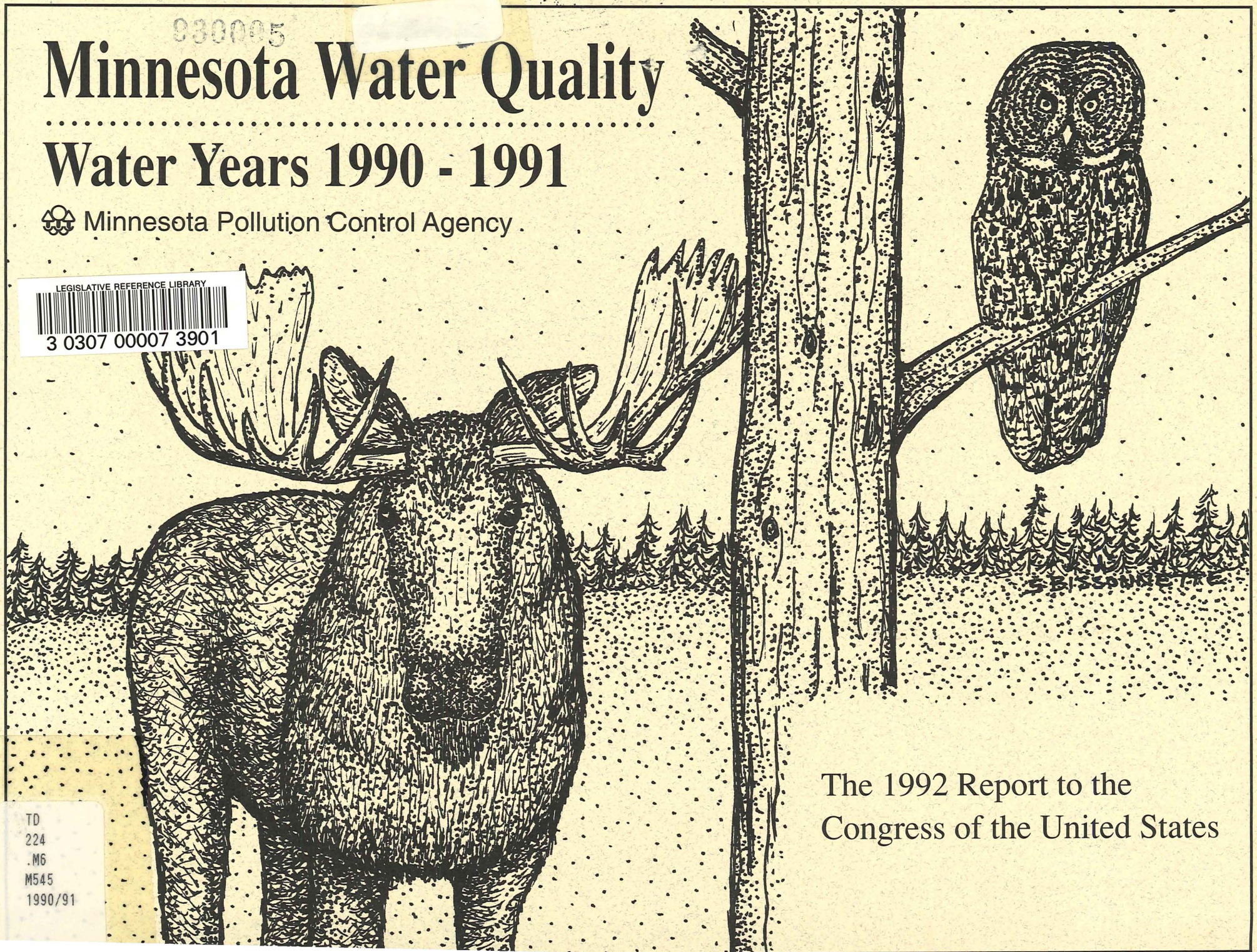
Minnesota Water Quality

Water Years 1990 - 1991

Minnesota Pollution Control Agency



The 1992 Report to the
Congress of the United States

Minnesota Water Quality

Water Years 1990 - 1991

**The 1992 Report to the Congress
of the United States of America
by the State of Minnesota
Pursuant to Section 305(b) of the
Federal Water Pollution Control Act**

Minnesota Pollution Control Agency

St. Paul, Minnesota 55155

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The following list of appendices is included to aid the reader in cases where the text refers to an appendix number. However, none of these appendices are included in this published report. All the appendices are available by requesting the 1992 305(b) Report Appendices from:

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PART I: EXECUTIVE SUMMARY

Background

The Clean Water Act was signed into law 20 years ago. Its passage has changed the face of America. Congress was reacting to public outrage at the pollution evident in the nation's rivers when it passed this legislation in 1972. The goals of the Clean Water Act — fishable, swimmable waters — quickly became part of our national vocabulary.

As our knowledge and technology has expanded, the U. S. Environmental Protection Agency (EPA) has further defined the "fishable" goal to include (1) maintaining support for all aquatic organisms and (2) ensuring that fish are safe for human consumption.

This report provides the EPA and Congress with a biennial summary of Minnesota's progress in meeting the goals of the Clean Water Act. The report contains assessments of the quality of state waters, descriptions of current water pollution control programs, and identification of future needs. This document also provides general information to the public and serves as a water quality management tool for state agencies and local water planning efforts.

Defining and Supporting Water Uses

The essence of a water quality program is to protect the beneficial uses of water. Minnesota's waters are classified for a variety of uses: to provide habitat for fish and aquatic wildlife; to supply drinking water; to serve recreational, agricultural, industrial, or navigational needs. When waters are able to be used according to their classification, their uses are said to be supported. Much of this report will describe how well these uses are supported.

Standards are set and must be maintained for a given use to be supported. As required by the 1987 amendments to the Clean Water Act, Minnesota's standards were amended in 1990 to include both numerical standards for 53 toxic pollutants and detailed procedures that can be used to establish criteria for additional toxic pollutants. Lakes and streams are monitored to determine if these water quality standards are being met. In addition, other criteria and objectives are used to determine whether a waterbody is suitable for recreational use, whether the fish caught there can be eaten, and whether it is impacted by nonpoint source pollution.

Rivers

River segments totaling 4,634 miles were assessed for this report. Out of the 91,944 total river miles in the state, the assessed segments have been selected to be monitored for a variety of purposes—these include obtaining spatial coverage, providing background information for other pollution control activities, and to do specific surveys near treatment plants or other areas of concern. The assessments in this report are done using all of these monitoring results combined, which means this is only a very general overview of the water quality of Minnesota's rivers. Twenty-four percent of the assessed miles fully support all designated uses. Assessments for specific uses show that 55 percent of assessed miles fully support aquatic life (fish and other organisms) and 48 percent fully meet the swimming goal. Where standards are not met, nonpoint source pollution (polluted runoff) is affecting 3,545 river miles and point source pollution (municipal and industrial dischargers) affects 891 river miles. The pollutants most frequently found in rivers are metals, nutrients, and fecal bacteria.

Lakes

A trophic status assessment was done for 1,753 of Minnesota's 11,842 significant lakes (as defined by the Minnesota Department of Natural Resources in its Protected Waters Inventory). This represents 15 percent of the lakes and 51 percent of the lake acres in the state. The assessment indicates that 68 percent of the lake acres fully support the swimming goal. Pollution affecting lakes in the south and central regions of the state comes primarily from nutrients in agricultural runoff. In the northeastern part of the state the primary concern is atmospheric deposition which leads to increased mercury contamination of fish.

Fish Consumption

Fish tissue was examined from rivers and lakes that are heavily fished and in areas where there is reason to believe contamination will be found. This means the fish tissue results are not representative of all Minnesota waters. In the lakes that were assessed, 2 percent of the lake acres fully support the fish consumption goal, 98 percent partially support (indicating some restrictions on consumption), and less than 1 percent do not support fish consumption. For the river miles assessed for fish consumption, 9 percent fully support that use, 65 percent partially support, and 26 percent do not support fish consumption.

Lake Superior

Lake Superior, which represents 10 percent of the world's freshwater supply, is the cleanest of the Great Lakes. However, it does have problems, primarily from pollution caused by persistent bioaccumulative toxic substances. Several initiatives are under way to address this problem.

The International Joint Commission (IJC) has established for binational toxic substance management the philosophy of zero discharge. The EPA Region V Great Lakes Initiative encompasses a variety of activities, of which the foremost is the development of water quality criteria. The Lake Superior Partnership is a public-private initiative with the broad goals of eliminating the discharge of pollutants to Lake Superior through pollution prevention and other methods. The St. Louis River and harbor of Lake Superior are classified as an Area of Concern by the IJC. The St. Louis River Remedial Action Plan (RAP) is being developed by scientists and interested citizens from Minnesota and Wisconsin to define actions and timetables to restore the beneficial uses of the area through pollution source controls and remediation of environmental problems.

Ground Water

A large majority of the citizens of Minnesota rely on ground water for good quality drinking water. The existing water quality data base indicates that human land use activities have introduced such contaminants as volatile organic compounds, pesticides, and high nitrate concentrations into a number of important aquifers in the state. The Minnesota Department of Agriculture pesticide monitoring program has detected pesticides in 58 of the 232 wells in the program. Atrazine detections account for 95 percent of the detections.

Nitrate is commonly found in Minnesota well water at levels exceeding the drinking water standard. While shallow wells in geologically sensitive areas showed higher levels of nitrate, newly constructed wells and municipal wells showed a lower percentage of high nitrate concentrations.

The MPCA is implementing a monitoring program designed to integrate data analysis techniques with site selection to improve trend and regional assessment capabilities for resource managers. A range of programs is in place to encourage or require better management practices in land use, control leaking underground storage tanks, and remediate serious point sources of contamination.

Wetlands

In spite of the heightened awareness of the beneficial function of wetlands in the containment and cleansing of natural waters, economic pressures continue to encourage the destruction of wetlands for other uses. Wetlands in Minnesota are critical to the protection of the water quality of the state's vast lake resources.

Historically, stemming the loss of wetlands by regulatory efforts has been stymied by lack of a common method of defining wetlands. Even though major federal agencies established a uniform definition in 1989, EPA has recently proposed definition changes that would put a significant amount of wetland area at risk in the state.

In 1991, Minnesota strengthened wetland preservation by both executive order and legislative initiative. These actions include provision for state assumption of the Clean Water Act 404 permit program, which is currently administered by the Corps of Engineers. Additionally, the responsible agencies are simplifying the application process for permitting activities in regulated wetlands and providing more effective oversight.

New Directions for Pollution Control

In the 20 years since the passage of the Clean Water Act, control of point source discharges has been greatly improved by the construction and operation of wastewater treatment facilities for cities and industries. This infrastructure must be maintained and updated as necessary. The focus of pollution control, however, will shift to more diffuse nonpoint source pollution and to toxic pollutants.

This shift in focus will require a parallel shift in the way water programs are conducted. The methods that were used successfully to bring point source pollution into control will not be sufficient to curb nonpoint source pollution and control toxics.

Monitoring programs, upon which environmental priorities are set, will need to become broader. Assessments will need to more fully integrate what is known about the biological, chemical, and physical integrity of a waterbody in order to provide the data for decisions that can maximize environmental results.

Cooperation among federal, state, and local levels of government, as well as citizen involvement, will be required to cope with the challenges of the future. Some of the activities and studies that are leading the way toward new directions for pollution control in Minnesota arelisted below:

- A recently completed study on Nitrogen in Minnesota's Ground Water identified best management practices associated with various sources of nitrogen and the need for long-term monitoring to assess nitrate trends over time and further identify problem areas.
- The MPCA is the lead agency for the Minnesota River Assessment Project, a four-year multi-agency comprehensive study of the Minnesota River and its tributaries. This study will provide information needed to develop specific water quality goals for the river and target pollution control practices in areas with the most pollution.
- Minnesota is implementing the NPDES permit program for storm water discharges. In the absence of federal funding, however, the scope of this program will necessarily be limited to the highest priority areas.
- The MPCA has developed River Watch/Water Watch partnerships with citizen volunteers and local governments who want to participate in monitoring and protecting their local waters.
- The MPCA is moving towards the integration of surface water monitoring, planning, and management on a watershed basis. Such an approach focuses on the whole resource, takes into account the various interconnections, and deals with water pollution problems in a comprehensive manner.

Looking Ahead

The data in this report reflect the improvement in water quality that has been achieved by control of point source discharges during the past 20 years. The work that has begun on controlling nonpoint source pollution, protecting ground water, and preventing toxic accumulations is both innovative and complex. It will take time before results from these programs are reflected in the monitoring data collected for this report.

There is much work yet to be done to totally achieve the goals of the Clean Water Act. However, much progress has been made. This anniversary year of the Clean Water Act is a good time to recognize the accomplishments of the past 20 years and to move forward with new programs to improve water quality for all Minnesotans.

PART II: BACKGROUND

Minnesota's water wealth includes 91,944 river miles, 3,290,101 acres of lakes and reservoirs (not including Lake Superior), and approximately 7,500,000 acres of wetlands. Headwaters in Minnesota drain to Lake Superior, Hudson Bay, and the Mississippi River. Minnesota's total stream estimate is based on digitized center traces of most streams, rivers, and ditches shown on 1:24,000 and 1:62,500 scale maps. As a result, it is a larger number of miles than the Environmental Protection Agency's Reach File 3 estimate of 72,595 total stream miles, based on features shown on United States Geological Survey 1:100,000 scale maps. Minnesota's estimate of lake acreage is only slightly larger than the Reach File 3 estimate of 3,208,328 acres. Figures II-1 and II-2 display some basic geographic information about Minnesota, and the dimensions of the waterbodies that form much of the state's boundaries.

Table II-1. Summary of Classified Uses

	Total Size Classified for Use		
Classified Use	Rivers (miles)	Lakes (acres)	Lake Superior (shoreline miles)
Aquatic fish and wildlife	91,144	3,290,101	272
Domestic water supply	3,900*	636,600*	272
Recreational	91,144	3,290,101	272
Agricultural	91,144	3,290,101	272
Industrial	91,144	3,290,101	272
Navigational	91,144	3,290,101	272
Nondegradation**	All	All	All
Limited Resource Value Waters	800		
Total	**91,944**	**3,290,101**	**272**

* Figures for total acres of water in Boundary Waters Canoe Area Wilderness are included in the lake acreage figure and not in the river mileage

** The level of protection provided by the nondegradation provision depends on the nature of the discharge and the characteristics of the receiving water

The state encompasses some of the most pristine waterbodies in the country. Because of the vast water surface area in the state, Minnesotans enjoy enormous recreational opportunities for fishing, boating, swimming, and diving. An important aspect of the economy depends on tourism, as state residents share these resources with enthusiasts from out of the area. Clearly, while Minnesota possesses abundant water resources, the people of the state have a considerable investment in protecting these waters.

In Minnesota, the designated uses of a waterbody are determined by its attainable water quality. There are seven use classes of water defined for the state. Table 1 provides a breakdown of river miles and lake acres by classified uses. As the table shows, all lakes in Minnesota are designated for fishable and swimmable use. All rivers are classified for agricultural, navigational, and industrial use, while 99 percent of Minnesota river miles are classified for fishable and swimmable use. Each use has a specific set of water quality standards that must be maintained in order for the waterbody to support that particular use. If these standards are not met, the waterbody is said to be not supporting or partially supporting the use, depending on how often the standards associated with the use are violated.

Figure II-1. Minnesota Background Information, 1992

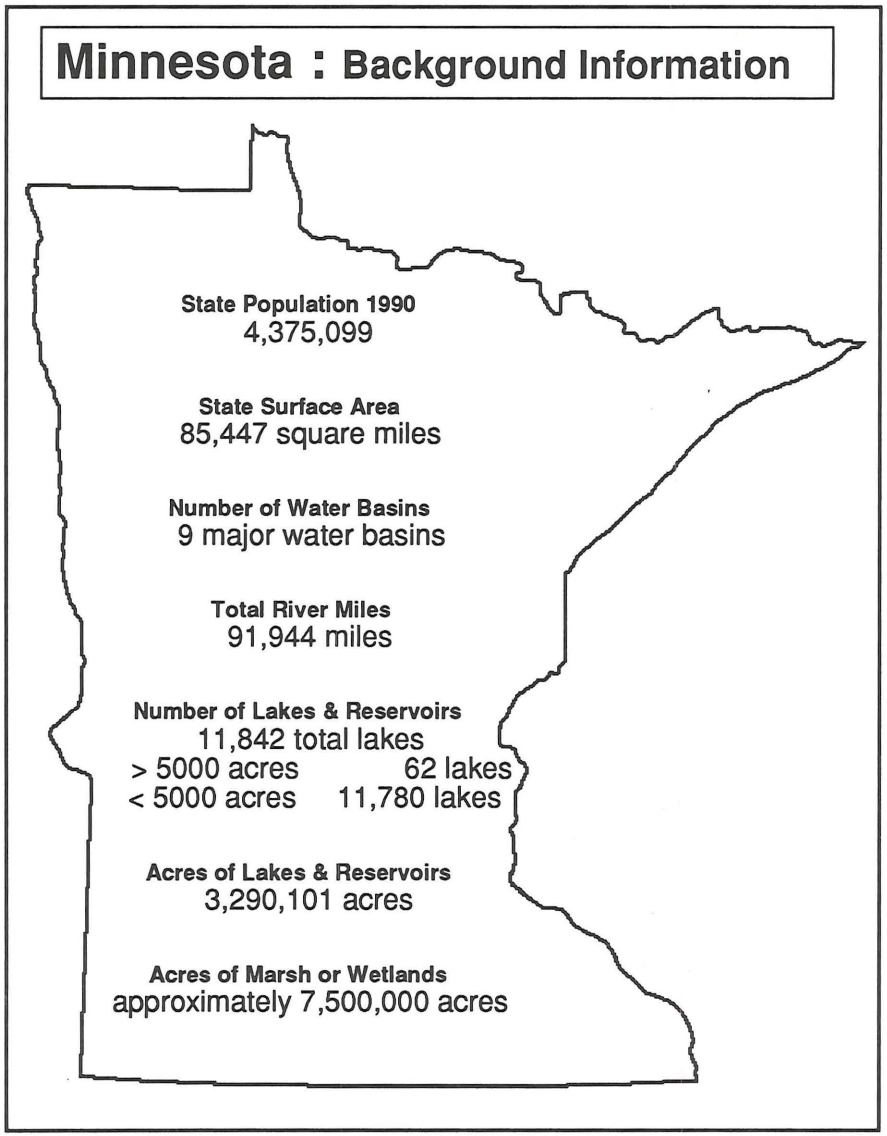
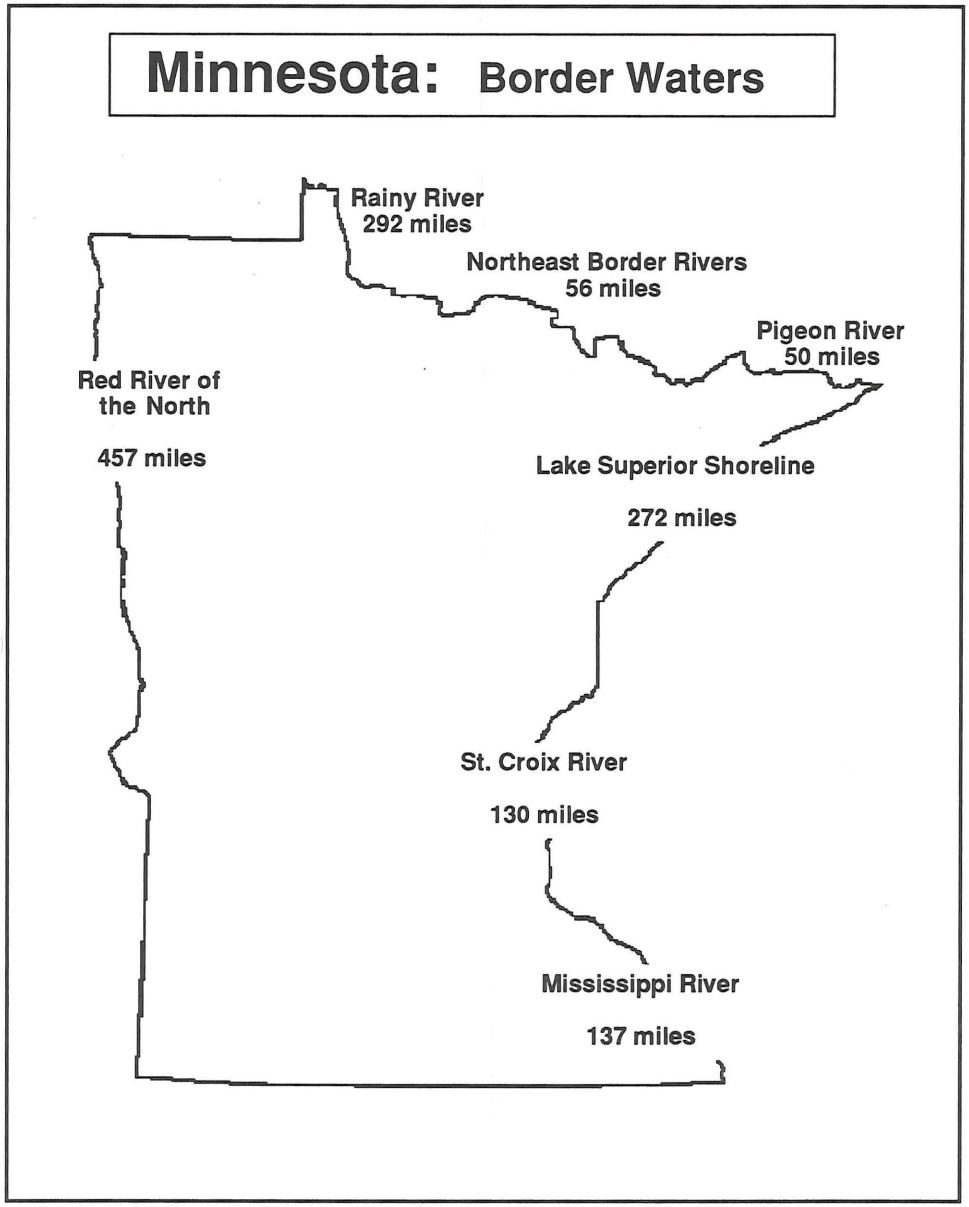


Figure II-2. Minnesota Border Waters



PART III: SURFACE WATER ASSESSMENT

Chapter One: Methodology

Background

Two types of data were used to determine use support assessments for this report. The first type of data is monitoring data, which includes water chemistry data for streams, fish tissue data for lakes and streams, lake assessments, and stream data that may reflect nonpoint source (NPS) pollution. The data was collected from both routine monitoring stations and intensive survey stations. Data from all monitored waterbodies is included in this report, but is not necessarily representative of the state's waterbodies. The second type of data was obtained from a survey of local resource managers who were asked to identify waterbodies that were threatened or impaired by NPS pollution.

For those waterbodies where both types of data were collected, separate assessments were made for each data source. The summary tables on use support in the following chapters are based on monitoring data.

Use Support Determination

Use support assessment for waterbodies with monitoring data was developed separately for each beneficial use:

Aquatic Life Use:

Support determination is based on the level of violations of ambient standards for the conventional pollutants (dissolved oxygen, pH low and high, and turbidity) and on the level of violations of acute or chronic and acute toxicity standards for unionized ammonia, arsenic, cadmium, chloride, chromium, lead, nickel, selenium and zinc.

Fully supporting: Less than 10 percent of conventional pollutant values violate standards AND no toxic violations within a three year period, if data for that pollutant is less than monthly, or no more than one violation within a three year period, if monthly data is available.

Partially supporting: Greater than 10 percent but less than 25 percent of conventional pollutant values violate standards AND toxic violations meet fully supporting provisions above.

Not supporting: Greater than 25 percent of conventional pollutant values violate standards OR one or more toxic violations within a three year period, if data for that pollutant is less than monthly, or two or more violations within a three year period, if monthly data is available.

Fish Consumption Use:

Fully supporting: No fish consumption advisories are in effect.

Fully supporting, but threatened: No fish consumption advisories are in effect. Lakes are in this category based on the likelihood of atmospheric deposition of mercury in the area.

Partially supporting: "Restricted consumption" advisory in effect for the general population or a subpopulation that could be at greater risk (e.g. women of child-bearing age and children).

Not supporting: "No consumption" advisory in effect for the general population.

Swimmable Use:

- For streams, support is based on level of violations of ambient standards for fecal bacteria.

Fully supporting: Less than 10 percent of values violate standards.

Partially supporting: Greater than 10 percent but less than 25 percent of values violate standards.

Not supporting: Greater than 25 percent of values violate standards.

- For lakes, support is based on Carlson's Trophic Status Index (TSI) ranges for use support determined by correlation of the index with user perception surveys.

Fully supporting: TSI less than 59.

Partially supporting: TSI equals 60-65.

Not supporting: TSI greater than 65.

All Uses:

Support is based on level of support for aquatic life, fish consumption use and swimmable use and on level of violations of ambient standards for conductivity (which are used to establish support of agricultural and wildlife uses).

Fully supporting: Aquatic life, fish consumption and swimmable uses are all fully supporting and less than 10 percent of conductivity values violate standards.

Partially supporting : One or more assessed uses are partially supported and remaining uses are fully supported.

Not supporting: One or more assessed uses are not supported or greater than 25 percent of conductivity values violate standards.

NPS Survey Use Support Determination

Use support for the NPS survey assessments was determined as follows:

Respondents evaluated waterbodies for actual uses and for potential uses with codes from the following table:

If the actual or potential use is:	Indicate:
Fishing (poor)	S
Fishing (moderate)	T
Fishing (good)	U
Fishing (unique)	V
Swimming (poor)	W
Swimming (good)	X
Unknown	Y
Other	Z

Codes S,T,U and V are used to determine aquatic life support. Codes W and X are used to determine swimmable support.

Within each of the two uses, aquatic life use and swimming use, the following rules were used:

–If the code for actual use and the code for potential use agree, then the use is determined to be fully supported.

