution Control Agency (MPCA)
Jim Strudell, MN Pollution Control Agency (MPCA)
Dave Skolasinski, Cleveland Cliffs

Introduction

The major mineral commodities mined in Minnesota are iron, aggregate, dimension stone, clay and peat. A major copper-nickel resource has been identified in the Duluth complex in northeastern Minnesota and significant potential for other base metals, including gold and silver, exists in the greenstone belts located in the northern portion of the state (Figure 13.1). Recently, there has been renewed interest in developing the copper nickel resources within the Duluth complex and exploration for platinum/palladium has occurred. Major mineral deposits have been found in similar greenstone formations in neighboring Wisconsin and Canada. A titanium deposit also exists in the northern portion of the state.

IRON

All of Minnesota's iron ore is produced by seven major taconite producers located in the northern portion of the state in the Mesabi Iron formation (Figure 13.1). These companies mine low grade iron formation or "taconite" from large (generally greater than 2 square miles) open pits to produce about 45 million tons of taconite pellets each year or about 2/3 of the nation's iron ore. Although substantial deposits of natural or "red" ore still exist, there is only occasional mining of this material.

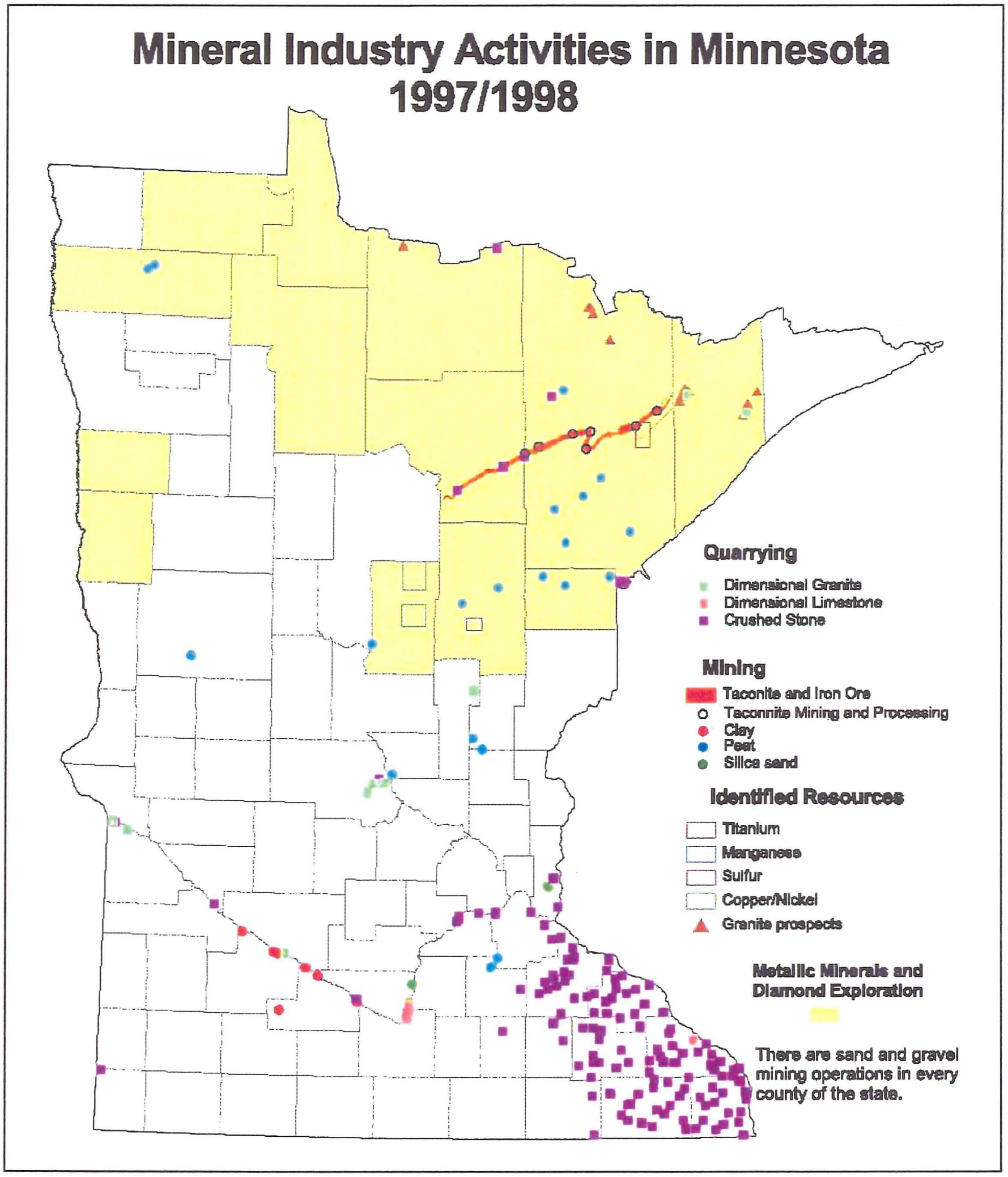
Historical natural iron ore mining created hundreds of mine pits, tailings basins and stockpiles. Most pits have filled with water and although there are sections of pit walls that are eroding, the general water quality in these abandoned pits is very good. Several cities use the pit water as their drinking water supply and some pits have been stocked with trout. Most old tailing areas have revegetated naturally. Erosion is still a problem on a few old surface overburden stockpiles. Surface material was stockpiled at the angle of repose and gullies have formed on those stockpiles. Most of the old surface stockpiles have revegetated naturally.

PEAT

Minnesota contains over seven million acres of peatlands, accounting for more than half of the known peat reserves in the lower 48 states. In 1999, a very wet year, about 270,000 cubic yards of peat were produced by the six largest mines in the state. This compares to 358,000 cubic yards in 1998 and 346,000 cubic yards in 1997. The largest operation mines peat from approximately 400 acres. The next five range in area from 95 acres to 285 acres. Currently there are ten operations under permit, with eight of those actively mining. Operations smaller than 40 acres in size are not regulated by the MN Department of Natural Resources (MDNR), but as of 1999, there were a total of 21 companies active in Minnesota.

Two types of peat are mined in Minnesota. These are sphagnum peat and reed-sedge peat, characterized as such by the types of vegetation from which the peat was formed. Minnesota peats are produced primarily for the horticultural market. An alternative market is being developed for use of peat as an absorbent

Figure 13.1



Mineral Industry Activities in Minnesota
1997/1998
Quarrying
Dimensional Granite
Dimensional Limestone
Crushed Stone
Mining
Taconite and Iron Ore
Taconite Mining and Processing
Clay
Peat
Silica sand
Identified Resources
Titanium
Manganese
Sulfur
Copper/Nickel
Granite prospects
Metallic Minerals and
Diamond Exploration
There are sand and gravel
mining operations in every
county of the state.

(such as in wastewater treatment systems). At one point in time, peat was considered as an alternative energy source, and several companies proposed peat-as-fuel operations. Although fuel peat could be successfully produced and burned in Minnesota, the high cost of transporting it and the low cost of western coal made these projects economically unattractive.

Industrial Minerals

SAND AND GRAVEL

Sand and gravel mining is an important industry in Minnesota that contributes significantly to the state economy. In 1998, Minnesota ranked fifth nationally in construction sand and gravel mining with production of 63.5 million short tons at a value of $291 million (USGS Mineral Industry Surveys, Minnesota). Sand and gravel has been or is currently being mined in each of the 87 counties in Minnesota.

Construction sand and gravel is used in concrete aggregates, concrete products, asphalt, road base, fill, snow and ice control, and other miscellaneous uses. In Minnesota, demand for construction aggregates has increased to approximately 10.5 tons per capita per annum (USGS Mineral Industry Surveys, Minnesota). However, calculations based on aggregate minerals taxes collected in 22 counties across Minnesota indicate that aggregate consumption may be as high as 15.3 tons per capita per annum. With a state population of 4.8 million, Minnesota annually consumes 50 million tons of aggregate.

Compared to other states, Minnesota has enjoyed a relative abundance of materials suitable for construction aggregates. In certain locations, however, quality aggregate is becoming a scarce commodity. The most widely available material is sand and gravel of fluvial or glacial origin. There are also abundant deposits of limestone and dolomite in the southern part of the state, and granitic bedrock in the central and northern parts of the state. These materials are quarried and crushed to make aggregate. In the southeastern portion of Minnesota, there are very few sand and gravel deposits and limestone is commonly crushed to produce aggregate. There are approximately 1500 quarries in the state, of which only 160 are presently active. Most of these were involved in the production of crushed stone aggregate (MDNR Occurrence Report, 1991). In the metropolitan areas, there is a maturing industry involving the recycling of concrete and asphalt waste streams.

Sand and gravel extraction is the most common form of mining in the state. Because sand and gravel is relatively inexpensive to mine but expensive to transport.(delivery distances over fifteen miles generally result in a doubling of the price), most operations are located close to where the resource will be used. According to data collected by MDNR in 1991, there are more than 4,000 gravel pits. Approximately 1,200 of these are active operations.

DIMENSION STONE

Both granite and carbonate rocks are being quarried for dimension stone in Minnesota. Typical dimension stone end products include: interior and exterior facing for building, paving and curbing stone, tile, counter tops, and monuments. Two dimension stone granite producers operate a total of nine quarries within the state. The quarries are located in the vicinity of St. Cloud, along the Minnesota Valley near Ortonville and Morton, and near Bellingham, Isle, and Babbitt. Most quarries occupy less than 40 acres.

Three carbonate dimension stone producers currently operate eight quarries within the state. The quarries are located near Mankato and Winona.

Quartzite is quarried near Jasper in southwestern Minnesota.

SILICA SAND

There are currently two silica sand producers located in the state. These operations produce uniform, fine sand from the Jordan and St. Peter sandstone for use in secondary oil recovery and for sand blasting.

CLAY

Clay mining has been conducted in Minnesota for many years. Most of the early (now inactive) mines produced clay for such things as brick, roof tiles, sewer and water pipes, and pottery. Today the industry is very small consisting of only seven mines located in the Minnesota River Valley in southwestern Minnesota. One of these mines has been in existence for about 100 years. Operations at this mine are conducted for two or three weeks each year to produce enough clay to manufacture a year's supply of brick at a local brickyard.

The remaining mines produce specialized clay called kaolin. All of this material is currently shipped out of state, to manufacturing plants where it is combined with limestone to produce portland cement. The kaolin mines are operated seasonally. Annual production is variable, being directly dependent on the number and size of construction projects, such as highway repair or new construction, and residential or commercial development activities that utilize substantial amounts of concrete products. Total annual production is on the order of 100,000 to 200,000 tons per year.

Kaolin refers to a group of hydrous aluminum silicates (clays), of which kaolinite is the predominant mineral. Kaolin is valued for a variety of physical properties including whiteness, inertness, and non-abrasiveness. Kaolin is used mainly as a filler in the manufacturing of a number of products including: adhesives, brick, cement, china and porcelain, floor and wall tiles, ink, paint, medicines and cosmetics, paper, and rubber.

Of the products listed above, the one most interesting to Minnesota is paper. Minnesota has a number of papermaking plants and all of the kaolin currently used in the process must be imported from Georgia, which is the major worldwide producer of high-grade kaolin. Unfortunately the deposits of kaolin, currently mined in Minnesota, are not of a high enough grade to be used for paper manufacturing. However, in order to take advantage of lower shipping costs that would be derived by having a local producer of kaolin, exploration for high-grade deposits is currently being conducted by a number of companies.

Impacts of Mining on Water Resources

For most current mining operations in Minnesota the water quality concerns are related to the control of suspended solids and the resulting turbidity and sedimentation in receiving waters. These are currently addressed by existing state programs. Site specific issues that may need to be addressed in the future could include the following: increased levels of total dissolved solids in wetlands and certain receiving waters; the discharge of water containing elevated concentrations of sulfate (which may impact the growth of wild rice and affect the rate of methyl mercury production), releases of nitrate from fertilized areas and blasting residuals, the discharge of low pH water and phosphorus from peat mining operations and the fate of reagents used in taconite processing. These issues can be addressed within the current regulatory programs.

The release of mercury to the environment from taconite operations and the production of methyl mercury in aquatic systems have become increasingly important since mercury levels in fish are elevated throughout most of northeastern Minnesota. Recently new analytical techniques have been developed that can detect mercury at concentrations over a thousand times lower than previous techniques. With these new techniques the contribution from mining areas can be quantified.

Potential nonferrous metal mining could pose serious threats to water quality, including the production of acid drainage and the release of trace metals and cyanide.

In 1987, a questionnaire was developed by Minnesota Pollution Control Agency (MPCA) and sent to local resource managers to help identify the potential scope of nonpoint source problems in the state. As a result of this questionnaire, over 1,000 miles of rivers and 15,000 acres of lakes were identified as threatened or impaired by activities related to mining. However, the questionnaire did not provide quantitative definitions of threatened or impaired, and the results are based on the subjective opinions of the people who responded. Impacts were not quantified nor was any distinction made between impacts that might be caused by existing or past mining practices. Although there may be significant nonpoint source impacts, mining is a much smaller contributor than other nonpoint sources such as land disposal, agriculture, and urban runoff. For each of these non-mining activities, the questionnaire identified over 5,000 river miles and one million acres of lakes that were threatened or impaired.

Current Activities

Minnesota's iron mines extract taconite (Fe_2O_3), an iron oxide found in the Mesabi iron formation. Very little iron sulfides or other problem minerals are present in this formation so as a result there has been little water quality impacts related to iron mining in Minnesota.

One iron mining company has stockpiled waste rock containing copper, nickel and iron sulfides, and this has resulted in water quality problems, including the production of acid drainage and the release of trace metals. As a result of research activities, which were partially funded with Section 319 money, several new best management practices were developed and applied at this facility. About 320 acres of mine waste have been capped or covered to reduce infiltration of water into the waste and five full scale wetland treatment systems have been built to remove metals from mine drainage. A lime treatment plant was also built and is currently discharging water that meets water quality standards. All the wetland systems remove metals but not all have been in compliance. In a study partially funded by Section 319 money, data was collected from two of the wetland systems to examine treatment lifetime. For one of the systems, it appears that the annual generation of removal sites is about equal to the annual metal input load, and theoretically, the wetland should last indefinitely.

Iron and peat mining are regulated primarily by the MDNR and the MPCA. Future non-ferrous mining will also be regulated by these two agencies. The MDNR through the Division of Lands and Minerals administers the Mineland Reclamation Act (Minn. Stat. §§ 93.44-93.51, rules adopted 1980) which requires that all facilities operating after 1980 obtain a permit to mine. This permit requires reclamation of the entire facility and requires the implementation of a variety of measures to stabilize all areas disturbed by mining, minimize the impact on water resources, and ensure that the land fulfills a future land use such as forestry, wildlife, or recreation activities. Included in the rules are requirements for lift heights and benches, sloping and revegetation. As a result of the program, over 6,600 acres of tailings basins, stockpiles and pit walls have been reclaimed since the program began in 1980. During the 1990's, research was conducted by the MDNR, the former US Bureau of Mines, and the Natural Resources Research Institute (NRRI) which identified the value of organic amendments for reclaiming coarse taconite tailings. Prior to this research, the mining companies had been unable to meet reclamation standards for percent vegetative cover. Although the overall impact from coarse taconite tailings areas is small, establishing a 90% vegetative cover will reduce both surface flow and infiltration, and as a result, reduce the overall load of dissolved constituents to the watershed from these areas.

A Permit to Mine Peat is required of all peat mining operations exceeding 40 acres in size and for those operations less than 40 acres where there is potential for significant environmental effects. The MDNR administers this permit under the authority of the Mineland Reclamation Act (Minn. Stat. §§ 93.44-93.51) and the rules adopted under that Act relating to the reclamation of mined peatlands (Minn. R. ch. 6131). The purposes of the permit are to control adverse environmental effects of peat mining and provide for reclamation and good mining practices.

The Division of Waters also regulates the mining industry through permits for appropriating surface and ground water and for working in the beds of public waters. Appropriation permits are issued to regulate the taking of water, usually for processing or for dewatering pits. Each application triggers an evaluation to identify and mitigate impacts associated with taking or discharging the water. For peat mining, appropriation includes drainage of the mine site. Drainage of less than 10,000 gallons per day and totaling no more than 1,000,000 gallons per year does not require a permit. All appropriation permits are normally issued in concert with MPCA's discharge permit.

Protected Waters permits are issued to regulate mining activities that alter the course, current or cross-section of a protected water basin or wetland. Provisions are included which require specific engineering design, construction, or reclamation to mitigate identified impacts.

The statute (Minn. Stat. ch. 103G) which provides for these regulations also requires that mined areas be reclaimed to restore the waters affected to their former condition, as much as practical. Watershed reclamation requirements are generally integrated with the Division of Lands and Minerals permit to mine. In addition, replacement of protected water basins and wetlands lost through mining has been required since the water law was passed in 1979. Prior to that time, numerous small lakes and wetlands were generally drained without replacement, and many streams were diverted, to accommodate iron mining. The Wetland Conservation Act, passed in 1991, required that all wetlands impacted by mining operations be replaced. Since northern Minnesota still contains over 90% of its pre-settlement wetlands and taconite mining impacts thousands of acres of land, wetland disturbance can not be avoided, and therefore, wetland replacement will be required at almost all of Minnesota's mining operations. The MDNR initiated studies to examine the feasibility of creating wetlands on lands disturbed by mining. In general, wetlands that developed naturally occurred in areas where there was a connection to the groundwater and tended to have low diversify and were dominated by cattails (Typha). The feasibility of reclaiming tailings areas to wetlands were investigated in several studies, and a cooperative research program is currently under way to examine the use of dredge material from Duluth as an organic substrate for creating wetlands at the EVTAC tailings basin. This research is supported by the US Environmental Protection Agency (USEPA), and the US Army Corps of Engineers, the Minnesota Department of Natural Resources and EVTAC mining. Since the wetland program began, about 1400 acres of wetlands have been restored, generally, in non-mining areas that had been previously drained.

MPCA is the lead agency for regulating ground water quality and surface water quality point and nonpoint source pollution throughout the state. This responsibility includes establishing and enforcing effluent limitations, water quality standards, and compliance monitoring. The MPCA administers the National Pollutant Discharge Elimination System (NPDES) and State Disposal System (SDS) permit program for mining facilities in Minnesota. Under this program, individual water quality permits are issued to all of the state's large iron and peat mines, as well as all clay mines. Individual NPDES/SDS permits are also required for any mine pit dewatering or process water surface discharges, such as occur at many crushed stone and construction sand and gravel mines and quarries. Those mine and quarry operations that do not have an individual NPDES/SDS permit are required to be covered by a general industrial NPDES/SDS storm water permit. This storm water permit requires the operations, which include the majority of Minnesota's construction sand and gravel mines, to develop pollution prevention plans and implement best management practices (BMPs) to control their storm water and to protect ground water quality.

Local units of government, such as counties, townships and cities, have the lead responsibility for mineland reclamation oversight at crushed stone, dimension stone, industrial sand, clay and construction sand and gravel mines and quarries throughout Minnesota. Specific reclamation requirements vary considerably depending on location. The MDNR and the MPCA at times have provided technical assistance to local units of government in this area. In 1998, a task force, comprised of eight legislators and 4 citizens, was established by the Minnesota legislature to examine issues concerning the need for and the use of aggregate resources. During the 1990's, MDNR worked with various gravel operations to reclaim areas with native plants. In a study at an Aggregate Resources mine on Grey Cloud Island, erosion was substantially reduced through the use of organic amendments and native species.

