2010 Minnesota Water Quality: Surface Water Section

(Abbreviated Narrative Report)

Report to the Congress of the United States Water Years 2008 - 2009

2010 Integrated Report

General Report to the Congress of the United States Pursuant to Section 305(b) of the 1972 Clean Water Act

Water Years 2008-2009

Beginning in 2004, the Minnesota Pollution Control Agency began providing the Water Quality Integrated Report to the U.S. Environmental Protection Agency. This report is intended to combine the requirements of Sections 305(b) and 303(d) through the following format: an annual electronic report accompanied biennially (in even years) by an abbreviated narrative report.

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Complete List of Acronyms

ac or Acs	acre or Acres
ADB	Assessment Database
AU	Assessment Unit
AUID	Assessment Unit Identification
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BWCAW	Boundary Waters Canoe Area Wilderness
BWSR	Minnesota Board of Water and Soil Resources
CALM	Consolidated Assessment and Listing Methodology
CBOD	Carbonaceous Biochemical Oxygen Demand
Cd	Cadmium
CFR	Code of Federal Regulations
ch.	chapter
chl-a or Chl	Chlorophyll-a
CLMP	Citizen Lake Monitoring Program
COE	St. Paul District Corps of Engineers
Cr	Chromium
CSMP	Citizen Stream Monitoring Program
CTI	Compound Topographic Index
Cu	Copper
CWA	Federal Clean Water Act
CWAMMS	Comprehensive Wetland Assessment, Monitoring and Mapping Strategy
CWF	Clean Water Fund
CWL	Clean Water Legacy
CWLA	Clean Water Legacy Act
CWP	Clean Water Partnership
DA	Driftless Area
DEMs	Digital Elevation Models
DO	Dissolved Oxygen
E. Coli	Escherichia Coli
EDA	Environmental Data Access
EDC	Endocrine Disrupting Chemical
EMAP	Environmental Monitoring and Assessment Program
ENRV	Exceptional Natural Resource Value
EQB	Minnesota Environmental Quality Board
FAV	Final Acute Value
FGDC	Federal Geographic Data Commission
FQA	Floristic Quality Assessment
FQAI	Floristic Quality Assessment Index

FY	Fiscal Year
GIS	Geographic Information System
GWPA	Groundwater Protection Act
Hg	Mercury
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
I&E	Information and Education
IR	Integrated Report
ISTS	Individual Sewage Treatment Systems
K	Potassium
LCMR	Legislative Commission on Minnesota Resources
LiDAR	Light Detection and Ranging
LUG	Local Unit of Government
LSTS	Large (10,000 gallons/day) Subsurface Treatment System
LRVW	Limited Resource Value Waters
m	meter
M.S.	Minnesota Statute
MCES	Metropolitan Council Environmental Services
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MDNR	Minnesota Department of Natural Resources
MIDS	Minimal Impact Design Standard
Minn.	Minnesota
MGS	Minnesota Geological Survey
MOA	Memorandum of Agreement
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer System
MWP	Mixed Wood Plains Ecoregion
MWS	Mix Wood Shield Ecoregion
MWSTMP	Minnesota Wetland Status and Trends Monitoring Program
N2K	Need-to-know
NAWQA	National Water Quality Assessment
NCHF	North Central Hardwood Forest
NE	Northeastern
ng/L	nanograms/Liter
NH_3	Un-ionized Ammonia
NHD	National Hydrography Dataset
Ni	Nickel
NLF	Northern Lakes and Forests
NMW	Northern Minnesota Wetlands
NO_2/NO_3	Nitrite/Nitrate
NO_3 - N	Nitrate - Nitrogen
NPDES	National Pollution Discharge Elimination System