–If there is an actual use code present, but different from the potential use code, then the use is determined to be partially supported.

–If there is no actual use code present, but there is a potential use code, then the use is determined to be not supported.

–If there is neither an actual use code or a potential use code, then no assessment is made.

For unknown and other uses, the same rules as above apply, except that it is not possible to make a determination of partially supported. To determine overall use support, the most restrictive of the single-use support determinations is used.

Biological monitoring data was not used to determine use support. However, biological monitoring protocols are currently being developed by MPCA staff and this information will be incorporated into future assessments of use support.

Part III, Chapters Two through Four include the following summary tables:

- Overall Use Support Summary ;
- Individual Use Support Summary ;
- Total (Waterbody Type) Not Fully Supporting Uses, Listed by Cause Categories ; and
- Total (Waterbody Type) Not Fully Supporting Uses, Listed by Source Categories.

These tables provide summaries of use support for the three major waterbody types, which are rivers and streams (Chapter Two), lakes (Chapter Three), and Great Lakes (Chapter Four).

Chapter Two: Rivers and Streams

Water Quality Summary

Minnesota's rivers and streams are used for a variety of purposes. Some of these purposes are specifically mentioned in the Clean Water Act. The fishable and swimmable goals of the Clean Water Act specify that all navigable waters be clean enough for swimming, boating and the protection of fish and wildlife. In addition to these recreational and aquatic-life support uses, the rivers of Minnesota are also used for agriculture, industry, navigation, and in some areas as a supply of drinking water.

For each of these uses, the Minnesota Pollution Control Agency (MPCA) sets specific water quality standards. Depending on the frequency of exceedance of the standards, the river is said to be not supporting, partially supporting or fully supporting for that use. Support for fish consumption use is based on level of contamination of fish tissue, as described in Part III, Chapter Six: Public Health/Aquatic Life Concerns. To determine overall use support, the most restrictive of the single-use support determinations was used. Table III-1, Overall Use Support Summary, gives the total number of miles in each support category for all assessed uses. Table III-2, Individual Use Support Summary, gives the total number of miles in each support category for the following uses: fish consumption, aquatic-life support, and swimming and secondary contact. These tables represent rivers for which there is water quality monitoring data, but are not necessarily representative of all the state's rivers.

Table III-1. Summary of **Overall Use Support**

River Miles with Violations of Chronic Toxicity Criteria

Degree of Use Support	Assessment Basis Evaluated	Monitored	Total Assessed
Fully Supporting	99.1	989.3	1,088.4
Partially Supporting	475.8	678.7	1,154.5
Not Supporting	396.4	1,994.4	2,390.8
TOTAL	971.3	3,662.4	4,633.7

River Miles with Violations of Acute Toxicity Criteria

Degree of Use Support	Assessment Basis Evaluated	Monitored	Total Assessed
Fully Supporting	108.6	1,074.7	1,183.3
Partially Supporting	475.8	713.3	1,189.1
Not Supporting	386.9	1,874.4	2,261.3
TOTAL	971.3	3,662.4	4,633.7

Table III-2. Summary of **Individual Use Support**

River Miles with Violations of Chronic Toxicity Criteria

Use	Supporting	Partially Supporting	Not Supporting
Fish Consumption	181.6	1,194.1	484.8
Aquatic Life Support	1,917.9	429.8	1,160.0
Swimming	1,696.0	488.3	1,323.5

River Miles with Violations of Acute Toxicity Criteria

Use	Supporting	Partially Supporting	Not Supporting
Fish Consumption	181.6	1,194.1	484.8
Aquatic Life Support	2,123.2	410.1	974.4
Swimming	1,696.0	488.3	1,323.5

Table III-3. Total River Miles Not Fully Supporting Uses, Listed by Cause Categories

River Miles with Violations of Chronic Toxicity Criteria

CAUSE CATEGORY	CONTRIBUTION TO IMPAIRMENT MAJOR	MODERATE/MINOR
Unknown Toxicity	0	473.1
Priority Organics	21.6	1,345.2
Metals	250.4	1,800.8
Ammonia	0	628.4
Nutrients	0	1,653.1
pH	16.8	571.4
Organic Enrichment/DO	80.8	1,230.6
Salinity/TDS/Chlorides	9.6	652.9
Pathogen Indicators	166.3	1,818.5
Suspended Solids	0	948.8

River Miles with Violations of Acute Toxicity Criteria

CAUSE CATEGORY	CONTRIBUTION TO IMPAIRMENT MAJOR	MODERATE/MINOR
Unknown Toxicity	0	473.1
Priority Organics	21.6	1,345.2
Metals	232.8	1,589.6
Ammonia	0	628.4
Nutrients	0	1,575.8
pH	16.8	571.4
Organic Enrichment/DO	80.8	1,213.3
Salinity/TDS/Chlorides	22.7	639.8
Pathogen Indicators	166.3	1,818.5
Suspended Solids	0	902.9

As stated in Part III, Chapter One: Methodology, one or more toxic violations in a three-year period results in a determination of nonsupport of aquatic life use for that waterbody. The Environmental Protection Agency (EPA) suggests that acute toxicity criteria (what EPA calls "criteria continuous concentration,"or the CCC) be used to make this determination. The MPCA believes it is important also to make this type of determination using the stricter chronic toxicity criteria (what EPA calls "criteria maximum concentration," or CMC). For each of the tables in this chapter, there is one table which uses chronic toxicity criteria and one which uses acute toxicity criteria. Percentages of use support reported in the executive summary and use support status listed in Appendix 1, Table of All Assessed Waterbodies, Monitoring Data, use the more restrictive chronic toxicity criteria.

Causes and Sources of Nonsupport

There are many possible pollutants that interfere with the use of a river. These are called the causes of nonsupport or the "pollution kinds." A river may be affected primarily by one cause, in which case the cause is listed in Table III-3 as a "major impact", or the river may be affected by several causes, each of which is then listed as a "moderate/minor impact." Those rivers with more than one cause of nonsupport will have mileages listed under as many causes as apply. As shown in Table III-3, the pollutants most frequently identified in Minnesota rivers were metals, nutrients and fecal coliform, a bacterial indicator.

Violations of toxicity criteria for aluminum were identified throughout the state, but were not

included in determining use support status as reflected in the tables in this chapter. Aluminum standards violations occurred in many waterbodies where aquatic life was judged to be unimpacted. MPCA staff plan to further investigate the possible causes of these aluminum violations and the degree of potential impact on aquatic life.

Pollutants come from a variety of sources. Point sources, or discharges from a pipe, include discharges from municipal wastewater treatment plants and industrial dischargers. Nonpoint sources, or polluted runoff, include agricultural runoff and runoff from construction sites, forestry areas, mining sites and urban streets and parking lots. Table III-4 does not specify types of runoff.

A river may be affected primarily by one source, in which case the source is listed in Table III-4 as a "major impact" or the river may be affected by several sources, each of which is then listed as a "moderate/minor impact." The mileage for a river with more than one source of pollution will be listed under as many sources as apply.

Table III-4. Total River Miles Not Fully Supporting Uses, Listed by Source Categories

River Miles with Violations of Acute Toxicity Criteria

SOURCE CATEGORY	CONTRIBUTION TO IMPAIRMENT MAJOR	MODERATE/MINOR
Industrial Point Sources	76.5	29.6
Municipal Point Sources	363.8	402.7
Nonpoint Sources-unspecified	3,018.1	432.3

River Miles with Violations of Chronic Toxicity Criteria

SOURCE CATEGORY	CONTRIBUTION TO IMPAIRMENT MAJOR	MODERATE/MINOR
Industrial Point Sources	76.5	29.6
Municipal Point Sources	382.5	402.7
Nonpoint Sources-unspecified	3,113.0	432.3

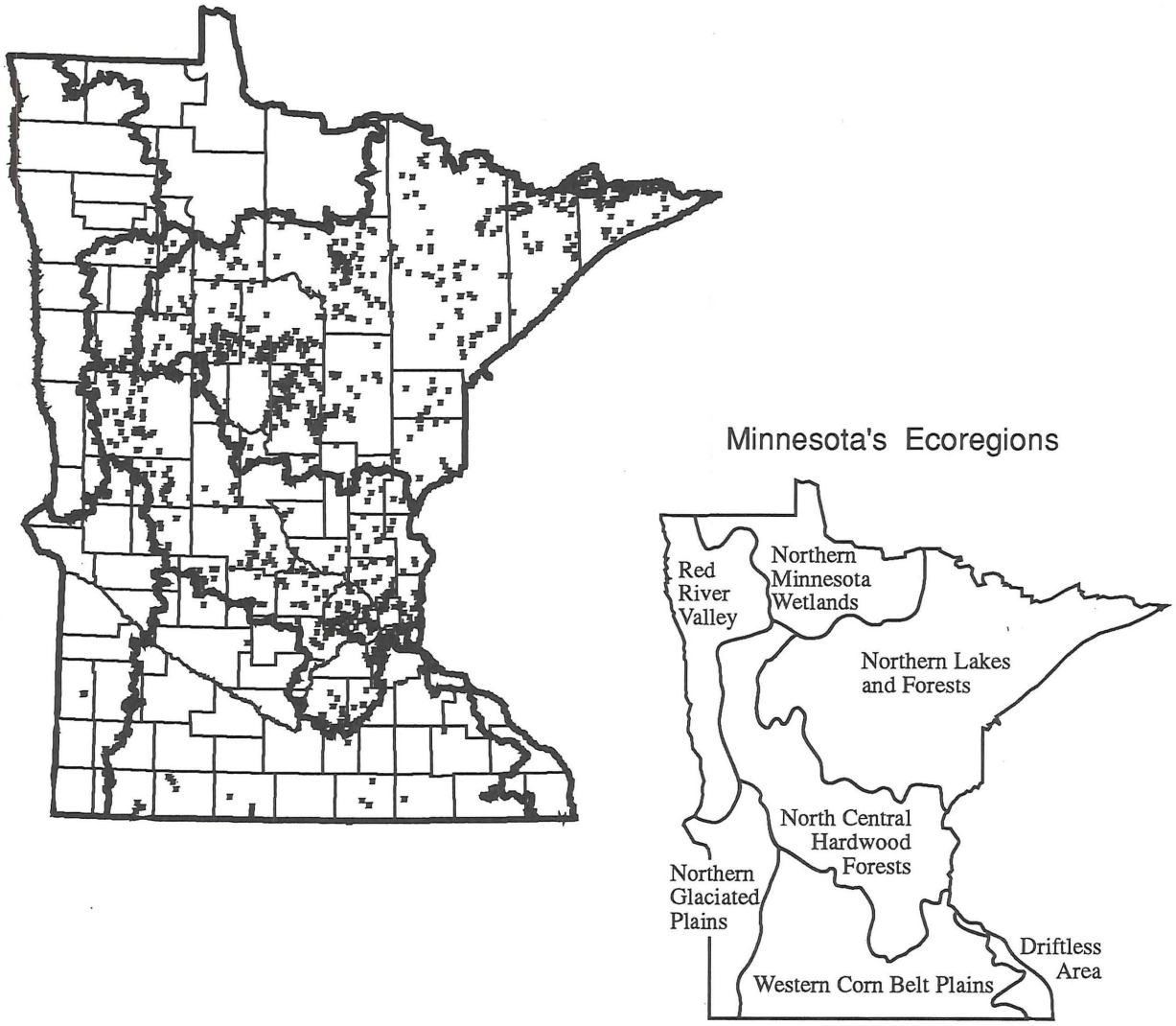
Chapter Three: Lakes

Background

Minnesota, "Land of 10,000 Lakes," is really the land of 11,842 lakes, encompassing 3,290,101 acres. Of this number, 62 (less than 1 percent) have surface areas greater than 5,000 acres. However, these lakes represent approximately 1,000,000 acres, or roughly 30 percent of the total. A majority of the lakes (70 percent) have surface areas between 10 to 100 acres. Our definition of "significant lakes" would be any lake greater than or equal to 10 acres in size that is publicly owned. In general, these lakes are identified as Protected Waters by the Minnesota Department of Natural Resources in their Inventory of Protected Waters and Wetlands (1984-1985) and is the basis for the previously cited numbers and acreage of lakes in the state.

Ninety-eight percent of Minnesota's lakes occur in four of the state's seven ecoregions: Northern Lakes and Forests, North Central Hardwood Forest, Northern Glaciated Plains, and Western Corn Belt Plains. Land use varies by region. The Northern Lakes and Forests is dominated by forests, with some water and marsh, while the Northern Glaciated Plains and Western Corn Belt Plains are primarily cultivated with some pasture and open land. The North Central Hardwood Forest ecoregion consists of a mixture of land uses. The subsequent lake data assessment will focus on these four ecoregions. Figure III-1 depicts the distribution of lakes included in this assessment.

Figure III-1. Locations of Lakes used in the 1992 Assessment, and Ecoregions.



Assessment Procedures/Definitions

Lake data collected during the past 21 years (1970 - 1991) and accessible through the United States Environmental Protection Agency's Storage and Retrieval Water Quality Base (STORET) was used in this assessment.

The primary focus of this portion of the assessment is on lake trophic state and its relationship to support-nonsupport of designated uses, specifically swimming and aesthetics. The variables used for assessing trophic state were epilimnetic total phosphorus, chlorophyll-a and Secchi transparency. Available data were analyzed as follows:

Monitored - Lakes with "summer" data collected between calendar years 1982 through 1991 (inclusive), with summer defined as the time period between June 24 - September 30. Summer data are preferred for assessment purposes as they generally correspond to maximum productivity of the lake, yield the best agreement between trophic variables and reflect the period of maximum use of the resource. Summer means were then calculated for each variable.

Evaluated - Lakes not meeting monitored criteria but with total phosphorus, chlorophyll-a and/or Secchi transparency measurements collected between 1970 - 1981. Summer season is used for calculating mean chlorophyll-a and Secchi transparency. Mean total phosphorus was calculated from data collecting during the "open water" season (May - November). Expanding the "season" for total phosphorus measures allowed for the inclusion of a large number of lakes in northern Minnesota which were sampled only during spring or fall turnover as a part of our acid rain lake-monitoring efforts.

Trophic Status was assessed for each lake using Carlson's Trophic State Index (TSI). This index was developed from the interrelationships of summer Secchi transparency and epilimnetic concentrations of chlorophyll-a and total phosphorus. TSI values are calculated as follows:

Secchi disk TSI (TSIS)= 60 - 14.41 ln (SD);
Total phosphorus TSI (TSIP)= 14.42 ln (TP)+4.15;
Chlorophyll-a TSI (TSIC)= 9.81 ln (Chl-a) =30.6;
(with chlorophyll-a and total phosphorus in micrograms per liter (µg/l) and Secchi disk transparencies in meters).

The resulting index values generally range between zero and 100 with increasing values indicating more eutrophic conditions. The TSI scale and support status corresponding are noted in Figure III-2 (Carlson TSI Scale). For this assessment, individual TSIs were calculated for each variable and then averaged to yield a single TSI for each lake.

Threatened/Impaired

The threatened or impaired status and supporting, partial supporting, and non-supporting status was assessed in terms of aesthetics and swimmable conditions. This portion of the assessment does not deal with the "fishable" status of the water. The assessment of aesthetics and "swimmability" is derived from the Minnesota Lake Water Quality Assessment Report (1988). This work relates user perception in terms of the physical appearance and recreational suitability of a lake to trophic status indicators. It should be noted that the user perception survey was distributed during June, July and August in conjunction with the Citizen Lake-Monitoring Program. Definitions for the different types of support are as follows:

Fully supporting: Lakes fully supporting should exhibit "impaired swimming" conditions less than 10 percent of the time and, in terms of physical condition, should exhibit "high algal levels" less than 10 percent of the time.

Fully supporting - threatened: These lakes may exhibit "impaired swimming" conditions 11-25 percent of the time and high algal levels 11-25 percent of the time.

Partial support - impaired: These lakes may exhibit "impaired swimming" 26-50 percent of the time and "no swimming" 11-25 percent of the time. In terms of physical condition these lakes may exhibit "high algal" levels 26-50 percent of the time.

Non-support - impaired: These lakes will exhibit "no swimming" conditions greater than 25 percent of the time and "no recreation possible" on occasion. In terms of physical condition these lakes will exhibit "high algal" levels greater than 50 percent of the time.

Using these criteria for defining support versus non-support, staff related "user perceived" conditions to the lake trophic status as derived from the Minnesota Pollution Control Agency's (MPCA) regional lake monitoring program. Based on that assessment, we have selected the following TSI categories as a basis for determining support, non-support, etc. Lakes with an average (average of available TSI indicators) TSI less than 50 will be classified as fully supporting swimmable and aesthetic uses. From a trophic standpoint this would correspond to oligo-mesotrophic conditions (Figure III-2). Lakes with an average TSI between 51-59 will be classified as supporting but threatened. This TSI range corresponds to

Table III-5. Lake Observer Survey.

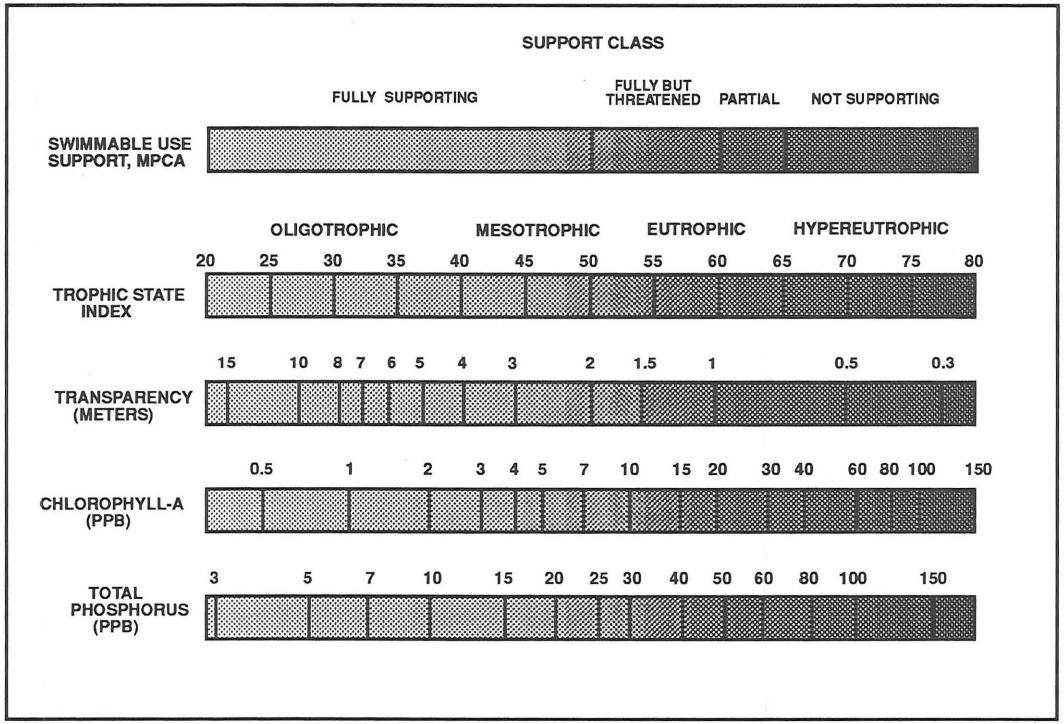
A. Please circle the one number that best describes the physical condition of the lake water today:

1. Crystal clear water.
2. Not quite crystal clear, a little algae present/visible.
3. Definite algal green, yellow or brown color apparent.
4. High algal levels with limited clarity and/or mild odor apparent.
5. Severely high algae levels with one or more of the following massive floating scums on lake or washed up on shore, strong odor, or fish kill.

B. Please circle the one number that best describes your opinion on how suitable the lake water is for recreation and aesthetic enjoyment today:

1. Beautiful, could not be any nicer.
2. Very minor aesthetic problems; excellent for swimming, boating enjoyment.
3. Swimming and aesthetic enjoyment slightly impaired because of algae levels.
4. Desire to swim and level of enjoyment of the lake substantially reduced because of algae levels (would not swim, but boating okay).
5. Swimming and aesthetic enjoyment of the lake nearly impossible because of algae levels.

Figure III-2. Carlson TSI Scale Used to Determine Swimmable Use in Lakes



MPCA SWIMMABLE USE SUPPORT CRITERIA RELATIVE TO CARLSON'S TROPHIC STATE INDEX . GRAPH ADAPTED FROM "LAKE AND RESERVOIR RESTORATION GUIDANCE MANUAL", ED. BY L. MOORE, AND K. THORNTON, USEPA. EPA 440/5-88-002 , (NALMS,1988).

"mildly" eutrophic lakes. Lakes with an average TSI from 60-65 were classified as partially supporting but impaired. This range corresponds to a transition between eutrophic-hypereutrophic conditions. Lakes with an average TSI greater than 65 will be classified as non-supporting. Lakes in this range are frequently considered hypereutrophic.

The TSI level we have selected as a basis for determining "impaired" use, i.e. TSI greater than 60 appears to be reasonable from a statewide perspective for Minnesota. Lakes with a TSI of 60 or greater will typically exhibit Secchi transparencies less than one meter and summer average chlorophyll-a concentrations greater than 20 ppb (Figure III-2). Chlorophyll-a concentrations greater than 20 ppb are generally considered "nuisance blooms."

Some regional differences in user perception do exist in Minnesota and are not reflected in the selection of a single TSI value (i.e. 60) as a basis for determining "impaired use." For example, lake users in the Northern portion of Minnesota (i.e. Northern Lakes and Forests ecoregion) tended to associate the survey response "swimming and aesthetic enjoyment slightly impaired" (survey response B-3 in Table III-5)

with a measured transparency of about 2.0 m or less. In contrast, lake users in the southern portion of the state (Western Corn Belt Plains) associated the same response with transparencies of less than one meter. Thus, a TSI of 60 (i.e. transparency less than one) would be considered "impaired conditions" by virtually all lake users, statewide.

Acres Assessed

A total of 1,729,357 acres or approximately 51 percent of the state's lake acres are included in the swimmable use assessment. Approximately 15 percent (1,753) of the state's lakes by number are included in this assessment. This represents an increase of 193,172 acres over that assessed in the 1990 report. Total acres monitored were 1,053,392 (representing 1,057 lakes). This represents an increase of 185,691 acres over that reported as monitored in the 1990 report.

Support for the fish consumption use is based on level of contamination of fish tissue, as described in Part III,Chapter Six: Public Health/Aquatic Life Concerns. From 1980 through 1991, 357 lakes representing 2,223,028 acres, or 65 percent of total lake acreage were sampled for contaminants in fish.

To determine overall use support, the most restrictive of the single use support determinations was used. Table III-6, Overall Use Support Summary for lakes, gives the total numbers of lake acres in each support category for all assessed uses.

Table III-7, Individual Use Support Summary for lakes, gives the total number of acres in each support category for fish consumption and for swimming.

Based on this assessment the majority of the lake acres (67 percent) fully support swimmable uses, while another 18 percent fully support but are

Table III-6. **Overall Use Support** Summary
Lake Acres

Degree of Use Support	Assessment Basis Evaluated	Monitored	Total Assessed
Fully Supporting	124,495.0	206,783.8	331,278.8
F/S but Threatened *	63,474.0	100,148.0	163,622.0
Partially Supporting	178,271.0	2,017,745.8	2,196,016.8
Not Supporting	86,138.0	105,762.0	191,900.0
TOTAL	452,378.0	2,430,439.6	2,882,817.6

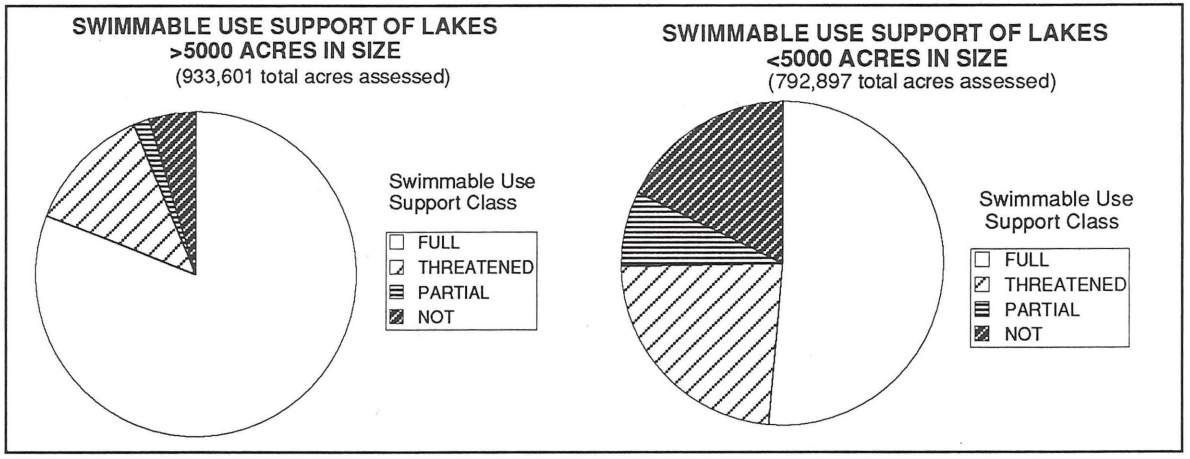
*Size Threatened is a distinct category of waters and is not a subset of the size fully supporting uses. It should be added into the totals entered in the last line.

Table III-7. **Individual Use Support** Summary
Lake Acres

Use	Supporting	Supporting but Threatened*	Partially Supporting	Not Supporting	Unassessed
Fish Consumption	46,670.8	1,132.0	2,168,356.8	6,869.0	
Swimming	1,167,640.0	301,814.0	74,361.0	185,542.0	

*Size Threatened is a distinct category of waters and is not a subset of the size fully supporting uses.

Figure III-3 . Swimmable Use Support for Large and Small Lakes



threatened. The remainder either partially support or do not support swimmable uses.

For lakes with surface areas less than 5,000 acres, 792,994 acres were assessed for swimmable use. This represents 1,713 lakes which corresponds to about 14 percent of the lakes in the state with surface areas less than 5,000 acres. Of this number 508,698 acres (1,030 lakes) were monitored. In the 1990 report 437,765 acres corresponding to 873 lakes were monitored.