Mining companies generally control erosion by utilizing best management practices that control water flow and establish vegetation. Appendix B of this 2001 NSMPP contains a detailed description of the specific practices that can be used for general erosion and sediment control. These practices are described in the section "Description of Urban and Agricultural BMP's" of Appendix B.

Abandoned iron mine lands, which include all areas disturbed prior to the adoption of the Mineland Reclamation Rules 1980, are handled by the Iron Range Resources and Rehabilitation Board (IRRRB). Founded in 1978 and supported by a tax on taconite production, the IRRRB has completed about 250 projects. Some of these have been recreation-oriented such as the development of campgrounds and sliding hills, but others have focused on stabilizing old areas of mine waste. Over three million trees have been planted and about 1,000 acres of abandoned mine lands have been reclaimed.

Priority Needs

Although the general consensus is that the current iron mining and peat industries are well regulated and have minimal impacts on water quality, the results of the original 1987 MPCA questionnaire seem to suggest some problems may exist. In the 1994 report it was suggested that additional data be collected and specific problems be identified and quantified in order to clarify the results of the original questionnaire. This has not been done, but on an ongoing basis, the MPCA and the MDNR are addressing potential water quality concerns at permitted facilities. The IRRRB continues to reclaim problem areas as they are identified and will continue with their ongoing reclamation activities.

Additional research is needed to investigate the contribution of mining to mercury in northeastern Minnesota. Several studies have been initiated by the MDNR in cooperation with MPCA and NRRI to look at the release of mercury from tailings areas and the effectiveness of the current scrubber technology employed at the taconite production facilities. MPCA is also collecting data on methyl mercury release from peat lands; additional data will be needed to determine the effect of peat mining on mercury release. If tailings basins and/or peat mines are a significant source of mercury, it will be necessary to develop best management practices to control this release.

Aggregate operations are now regulated by the MPCA storm water runoff program. Four MDNR fact sheets on aggregate mining practices and requirements are available on the MDNR web site. The MDNR has also produced a general guidebook for the reclamation of sand and gravel pits. Although this book contains some management practices, it is not a comprehensive list of specific BMPs. The Aggregate Resources Task Force recommended that BMPs for aggregate mining be developed. Development of the BMPs will be coordinated by MDNR Division of Lands and Minerals with input from other state agencies, local governments, environmental groups, the aggregate industry and other interested parties. Compliance with the BMPs will be voluntary.

The focus of the current regulatory programs has been on the approximately 1200 pits that are active, not the estimated 2800 that are inactive or abandoned. These sites have not been reclaimed and typically do not revegetate naturally. Some of these sites become areas for illegal dumping, which can result in ground water pollution. In the 1994 report an initial survey to determine the magnitude of the problem and to target areas that may require additional work was proposed. While this still may be a worthwhile effort, efforts targeted at reported problem areas will be a more cost-effective approach to addressing any problems related to abandoned operations.

Non-ferrous mining has the largest potential to impact water resources but there is presently no mining of these minerals in the state. Reclamation rules have been developed to regulate the industry, which are performance based and do not contain specific best management practices. This approach allows each company flexibility in meeting permit standards based on site-specific conditions. Additional research is needed to describe the relationship between mine waste solid phase characteristics and resultant drainage quality and to develop a variety of methods that will limit the reactivity of non-ferrous mine waste. In 1994, several areas were suggested for additional research. The MDNR, through both the 319 and other funding programs, was able to address several of these areas. Laboratory dissolution tests were conducted on several different rock types to provide a basis for drainage quality prediction. Although these tests were initiated with short-term funding, additional funds will be required to continue dissolution testing, conduct more detailed mineralogical analyses, provide rigorous geochemical interpretation of the results, and extrapolate the results to other Minnesota rock types. Wetlands established over acid producing tailings were successful in preventing water quality problems and water covers reduced acid generation and metal release from both tailings and waste rock. The immediate disposal of sulfide bearing waste into a saturated environment should be adopted as a best management practice for reducing water quality problems at future non-ferrous operations. Additional mitigation techniques need to be developed, particularly for waste rock stockpiles. The MDNR has obtained some funding to begin a preliminary investigation of some promising technologies, but additional funding will be needed to initiate and monitor field trials and evaluate the results before these can be recommended as best management practices. Field trials may include adding alkaline material to the waste, covering stockpiles with organic material to prevent oxygen transport, creating a non-reactive surface on sulfide mineral surfaces, and changing the environment within a waste rock stockpile. Although wetland treatment of mine drainage can be considered a best management practice, there are still some issues related to lifetime that should be investigated. Work is continuing on quantifying and predicting the lifetime of wetland treatment systems, but the long-term success of several of the systems constructed at the Dunka Mine is very encouraging. Additional information is needed to determine the specific forms of the metals removed in the wetland and their long-term stability. The ability of organic supplements to increase treatment lifetime should also be investigated.

Chapter 13 Mining
Needs, Priorities and Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005 five-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Goal 1: To Develop and Test Best Management Practices for Non-Ferrous Mining

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Conduct field trials on techniques to prevent drainage problems from waste rock stockpiles:						USEPA, Environmental Cooperative Research	MDNR
a. alkaline addition	X	X	X	X	X		
b. the use of organic covers to limit oxygen transport	X	X	X	X	X		
c. creating non-reactive surfaces on sulfide minerals	X	X	X	X	X		
d. change the internal environment of the stockpile through the addition of organic material.	X	X	X	X	X		
2. Collect additional data, which could lead to the development of more efficient wetland treatment systems.						USEPA, Environmental Cooperative Research	MDNR
a. examine the form of the metals removed as a function of time	X	X	X	X	X		
b. examine the use of adding supplemental organic material to improve performance and extend lifetime.	X	X	X	X	X		

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
3. Conduct and interpret results of laboratory dissolution experiments on potential mine waste materials:						USEPA, Environ- mental Cooperative Research	MDNR
a. generate empirical data on solid phase characteristics and drainage quality for potential nonferrous mine waste rock types.	X	X	X	X	X		
b. describe relationships between mine waste solid phase characteristics and resultant drainage quality.	X	X	X	X	X		
c. assess the value of reported mineral dissolution rates in interpreting mine waste drainage quality.			X	X	X		
4. Interpret waste rock drainage quality in the field using existing laboratory and field data and analyses of leached rock phases:						USEPA, Environ- mental Cooperative Research	MDNR
a. determine relationships between solid phase characteristics, environmental variables, and drainage quality,	X	X	X	X	X		
b. assess the value of using reported mineral dissolution rates to interpret drainage quality from waste rock under environmental conditions.					X		

Goal 2: To Identify Best Management Practices for Sand and Gravel Operations

- To develop new management practices as needed
- To distribute the information to operators
- To perform follow-up audits to insure that the BMPs are being implemented

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Identify BMPs.	X					Minerals Coordinating Committee.	MDNR
2. Develop new BMPs.		X				Minerals Coordinating Committee.	MDNR
3. Prepare BMP guidance manual for operators.	X	X				Minerals Coordinating Committee.	MDNR
4. Hold a series of information sessions.		X				Minerals Coordinating Committee.	MDNR

Goal 3: To Develop Best Management Practice to Control Mercury Release from Mining Areas

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Investigate mercury release from taconite mining areas.	X	X				USEPA, Environmental Cooperative Research.	MPCA
2. Investigate mercury release from peat mining areas.		X	X			USEPA, Environmental Cooperative Research	MPCA
3. Develop BMPs to control mercury release.				X	X	USEPA, Environmental Cooperative Research.	MPCA

1994 NSMPP
Needs, Priorities and Milestones

The following Table provides the Goals and Action Steps included in the 1994 NSMPP. The Products, Services and Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps. Implementation of all action steps is contingent upon adequate funding and local involvement.

Goal 1: Document the Presence of the NPS Impacts Reported in the MPCA Questionnaire

- *To quantify any impacts*
- *To identify the source(s)*
- *To submit the results to the appropriate regulatory agency for corrective action*

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Contact resource managers, identify specific areas of concern.	Not Applicable	MPCA	Postponed until further reports of problems.
2. Conduct field surveys, collect water quality data.	Not Applicable	MPCA	Postponed until further reports of problems.
3. Based on field surveys, identify sources of nonpoint pollution.	Not Applicable	MPCA	Postponed until further reports of problems.
4. Report findings to appropriate regulatory authority.	Not Applicable	MPCA	Postponed until further reports of problems.

Goal 2: To Identify Best Management Practices For Sand And Gravel Operations

- *To develop new management practices as needed*
- *To distribute the information to operators*
- *To perform follow-up audits to insure that the BMPs are being implemented.*

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Identify BMPs.	Not Applicable	Local Government Units	Goal adopted by Aggregate Resources Task Force (2000).

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
2. Develop new BMPs.	Not Applicable	Local Government Units	Goal adopted by Aggregate Resources Task Force (2000).
3. Prepare BMP guidance manual for operators.	Not Applicable	Local Government Units	Goal adopted by Aggregate Resources Task Force (2000).
4. Hold a series of training sessions.	Not Applicable	Local Government Units	Goal adopted by Aggregate Resources Task Force (2000).
5. Follow-up audits.	Not Applicable	Local Government Units	Not included in Aggregate Resources Task Force recommendations.

Goal 3: To Conduct a Survey of Problems Associated with Abandoned Sand and Gravel Pits

- *To identify areas with potential problems*
- *To determine if significant water quality impacts are occurring*

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Conduct survey.	Not Applicable	Local Government Units	Postponed until further reports of problems.
2. Identify areas where significant water quality problems are occurring.	Not Applicable	Local Government Units	Postponed until further reports of problems.
3. Identify water quality impacts.	Not Applicable	Local Government Units	Postponed until further reports of problems.
4. Report impacts to appropriate regulatory agencies for corrective action.	Not Applicable	Local Government Units	Postponed until further reports of problems.

Goal 4: To Develop and Test Best Management Practice for Non-Ferrous Mining

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1.	Determine the effectiveness of methods to control acid and metal release from mine waste: a. reclaim tailings as wetlands in lined basins. b. add alkaline material to mine waste.	319, Environmental Cooperative research funding received for wetland portion.	MDNR	Final report submitted in 2000, recommended as a best management practice.
2.	Assess impacts of the underwater disposal of mine waste in lined basins: a. sulfide containing waste b. non-sulfide waste.	Iron Ore Cooperative Research, Environmental Cooperative Research.	MDNR	Final report prepared for in pit disposal of taconite tailings; Inland Steel's in pit disposal is currently being reviewed.
3.	Develop guidelines for the use of constructed wetlands to treat mine drainage.	319, Environmental Cooperative Research.	MDNR	Final report (Jan. 2001). One of the wetlands appears to be self-sustaining, providing long-term treatment.
4.	Refine procedures for the prediction of mine drainage quality.	Bureau of Land Management (Salt Lake Field Office).	MDNR	Ongoing study; several reports and technical papers prepared.

* Funding was not received until Fiscal Year 1998

Chapter 14 Land Treatment and Disposal

Strategy 14.1 Individual Sewage Treatment Systems

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Introduction

According to the 1990 census, twenty-seven percent or 492,000 of the housing units in Minnesota are served by individual sewage treatment systems (ISTS). These figures reflect a 22 percent increase in the number of housing units served by an ISTS between the 1980 and the 1990 census (a 13 percent increase in the total number of housing units occurred during this time period.). If this same rate of growth occurred from 1990 to 2000, approximately 600,000 homes would currently be served by an ISTS. The 2000 census no longer asks the method of sewage treatment, so the estimate of 600,000 systems cannot be verified by the new census data. A better estimate of current systems will be available by March 1, 2001, when local units of government will provide an estimate of the number of systems within their jurisdictions.

An informal survey of county planning and zoning administrators done by the Minnesota Pollution Control Agency (MPCA) in the 1980's indicated that 70%, or approximately 344,000, housing units have systems that fail to provide basic sewage treatment and disposal. Recent informal estimates have reduced that amount to approximately 60%, a 10% decrease. As stated above a more accurate estimate of nonconforming systems will be available on March 1, 2001.

The large numbers of housing units that do not have adequate sewage treatment are due, in part, to:

- no or limited past regulation of ISTS at the local level;
- local political pressure preventing proper enforcement of regulations;
- lack of system maintenance and management; and
- minimal training of ISTS professionals.

It should be noted that local units of government were not required to adopt and enforce a county-wide ISTS ordinance until 1999 and a statewide ISTS licensing program began in 1996. Local units have been required to adopt an ISTS ordinance in shoreland areas for many years, with some having an effective program and some not.

It should also be understood that nonconforming system criteria is vastly different for new systems currently being construction versus existing systems. Nonconforming status for systems under construction are those systems that do not meet all code requirements such as the number of inspection pipes, cleanliness of distribution rock, etc. Nonconforming status for existing systems are those systems that do not provide basic treatment and disposal. More specifically Minn. R. ch. 7080 (Individual Sewage Treatment System Program) defines nonconforming existing systems as:

- *Systems which fail to protect ground water, which includes: seepage pits, cesspools, drywells, leaching pits, other pits, tanks that obviously leaks below the designated operating depth, or systems with less than a 3-foot (2 foot in some areas) vertical separation distance from the system bottom to the seasonally high watertable or bedrock.*

- *Systems which pose an imminent threat to public health or safety. These situations include ground surface or surface water discharges and sewage backups.*

- *Systems which fail to perform as designed, or systems which are not monitored or failure to report monitoring (for performance and non-standard systems).*

Important Geographic Areas

The majority of housing units served by ISTS are located in rural agricultural or remote areas, small cities, rural subdivisions and unincorporated areas of the state. In addition, numerous ISTS are used for homes and cabins on lakeshore lots, with a few located on urban lots within sewered cities.

Ground water contamination is a concern from cesspools, seepage pits and drywells. Surface water could also be impacted from the discharge of contaminated groundwater. Direct surface water contamination is a concern from systems discharging to agricultural drain tile, road ditches, or to the ground surface. These concerns are magnified in areas of higher population density.

In addition to the above general areas, two areas of the state are of special concern. These areas are lakeshore areas and the Minnesota River Basin. In many parts of the state local water planners have identified nonconforming ISTS as a priority issue in regards to lake water quality management. As an active response, many counties are undertaking surveys of ISTS in lakeshore areas and have enacted programs to bring systems into compliance. In the Minnesota River basin, it is estimated that 80% of systems are nonconforming, with approximately 45% or more discharging to draintile, road ditches or to the ground surface. This (along with feedlot discharges) has resulted in high levels of fecal organisms in the river.

Programs, Authorities and Best Management Practices for Implementing Individual Sewage Treatment System Controls

HISTORY OF PROGRAM

ISTS regulation started in Minnesota in the 1960's with development of an ISTS code by the Minnesota Department of Health. This code was not widely adopted or administered at the local level. In the mid-1970's the Shoreland Management Act was passed that required proper sewage treatment from all dwellings in shorelands. In response to this Act, the University of Minnesota started a training program for the ISTS contractors and local unit of government inspectors on the proper siting, design, construction, inspection and maintenance of ISTS. The Minnesota Pollution Control Agency then developed a voluntary certification program for ISTS professionals and established state standards (Minn. Rules ch. 7080) in 1978. Chapter 7080 was mandatory in shoreland areas but not mandatory outside of shoreland areas. The shoreland regulations were to be administered by local governmental units (LGUs). Some LGUs adopted chapter 7080 in shorelands but few provided adequate administration and enforcement. Some also adopted the standards outside of shoreland areas, but few had adequate administration and enforcement. Therefore, in a broad sense, ISTS regulation was spotty with weak administration and enforcement.

The first statewide ISTS legislation was passed in 1994 (Minnesota Laws chapter 617), codified as Minn. Stat. § 115.55. This statue contained rule requirements, inspection requirements and local ordinance requirements. The statute also contained requirements for an ISTS licensing program (Minn. Stat. § 115.56).

These statutes were amended six times from 1995 through 1999; therefore, the state ISTS program requirements have been under continual change since 1994. Below are some of the major provisions of these statutes.

Ordinances

The statute requires LGUs to adopt and enforce ISTS ordinances. The deadline for adoption was January 1, 2000. The statute requires ordinances to comply with Minn. R. ch. 7080; however, LGUs are allowed to adopt both more and less restrictive standards. The less restrictive standards are only allowed under limited conditions and must still adequately protect the public health and the environment.

Inspection

All systems under construction must be inspected. Systems must be in compliance before adding a bedroom to a dwelling. In shoreland areas, systems must be in compliance before any type of permit is issued for the property. Upon property transfer in all areas, a disclosure of the status of the system must be provided between the buyer and seller. Many LGUs and lending institutions require a compliant system (or escrow funds) before a property is sold.

Upgrade requirements

If a system is found to be an imminent threat to the public health and the environment, the statute requires an upgrade within 10 months (maximum). If a system is found to be impacting groundwater, the upgrade requirement is set by the local ordinance.

Licensing

Per statutory requirements, the MPCA has adopted rules to license ISTS professionals. The agency licenses designers, installers, inspectors and pumpers. Exemptions with qualifiers exist for state or local government employees; however, Chapter 7080 requires training, exam and experience requirements. License exemptions are also provided for individuals doing work on their own property and individuals performing work under a licensed person. The state licensing program includes requirements for enforcement, training, examination, experience, proof of general liability insurance, a corporate surety bond of at least $10,000 and an annual fee of $100/license category.

ROLES OF EACH UNIT OF GOVERNMENT

Local Governmental Units

Local governmental units are responsible to adopt and enforce an ISTS ordinance. The ordinance may be either more or less restrictive than chapter 7080. The LGU is required to issue permits and inspect for all new construction or replacement of systems and when issuing a permit for a bedroom addition.

Minnesota Department of Health (MDH)

The MDH reviews and approves ISTS for establishments that require a MDH license to operate (e.g., restaurants, resorts, mobile home parks, etc.).

MN Pollution Control Agency (MPCA)

The MPCA makes revisions and provides interpretation to chapter 7080; administers the statewide ISTS licensing and registration program; issues permits for ISTS with an average design flow of 10,000 gpd or greater; assists the University of Minnesota (U of M) in training ISTS professionals; reviews local ordinances to determine if the adequately protect the public health and the environment; and reviews annual reports submitted by the LGU and provides technical and administrative assistance to LGUs.

U of M Extension Service

The U of M conducts research on new ISTS technologies, provides statewide training workshops for ISTS professionals, provides education to homeowners on ISTS operation and maintenance, provides education to local decision-makers of small communities with nonconforming ISTS.

BEST MANAGEMENT PRACTICES (BMP)

The following general list of Best Management Practices (BMPs) is commonly used to reduce nonpoint source pollution from individual sewage treatment systems (ISTS). This list is not comprehensive and does not suggest additional BMPs would have no benefit.

Please refer to the Part I Agricultural BMPs, Part II Erosion and Sediment Control BMPs and Part III Other Cultural and Structural BMPs in Appendix B of this 2001 NSMPP, Best Management Practices for definitions of the following BMPs.

Part I Agricultural Best Management Practices (BMP)

12. Fencing

Part II Erosion and Sediment Control Best Management Practices (BMPs)

1. Vegetation Establishment
12. Silt Fence
34. Topsoiling

Part III: Other Cultural And Structural Best Management Practices

56. Correct Use of Soils for Septic Systems
64. Proper Installation of Septic Tanks and Drainfields
66. Routine Maintenance of Septic Tank Systems

Chapter 14.1 Individual Sewage Treatment Systems (ISTS) Needs, Priorities and Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) five-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Goal 1: To Have all Counties Adopt a Countywide (vs. Shoreland Only) ISTS Ordinance (Unless all Cities or Townships Within That County Have Adopted an Ordinance).