NPS	Nonpoint Source
NS	Non-Support
NSMPP	Nonpoint Source Management Program Plan
NWI	National Wetland Inventory
OIRW	Outstanding International Resource Water
ORVW	Outstanding Resource Value Waters
P	Phosphorous
PAH	Polyaromatic Hydrocarbons
Pb	Lead
PCB	Polychlorinated Biphenyl
PFC	Perfluorocarbon
PFOS, PFOA & PFBA	Perflourinated Chemicals
PJG	Professional Judgment Group
POTWs	Publicly Owned Treatment Plants
ppb	parts per billion
pt.	part
PWI	Public Waters Inventory
R.	Rule
Red River	Red River of the North
Report	Integrated Report
RF1	Reach File 1
RRV	Red River Valley
RWI	Restorable Wetland Inventory
SD	Secchi Disk
SCSU	St. Cloud State University
SSC	Stormwater Steering Committee
SSTS	Subsurface Sewage Treatment System
SSURGO	Digital Soil Survey Data
Stat.	Statute
STORET	Storage and Retrieval System
subp.	subpart
SVOC	Semi-Volatile Organic Compound
SWPPP	Stormwater Pollution Prevention Plan or Program
TACS	Training and Certification System
TCDD	2, 3, 7, 8-Tetrachlorodibenzodioxin
TCMA	Twin Cities Metropolitan Area
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TPE	Temperate Prairies Ecoregion
TSS	Total Suspended Solids
US	United States
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

VOC	Volatile Organic Compound
WCA	Minnesota Wetland Conservation Act
WDP	Wetland Demonstration Pilot
WLSSD	Western Lake Superior Sanitary District
WQ	Water Quality
WQS	Water Quality Standard
WWTP	Wastewater Treatment Plant
Zn	Zinc

Table of Contents

Part A. Introduction and Executive Summary

The Minnesota Pollution Control Agency (MPCA) surface and groundwater monitoring activities provide critical information to support our mission of helping Minnesotans protect the environment. To prevent and address problems, decision-makers need good information about the status of the resources, potential and actual threats, options for addressing the threats, and data on how effective management actions have been. The MPCA follows a ten-year rotation for assessing waters of the state on the level of Minnesota's 81 major watersheds.

Sections 305(b) and 303(d) of the Federal Clean Water Act (CWA) both call for states to report on their waters to help measure progress toward the national goals of fishable and swimmable waters. The United States Environmental Protection Agency's (USEPA) Consolidated Assessment and Listing Methodology (CALM) integrates the 305(b) Report with the 303(d) Total Maximum Daily Loads (TMDL) List. Data analyses determine the extent that all waters are attaining water quality standards (WQSs), identify impaired waters and the need to be added to the 303(d) list, and identify waters attaining standards that can be removed from the List. The USEPA Web site has a significant amount of information on CALM and how it was developed at: http://www.epa.gov/owow/monitoring/calm.html.

Water Quality Assessments for Rivers and Lakes

Presented below are the summary tables for statewide river and lake assessments, using information from the Assessment Database (ADB). An electronic update of the entire ADB is also being submitted to the USEPA. Water body specific information will be posted on the MPCA Web site, http://www.pca.state.mn.us/water/index.html. The methodology for determining these assessments is presented on pages 33-35 of Part C of this report.

A note to readers about the summary tables:
The summaries in these tables reflect the cumulative assessments from the current reporting cycle and the previous reporting cycles that have not been changed by newer data. They are current with data contained in the 2010 Cycle of the ADB on a particular date. Because there are many steps in developing this document occurring over time, there may be minor differences between the mileage and acreage in the summaries and those in the final ADB submittal if last minute changes occur. Tables I-4, I-5 and I-6 include Minnesota's estimated portion of Lake Superior.

Table I-1. Summary of Fully Supporting and Impaired Waters – Streams

Degrees of Use Support	Miles
Supporting All Assessed Uses - Category 1	**0**
Supporting at Least One Use & None Impaired – Category 2	**2999**
Impaired for One or More Uses – Categories 4 & 5	**11559**
Reviewed but having Insufficient Data to Assess as Impaired or Supporting - Category 3	**3126**
Total:	**17684**

Based on ADB 2010 Cycle data from March 2, 2010

Table I-2. Individual Use Support Summary – Streams

Goals	Use	Miles Reviewed	Miles Supporting	Miles Insufficient Information to Assess	Miles Not Supporting
Protect & Enhance Ecosystems	Aquatic Life	**15856**	**4250**	**3794**	**7812**
	Limited Value Resource Waters	**222**	**0**	**121**	**101**
Protect & Enhance Public Health	Aquatic Consumption	**5528**	**0**	**619**	**4909**
	Aquatic Recreation	**6218**	**1306**	**946**	**3966**
	Drinking Water	**1430**	**0**	**1313**	**117**

Based on ADB 2010 Cycle data from March 2, 2010

Table I-3. Total Miles of Waters Impaired by Various Cause/Stressor Categories – Streams