For lakes with surface areas, greater than 5,000 acres, 933,604 acres were assessed for swimmable use. This represents 40 lakes, which corresponds to 65 percent of the lakes with surface areas greater than 5,000 acres. Of this number, 544,712 acres (27 lakes) were monitored. This compares to 429,936 acres (25 lakes) monitored in the 1990 305(b) report.

Figure III-3 shows the relative use support for assessed lakes less than 5,000 acres and for lakes greater than 5,000 acres. In terms of numbers of lakes, 58 percent of the lakes greater than 5,000 acres fully supported uses, while about 8 percent did not support. For lakes less than 5,000 acres, 48 percent fully supported uses, while 19 percent did not support.

Trophic Status and Swimmable Use Support by Ecoregion

The relative trophic status of Minnesota's lakes based on the numbers of assessed lakes is presented in Figure III-4. In terms of lakes, 48 percent would be considered oligo or mesotrophic.

The ecoregion framework provides us with an opportunity to examine spatial trends in trophic status and use support of Minnesota lakes. It allows us to relate lake resources present in each region with some of the morphometric and watershed constraints which may affect the ability of those lakes to support the swimmable use. It also allows for a relative assessment of the importance of point source versus nonpoint sources of pollution in each region. Figure III-4 shows the distribution of assessed lakes by ecoregion.

All lakes designated as fully supporting swimmable use, with the exception of one lake, are located in either the Northern Lakes and Forest or North Central Hardwood Forests ecoregions . The majority of lakes designated as supporting but threatened (97 percent) or partially supporting-impaired (97 percent) are also located in these two regions. Lakes designated as non-supporting of swimmable use are found in each ecoregion, with the majority (65 percent) in the Central Hardwood Forests. Table III-8 provides a breakdown of assessed lakes by ecoregion.

In the Northern Lakes and Forests ecoregion, 6 percent (57 lakes) of the assessed lakes were impaired. The primary cause of

Table III-8. Lake Assessment Summary By Ecoregion

(Values from the 1990 report in parentheses)

Characteristic	Northern Lakes and Forests	North Central Hardwood Forests	Western Corn Belt Plains	Northern Glaciated Plains
Number of lakes total:	5,558	4,765	577	855
Number of lakes assessed:	960 (866)	674 (541)	84 (64)	33 (27)
Percent of total:	17%	14%	15%	4%
Number of lakes monitored:	496 (408)	473 (355)	47 (34)	27 (23)
Percent of assessed:	52%	70%	56%	82%
Number of acres assessed:	1,213,592 (1063,685)	380,26 (350,491)	82,661 (72,359)	49,469 (49,040)

Figure III-4. Trophic Status of Lakes by Ecoregion

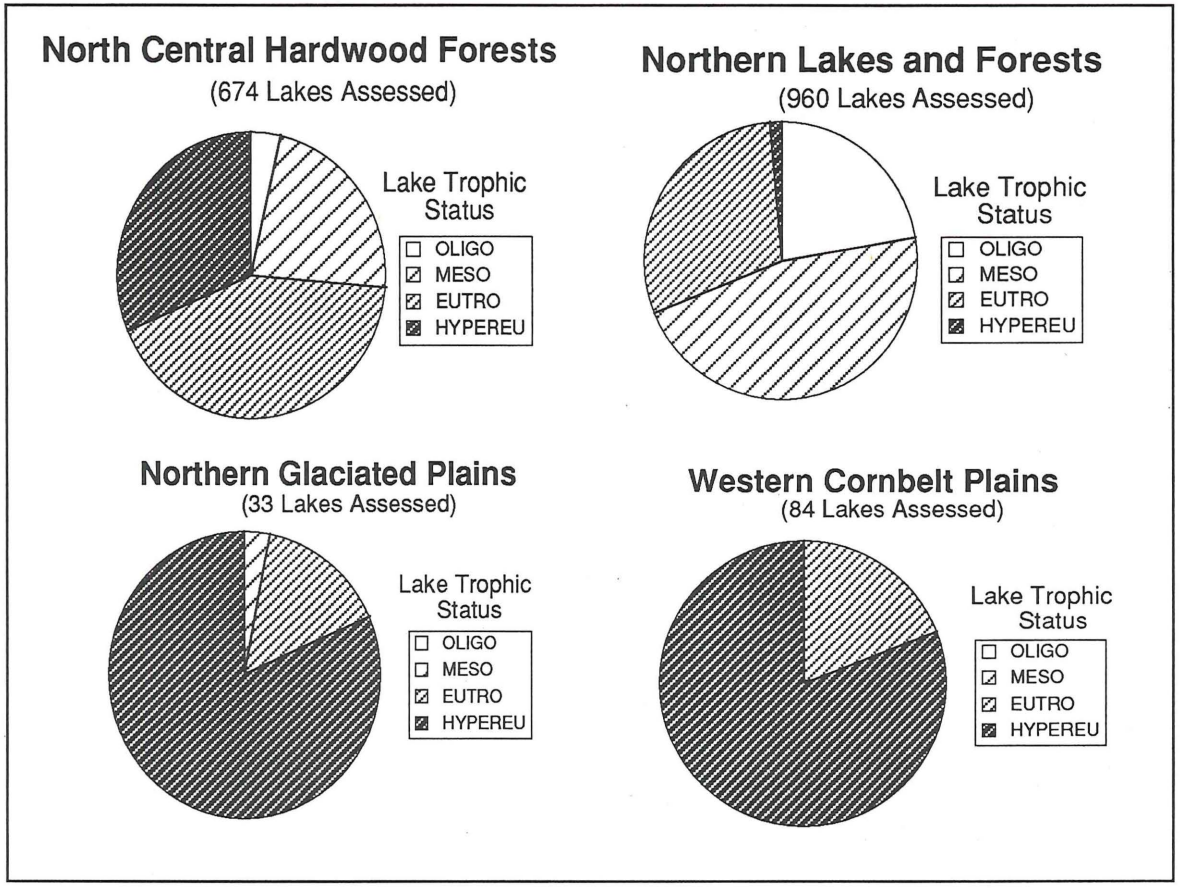


Table III-9. Total Lake Acres Not Fully Supporting Uses Listed by Source Categories

SOURCE CATEGORY	CONTRIBUTION TO IMPAIRMENT MAJOR	MODERATE/MINOR
Municipal Point Sources	285,365.0	
Nonpoint Sources-unspecified	2,102,551.8	

nonsupport in 10 percent of these lakes was point source discharges, with nonpoint sources accounting for the remainder.

In the North Central Hardwood Forests ecoregion, 44 percent (299 lakes) of the assessed lakes were impaired. The primary cause of nonsupport in 17 percent of these lakes was point source dischargers, with nonpoint source pollution (NPS) accounting for the remainder.

In the Western Corn Belt Plains ecoregion, 90 percent (76 lakes) of the lakes assessed were impaired. This is largely a function of the shallow depth of the lakes and the impact of agricultural NPS pollution. Of those lakes considered to be impaired, 17 percent have or had point source discharges to them.

In the Northern Glaciated Plains ecoregion, virtually all lakes (91 percent) are impaired. Again, this is largely due to the shallowness of the lakes, in conjunction with the high level of nutrients received by the lakes through agricultural runoff.

Although no culturally acidified lakes have been identified in Minnesota, the MPCA has assessed 1,153 lakes for acid sensitivity. Virtually all (95 percent) of the 218 assessed lakes threatened by acid deposition are located in the Northern Lakes and Forests ecoregion. In the Northeastern portion of the ecoregion, acid sensitive lakes are found in areas with little topsoil over granitic bedrock formations. Other acid sensitive lakes are found in the same ecoregion, but in moraine areas.

Table III-9 summarizes the assessed sources of nonsupport designated for Minnesota lakes. It indicates nonsupport for the overall use, including both swimming and fish consumption. It shows a relatively greater impact on lakes from nonpoint sources than from point sources.

Relative Assessment of Major Pollutants Causing Nonsupport of Designated Uses

An assessment of major pollutants causing nonsupport of the designated uses was made. The parameters chosen as pollution indicators were: pH and nutrients (e.g., total phosphorus and nitrite-nitrate). Measures such as chlorophyll-a and transparency can be related to nutrient levels in lakes. Based on monitored and evaluated data, nutrients are the primary pollutant found to be causing nonsupport in lakes with phosphorus being the most significant. Since agricultural runoff is the most significant source of nutrients in Minnesota's lakes, it appears that NPS agricultural pollution should be a primary area of concern.

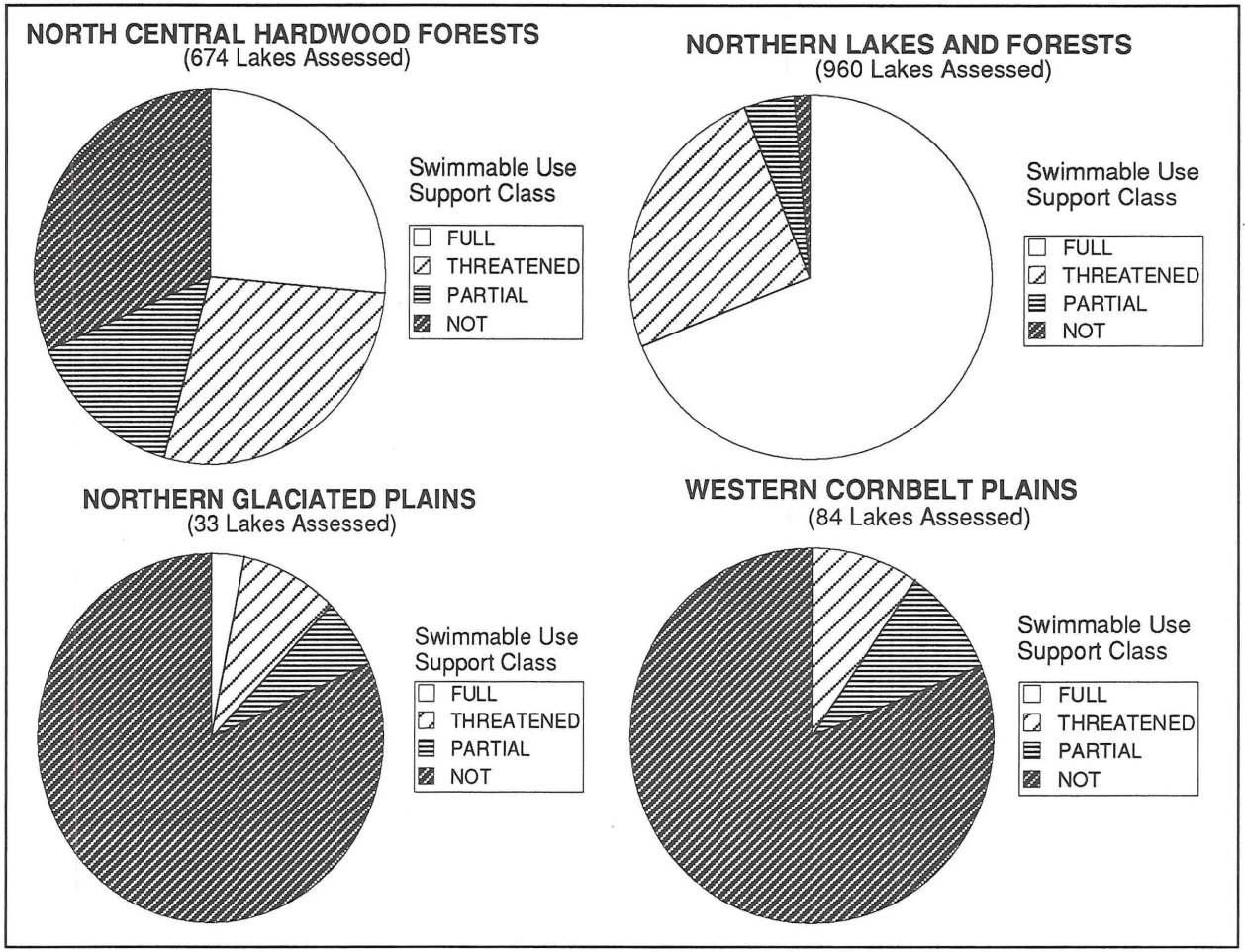
The following discussion is a summary of trophic status (see Figure III-4) and use support (see Figure III-5) by ecoregion.

The Northern Lakes and Forests ecoregion contains approximately 5,558 lakes or about 46 percent of Minnesota's lakes. These lakes are generally small and deep. Based on the assessed lakes, surface areas are typically 100 - 550 acres, while maximum depths are typically between 20 - 60 feet.

The trophic status of lakes in this region range from oligotrophic to hypereutrophic. The vast majority (93 percent) of the assessed lakes in this region fully support swimmable use, while less than 2 percent do not support swimmable use. Those that do not fully support swimmable use (hypereutrophic) tend to be much shallower (mean maximum depth = 18 feet) than the norm (median = 32 feet) for this region.

The North Central Hardwood Forests ecoregion contains approximately 4,765 lakes or about 40 percent of Minnesota's lakes. In terms of physical morphometry, these lakes are quite similar to those of the Northern Lakes and Forest ecoregion.

Figure III-5. Swimmable Use Support of Lakes, by Ecoregion



A very wide range in trophic status is evident in the lakes of this region, ranging from oligotrophic to hypereutrophic. Typically, lakes in this ecoregion can be characterized as eutrophic in nature (42 percent). The remainder are rather evenly divided between mesotrophy and hypereutrophy (Figure III-4).

The Western Corn Belt Plains ecoregion contains approximately 577 lakes, or about 5 percent of Minnesota's lakes. In general, these lakes are quite shallow and have larger surface areas than the lakes in the Northern Lakes and Forests and North Central Hardwood Forests ecoregions.

Typically, surface areas are between 250 to 1,000 acres and maximum depths are between 5 and 20 feet. All assessed lakes in this region are either eutrophic or hypereutrophic, and about 10 percent of the lakes in this region fully support swimmable use (Figure III-5). The eutrophic lakes tend to be slightly deeper (mean maximum depth = 20 feet) than the norm (median = 10 feet) for this region.

The Northern Glaciated Plains ecoregion contains approximately 855 lakes, or about 7 percent of Minnesota's lakes. Lakes in this region are all quite shallow and rather large in size. Based on assessed lakes, surface areas are typically 250 - 900 acres and maximum depths are typically 6 - 12 feet.

The lakes in this region are very fertile, based on their phosphorus concentrations, and the vast majority (82 percent) can be considered hypereutrophic. A single lake in the northern portion of this ecoregion, near the North Central Hardwood Forest ecoregion, was assessed as fully supporting swimmable use based on its transparency. This lake is somewhat smaller (190 acres) and significantly deeper (maximum depth = 26 feet) than the norm for the Northern Glaciated Plains.

Causes of Nonsupport of Designated Uses

The nature of runoff from a lake's watershed, both its quantity and quality, in conjunction with the physical characteristics of the lake, determines the water quality of the lake. Generally, runoff from cultivated and urban areas will carry more nutrients and sediments to lakes than that from forested or wetland areas. The mean depth (or maximum depth) together with the surface area of a lake provides an indication of the lake's ability to assimilate nutrients and sediments coming from the watershed, as well as the likelihood of internal sources of nutrients contributing to the production of algae and rooted vegetation. Thus, as in-lake total phosphorus concentrations increase, lake eutrophication tends to increase. The impact of increased nutrient levels, together with NPS, contribute to impairment, or nonsupport of a lake's uses. Table III-10 shows causes of nonsupport for overall lake use including both swimming and fish consumption.

Lake Information

Trophic Status:

Minnesota's abundance of lakes creates much enjoyment for its citizens and annually draws thousands of visitors to the state. The value of these lakes is directly related to their quality or purity. A listing of all assessed lakes is included in the list of all assessed waterbodies, Appendix 1. The list is organized by watershed, or hydrologic unit code (HUC). Ecoregion and swimmable use support are given. Trophic status is listed in the column labeled PKTR.

Acid Deposition:

Alkalinity was used as the basis for assessing support status for Minnesota lakes with respect to acid deposition. No culturally acidified lakes have been identified in Minnesota. However, 1,153 lakes were assessed for acid sensitivity. These lakes were classified as either fully supporting their uses (alkalinity greater than 10 milligrams per liter (mg/l) or supporting, but threatened (alkalinity less than 10 mg/l).

Lake Programs and Support Activities

Lake Monitoring:

Monitoring of lake water quality is a very important part of any program intended to protect or improve water quality. As more information on the status of lakes is obtained, the state is better able to develop appropriate programs to protect and improve the condition of lakes becomes possible. The state's ability to track changes or trends in water quality is directly tied to statewide lake monitoring programs. Funding under the Lake Water Quality Assessment grant -314(a)-has helped to improve the data base.

Since the 1990 305(b) report, gains have been made in terms of assessed acres (and numbers) of lakes. In this current assessment, 1,753 lakes and 1,726,607 acres have been assessed for support of swimmable use. This represents an increase of 293 lakes and 262,091 acres over the previous

Table III-10. Total Lake Acres Not Fully Supporting Uses Listed by Cause Categories

CAUSE CATEGORY	CONTRIBUTION TO IMPAIRMENT	
	MAJOR	MODERATE/MINOR
Priority Organics	7,096.0	1,293,439.8
Metals	834,107.0	1,332,234.8
Nutrients	212,691.0	47,212.0

assessment. A very significant increase in the number of monitored lakes (236 lakes) and lake acres (231,955 acres) was also realized in the current assessment. Data in Table III-8 shows the increase in monitored lakes by ecoregion. The number of monitored lakes increased in each region, with some data poor regions such as the Western Corn Best Plains and Northern Glaciated Plains exhibiting increases in monitored lakes of 38 percent and 17 percent, respectively, and large increases in terms of assessed acres. Thus, improvements in the database have been realized, not only in terms of absolute number of lakes and acres (i.e. assessed) but also an improvement in the quality of the data that goes into that assessment (i.e. increase in monitored data).

Most of these improvements in the data base can be attributed to three lake monitoring programs. They are:

1) *Citizen Lake Monitoring Program (CLMP):* This program involves voluntary assistance from citizens residing on lakes. Participants take weekly transparency measurements of their lake during the summer months. Data from this program is extremely valuable to persons/groups interested in assessing and keeping track of the water quality of their lake over time. In many lakes this represents the only monitoring data available. This represents the primary source of data that will be used to assess temporal trends in lake water quality. The number of lakes included in this program increased from 483 in 1989 to 600 in 1991.

2) *Lake Assessment Program (LAP):* This program takes the CLMP ideas one step further. LAP is a cooperative study of a lake involving MPCA staff and local citizens through lake associations and municipalities. LAP studies serve to characterize a lake's condition and provide some basic information regarding the interaction of the lake and its watershed. The format used in the LAP studies provides valuable information for the local groups, MPCA, and others interested in protecting or improving the quality of a lake. While a relatively small number (8 to 10) LAP studies are conducted each year, a very good data base is started for those lakes. By 1990 44 studies had been completed since the inception of the program, with another 12 getting underway in 1991. In some instances the local cooperators have elected to undertake further study, such as a Clean Lakes diagnostic-feasibility project, or have instituted lake protection efforts as a result of LAP involvement.

3) *Ecoregion reference lakes:* In this program, lakes representative of minimally impacted lakes are selected from each ecoregion and sampled over two or three summers. A comprehensive data base for each region results. Data from these lakes

Table III-11. Most Sensitive Lake Uses and Corresponding Phosphorus Criteria, by Ecoregion

ECOREGION	MOST SENSITIVE USES	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
Northern 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 and aesthetics *(full support)* *(partial support)*	40 µg/L 40 µg/L 90 µg/L
Northern Glaciated Plains	- recreation and aesthetics *(partial support)*	90 µg/L

have been used to develop phosphorus criteria for each ecoregion (Table III-11).

These criteria have been used first to prioritize and select projects to be funded through Minnesota's nonpoint source program, Clean Water Partnership Program, and the federally funded section 314 Clean Lakes Program; second, by resource managers in developing water quality management plans; third, as an educational tool for communicating what can reasonably be expected in terms of lake quality; fourth, as a guide for enforcement decisions; and fifth, as a guide to interpret nondegradation requirements.

Secchi transparency was selected as the variable for assessing temporal trends in lake trophic state. The bulk of this data was collected by citizen volunteers through Minnesota's CLMP program.

As in the 1990 report, lakes with eight years or more of CLMP data were assessed for trends. One-hundred and one lakes were included in the 1990 assessment. Based on published work, it appears that eight to ten years of data are required to produce a Secchi disk transparency database sufficient to detect (at some point in the future) a 10 percent degradation in clarity.

The 1992 assessment for trend in transparency included data from 161 lakes. This represents 9 percent of the overall 1,737 lakes included in this report. The Kendall's tau correlation coefficient (a non-parametric test) was used to test for trends in transparency over time. A level of p less than .10 was used as the basis for identifying significant trends. Using this test, 6 lakes were considered to have a significant decline in transparency and 26 lakes were considered to have a significant increase in transparency over time. The remainder were rather evenly divided between nonsignificant declines and nonsignificant increases in transparency (Table III-12).

No strong regional patterns were found in this data. However, all six of the lakes posting a significant decline in transparency were located in the North Central Hardwood Forests ecoregion. This ecoregion includes the majority of the state's population and the lakes receive much usage. More citizen complaints regarding lake water quality arise from this ecoregion than any other in Minnesota.

Some of the lakes showing significant trends were selected for more intensive monitoring of chemical, physical, and biological characteristics in order to better evaluate the trends suggested by the Secchi transparencies. This analysis is an ongoing part of the 314(a) Lake Water Quality Assessment grant activities.

Table III-12, A-F. Trends for Lakes, Listed in Groups by Significance Level of Trend in Secchi Transparency, and by Ecoregion of Lake

Trends in Secchi Disk Transparency Data for Lakes with Eight or More Years of Data

*A. Lakes with **Significant Increases** in Transparency*

North Central Hardwood Forest Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
03-0500	BECKER	MAUD	10
03-0657	BECKER	TURTLE 4 MI NE OF	8
27-0038	HENNEPIN	BROWNIE	10
27-0133-02	HENNEPIN	MINNETONKA (LOWER L	14
56-0328	OTTER TAIL	LITTLE MCDONALD	9
56-0369	OTTER TAIL	SIX	10
60-0217	POLK	UNION	10
62-0006	RAMSEY	KOHLMAN	15
73-0118	STEARNS	PELICAN	9
82-0106	WASHINGTON	ELMO	8
86-0120	WRIGHT	RAMSEY AT MAPLE L	8
86-0289	WRIGHT	SYLVIA	15
86-0279	WRIGHT	TWIN	18

Northern Lakes and Forest Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
01-0159	AITKIN	FARM ISLAND	8
01-0178	AITKIN	SPIRIT	9
01-0102	AITKIN	WILKINS	14
11-0250	CASS	ADA	8
11-0203-04	CASS	LEECH (SHINGOBEE BA	10
11-0383	CASS	PLEASANT	15
18-0034	CROW WING	BAY	8
18-0271	CROW WING	DAGGETT	10
18-0050	CROW WING	PORTAGE	8
18-0310	CROW WING	WHITEFISH	12
29-0117-02	HUBBARD	SPIDER (EAST BAY) 2	10

Western Cornbelt Plains Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
32-0022	JACKSON	CLEAR 3 MI W OF J	12
34-0086	KANDIYOHI	BIG KANDIYOHI	8

Trends in Secchi Disk Transparency Data for Lakes with Eight or More Years of Data

B. Lakes with **Moderate Increases** in Transparency

North Central Hardwood Forest Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
02-0091	ANOKA	GEORGE	8
10-0045	CARVER	STIEGER	10
27-0176	HENNEPIN	INDEPENDENCE	13
73-0157	STEARNS	HORSESHOE	9
82-0080	WASHINGTON	HALFBREED	15
86-0227	WRIGHT	CEDAR	8
86-0252	WRIGHT	CLEARWATER	16
86-0146	WRIGJT	IDA	16
86-0134	WRIGHT	MAPLE	12

Northern Lakes and Forest Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
04-0069	BELTRAMI	BLACKDUCK	10
11-0351	CASS	FIVE POINT	9
11-0472	CASS	HOWARD	8
11-0413	CASS	TEN MILE	15
16-0360	COOK	CARIBOU	10
16-0139	COOK	CLEARWATER	12
16-0228	COOK	WEST BEARSKIN	16
18-0041-02	CROW WING	CROOKED-MAIN BASIN`	14
18-0312	CROW WING	CROSS	8
18-0183	CROW WING	ISLAND	8
18-0403	CROW WING	LOWER CULLEN	8
18-0372	CROW WING	NORTH LONG	9
18-0308	CROW WING	PELICAN	8
18-0311	CROW WING	RUSH	17
31-0719	ITASCA	DEER	12
38-0744	LAKE	STEWART	12
69-0069	ST. LOUIS	SHAGAWA	13
69-0378	ST. LOUIS	VERMILION	15

C. Lakes with **Non-significant Increases** in Transparency

North Central Hardwood Forest Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
02-0084	ANOKA	CROOKED	15
02-0034	ANOKA	MARTIN	12
03-0387	BECKER	FLOYD	15
05-0013	BENTON	LITTLE ROCK	8
10-0002	CARVER	RILEY	10
10-0041	CARVER	ZUMBRA	11
19-0027	DAKOTA	CRYSTAL	18
21-0123	DOUGLAS	IDA	11
27-0111-01	HENNEPIN	EAGLE (EAGLE BAY) I	11
27-0118	HENNEPIN	FISH	14
27-0104	HENNEPIN	MEDICINE	11
27-0191	HENNEPIN	SARAH	15
27-0149	HENNEPIN	SPURZEM	10
27-0026	HENNEPIN	WOOD	10
34-0044	KANDIYUOHI	DIAMOND	11
34-0142	KANDIYOHI	GEORGE	16
34-0079	KANDIYOHI	GREEN	11
62-0056	RAMSEY	OWASSO	14
62-0061	RAMSEY	TURTLE	10
66-0008	RICE	CANNON	8
66-0027	RICE	CIRCLE	12
70-0022	SCOTT	CLEARY	10
70-0011	SCOTT	MINNREG	10
70-0010	SCOTT	MURPHY	9
70-0072	SCOTT`	UPPER PRIOR	13
73-0088	STEARNS	BOLFING	8
73-0200	STEARNS	KORONIS	11
82-0103	WASHINGTON	OLSON	14
86-0053	WRIGHT	PULASKI 1 MI NE 0	10