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Meet with counties that have not adopted an ISTS ordinance.			X			State	MPCA
2. Take any necessary actions to bring about adoption.				X		State	MPCA
3. State standards adopted statewide.					X	State	MPCA

Goal 2: To Have all LGUs Effectively Administering Their ISTS Ordinance.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency
1. Secure funding for LGU to properly administer their ISTS ordinance.			X			State	MPCA
2. Distribute funding per item #2 above.				X		State	MPCA
3. Increase technical/practical training for ISTS inspectors.				X		State	MPCA, U of M.
4. Conduct regular audits of LGU programs.				X		State	MPCA

Goal 3: To Effectively Enforce the ISTS Licensing Program.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency
1. Develop and design an effective ISTS licensing enforcement program.			X			State	MPCA
2. Build effective program with increased funds.				X		State	MPCA
3. Implement increased program.					X	State	MPCA

Goal 4: To Increase the Knowledge and Skill Levels of ISTS Professionals

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency
1. Identify deficient areas per professional discipline.		X				319	U of M
2. Modify program to overcome deficiencies.			X			319	U of M
3. Implement modified program (compliance may be different for newly-registered individuals vs. existing registered individuals).				X	X	319	U of M

Goal 5: Provide Technical and Financial Assistance to Areas with Inadequate Sewage Treatment (Small Communities, Rural Subdivisions, Lakeshore Areas, Unincorporated Communities, etc.)

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Request funding for wastewater treatment planning.		X				319 (for non-NPDES solutions), State.	MPCA
2. Request funding for education of local leaders.		X				319 (for non-NPDES solutions), State.	MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
3. Request funding for technical assistance, organizational assistance, permitting, rule revision to accommodate moderate sized flows, financing assistance, enforcement of non-compliance.		X				319 (for non-NPDES solutions), State.	U of M and MPCA.
4. Request funding for construction upgrades of failing systems.		X				319 (for non-NPDES solutions), State.	MPCA
5. Implement expanded program.			X	X	X	319 (for non-NPDES solutions), State.	MPCA

Goal 6: Provide Education to Local Decision-makers, the Public and Special Groups.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Increase homeowner education on the importance of proper ISTS maintenance.		X				U of M, 319.	U of M
2. Develop and implement presentations to local decision makers on the importance of conforming systems.			X			U of M, 319.	U of M
3. Provide presentations for special groups.				X	X	U of M, 319.	U of M

Goal 7: Increase Regulatory Control of Operation and Maintenance of ISTS

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency
1. Develop regulatory methods to ensure proper system maintenance.		X				319, State.	MPCA
2. Provide funding for administration of local maintenance programs.			X			319, State.	MPCA
3. Encourage local units of government to adopt maintenance requirements in local ordinances.				X		319, State.	MPCA

Goal 8: Research New ISTS Technologies in Minnesota, Including Demonstration Projects and Information Dissemination.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency
1 Seek funding for research/ demonstration efforts.		X				319	U of M
2. Develop work plans.		X				319	U of M
3. Research/Reporting.			X	X	X	319	U of M
4. Integrate results into rule revisions and training programs.			X	X	X	319	U of M, MPCA

Goal 9: Revise State ISTS Rules per Needed Updates, Simplification and Flexibility

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Canvass stakeholders to determine if rule revision is necessary and desired.		X				State	MPCA, U of M.
2. Revise Chapter 7080, if needed.			X			State	MPCA
3. Administrative procedures for rule adoption.				X		State	MPCA
4. Rule effective.					X	State	MPCA

1994 NSMPP
Needs, Priorities and Milestones

The following Table provides the Goals and Action Steps included in the 1994 NSMPP. The Products, Services and Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps. Implementation of all action steps is contingent upon adequate funding and local involvement

Goal 1: Implement statewide standards (Minn. Rules Ch. 7080) legislation was enacted that requires that Minn. Rules Ch. 7080 be the minimum statewide standard for all local ordinances to provide consistent standards for the design, location, installation and maintenance of ISTS.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Complete ch. 7080 revisions.	General Fund	MPCA	Two Revisions since 1994 – January 1996 & October 1999.
2. Implementation activities			
a) Develop sample ordinances;	General Fund	MPCA	All but five counties have an ISTS ordinance.
b) Develop local government guidance documents;	General Fund	MPCA	Completed – both revisions
c) Conduct local government training;	General Fund	MPCA	Completed – both revisions.
3. Local governments implement standards.	General Fund	Local Governmental Units.	Counties, cities and townships are implementing – some need to improve.

Goal 2: Implement mandatory certification program legislation was enacted requiring a mandatory certification program for ISTS professionals..

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Implementation activities			
a) Enact new licensing rules;	General Fund	MPCA	Completed – June 1994.
b) Revise current workshops;	Workshop fees	MPCA, U of M.	Completed – August 1995.
c) Expand education and certification programs;	Workshop fees	MPCA, U of M.	Completed – August 1995.
d) License all professionals.	Licensing fees	MPCA	Completed – April 1, 1996.

Goal 3: Statewide Enforcement. Current legislation should be changed for a statewide enforcement program to provide a mechanism for bringing all ISTS in the state up to code. ISTS should, at a minimum, be inspected whenever is a property transfer, before a building permit is issued, and if there is a complaint or nuisance condition. Nonconforming ISTS would then be upgraded or replaced within a specified period in order to protect although the new legislation makes progress public health and the environment. in these areas, further strengthening is necessary.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Garner support for legislation.	General Fund	MPCA	Not Applicable
2. Introduce legislation.	General Fund	MPCA	Legislation passed requiring 10-month upgrade for public health threats. Local ordinances are required to have upgrade requirements for systems failing to the groundwater.

Goal 4: Maintenance program. Maintenance guidance should be provided to municipalities for the oversight of ISTS within their jurisdictions. Municipalities should be required to track system maintenance by using a reporting system, or the municipalities could contract to have the systems maintained and bill the residents for the service.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Develop municipal guidance documents.	U of M	U of M	Completed. Metropolitan Commission developed software for tracking system maintenance. Available to all LGUs.
2. Provide training.	U of M	U of M	Not Complete – some training has occurred.

Goal 5: Continuation of Current Funding Program. The legislature should continue to support the current ISTS grant program until a revised program, using environmental priorities, can replace it.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Seek additional funding for current program.	General Fund	MPCA	Current funding has not changed. However, a one-time $1,000,000 extra appropriation was awarded in 1997.
2. Revise program to include environmental priorities.	General Fund	MPCA	Program not yet revised based on environmental priorities – awaiting coordination with other programs. However, program now includes funding for systems with less than 10,000 gpd with a surface discharge.

Goal 6: Education. For many of the recommended solutions to be effective, education on the benefits and importance of conforming ISTS is necessary. Three primary target groups must be reached:

a) *Decision-Makers - county commissioners, township boards, city councils and other local government decision-makers;*
b) *The general public in unsewered areas; and*
c) *Special Groups*

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Seek funding for educational efforts.	U of M, General Fund.	MPCA, U of M.	With cooperation with the MPCA, a new position was created at U of M Extension Service for ISTS homeowner education.
2. Develop public relations plan.	U of M, General Fund.	MPCA	Completed.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
3. Implement education and public relations plans.	U of M, General Fund.	U of M, MPCA.	Workshops have been conducted statewide. Revisions to, and development of, new informational materials has been completed. Conducted of 3 national satellite conferences.

Goal 7: Research/Funding. Research is needed and would include investigation of alternative and possibly lower cost designs, small collector systems, studies on siting, design and proper management of ISTSs in Minnesota's soils and climatic conditions.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Seek funding for research efforts.	LCMR	MPCA, U of M.	Three cycles of funding awarded – LCMR.
2. Develop work plans.	LCMR	U of M	Completed.
3. Integrate results into training programs.	U of M	U of M	Completed. Additional changes will be made as new information is received.

Goal 8: Planning Assistance. Planning assistance is needed for municipalities. Determining whether ISTS are the best environmental and most cost-effective solution for wastewater treatment is a difficult problem for small municipalities.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Seek funding for planning efforts.	319	MPCA	Not complete, legislative report (due July 2000) will request funding for wastewater planning function.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
2. Develop comprehensive guidance materials.	319	MPCA	Not complete, funding was not available. Tasks now fund in new Goal 5 for 2001 – 2005.
3. Hold training workshops.	U of M	U of M, MPCA.	Some training has been provided for wastewater treatment decision-making by the new U of M Extension Service personnel.

Goal 9: Technical Approval Methodology. Methodology to facilitate the use of promising innovative alternative systems should be developed. Revisions to Minn. Rule chapter 7080 should include a performance standard for the level of treatment required from an ISTS. Systems that consistently meet these performance standards would then be allowed under the code.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Seek funding for denitrification systems.	LCMR	MPCA, U of M.	LCMR funding acquired
2. Seek funding for mound system alternative.	FEMA, LCMR	MPCA, U of M.	LCMR funding acquired
3. Construct alternative systems.	LCMR	U of M	Constructed 1995+
4. Monitor performance.	LCMR		Monitored since 1995
5. Report findings.	LCMR	U of M	Many research papers were written and presented at national symposiums. Results were presented to ISTS professionals at U of M training workshops.

Goal 10: Financial Assistance. Efforts To fund ISTS should first be concentrated on municipalities. The greatest environmental benefit will be derived from concentrating limited funding sources on problem areas. Funding for individuals also needs to be increased to resolve this approximately $1.7 billion problem.

	1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1.	Seek additional funding for municipalities.	None	MPCA	No additional funding acquired
2.	Expand existing individual funding sources.	None	MPCA	Not expanded.
3.	Implement program revisions.	None	MPCA	Not revised.

Chapter 14 Land Treatment and Disposal

Strategy 14.2 Land Application/Treatment of Biosolids, Industrial By-Products, and Commercial Wastes

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Introduction

Land application/treatment of many types of wastes occurs in Minnesota. The primary categories of wastes that are land applied include the following:

- **Animal wastes** (manures, paunch manure, and animal bedding).
- **Biosolids** (sewage sludge) generated from the treatment of wastewater.
- **Septage** generated by individual sewage treatment systems and large drainfields.
- **Industrial By-Products:**
  - Industrial wastewater and pretreatment sludges mainly from the processing of foods and beverages (dairy, vegetables, beer, meat, and poultry);
  - Dairy processing wastes (rinse/wash waters, lactose, antibiotic milk, diatomaceous earth, whey, etc.);
  - Ethanol processing wastes (thin stillage and process condensate);
  - Corn silage / silage leachate from the processing of sweet corn;
  - Sugar beet processing wastes (spoiled beets, beet pulp, tare wastes, lime, etc.);
  - Ashes from the generation of power. These consist of wood and mixed ashes (mixtures can include wood, coal, paper mill sludge, railroad tie chips, and manufacturing residues). There is some coal ash land applied in mixed ashes, as a liming material for biosolids, and on an experimental basis;
  - By-product limes that are the result of treating drinking water and industrial process water, acetylene production, and refining sugar;
  - Pulp and paper mill sludges mainly on a pilot project basis.
- **Commercial wastes** generated from a variety of small businesses such as animal slaughtering operations (wash waters), vehicle repair and maintenance facilities (sand and flammable trap wastes), restaurants (grease trap wastes), and others not yet identified.

- **Irrigated industrial and municipal effluents.**
- **Landfill leachate.**
- **Municipal compost.**
- **Petroleum contaminated soils.**

These materials have been land applied in Minnesota for many years with varying levels of regulation.

Agricultural land is the primary destination for these wastes with farmers being the primary end users because of their value as soil amendments (with some exceptions such as petroleum contaminated soil). There has also been some land application done on mine lands for reclamation and on forestlands in the northeastern part of the state.

This section will describe the regulatory programs for land application/treatment of biosolids, industrial by-products, and commercial wastes in Minnesota and identify some program needs.

Biosolids Program Description

In 1982 the MN Pollution Control Agency (MPCA) adopted rules for the management of municipal sewage sludge land applied in Minnesota. This rule was updated in 1997 to integrate federal requirements that came into effect in 1993 (40 CFR part 503). Minnesota Rules Chapter 7041 "Sewage Sludge Management Rules" regulate biosolids (sewage sludge which meets the rule's quality requirements) generated during the processing of wastewater from municipalities, sanitary districts, and some private facilities.

There are approximately 200 facilities that are regulated by this rule. The quantity of biosolids land applied each year is approximately 50,000 dry tons per year.

The rule details requirements for biosolids quality (pathogen reduction, vector attraction reduction, and metal concentration limits), management, analysis, and record keeping. It also details site suitability criteria and the site approval procedure. The biosolids program is part of the overall National Pollutant Discharge Elimination Program (NPDES). As pointed out in Chapter 2, Table 3 of the NSMPP, activities regulated by the NPDES permit program are generally not fundable by Section 319 grants. However, biosolids is a nonpoint source concern and may be fundable through other sources.

Industrial By-Products (IBPs) Program Description

In 1996 the MPCA utilized 319 funding to begin development of a program for land application of "industrial sludges." The first part of this project was to define what industrial sludge is in an attempt to focus the program efforts. This term turned out to be so broad and poorly defined that a new term was developed to better describe the industrial wastes being land applied in the state. These solid wastes are now termed "Industrial By-Products" (IBPs) and cover a broad range of industrial wastes that are land applied (see introduction of this section).

An inventory of the main categories of IBPs land applied was conducted. Once this inventory was completed it was clear that the program developed would need to be flexible enough to cover a variety of wastes with variable characteristics, beneficial properties, and contaminants of concern. The quantities of each IBP land applied are documented in some cases; however, this information needs to be developed further.

At the point in time that the need for regulating this activity was determined, it was felt that development of rules would be difficult, therefore, a permitting program was established and put into place in the fall of 1998. A complete description of the permitting program can be found on the following web site: http://www.pca.state.mn.us/water/landapp.html

The permitting program is based on a tiered regulatory approach, with less regulatory oversight for land applied IBPs that have a low risk of impacting the environment and more regulatory oversight for those IBPs that have a higher risk of impacting the environment. The tiered regulatory approach was established so that all land application of IBPs is done in an environmentally responsible manner.

Permits for land application of industrial by-products are not part of the NPDES program, however, in cases where industries have permitted surface water discharges, requirements for land application are included in their NPDES permit. This saves the permittee from having more than one permit. When a permittee does not have an NPDES permit, then either a state disposal system or solid waste permit is issued.

Criteria for evaluating relative risk levels were developed as part of the program and are used as a basis for determining permit requirements for specific IBPs. At the time that the criteria were established, it was understood that additional work would be needed to make the risk criteria more comprehensive. This remains a key to the permitting program and has not been completed.

Commercial Wastes

The wastes that are referred to as commercial wastes in this proposal are those wastes that are generated from activities that involve the use of holding tanks or pretreatment tanks for wastewater flows. The MPCA does not have an extensive inventory of commercial wastes which are land applied, however, there are a few waste types which are being land applied that the MPCA is aware of.

Grease trap wastes from restaurants are typically land applied by septage haulers on the same areas that receive septage. It is not believed that this waste is harmful to soils, however, appropriate application rates have not been established and odors can be a problem when oils and greases become rancid. The National Waste Haulers Association has conducted a study on land application of restaurant grease trap wastes and found that the soil does break the material down and the waste has some beneficial properties.

Sand traps and flammable waste trap wastes from vehicle and equipment repair/maintenance shops, and car washes is land applied; however, the quantity is not known at this time. A survey of some septage haulers indicates that it is land applied in some areas of the state, because of a lack of other feasible options for management of the waste stream. In some cases the wastes can be separated and the solids landfilled, and liquids taken to a wastewater treatment plant. This is not always a practical option for management of this waste stream.

Because, there has been only limited testing of this waste stream, the MPCA is unsure of the environmental safety of using land application as a management option. The MPCA has applied for grants to study this waste and determine whether land treatment is a feasible option; however, no funding has been made available at this point in time.

Wash waters from small businesses that butcher animals is also a waste which is land applied. It is believed that in most cases the waste consists mainly of fats and wash waters that contain some blood (assuming most blood is rendered), however, an extensive survey has not been completed.

The MPCA is unsure of the quantities of commercial waste land applied or whether there are any significant environmental concerns associated with land application. There are only limited analysis results to review. These wastes are problematic to regulate because the quantity produced by each facility is small, yet it is believed that the total quantity statewide may be large.

An issue related to commercial waste land application is the Underground Injection Control (UIC) rules. These rules have requirements for wastes being discharged below the soil surface, however, do not address residuals associated with these waste streams. It is important to deal with the entire waste problems at facilities with UIC's and assist by determining disposal or treatment options for the wastes generated. Unless this is done, there may be confusion in the future for those complying with the UIC rules.

Biosolids and Industrial By-Product (IBP) Program Priorities/Issues

EVALUATE EFFECTIVENESS OF CURRENT LAND APPLICATION PROGRAMS IN PREVENTING NONPOINT SOURCE POLLUTION

Because preventing nutrients such as phosphorus, nitrogen, and other contaminants from negatively impacting land use, soil productivity, or surface and ground waters is a major goal of land application/treatment programs, effective controls are needed. There has been limited field evaluation of existing land application programs to determine the effectiveness of the required best management practices in preventing nonpoint source pollution.

Examples of best management practices required by land application rules and permits are maintaining separation distances to surface water features (including tile inlets) and wells, requiring slope restrictions on application sites, limits on application rates and soil phosphorus levels, and storage requirements. There is a need to determine if these best management practices are working or whether changes are needed based on new information.

There is also a need to make sure that the programs that are in place are sustainable for the environment over time. Long term monitoring of the quality of surface water, ground water, and air are being done, however, this data collected has not been related directly to land application programs. There is limited work in the area of monitoring soil quality over time and a lack of good information on background or ambient levels of contaminants in the soil. This is important information for establishing standards.

Related to this is the need to improve the data management system developed for biosolids and IBP compliance tracking. The current system developed is not yet working as needed to track compliance. Compliance is now determined by limited computer screening of data and detailed review of annual reports.

There have been limited discussions on using Geographic Information Systems (GIS) to track land application activities on a watershed basis. It is felt that GIS systems are especially well suited to land application activities and could greatly improve the type of information available for land application activities.

COORDINATE EFFORTS TO CONTROL NONPOINT SOURCE POLLUTION

There is a need for the MPCA to coordinate efforts between programs that are establishing standards for nonpoint source pollution and land application programs that are in place. Development of an overall strategy that addresses control of nonpoint source pollution and determines the relative contribution of different activities to nonpoint source pollution would assist the MPCA in its efforts to prioritize program needs.

The Environmental Outcomes Division of the MPCA is charged with identifying and monitoring environmental trends and areas of concern to help establish overall MPCA priorities. There have been some discussions on the need for a more focussed effort at evaluating the effectiveness of land application programs in preventing nonpoint source pollution and protecting soils, however, specific monitoring efforts have not taken place.

Work within the Environmental Outcomes Division is needed to assist in communicating issues and tracking environmental concerns related to land application.

There is increasing concern over the role that nonpoint source pollution plays in contributing to hypoxia problems occurring in the Gulf of Mexico. It is unclear how the land application of waste may be contributing to this problem. It is also possible that the best management practices already in place for biosolids and IBP land application could be helpful for establishing effective controls for nonpoint source pollution.

There have also been recent discussions of establishing Total Maximum Daily Loads (TMDL's) for nonpoint sources of pollution, however, a coordinated effort by the MPCA between programs has not occurred. This is a major concern for the land application programs and should be addressed as early as possible in the process for establishing TMDLs.

DEVELOP COMPREHENSIVE RISK CRITERIA OR RISK EVALUATION PROCEDURE FOR LAND APPLICATION OF WASTES

During the establishment of the risk criteria used for the IBP land application-permitting program, interim risk criteria were established. These criteria relied heavily on standards developed for land application of biosolids. It was understood at that time that a more comprehensive strategy for establishing standards and estimating risks to the environment would be needed. Decisions to allow land application to take place must be based on sound and scientifically established risk criteria.