Cause/Stressor Name	Impaired Miles
Acetochlor	**9**
Ammonia (Un-ionized)	**97**
Aquatic Macroinvertebrate Bioassessments	**553**
Arsenic	**147**
Chloride	**205**
DDT	**19**
Dieldrin	**19**
Dioxin (including 2, 3, 7, 8-TCDD)	**13**
Escherichia coli	**771**
Fecal Coliform	**3265**
Fish Bioassessments	**2068**
Lack of Coldwater Assemblage	**38**
Mercury in Fish Tissue	**4791**
Mercury in Water Column	**434**
Nitrates	**117**
Oxygen, Dissolved	**1820**
PCB in Fish Tissue	**1187**
PCB in Water Column	**43**
Perfluorooctane Sulfonate (PFOS) in Fish Tissue	**85**
pH	**126**
Temperature	**10**
Toxaphene	**13**
Turbidity	**5887**

Based on ADB 2010 Cycle data from March 2, 2010

Table I-4. Summary of Fully Supporting and Impaired Waters – Lakes*

Degrees of Use Support	Acres
Supporting All Assessed Uses – Category 1	**0**
Supporting at Least One Use & None Impaired – Category 2	**169076**
Impaired for One or More Uses – Categories 4 & 5	**3589335**
Reviewed but having Insufficient Data to Assess as Supporting or Impaired – Category 3	**217926**
Total:	**3976337**

Based on ADB 2010 Cycle data from March 2, 2010

Table I-5. Individual Use Support Summary – Lakes*

Goals	Use	Acres Reviewed	Acres Supporting	Acres Insufficient Information to Assess	Acres Not Supporting
Protect and Enhance Ecosystems	Aquatic Life	**497**	**0**	**0**	**497**
Protect and Enhance Public Health	Aquatic Consumption	**3465158**	**0**	**11943**	**3453215**
	Aquatic Recreation	**2297145**	**732141**	**1024215**	**540789**

Based on ADB 2010 Cycle data from March 2, 2010

Table I-6. Total Acres of Waters Impaired by Various Cause/Stressor Categories – Lakes*

Cause/Stressor Name	Acres
Chloride	**497**
Mercury in Fish Tissue	**3452498**
Mercury in Water Column	**6968**
Nutrient/Eutrophication Biological Indicators	**541373**
PCB in Fish Tissue	**1627560**
Perflurorooctane Sulfonate (PFOS) in Fish Tissue	**2330**

Based on ADB 2010 Cycle data from March 2, 2010

*Data include Lake Superior.

Table I-7. Summary of Fully Supporting and Impaired Waters – Wetlands

Degrees of Use Support	Acres
Supporting All Assessed Uses – Category 1	**0**
Supporting at Least One Use and None Impaired – Category 2	**0**
Impaired for One or More Uses – Categories 4 & 5	**940**
Reviewed but Insufficient Data to Assess as Supporting or Impaired – Category 3	**0**
Total:	**940**

Based on ADB 2010 Cycle data from March 2, 2010

Table I-8. Individual Use Support Summary – Wetlands

Goals	Use	Acres Reviewed	Acres Supporting	Acres Insufficient Information to Assess	Acres Not Supporting
Protect and Enhance Ecosystems	Aquatic Life	**940**	**0**	**0**	**940**

Based on ADB 2010 Cycle data from March 2, 2010

Table I-9. Total Acres of Waters Impaired by Various Cause/Stressor Categories – Wetlands

Cause/Stressor Name	Acres
Aquatic Macroinvertebrate Bioassessments	**323**
Aquatic Plant Bioassessments	**878**

Based on ADB 2010 Cycle data from March 2, 2010

Wetlands

Minnesota's approximately, 9.2 million wetland acres (Acs) comprise about 1/6 area of the state. Historically, Minnesota is believed to have had as much as 21 million Acs of wetland.

Minnesota wetland protection agencies have traditionally placed support for wetland regulatory programs ahead of monitoring and assessing status and trends in this resource. In recent years additional resources have been directed toward wetland monitoring as well as regulatory program delivery. Effective management and assessment of wetland status and trends is challenging and will require continued efforts by local, state and federal agencies.