Trends in Secchi Disk Transparency Data for Lakes with Eight or More Years of Data

C. Lakes with **Non-significant Increases** in Transparency (Cont.)

Northern Lakes and Forest Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
01-0147	AITKIN	ESQUAGAMAH	10
01-0125	AITKIN	LONE	11
03-0030	BECKER	BOOT 2 MI N W OF TW	13
09-0038	CARLTON	HANGING HORN	9
09-0035	CARLTON	LITTL HANGING HORN	8
09-0029	CARLTON	PARK	9
11-0069	CASS	BASS	12
16-0632-01	COOK	GULL (MAIN BASIN) 2	12
18-0315	CROW WING	BIG TROUT	11
18-0041-01	CROW WING	CROOKED-SUGAR BAY	11
18-0044	CROW WING	HANKS	11
18-0266	CROW WING	LITTLE PINE	8
18-0136	CROW WING	LONG (LOWER SOUTH)	13
18-0284	CROW WING	VELVET	8
18-0297	CROW WING	WEST FOX	8
29-0066	HUBBARD	MIDGE	16
31-0536	ITASCA	DOAN	9
58-0062	PINE	ISLAND	10

Western Cornbelt Plains Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
07-0044	BLUE EARTH	MADISON	8

D. Lakes with **Non-significant Decreases** in Transparency

North Central Hardwood Forest Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
03-0153	BECKER	ISLAND	8
03-0475	BECKER	MELISSA	8
10-0059	CARVER	WACONIA	14
19-0021	DAKOTA	ALIMAGNET	16
27-0047	HENNEPIN	BUSH	9
27-0039	HENNEPIN	CEDAR	14
27-0133-09	HENNEPIN	MINNETONKA (HALSTED	9
27-0200	HENNEPIN	RATTAIL	8
27-0184-01	HENNEPIN	WHALETAIL (NORTH BA	9
34-0217	KANDIYOHI	FLORIDA	10
56-0141	OTTER TAIL	RUSH 2 MI N OF OT	13
61-0130	POPE	MINNEWASKA	11
66-0052	RICE	CEDAR	11
66-0029	RICE	FOX	17
66-0038	RICE	FRENCH	14
66-0015	RICE	KELLY	8
66-0018	RICE	ROBERDS	8
70-0091	SCOTT	CEDAR	10
70-0026	SCOTT	LOWER PRIOR	12
70-0054	SCOTT	SPRING	12
71-0040	SHERBURNE	SANDY	11
73-0086	STEARNS	KNAUS	8
73-0196	STEARNS	RICE	10
82-0101	WASHINGTON	DEMONTREVILLE	14
82-0046	WASHINGTON	SQUARE	9
86-0023	WRIGHT	BEEBE	9
86-0041	WRIGHT	DEAN	8

Trends in Secchi Disk Transparency Data for Lakes with Eight or More Years of Data

D. Lakes with **Non-significant Decreases** in Transparency (Cont.)

Northern Lakes and Forest Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
01-0062	AITKIN	BIG SANDY	10
01-0099	AITKIN	GUN	8
01-0033	AITKIN	MINNEWAWA	11
04-0130	BELTRAMI	BEMIDJI	15
04-0030	BELTRAMI	CASS	12
11-0305	CASS	GULL	19
11-0062	CASS	THUNDER	10
11-0171-01	CASS	WABEDO (NE BAY) 5	13
18-0376	CROW WING	UPPER CULLEN	10
29-0239	HUBBARD	SPEARHEAD	10
29-0077	HUBBARD	THIRD CROW WING	15
58-0123	PINE	GRINDSTONE	11

E. Lakes with **Moderate Decreases** in Transparency

North Central Hardwood Forest Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
10-0044-01	CARVER	AUBURN (WEST BAY)	12
10-0018	CARVER	SCHUTZ	9
27-0192	HENNEPIN	REBECCA	12
27-0141	HENNEPIN	TANAGER	11
33-0015	KANABEC	MUD	12
49-0137	MORRISON	FISHTRAP	10
56-0358	OTTER TAIL	SCALP (SEVEN) 1 M	8
62-0082	RAMSEY	WABASSO	9
66-0014	RICE	DUDLEY	8
66-0055	RICE	SHIELDS	8
82-0104	WASHINGTON	JANE	16
82-0474	WASHINGTON	UNNAMED	12

Northern Lakes and Forest Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
03-0085	BECKER	BAD MEDICINE 11 MI	10
18-0038	CROW WING	CLEARWATER	12
18-0096	CROW WING	UPPER (SOUTH) LONG	11

F. Lakes with **Significant Decrease** in Transparency

North Central Hardwood Forest Ecoregion

LAKE ID	COUNTY	LAKE	YEARS
27-0067	HENNEPIN	BRYANT	9
27-0048	HENNEPIN	HYLAND	10
62-0080	RAMSEY	EMILY	12
77-0084	TODD	BIG BIRCH	14
82-0052	WASHINGTON	BIG MARINE	8
86-0009	WRIGHT	MARTHA	11

Chapter Four: Great Lakes

Background

If everyone could choose one Great Lake to be in their home state, Lake Superior would probably be most people's choice since it is the cleanest of the Great Lakes and remains relatively pristine. Minnesota is indeed fortunate to have 272 miles of Lake Superior shoreline as its northeastern border. However, with this privilege comes the responsibility of making sure the lake receives the high degree of pollution protection it deserves. Indeed, as the largest lake in the world (by volume), Lake Superior contains ten percent of the world's supply of freshwater. Although Minnesota's shoreline represents only ten percent of the lake's total shoreline, the state of Minnesota understands its stewardship responsibility and has worked diligently toward restoring and protecting this unique water resource.

Over the last 20 years, the demands of protecting Lake Superior have grown, changed, and become more complex. Pollution of the lake by the conventional pollutant types (oxygen-demanding substances, solids, pathogenic organisms, nutrients and other pollutants) has been addressed by using a variety of point source control methods. Currently, nonpoint source control methods are beginning to be employed. The major remaining concern is the pollution caused by persistent bioaccumulative toxic substances. The solution to this problem is much more complex, expensive and far reaching, and is being pursued by a diverse group of participants through a variety of programs and activities.

Lake Superior Bi-National Program

The International Joint Commission (IJC) recommended that Lake Superior be designated as a zero discharge demonstration zone for persistent toxic pollutants because it is the cleanest of the Great Lakes. The three states adjacent to Lake Superior, the United States Environmental Protection Agency (EPA) and the provincial and federal governments of Canada have initiated a cooperative effort, the Lake Superior Initiative, to provide Lake Superior with the high degree of water quality protection recommended by the IJC. The goal of the Initiative is to achieve zero discharge or zero emissions of persistent bioaccumulating substances from point and nonpoint sources, which impact the ecosystem of the Lake Superior drainage basin. The Zero Discharge Demonstration Program will focus on three activity areas: (1) pollution prevention activities to control pollutants at the source by preventing the discharge of persistent bioaccumulative toxic substances into the lake, (2) "special designation" actions that establish resource classifications for the lake to control activities possibly detrimental to water quality or the ecosystem, and (3) regulatory controls that will continue to enforce existing and develop new point source regulations. These activities will be part of a broader program of ecosystem management developed for the lake.

Great Lakes Initiative

In 1989, the EPA Region V proposed an initiative under which uniform water quality criteria and guidance would be developed for the Great Lakes Basin. In addition, the Initiative seeks to embrace the concept of pollution prevention to protect Great Lakes water quality. The objectives are to restore and maintain the beneficial uses of the Great Lakes and seek the virtual elimination of toxic pollutants that are adversely affecting them.

The Initiative encompasses a variety of work products, of which the foremost is the development of water quality criteria. The criteria are to be developed to protect aquatic life, human health, wildlife and other uses. Development of the criteria first includes documenting the procedures to be used by Great Lakes states in developing the criteria and then the establishment of the numeric criteria themselves. A second component of the Initiative is the establishment of an antidegradation policy and procedures for Great Lakes waters. A third component of the Initiative is the development of a pollution prevention policy.

The final component of the Initiative is the Application Procedures component. This component will focus on procedures to translate the numerical criteria, antidegradation policy, and pollution prevention policy into controls for specific sources of pollution. Minnesota has participated fully in this effort by assigning staff to serve on the Steering Committee and Implementation Committee and by leading the effort to establish appropriate bioaccumulation factors on which to base standards.

Lake Superior Partnership

The Minnesota Pollution Control Agency (MPCA) proposed the formation of the Lake Superior Partnership to implement the zero discharge goal recommended by the IJC. The partnership will utilize the established pollution prevention policy

of the state and the EPA's Great Lakes Pollution Prevention Action Plan. The Lake Superior Partnership is a public-private initiative with the broad goals of eliminating the discharge of pollutants to Lake Superior through pollution prevention and other methods. It will focus the state's resources and pollution prevention efforts in a high priority area. The Partnership is conceived as an informal network of persons with interest in eliminating the discharge of pollutants into Lake Superior. It is intended to maximize the coordination of existing programs and stimulate new initiatives. The emphasis of the Partnership is on encouraging cooperation among government, businesses, educational institutions, community groups and citizens. It is more a forum than it is an organization and will have no specific staff assigned to it. The MPCA will be the lead agency and will serve as a contact and or coordinator for any firms, organizations, or agencies that wish to participate.

St. Louis River Remedial Action Plan

The IJC has designated 43 Great Lakes Basin areas as having impaired beneficial uses of the water resource due to pollution. Remedial Action Plans (RAP) are to be developed for each of the 43 Areas of Concern (AOC). The goal for each RAP is to define actions and timetables to restore all beneficial uses of an AOC. Restoration of uses is to be achieved through pollution source controls and efforts to remediate environmental problems. The portion of the St. Louis River initially designated as the AOC was the lower section of the river below Fond du Lac Dam, St. Louis Bay and Superior Bay. This area of the river will be the main focus of the RAP, but any factor within the watershed which impairs the beneficial use of the water resource will be considered in the plan. The St. Louis River AOC is shared by Wisconsin and Minnesota and both are actively cooperating and involved in the RAP development.

The RAP is being developed by a diverse group of government, industry, municipal, academic and citizen participants. The organization is based on a Citizens Advisory Committee to which information and recommendations are provided from five technical committees. The RAP is comprised of three stages:

Stage 1 consists of the following and is completed:

- Characterizes the AOC
- Identifies pollution problems and their sources
- Sets goals for the restoration
- Identifies areas that need additional information

Stage 2 consists of the following, and is scheduled for completion on September 30, 1993:

- Identifies the most appropriate remedial action to correct problems
- Identifies who is responsible for conducting the remedial action
- Estimates costs

Stage 3 contains the following, and is not yet scheduled:

- Monitors the AOC
- Determines if remedial actions are restoring beneficial uses
- Provides data for eventual removal of the area from the list of AOCs

After the reports and recommendations of the citizen and technical advisory committees are completed and the appropriate state approvals are received, the RAP will be incorporated into the state water management plan. Table III-13 shows the summary of impaired uses developed in Stage 1.

Assessment of Support for Beneficial Uses

Lake Superior has been assessed for support of fish consumption, and along the entire 272 miles of shoreline, the lake has been classified as "not supporting" fish consumption. This is due to levels of Polychlorinated Biphenyls (PCB) measured in fish collected from Lake Superior in 1987-1989. Some fish from the lake have also been found with detectable levels of mercury. The assessment of fish consumption is discussed in general for Minnesota waters in Part III, Chapter Six: Public Health/ Aquatic Life Concerns.

The assessment of 23.2 miles of shoreline as "not supporting" for aquatic life use is due to concentrations of copper and lead that violate water quality standards. The lake is also receiving discharge water from three municipal sewage treatment plants (Grand Marais, Two Harbors, and Silver Bay) that chlorinate but do not dechlorinate.

A summary of use support assessments for Lake Superior shoreline miles is shown in Tables III-14 and III-15. Listings of causes and sources of nonsupport are shown in Tables III-16 and III-17.

Table III-13. Summary of IJC Impaired Use Criteria for St. Louis AOC

IJC Criteria	Reason	Comments
IMPAIRMENTS IDENTIFIED IN AOC		
• Fish Consumption Advisories	Advisories issued by MN and WI	
• Fish Tumors & Other Deformities	Observations in 1991 (Harbor) and 1985 (Crawford Creek)	Data on incidence of tumors and deformities needed
• Restrictions on Dredging	Contaminated sediment	Data lacking for many parts of AOC
• Degradation of Benthos	Documented at Stryker Bay and Hog Island/Newton Creek	Surveys are needed to document extent of problems in AOC
• Degraded Fish Populations	Impact of ruffe (exotic fish species)	
• Degraded Wildlife Populations	Decline in threatened and endangered species	
• Loss of Fish and Wildlife Habitat	Documented loss of habitat at Stryker Bay and Hog Island	Continuing loss of physical habitat limits populations due to contamination
• Degradation of Aesthetics	Aesthetics of water degraded by oily materials at Stryker Bay/InterLake and at Hog Island/Newton	Other areas may have aesthetic impairment
• Beach Closings/Body Contact	Sewage bypasses	Probable site specific bacterial problems from bypasses, spills, etc.
• Excessive Loading of Sediments and Nutrients to L. Superior[1]	High sediment/nutrient load from AOC to L. Superior	
IMPAIRMENT NOT CLEAR		
• Fish Tainting	Historical problem. Current evidence is conflicting.	Clarify existence or extent of problem in Stage II
• Bird or Animal Deformities or Reproductive Problems	Low reproductive success in common terns-reasons not clear. Potential factors include toxics, competition, physical loss of habitat	Additional data on toxics in terns and other species needed
NOT IMPAIRED CURRENTLY		
• Wildlife Consumption Advisories	No advisories issued	Limited data
• Degradation of Phytoplankton and Zooplankton	No evidence of impairment	Future impairment possible due to exotics (BC and zebra mussel)
• Eutrophication or Undesirable Algae[2]	High nutrient levels but no evidence of eutrophication	High nutrient loading to L. Superior is of concern
• Restrictions on Drinking Water Consumption	Drinking water not taken from AOC	Concerns for spills
• Added Costs to Agriculture or Industry	No impairment currently	Zebra mussel could cause problems

[1] Adaptation of IJC Eutrophication criteria to fit local conditions

[2] IJC Eutrophication criterion not impaired, see "Excessive Loading" criterion

Table III-14. **Overall Use Support** Summary

Degree of Use Support	Assessment Basis Evaluated	Monitored	Total Assessed
Fully Supporting	0	0	0
F/S but Threatened*	0	0	0
Partially Supporting	0	0	0
Not Supporting	0	272.0	272.0
TOTAL	0	272.0	272.0

Table III-15. **Individual Use Support** Summary

Use	Supporting	Supporting but Threatened*	Partially Supporting	Not Supporting	Unassessed
Fish Consumption	0	0	0	272.0	0
Aquatic Life Support	0	0	0	23.2	248.8
Swimming	23.2	0	0	0	248.8

Table III-16. Total Great Lakes Shoreline Miles Not Fully Supporting Uses (Listed by Cause Categories)

CAUSE CATEGORY	CONTRIBUTION TO IMPAIRMENT MAJOR	MODERATE/MINOR
Priority Organics	0	272.0
Metals	0	272.0

Table III-17. Total Great Lakes Shoreline Miles Not Fully Supporting Uses (Listed by Source Categories)

SOURCE CATEGORY	CONTRIBUTION TO IMPAIRMENT MAJOR	MODERATE/MINOR
Industrial Point Sources		0
Municipal Point Sources		23.2
Nonpoint Sources-unspecified	248.8	23.2

Chapter Five: Wetlands

Background

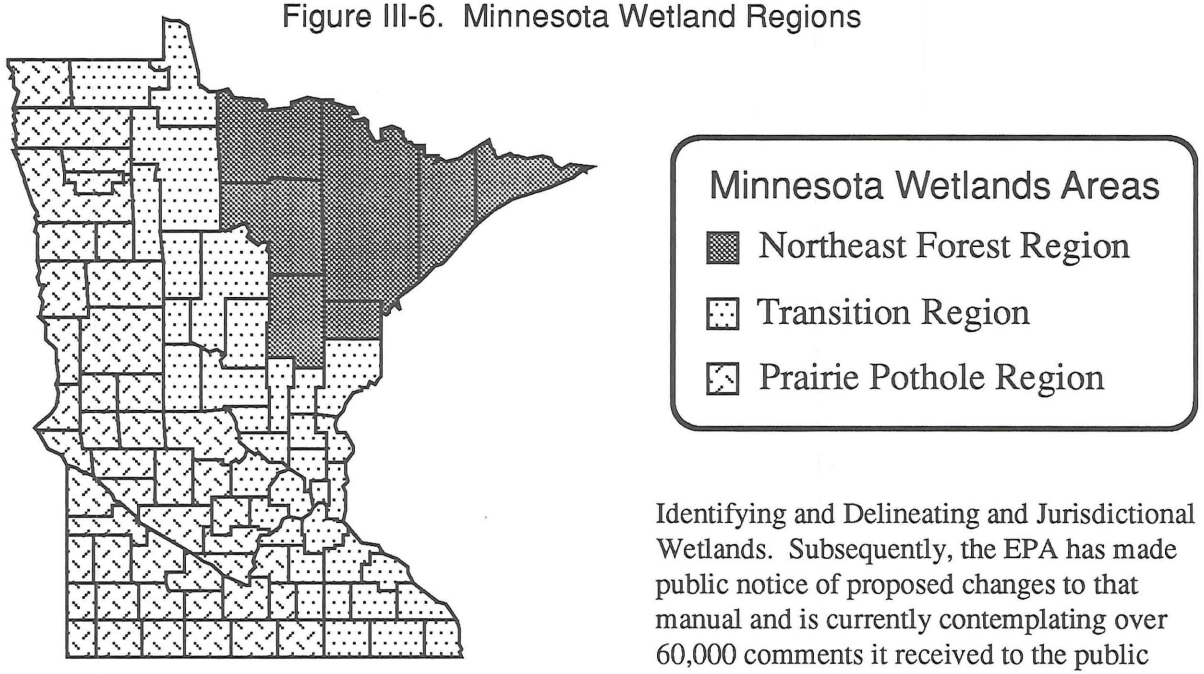
Wetlands are a critical water resource. They provide wildlife and fisheries habitat and many other benefits to the waters of the state of Minnesota. The importance of wetlands to the water quality of both surface waters and ground waters is becoming increasingly evident. Wetland functions include: flood water storage and retention, nutrient assimilation, sediment entrapment, ground water recharge, low flow augmentation, shoreland anchoring and erosion control, wildlife habitat, fisheries habitat, and aesthetic, recreational and educational benefits to the public. Pre-settlement information indicates that Minnesota originally had approximately 18.6 million acres of wetlands of all types. Recent estimates indicate that there are only 7.5 million acres of wetland remaining in the state (Table III-18). This loss represents a 60 percent reduction in wetlands throughout the entire state. While the northeast forest region has only lost approximately 4 percent of its wetlands, the transition region has lost 62 percent and the prairie pothole region has lost 87 percent of its wetlands (Figure III-6).

Table III-18. Extent of Wetlands in MN

Wetland Type	*Existing Acreage (1980)*
1 Seasonally flooded basins or flats	192,000
2 Inland fresh meadows	680,000
3 Inland shallow fresh marshes	645,000
4 Inland deep fresh marshes	470,000
5 Inland open fresh water	313,000
6 Shrub swamps	2,525,000
7 Wooded swamps	2,300,000
8 Bogs	375,000
TOTAL EXISTING ACRES	7,500,000

Figures from Minnesota Wetland Loss Analysis, MN Department of Natural Resources, 1990.

Figure III-6. Minnesota Wetland Regions



Currently, there is much debate surrounding the definition of wetlands and the delineation methods to be used to establish wetland boundaries. The major federal agencies including the U.S. Army Corps of Engineers (COE), U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (EPA) and U.S. Soil Conservation Service (SCS) had recently agreed upon a uniform method of defining wetlands and determining the wetland boundaries through the 1989 Federal Manual for Identifying and Delineating and Jurisdictional Wetlands. Subsequently, the EPA has made public notice of proposed changes to that manual and is currently contemplating over 60,000 comments it received to the public notice on the proposed changes. Minnesota has expressed strong concern about those proposed changes in that a significant loss of wetlands by definition is expected to occur if the proposed changes in the manual are promulgated.

Minnesota utilizes both the USFWS circular #39 (1971 edition) categories and the Cowardin system of Classification of Wetlands and Deep Water Habitats of the United States, et. al. 1979. Recent legislation in Minnesota, the 1991 Minnesota Wetland Conservation Act requires, that for Minnesota, the 1989 Federal Manual be used for Wetland Delineation.

The National Wetland Inventory being conducted by the USFWS is near completion. The Minnesota Department of Natural Resources (MDNR) is undertaking a project to digitize the inventory for use with Geographic Information Systems to quantify wetland activities. When complete, this project should

provide a data bank for current wetland sizing, location and future inventory.

Development of Wetland Water Quality Standards

Existing Minnesota law includes marshes in the definition of waters of the state. The definition proposed in the revised water quality standards will be more specific to describe wetlands as areas that have the following attributes:

- have a predominance of hydric soils,
- are inundated or saturated by surface or ground water at a frequency and duration sufficient to support the prevalence of hydrophytic vegetation typically adapted for life in saturated soil condition, and
- under normal circumstances, can support a prevalence of such vegetation.

It is expected that the antidegradation portion of the rule will still be applicable to wetland activities, but it will be expanded to include a sequenced review process to require avoidance of impacts to wetlands and minimization of impacts before a proposed project may be considered approvable.

Compensatory mitigation on any remaining impacts to wetlands would be required as part of the project.

Table III-19 shows which wetland water quality standards are in place and which standards are still under development.

Additional Wetland Protection Activities

On January 17, 1991, Governor Arne Carlson issued Executive Order 91-3 directing state departments and agencies to follow a "no-net loss" of wetlands policy. In his executive order, Governor Carlson recognized the loss of wetlands throughout the state and required all departments of the state to protect, enhance, and restore Minnesota's wetlands to the full extent of their authority. Agencies are required to operate to the fullest extent of their authority under the strict concept of "no-net loss" of wetlands. The Executive Order also directed departments to implement this policy by using the following criteria in priority order: avoidance, minimization, then mitigation of wetland impacts for project approval. State agency jurisdictions and existing laws were unchanged by the executive order.

During 1991, Minnesota also enacted the Wetland Conservation Act of 1991, which placed into statute the policy of "no-net loss" in the quantity, quality and biological diversity of Minnesota's existing wetlands. The Wetland Conservation Act also requires project proposers to avoid impacts to wetlands where it is prudent and feasible, and replace wetland values where avoidance is not feasible and prudent. Local units of government will be required to approve the wetland replacement plans. The act requires the MDNR to identify high priority regions for programs that provide for wetland preservation, enhancement, restoration and establishment. The act also provides a compensation program for permanent easements on Type 1, 2, or 3 wetlands, and provides for property tax incentives in the form of exemptions for wetlands to be placed in a wetland

Table III-19. Development of State Wetland Water Quality Standards

	Standards In Place	Standards Under Development
Use Classification:	All waters of the state (including wetlands) are assigned beneficial uses. Wetlands not specifically listed default to use classifications2B, 3B, 4A, 4B, 5, and 6.	Language clarifying the role of wetlands for existing beneficial uses and the addition of beneficial uses specific to wetlands (e.g., low flow augmentation and flood storage) is proposed in the1993 7050 Water Quality revision.
Narrative Biocriteria:	There are currently no specific bio-criteria, but narrative general criteria exist protecting all waters of the state.	Language specifically addressing narrative biocriteria is proposed in the1993 7050 Water Quality revision.
Numeric Biocriteria:	There are currently no specific numeric biocriteria.	Language specifically addressing numeric biocriteria is planned for the 1996 7050 Water Quality revision.
Anti-degradation:	All waters of the state are protected from degradation.	Language specifically addressing a mitigative process to clarify wetland anti-degradation protection is proposed in the 1993 7050 Water Quality revision.

preservation program of at least eight years in duration. The wetland establishment and restoration program will be administered by the state to create and restore wetlands with a cost-sharing program.

The Minnesota Wetlands Conservation Act of 1991 also includes provisions for state assumption of the Clean Water Act 404 permit program from the COE. The MDNR is to pursue application to the EPA for assumption on the 404 program.

The Wetlands Conservation Act provides authority to local units of government to implement the provisions. It is expected that local water plans will incorporate the activities associated with the wetlands conservation act.

Minnesota Rules chapter 7050 Water Quality Standards are revised every three years as required by the EPA. The Water Quality Rules have always been applicable to all waters of the state, including wetlands. In this rule, Minnesota will address wetlands specifically to ensure the applicable standards are appropriate without expanding the scope or MPCA's authority in wetland regulation.

Minnesota Statute 105 protects wetlands defined as all Types 3, 4, and 5 that are not included in the definition of public waters. In unincorporated areas, the definition of public waters includes wetlands that are at least ten acres in size, and in incorporated areas includes wetlands greater than 2.5 acres. The MDNR oversees the Protected Waters and Wetlands Permit Program for any work done below the ordinary high water mark of the protected water or wetland. Typical examples of projects requiring a permit include draining, filling, dredging, channelization, construction of dams, harbors, or permanent offshore structures, and placement of bridges and culverts. Some projects do not require permits from the MDNR if certain conditions are met.

The Federal Food Securities Act of 1985 includes Wetland Conservation Provisions commonly known as "Swampbuster." The Act provides that farm subsidies will be lost to the owner if wetlands are altered or converted to cropland. This Act is actively being implemented in Minnesota, and activities are monitored by the SCS.