IMPROVE NUTRIENT MANAGEMENT

Understanding nutrient management remains a key to good biosolids and IBP management. Most land applied wastes have some beneficial value as soil amendments which is often the basis for application rates. It is important to relay the nutrient and soil amendment value of the wastes to farmers, so that credits are taken for the nitrogen, phosphorus, micronutrients, etc. supplied. Unless this is done, the end user may apply fertilizer in addition to the biosolids or IBPs that have already been applied.

Biosolids and many IBP application rates are based on the agronomic needs of a crop for nitrogen. In many wastes this can result in application rates for phosphorus over the crop's agronomic need. In cases where wastes are repeatedly applied to the same sites, this can result in a build up of phosphorus in the soil. The factors that make this a possible environmental concern are very complicated.

For land application programs, this issue has been simplified by placing a limit on soil test phosphorus levels, however the effectiveness of this limit on preventing problems in surface waters has not been evaluated. More work is needed to determine appropriate management requirements and limits for phosphorus.

DEVELOPMENT AND UPDATING OF TYPE IV CERTIFICATION TRAINING AND OUTREACH MATERIALS

Mandatory certification of operators managing land application of biosolids and IBPs is a key program element. Courses are offered yearly for certification and continuing education credits. This training program is essential for relaying information on management and rule requirements to the people land applying these materials and for maintaining good communication with operators and inspectors.

Prevention of problems has been the focus of the land application training programs. Training of operators and inspectors has taken place for many years as required by rule. With the addition of the IBP permitting program additional training was developed specifically for industries that land apply. Based on comments from course attendees and compliance issues, the following training needs have been identified:

- There is a need for a Type IV inspector course (at present inspectors and operators receive identical classroom training).
- There is an interest in having courses that focus on specific waste types (examples: waste limes, mixed ashes, food-processing wastes) in the areas of the state they are concentrated.
- The current IBP course needs to be improved and a manual developed.
- Fact sheets or information booklets are needed that provide concise information about the biosolids rules and IBP permitting program for operators, local units of government, and the public.

Land application is a very complex management system. Operators must have a basic understanding of agricultural practices in addition to understanding permit requirements. They are required by rule to be Type IV certified operators. These courses must be updated as needed and adapted to meet the needs of operators and MPCA inspectors.

Education of end users of biosolids and industrial by-products is also needed. Informational materials need to be developed that explain the rules and permitting programs in easy to understand language.

CONTINUE DEVELOPMENT OF PERMITTING PROGRAM FOR LAND APPLICATION OF INDUSTRIAL BY-PRODUCTS (IBPs)

The permitting program established for land application of IBPs needs further development. Questions have arisen which cannot be answered using the permitting criteria which have been established. At this time all IBPs that are land applied are required to obtain permits from the MPCA. A framework exists to write these permits, however, there are specific contaminants of concern which do not established limits. This may require changes be made to the current permitting criteria, so that they are more comprehensive. This need is addressed in Goal 3 of the Needs, Priorities and Milestones table toward the back of this strategy.

At this time there is a need to continue the development of specific permit requirements for by-product limes, mixed ashes, and some other IBPs that are being land applied. Currently, there is a Legislative Commission on Minnesota Resources (LCMR) project that will be completed in 2001 which is evaluating the environmental impacts of mixed ash on crops and soils. It is hoped that the information from this study will assist in development of the permit requirements for mixed ashes.

There is also a need to better quantify the various IBPs that are being land applied. This will occur as permitting takes place that requires annual reporting on the quantity of IBPs land applied each year. This information will assist in determining the relative impacts of land application of IBPs on nonpoint source pollution.

There have also been some discussions on whether there is a need to incorporate the permitting requirements into the solid waste rules. There is some interest in doing this in order to streamline processes and make requirements clear. This needs to be looked into further.

Commercial Wastes Program Needs

EVALUATE THE REGULATORY NEEDS FOR LAND APPLICATION OF COMMERCIAL WASTES

Information is needed to identify and quantify the types of commercial wastes that are being land applied. Once this information is obtained, an assessment of the relative impact these practices may be having on the environment can be conducted. For the commercial wastes that we have knowledge about these specific items are needed:

- A determination of best management practices needed for land application of grease trap wastes from restaurants.
- A thorough characterization of sand trap/flammable waste traps and a determination of whether land treatment of this waste is protective of the environment and an appropriate management option.
- A determination of how to regulate land application of commercial wastes.
- A determination of the impacts the underground injection control (UIC) rules may have on land application of commercial wastes.

BEST MANAGEMENT PRACTICES (BMPs)

The BMPs identified below are commonly used to reduce nonpoint source pollution from land application of biosolids and industrial by-products. This list is not comprehensive and does not suggest additional BMPs would have no benefit but, is provided to highlight the more common BMPs.

Please refer to the "Part I Agricultural Best Management Practices and "Part III Other Cultural and Structural Best Management Practices" in Appendix B of this 2001 NSMPP for definitions of the following BMPs.

Part I Agricultural BMPs
24 Nutrient Management
34 Slow Release Fertilizer
35 Soil Testing and Plant Analysis
38 Timing and Placement of Fertilizers
42 Waste Utilization

Part III Other Cultural and Structural BMPs
61 Maintain Set Backs From Surface Waters

In addition to the common BMP's listed, there are slope restrictions that are put in place at land application sites. Winter applications are restricted to areas with 0 to 2 percent slopes. Summer application require injection or incorporation on areas with slopes greater than 6 percent and no application is allowed on lands with slopes greater than 12 percent.

Separation distances are also used to prevent runoff into surface waters. There are requirements for minimum separation distances that must be maintained to surface water and other features that connect to surface waters (e.g. tile inlets, drainage ditches, etc.).

Chapter 14.2 Biosolids
Needs, Priorities, and Milestones, 2001 – 2005 Action Plan

The 2001 through 2005 (January 1, 2001 through December 31, 2005) five-year action plan provided below summarizes the goals and milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Due to budgetary constraints, the MPCA industrial by-products and biosolids programs are slated for funding reductions and possible elimination at this time. The ability of the MPCA to achieve the goals stated here will depend largely on whether or not funding becomes available in the future.

Goal 1: Evaluate Effectiveness of Current Land Application Programs in Preventing Nonpoint Source Pollution.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Work with Outcomes Division to develop effective methods for evaluating the effectiveness of land application programs in preventing nonpoint source pollution (monitor tile line discharges, ground water quality, determine ambient contaminant levels in soils, monitor runoff, etc.).	X	X	X	X	X	319	MPCA
2. Work with MPCA data management personnel and other computer professionals to improve the Delta database and determine changes needed or additional software needs for effective tracking of land application programs.	X	X				General Funds	MPCA
3. Tie ambient monitoring to correlate with land application sites if possible (may use GIS).	X	X	X	X	X	319	MPCA
4. Provide staff training on the use of the database.	X	X				General Funds	MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5. Design inspection program to obtain data necessary to evaluate the program, determine compliance, evaluate operator knowledge, and provide operator assistance when appropriate. This would involve development of a standard inspection protocol, development of inspection forms compatible with database format needs, establishment of an inspection schedule, and identification of staff responsible for performance of inspections.	X	X				General Funds	MPCA
6. Conduct scheduled inspections of biosolids and IBP processing facilities and land application sites.	X	X	X	X	X	General Funds	MPCA
7. Summarize inspection results to determine compliance in the field and take actions based on the results of inspection findings (i.e. enforcement or assistance). Flag compliance issues for Environmental Outcomes Division to establish links between compliance and environmental outcomes.	X	X	X	X	X	General Funds	MPCA
8. Continue to inventory and quantify the materials that are land applied.	X	X	X	X	X	General Funds	MPCA

Goal 2: Coordinate Efforts to Control Nonpoint Source Pollution.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Designate a staff person in the Outcomes Division that will be responsible for coordinating efforts to evaluate land application programs (including monitoring efforts) and communicating issues between programs that work with land application of all the waste types. This individual would track related research, provide awareness of monitoring activities taking place in other programs, and determine where there are gaps in environmental information.	X	X	X	X	X	319	MPCA
2. Set up and maintain communication between programs that establish standards for nonpoint source pollution and the various programs that regulate nonpoint source pollution for specific land use activities.	X	X	X	X	X	319	MPCA
3. Develop a protocol for establishment and review of standards and limits related to land application.	X	X	X			319	MPCA
4. Keep track of changes to rules that may affect land application standards or waste characteristics (example; MN Health Department changes to drinking water standards that may impact metal water treatment limes).	X	X	X	X	X	319	MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5. Assign policy and planning division staff person to work with districts and watersheds to flag environmental problems related to nonpoint source pollution and establish priorities based on Outcome Divisions recommendations.	X	X	X	X	X	319	MPCA

Goal 3: Develop Comprehensive Risk Criteria or Risk Evaluation Procedure for Land Application of Wastes.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Set up a work group to develop risk criteria or a risk evaluation process specifically for land application of wastes which is tied to other risk development strategies the Environmental Outcome Division is developing.	X	X				319	MPCA
2. Establish risk criteria or standards for land application that take into account other efforts taking place that are also working on establishment of standards for nonpoint source pollution (establishment of TMDL's, watershed approaches to setting limits, hypoxia prevention, IBP land application standards, manure land application standards, etc.).			X	X	X	319	MPCA

Goal 4: Improve Nutrient Management On Land Application Sites.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Evaluate the effects of using nitrogen as the most limiting factor for basing application rates. Determine need for phosphorus based limits.	X	X	X			319	MPCA
2. Evaluate current Best Management Practices (BMPs) for nutrient management and determine if changes are needed. Interpret data and determine impact of current nutrient management requirements on ground water and surface water quality and its interaction with other nonpoint sources of contamination within watersheds.	X	X	X	X	X	319	MPCA
3. Update BMPs as indicated by environmental need or new research findings.				X	X	319	MPCA

Goal 5: Develop and Update Type IV Certification Training and Outreach Materials.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Develop Type IV inspector course and exam.	X	X				319	MPCA
2. Update current courses and manuals as needed.	X	X	X	X	X	General Funds	MPCA
3. Provide training for land application of biosolids and IBPs to fulfill the training requirements of the rule for operators and inspectors.	X	X	X	X	X	Course Fees	MPCA
4. Develop fact sheets for operators, inspectors, end users of wastes, and the public.	X	X	X	X	X	319	MPCA

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
5. Identify training needs for land application of biosolids and industrial by-products. Utilize inspection, and participant comments to determine areas of weakness for training emphasis. Determine number of courses to offer and training format for these courses.	X	X	X	X	X	General Funds	MPCA
6. Develop training and educational materials to address identified needs. This will include development of courses, manuals, fact sheets, farmer information sheets, etc.	X	X	X	X	X	General Funds	MPCA
7. Evaluate training effectiveness on a continuous basis by looking at test results, course evaluations, and compliance with regulations.	X	X	X	X	X	General Funds	MPCA
8. Evaluate the need to modify the certification rule related to Type IV certification (land application certification)		X				General Funds	MPCA
9. Expand web site to include more educational materials.	X	X	X	X	X	General Funds, 319.	MPCA

Goal 6: Continue to Develop Permitting Program for Land Application of Industrial By-Products.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Continue to quantify the industrial by-products that are land applied.	X	X				General Funds	MPCA
2. Update permitting criteria based on risk evaluation process developed in Goal 3.			X	X	X	319	MPCA

	2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
3.	Develop permit requirements for specific IBPs such as mixed ashes.	X	X	X			Solid Waste Funds, LCMR.	MPCA
4.	Develop a more comprehensive list of typical contaminants of concern in each specific IBP land applied to assist in development of appropriate limits.		X	X			319	MPCA
5.	Determine the need to control pathogens in industrial by-products and appropriate indicator organisms for testing for presence of pathogens. If necessary develop sampling requirements and protocols for testing pathogens in industrial by-products.	X	X				319	MPCA
6.	Establish best management practices for land application of wastes on forestland or for mineland reclamation projects.		X	X	X	X	319	MPCA
7.	Adapt permitting criteria as determined necessary based on Goals 1 and 2.			X	X	X	319, Solid Waste Funds.	MPCA
8.	Determine if the permitting requirements for industrial by-product should be incorporated into the solid waste rule.	X					Solid Waste Funds.	MPCA

Goal 7: Evaluate the Regulatory Needs for Land Application of Commercial Wastes.

2001-2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Inventory the types and quantities of commercial wastes being land applied, and how the UIC rule may effect the types and quantities of commercial wastes that are land applied.		X				319	MPCA
2. Determine whether environmental problems are resulting for land application of specific commercial wastes identified in #1 above.			X	X		319	MPCA
3. Characterize sand and flammable trap wastes from vehicle repair and maintenance facilities to determine whether land treatment is a feasible option for management of these wastes.			X	X		319	MPCA
4. Determine whether regulation of the commercial wastes identified in #1is needed and, if so, prioritize and develop methods of regulation for the various commercial wastes.				X	X	319	MPCA
5. If it is determined land application is not an appropriate management option for specific commercial wastes, assist businesses in identifying other suitable options for disposal to prevent illegal dumping or land application.				X	X	319	MPCA

1994 NSMPP
Needs, Priorities And Milestones

The following Table provides the Goals and Action Steps included in the 1994 NSMPP. The Products, Services and Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps. Implementation of all action steps is contingent upon adequate funding and local involvement.

Goal 1: Develop a database designed specifically for sludge land application which will automate data tracking and compliance monitoring, and provide information to satisfy EPA reporting requirements by down loading data to EPA's data management system (PCS). The database would also be utilized for further evaluation of the land application program by providing data for numerical analysis of the program.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Determine the data elements necessary for evaluating compliance with federal and state sludge management rules and program impacts within watersheds. Work with non-point source program personnel and local resource managers to develop data needs for coordination of the sludge land application program with overall watershed management efforts.	319, General Funds.	MPCA	WATERS/Delta system developed to include some capability to track land application. The system still needs improvement in order to be useful for compliance monitoring and site tracking. There are still bugs in the system for entering annual reporting data.
2. Work with MPCA data management personnel and other computer professionals to develop the database and other data management software necessary to create a system which is user friendly and applicable to program needs.	None	MPCA	System developed is not considered user friendly. Difficult to get useful reports and information from the system at present.
3. Complete database and software design and provide necessary hardware for program operation.	General Funds	MPCA	Hardware available for use in Delta database.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
4. Determine staffing needs for data management and provide staff training on the use of the database.	None	MPCA	Not accomplished, not funded.

Goal 2: Develop and implement inspection program to evaluate program effectiveness in the prevention of nonpoint source pollution.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Design inspection program to obtain data necessary to evaluate the program, determine compliance, evaluate operator knowledge, and provide operator assistance when appropriate. This would involve development of a standard inspection protocol, development of inspection forms compatible with database format needs, establishment of an inspection schedule, and identification of staff responsible for performance of inspections.	None	MPCA	Not completed.
2. Conduct scheduled inspections of sludge processing facilities and land application sites.	General Fund	MPCA	Inspections are mainly complaint driven.
3. Summarize inspection results to determine compliance in the field and take actions based on the results of inspection findings (i.e. enforcement or assistance).	None	MPCA	Inspections complaint driven. Some valid and lead to enforcement, some are caused by poor communication and corrected.

Goal 3: Develop/Update training program and materials for land application certification program.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Identify training needs for implementation of new sludge management regulations and any future federal program delegation requirements. Utilize inspection results to determine areas of weakness for training emphasis. Determine number of courses to offer and training format for these courses.	General Fund	MPCA	New manual is near completion for biosolids courses. Course is updated to agree with new rule requirements.
2. Develop training and certification program to address identified needs. This will include development of courses and a manual for the certification course. Preparation of a written exam for certification will also be necessary.	General Fund	MPCA	New test is written for biosolids courses. New course developed for land application of industrial by-products (needs some additional changes).
3. Conduct training.	Course Fees	MPCA	Training is being conducted as scheduled.
4. Evaluate training effectiveness on a continuous basis by looking at test results, course evaluations, and compliance with regulations.	General Fund	MPCA	This is done on an ongoing basis.

Goal 4: Evaluate the effects of land applying sludge at agronomic rates on ground water and surface water quality by reviewing data submitted and information collected during site inspections.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Develop data elements needed for evaluation of ground water and surface water quality as it relates to land application of sludge. Coordinate data collection with other programs for consistency.	None	MPCA	Not completed, this part of project not funded.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
2. Establish program responsible for collection of necessary data.	None	MPCA	Not completed, this part of project not funded.
3. Collect data.	None	MPCA	Not completed, this part of project not funded.
4. Utilize the existing MPCA database Integrated Ground Water Information System (IGWIS) for entry of all ground water monitoring data.	None	MPCA	Not completed, this part of project not funded.
5. Identify software or databases available for entry of surface water quality data.	None	MPCA	Some data has been entered.
6. Interpret data and determine impact of sludge land application on ground water and surface water quality and its interaction with other nonpoint sources of contamination within watersheds.	None	MPCA	Not completed, this part of project not funded.

Goal 5: Determine nitrogen availability of sludge as affected by external conditions (i.e. sludge type, soil texture, organic matter content, or number of years of continuous sludge application).

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Conduct mineralization studies under varied conditions of interest.	None	MPCA	Not completed, funding not available. It was decided that because of cost and benefit to individual industries, it was more appropriate that this be paid for by industry(s) that benefits.
2. Collect and interpret data to establish mineralization rates.	None	MPCA	Not completed. Some industries have completed studies of their own.
3. Verify results by conducting field studies and yield comparisons to determine if predicted availability is accurate.	None	MPCA	Not completed, funding not available. It was determined that individual industries that benefit from this information should fund this research.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
4. Apply information to establish nitrogen application rates that more closely match crop nitrogen uptake. Develop BMPs for sludge land application designed to prevent ground water contamination by nitrate nitrogen	Industries	MPCA	MPCA reviews industry specific data and does allow adjustments in application rates based on industry specific research, however, funding is provided by industry. There is an opportunity for industries to cooperate to provide additional information related to nutrient availability.

Goal 6: Evaluate sludge land application affects on surface water quality.

1994 NSMPP Milestones (Action Steps)	Funding Source(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Monitor runoff and discharge through tile lines from sludge application sites and under different site conditions (i.e. high soil test phosphorus, steep slopes, tiled fields, tillage method, etc.).	None	MPCA	Not completed, funding not available.
2. Collect data and interpret results.	None	MPCA	Not completed, funding not available.
3. Develop BMPs for sludge land application designed to prevent surface water contamination with phosphorus..	None	MPCA	Not completed, funding not available.

Chapter 15 Effects of Atmospheric Pollution on Water Quality

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Introduction

The idea that the atmosphere can be a significant source of pollution to surface water is a relatively recent idea, first demonstrated for acid rain, and later for mercury, PCBs, and nutrients such as nitrogen (N) and phosphorus (P). Unfortunately, it is often assumed that rain water is free of pollutants. For instance, it is sometimes assumed that pollutants in urban runoff are picked up by clean precipitation running off dirty surfaces. Yet it is possible that the rain already contains some of the pollutants, such as phosphorus, nitrogen, mercury, pesticides, and PCBs. In the case of urban runoff, the creation of impervious surfaces alone may create a nonpoint source (NPS) pollution problem for surface water, even without considering the watershed activities that contribute pollutants, such as lawn care, pet feces, eroded soil, and vegetative litter. The importance of atmospheric loading will vary greatly depending on the pollutant and the nature of the watershed. In urbanized and agricultural watersheds, nutrient loading from the atmosphere may be negligible. But in the same watersheds, the atmosphere may be the main source of toxic pollutants, such as PCBs and mercury.