The Wetland Conservation Act (WCA) continues to be the principal wetland regulatory program in Minnesota. Central to the WCA is the enactment of state policy to achieve a 'no net loss' and to increase the "quantity, quality and biological diversity of wetlands in the state" (Minn. Stat. § 103A.201). Several water-related regulatory programs including the 404/401 certification permit program, the Department of Natural Resources (MDNR) Protected Waters Permit Program and the National Pollution Discharge Elimination System (NPDES) (including stormwater), align with the WCA to provide broad oversight of most types of direct physical wetland alteration in Minnesota.

With support from USEPA, Minnesota recently completed a Comprehensive Wetland Assessment, Monitoring and Mapping Strategy (CWAMMS 2006) in which three integrated approaches are recommended to effectively monitor the status and trends of Minnesota wetland quantity and quality. These three approaches include the following, not in order of importance:

- an online georeferenced wetland permitting and restoration accounting system
- update Minnesota's National Wetland Inventory (NWI)
- implement statewide surveys to assess wetland quantity and quality status and trends

The recommendations in the CWAMMS blend well and support the 2006 Governors Wetland Vision and Strategies for Minnesota. The Wetland Vision is found at: http://cwc.state.mn.us/documents/Wetlands.vision.pdf

The Wetland Vision complements the Working Lands Initiative and ongoing efforts to develop a wetland restoration strategy for the state and will enable Minnesota to effectively evaluate the success of these measures in a comprehensive way.

Stream Water Quality Trends

The best available information on pollutant trends in rivers and streams comes from 'Minnesota Milestone' sites. These are a series of 80 monitoring sites across the state with good, long-term data.

For the total period of record, which in some cases goes back to the 1950's, the following table shows the percentage of the 80 Milestone sites which had decreasing, increasing or no trends for various pollutants.

	Biochemical Oxygen Demand	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Unionized Ammonia	Fecal Coliforms
Decreasing pollutant trend	89%	41%	78%	1%	83%	82%
Increasing pollutant trend	1%	4%	1%	75%	4%	0%
No trend	10%	54%	21%	23%	13%	18%

Lake Water Quality Trends

Detecting trends requires many measurements each summer and several years' worth of data. A variety of statistical tests can be used to perform trend analysis on historical Secchi readings. Kendall's tau-b is a statistical test that has been used in previous MPCA 305(b) reports to Congress (MPCA, 1990 and 1992) for assessing trends in Secchi transparency over time. In 2008, the Seasonal Kendall test was used to determine whether the historic Secchi data for each lake in Minnesota exhibit increasing or decreasing trends. All Secchi readings were assigned a 'season' based on their Ecoregion. Medians were calculated for the readings in each season/year. The statistical software package Systat[U] then ran the Seasonal Kendall test on these medians. Only lakes with more than eight years of data were included in the trend analysis.

Table I-10. Trends in Minnesota Lake Water Quality

Description	Number of Lakes	Acres of Lakes
Assessed for Trends	1201	-
Improving	455	-
Declining	231	-
No Clear Trend	515	-

Groundwater

The Groundwater Portion of the Integrated Report is included within this submittal as Appendix D.I. and D.II., pages 79 through 94.

Public Participation

A description of the public participation process and a copy of all letters, e-mails, etc. received from the public and a responsiveness summary was included along with the draft TMDL List sent to USEPA on April 1, 2010.

The TMDL List is not included here but it will be added as Appendix C.IV. once USEPA provides MPCA with final approval.

The draft 2010 TMDL List can be found on the MPCA TMDL Assessment and Listing Web site at:
http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesota-s-impaired-waters-and-tmdls/assessment-and-listing/tmdl-assessment-and-listing.html