Minnesota Rules ch. 7050 also contains specific protection for nondegradation of outstanding resource value waters (ORVW). Calcareous fens are designated as ORVWs in Minnesota. Provisions are included for restricting discharges to prohibit new or expanded discharges to ORVWs, unless it can be proven there is no prudent or feasible alternative. Currently there are 31 designated calcareous fens in Minnesota.

State and federal agencies including the MPCA, the MDNR, the Board of Water and Soil Resources, and the COE are working on a permit simplification program for applicants proposing activities in wetlands. The first effort is to produce a combined permit notification form that may serve as application for a COE 404 permit and serve as notification to the MDNR, the SCS, and local county or municipal governments. The purpose for providing this joint notification form is to allow the applicant to notify all concerned agencies with a single form of a proposed action in a regulated wetland.

Minnesota has also negotiated a general permit with the COE for projects in wetlands that require state permits. The intent of this general permit is to reduce duplicative review by the state and federal agencies on a particular project.

The Clean Water Act 404 permit program offers one of the broadest regulatory protection programs for wetlands in Minnesota. Particular aspects of the program are problematic, but could be adjusted to improve wetland protection. What follows is a short discussion of three issue areas.

1) The proposed revisions to the federal wetland delineation manual are problematic. Minnesota has estimated that this new definition will remove over 20 percent of its wetlands from jurisdictional definition. Also, the Minnesota Wetland Conservation Act of 1991 requires the use of the 1989 wetland delineation manual to be used for determining wetland boundaries. The potential conflict between these two jurisdictional definitions will cause great problems in determining where wetland boundaries exist, under either state or federal definition.

2) Wetlands can be impacted by either filling activities or drainage activities. Currently, the 404 permit program does not address drainage as a regulated activity. This should be included under the 404 program in order to provide equal regulatory protection from the common activities that do impact wetlands.

3) The nationwide permit program, as promulgated in final rules November 22, 1991, have greatly expanded the use of nationwide permits for activities in wetlands. Minnesota is one of many states that have documented serious concerns with the expanded applicability of nationwide permits. Also, many wetland fill projects that may be authorized under the nationwide permits do not require reporting or accounting to the COE. Without reporting, it becomes impossible to accurately maintain wetland inventories and formulate conclusions regarding the potential of cumulative or individual impacts from this portion of the permit program.

Chapter Six: Public Health/ Aquatic Life Concerns

Size of Waters Affected by Toxics

Toxic pollutants are a growing concern in Minnesota waters. As required by the 1987 amendments to the Clean Water Act, Minnesota's standards were amended in 1990 to include numerical standards for 54 toxic pollutants and a detailed set of procedures that can be used to establish criteria for additional toxic pollutants in the water column.

Table III-20, Total Size Affected by Toxicants, reflects waters that have either exceedances of standards in the water column or elevated levels of toxicants in fish tissue or both.

Table III-20. Total Size Affected by Toxicants

Waterbody	Size Monitored for Toxicants	Size with Elevated Levels of Toxicants
Rivers (miles)	3,662.4	1,651.9
Lakes (acres)	2,223,028.6	2,175,225.8
Great Lakes (miles)	272.0	272.0

Public Health/ Aquatic Life Impacts: Fish Consumption Advisory

Fishing in Minnesota has always been important as a food source, a recreational activity, and an attraction for tourists. Minnesotans enjoy relatively good water quality in the state's numerous lakes and rivers, which provide rich fisheries. Unfortunately, some of the waterways in Minnesota are contaminated with chemicals that accumulate in fish and may be toxic to human and animal consumers. In terms of the Clean Water Act assessment categories, these waterways "do not support or partially support" fish consumption.

To provide consumption advisories for people who eat fish from state waters, and to monitor contaminants, state agencies cooperate on different aspects of a monitoring program. The Minnesota Department of Natural Resources (MDNR) collects fish to be analyzed for contaminants. In the past, the Minnesota Pollution Control Agency (MPCA) processed the fish, contracted for their analyses, and prepared environmental reports from the data. Currently, the MDNR does this work due to a shift from federal funding to state funding.

Fish consumption advisories are issued by the Minnesota Department of Health (MDH). MDH annually reviews the toxicological literature to determine the appropriate fish consumption advice and issues a consumption advisory each spring. Information in the advisory is disseminated through the news media and booklets that are distributed by MDH, MPCA, and MDNR.

Methods

Data collected for the 1991 fish consumption advisory were used to determine the use category in this section of the report. Data from 1970 to 1979 were not used due to significant changes in contaminant levels in the past decade. Data from 1980 to 1986 were considered "evaluated" data. Data from 1987 to 1991 were considered "monitored" data. Only monitored data were used if both existed. At this time, 4925 fish fillet samples have been analyzed for one or more contaminants. Of these, sixty 2,3,7,8 tetrachlorodibenzo-a-dioxin (TCDD) samples, 1,696 polychlorinated biphenyls (PCB) samples, and 3,169 mercury (Hg) samples in fish fillets from waterbodies in Minnesota were used. A total of 438 fish fillet samples (359 PCBs and 79 Hg samples) from the Wisconsin Department of Natural Resources were included for border water portions of the Mississippi, St. Croix, and St. Louis rivers. Fish tissue samples have not been analyzed for other International Joint Commission pollutants of concern.

There are four categories of recommendations in the MDH fish consumption advisory, ranging from "unrestricted consumption" to "no consumption advised." The consumption recommendations are based on both contaminant level and frequency of consumption of fish. This report considered only the recommendations for the annual fish consumer (a person who eats sport-caught fish three or more months per year), since the recommendations for seasonal and vacation consumers are less restrictive. Waterbodies where all tested fish fell under the "unrestricted consumption" guidelines were listed in the "fully supporting and not threatened" use category. Waterbodies where at least one fish sample was placed in one of the two intermediate

recommendations (one meal/week or one meal/monthly) were listed in the "partially supporting" use category. Waterbodies where at least one of the fish samples fell under the "no consumption advised" recommendation were listed in the "not supporting and impaired" use category. Lakes were placed in the "fully supporting but threatened" use category, based on the likelihood of atmospheric deposition of mercury in that area.

Contaminant levels for each category are listed in Table III-21. It contains significant differences from the previous report due to changes in the PCB advisory based on studies of the chemical's effects on human reproduction. This change caused some lakes and streams to be changed from the "partially supporting" category in the last report (PCB level above detection) to the "not supporting" category (PCB level above 0.47 µg/g).

Children under six years of age or women who are pregnant or plan to bear children should not eat fish from waterbodies where PCBs exceed 0.10 µg/g, mercury exceeds 0.65 µg/g or dioxin is detectable.

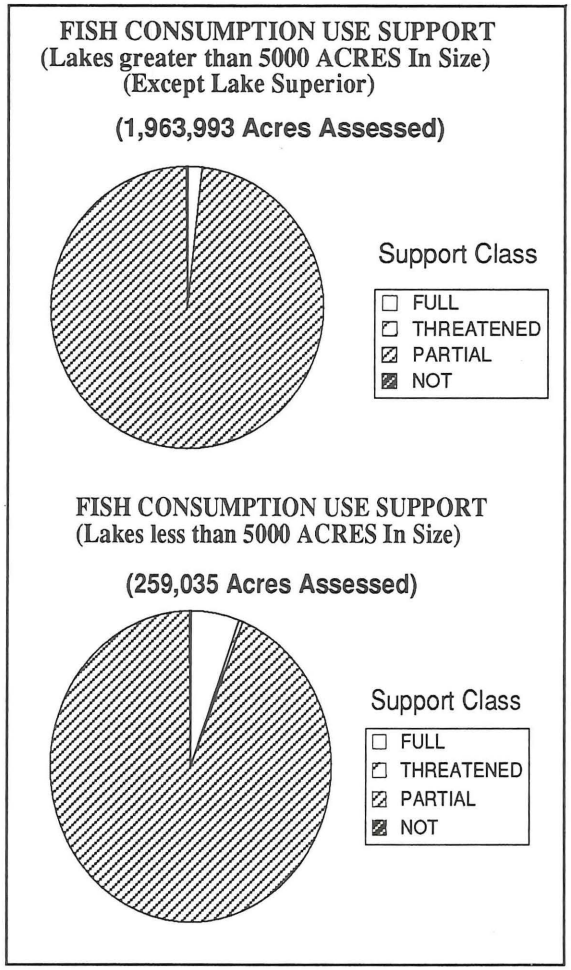
The lake surface area, Great Lake shoreline length, and stream reach length that were represented by each station were summed by use category. For each monitoring station, the entire surface area, shoreline length, or reach length was summed irrespective of the number of stations or samples. For lakes, the surface area of the entire lake or bay was listed in acres, and large (over 5,000 acres) and small (under 5,000 acres) lakes' acres summed separately. For streams, the main channel length (i.e., no tributaries) represented by each station was determined by: (1) mileage between fish barriers (falls or dams), (2) mileage between major sources of contaminants, (3) mileage between major tributaries or (4) best professional judgment. These reaches generally correspond to river boundaries established for the fish consumption advisory. However, slight differences occurred in a few cases when the advisory lumped together several reaches that were considered separate for fish sampling.

The waterbodies used for this section of the report may not be representative of all Minnesota waters. The fish samples used in this analysis are generally collected from

Table III-21. Fish Contaminant Concentrations for Each Use Category

Use Category	Contaminant		
	TCDD (ng/kg)	PCB (µg/g)	Hg (µg/g)
Fully Supporting (unrestricted consumption)	< .032	< .025	0.00 - 0.15
Partially Supporting (moderate consumption)	> .032	> .025	0.16 - 2.80
Not Supporting (no consumption advised)	> .6	> .47	> 2.81

Figure III-7. Fish Consumption Use Support for Large and Small Lakes



waters that: (1) have a history of contamination, (2) are near suspected sources, (3) have characteristics similar to contaminated waters, or (4) are heavily fished. Waterways not suspected of being contaminated are not sampled as frequently.

This assessment also does not take into account the variability in contaminant levels due to fish size (i.e., waterbodies with a high proportion of large fish sampled may be placed in a more restrictive category than waterbodies with a high proportion of small fish sampled). In addition, it does not distinguish between locations with different levels of sampling effort. For example, large lakes (over 5,000 acres) are not sampled as intensively as small lakes (under 5,000 acres) due to logistical difficulties in obtaining samples.

Results

Lakes:

From 1980 through 1991, 357 lakes (representing 2,223,028 acres, or 65 percent of total lake acres) were sampled for contaminants in fish. Most of the lakes in Minnesota (99 percent) are smaller than 5,000 acres. Likewise, most of the lakes sampled for contaminants were less than 5,000 acres (321 lakes). However, these small lakes represented only 7.6 percent of the total acres assessed. Lakes larger than 5,000 acres (36 lakes) represented the majority (92.4 percent) of the acres assessed. Small and large lakes will be discussed separately to avoid over representing the large lakes because of their extensive area..

Large Lakes (> 5,000 acres):

Over one-half of Minnesota's large lakes (36 out of 62, representing 1,963,993 acres) has been sampled for contaminants in fish. Of these, three large lakes (representing 32,039 acres, or 1.6 percent) fully supported fish consumption uses. See Figure III-7 for a graphic display of fish consumption use support in larger lakes. Thirty-two lakes (representing 1,925,826 acres, 98.1 percent) partially supported fish consumption uses, primarily due to mercury concentrations. One lake, Minnetonka (Lower Lake) (representing 6,128 acres, less than 1 percent) did not support fish consumption use due to PCB levels in carp.

Small Lakes (< 5,000 acres):

Relatively few lakes with surface areas less than 5,000 acres have been sampled for contaminants in fish (see Figure III-7). These lakes represent 259,035 acres, or 321 of 11,972 small lakes in Minnesota. Of the 321 small lakes sampled, 14 lakes (representing 14,631 acres, or 5.7 percent) fully supported fish consumption uses. Six lakes (representing 1,132 acres, or 0.44 percent) were classed as "threatened" due to widespread mercury contamination in their region. Two hundred and ninety-seven lakes (representing 242,530 acres, or 93.6 percent) partially supported fish consumption uses. Four lakes (representing 741 acres, or 0.3 percent) did not support use. These lakes were two in the Twin Cities and one in Rochester that do not support use because of PCB levels, and one lake in the Voyageurs National Park with evidence of high levels of mercury in fish tissue.

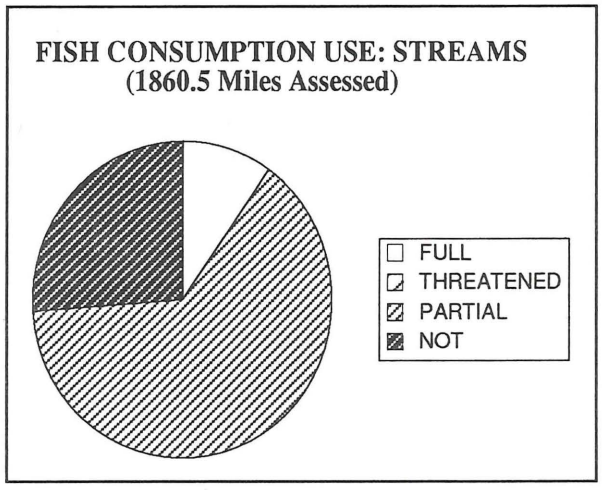
Great Lakes:

Nearly 100 fish samples were collected from Lake Superior from 1987-1989 (data from 1988 and 1989 samples were first available for this report). Fish were collected from the near-shore areas of the French River, Two Harbors, Beaver Bay, Grand Marais and Grand Portage and are thought to represent the whole lake. Sampled species included lake trout, siscowet lake trout, rainbow trout, coho salmon, chinook salmon, bloaters, herring, lake whitefish, and smelt. PCBs were detected in most samples. Highest levels of PCBs were found in siscowet lake trout, followed by lake trout, chinook salmon, and bloaters. Lower levels were found in coho salmon, rainbow trout, herring and lake whitefish. Siscowet lake trout and lake trout PCB levels frequently exceeded the PCB guideline of 0.47 micrograms per gram. Together, these two species make up approximately 80 percent of the recreational fish catch. Therefore, all of the Lake Superior shoreline length was classed as "not supporting" fish consumption use. The 1990 Water Quality report classified Lake Superior as "partially supporting." This change is due to a change in the most recent fish consumption advisory and probably does not reflect an increase in PCB concentrations in fish.

Rivers:

Fish from 209 river locations, representing 1,860 miles, have been analyzed for contaminants in Minnesota. As Figure III-8 shows, 17 locations

Figure III-8. Fish Consumption Use Support for Streams



representing 181 miles (9.8 percent) fully supported fish consumption uses. These reaches are generally upstream of any dischargers. One hundred and twenty-six locations (representing 1,194 miles, or 64 percent) partially supported fish consumption use due to PCB and mercury contamination. Sixty-six locations (representing 484 river miles, or 26 percent) were classified as not supporting fish consumption. The majority of these are large rivers near or downstream of major municipalities and are contaminated with PCBs. They include the Mississippi, Minnesota, St. Louis River, Cedar, Le Sueur, Red, St. Croix, Sauk and Zumbro River. Like Lake Superior, the change in the fish consumption advisory is responsible for the reclassification of these reaches.

Fish Kills

The MDNR maintains a log of recorded fish kills that have occurred in Minnesota waterbodies. Thirty-one fish kills that formally occurred during October 1989 to October 1991 are listed in Table III-22.

Section 303(d) Waters

The MPCA has identified those waters where determination of total maximum daily loads are required by Section 303(d) of the Clean Water Act. Additional reaches may be added as needs are identified and resources are available. These are waterbodies where existing requirements are not adequate to maintain water quality standards. These waterbodies are identified on the Table of All Assessed Waterbodies, Monitoring Data in Appendix 1 in the column on 303(d) status.

Table III-22. Documented Fish Kills In Minnesota, October 1989 To October 1991

DATE	WATERBODY (OR LOCATION)	COUNTY	NUMBER	CAUSE
891226	Redwood River	Lyon	1000	Chemical
900105	N. Fork Crow River	Meeker	14	O2 Depletion
900424	St. Croix River	Washington		Chemical
900514	Allie	Renville	60000	Disease
900519	Lucy	Carver	100	Unknown
900611	Johanna	Ramsey		Disease
900614	Green	Chisago		Disease
900615	Cooks Bay (Minnetonka)	Hennepin		Disease
900720	Wirth	Hennepin		Disease
900723	Medicine	Hennepin		Disease
900806	Twin	Hennepin		Disease
900815	Nokomis	Hennepin		Disease
910205	small pond	Hennepin		Winterkill
910303	La Prairie River	Itasca	10	Oil spill
910412	Cascade Creek	Olmsted	29591	Fertilizer spill
910429	Harriet	Hennepin	20	Disease
910516	Goose	Ramsey	3	Disease
910527	small pond	Scott		Summerkill
910606	Cedar	Scott		Disease
910607	Barvia	Carver		Disease
910608	Independence	Hennepin		Disease
910610	Lotus	Carver		Disease
910612	Rush Creek	Fillmore	3000	Chemical
910627	Mississippi River	Goodhue	8212	Thermal
910711	Green	Chisago		Disease
910712	Forest	Chisago		Disease
910722	St. Croix River	Chisago		Unknown
910723	Keller	Dakota	28	Disease
910727	Dutch	Hennepin	3	Unknown
910815	Pearl Creek	Goodhue	18730	Chemical
910829	Rice	Hennepin		Unknown

(Information is from a fish kill log kept by the Minnesota Department of Natural Resources. "Number" is the number of dead fish counted or estimated based on the count.)

PART IV: GROUND WATER QUALITY

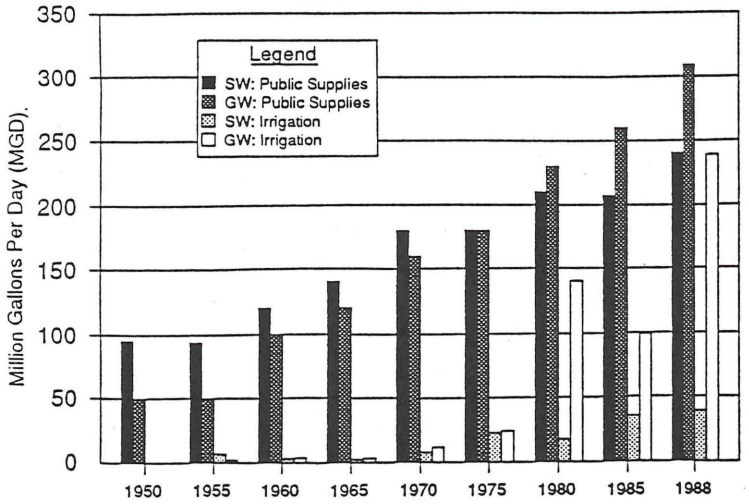
Chapter One: Ground Water Resource Overview

Ground Water Usage

Minnesota relies on high quality ground water resources to sustain economic growth and maintain a healthy environment. Water usage data indicates Minnesota is growing increasingly dependent on ground water as a source of drinking water and irrigation water (Figure IV-1).

While ground water accounted for approximately 35 percent of public supply in 1950, it accounted for 63 percent in 1990. In addition, 100 percent of private domestic water supplies rely on ground water as a source of drinking water. The demands for ground water are highest in the Twin Cities Metropolitan area and the agricultural regions of central and northwestern Minnesota. Ground water is also an important component of the hydrologic cycle in Minnesota. Ground water contributes to stream base flow and lake levels. The interactions between ground water and surface water are important considerations for assessing and managing nonpoint source pollution in Minnesota. Elevated nutrient levels and other contaminants found in ground water may adversely affect both streams and lakes. As such, the quality of Minnesota's ground water is important both from public health and environmental perspectives.

Figure IV-1. Trends in Surface Water and Ground Water Use



Ground Water Occurrence

Ground water resources are not evenly distributed in Minnesota. Minnesota's geological history spans 3.5 billion years and resulted in Minnesota having 14 principal aquifers. Only one of these aquifers, the Red River-Winnipeg Formation located in Northeastern Minnesota, is not used as a water supply (due to elevated salinity).

The geologic material comprising the aquifers varies dramatically and ranges from unconsolidated sand and gravel deposits to soluble limestone and fractured volcanic and granite (Figure IV- 2). The extent of these aquifers is not uniform across the state (Figure IV-3).

The northeastern reaches of the state rely on low-yielding Precambrian volcanic and metasedimentary aquifers (with occasional surficial and buried sand aquifers) for a ground water source. The principal aquifers used in southeastern Minnesota include up to six high-yielding sedimentary formations that are overlain by surficial and buried sand aquifers. The remaining areas of the state extract water from surficial and buried sand aquifers with the exception of the Cretaceous Sandstone beds and Precambrian Sioux Quartzite in southwestern Minnesota.

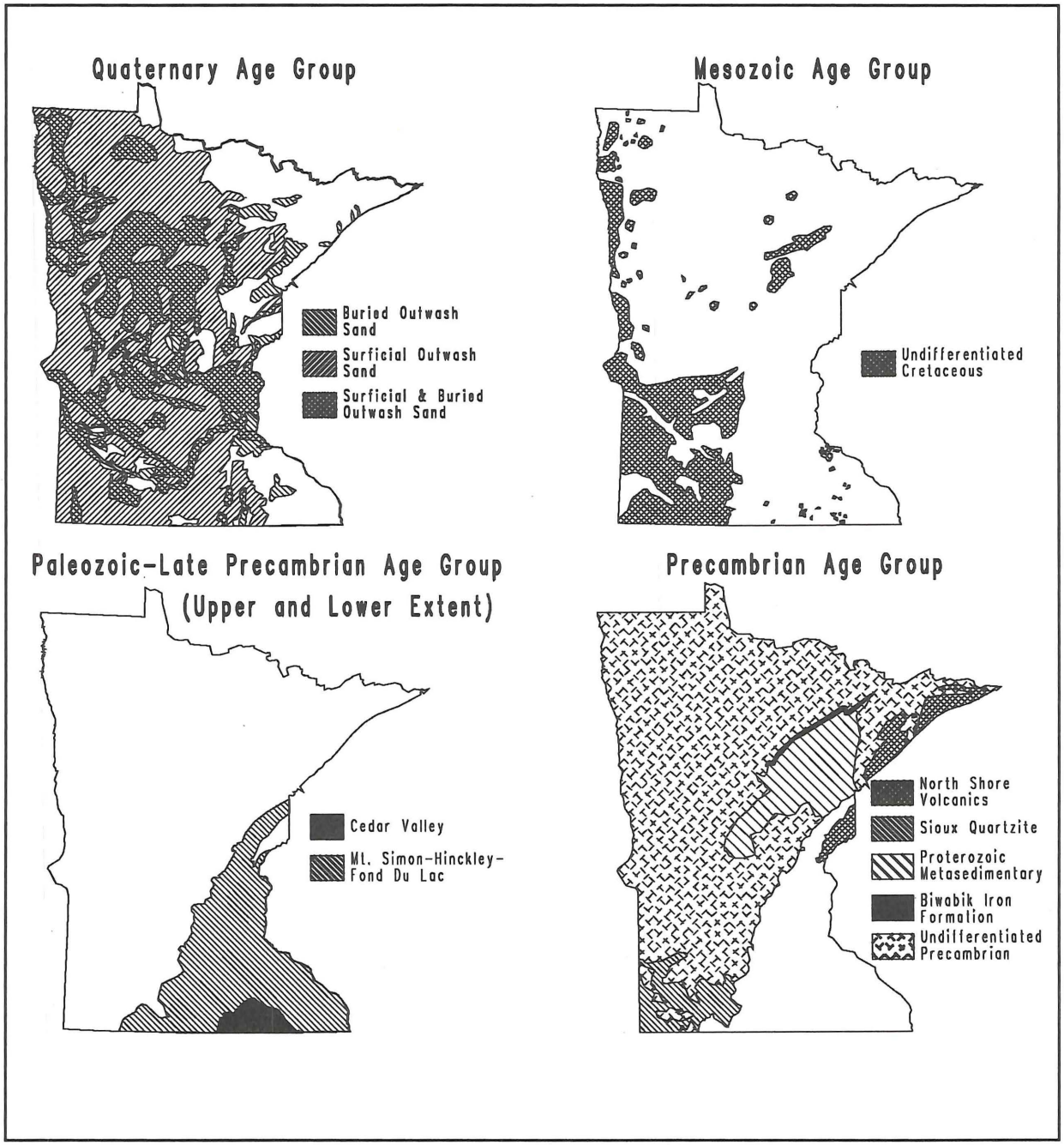
These diverse geologic settings (along with precipitation gradients across the state and changing soil types and soil depths) influence the quality of Minnesota's ground water resources. Of particular importance is the susceptibility of ground water to contamination from land use practices.

Figure IV-2. Generalized sequence of bedrock aquifer systems and confining beds.