There are two situations where atmospheric deposition may be especially important sources of NPS pollution to surface water. First, lakes with a small watershed to lake surface area ratio can receive a large proportion of their loading from the atmosphere. For example, a study of Lake Mille Lacs suggests that precipitation (wet and dry fall) may contribute approximately 48 percent of the annual phosphorus loading to the lake. (Lake Mille Lacs occupies 53 percent of its total watershed area.) Similarly, airborne dust is thought to deliver the majority of phosphorus loading to Lake Superior. Second, some pollutants may be primarily delivered by the atmosphere even when there is significant human activity in the watershed. For instance, the geological source material in most watersheds does not contain a significant source of mercury. When mercury is found in a waterbody it is most likely a result of atmospheric deposition. In addition, environmentally significant levels often accumulate in soils due to atmospheric deposition. If soil is eroded or inundated (say, through impoundment), there may be significant increases in mercury contamination to aquatic systems in the watershed. The development of impervious surfaces (paving, etc.) and storm sewers has the effect of increasing the efficacy of transport to surface water of deposition to the watershed, not only for mercury but also for other airborne pollutants.

Definitions

POINT SOURCE EMISSIONS TO AIR CAN BECOME NONPOINT SOURCE POLLUTION

Atmospheric deposition of pollutants is implicitly nonpoint source pollution in this document. Yet, the emission source to the atmosphere may well be a point source such as an emission stack. It is worth pointing out that even if modeling or measurement studies verify a direct relationship between a point source of air emissions and deposition to a water body, water managers may still consider that source of pollution to be nonpoint, because it is delivered by the atmosphere.

Air managers identify three basic categories of emission: point sources, area sources, and mobile sources. Each category is further subdivided into subcategories. Point sources are permanently fixed stacks of known diameter, elevation, temperature, and exit velocity.

Area sources include windblown dust from stockpiles or tilled fields, fugitive emissions from a landfill or the numerous valves and connections at a refinery, and forest fires. Mobile sources are divided into on-road sources such as traffic emissions and dust from unpaved roads, and off-road sources such as lawn mowers, portable generators, chain saws, and snowmobiles.

WET DEPOSITION

Pollutants in the atmosphere can be scavenged by precipitation or act as condensation nuclei for precipitation formation and thereby be deposited to surface water and land in the form of rain or snow.

DRY DEPOSITION

Particles in the air are deposited onto surface water and land surfaces at a rate that depends on the particle size, wind speed, and other factors. Gaseous pollutants can also be deposited to water and land.

INDIRECT VERSUS DIRECT DEPOSITION

Air pollutants are not only deposited directly to the surface of waterbodies, but are also deposited to watersheds and then enter surface waters indirectly, through storm water runoff, tributaries, and groundwater seepage. Where the watershed is large relative to the open water, indirect loading can exceed direct loading.

VOLATILIZATION

Previously deposited gaseous and semivolatile chemicals, such as mercury and PCBs, can be re-emitted to the atmosphere as the result of many factors, including chemical reactions and changes in temperature or wind speed.

Types Of Airborne Pollution That Can Affect Surface Water

Any change in the physics or chemistry of the atmosphere can negatively affect surface water. For example, depletion of stratospheric ozone could increase the damage to aquatic life from increased UV radiation. Global warming is projected to virtually eliminate the cold water fishery in Minnesota, while simultaneously reducing the duration of ice-cover and therefore winterkills.

A wide variety of materials are deposited from the atmosphere that can affect the surface water. Some airborne materials are toxic (e.g. mercury, PCBs, lead, dioxin), some are nutrients (e.g., phosphorus and nitrogen), and some interact with other pollutants (e.g., calcium carbonate in wind-blown soil can neutralize acid rain, or sulfate deposition may stimulate the methylation of mercury in low-sulfate systems).

The following is a description of the different types of changes in the atmosphere that can affect surface water.

CARBON DIOXIDE AND OTHER GREENHOUSE GASES

Scientists believe that emissions of certain gases to the atmosphere are causing warming and possibly other changes in the climate. The greenhouse gases include the naturally occurring compounds carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Humans also release synthetic greenhouse gases that contribute significantly to climate change (chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

Carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), and wood and wood products are burned.

Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock.

Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels.

Greenhouse gases that are not naturally occurring include byproducts of foam production, refrigeration, and air conditioning called *chlorofluorocarbons* (CFCs), as well as *hydrofluorocarbons* (HFCs) and *perfluorocarbons* (PFCs) generated by industrial processes.

Each greenhouse gas differs in its ability to absorb heat in the atmosphere. HFCs and PFCs are the most heat-absorbent. Methane traps over 21 times more heat than carbon dioxide, and nitrous oxide absorbs 270 times more heat than carbon dioxide.

Global warming has already caused significant reductions in the duration of ice cover in Minnesota. Models show that winterkills will get rarer. As summer temperatures rise, summer kills will become more common and in some lakes cold water fisheries will shift to warm water. There will be harder to predict effects on other temperature- and CO_2-sensitive processes, such as mercury methylation and plant growth. Since chemical reaction rates, and the growth rates of bacteria, plants, and cold-blooded animals are all highly dependent on temperature, there may be many unanticipated effects of global warming.

CFCS AND OTHER OZONE-DEPLETING SUBSTANCES

When chlorofluorocarbons (CFCs) reach the stratosphere, the ultraviolet radiation from the sun causes them to break apart and release chlorine atoms which react with ozone, starting chemical cycles of ozone destruction that deplete the ozone layer. One chlorine atom can break apart more than 100,000 ozone molecules.

Other chemicals that damage the ozone layer include methyl bromide (used as a pesticide), halons (used in fire extinguishers), and methyl chloroform (used as a solvent in industrial processes). As methyl bromide and halons are broken apart, they release bromine atoms, which are 40 times more destructive to ozone molecules than chlorine atoms.

Reductions in stratospheric ozone levels lead to higher levels of UVB reaching the Earth's surface. Studies have shown that in the Antarctic, the amount of UVB measured at the surface can double during the annual ozone hole. Another study confirmed the relationship between reduced ozone and increased UVB levels in Canada during the past several years.

Ozone levels vary by season and latitude. In the middle latitudes (most of the populated world), ozone levels have fallen about 10% during the winter and 5% in the summer. Since 1979, they have fallen about 5% per decade when averaged over the entire year. Depletion is generally worse at higher latitudes, i.e. further from the Equator.

In the marine environment, solar UVB radiation has been found to cause damage to early developmental stages of fish, shrimp, crab, amphibians and other animals. The most severe effects are decreased reproductive capacity and impaired larval development. Even at current levels, solar UVB radiation is a limiting factor in some systems. It is uncertain what effect enhanced UVB radiation would have on the Minnesota environment.

MERCURY

Mercury vapor emissions from combustion sources result in ambient air concentrations below those of concern for direct human health effects through inhalation. Once in the atmosphere, mercury vapor is slowly converted to an ionized form that is water soluble, and subject to wash out in precipitation. Its concentration in rain is usually above the ambient surface water quality standard of 6.9 nanograms per liter (ng/L) (1.3 ng/L in the Lake Superior basin). Some proportion (usually between 1 to 20%) of this mercury is converted to methyl mercury by sulfate-reducing bacteria in the aquatic system or its watershed. Methyl mercury is bioaccumulated to a great degree in the aquatic food chain. Methylation rates appear to be higher in wetlands than other environments by one or two orders of magnitude. Mercury is probably the most pervasive type of atmospheric NPS pollution in Minnesota, causing fish consumption restrictions on over 90 percent of the lakes tested in the state.

ACID RAIN

Sulfuric Acid:

Sulfuric acid presents the potential for acidification of surface water, although there is no known permanent damage in Minnesota. There is evidence that increased loading of sulfate stimulates the growth of bacteria that convert sulfate to sulfide in wetlands, which also increases the proportion of mercury that is methylated.

Nitric Acid:

Nitric acid presents the potential for acidification of surface water, although there is no known permanent damage in Minnesota. Nitric acid acts as nutrient in nitrogen-poor lakes, such as oligotrophic lakes in northern Minnesota.

WIND-BLOWN SOIL

Generally, the size spectrum of wind blown soil particles is sufficiently large that it is not a human health concern for inhalation. However, some components of wind blown soil can have impact on surface water.

Calcium carbonate:

Calcium carbonate, a base, neutralizes acid rain in the atmosphere.

Calcium sulfate:

Calcium sulfate, which is pH-neutral, can contribute sulfate to sulfate-poor systems, which may stimulate the methylation of mercury.

Phosphorus:

Phosphorus is held tightly by soil, so that movement of wind blown soil to surface water can contribute to eutrophication.

Mercury:

Soil binds and efficiently holds mercury deposited from the atmosphere, so that the movement of soil to surface water can introduce large amounts of this metal. Lakes in agricultural areas receive high loading of mercury due to soil erosion, but it is unclear whether this mercury is always available for methylation. It is not known how much mercury is carried to lakes by wind blown soil.

Iron:

Iron is a limiting nutrient in oligotrophic systems, a phenomenon well documented for the Pacific Ocean and Lake Tahoe. The oligotrophic lakes in northern Minnesota may also respond to iron additions, although the critical experiments have never been performed. Soil contains significant quantities of iron, so wind blown soil could conceivably fertilize lakes.

ANTHROPOGENIC PARTICULATE MATTER IN THE ATMOSPHERE

Particulate matter is emitted by point sources, area sources, and mobile sources, and often contain materials that might affect surface waters.

Metals:

Heavy metals such as cadmium, lead, and silver can be emitted in quantities that are potentially significant to surface water.

Soot:

A product of incomplete combustion, soot provides a highly adsorptive surface that can scavenge pollutants such as mercury and dioxin from the atmosphere. Sources of soot include forest fires and poorly tuned combustion devices. Soot may enhance deposition of pollutants to nearby lakes.

PCBS

In earlier times, PCBs were introduced into the environment from point sources, but now PCBs cycle from water bodies to the atmosphere and back to the water. PCBs present a challenge for remediation because they are semivolatile, hydrophobic, bioaccumulate, and are extremely resistant to decay . The Great Lakes are at present net emitters of PCBs to the atmosphere. NPS impacts appear to be in oligotrophic lakes with long-lived lake trout, and perhaps urban areas possessing impervious surfaces that funnel deposition to surface water.

DIOXIN

Dioxin is a product of incomplete combustion, and also can be formed in processes that utilize chlorine such as paper bleaching. Air emissions of dioxin are extremely low and atmospheric deposition has not been satisfactorily measured. Direct discharge can result in dioxin accumulation in fish in the surface water.

PESTICIDES

Many pesticides have the potential to cause problems in aquatic systems. Potentially damaging pesticides that have significant deposition rates from the atmosphere include chlordane, DDT/DDE, dieldrin, hexachlorobenzene, alpha-HCH, lindane, and toxaphene. Because of restrictions, none of these currently have significant sources within the United States. However, volatilization from soils or wind blown soil can deposit significant quantities of these persistent chemicals. In some cases, the compounds are currently used in other countries and transported by the atmosphere to the United States.

CHEMICALS THAT DISRUPT HORMONAL FUNCTION IN WILDLIFE AND HUMANS

Many chemicals released by human activity have the potential to disrupt of disrupting the endocrine system of animals, including fish, birds, mammals, and humans. Among these chemicals are persistent, bioaccumulative compounds that include some pesticides, and industrial chemicals such as DDT, lindane, octachlorostyrene, certain PCB congeners, 2,3,7,8-TCDD and other dioxins, 2,3,7,8-TCDF and other furans, atrazine, cadmium, and mercury. The impacts include thyroid dysfunction in birds and fish, decreased hatching success in birds, fish, and turtles, gross birth deformities, in birds, fish, and turtles, demasculinization and feminization of male fish, birds, and mammals, and defeminization and masculinization of female fish and birds. Many of these compounds are delivered by the atmosphere to aquatic systems.

AMMONIA

Like nitrate, atmospheric ammonia that is deposited to lakes and watersheds adds nitrogen to aquatic systems. The addition of nitrogen can contribute to eutrophication, a particular problem in N-limited, oligotrophic lakes in northern Minnesota. Additions of nitrogen may also affect species balances in other systems like prairies and wetlands. The largest sources of ammonia emissions to the atmosphere are: animal agriculture (81%), fertilizer application (10%), refrigeration (5%), and other activities (4%). In terms of total nitrogen emissions to the atmosphere in Minnesota, the major contributors are: animal agriculture (32%), mobile sources (22%), electric utilities (22%), other fuel combustion (13%), and nitrogen fertilizers (11%).

Geographic Areas of Concern

For most airborne pollutants, it is uncertain what factors might make some geographic regions more sensitive than others. However, it is clear that geological areas low in alkalinity are more sensitive to acid rain. For less obvious reasons, low alkalinity regions are also more sensitive to mercury deposition. These areas of Minnesota are of special concern and will be included in ongoing research into atmospheric deposition of pollutants.

Best Management Practices (BMPs)

By far the BMP to reduce atmospheric deposition is to halt the release of these pollutants into the atmosphere. Because of the diversity of sources, cessation of release is complicated and would require the coordination of the full spectrum of the economy, including agriculture, energy production, transportation, waste disposal, manufacturing, and government. Because the atmosphere carries some materials long distances, it may be necessary to address many of these atmospheric pollutants on a national and international basis. For instance, the MPCA estimates that 90% of the mercury deposited in Minnesota comes from out of state. It is therefore important to communicate the need for national level controls to the U.S. Environmental Protection Agency for mercury and other pollutants subject to long-distance atmospheric transport.

Existing BMPs for some other pollutants may lead to some surprising situations. For instance, it is increasingly common to use wetlands to trap sediments and associated nutrients in storm water before the pollutants can get to a lake or stream. However, the high biological activity of wetlands may lead to some negative consequences for persistent bioaccumulative chemicals. For instance, mercury deposited to terrestrial systems binds strongly to soil particles. Eroded soil may be caught in a wetland, where the mercury would be subject to biological activity. Because of the heightened activity of anaerobic bacteria that convert sulfate to sulfide, methylation rates are perhaps 100 times higher in wetlands than in lakes. Use of wetlands to clean runoff may therefore enhance methyl mercury loading to surface water, which would increase the concentration of mercury in fish.

BMPs for a particular atmospheric pollutant should be selected only after its cycle and fate have been evaluated. Otherwise, we may find ourselves exacerbating the effects of a particular pollutant, as in the hypothetical case of mercury, above. Another example of the consequences of an incomplete understanding might be attempting to reduce PCBs in Lake Superior by reducing inputs. The PCB burden in Lake Superior is determined by volatilization back to the atmosphere, not external loading. Although research on the environmental fate and budgets of persistent chemicals may be expensive, it is less expensive than making management decisions based on erroneous assumptions, resulting in expensive but ineffective treatment.

Programs and Authorities

- National Pollutant Discharge Elimination System permits - pretreatment requirements,
- Pollution prevention,
- Water quality standards,
- Air emission controls,
- Fish consumption advisories,
- Recycling and product screening (e.g., Hg switches in consumer items, such as shoes),
- Market incentives, and
- Statutes and Rules (e.g., ch. 7050).
- Minn. Stat. § 116.454, authorized the Minnesota Pollution Control Agency (MPCA) to initiate a statewide air toxics monitoring network and air toxics inventory in calendar year 1993.
- The Minnesota Legislature passed the Acid Deposition Control Act in 1982 (Minn. Stat. § 116.42-116.45). This act, which was the first of its kind in the nation, required the MPCA to (1) identify the areas of the state containing resources sensitive to acid deposition, (2) develop a standard to protect these resources, (3) adopt a control plan to reduce sulfur dioxide emissions, and (4) ensure that all Minnesota sources subject to the control plan are in compliance by January 1, 1990.

Sequence for implementation of NPS effort for atmospheric pollutants

1	Identify water quality problem.
2	Determine air pollution as the cause.
3	Determine source of air pollution (e.g., area or facility).
4	Evaluate the relative efficacy of BMPs within the watershed in contrast to air emission reductions.

Chapter 15: Effects of Atmospheric Pollution on Water Quality Needs, Priorities and Milestones, 2001-2005 Action Plan

The 2001 through 2005 (January 31, 2001 through December 31, 2005) 5-year Action Plan provided below summarizes the milestones identified in the preceding sections. Many of the 2001 through 2005 milestones listed below, as well as the implementation of specific projects, are contingent upon adequate funding and local involvement.

Goal: To Develop a Quantitative Understanding of the Effect of Air Pollutants on Water Quality, and to Develop Appropriate Best Management Practices to Minimize the Impact of Air Pollution on Water Resources.

2001 – 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
1. Quantify deposition of metals (cadmium, lead, iron, etc.) and phosphorus in select watersheds.	X					MPCA, TMDL	MPCA
2. Develop monitoring effort for effect of global warming on surface water; ice cover times and water temperature.	X					General Fund	MPCA
3. Quantify proportion of phosphorus and mercury deposited from atmosphere that results from wind erosion of soil.	X					TMDL	MPCA
4. Evaluate why lakes vary greatly in mercury contamination of fish, given that atmospheric deposition is relatively homogeneous.	X	X				TMDL, USGS	MPCA, USGS
5. Evaluate effect of nonpoint sulfate loading on mercury methylation.	X	X				USEPA STAR grant to MPCA	MPCA
6. Quantify relationship between emissions of pollutants and deposition to surface water & watersheds.				X		General Fund	MPCA
7. Evaluate methylation of mercury in wetlands used as BMPs for trapping storm water runoff.					X	General Fund	MPCA

2001 – 2005 Milestones (Action Steps)	01	02	03	04	05	Funding Source(s)	Lead Agency(ies)
8. Quantify the deposition of calcium carbonate and its effect on acid precipitation.					X	General Fund	MPCA
9. Investigate the impact of atmospheric deposition of "hormonal copycats" on aquatic organisms.				X		General Fund	MPCA
10. Investigate whether aquatic resources near emission sources experience increased impacts.			X			General Fund	MPCA
11. Develop land based BMPs for watersheds to minimize the impact of pollutants deposited from the atmosphere.				X		General Fund	MPCA
12. Study the effect of UV radiation on the health of aquatic organisms.					X	General Fund	MPCA

1994 NSMPP
Needs, Priorities, and Milestones

The following Table provides the recommended Action Steps included in the 1994 NSMPP. The Products, Services & Outcomes Column provides information on the accomplishments, progress and status of those recommended 1994 action steps. Implementation of all action steps is contingent upon adequate funding and local involvement

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
1. Quantify relationship between emissions and deposition to surface water & watersheds.	Not Funded	MPCA	None – No Funding
2. Evaluate methylation of mercury in wetlands used as BMPs for trapping storm water runoff.	Not Funded	MPCA	None – No Funding
3. Quantify deposition of metals (cadmium, lead, iron, etc.) and phosphorus in select watersheds.	LCMR	MPCA	Ongoing at 4 sites in Minnesota
4. Quantify proportion of phosphorus and mercury deposited from atmosphere that resulted from wind erosion of soil.	TMDL	MPCA	Ongoing in 2001
5. Quantify the deposition of calcium carbonate and its effect on acid precipitation.	Not Funded	MPCA	None – No Funding
6. Quantify the deposition of organics: PCBs, dioxin, and pesticides (chlordane, DDT/DDE, dieldrin, hexachlorobenzene, alpha-HCH, lindane, toxaphene, and others.	LCMR	MPCA	Deposition to be inferred from sediment core data being produced.
7. Investigate the impact of atmospheric deposition of hormonal disrupters on aquatic organisms.	Not Funded	MPCA	None – No Funding
8. Investigate whether aquatic resources near emission sources experience increased impacts.	LCMR	MPCA	Data from sediment cores obtained; interpretation scheduled.