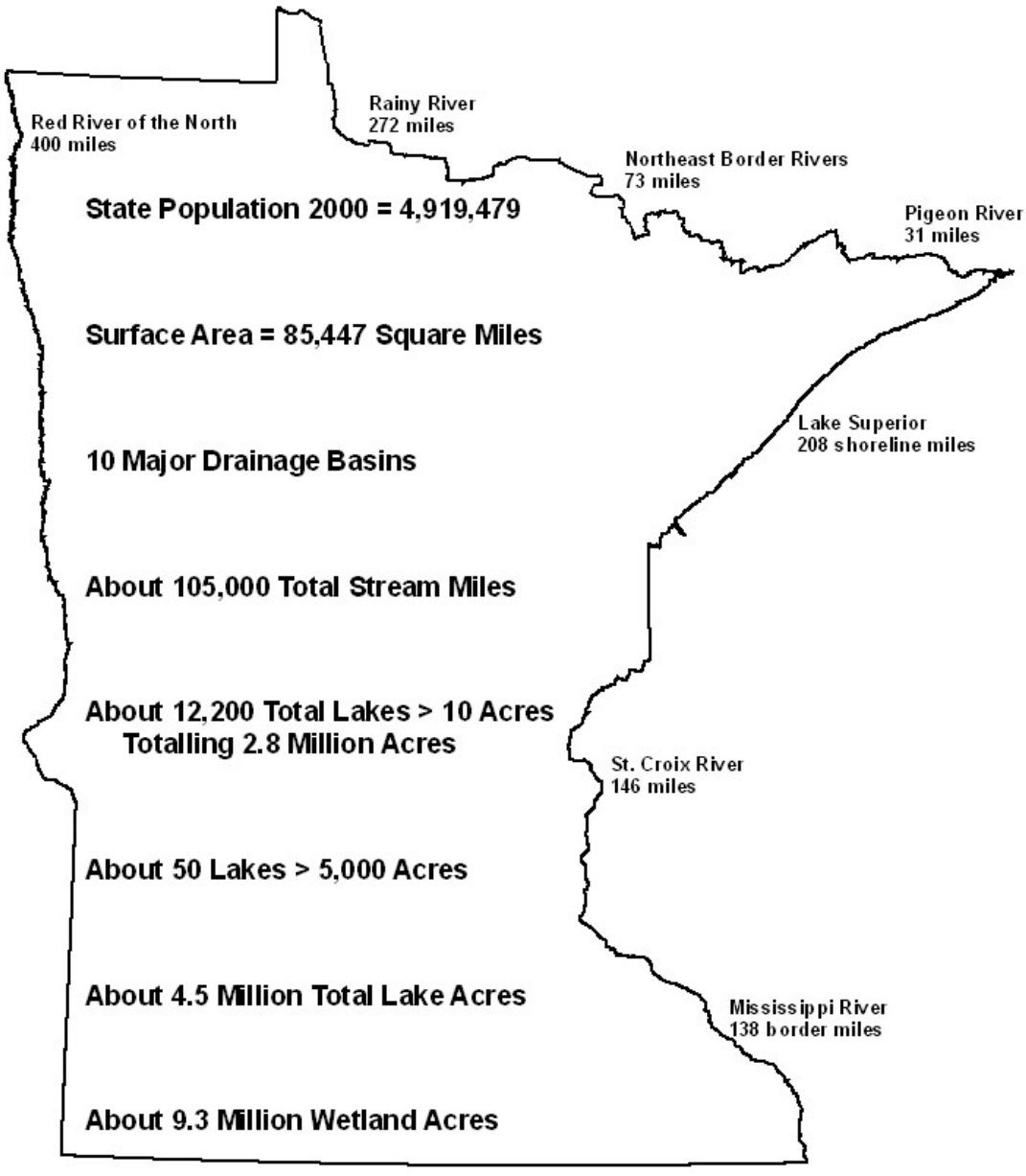
Part B. Background Information

B.1. Total Waters

State Background Information

The estimates of background information (in Figure II-1, below) for water bodies were developed from 1:24,000 scale National Hydrography Dataset (NHD), with the exception of the estimate for wetland Acs. The total lake Acs estimate includes the Minnesota portion of border lakes and Lake Superior. Wetland Acs estimates were obtained from the NWI dataset, which is not derived from 1:24,000 source data; rather it was interpreted from aerial imagery at a resolution that makes it appropriate for use at 1:24,000 or smaller.

Figure II-1. Minnesota Background Information and Border Waters



Watershed Approach

Minnesota's Clean Water Legacy Act (CWLA), passed in 2006, provides a policy framework and resources to state and local governments to accelerate efforts to monitor, assess, and restore impaired waters, and to protect unimpaired waters. The MPCA follows a ten-year rotation for assessing waters of the state on the level of Minnesota's 81 major watersheds. The watershed approach provides a unifying focus on the water resource as the starting point for water quality (WQ) assessment, planning, and results measures. It provides a predictable schedule to monitor all of the state's major watersheds while accomplishing the following:

- Provides advance notice to interested stakeholders, local governments and volunteers participating in monitoring plans.
- Allows local groups to conduct monitoring efforts in conjunction with or in-between agency monitoring efforts.
- Informs stakeholders when TMDL study or protection strategy work will begin in their area.
- Insures that comprehensive information on the status of WQ and WQ management efforts is collected, evaluated and provided to state and local partners at least once each decade.