ERA	PERIOD	GROUP or FORMATION	GRAPHIC COLUMN	MAXIMUM THICKNESS (FEET)	HYDROGEOLOGIC UNITS
Cenozoic	Quaternary	Drift		500	Surficial sand and gravel aquifer Clay-rich till confining beds Buried sand and gravel aquifers
Mesozoic	Cretaceous	Cretaceous beds		550	Cretaceous confining beds—shale Cretaceous aquifer—sandstone lenses in shale
Paleozoic	Devonian	Cedar Valley Limestone		300	Upper Carbonate aquifer—limestone, dolomite, and dolomitic limestone
	Ordovician	Maquoketa Shale		70+	
		Dubuque Formation		35	
		Galena Formation		230	
		Decorah Shale		95	Confining bed—shale dolomitic limestone, and limestone
		Platteville Limestone		35	
		Glenwood Shale		18	
		St. Peter Sandstone		155	St. Peter aquifer—sandstone St. Peter confining bed—siltstone and shale
		Prairie du Chien Group		360	Prairie du Chien-Jordan aquifer—dolomite and sandstone
	Cambrain	Jordan Sandstone		115	
		St. Lawrence Formation		65	St. Lawrence confining bed—shaly, silty dolomite
		Franconia Formation		200+	Franconia—Ironton Galesville aquifer—sandstone interbedded with shale, siltstone, and dolomite
		Ironton Sandstone		45	
		Galesville Sandstone		95	
		Eau Claire Sandstone		195	Eau Claire confining bed—sandstone, siltstone,
		Mt. Simon Sandstone		315	Mt. Simon-Hinckley aquifer—sandstone, siltstone, and shale
Precambrian	Proterozoic and older	Hinckley Sandstone		500	
		Fond du Lac		2000+	Hydrogeolgic properties little known, sandstone and sandy shale
		* Sedimentary, metamorphic, and igneous rocks			

* Note: This includes the North Shore Volcanic Group, Biwabik Iron Formation, Sioux Quartzite, and Precambrian Undifferentiated

Figure IV-3. Extent of Aquifers in Minnesota

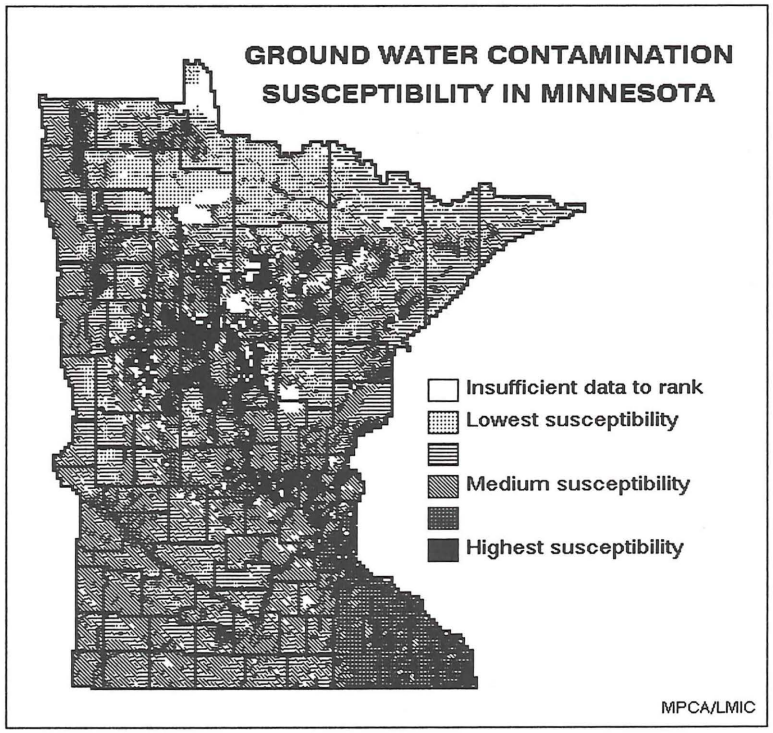


Susceptibility of Ground Water Resources to Contamination

The Minnesota Pollution Control Agency published the statewide map, Ground Water Contamination Susceptibility in Minnesota, in 1989. Figure IV-4 is adapted from that map. The map was compiled from existing data (published maps and a water well database) using a geographic information system (GIS). The map depicts the relative ability of geologic materials to restrict downward migration of contaminants to the first-encountered aquifer. The criteria used to rank the susceptibility included: recharge potential and the hydrologic properties of the soil zone, vadose zone, and the first encountered aquifer. The scale of this map is too small to be useful for evaluating local conditions; however, this map is a useful tool for broad scale assessments, management, planning, and education.

The areas with the highest susceptibility for ground water contamination extend from the population growth centers of the Twin Cities Metropolitan area south to Rochester and to include the prime agricultural areas of northwestern and north central Minnesota (Figure IV-4). These areas may transmit contaminants from the land surface on a scale of hours to the ground water and thus are at greatest risk for land use impacts. Sand and gravel deposits lacking a confining unit or limestone formations located near the land surface dominate these areas. The areas that are least susceptible to ground water contamination are characterized by thick clay-rich soils overlying low-yielding aquifers (where water may take years to reach the saturated zone and to eventually enter an aquifer).

Figure IV-4. Areas of Highest Ground Water Contamination Susceptibility in Minnesota, adapted from 1989 Ground Water Contamination in Minnesota.



Summary

Minnesota's reliance on ground water as a source of drinking water and irrigation is growing. The hydrogeology of Minnesota provides the state with abundant sources of ground water, but these are not evenly distributed. Finally, the susceptibility of ground water resources to contamination varies, and the highest susceptibilities are in the major population growth areas and in agricultural areas of the state where ground water withdrawals are the greatest.

Chapter Two: Ground Water Quality

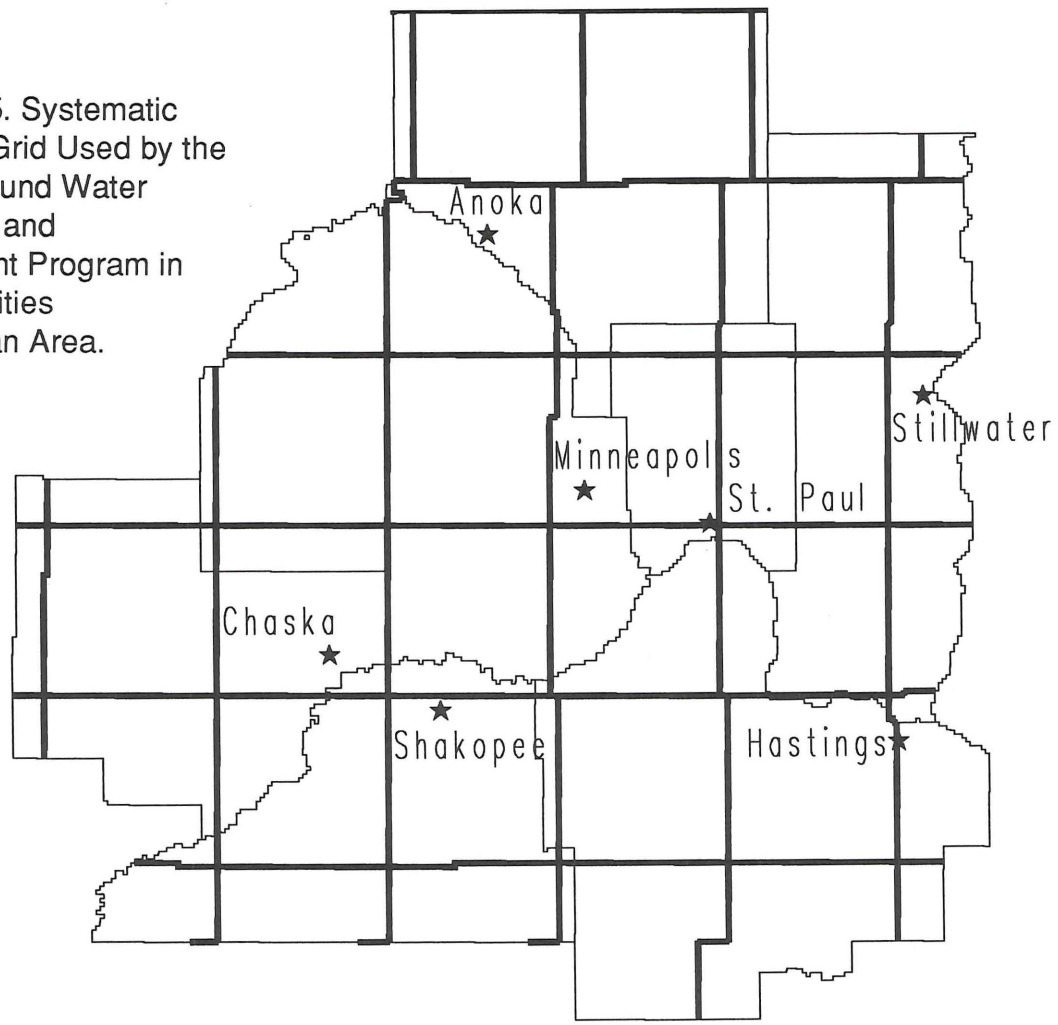
Statewide Water Quality Assessments

Statewide assessments of Minnesota's ground water quality are conducted by the MPCA and the Minnesota Department of Agriculture (MDA). These water quality assessments are designed to assess broad scale spatial and temporal changes in water quality in relation to domestic, commercial and industrial activities, and widespread application of pesticides and nutrients.

MPCA Ground Water Monitoring and Assessment Program

The MPCA's Ground Water Monitoring and Assessment Program (GWMAP) was designed in the 1990-1991 biennium and is in its first year of implementation. The program is designed to collect and evaluate ground water data for assessing regional variations and temporal trends in ground water quality on a statewide basis. The program utilizes a systematic sampling technique to select wells for data collection. Figure IV-5 illustrates the grid used for systematic sampling in the Twin Cities Metropolitan Area. Ground water samples will be collected at the center of each grid cell for each of the nine aquifers used in this area. Data collection to assess temporal trends is focused on areas at greatest risk for ground water contamination. In addition, the program will seek out and evaluate data collected by other programs and projects that are suitable for assessing baseline water quality conditions. GWMAP also has available ground water quality data collected between 1978 and 1989 by its predecessor, the Ambient Ground Water Monitoring Program.

Figure IV-5. Systematic Sampling Grid Used by the MPCA Ground Water Monitoring and Assessment Program in the Twin Cities Metropolitan Area.



During this time period, the program collected and analyzed approximately 1,100 water samples from 486 domestic, public, commercial, industrial, and irrigation supply wells, as well as springs. Water samples were collected on an irregular basis and analyzed for up to approximately 130 chemical parameters. Irregular sampling schedules, inconsistent well selection criteria, and changing parameters of interest severely limit the use of this data. However, this data is useful for identifying characteristics of ground water quality in general. This data is summarized, in combination with data from current GWMAP monitoring, in Appendices 3 through 13.

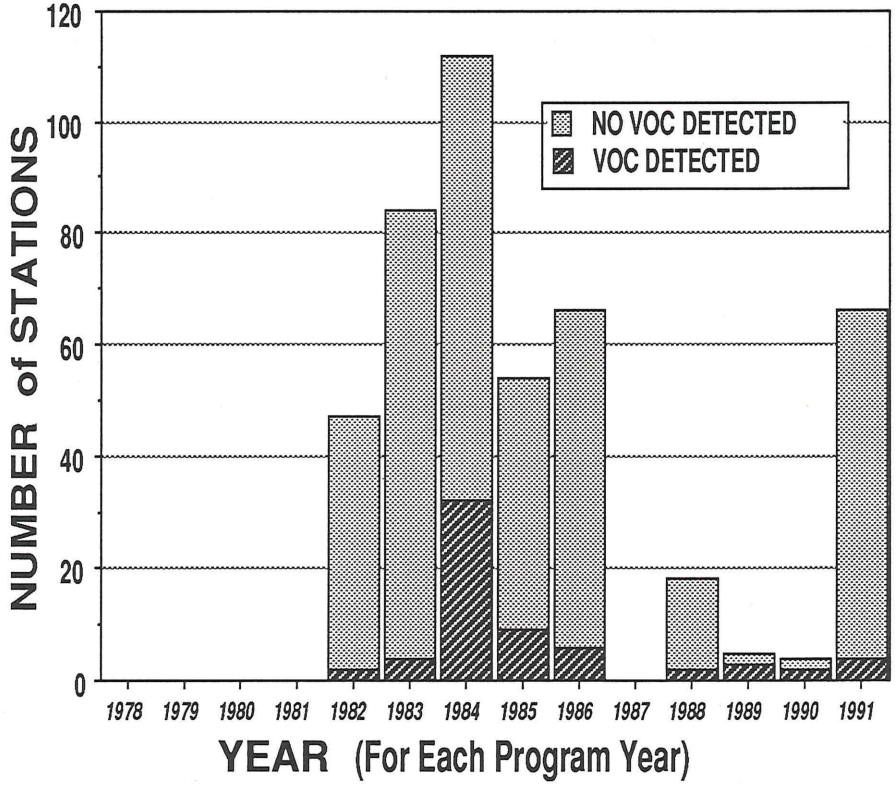
In general, Minnesota's ground water quality can be described as a calcium-magnesium bicarbonate type water, commonly containing concentrations of iron and manganese that frequently exceed secondary drinking water limits and Recommended Allowable Limits (RAL). Calcium-magnesium bicarbonate waters are generally good sources of drinking water, but high concentrations of these minerals may make water unsuitable for some uses.

Concentrations of manganese and arsenic exceeding the RALs have been observed in approximately half of the aquifers monitored. The Recommended Allowable Limits are non-enforceable drinking water guidelines established by the Minnesota Department of Health. These values are based on health effects only and may not be adequately protective if more than one contaminant is present.

Human activities on the land surface produce material that is apparent in the trace constituents in the water. The presence of these trace constituents above the RAL is potentially compromising for the resource as a drinking water supply, and may be contributing also to pollution problems in the surface water. The clearest indicators of this human impact are the data for nitrate, volatile organic compounds (VOC), and pesticides. Of these three substances, nitrate samples having concentrations exceeding RALs are the most common.

Exceedances of the RAL for nitrate have been observed in the following geologic units: surficial outwash sands, buried sands, Galena limestone, St. Peter sandstone, Prairie du Chien limestone, Jordan sandstone, Mt. Simon-Hinckley sandstones, Sioux quartzite, and undifferentiated Precambrian. VOCs have been detected in 53 of the wells sampled, however no exceedances of RALs for VOCs have been observed in this data. Detections of VOCs have varied from 5 percent to 50 percent of samples analyzed annually from 1982 through 1991 (Figure IV-6). However, this variation in detections reflects mainly the changing station selection criteria and monitoring objectives and is not indicative, necessarily, of changes in the quality of ground water. Because of this, Figure IV-6 cannot be used to estimate the number of detections of volatile organic compounds in Minnesota. Pesticide analyses were conducted in the early years of this program, and results indicate that pesticides were detected in approximately five of the 37 wells sampled in 1978 to 1982. Other trace constituents observed above the RAL on a less frequent basis include cadmium, chromium, copper, lead, mercury, and zinc (See Metals Summary Tables, Appendices 8-11). Reports of elevated concentrations of fluoride are not unusual in the Cretaceous Sandstones of southwestern Minnesota. This phenomenon is not apparent in the data collected by the MPCA. The currently available data is not useful for identifying the temporal or regional trends in ground water quality or making

Figure IV-6. Frequency of Detection of Volatile Organic Compounds



quantitative estimates of baseline water conditions. However, the MPCA is in the early phases of implementing the Ground Water Monitoring and Assessment Program (see Part V, Chapter 5: Special State Concerns).

Minnesota Department of Agriculture - Pesticide and Nutrient Monitoring Program

The Minnesota Department of Agriculture ground water monitoring program was developed as part of the 1987 Minnesota Pesticide Control Law, which mandated the MDA to determine the impact of pesticides on waters of the state. The program's primary interest is to determine the long-term impacts of routine pesticide use on ground water quality. Information generated from the program is used to develop and implement best management practices and to otherwise regulate the use of pesticides in the state.

The program includes two components. The first is a diagnostic network designed to assess spatial occurrence of pesticides across the state. General qualitative geologic sensitivity is determined to prioritize areas for monitoring. Monitoring efforts focus in areas downgradient of agricultural fields that have had pesticide applications during the previous three growing seasons.

Individual well locations are based on a randomly initiated square grid pattern determined by the physical characteristics of the area. Water samples collected from existing water level observation wells and domestic water supply wells are analyzed for up to 32 pesticides and a small number of associated breakdown products, as well as nitrate-nitrogen. The second component is designed to evaluate long-term monotonic trends in pesticide concentrations and occurrence. Only wells that have shown repeated detections over a two year period in the diagnostic network are sampled for trend analysis. As of March 1992, nearly all wells in the network have six or more years of data.

Pesticides have been detected in 58 of the 232 wells monitored by the MDA. Atrazine detections account for 95 percent of the pesticides detections in wells with one or more pesticide detections. Atrazine concentrations in two wells exceeded the RALs of 3 micrograms per liter. Alachlor, cyanizine, and metalachlor account for 10 percent, 5 percent, and 3 percent of the detections respectively. Atrazine is the only pesticide that occurs frequently enough to evaluate concentration trends. Statistically significant trends have been detected in only a small number of the 22 wells. Both increasing and decreasing trends have been identified. The interpretation of this data is difficult due to the lack of information on pesticide use.

Sources of Ground Water Contamination

Most of the sources of ground water contamination in Minnesota have been introduced by human activity (Table IV-1). Naturally occurring sources of contamination documented in Minnesota include arsenic, manganese, selenium, and radionuclides. Minnesota has not yet developed or adopted a criteria to prioritize the sources of ground water contamination listed in Table IV-1. The potential for ground water contamination resulting from the sources listed in Table IV-1 varies widely. Many of these potential sources are regulated by the MPCA or the MDA and when well-managed can result in a very low potential for ground water contamination.

The most serious localized or point sources of contamination are included in the Minnesota Permanent List of Priorities (Superfund). Individual sites are evaluated to determine the priority for investigative and remedial activities under state and federal Superfund regulations (CERCLA and MERLA). This list is updated semiannually by the MPCA. The December 1991 update included 179 sites. Currently 140 of the 179 sites are actively investigating or remediating ground water contamination problems. Remedial activities are currently underway at 48 of these sites. Throughout the eight years of Superfund, 13 sites have been cleaned up and removed from the list.

A prolific source of ground water contamination in Minnesota is leaking underground storage tanks. Minnesota was one of the first states to implement an underground storage tank program. To date, approximately 27,601 tanks have been registered with the MPCA. Approximately 20 percent have documented leaks (Figure IV-7). In addition, the MPCA maintains a database of known and potential sources of ground water contamination, the Master Entity System. The locational information in this database is currently being updated.

Substances Contaminating Ground Water

The occurrence of ground water contamination has been documented through several different types of monitoring programs in Minnesota during 1991. These include site specific investigations to assess the extent of contamination and evaluate remediation actions, regional and statewide water quality assessments, and public water supply monitoring. Table IV-2 summarizes the available data and does not include water quality data collected by the Property Transfer Technical Assistance Program at the MPCA. Because information is collected by each source for fundamentally different reasons, the data is

Table IV-1. Potential Sources of Ground Water Contamination

POTENTIAL SOURCE	NUMBER OF FACILITIES
Septic tanks	Approx. 400,000 tanks
Permitted municipal landfills	49 active landfills
On-site industrial landfills (excludes pits, lagoons, surface impoundments)	17 landfills
Other permitted landfills (ash disposal, demolition debris disposal).	96 landfills
Surface impoundments	309
Underground storage tanks	27,600 registered tanks, 1,756 sites impacting ground water
Injection wells (Stormwater disposal, abandoned water wells, industrial/commercial waste disposal systems, thermal wells, aquifer remediation, septic systems servicing >20 people)	Unknown
Abandoned hazardous waste sites (Superfund sites)	179 sites
Permitted hazardous waste facilities (treatment, storage & disposal)	21 facilities
Repeated land application treatment of waste and wastewater	Data not available
Agricultural activities (application of pesticides & nutrients, feedlots)	Unknown
Road salting	184,453 tons (1991-92 season)
Other: Historical Open Dumps	1,800 dumps
Scrapyards	unknown

presented in Table IV-2 according to type of monitoring. In addition, each definition of contamination is specific to the type of monitoring. Contamination at public water supply wells is determined by the number of wells with exceedances of Maximum Contaminant Levels (MCL). Contamination for the remaining water quality data is based on an exceedance of an RAL for inorganics and the detection of an organic compound. The frequency of contamination documented by on-site investigations is determined by the number of sites whereas regional and statewide assessments use the number of wells.

Ground Water contamination is most frequently documented by site-specific investigations. The substances most frequently contaminating ground water in Minnesota are volatile organic compounds (VOC) (Table IV-2). Site investigations account for 97 percent of the 2,002 VOC detections or exceedances (public

Table IV-2. Substances Contaminating Ground water

Substance	Site Investigations *# Sites*	Regional Assessments *# Wells*	Public Water Supply *# Wells*
Organic Chemicals			
Volatile	1942[1]	57[1]	3[3]
Other Synthetic	79[1]	no data	no data
Inorganic Chemicals			
Arsenic	95[2]	130[2]	1[3]
Metals	165[2]	74[2]	1[3]
Nitrates	34[2]	40[2]	76[3]
Pesticides	33[1]	60[1]	0[3]
Other			
Cyanide	7[2]	0[1]	no data
Fuel Oil	29[1]	no data	no data

1:Detection of Substance; 2:Exceedance of Recommended Allowable Limit; 3:Exceedance of Maximum Contaminant Level

water supplies) in ground water. Additional work completed in 1988 by the MDH detected VOCs in 25 percent of the wells considered to be the most at risk for contamination, 2 percent of which exceeded MCLs. This study included VOC analysis of water samples collected from 300 of the 11,000 non-community public water supplies in Minnesota.

Metals are the second most frequently encountered contaminant in Minnesota. However, this is due in large part to the common exceedance of the RAL of 300 micrograms per liter for manganese in the baseline quality of Minnesota's ground water. Similarly, arsenic concentrations frequently exceed the RAL of 0.2 micrograms per liter. Both RALs are undergoing revision.

Pesticides in ground water are a significant concern in Minnesota. On-site investigations as well as regional and statewide assessments have detected pesticides. For more information see the first section in this chapter, Statewide Water Quality Assessment. Pesticide concentrations exceeding the MCL have not been documented in the 600 public water supply systems evaluated by the MDH.

The frequency of nitrate-nitrogen contamination is under-represented in Table IV-2. This table does not include the water quality data collected by local units of government, the largest source of nitrate-nitrogen data. Nitrate-nitrogen exceedances account for 94 percent of the 82 MCL exceedances at public water supply wells (Table IV-2). Nitrate-nitrogen is the second most frequent contaminant detected by the

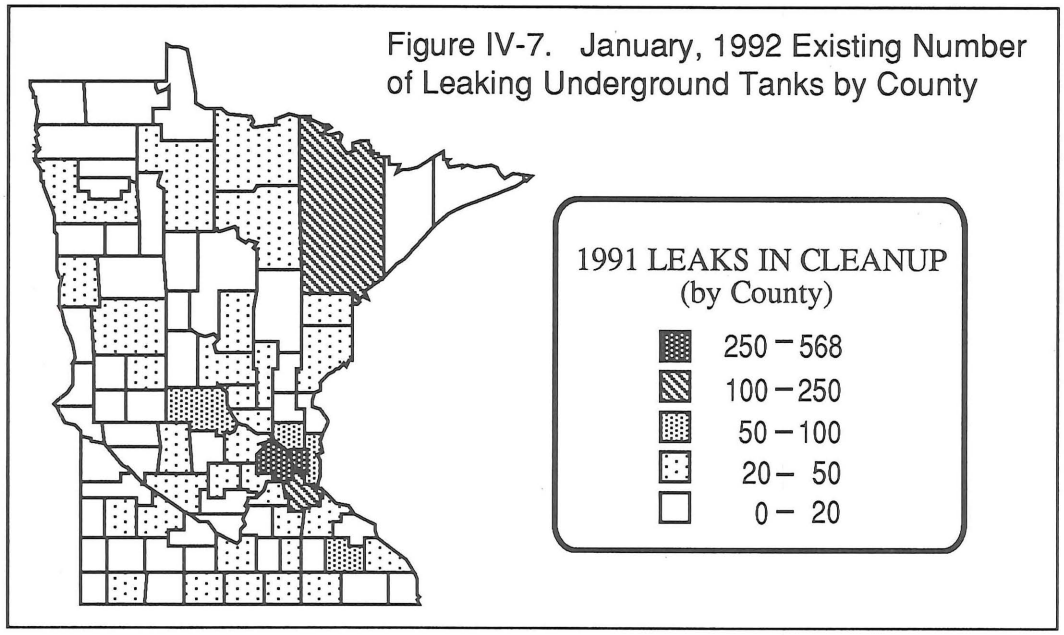


Figure IV-7. January, 1992 Existing Number of Leaking Underground Tanks by County

MPCA GWMAP. For more information see Part V, Chapter Five: Special State Concerns.

Summary

Chemical analyses of major cations and anions indicate that Minnesota's ground water resources are generally calcium-magnesium bicarbonate type waters with significant amounts of iron and manganese. However, analysis of trace constituents indicate that human activities on the land surface are impacting ground water quality. The most frequently encountered substances contaminating Minnesota's ground water are volatile organic compounds and nitrate-nitrogen. Substances of particular concern in Minnesota include pesticides and nitrates (see Part V, Chapter Five: Special State Concerns).

Chapter Three: Ground Water Management

In 1989, the Minnesota State Legislature enacted the Ground Water Protection Act. This legislation built upon two reports published in 1988: Minnesota Ground Water Protection Strategy (Minnesota Pollution Control Agency) and A Strategy for the Wise Use of Pesticide and Nutrients (Minnesota State Planning Agency). The requirements and authorities granted in the Ground Water Protection Act supplement previously existing authorities of the various environmental agencies in Minnesota as well as local units of government. A thorough and concise description of the specific provisions of the act is available in the Minnesota State Planning Agency publication entitled Minnesota Ground Water Protection Act of 1989, A Summary.

Currently, many state agencies and local units of government are implementing the provisions of the Act. The major provisions of the Act include: a policy framework stressing prevention of ground water degradation as a goal; improved ground water monitoring and information management; strengthened control of pollution sources; increased drinking water protection and regulation of water supply wells; increased regulation of pesticides and fertilizers; development of a program for cleanup of agricultural chemical contamination incidents; encouragement of water conservation; and funding for local water planning and plan implementation activities.

Responsibilities for ground water management in Minnesota are shared among nine state organizations and one regional organization as well as local units of governments. The principal roles of these organizations include planning and policy development, supplying information and conducting resource assessments, providing assistance and incentives for pollution control, and administering regulatory programs. Ninety-eight percent of the 87 counties in Minnesota are developing or have completed comprehensive water resource plans. Implementation of these plans will increase the role of local government in ground water management.