1994 NSMPP Milestones (Action Steps)	Funding Sources(s)	Lead Agency(ies)	Products, Services & Outcomes
9. Evaluate the environmental cost of atmospheric pollutants on aquatic systems.	LCMR	MPCA	Willingness to pay study on mercury is done.
10. Evaluate why lakes vary greatly in mercury contamination of fish.	TMDL, USGS	MPCA, USGS	Study on lakes in Voyageurs park underway.
11. Develop BMPs for the watersheds where pollutants are deposited from the atmosphere.	Not Funded (Forwarded to 2001-05)	MPCA	None – No Funding
12. Determine environmental fate and budgets for persistent chemicals, so that appropriate BMPs can be developed.	Not Funded (Similar to No. 11; merged for 2001-05)	MPCA	None – No Funding

APPENDIX A

Nine Key Elements of a Successful Nonpoint Source Management Program
Minnesota's 2001 Nonpoint Source Management Program Plan (NSMPP)

On February 24, 2000, Minnesota presented the U.S. Environmental Protection Agency (USEPA) with an interim nonpoint source management plan addressing the "9 Key Elements" with the understanding it was to serve until the more comprehensive NSMPP is submitted. The USEPA approved this Interim 9 Key Elements document March 8, 2000. Upon acceptance of the 2001 NSMPP by USEPA, the interim 9 Key Elements is to be replaced by Minnesota's 2001 Nonpoint Source Management Program Plan (NSMPP).

Citations provided after each element, indicates where and how the 2001 NSMPP satisfies each of the 9 Key Elements.

ELEMENT 1. *Explicit short- and long-term goals, objectives and strategies to protect surface and ground water.*

All 19 chapters/strategies of the 2001 NSMPP include a narrative providing nonpoint source (NPS) information for that chapter/strategy. The effective time period of the NSMPP is January 1, 2001, through December 31, 2005. Chapters/strategies 4 through 15 include;

1) Goals,
2) Needs, Priorities and Milestones, and
3) Action Steps recommended to be carried out during the effective time period.

The combination of narratives of the 19 chapters/strategies including Goal statements and Needs, Priorities and Milestones (Action Steps) Tables in Chapters/Strategies 4 through 15, present Minnesota's strategy for protecting surface and ground water during the 2001 – 2005 time period.

Nonpoint Source Management Program Plan (NSMPP) Revisions
Short-term Goal: Receive approval of Minnesota's 2001 NSMPP from US EPA.
Long-term Goal: Review and revise as necessary the state NPS Management Program Plan every five years. The next revision after the 2001 revision would be in 2006. Review will include an evaluation of to what extent basin plans satisfy NPS planning requirements to avoid duplication of effort.

Minnesota's long-term goals for impaired waters are as follows:

- Long-term goals for Minnesota's impaired water can be found in Minnesota's Environmental Performance Partnership Agreement (EnPPA) October 1, 1997 – June 30, 1999, pages 73 – 115.

- Secure US EPA approval of 100 percent of total maximum daily loads (TMDL) on the 1998 CWA 303d list by 2011. Begin implementation of all TMDLs on Minnesota's 1998 Clean Water Act Section 303(d) list by 2015 and complete implementation in accordance with the applicable TMDL/watershed plan schedule.

Minnesota's short-term goals for Minnesota's impaired waters are as follows:

- Begin TMDL development in accordance with 1998 schedule. Approve 33 percent of TMDL's on 1998 303(d) list by 2005. Continue developing approach for performing TMDL's, focusing on encouraging local involvement and leadership in TMDL development and implementation.

- Continue developing approach for performing TMDLs, focusing on encouraging local involvement and leadership in TMDL development and implementation.

- Integrate TMDL and source-water protection efforts where practical.

- Provide comments on proposed TMDL regulations.

- Continue to inform parties impacted by TMDLs of their implications including local water resource managers in areas where impaired waters are found, agricultural interests, industry, forestry interests, environmental advocacy groups, etc.

ELEMENT 2. *Strong working partnerships and collaboration with appropriate State, interstate, Tribal, regional, and local entities (including conservation districts), private sector groups, citizens groups, and Federal agencies.*

The Minnesota Environmental Quality Board (EQB) Water Resources Committee (WRC) is the State Coordinating Body for water activities in Minnesota. The EQB WRC includes multiple state and federal agency representatives, and local government participation as well. This committee is in the process of developing the state water plan for the first decade of the new millennium, under the directive of the Governor's Executive Order on Water Management Unification. Phase I of the plan was completed in October 2000 and the second phase will be completed in late 2002.

A group of representatives from some 20 different state, local, federal and Tribal agencies, called the Project Coordination Team (PCT) meets monthly and assists the MPCA in ranking and choosing the 319 and State Clean Water Partnership (CWP) projects to be funded each year. More recently, the PCT has taken a more active role in setting policy and direction for the various state and federal NPS funding programs within the MPCA. The PCT has served as a useful touchstone for the MPCA because the members can bring a wider perspective from their programs. The PCT has been consulted regularly on the development of the 2001 NSMPP and has provided direction on its scope and completion.

As defined in Minn. Stat. 103F.761 the interests required to be represented on the PCT include:

State Government:
- Minnesota Pollution Control Agency
- Minnesota Department of Natural Resources
- Minnesota Department of Agriculture
- Minnesota Board of Water and Soil Resources
- Minnesota Department of Health

Federal Government:
United States Department of Agriculture Natural Resources Conservation Service
United States Army Corps of Engineers
United States Environmental Protection Agency
United States Department of Agriculture Agricultural Stabilization and Conservation Service

Regional Government:
Metropolitan Council

Educational Organizations:
University of Minnesota – Agricultural Experiment Station
University of Minnesota - Extension Service

Private Organizations:
Association of Minnesota Counties
League of Minnesota Cities
Minnesota Association of Townships

The Statute grants authority to the Commissioner of the MN Pollution Control Agency to add other agencies to the PCT as the commissioner may determine:

Bureau of Indian Affairs
USGS
Minnesota Geological Survey
Minnesota Planning
MN Association of Soil and Water Conservation Districts.

MPCA BASIN MANAGEMENT AND COORDINATION: Although the MPCA has legal responsibility for administering the Clean Water Act, the protection and restoration of the Minnesota's streams, rivers, lakes, wetlands, and shores depends on the collective efforts of citizens, businesses, tribal nations, and governmental agencies. The basin management process was designed to establish and support a strong partnership among the MPCA and other organizations responsible for managing the states water resources. Basin management is also intended to ensure meaningful public participation in decision-making processes. As the MPCA works to involve citizens in basin planning efforts, it will ensure that public participation efforts conform to the requirements of Part 25 of 40 CFR Chapter 1. Upon completion of the draft basin plan, the draft plans will be noticed in the State Register and copies of final plans will be placed in libraries in each basin.

A stakeholder is defined as any entity involved in or affected by watershed management activities. The term "stakeholder" covers a broad range of people and organizations, which can be grouped into three general categories:

- *Government*: city, county, regional, state and federal agencies
- *Business*: commercial and industrial establishments; mining, agricultural and forestry operations; utilities; business groups; and trade associations
- *The Public*: individual residents and landowners; schools; and interest groups (including citizen, environmental, consumer and community groups)

By establishing more cooperative working relationships and providing opportunities for participation, the Basin Management approach strives to improve ways of identifying common water quality goals and problems and implementing cost-effective solutions.

- *Statewide* for agencies and organizations concerned about watershed management-related activities across the entire state who need a statewide structure for targeting and synchronizing efforts with one another.

- At the *basin level* for assessing water-quality conditions within a large basin and finding basin-specific management goals and priorities that multiple stakeholders share and want to work on together.

- At the *local watershed level* to develop management strategies and plans and to rally public support and participation for protecting and restoring water quality. This means cooperatively developing and implementing plans for priority areas that incorporate both voluntary and regulatory actions.

See Chapter 3 of the Minnesota NSMPP for more information on how collaboration on NPS issues is fostered through the watershed approach in Minnesota.

Revision of This Plan
The process for updating individual sections of the NPS Management Program Plan is as follows:

a) Subcommittees will reconvene and reevaluate membership (subcommittee will solicit additional representation of private industry and local interests);
b) Proposed amendments will be reviewed and approved by the Project Coordination Team;
c) Proposed amendments will be reviewed and approved by EQB; and
d) Amendments must be approved by the USEPA.

ELEMENT 3. *A balanced approach that emphasizes both statewide nonpoint source programs and on the ground management of individual watersheds where waters are impaired or threatened.*

The 319 and Clean Water Partnership (CWP) Programs both contribute financial and technical resources to protect water resources in watershed areas. See Chapter 2 for more information on how Minnesota uses its funding programs to foster the watershed approach. Chapter 3 Watershed Management of the 2001 NSMPP details the relationship between resources and management of impaired or threatened water resources.

Minnesota Clean Water Partnership (CWP) Program:
The CWP program was established by Minn. Stat. §§ 103F.701 to 103F.761. The program focus is on control of nonpoint sources of pollution through watershed management to protect and improve surface and ground water in Minnesota. The CWP program provides financial assistance through matching grants, State Revolving Fund (SRF) loans, and technical assistance to local units of government to lead pollution control projects. Through 11 application cycles, the MPCA has awarded loans and grants to 67 resource investigation projects and 29 implementation projects. These projects represent more than 25 million dollars of state, federal, and local funds to protect and improve lakes, streams, ground water, wellhead areas and wetlands.

The Clean Water Partnership Rules (Minn. Rules ch. 7076) adopted in September 1988 and revised September 1991 and 1995 define the criteria and procedural conditions under which the MPCA may award grants to local governments. The rules provide separate grants for 50 percent of the eligible costs for resource investigation projects (Phase I) and implementation projects (Phase II). Resource investigation projects are designed to complete a Phase I diagnostic study and subsequently develop an implementation plan. Phase I activities include water quality monitoring, identifying the sources of pollution and the combination of best management practices (BMPs), activities and protective measures that will be necessary to solve the identified problems. A Phase II project is designed to install the BMPs and carry out educational and other support activities identified in the implementation plan.

Federal Clean Water Act Section 319 Funding:
In 1987 the Clean Water Act was amended to include Section 319, a new section which authorized federal assistance for implementing NPS programs.

USEPA has granted Section 319 funds by first establishing a base funding level for each state to institutionalize the program over the long term. In addition to base level funding, the USEPA regional offices allocate additional funds to each state in their region for selected NPS implementation projects. Project money is allocated competitively among the states within an USEPA Region.

From 1990 through 1992, Minnesota received approximately $1.5 million per year. Of this amount, approximately half was allocated to institutionalize the program with the remainder dedicated to implementation projects. Congress added $20 million to the Section 319 appropriation in 1993 and this has translated to approximately $2.6 million per year for Minnesota. Today, this amount has risen to $6 million per year.

Project funding is available to all state agencies or local entities that meet USEPA match requirements and USEPA/MPCA funding criteria. Project money is awarded competitively based upon project merit and consistency with Section 319 program requirements and priorities.

MPCA Basin Management:
The MPCA is in the process of moving toward a more integrated, water resource-based approach for its water quality management programs. This approach is referred to as basin management. The same concepts are sometimes referred to as watershed management, particularly when they are applied on a smaller scale.

Traditional water quality efforts have focused on specific pollutants and pollution sources. In contrast, basin management starts with a focus on the water resources themselves and considers each in terms of the cumulative effects from multiple pollution sources that may threaten or impair its use. By shifting the focus to the problems and needs of individual water resources, the basin management approach helps to link point source and NPS programs together to form a coordinated management strategy.

The MPCA's basin planning and management process will strengthen the connections between all water quality program activities -- from monitoring and assessment to assistance and compliance. On a rotating cycle, priority water bodies will be identified in each of Minnesota's ten major drainage basins. Point source and NPS program resources will then be coordinated in a way that addresses the particular problems and needs of those priority water bodies. A basin plan has or is being prepared for each basin that describes the condition of water bodies in the basin and identifies the priorities, sets water quality goals and describes the specific management strategies that will be taken.

ELEMENT 4. *The State program (a) abates known water quality impairments resulting from nonpoint source pollution and (b) prevents significant threats to water quality from present and future activities.*

The entirety of this Nonpoint Source Management Program Plan (NSMPP) is about how Minnesota uses a combination of approaches and programs to abate and prevent NPS pollution. The plan documents progress that has been made since the 1994 plan was produced, and includes action strategies on how NPS pollution abatement and prevention will be carried out over the next five years.

Regarding MPCA administered funding programs, 319 and CWP funds are awarded to proposals with documented impairments and proposing measures for the protection and enhancement of water quality in the future.

The State has been implementing a basin management approach over the last several years, in part to better address nonpoint source pollution. Basin management brings together resource managers from all sectors and levels of government to consider and address the cumulative impacts of all sources of pollution in a given basin. Basin plans include strategies for restoring impaired waters and preventing further degradation of water resources.

More specifically, the MPCA uses its own monitoring data and data from other sources to characterize the condition of water resources in the state in preparing the CWA 305b water body assessments. The assessments characterize the conditions of monitored waters of the state and suggest possible causes of impairments for individual waterbodies, including specific types of nonpoint source pollution. From the 305b assessments, the MPCA develops its CWA 303d list of impaired waters, or Total Maximum Daily Load (TMDL) list. The MPCA has developed a schedule for developing TMDLs for these waters and has begun work with local resource managers and citizens on several of the state's impaired waters impacted by nonpoint source pollution.

ELEMENT 5. *An identification of waters and watersheds impaired or threatened by nonpoint source pollution and a process to progressively address these waters.*

Chapter 1 of the NSMPP is the "Updated Nonpoint Source Assessment" Chapter where impaired waters are identified as being affected by nonpoint source pollution. Through 319 and State CWP funding, the State continues to address nonpoint source pollution.

Basin Information Documents/Plans: The basin planning approach emphasizes watershed protection and restoration. Key elements include watershed-based permitting, identification of goals and priorities at the basin scale, and greater involvement by partners and the public.

The following programs are all part of the MPCA's efforts to identify impaired water resources and systematically address these resources:

Citizen Lake Monitoring Program (CLMP) & Lake Assessment Program (LAP):
Since the mid-1980s, MPCA's lake monitoring efforts have been focused on several areas, including CLMP & LAP. In the CLMP, citizens residing on or near lakes take weekly transparency measures using a secchi disk and record their perceptions of the physical appearance and recreational suitability of their lake. This program is wholly based on public participation. This information is used for problem identification and goal setting.

LAPs are more complicated. Each LAP is a cooperative study of a lake involving MPCA staff and local citizens. The studies characterize a lake's condition and how it is being affected by its watershed. They provide valuable information for local governments and others interested in protecting or improving the quality of a lake.

Continuous Planning Process (CPP):
The Clean Water Act Section 303(e) Continuous Planning Process document for the MPCA describes the processes and procedures we use for water quality planning. There are nine specific processes that must be contained in each state CPP, including water quality standards development, Total Maximum Daily Load (TMDL) allocation implementation, and a process for determining the priority of permit issuance.

The MPCA CPP emphasizes basin planning as a foundation for water resource protection and restoration. Chapter 2 deals with geographic planning, stakeholder involvement, and water quality standards. Chapter 3 focuses on stakeholder outreach, our 5-year planning cycle, and other scheduling issues. The planning cycle includes data assessment, prioritization & targeting, integrated management strategy development, and implementation. This is graphically demonstrated in Figure 3-1, showing the strong commitment to public participation, coordination with other agencies, problem identification and implementation, the role of TMDLs, and goal setting.

Citizen Stream Monitoring Program (CSMP):
The CSMP is a new program. It is designed to be equivalent to Minnesota's Citizens Lake Management Program (CLMP), but focusing on streams and rivers. This program is also wholly based on public participation. A transparency tube is used instead of the secchi disk and user perception measures are gathered similar to the CLMP. The information will be used to address short term questions like seasonal differences in streams and impacts of storm events, and also be used for long term questions like trend analyses basin planning.

Clean Water Action Plan (CWAP):
The CWAP is based on a broad vision of cooperative watershed protection and restoration. The watershed scale focus creates opportunities for comprehensive solutions. One important tool is the creation of Unified Watershed Assessments. This involved coordination with the public, local units of government, other state agencies, many other federal agencies and all of the tribes in the state. State water quality resources were divided into four categories: watersheds needing restoration, watersheds needing protection, watersheds with water resources needing extra measures of protection, and watersheds with insufficient data to determine its category. Minnesota's CWAP, version 1, was published in September 1998.

Clean Water Partnership Program (CWP):
The CWP program was created to address pollution associated with runoff from agricultural and urban areas. It provides local governments with resources to protect and improve lakes, streams, and ground water. CWP projects have two phases: Phase 1 is the resource investigative phase and Phase 2 is the implementation phase. Local sponsors work with the MPCA to collect data and information on the resource and its watershed. These programs strongly emphasize public participation, problem identification, and goal setting.

Environmental Performance Partnership Agreement (EnPPA):
The major subgoal of the MPCA EnPPA for water is protecting Minnesota's rivers, lakes, wetlands, and ground water to meet their designated uses. The basin planning approach is emphasized by delineating the goals of protecting, restoring, and maintaining the chemical, physical, and biotic integrity of the water resources in each major basin planning basin. Each basin has specific environmental objectives. Specific examples include "To increase the

percentage of stream miles in the Lake Superior basin that support aquatic life by 80% by the year 2005"; "To increase the percentage of stream miles in the Minnesota River basin that support aquatic life [using the Index of Biotic Integrity – IBI] to 70% by the year 2005"; and "To increase the percentage of stream miles in the Red River basin that support aquatic life to 80% by the year 2005." These are very specific goals, with the main emphasis on the basin planning approach.

Great Lakes Initiative (GLI) [Minn. R. ch. 7052]:
The process for incorporating the Great Lakes Initiative into the MPCA water quality standards [MN Rules Ch 7052] is an excellent example of the strong commitment the agency has toward public participation and coordination with local units of government, other state agencies, and other federal and international agencies. All our major modifications to our water quality standards, such as the incorporation of toxic standards and wetland water quality standards, follow these same measures to ensure the broadest possible review.

Phosphorus Strategy:
MPCA recognizes that phosphorus is a pollutant of concern, and has developed a seven part strategy: education & outreach to the public, initiate several phosphorus forums, emphasize the watershed approach to deal with the cumulative problems associated with phosphorus, more broadly implement water quality standards, promote lake initiatives focusing on phosphorus, begin to address phosphorus impacts to rivers, and, if necessary, modify the water quality standards.

Minnesota Water Plan (MWP):
The MWP stresses the importance of understanding water's interconnections and integrating governments efforts to address them. The MWP has several ten-year objectives and accompanying recommendations, including "Strengthen efforts to meet the ongoing training needs of local and state water managers and policy makers," "Make comprehensive local water plans a highly visible element of the coordination strategy," and "Address water and related land resource issues from both a major river basin and a smaller watershed perspective." Clearly, the state water goals include maximizing public participation and focusing on basin planning as the important tool to deal with water pollution in an efficient and cumulative way.

Total Maximum Daily Load (TMDL) studies:
The federal Clean Water Act requires states to adopt water quality standards to protect the nation's waters. These standards define how much of a pollutant can be in a surface and ground water and still meet its designated uses, such as for drinking water, fishing, swimming, irrigation, and/or industrial purposes. Many of Minnesota's water resources can not meet their designated uses because of pollution problems from a combination of point and nonpoint sources.

The Clean Water Act requires states to publish a list of streams and lakes every two years that are not meeting their designated uses because of excess pollutants. The list, known as the 303(d) list, is based on violations of water quality standards, and is organized by river basin. The MPCA must complete total maximum daily load (TMDL) studies for all waters on this list.