This approach may be modified to meet local conditions, based on factors such as watershed size, landscape diversity and geographic complexity (e.g., Twin Cities metro area).

For more detail on MPCA's watershed approach including the ten-year Intensive Watershed Monitoring Schedule see the Watershed Approach Web page at:
http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/basins-and-watersheds/watershed-approach.html

B.2. Water Program Areas

B.2.1. Wastewater Overview

Plan Background

The overall goal of this plan is to assure that discharge of treated wastewater to surface waters and groundwater is protective of public health, and the environment, and assures that we achieve the following two MPCA Strategic Plan objectives:

W3b) Wastewater NPDES facilities do not contribute to the impairment or degradation of state waters.

W3c) By January 1, 2014, strengthen local programs to reduce the percentage of subsurface sewage treatment systems (SSTS) characterized as failing or imminent threats to public health and safety from 39 percent to less than five percent.

Find the MPCA Strategic Plan at this link:
http://www.pca.state.mn.us/index.php/download-document/5661-mpca-strategic-plan.html

To meet the overall goal, the MPCA and its partners conduct technical assistance, develop rules and policy, permitting, land application approvals, limits determination, environmental reviews, technical reviews, compliance and enforcement, financial assistance, training, certification and licensing. The MPCA conducts this work with partners that include the municipal wastewater, water treatment, industrial wastewater and industrial stormwater facilities; local units of government, USEPA, other funding agencies and pumpers, installers, and inspectors of individual sewage treatment systems (ISTS).

2009 Accomplishments

TMDLs

- As of May 2009, 23 TMDL reports have been approved by the USEPA containing 228 individual wasteload allocations for industrial and municipal dischargers and ninety seven TMDL projects are underway.

Pretreatment

- In October of last year, the pretreatment rulemaking was completed and the rules are now final.
- Routine program oversight, including review of annual reports, and annual inspections of the eight delegated publicly owned treatment plants (POTWs), and two audits.
- Enforcement support.

Large Subsurface Treatment Systems (LSTS)

- Design guidance update.
- Reduced permit monitoring policy.

Hydrologists

- Permit technical support.
- Enforcement support.
- Training support.

Training and Certification

- Continued success with the Need-to-Know (N2K) Certification Implementation. The Subsurface Sewage Treatment System (SSTS) Business License Expiration Notification process was also implemented.
- Successful Collection System Operators and Wastewater Treatment Plant (WWTP) Operation Annual Conferences had a combined attendance of almost 800 people.
- The Wastewater Training Team conducted 14 learning events, which trained over 1200 operators, and led our annual conferences.
- The Wastewater Training Advisory Committee continues to review current courses and complete a needs assessment for new wastewater courses. As a result, two new courses (Industrial By-Products and Monitoring Wells) were added in 2008 with the potential for more in 2009.
- Training and Certification Administration System (TACS). The Training and Certification Unit assisted debugging the new TACS database.
- The Unit continues to work to establish better systems, processes and procedures to do more with fewer resources. We are working hard to reach out to new customers and reaffirm and strengthen relationships with established partners and customers.

- Formal training is offered in the Wastewater, Solid Waste and ISTS programs, the unit also provides much needed one-to-one consulting with city, wastewater facility, and small business personnel.
- The Wastewater Training Team has reviewed and updated the Wastewater Collection System Operator Exams (SA, SB, SC, SD). This review will be conducted again as the Wastewater Need-to-Know is completed.

Financial Assistance Program and Policy Development/Implementation

- Managed new program development and startup for the American Recovery and Relief Act of 2009 (Federal Stimulus) which is providing a significant amount of new wastewater and stormwater infrastructure funding assistance and related project activity.
- Completed 2009 Project Priority List to the satisfaction of our Clean Water Revolving Fund partner, the Public Facilities Authority.
- Completed the 2008 Clean Watershed Needs Survey and report to the USEPA.
- Completed required legislative report on New Wastewater Treatment Facilities.
- Provided 2009 legislative session assistance for budget and the first appropriations for the Clean Water Legacy (CWL) Sales Tax Amendment funds.