Minnesota's Regulatory Framework

Minnesota's regulatory framework includes both incentives and assistance to prevent pollution as well as regulations. Incentive and assistance programs have been developed by several state agencies to address agricultural practices, solid and hazardous waste management, wastewater treatment (municipal and septic tank systems), and the sealing of abandoned wells. The Minnesota Department of Natural Resources (MDNR), Minnesota Pollution Control Agency (MPCA), Minnesota Department of Administration (MDA), and Minnesota Department of Health (MDH) are the principal state agencies that administer ground water related regulatory programs in Minnesota. In general, issues relating to ground water quantity and geologic mapping are handled by the MDNR. The MDNR works cooperatively with the Minnesota Geological Survey on the development of regional and county geologic maps, and assessments of geologic sensitivity. Issues relating to drinking water quality are handled by the MDH, which has delegated the enforcement of the water well construction code to nine counties in Minnesota. Programs and activities to prevent, regulate, and remediate ground water contamination are administered by the MDA and the MPCA.

Minnesota regulates ground water quality through MPCA regulations Chapter 7050 and Chapter 7060. Chapter 7060 is currently being revised (see Part V, Chapter Five: Special State Concerns).

Table IV-3. Minnesota Regulatory Framework for Ground Water

FEDERAL Agency	Information/Technical Assistance	Projects/Incentives	Regulation
Agricultural Stabilization and Conservation Service		Agriculture Conservation Program; Conservation Reserve Program.	
Corps of Engineers	Planning Assistance to State / Local Government.		
Environmental Protection Agency	STORET Database *(w/PCA)*; Guidance Documents.		Safe Drinking Water Act; RCRA; CERCLA; FIFRA; Clean Water Act; Underground Injection Control.
Geological Survey	Cooperative Geological Studies.		
Soil Conservation Service	Water Resource Assessment; Conservation Planning & Application Technical Assistance.	Demonstration Project; Hydrologic Unit Project.	Watershed Protection *(PL-566)* Cost Share.
STATE			
Agriculture	Pesticide & Fertilizer Monitoring; Pesticide Use Survey.	Sustainable Agriculture; Integrated Pest Management; Waste Pesticide Collection; Pilot Pesticide Container Collection.	Fertilizer Regulation; Pesticide Regulation; Applicator Certification; Crop Consultant Certification; Ag Chemical Incident Response.
Board of Water & Soil Resources	Local Water Planning Assistance.	Local Water Resources Protection and Management Grants; RIM Reserve; Environmental Ag Education Contracts; Well Sealing Grants.	Local Water Plan Approval.
Environmental Quality Board	Minnesota Water Plan; Research Priorities Reports; State Monitoring Plan; Quality / QuantityTrends Reports.		Environmental Assessment; Pipeline Routing.
Health	Health Risk; Public Water Supply Monitoring / Assistance; Well Management.	Community Health Service Grants.	Health Risk Limits; Public Water Supply; Water Well Code; Wellhead Protection.
Metropolitan Council*	Metropolitan Water Plan; Water Quality Goals; Water Supply Plan.		
Minnesota Geological Survey	County Geologic Atlas (w/DNR); Regional Hydrogeologic Assessments (w/DNR); Hydrogeologic Mapping.		
Natural Resources	Sensitive Area Mapping; County Geologic Atlas (w/MGS); Aquifer Safe Yields; Regional Studies & Assessments; Observation Well Network; Water Use Database; Well Log Database.		Water Appropriation Permits; Sensitive Area Criteria.
Office of Waste Management	Solid and Hazardous Waste Management Assistance; Waste Education.	Solid and Hazardous Waste Management Grants and Loans.	County Solid Waste Management Plan Approval.
Pollution Control Agency	Ambient Ground Water Monitoring; Best Management Practices; IGWIS Database; Monitoring and Data Management Assistance; Special Ground Water Studies.	Clean Water Partnership; Wastewater Treatment Grants and Loans (w/TED); Septic System Upgrade Program; Tanks Program.	Water Quality Standards; Pollution Discharge / Management Permits; Tanks / Spills Regulations; Animal Waste Management; Superfund Program.
State Planning Agency	Ground Water Data Clearinghouse; Land Management Information Center / Geographic Information Systems Support.		

PART V: WATER POLLUTION CONTROL PROGRAM

Chapter One: Point Source Pollution Control Program

The Water Quality Division of the Minnesota Pollution Control Agency (MPCA) is organized into four sections: Municipal, Industrial, Assessment and Planning, and Nonpoint Source. The Municipal Section and the Industrial Section carry out regulatory activities with concern to municipal wastewater treatment plants and industrial dischargers, respectively. These activities include engineering review of wastewater systems, issuance of permits for new facilities, reissuance of permits on a five-year cycle for existing facilities, tracking of compliance, monthly reports, identification of permit violations and subsequent enforcement activities associated with returning facilities to compliance. The Municipal Section also provides technical and financial assistance for wastewater treatment operations in cities. The focus of these two sections is on achieving compliance with effluent limits and other special conditions contained in National Pollutant Discharge Elimination System (NPDES) and State Disposal System (SDS) permits.

The Assessment and Planning Section carries out Great Lakes programs, water quality monitoring and assessment, special efforts on toxic water pollutants and rules development. Some of the activities of this section are part of the Point Source Control Program. These activities include development of water quality standards which serve as a regulatory framework in establishing effluent limits for dischargers, and establishment of a Toxics Substances Control Strategy. This strategy consists of developing numeric water quality criteria and procedures for toxic substances, and the development of toxic substances effluent limits for NPDES permits. This section measures the toxicity of effluents on test organisms and works with the Municipal and Industrial Sections to establish effluent toxicity limits for NPDES permits.

The fourth section, the Nonpoint Source Section, administers the Nonpoint Source Control Program described in Part V, Chapter Two.

Minnesota's current Point Source Element of the Water Quality Management Plan (WQMP) assesses problems in terms of water quality standards violations on rivers and streams. It identifies actions taken for point source impacted stream segments.

Appendices 14, 15, and 16 are produced as part of the Water Quality Management Plan. These appendices list only river reaches where at least ten percent of the measurements for one or more parameters are in violation of Water Quality standards, and that have had at least five measurements collected during water years 1982-1991. Fecal coliform violations were included only if they exceeded 50 percent of the measurements taken.

Appendix 14 includes reaches for which the cause of violations is other than from point sources. It may be from either nonpoint sources or natural causes. Appendix 15 includes reaches for which both point sources and other sources contribute to the violations. Appendix 16 lists reaches which are only point source impacted.

Each table gives some characteristics of the impacted river reaches. Appendices 15 and 16 also give some characteristics of the dischargers that are affecting the reaches. The final column of each table indicates the actions being taken. If the facility has been funded for construction or upgrading recently, the year of funding is indicated. If the facility has not been funded, but is on the Construction Grants Priority List (the Needs List), its rank on the list is noted. If the reach affected by a point source discharge is currently being studied, or if there are other actions being taken, these actions are also listed in the "Actions Taken" column.

Chapter Two: Nonpoint Source Pollution Control Program

Background

Minnesota is committed to protecting and improving the water quality of lakes, rivers, ground water and wetlands through abatement of nonpoint sources of pollution. Because of this historically strong commitment, Minnesota readily established itself as a leader in the development of comprehensive and coordinated programs focused on controlling nonpoint source pollutants. As the state's nonpoint source management program has progressed into the implementation stages, Minnesota has continued to distinguish itself as a nationally recognized leader. Some of the specific activities which characterize the quality of Minnesota's nonpoint source program are summarized below.

Interagency Coordination

In 1985, the Minnesota Pollution Control Agency (MPCA) brought together representatives from 13 state and federal agencies with various responsibilities and authorities for addressing nonpoint source pollution (NPS). This group evaluated the nature and extent of the problem, previous state and federal recommendations, and the effectiveness of currently existing nonpoint source activities. In 1987, the Clean Water Act was amended to include Section 319, which required each state to develop a NPS Pollution Assessment Report and Management Program. The work accomplished previously by the interagency team became the foundation of the Nonpoint Source Management Program, and in 1987 the team was formally adopted by rule as the Project Coordination Team.

The Project Coordination Team is currently comprised of 19 local, state, and federal representatives, many of whom were original representatives in 1985. This team has continued to act as the prime interagency force addressing statewide nonpoint source issues. Some of the major responsibilities undertaken by the Project Coordination Team over the past two years include:

- participation in the evaluation and selection of proposed Clean Water Partnership (CWP) projects;
- participation in the revision of the 1988 NPS Management Program to reflect changing needs and priorities;
- coordination of the represented agencies' proposals for 319 funding assistance, ensuring consistency with the NPS Management Program;
- development of annual reports documenting the represented agencies' progress in abating pollution by NPS controls;
- participation in regularly scheduled meetings focused on coordination of programmatic issues; and
- development of the state's education strategy for NPS.

Minnesota River Assessment Project

The Minnesota River Assessment Project (MRAP) received a four-year funding commitment of $1.4 million from the Minnesota Legislature to create a $2.5 million cooperative study involving MPCA, the U.S. Geological Survey, Environmental Protection Agency's Environmental Research Laboratory in Duluth, South Central Minnesota Counties Water Planning Project, Mankato State University, Board of Water and Soil Resources, U.S. Department of Agriculture Soil Conservation Service, Minnesota Department of Natural Resources, and the Minnesota Department of Agriculture (MDA). Additional support is provided by Metropolitan Waste Control Commission, Metropolitan Council, U.S. Fish and Wildlife Service, U.S. Corps of Engineers, and University of Minnesota Natural Resources Research Institute.

The study has established a comprehensive monitoring network in the Minnesota River Basin, designed to identify critical mainstream reaches and tributaries contributing the greatest nonpoint source pollution loading. This information will allow estimation of the NPS load reductions necessary to achieve water quality goals and the amount of resources necessary to achieve those goals, as well as targeting of future water quality management programs. Additional cooperators and resources continue to be added to MRAP as it receives more attention from federal, state and local units of government. Monitoring began in August 1989. The study completion date is scheduled for June 30, 1993.

Clean Water Partnership Program

The Minnesota Legislature enacted the CWP in 1987. The program provides financial and technical assistance to local units of government for water quality protection and improvement projects.

The projects involve:

- completing a comprehensive diagnostic study of a waterbody and its watershed;

- identifying the pollutants that are causing a reduction of water quality and the origin of those pollutants; and
- setting realistic water quality goals and objectives.

An implementation plan is developed by each project that identifies the best management practices needed to restore and protect water quality.

Thirty-two projects have been selected out of 115 applications through four application cycles. The chosen projects represent over $6,400,000 of state and local efforts in lake, stream, ground water, and wellhead protection and wetland restoration across the state. There is tremendous interest and demand for participation in this new and innovative program.

Nitrogen in Minnesota Ground Water

The Nitrogen Study was conducted in response to the 1989 Ground water Bill (Chapter 103H, Article 1, Section 12), which directed the MPCA and the MDA to prepare a report on nitrate (NO3) and related nitrogen compounds in ground water. The report was prepared in consultation with the Board of Water and Soil Resources and Minnesota Experiment Station. Other agencies were also consulted during the report writing and review process.

One of the primary objectives of this study was to examine and summarize existing data and literature in order to provide legislators, federal, state, and local water planners, and other policy makers the information necessary to most appropriately respond to the issue of nitrogen (N) in ground water. This comprehensive report was written with the intent of providing enough detailed information and related references to satisfy those readers interested in studying specific issues, yet focusing on the most pertinent and relevant information needed to understand the situation in Minnesota.

Another objective of this study was to review federal, state and local response to the issue of nitrogen in ground water and make feasible recommendations for improvement in state and local response. Recommendations are made throughout the report with the highest priority recommendations listed in the first chapter. For further information on the study, see Part V, Chapter Five: Special Concerns.

Local Comprehensive Water Management

One of the key tools in addressing nonpoint source issues in Minnesota is the state's comprehensive water planning process. The water planning process was directed by the state legislature to be coordinated at the local level to address specific water quality and quantity problems. This approach to water planning has fostered strong local-state partnerships focused on efficiently dealing with the numerous and diverse NPS issues in Minnesota.

Since metropolitan and rural areas have different needs and priorities with respect to comprehensive water management, it was necessary for the state legislature to create separate legislation specific to those areas. The Metropolitan Surface Water Management Act (1982) and the Comprehensive Local Water Management Act (1985) created a process through which comprehensive water resource planning and management on both an urban and rural basis could be achieved.

FY 91 Accomplishments: With respect to the metropolitan area, in the 1991 federal fiscal year 12 watershed management plans were approved by the state bringing the total to 31 of the 46 Watershed Management Organizations that have a state approved plan. The plans all include provisions for local ordinances to control erosion, and most address nutrient management in storm water facility design.

Outside of the metropolitan area, 78 of 80 greater Minnesota (rural) counties are involved in Local Water Planning/Management. In the 1991 federal fiscal year, ten county comprehensive water management plans were approved by the state, bringing the total number of approved plans to 62. The remaining 16 counties are expected to have approved plans by the end of the 1992 federal fiscal year.

The process of resource management planning at the local level has served to focus interest and raise awareness of resource value and degradation problems. The planning process fosters ownership and responsibility for resource protection and improvement at the local government level. These local and inter-county efforts provide a unique opportunity for implementation of NPS pollution control efforts.

Feedlot Program

The MPCA Feedlot Program is governed by Minnesota Rules Chapter 7020, which describes an animal feedlot as any facility where animals are confined in such a way that manure can accumulate and a vegetative cover cannot be maintained within the enclosure. The purpose of the MPCA feedlot program is to evaluate these 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.

The owner of a proposed or existing feedlot of 10 or more animal units (10 steers, 1000 chickens, etc.) is required to apply to the MPCA or to the county feedlot officer for a feedlot permit whenever the following conditions exist:

a) a new feedlot is proposed;

b) a change in an existing feedlot is proposed (expansion modification);

c) ownership of an existing feedlot is changed;

d) a National Pollutant Discharge Elimination (NPDES) Permit application is required under state or federal rules and regulations; or,

e) investigation of a complaint on a feedlot reveals a potential pollution hazard.

In the application, 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 must be corrected within ten 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.

Existing or proposed facilities that do not pose water pollution hazards receive Certificates of Compliance. These certificates are documents that certify that a facility has been reviewed by MPCA staff or by a county feedlot officer, and that if operated as described in the permit application it will not cause a water pollution problem.

At present there are an estimated 45,000 to 50,000 facilities regulated under the MPCA feedlot rules. Approximately 16,000 facilities have received permits and certificates issued by the MPCA or county feedlot officers since 1972. 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 Soil and Water Conservation Districts, Soil Conservation Service, and Agricultural Stabilization and Conservation Service. 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.

Jordan Aquifer Sensitivity Study (Garvin Brook Area)

Ground water monitoring is being conducted in a 100 square mile area of west-central Winona County, which includes the Garvin Brook Rural Clean Water Project area. This study is being conducted as part of a multi-agency study related to assessing sensitivity of ground water resources in Minnesota. An additional objective of the study is to inform water planners and the public about information that was learned from previous monitoring in the Garvin Brook area. The primary goals of MPCA's efforts in this project include: determining the variability of water chemistry within the formations, relating the water quality and variability to geologic sensitivity, and assessing the factors affecting water quality and residence times within the aquifer.

Two rounds of samples were taken from 22 Prairie du Chien wells and 32 Jordan wells during 1990. Water from all wells was analyzed for nitrate and field parameters, and most wells were analyzed for other major ions, dissolved organic carbon, and silica. Twenty-two wells were analyzed for tritium and six wells were analyzed for pesticides.

Geologic information was obtained largely from the Winona County Geologic Atlas, supplemented with downhole geophysical logging analyses performed by the Minnesota Geological Survey.

During 1991, the data from the first two rounds of sampling was analyzed and a 63-page report was written entitled "Water Quality and Sensitivity of the Prairie du Chien - Jordan Aquifer in Western Winona County." In addition, a third round of sampling was conducted in April 1991 in order to provide additional information to aid in further understanding residence times, nitrate levels and denitrification potential in the study area.

Several presentations were made of previous study results including a half-day case study presentation at a workshop for local water planners to help them better understand and interpret water quality data.

Additional ground water nitrate sampling was conducted in the Garvin Brook area by Winona County Extension. Monthly sampling of Garvin Brook was conducted by MPCA in order to evaluate long term trends.

Agricultural Nonpoint Source Model

Minnesota developed the Agricultural NPS Model to help resource managers obtain uniform and accurate estimates of runoff quality and compare the effects of various pollution control practices that could be incorporated into the management of agricultural watersheds. The model has been expanded to include components for urban watersheds and the delivery of pollutants to lakes and ground water.

Chapter Three: Cost/Benefit Assessment

Background

Underlying the enactment of environmental laws and the implementation of environmental programs is the implicit statement by the American public that the considerable costs of pollution control are outweighed by its benefits. Actual empirical measurements of these costs and benefits, however, remain few and incomplete. The methods, particularly for determining benefits, are complex, difficult, and still in the developmental stages, and the necessary data largely non-existent.

Some cost/benefit information, though, is available, if not in dollar figures then at least in theoretical or descriptive terms.

Costs

The costs of water pollution control include capital costs for wastewater treatment facility construction and equipment, operating costs (including any foregone production) and programming costs at the various levels of government having water quality programs.

In Minnesota, over the past 20 years since the enactment of the federal Clean Water Act, approximately $1.2 billion in federal and state funds have been matched by local expenditures of $.3 billion for municipal wastewater treatment facility construction under federal and state grants programs, followed by another $.2 billion under the state loan program, for a total of $1.7 billion. To present, an additional $80 million in federal and state funds have been spent, matched by $60 million in local expenditures, in resolving combined sewer overflows in the Twin Cities metropolitan area. Operating costs for municipal sewer utilities in 1989 in Minnesota totaled an estimated $180 million.

At this point, no similar figures exist regarding industrial water pollution control costs. It should be noted, however, that municipal facilities treat industrial as well as municipal wastes and that industrial contributions thus represent a significant portion of the above figures.

Expenditures for the Minnesota Pollution Control Agency's (MPCA) point source water quality programs are currently approximately 9.5 million dollars per year. This covers monitoring, standards-setting, permitting and enforcement activities, and technical and administrative assistance.

The costs of nonpoint source pollution control have become a larger part of the overall picture in Minnesota in recent years, as nonpoint source problems have become more apparent and as control efforts have increased accordingly. The costs, however, are both more diffuse and more difficult to calculate than those for point source programs.

The primary nonpoint source programs at the state level are those of the MPCA and the Minnesota Board of Water and Soil Resources. Current program expenditures at the two agencies are approximately $2.5 million and $1.7 million per year, respectively. In addition, the MPCA's Clean Lakes and Clean Water Partnership programs have provided approximately $3.2 million and $8.0 million, respectively, in federal and state funds for local nonpoint source planning and implementation projects, matched by equal amounts of local funding. Likewise, the Board of Soil and Water Resources passes through approximately $6.4 million per year, including cost-share funds, to counties and Soil and Water Conservation Districts for a number of water quality programs at the local level. Other costs are incurred at the local level in the regulation of land-use, feedlots, and on-site sewage disposal systems.

In addition to expenditures specifically on the point source and nonpoint source programs of the MPCA's Water Quality Division, current funding for the Ground Water and Solid Waste Division's ground water program is approximately $1.0 million per year. This includes program development, ambient monitoring, data management, planning, and standard-setting activities.

It should also be noted that other environmental programs such as air quality, solid waste, hazardous waste, and agricultural pesticide regulation have direct effects on the quality of the state's surface and ground waters.

Benefits

Having concluded that the comprehensive costs of water pollution control efforts are not yet fully calculated, we find the benefits are even less precisely measured. Theoretical models for translating water quality improvement into economically measured benefits exist, but no attempts have been made to do this for the state as a whole. Table V-1 presents a scheme for looking at and possibly analyzing the various benefits that individuals and society as a whole receive from water quality protection efforts.

For point source programs, even if dollar figures are not readily available, benefits can be illustrated in descriptive terms. Significant improvements in state water quality have occurred over the past several decades, especially in the 20 years since the

Table V-1. Classification of Economic Benefits Related to Water Quality Conditions

INTRINSIC BENEFITS

A. No Current Use by the Individual

Community Benefits -Satisfaction that an ecological community is sustained for its own sake.
Existence Benefits - Vicarious enjoyment that other individuals are now using the resource. Stewardship interest in providing future opportunity for use of the resource.

B. Potential Future Use by the Individual

Option Benefits - Interest in option to participate in an activity or use a resource at some future time (i.e., categories listed below under "CURRENT BENEFITS.")

CURRENT BENEFITS

A. Indirect Use by the Individual

Aesthetic Benefits - Conditions enhance current adjoining fixed amenities (e.g., lakeside property).

Recreational Benefits - Conditions enhance current adjoining transitory activities (e.g., hiking, picnicking, birdwatching, and photography).

Structural Ecosystem Benefits - Conditions maintain functional ecosystem processes (e.g., stable climate, purification of air, land, and water, storm protection).

B. Direct Use by the Individual

Recreational Benefits - Conditions enhance current water-contact activities (e.g., commercial and private boating, swimming, and fishing).

Commercial Benefits - Conditions enhance current production processes and activities.

- Extractive Commercial Uses - Production practices where water is a medium for other goods (e.g., commercial fishing, chemical industries, medical industries).
- Commercial Navigation - (e.g., dams, locks, canals, ports).
- Agricultural Irrigation - Water used as an input to production of agricultural crops.
- Industrial Processes - Water itself is used as input to production (e.g., processing, cooling, waste disposal, and steam generation).
- Municipal Water - (e.g., water used for drinking, washing, and fire protection).

Source: Adapted from Figure 3-1, page 3-2 in Benefit-Cost Assessment Handbook for Water Programs, Volume 1, Research Triangle Institute, prepared for the USEPA, Economic Analysis Division, April 1983.

passage of the Clean Water Act. While only 20 percent of the state's sewered population was served by facilities capable of at least secondary treatment in 1952, fully 99.9 percent are so served at present. In a similar vein, rates of compliance with effluent limits for major municipal and industrial facilities are at a high level. For 1991, an average of 94 percent of facilities were in significant compliance, as defined by federal regulation, during any given quarter.

Even more striking are the indications of water quality improvements associated with improvements in specific major wastewater treatment facilities. On the Mississippi below the Twin Cities, both the elimination of floating mats of sludge and the return of the mayfly are evidence of cleaner water conditions that followed massive treatment facility construction and storm sewer separation. Parks are being developed up and down the river's shores and recreational boat use has increased significantly. In the St. Louis River Bay, while sediment and fish tissue contamination problems remain, facility construction by the Western Lake Superior Sanitary District has led to noticeably cleaner water and return to use of the river as a walleye fishery. Similar results have been achieved on the Rainy River below International Falls.

The nonpoint source program is considerably younger than the point source program, and to some extent is still in the developmental stages. One of the challenges for this program is to translate control activities into measureable benefits. If not in terms of dollars, results should have been seen at least in terms of pollutant load reductions. At present, however, little quantifiable information exists for assessment of the benefits of nonpoint source controls.

Chapter Four: Surface Water Monitoring Program

Ambient (Routine) Monitoring

There are currently 78 ambient stream stations monitored each year by the MPCA. This includes about 15 stations each year for a geographic area of emphasis and a network of about 60 stations designed to represent all areas of the state. There is a three-year rotation of area of emphasis among the southern, northeastern and northwestern areas of the state. This program began in 1953 and provides the largest source of computerized, long-term water quality information in the state. Nineteen of the 78 stations are part of the Environmental Protection Agency (EPA) national fixed-station network. They are monitored every year.

Monitoring is done at each station either 9 or 10 months a year. The basic set of parameters includes temperature, dissolved oxygen, fecal coliform, BOD5, suspended solids, pH, conductivity, nitrite+nitrate, total phosphorus, total kjeldahl nitrogen, ammonia nitrogen, and organic nitrogen. Other parameters are sampled and analyzed at selected stations—either on a monthly basis or only for certain months. A complete list of the sampling locations and parameters sampled is in Appendix 17.

Fish Tissue Monitoring

Currently, the Minnesota Department of Natural Resources (MDNR) does fish tissue monitoring. The Minnesota Pollution Control Agency (MPCA) focuses on analyzing sources and trends. An interagency task group, with representatives from MDNR, Minnesota Department of Health, Minnesota Department of Agriculture and MPCA guides where MDNR monitors. Fish tissue monitoring is done where there are suspected problems or in heavily fished waterbodies. This program is further described in Part III, Chapter Six: Public Health/Aquatic Life Concerns.

Effluent Toxicity Testing

Toxicity tests measure the response of fathead minnows and Daphnia (water fleas) to effluent from a discharger. Percent of organisms surviving and effect on reproduction are measured. Toxicity tests are always done on the unchlorinated effluent. Sometimes the effluent is analyzed at the time of the screening test; it is always analyzed in connection with the follow-up test.

Major (larger) permittees are now required to do this testing themselves. The MPCA has done screening tests for all minor (smaller), as well as major, municipal mechanical plants. Where screening indicates problems, MPCA does a follow-up or requires the permittee to do so.

Sediment Monitoring

Sediments are monitored where there is a problem identified by fish tissue monitoring. Sediments are used to help locate sources of pollution. Areas of accumulation are identified. Pollutants tend to accumulate on organic material. Some dating of sediment cores has been done, which can also help identify trends over time. There is a need for incorporating monitoring by dischargers where the ambient water quality shows problems. For bioaccumulative pollutants, a few dischargers including Metropolitan Waste Control Commission and Western Lake Superior Sanitary District do sediment monitoring.

Intensive Surveys

Intensive surveys are conducted on the receiving waters of selected municipal wastewater treatment plants to determine appropriate effluent limits for a discharge. These effluent limits are incorporated into the NPDES permits administered by the MPCA.

The MPCA sets effluent limits to protect water quality standards at all flows greater than the 7Q10 low flow, which is the seven-day low-flow with a recurrence interval of ten years. Intensive surveys are conducted at times that approximate low-flow conditions, usually in late summer and midwinter. The low-flow and extreme temperature conditions during these times are most stressful to the stream environment and may result in extremely low dissolved oxygen levels and concentrations of substances harmful or toxic to fish and other organisms.