A TMDL study identifies the sources of each pollutant that result in the exceedence of water quality standards. When conducting a TMDL, all the point sources and all types of the nonpoint sources that contribute are identified. Water quality sampling and computer modeling work are done to determine how much each pollutant must reduce its contribution to assure the water quality standard is met. Individual lakes and streams may require TMDLs for more than one pollutant.

The list of Minnesota's impaired waters include streams throughout the state, including segments of the Mississippi River, the Red River, the Long Prairie River, the Minnesota River, the Chippewa River, the Grindstone River, and the Whitewater River. It also includes a number of lakes in northern Minnesota affected by excess mercury. By establishing TMDLs in these areas, the agency will be able to implement steps to regain designated uses in these waters.

Minnesota's published 1998 303(d) list includes about 100 areas where TMDLs need to be established. These include 13 ammonia, two regional mercury, 18 dissolved oxygen (DO), one chloride, 36 bacteria, and 28 turbidity impacted waters.

The iterative approach to creating TMDLs is to use the simplest method appropriate for the parameter of concern. For streams dominated by nonpoint source pollution that are diffuse and watershed wide in scope, a load or concentration based spreadsheet will usually be the most appropriate approach. For streams dominated by point source pollution and for those streams with atypical hydrology, a complex water quality modeling approach that is very data intensive will usually be the most appropriate approach. The actual approach taken for each TMDL will be based on reach specific concerns, including local preferences. For either approach, a pollutant reduction goal will be established. As implementation proceeds, the reach will be monitored to ensure that the water quality objectives are being achieved. If the selected approach is not succeeding, a more rigorous approach will be developed. The iterative approach to creating and implementing TMDL reduction goals is very much a dynamic process.

ELEMENT 6. *The State reviews, upgrades and implements all program components required by section 319 of the Clean Water Act, and establishes flexible, targeted, iterative approaches to achieve and maintain beneficial uses of water as expeditiously as practicable.*

Minnesota's NSMPP is updated approximately every 5 years. The 1994 NSMPP contained only the ground water strategy of Chapter 4 "Overall Strategy for Each Water Resource." However, the 2001 NSMPP includes a strategy for 4.1 Ground Water, 4.2 Lakes, 4.3 Rivers and Streams and 4.4 Wetlands thereby, providing a more comprehensive view and approach for assessing and addressing nonpoint source pollution control. Chapters 4 through 15 of the 2001 NSMPP provide individual time frames and goals identifying the major water quality concerns of that chapter/strategy.

The Minnesota Pollution Control Agency (MPCA) is proposing a strategy that would integrate the water quality grants and loans process into one system. The MPCA began development by focusing on its funding programs. Other state and federal agencies with water quality funding programs encouraged the agency to broaden the scope of this project to include non-MPCA funding. While these programs fund different activities, they are complementary and would be enhanced through a single process that allocates these funds.

The proposed system would streamline the existing system by combining many of the administrative aspects of these funding programs, including a single funding application, integrated priorities and criteria for funding, and a unified scoring and ranking process. In addition to the proposed system being more accessible by applicants, this would eliminate existing duplication of effort by administering agencies.

The second component of the integrated system is that point source (wastewater projects) and nonpoint source activities be ranked together on a single, prioritized list of projects. The overall funding priorities would focus on priorities established by water resource managers of the states' major drainage basins. The priorities will also incorporate state and federal priorities in the overall system. Considering all applications for multiple funding sources together using one set of criteria and priorities will help ensure that the projects that will be funded will effectively deliver the best environmental results for the money spent.

The Integrated Funding System (IFS) discussed in Chapter 2, "Programs and Funding for Implementing the Nonpoint Source Program" further details approaches to upgrade and improve the NPS program.

ELEMENT 7. *An identification of Federal lands and objectives which are not managed consistently with State program objectives.*

Minnesota's Project Coordination Team (PCT) is comprised of over 20 organizations, including federal agency representatives, providing direction on nonpoint water quality program activities.

Representation of the USDA and US Geological Survey on the PCT promotes and provides the avenue for strong cooperation between state and federal officials to discuss management of federal lands and objectives in concert with the State Program.

The EQB Water Resources Committee, which includes federal government representatives, also periodically prepares a framework water plan. The *Minnesota Water Plan*, developed in 1991, is an ambitious agenda for managing water in the 1990s and beyond. The plan calls for a "focus on the resource" to aid integration among agencies and levels of government. The *Water Monitoring Plan*, developed in 1992, provides a comprehensive focus for water monitoring in Minnesota. The EQB is currently working on the 2000 Minnesota Water Plan which will focus on basin activities in Minnesota's 10 major basins.

The EQB is currently leading an innovative initiative to move Minnesota toward sustainable development. Business and environmental leaders worked on seven teams to recommend more sustainable measures relating to agriculture, energy, forestry, manufacturing, mining, recreation and settlement. The outcome of this effort will result in a more comprehensive approach toward safeguarding the environment.

ELEMENT 8. *Efficient and effective management and implementation of the State's nonpoint source program, including necessary financial management.*

The Project Coordination Team is consulted in the administration of 319 grants and Minnesota's nonpoint source program. MPCA provides staff resources to assist grant recipients and managing the day- to- day financial administration of the nonpoint program.

Minnesota receives approximately $6 million of 319 funds per year with approximately $3 million passed through to local NPS entities.

ELEMENT 9. *A feed back loop whereby the State reviews, evaluates, and revises its nonpoint source assessment and its management program at least every five years.*

Minnesota will update the NSMPP approximately every five years. The feasibility of having Minnesota Basin Management Plans satisfy, in whole or in part, the need for future updates of the NSMPP will be explored with US EPA officials.

APPENDIX B

Best Management Practices - Definitions
Minnesota's 2001 Nonpoint Source Management Program Plan (NSMPP)

The following Best Management Practices (BMPs) are listed by number and title. This list includes definitions of BMPs to more fully describe BMPs and the pollutant minimized. BMPs listed in the Best Management Practices section of most chapters and in Appendix C "BMP Matrix" of this document were taken from the following list. (See Appendix C, "BMP Matrix" to see BMPs used individually or in combination for reducing NPS pollution per chapter/topic.)

PART I: AGRICULTURAL BMPs

Most agriculture BMPs used in Minnesota are based upon the Natural Resources Conservation Service (NRCS) conservation practices described in the NRCS National Handbook of Conservation Practices, and modifications set forth in the Minnesota NRCS Field Office Tech Guide.

1. **Access Road** - A road constructed to minimize soil erosion while providing needed access.

2. **Biological Control of Pests** - Use of natural enemies as part of an integrated pest management (IPM) program which can reduce the use of pesticides.

3. **Brush Management** - Management and manipulation of brush to improve or restore a quality plant cover in order to reduce soil erosion.

4. **Conservation Crop Rotation**- Growing crops in a recurring sequence on the same field to improve the soil, control erosion and pests, balance plant nutrients and provide food for livestock.

5. **Contour Farming** - Farming sloped land on the contour in order to reduce erosion, control water flow, and increase infiltration.

6. **Correct Application of Pesticides** - Spraying when conditions for drift is minimal. Mixing properly with soil when specified. Avoiding application when heavy rain is forecast.

7. **Correct Pesticide Container Disposal** - Following accepted methods for pesticide container disposal.

8. **Critical Area Planting** - Planting vegetation to stabilize the soil and reduce erosion and runoff.

9. **Cultural Control of Pests** - Using cultural practices, such as, elimination of host sites and adjustment of planting schedules, to partly substitute for pesticides.

10. **Deferred Grazing** - Postponing grazing for a prescribed period to improve vegetative conditions and reduce soil loss.

11. **Diversion and Terraces** - Channels with a mound or ridge along the lower side, constructed across a slope to divert runoff water and help control soil erosion. Grassed or lined waterways and subsurface pipes are used to handle water from terrace systems.

12. **Fencing** - Enclosing a sensitive area of land or water with fencing to exclude or control livestock.

13. **Field Border** - A border or strip of permanent vegetation established at field edges to control soil erosion and filter nutrients.

14. **Field Windbreak** - A strip or belt of trees established to reduce wind erosion.

15. **Forest Stand Improvement** – Managing species composition, stand structure and stocking to achieve numerous objectives including restoration of natural communities, improvement of wildlife habitat, and increasing quantity and quality of forest products.

16. **Grade Stabilization Structure** - A structure to control the erosion in natural or constructed channels.

17. **Grassed Waterway or Outlet** - A natural or constructed waterway or outlet maintained with vegetative cover in order to prevent soil erosion and filter nutrients.

18. **Integrated Crop Management** - A crop production system that uses a combination of cultural and/or agronomic measures to produce economic returns while lowering inputs and reducing detrimental effects to the environment.

19. **Integrated Pest Management** - Managing agricultural pests including weeds, insects and disease to reduce adverse effects on plant growth, crop production and environmental resources. Management methods may be a combination of cultural, biological and chemical controls.

20. **Irrigation Water Management** - Determining and controlling the rate, amount, and timing of irrigation water application in order to minimize soil erosion, runoff, water use and fertilizer and pesticide movement.

21. **Lined Waterway or Outlet** - A runoff water channel or outlet with an erosion resistant lining to prevent erosion. Applicable to situations where unlined or grassed waterways would be inadequate.

22. **Use Exclusion** - Excluding livestock and other activities from an area to maintain soil and water resources.

23. **Mulching** - Applying plant residues or other suitable materials to the soil surface in order to reduce water runoff and soil erosion.

24. **Nutrient Management** - Managing the amount, form, placement and timing of plant nutrient applications to maximize uses and reduce detrimental off-site effects.

25. **Pasture and Hayland Management**- Proper treatment and use of pasture land or hay land to prolong life of desirable forage species and protect the soil and reduce water loss.

26. **Pasture and Hayland Planting** - Establishing forage plants to reduce runoff and erosion and produce high quality forage.

27. **Pesticide Selection** - Selecting pesticides which are less toxic, persistent, soluble and volatile, whenever feasible.

28. **Prescribed Grazing** - Controlling grazing to improve plant health and vigor, reduce erosion and improve water quality.

29. **Pond Sealing or Lining** - Installing a fixed lining or impervious materials or using soil treatment to prevent excessive infiltration, water loss and to minimize the potential for ground water contamination.

30. **Residue Management (no till, strip till, mulch till and ridge till)** – Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface year-round.

31. **Residue Management-seasonal -** Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface during part of the year, while growing crops in a clean tilled seedbed.

32. **Resistant Crop Varieties** - Use of plant varieties that are resistant to insects, nematodes, diseases, etc., in order to reduce pesticide use.

33. **Riparian Buffer** - A strip of land varying in width, along streams and other waterbodies in which grass and trees is planted and maintained to filter pollutants from runoff.

34. **Shade Areas** - Lessening the need for animals to enter water for relief from heat by using trees or artificial shelters to provide shade at selected locations.

35. **Slow Release Fertilizer** - Applying slow release fertilizers to minimize nitrogen losses from soils prone to leaching.

36. **Soil Testing and Plant Analysis** - Testing to avoid over-fertilization and subsequent losses of nutrients to surface or ground waters.

37. **Streambank Protection** - Stabilizing and protecting banks of streams, lakes, estuaries, or excavated channels against scour and erosion with vegetative or structural means.

38. **Stripcropping** - Growing crops in a systematic arrangement of strips or bands to reduce water and wind erosion.

39. **Timing and Placement of Fertilizers** - Timing and placement of fertilizers for maximum utilization by plants and minimum leaching or movement by surface runoff.

40. **Tree Planting** - Planting trees, especially on critical or highly erodible areas, to prevent erosion, conserve moisture and reduce water quality impacts.

41. **Vegetative Filter Strip** - A strip of land, varying in width, along streams and other waterbodies in which a lush establishment of grass is planted and maintained to filter pollutants from runoff.

42. **Waste Management System** - A planned system to manage wastes from animal concentrations in a manner which does not degrade air, soil or water resources. Often wastes are collected in storage or treatment impoundments such as ponds or lagoons.

43. **Waste Utilization** - Crediting organic wastes for fertilizer in a manner which improves the soil and protects water resources. May also include recycling of waste solids for animal feed supplement.

44. **Water and Sediment Control Basin** - Earthen embankments constructed across a minor watercourse to form a sediment trap and detention basin.

45. **Water/Feeder Location** - Locating feeders and watering facilities a reasonable distance from streams and water courses, and dispersing them to reduce livestock concentrations, particularly near streams, and to encourage more uniform grazing.

PART II: EROSION AND SEDIMENT CONTROL BMPs

1. **Vegetation Establishment** - Establishment of vegetative cover by planting sprigs, stolons or plugs to stabilize fine-graded areas where vegetation is especially suited to the site and establishment with sod is not preferred.

2. **Brush Barrier** - A temporary sediment barrier composed of limbs, weeds, vines, root mat, soil, rock and other cleared materials pushed together to form a berm; located across or at the toe of a slope to intercept and detain sediment and decrease flow velocities.

3. **Construction Road Stabilization** - Temporary stabilization with stone of access roads, subdivision streets, parking areas and other traffic areas immediately after grading to reduce erosion caused by vehicles during wet weather, and to prevent having to regrade permanent roadbeds between initial grading and final stabilization.

4. **Check Dams** - Small, temporary dams constructed across a drainage ditch to reduce the velocity of concentrated flows, reducing erosion of the swale or ditch. Limited to use in small open channels which drain 10 acres or less; should not be used in live stream.

5. **Critical Area Planting** - Establishment of vegetative cover by planting sprigs, stolons or plugs to stabilize fine-graded areas where especially suited to the site and establishment with sod is not preferred.

6. **Diversion** - A permanent channel with a ridge on the lower side constructed across a slope to reduce slope length and intercept and divert storm water runoff to a stabilized outlet to prevent erosion on the slope.

7. **Dust Control** - Reducing surface and air movement of dust during land disturbance, demolition or construction activities in areas subject to dust problems in order to prevent soil loss and reduce the presence of potentially harmful airborne substances.

8. **Filter Strips** - This practice involves using grassed surfaces to reduce runoff velocities, enhance infiltration and remove runoff contaminants, thus improving runoff quality and reducing the potential for downstream channel degradation and sediment pollution.

9. **Grade Stabilization Structures** - A permanent structure or series of structures designed to step water flow down a slope without causing channel erosion; applicable in natural or man-made channels with long, relatively steep reaches.

10. **Grassed Waterways or Outlets** - This practice involves using grassed surfaces to reduce runoff velocities, enhance infiltration and remove runoff contaminants, thus improving runoff quality and reducing the potential for downstream channel degradation and sediment pollution.

11. **Gravel Inlet Filter** - The installation of various kinds of sediment trapping measures around drop inlet or curb inlet structures prior to permanent stabilization of the disturbed area; limited to drainage areas not exceeding one acre, and not intended to control large, concentrated storm water flows.

12. **Level Spreader** - An outlet for dikes and diversions consisting of an excavated depression constructed at zero grade across a slope to convert concentrated, sediment-free runoff to sheet flow and release it onto areas of undisturbed soil stabilized by existing vegetation.

13. **Mulching** - Application of plant residues or other suitable materials to disturbed surfaces to prevent erosion and reduce overland flow velocities. Fosters plant growth by increasing available moisture and providing insulation against extreme heat or cold. Applicable to all seeding operations, other plant materials which do not provide adequate soil protection by themselves, and bare areas which cannot be seeded due to the season but which still need soil protection.

14. **Outlet Protection** - The installation of paved and/or riprap channel sections and/or stilling basins below storm drain outlets to reduce erosion from scouring at outlets and to reduce flow velocities before storm water enters receiving channels below these outlets.

15. **Paved Flume** - A permanent concrete-lined channel constructed to conduct concentrated runoff from the top to the bottom of a slope without causing erosion on or below the slope.

16. **Permanent Seeding** - Establishment of perennial vegetative cover by planting seed on rough-graded areas that will not be brought to final grade for a year or more or where permanent, long-lived vegetative cover is needed on fine-graded areas.

17. **Riprap** - A permanent, erosion-resistant ground cover of large, loose, angular stone usually underlain by erosion mat or filter fabric installed wherever soil conditions, water turbulence and velocity, expected vegetative cover, etc., are such that soil may erode under design flow conditions.

18. **Silt Fence** - A temporary sediment barrier constructed of posts, filter fabric and, in some cases, a wire support fence, placed across or at the toe of a slope or in a minor drainageway to intercept and detain sediment and decrease flow velocities from drainage areas of limited size; applicable where sheet and rill erosion or small concentrated flows may be a problem. Effective life is six months.

19. **Sodding** - Stabilizing fine-graded areas by establishing permanent grass stands with sod. Provides immediate protection against erosion, and is especially effective in grassed swales and waterways or in areas where an immediate aesthetic effect is desirable.

20. **Sod Inlet Filter** - The installation of various kinds of sediment trapping measures around drop inlet or curb inlet structures prior to permanent stabilization of the disturbed area; limited to drainage areas not exceeding one acre, and not intended to control large, concentrated storm water flows.

21. **Storm Drain Inlet Protection** - The installation of various kinds of sediment trapping measures around drop inlet or curb inlet structures prior to permanent stabilization of the disturbed area; limited to drainage areas not exceeding one acre, and not intended to control large, concentrated storm water flows.

22. **Storm Water Conveyance Channel** - This practice involves using grassed surfaces to reduce runoff velocities, enhance infiltration and remove runoff contaminants, thus improving runoff quality and reducing the potential for downstream channel degradation and sediment pollution.

23. **Straw Bale Barrier** - A temporary sediment barrier composed of straw bales placed across or at the toe of a slope to intercept and detain sediment and decrease flow velocities from drainage areas of limited size; applicable where sheet and rill erosion from low to moderate channel flows may be a problem. Effective life is three months.

24. **Subsurface Drain** - A perforated conduit installed beneath the ground to intercept and convey ground water. Prevents sloping soils from becoming excessively wet and subject to sloughing, and improves the quality of the vegetative growth medium in excessively wet areas by lowering the water table. Can also be used to drain detention structures.

25. **Surface Roughening** - Grading practices such as stair-stepping or grooving slopes or leaving slopes in a roughened condition by not fine-grading them. Reduces runoff velocity, provides sediment trapping and increases infiltration, all of which facilitate establishment of vegetation on exposed slopes. Applicable to all slopes steeper than 3:1 or that have received final grading but will not be stabilized immediately. Also recommended for other exposed slopes.

26. **Temporary Diversion Dike** - A ridge of compacted soil located at the top or base of a sloping disturbed area to divert off-site runoff away from unprotected slopes and to a stabilized outlet, or to divert sediment-laden runoff to a sediment trapping structure.

27. **Temporary Fill Diversion** - A channel with a supporting ridge on the lower side cut along the top of an active earth fill to divert runoff away from the unprotected fill slope to a stabilized outlet or sediment trapping structure; applicable where the area at the top of the fill drains toward the exposed slope and continuous fill operations make the use of a Temporary Diversion Dike unfeasible. Effective life is one week.

28. **Temporary Gravel Construction Entrance** - A gravel pad, located at points of vehicular ingress and egress on a construction site, to reduce the mud transported onto public roads and other paved areas.

29. **Temporary Right-Of-Way Diversion** - A ridge of compacted soil or loose gravel constructed across a disturbed right-of-way or similar sloping area to shorten the flow length within the disturbed strip and divert the runoff to a stabilized outlet. Earthen diversions are applicable where there will be little or no construction traffic within the right-of-way, and gravel structures are applicable where vehicular traffic must be accommodated.