An intensive survey provides a detailed examination of the water quality at a specific site and within a well-defined reach of a waterway. 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. In the course of each survey, the study reach of the receiving water is examined for the following: (1) Hydrologic characteristics (2) Biological characteristics (3) DO variation and fluctuations and (4) Chemical water quality, including conventional pollutants and sometimes metals.

Citizen Lake-Monitoring Program (CLMP)

This program involves voluntary assistance from citizens residing on lakes. Participants take weekly transparency measurements of a lake during the summer months. Data from this program is extremely valuable to persons/groups interested in assessing and keeping track of the water quality of a lake over time. In many lakes this represents the only monitoring data available.

Lake Assessment Program (LAP)

This program takes the CLMP ideas one step further. LAP is a cooperative study of a lake involving MPCA staff and local citizens, such as lake associations and municipalities. LAP studies characterize a lake's condition and provide some basic information regarding the interaction of the lake and its watershed. While a relatively small number of LAP studies are conducted each year, usually 8 to 10 lakes, a very good data base results for those lakes. In some instances, the local cooperators have elected to undertake further study, such as a Clean Lakes diagnostic-feasibility study, or have instituted lake protection efforts as a result of information gained during the LAP work.

Routine Lake Monitoring Program

This program uses the ecoregion framework to improve water quality assessments. Lakes that are representative of minimally impacted lakes from each ecoregion are sampled throughout two or three summer seasons. Data from these lakes have been used to develop phosphorus criteria for each ecoregion. This program is further discussed in Part III, Chapter Three: Lakes.

Citizen Monitoring and Protection Programs

Citizens of Minnesota have become more aware of the value of the state's water resources through the development of county local water planning documents and comprehensive projects such as the Remedial Action Plan (RAP) for the St. Louis Bay. They also want more information on the quality of their lakes and rivers than state agencies can afford to provide, and they are willing to learn how to collect information that is accurate and meaningful. Several pilot programs have been established through funding by the Legislative Commission on Minnesota Resources (LCMR) for the MPCA to develop partnerships with citizens and local governments who want to participate in monitoring and protecting their local waters.

"River Watch" is one of the pilot programs whereby citizen volunteers, teachers, and students collect and analyze water samples from a river in their area. River Watch programs have been established in Minnesota for the Mississippi River and the St. Louis River. The major cooperators, the Mississippi Headwaters Board and the St. Louis Remedial Action Plan Citizen Advisory Council, initially used the national River Watch Network model to begin a local program. The process involves recruiting and organizing volunteers, designing a monitoring program, collecting water samples, and conducting field and lab measurements. The MPCA staff provides technical assistance to insure that quality information is collected and that the data is analyzed and computerized to be compatible with other MPCA data.

Another partnership was developed when Itasca County identified the need for a county-wide lake monitoring and protection program in the county's Local Water Management Plan. The MPCA is working with the county's cooperator, the Itasca Soil and Water Conservation District, to provide technical assistance in designing a monitoring program and protection activities.

Biological Monitoring

The U.S. EPA has directed states to adopt biological criteria and integrate biological surveys into their water quality programs. Biological criteria are numerical values or narrative expressions that describe the attainable structure and function of aquatic communities. The MPCA is initiating development of narrative biological criteria that will be incorporated into water quality standards in the 1991-1993 triennium.

Efforts to develop numerical biological criteria have focused on adapting the Index of Biotic Integrity (IBI) for use in streams of the Minnesota River basin as part of the Minnesota RAP. The IBI is comprised of 12 fish community attributes or metrics, that when combined give an overall measurement of biological stream health. Expected values for each metric are determined by information from reference data. The reference data base utilized for determining expected metric values was fish community information collected at 45 least impacted sites during 1990 and from over 650 historical site collections. This working IBI will be refined as additional work is conducted in the basin.

The MPCA, along with the MDNR, is attempting to secure funds to establish numerical biological criteria for streams in all regions of the state. The numerical indices would be for fish and macroinvertebrate communities.

Chapter Five: Special State Concerns

Ground Water: Emerging Issues and Concerns

Nitrogen in Minnesota Ground Water

Recognizing that nitrate was commonly found in Minnesota well water at levels exceeding the drinking water standard and that nitrate can originate from numerous sources, the Minnesota Legislature requested that a report be prepared to serve as a reference document for making policy decisions concerning nitrogen sources and an educational document to those interested or involved in protecting water resources from nitrogen contamination. The report was prepared between 1989 and 1991 by the Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Agriculture (MDA) with the assistance of several other groups. The report was developed from existing data and research and describes existing conditions, causative factors, trends, best management practices, and regulatory controls. Recommendations made by local government and the Nitrogen Fertilizer Task Force were also incorporated into the report.

Ground water monitoring results of four nitrogen compounds were examined for the nitrogen report: nitrate (NO3), nitrite (NO2), ammonium (NH4) and organic nitrogen. Nitrate was the compound most frequently found at elevated concentrations in ground water and was the focus of much of the discussion in the report.

The only verified human health concern associated with exposure to nitrate is methemoglobinemia, commonly known as "blue baby syndrome." This disease, which generally affects only infants, affects the ability of the blood to carry oxygen. The Minnesota Recommended Allowable Limit (RAL) and the federal Maximum Contaminant Level (MCL) for nitrate in water are both set at ten milligrams per liter (mg/L) nitrate-N. Most documented methemoglobinemia cases in Minnesota occurred prior to 1950. Three cases, one fatal, have been documented in South Dakota, Minnesota and Iowa since 1979. The number of reported cases may underestimate actual events since most states, including Minnesota, do not have a methemoglobinemia registry established.

Two additional health effects have been postulated to be associated with exposure to nitrate in drinking water: (a) esophageal and gastric cancer, and (b) central nervous system birth defects. Neither of these health effects have been adequately substantiated by experimental evidence.

Animals are also susceptible to methemoglobinemia. In general, the literature indicates that water containing less than 100 mg/L nitrate-N can be considered safe for livestock and poultry.

Nitrate can also contribute to increased algae and weed growth in surface waters. The ammonia and ammonium hydroxide forms of nitrogen are directly toxic to fish.

Data summarized from over 25,000 wells clearly illustrate that nitrate contamination of ground water resources is a problem in many areas of Minnesota. Major differences in ground water nitrate conditions are found when comparing results from 16 data sets examined. Data sets created by targeting mostly shallow wells in geologically sensitive areas under agricultural production showed a relatively high percentage (27 to 44 percent) of wells exceeding 10 mg/L nitrate-N. Sampling programs targeting newly constructed wells or municipal wells showed a much lower percentage (1 to 4 percent) of wells with nitrate-N exceeding 10 mg/L. MPCA ambient monitoring program results from 484 wells in different aquifers throughout the state showed nitrate-N exceeding 10 mg/L in 7 percent of the wells sampled. Results from certain county sampling programs showed more than 20 percent of wells exceeding 10 mg/L nitrate-N, yet other counties had less than 6 percent of wells exceeding 10 mg/L nitrate-N. The degree of contamination is variable across the state. Ground water age dating results suggest that the current nitrate problem is due to land use activities since 1953.

Three data sets had sufficient nitrate data collected from different aquifers to allow limited comparison of nitrate among aquifers. In all three data sets, unconfined surficial sand aquifer wells generally had higher nitrate levels than buried drift wells. Nitrate concentrations were consistently low in older bedrock formation aquifers of the southeastern quarter of the state (St. Lawrence, Franconia, Ironton, Galesville, Mt. Simon and Hinkley formations). Varying degrees of nitrate contamination are evident in the other major bedrock aquifers in the southeastern quarter of the state, including the Cedar Valley-Maquoketa-Dubuque-Galena, Decorah-Platteville-Glenwood, St. Peter and Prairie du Chien-Jordan.

There are very few wells in Minnesota that have continuous nitrate sampling records sufficient for time-trend analysis. Twenty-two monitoring wells have been sampled quarterly since 1986 by MDA. Results showed some wells with increasing nitrate levels and other wells with decreasing nitrate levels.

In addition to the MDA well data analysis, 29 Minnesota Department of Health (MDH) municipal well records with 12 to 40-year nitrate monitoring records were visually examined for this report. The relatively small number of wells analyzed, inconsistency in trends, and uncertainty of data integrity limits the usefulness of this data set in drawing regional or statewide conclusions regarding long-term nitrate trends.

Streams routinely monitored by the MPCA at 100 sites across the state from 1981 to 1990 generally had nitrate-N levels below 3 mg/L. Nine sites had nitrate-N levels exceeding 10 mg/L 10 percent of the time. The same stream sites monitored for ammonium-N generally showed concentrations less than 1 mg/L. Ammonia (NH3), which is toxic to fish, exceeded standards in eight of the 110 stream sites 10 percent of the time. In lakes, nitrate-N is usually found at concentrations less than 0.1 mg/L and ammonium-N is typically between 0.4 and 2 mg/L. Since some lakes in southwest Minnesota are reported to be nitrogen-limited, existing nitrogen in these areas may be controlling the amount of algae produced.

The ground water nitrogen effects and best management practices associated with the following sources were described in the report: commercial, agricultural fertilizers, applied manure, soil organic matter, legumes, septic systems, feedlots and turf grass. Nitrogen from precipitation, forest, prairie, landfills and fertilizer spills was also considered in the report. The highest priority recommendations were made regarding: Setting proper crop yield goals, manure management and feedlots, irrigated agriculture, septic systems, and proceeding with the state's Nitrogen Fertilizer Management Plan. Recommendations were also made to conduct long-term monitoring in order to assess nitrate temporal trends and further identify problem areas.

Minnesota has a number of existing and developing programs that affect, or have the potential to reduce nitrogen movement to ground water. The effect of these programs on ground water nitrogen levels will not be known for many years. The only statewide effort that focuses specifically on nitrogen pollution prevention is the Minnesota Nitrogen Fertilizer Management Plan, which was developed and recommended by the Nitrogen Fertilizer Task Force. Several programs exist that each deal with a variety of contaminants from specific sources, such as feedlots, septic systems and municipal and industrial waste. Other programs deal with multiple pollution sources, including the Minnesota Clean Water Partnership Program, Wellhead Protection Program, and Comprehensive Local Water Planning. Several other regional and local efforts are underway. These existing programs show promise for minimizing nitrogen movement to ground water.

Ground Water Indicators

Minnesota is participating in the development of ground water indicators project as one of the three pilot states. The MPCA's involvement in this project began in November 1989 by collecting necessary information for the pilot study and arranging for interviews and accompanying project staff to each of the state agencies involved in ground water management activities. Since that time, the MPCA has supplied water quality data and reviewed the study report entitled Ground-Water Indicator Pilot Study in the State of Minnesota released January 1991. Minnesota is looking forward to developing a work plan to collect this information once the indicators have been finalized. However, the MPCA is concerned because the 1991 study revealed that a minimum of 1400 hours (approximately 35 staff weeks) would be required to compile the information needed for the proposed indicators. Because the proposed indicators would require a large commitment of staff time that is presently unavailable, the MPCA has not included the proposed indicators in this report. Once the indicators have been finalized and the Technical Assistance document prepared, the MPCA will then begin to develop a work plan to accommodate the collection of ground water indicators.

Ground Water Monitoring

The lack of long-term stable source of funding is undermining the ability of the MPCA to evaluate regional variations and temporal trends in ground water quality in Minnesota. This information is fundamental for evaluating the progress in ground water protection and targeting resources for increased land use management. The MPCA is striving to implement the statewide Ground Water Monitoring and Assessment Program to develop this needed information base as well as provide technical assistance to local units of government for collecting and evaluating ground water quality information. Without stable funding, the MPCA will not be able to develop the information base needed by water resource planners and policy-makers to develop effective water resource management policies that ensure safe drinking water supplies for future generations and maintain the overall quality of Minnesota's natural environment.

Ground Water Rule Revision

The Ground Water & Solid Waste Division of the MPCA is revising the Minnesota Rules, Chapter 7060, Underground Waters, to provide a

comprehensive framework for ground water protection in all MPCA permitting and remediation programs. The rule will also classify ground water as a source of potable water and to be protected as such, incorporate the degradation prevention goal of the 1989 Ground Water Protection Act, and establish minimal technical requirements for hydrogeologic and geochemical work done for MPCA permits and cleanups.

A draft rule was released on December 17, 1991, and MPCA staff are soliciting feedback from all interested parties. Staff have also been meeting with an Advisory Committee, consisting of representatives of academia, business, consulting firms, environmental groups, local units of government, utilities, and other state agencies to review the draft rule in detail. Likewise, staff have been meeting with the Ground Water and Solid Waste Committee of the MPCA Board and with the staff of various MPCA programs to better define implementation of the rule. Rulemaking is scheduled to begin in the fall of 1992, with promulgation of the new rules in early 1993.

Wellhead Protection

The 1986 Amendments to the federal Safe Drinking Water Act and the Minnesota Ground Water Protection Act of 1989 mandated the development and implementation of wellhead protection measures for public water supply wells. Unfortunately, federal funds to establish this program at the state level were never appropriated. Current funding for program development is being supplied by the Environmental Protection Agency (EPA), Region 5, Ground Water Protection Branch, under the Clean Water Act, Section 106 Ground Water Grant and through state funding. Resources to help local units of government manage wellhead protection areas are not currently available. Local units of government will likely need technical and financial assistance, education, and possibly demonstration projects to implement a wellhead protection program in their area.

Development and implementation of the program is a formidable task because the diversity of hydrogeologic conditions in Minnesota and the large number of public water supply wells (17,000, of which approximately 2,000 are community water supply wells). The MDH is responsible for developing state wellhead protection rules and for preparing the state program plan for submittal to the U.S. EPA. The roles of the state, local governmental units, and public water suppliers in wellhead protection program development and implementation have not been well defined. Local units of government will manage the program. Much of the task of protecting water supplies is likely to fall to the agencies that regulate the contaminant sources: MPCA and MDA. The program starting date is estimated to be mid-1993. However, successful implementation of this program depends on a stable source of funding.

Storm Water

In accordance with requirements of the 1987 Clean Water Act and associated regulations, Minnesota is implementing the NPDES permit program for storm water discharges. Under the current regulations, the resources required to administer this program effectively exceed the capabilities of the state. Since the federal government has not appropriated any additional funds to the states to administer this program, the states are left to bear the costs. Minnesota, like many other states, is under tight budget constraints. This forces the state to shift current priorities in order to implement this program. Minnesota is evaluating the environmental benefit of this program in contrast to the benefits of other programs to determine the appropriate resource commitment. Minnesota has made progress since the storm water regulations were published in the Federal Register on November 16, 1990. The MPCA has been working with the two Minnesota cities, Minneapolis and St. Paul, that are required to obtain municipal permits for their storm water discharges.

The cities are cooperating with suburban areas that discharge storm water through their systems in order to achieve water quality benefits on a regional basis. Part one of the application includes existing data, which is used to identify possible strategies to reduce pollution caused by storm water runoff, and establishes a sampling network to identify possible sources of pollution. Part two of the application, which will be due one year after part one is submitted, will identify specific activities to reduce the discharge of pollutants to the maximum extent possible, including prohibition of non-storm water discharges to the storm sewer, management practices, control techniques, system design and engineering methods.

In addition to the municipal program, Minnesota is implementing its industrial storm water permit program. The federal regulations identify by Standard Industrial Classification (SIC) code the industries that must apply for storm water permits by October 1, 1992. In Minnesota, there are approximately 16,000 industries that fall under those SIC codes. We estimate that 4,000 Minnesota industries will be required to obtain NPDES permits. Compare this to Minnesota's

approximately 1100 existing NPDES permits for point source discharges.

Due to the large number of facilities to be permitted and the lack of federal funds for implementation of the program, it is apparent that priorities must be set for implementation of the program. These priorities will be set to maximize positive environmental results and will be based on the risk to the water resources affected by the discharges. Minnesota intends to issue general permits for storm water discharges associated with industrial activity initially, and as more information is obtained about the discharges through permit requirements, the MPCA will determine which industries require individual attention.

In order to achieve the goal of improving the quality of surface waters by reducing pollution from run-off of storm water, states will require continued flexibility by the federal government in program implementation, recognizing differences in existing state programs and organization. Financial assistance from the federal government for administration of the storm water program will also be required to implement an effective program.

Basinwide Planning

There has been an increasing recognition of the need for basinwide planning among state organizations in Minnesota. The Minnesota Department of Natural Resources is moving toward a comprehensive resources planning program for those resources under its control. The Minnesota Environmental Quality Board has called for addressing water and related land resource issues from a major river basin and small watershed perspective in both its 1991 Minnesota Water Plan and its draft 1991 Minnesota Resources Monitoring Plan. Comprehensive Water Plans, which have been prepared by most Minnesota counties with Board of Soil and Water Resources funding, were developed using a comprehensive resource-based approach. Finally, the Legislative Water Commission in its draft Minnesota Water Management Needs for the Year 2000 report also recommends addressing water and related land resource issues from a major river basin and small watershed perspective.

The MPCA has largely addressed the point source water pollution problems in Minnesota and now recognizes that to further improve water quality within the state it will have to begin addressing non point source (NPS) problems. Addressing these problems can most effectively be done on a watershed or stream reach basis where cost-effective tradeoff decisions can be made as to which pollutant sources to attack.

The Clean Water Act requires that Total Maximum Daily Load (TMDL) studies be done in those stream segments where water quality standards are not being met. EPA guidance directs that pollutant loading reductions be apportioned between point and nonpoint sources. Reductions for point sources would be written into permits and therefore be enforceable. Reductions for nonpoint sources would be cast into the form of voluntary best management practices (BMP). If water quality standards are not being met after point source reductions are in place and BMPs have been introduced, EPA guidance directs that any further loading reductions that are necessary come from point sources. This is to be done even if the reason for not meeting water quality standards involves the refusal of nonpoint sources of pollution to voluntarily implement BMPs. Taking this approach would present real political difficulties and in most cases would not be cost-effective. A more equitable approach would involve making BMPs mandatory.

Minnesota River

The Minnesota River suffers from the cumulative impact of human activities on the land. The Minnesota River is one of the most severely impacted rivers in the state. In the past, efforts to restore water quality in the river have focussed on the most obvious sources of pollution, typically those from industrial and municipal treatment plants on the river. The emphasis has recently shifted to controlling those sources of pollution that are less obvious but which are, in actuality, the most serious threat to water quality in the Minnesota River today.

These diffuse sources of pollution, known as NPS pollution, are delivered to surface and ground water aquifers during or after rainfall and snowmelt events. Water running over and through the ground can carry a host of pollutants to surface and ground waters. Sediment, excess nutrients, pesticides, oil, grease, bacteria, toxic metals, salts, and other harmful chemicals are just some of the pollutants that find their way to the Minnesota River through these events.

In an effort to better understand the effects of NPS pollution on the river, the Minnesota River Assessment Project (MRAP) was initiated in 1988. MRAP is a four-year comprehensive study of the river and its tributaries. Results from MRAP will provide the information needed to

develop and refine specific water quality goals for the river and to target pollution control practices in areas of the river basin that are contributing the most NPS pollution.

Over the next two years, MPCA, the Metropolitan Council, and other federal, state and local agencies will be working together to complete MRAP. Beyond that, these same entities will be collaborating on activities to reduce loadings of NPS pollution to the river by 40 percent. This reduction goal has been set in an effort to ensure that water quality standards are met in the lower reaches of the river during low-flow conditions.

While final results and recommendations from MRAP will not be available until 1993, actions to improve water quality in the river need to be initiated now. To ensure that federal, state and local governments are prepared to implement the practices and programs recommended as a result of MRAP, the Minnesota River Implementation Planning Project (MRIP) has been initiated by the MPCA. The MPCA will be active in facilitating this process.

MRIP will lay out a strategy for restoring the river and for implementing needed changes in the basin. The MRIP strategy may include proposals for new programs, regulations, recommendations for changes in existing programs, etc. MRIP will provide the forum for public participation, healthy debate and negotiation. It is hoped that the resultant river restoration plan will provide a vision for the river, one that balances economic interests with ecological integrity.

Contaminants in Minnesota Wildlife

Traditionally, contaminant monitoring in animals by regulatory agencies has been limited to fish. The MPCA is concerned that contaminants may have a major impact on other wildlife populations. In 1989, the Legislative Commission on Minnesota Resources funded a two-year statewide survey to determine the level of contaminants in Minnesota's wildlife. During 1989-1991, 553 animals were collected representing 13 species of wildlife including furbearers, big game, upland birds, waterfowl and nongame species. Contaminant analysis included polychlorinated biphenyls (PCB), organochlorine pesticides (OC), and trace metals. The primary objective of the study was to provide baseline data on environmental contamination in wildlife species on a regional basis.

Preliminary results indicate several areas of concern. Overall, carnivorous aquatic organisms have higher levels of all contaminants than terrestrial or herbivorous species. Mink and river otters appear to be accumulating high levels of PCBs, which may impair reproduction. Ring-necked pheasant tissues had high levels of lead, two of which were high enough to cause lead-poisoning in birds. Grouse and big game had low contaminant levels; however, terrestrial herbivores are not known to accumulate contaminants. Common merganser and herring gull eggs from Voyageur National Park had high levels of PCBs and OCs, which exceeded levels known to cause reproductive failure. Such elevated levels warrant additional attention.

Based on these results, the study report will make the following recommendations for continued research: (1) The establishment of a long-term, multiple ecosystem, monitoring program to examine an array of contaminants in several species; (2) monitoring of additional groups of species (raptors, wading birds, amphibians, reptiles and small mammals) and contaminants (dioxins, furans, synthetic pyrethroids, carbamates, and organophosphates) as baseline data; (3) examination of contaminant levels in predatory species for correlation to levels in appropriate prey items. Additionally, water quality regulations and standards should take into account the possible impacts on wildlife indicated by the high contaminant levels found in aquatic wildlife.

A final report will be available during the fall of 1992. The study was a cooperative effort among the University of Minnesota, the Minnesota Department of Natural Resources, MDH, the United States Fish and Wildlife Service, and the MPCA.

Chapter Six: Recommendations

Background

Minnesota is a state rich in water resources. Most of the state's borders are actually water, and three of the major continental drainage basins have headwaters in Minnesota. Surface water leaving Minnesota flows in three directions: east through Lake Superior to the Great Lakes and the Atlantic Ocean, south through the Mississippi and Missouri basins to the Gulf of Mexico, and north through the Red River and Lake of the Woods basins to Hudson Bay.

Minnesota recognizes the importance of this wonderful natural resource, not only to the state's economy and quality of life, but also to the nation as a whole because of the state's unique geographical location.

Past Progress and New Directions

A good deal of progress has been made in protecting Minnesota's environmental resources over the past few decades: the state's waters are cleaner than they were twenty years ago and certainly cleaner than they would be in the absence of federal, state, and local water pollution control programs.

Nevertheless, much remains to be done. The problems that have been dealt with most successfully thus far have been the most obvious ones. The newly emerging problems, such as toxics, nonpoint sources, and storm water, are less visible but at the same time more complex and more difficult to solve.

Minnesota has undertaken a concerted effort both to identify the state's remaining water protection needs and to develop a systematic approach for meeting these challenges. The Minnesota Water Plan, written in 1991, and the Minnesota Water Resources Monitoring Plan, written in 1992, contain a comprehensive set of recommendations and commitments by state agencies to that end.

With regard to water quality monitoring, the two documents call for significant changes. The picture of the state's water resources given by current monitoring programs is a very incomplete and fragmented one. The plans call for expanding monitoring substantially, and specifically recommend:

(1) Revamping the surface water monitoring program to include:

- Intensive assessments on a watershed basis that integrate point and nonpoint source monitoring, biosurveys, and toxicity testing to provide the grounds for comprehensive basin management.
- Biosurveys and toxicity testing to provide for detection of problems that otherwise might be missed.
- Establishment of nonpoint reference sites for use as a gauge of what can be achieved with nonpoint source controls.
- A strengthened lake monitoring network of routine sampling stations across the state, as well as an expanded Citizen Lake-Monitoring Program.
- Statistically based sampling that would allow valid generalizations about statewide water quality and trends over time.

(2) Fully supporting and intensifying the groundwater monitoring program:

- Implementation of the recently redesigned and comprehensive Ground Water Monitoring and Assessment Program.
- A baseline assessment of the age of Minnesota's ground waters as a valuable tool for identifying wells that may be usceptible to contamination.
- A concerted statewide effort to locate and characterize the state's buried drift aquifers, a major missing link in the understanding of Minnesota's ground water.
- Accelerated county-level ground water sensitivity assessments.

(3) Increasing the integration of and access to the data collected under the various water quality monitoring efforts across the state:

- Further establishment of data repositories and linked information systems.
- Increased use of geographical information system technology.
- Improved ability to use the Environmental Protection Agency's Storage and Retrieval Water Quality Data Base (STORET) for ground water data.
- Provision of assistance to local governments for contaminant source inventories and ground water monitoring.

Integrating Monitoring and Assessment Efforts with Decision-making

Key to all these individual recommendations is the emphasis on integration and consideration of the interconnections between surface water and ground water, between water quantity and quality, between water and related resources, within watersheds or aquifers, among different data systems and sources, and among the various agencies involved in monitoring the state's water resources. It is only by taking into account the full range of these interconnections that monitoring can provide the basis for an overall program that will protect water in a comprehensive and holistic fashion and focus on the needs of the resource as a part of the complete environment.

Finally, the establishment of a more complete and unified monitoring and assessment program, that leads to a more complete and effective water resource protection program, requires sufficient and stable funding.

The environmental problems facing the country have become more complex and demands on agencies charged with solving those problems have increased; however, funding has not kept pace. Effective programs do cost all of us money. Since monitoring is considered a background activity that doesn't produce immediate visible results, it is often one of the first things to be cut in times of budget shortage. Sufficient and stable funding is essential to monitoring programs which are necessary to provide the information that is essential for wise resource decisions.