30. **Temporary Sediment Basin** - A basin with a controlled storm water release structure, formed by constructing an embankment of compacted soil across a drainageway, to detain sediment-laden runoff from disturbed areas greater than 5 acres for enough time to allow most of the sediment to settle out. Can be constructed only where there is sufficient space and appropriate topography. Effective life is 18 months unless designed as a permanent pond.

31. **Temporary Sediment Trap** - A small pond area, formed by constructing an earthen embankment with a gravel outlet across a drainage swale, to detain sediment-laden runoff from small disturbed areas for enough time to allow most of the sediment to settle out. Effective life is 18 months.

32. **Temporary Seeding** - Establishment of temporary vegetative cover on disturbed areas by seeding with appropriate rapidly-growing plants on sites that will not be brought to final grade for periods of 30 days to one year.

33. **Temporary Slope Drain** - A flexible or rigid tube or conduit, used before permanent drainage structures are installed, intended to conduct concentrated runoff safely from the top to the bottom of a disturbed slope without causing erosion on or below the slope.

34. **Topsoiling** - Preserving and using topsoil to provide a suitable growth medium for vegetation used to stabilize disturbed areas. Applicable where preservation of importation of topsoil is most cost-effective method of providing a suitable growth medium.

35. **Tree Preservation and Protection** - Protecting existing trees from mechanical and other injury during land disturbing and construction activity to ensure the survival of desirable trees where they will be effective for erosion and sediment control and provide other environmental and aesthetic benefits.

36. **Trees, Shrubs, Vines and Ground Covers**- Stabilizing disturbed areas by planting trees, shrubs, vines and ground covers where turf is not preferred. These plant materials also provide food and shelter for wildlife as well as many other environmental benefits. Especially effective where ornamental plants are desirable and turf maintenance is difficult.

37. **Waterway Drop Structure** - A permanent structure or series of structures designed to step water flow down a slope without causing channel erosion; applicable in natural or man-made channels with long, relatively steep reaches.

38. **Fertilizer Application Control** - This practice involves managing the use of fertilizer so as to keep it on the land and out of our waterways. Implementation will result in maximum effectiveness of the nutrients on vegetation and reduced nutrient loads in our waterways. The practice covers concepts such as public education, the need for soil testing, and the proper timing of fertilizer applications.

39. **Pesticide Use Control** - This practice involves eliminating excessive pesticide use by proper application procedures and the use of alternatives to chemical pest control. The goal is to reduce the load of pesticide-related contaminants in urban storm water runoff. The practice covers legal requirements for pesticide application, methods of application, equipment cleaning, disposal of unused chemicals and empty containers, pesticide storage, alternative pest control methodologies, and public education. Both commercial-scale application and private home use are discussed.

40. **Solid Waste Collection and Disposal** - This practice involves the routine management and handling of urban refuse, litter and fallen leaves in ways that will prevent their becoming water pollutants. Recommendations range from municipal trash and leaf collection and disposal operations to public education concerning collecting procedures and schedules to concepts such as recycling wastes. Responsibility for implementation lies equally with the municipality and the citizenry.

41. **Source Control on Construction Sites** - This practice encourages the use of good management and "housekeeping" techniques on construction sites to reduce the availability of construction-related pollutants that contaminate runoff water and, where runoff contamination cannot be avoided, to retain the pollutants and polluted water on the site. Concepts covered include erosion and sediment control, equipment maintenance and repair, storm sewer inlet protection, trash collection and disposal, the use of designated washing areas for cleaning equipment, proper material storage, dust control at demolition sites, use of proper sanitary equipment and pesticide use control.

42. **Street Cleaning** - This practice involves sweeping, vacuuming, flushing, or otherwise cleaning streets, parking lots and other paved vehicular traffic areas. The objective is to remove dry-weather accumulations of pollutants, especially fine particulate matter, before washoff can occur, thus reducing the potential for pollution impacts on receiving waters. In the past, street cleaning operations were conducted primarily for aesthetic purposes; however, they are now known to be an effective method for improving the quality of runoff when utilized during the appropriate time of the year.

43. **Concrete Grid and Modular Pavement** - This practice involves the use of a special pervious paving material in low traffic areas. The pavement consists of concrete grids or other structural units alternated with pervious fillers such as sod, gravel or sand. The resultant pavement provides an adequate bearing surface and yet allows a significant amount of infiltration thereby reducing runoff volume, discharge rate, pollutant load and improving the water quality.

44. **Detention Basins** - This practice involves the construction or modification of surface water impoundments in a manner which will protect downstream areas from potential water quality degradation, flooding, and stream channel degradation due to upstream urban development. The objective is to detain storm water and release it at a controlled rate. Downstream water quality is improved through sediment removal, plant uptake of nutrients, chemical transformation, and other processes.

45. **Exfiltration Trenches** - This practices involves the excavation of pits or trenches which are backfilled with sand and/or graded aggregates. Storm water runoff from impervious surfaces can be directed to these facilities for detention and infiltration. Permeable soils are a prerequisite. The potential for ground water pollution must also be carefully evaluated.

46. **Grassed Waterway (Swale)** - This practice involves using grassed surfaces to reduce runoff velocities, enhance infiltration and remove runoff contaminants, thus improving runoff quality and reducing the potential for downstream channel degradation and sediment pollution.

47. **Parking Lot Storage** - This practice involves the use of impervious parking areas or landscape islands as temporary impoundments during rainstorms. Parking lot storm water systems can be designed to temporarily detain storm water in specially designated areas, and release it at a controlled rate. The objective is to protect downstream areas from increased flooding, stream channel degradation and pollutant loads caused by urban development. It is important that these facilities be designed to minimize potential safety hazards and inconvenience to motorists and pedestrians.

48. **Porous Pavement** - This practice involves the use of a special asphaltic or concrete paving material which allows storm water to infiltrate at a high rate. Infiltration water is stored below the pavement in a high-void aggregate base. This practice provides for storm water detention and, in some cases, increases infiltration into the ground. Use of the practice can

contribute to reduced sewer overflows, decreased flooding and stream channel degradation, and improved water quality. This type of pavement offers many other benefits not related to water quality, including enhanced visibility, increased safety and reduced drainage system costs.

49. **Retention Basins** - This practice pertains to the construction of infiltration reservoirs or basins (usually dry) to provide complete on-site storage of a specific volume of storm water runoff. For pollution control purposes, these facilities are usually designed and constructed to divert and percolate runoff volume associated with the first flush of storm water pollutants leaving the site. The practice incorporates both pollution control and ground water recharge concepts into the design. Such facilities are practical wherever permeability is sufficient to allow rapid percolation between storms. Potential ground water contamination may be a problem associated with these systems and must always be considered in their design.

50. **Rooftop Runoff Disposal** - This practice encourages the disposal of rooftop runoff by systems and techniques that avoid or replace direct connections of roof drainage systems to storm sewer systems. The objective is to help reduce storm sewer flows. Proposed alternatives to sewer connection include surface drainage through swales, subsurface infiltration, and runoff collection and storage.

51. **Storage/Treatment Facilities** - This practice involves the use of some water treatment unit operations applied at such a scale that they are less involved and less costly than treatment plant technology. These procedures are most applicable when used in conjunction with other BMPs to remove contaminants from collected storm water. Unit operations considered applicable are the physical processes of settling, filtration, and screening; and the chemical processes of flocculation and disinfection.

52. **Underdrain Storm Water Filter Systems** - This practice usually consists of a conduit, such as a pipe and/or a travel filled trench which intercepts, collects, and conveys drainage water following infiltration and percolation through the soil, suitable aggregate, and/or filter fabric. Underdrain or filtration systems may be used in combination with a variety of storm water management measures where space, soil permeability or high water table conditions limit the magnitude of pollutant removal that can be achieved through natural percolation, sedimentation, or other means. Pollutant removal primarily occurs as the prescribed volume of storm water passes through the sand, gravel, and filter cloth which usually surrounds the conduit.

PART III: OTHER CULTURAL AND STRUCTURAL BMPs

BMPs listed under Part III are defined by their title.

53. Adequate Containers for On-Site Solid Waste

54. Aeration of Lawns

55. Compost Production and Use

56. Correct Use of Soils for Septic Tanks

57. Dry Weather Flow Testing of Storm Sewers and Ditches

58. Increase Flow Distances

59. Lane Absorption Areas and Use of Natural Systems

60. Leash Laws and Clean Up After Your Pet Programs

61. Maintain Set Backs From Surface Waters

62. Maximum Recycling of Solid Waste

63. Prompt Clean-Up of Chemical Spills

64. Proper Installation of Septic Tanks and Drainfields

65. Proper Maintenance of Motorized Equipment

66. Routine Maintenance of Septic Tank Systems

67. Soil Testing and Plant Analysis

68. Training for Pesticide Home Applicators

69. Waste Treatment System, Publicly Owned Treatment Works (POTWs)

Additional Water Quality Protection BMPs

- Alum treatments of lakes to stop internal loading once watershed inputs have been addressed
- Storm water chemical treatment systems (alum addition system that treats storm water in-line using alum to remove phosphorus, or ponds that use polymer addition to bind phosphorus)
- NPS ordinances (phosphorus fertilizer use restrictions)
- Wetland restoration
- Rock drain tile inlets
- Land idling/retirement

APPENDIX C

Best Management Practices (BMP) Matrix

BMPs Listed by Chapter Commonly Used for Nonpoint Source Pollution Control

This Best Management Practices (BMPs) matrix is a compilation of BMPs listed in individual Chapters of the 2001 NSMPP. This list helps to illustrate that many BMPs, individually or in combination can be used effectively for many nonpoint pollution sources. Most of the BMPs listed below are from the Natural Resources Conservation Service (NRCS) formally (Soil Conservation Service) Field Office Technical Guide Volume 4.

The BMPs including their definitions are in Appendix B, Best Management Practices of this document. (NOTE: Chapters 12 Forestry and 13 Mining include discussions of BMPs in the chapters and are not included in this Matrix.)

BMP Matrix

BMP	CH 7 Feedlots	CH 8 Ag Erosion	CH 9 Ag Nutrients	CH 10 Agl Pesticides	CH 11 Urban Runoff	CH 14.1 ISTS	14.2 Biosolids By-Products Com. Waste
Part I. Agricultural BMPs							
1. Access Road		X					
2. Biological Control of Pests				X			
4. Conservation Crop Rotation		X	X	X			
5. Contour Farming	X	X					
6. Correct Application of Pesticides				X			
7. Correct Pesticide Container Disposal				X			
8. Critical Area Planting	X	X					
9. Cultural Control of Pests				X			
10. Deferred Grazing	X						
11. Diversions and Terraces	X	X					
12. Fencing	X	X				X	
13. Field Border		X					
14. Field Windbreak		X					
16. Grade Stabilization Structure		X					
17. Grassed Waterway or Outlet	X	X					
19. Integrated Pest Management				X			
20. Irrigation Water Management		X	X				
21. Lined Waterway or Outlet	X	X					
22. Use Exclusion	X	X					
23. Mulching		X					
24. Nutrient Management	X		X				X
25. Pasture and Hayland Management	X	X					
26. Pasture and Hayland Planting	X	X					
27. Pesticide Selection				X			
28. Prescribed Grazing	X	X					
30. Residue Management (annual)		X					
31. Residue Management (seasonal)		X					

BMP	CH 7 Feedlots	CH 8 Ag Erosion	CH 9 Ag Nutrients	CH 10 Agl Pesticides	CH 11 Urban Runoff	CH 14.1 ISTS	14.2 Biosolids By-Products Com. Waste
Part 1 Agricultural BMPs, (continued)							
32. Resistant Crop Varieties				X			
33. Riparian Buffer	X	X					
34. Shade Areas	X						
35. Slow Release Fertilizers			X				X
36. Soil Testing and Plant Analysis	X		X				X
37. Streambank Protection		X					
38. Stripcropping		X					
39. Timing and Placement of Fertilizers			X				X
40. Tree Planting		X					
41. Vegetative Filter Strip	X	X					
42. Waste Management System	X						
43. Waste Utilization	X						X
44. Water and Sediment Control Basin	X	X					
45. Water/Feeder Location	X						

BMP	CH 7 Feedlots	CH 8 Ag Erosion	CH 9 Ag Nutrients	CH 10 Ag Pesticides	CH 11 Urban Runoff	CH 14.1 ISTS	CH 14.2 Biosolids By-Products Com. Waste
Part II Erosion and Sediment Control BMPs							
1 Vegetation Establishment					X	X	
2 Brush Barrier					X		
3 Construction Road Stabilization					X		
4 Check Dams					X		
5 Critical Area Planting					X		
6 Diversion					X		
7 Dust Control					X		
8 Filter Strips	X		X		X		
9 Grade Stabilization Structures					X		
10 Grassed Waterways or Outlets					X		
11 Gravel Inlet Filter					X		
12 Level Spreader	X				X		
13 Mulching					X		
14 Outlet Protection					X		
15 Paved Flume					X		
16 Permanent Seeding					X		
17 Riprap					X		
18 Silt Fence					X	X	
19 Sodding					X		
20 Sod Inlet Filter					X		
21 Storm Drain Inlet Protection					X		
22 Storm Water Conveyance Channel					X		
23 Straw Bale Barrier					X		
24 Subsurface Drain	X				X		
25 Subsurface Roughening					X		
27 Temporary Fill Division					X		
28 Temp. Gravel Construction Entrance					X		
29 Temporary Right-Of-Way Diversion					X		
30 Temporary Sediment Basin					X		
31 Temporary Sediment Trap					X		
32 Temporary Seeding					X		
33 Temporary Slope Drain					X		
34 Topsoiling					X	X	
35 Tree Preservation and Protection					X		
36 Trees, Shrubs, Vines and Ground Covers					X		
37 Waterway Drop Structure					X		
38 Fertilizer Application Control			X		X		
39 Pesticide Use Control					X		
40 Solid Waste Collection and Disposal					X		
41 Source Control on Construction Sites					X		
42 Street Cleaning					X		
43 Concrete Grid and Modular Pavement					X		
44 Detention Basins					X		

BMP	CH 7 Feedlots	CH 8 Ag Erosion	CH 9 Ag Nutrients	CH 10 Ag Pesticides	CH 11 Urban Runoff	CH 14.1 ISTS	CH 14.2 Biosolids By-Products Com. Waste
Part II BMPs (continued)							
45 Exfiltration Trenches					X		
46 Grassed Waterway (Swale)					X		
47 Parking Lot Storage					X		
49 Retention Basins					X		
50 Rooftop Runoff Disposal	X				X		
51 Storage/Treatment Facilities	X				X		
52 Underdrain Storm Water Filter Systems	X				X		
Part III Other Cultural and Structural BMPs							
50 Adequate Containers for On-Site Solid Waste					X		
55 Compost Production and Use	X				X		
56 Correct use of soils for septic systems					X	X	
57 Dry Weather Flow Testing of Storm Sewers and Ditches					X		
58 Increase Flow Distances					X		
59 Lane Absorption Areas and Use of Natural Systems	X				X		
60 Leash Laws and Clean Up After Your Pet Programs					X		
61 Maintain Set Backs From Surface Waters	X				X		X
62 Maximum Recycling of Solid Waste					X		
63 Prompt Clean-Up of Chemical Spills					X		
64 Proper Installation of Septic Tanks and Drainfields					X	X	
65 Proper Maintenance of Motorized Equipment					X		
66 Routine Maintenance of Septic Tank Systems					X	X	
67 Soil Testing and Plant Analysis					X		
68 Waste Treatment System, Publicly					X		

Additional Water Quality Best Management Practices:

- alum treatments of lakes to stop internal loading once watershed inputs have been addressed
- stormwater chemical treatment systems (lake alum addition system that treats stormwater in-line using alum to remove phosphorus, or ponds that use polymer addition to bind phosphorus)
- NPS ordinances - like phosphorus fertilizer use restrictions and broader categories of NPS ordinances (zoning provisions, permitted/non-permitted and conditional uses)
- rock drain tile inlets
- land idling/retirement

APPENDIX D

Minnesota 2001–2005 Nonpoint Source Management Program Plan

Summary of Public Participation

Development of the NSMPP
The 19 chapters/strategies of the Minnesota 2001 – 2005 Nonpoint Source Management Program Plan (NSMPP) were developed by 19 technical committees, chairs and co-chairs. Collectively, technical committees were comprised of over 250 members representing 50 federal and state agencies, local units of government and public and private organizations.

Noticing of the Draft NSMPP
Prior to the beginning of the public comment period, a notice was published in the *Minnesota State Register*, providing public notification that the Draft Minnesota NSMPP was available for public review and comment. The notice also informed the public where the document could be reviewed.

The public comment period for the Draft began January 22 and closed February 23, 2001.

Public notices announcing the availability of the draft NSMPP were also provided through:

- MPCA statewide press releases to newspapers, radio and television stations
- Notices to most Soil and Water Conservation Districts and Watershed Districts in Minnesota
- Notices to the leadership of environmental organizations with requests that their members be notified

Format of the Draft NSMPP
To encourage public outreach, the draft NSMPP was available for public review in four formats.

- MPCA's website (over 1,000 hits)
- Compact Disk
- Paper Copies
- E-mailing of individual chapters/strategies

Public comments received at the MPCA were distributed to technical committee chairs and co-chairs for consideration. After consideration, draft chapters/strategies were revised as appropriate, resulting in the final Minnesota 2001–2005 Nonpoint Source Management Program Plan.

Appendix E

Federal Assistance Programs and Development Projects for Consistency with the Minnesota 2001 Nonpoint Source Management Program Plan (NSMPP)

Executive Order 12372

The federal consistency provisions in Section 319 of the Clean Water Act (CWA) authorize each State to review Federal activities for consistency with the state nonpoint source (NPS) management program in accordance with Executive Order 12372. Much of the consistency criteria pertain to use of federal lands.

The state of Minnesota has long considered consistent application of nonpoint source management practices to be critical on all lands, be they private or public lands owned by the local, state, or federal governments. As part of the process to ensure that, a number of steps have been taken. They include official interagency agreements as well as both formal and informal project coordination and review efforts.

Section 319(b)(2)(F) requires states to identify federal financial assistance programs and development projects which will be reviewed for their effect on water quality consistent with the state NPS Management Program.

At this time, the federal financial program that most clearly relates to the NPS Management Program is the Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP). A state technical committee has been formed where consultations on EQIP activities take place.

Minnesota intends to maintain the current structure but will work with the U.S. Environmental Protection Agency, under a process separate from the Nonpoint Source Management Program Plan, if needed.

APPENDIX F

STATE OF MINNESOTA

OFFICE OF THE ATTORNEY GENERAL

MIKE HATCH
ATTORNEY GENERAL

SUITE 900
445 MINNESOTA STREET
ST. PAUL, MN 55101-2127
TELEPHONE: (651) 297-1075

June 8, 2001

RECEIVED
JUN 11 2001

Elizabeth Shevi, Division Director
Policy and Planning Division
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, Minnesota 55155-4194

Re: Attorney General Certification
State of Minnesota Nonpoint Source Management Program Plan

Dear Ms. Shevi:

I am the state's attorney of record in the development and adoption of the State of Minnesota Nonpoint Source Management Program Plan (NSMPP) in accordance with Section 319 of the Clean Water act. I make this certification on behalf of the State of Minnesota, by and through its Minnesota Pollution Control Agency (MPCA).

I certify that the NSMPP was duly adopted in accordance with Minnesota law, and that the state, by and through its MPCA, has adequate authority to administer and implement the standards, policies and procedures adopted therein. The applicable law includes, but is not limited to, Minn. Stat. chapters 115 and 116 and Minnesota Rules, chapters 7000, 7001, and 7050.

Thank you in advance for your cooperation and consideration in this matter.

Sincerely,

Paul Merwin

PAUL MERWIN
Assistant Attorney General

(651) 297-8754

AG: 482731,v. 01