SSTS Program and Policy Development/Implementation

- Completed annual activities and reporting for the "Unsewered (small community needs) Strategy", the SSTS Annual Report, the MSA Small Community Wastewater Technical Guidance contract, the Phase I LSTS Report, and the Tank Fee Program.
- Continued SSTS rule implementation by developing new programs like Product Registration and the Septic Tank program, assisting LGUs update local ordinances, providing design guidance; rule interpretations and fact sheets; communication through Web sites, SSTS Report, and newsletters.
- Provided assistance in the certification and licensing of SSTS Professionals including application reviews, participating with the SSTS Advisory Committee and other partners, providing technical assistance, and by assisting in the On-site Training Program offered by the University of Minnesota, as well as other training events.
- Completed SSTS prescriptive design guidance as required by Statute 115.56 for systems up to 5,000 gpd. This work, with both internal and external partners, is to resolve long standing issues relating to the design of SSTS and the need for professional licenses and/or certifications.
- USEPA granted recognition for MPCA's SSTS program as "functionally equivalent" to USEPA's decentralized management guidelines.
- Provided 2009 legislative session assistance for budget and other program needs as they impact the MPCA, Local Units of Government (LUGs) and the SSTS industry.

Inspection numbers and other accomplishments

- Continued implementation of Regional Teams for the Unsewered (small community needs) Strategy.
- Continued work on DELTA Inspections team to improve usefulness of DELTA for inspection activities.
- Completed all Biosolids and Pretreatment Annual Report Reviews.
- Enhanced use and of a new Biosolids Inspection Checklist.

- Issued newly revised Pretreatment Rules.
- Regulated point source water quality program: (October of 2008)
- Completed 287 inspections (represents 18 percent of universe)
  - Industrial - 31
  - Municipal - 256
- Completed 79 compliance actions (formal with penalty and schedule of compliance)
  - Industrial - 34
  - Municipal - 45

B.2.2. Nonpoint Source (NPS) Pollution Control

Introduction
Minnesota is fortunate to have many water bodies that are in good condition because their terrestrial watersheds still have minimal development, although all surface waters are affected by atmospheric pollutants such as mercury (Hg). It is important to protect the good condition of many water bodies, while also addressing degraded water resources.

Most of the pollution originating from point sources (municipal and industrial facilities discharging to a state water) has been controlled. WQ is mainly degraded by the pollutants entering surface waters from nonpoint sources (NPS); derived from both air pollution and runoff from land, particularly from watersheds dominated by agricultural and urban land use. NPS pollution is the major cause of degradation of Minnesota's surface and groundwater, impairing recreation, fish consumption, drinking water use, and support of aquatic life.

The state restoration plans follow a 'resource management system' concept on a watershed basis, selecting and applying a set of site-specific Best Management Practices (BMPs) within a watershed unit.

Updated Nonpoint Source (NPS) Assessment
The Updated NPS Assessment in the 2008 Nonpoint Source Management Program Plan (NSMPP) reports the following steps have been taken since 2001 to improve the assessments.

- Incorporate biological assessment information, where available, into the process including development of biocriteria for watersheds where none had existed before.
- Biological monitoring of randomly selected sites was conducted to allow for characterization of entire basins.
- Increased coordination of monitoring and assessment activities among local, state and federal agencies.
- Included atmospheric deposition as a source of pollutant loading in the assessment.
- Developed assessments using an increasing number of credible sources of information.
- All contributing monitoring entities are reviewing assessment data for adequacy, relevance and validity.
- Reporting different use supports to reflect adequacy of water quality (WQ) for various uses, rather than simply reporting an 'overall use'.

2008 Nonpoint Source Management Program Plan (NSMPP)
Minnesota's 2008 NSMPP was approved by the USEPA March 14, 2008. Developing this Plan was a massive statewide effort. Seventeen technical committees comprised of more than 200 representatives of 50 federal, state and local governmental agencies and public and private environmental organizations worked to develop the NSMPP. The MPCA coordinated overall development of the NSMPP. The 17 chapters/strategies of the NSMPP examine sources contributing to NPS water pollution. Most of the chapters/strategies include five-year action plans recommending implementation of NPS pollution control measures.

The state of Minnesota NSMPP is a requirement for Minnesota to remain eligible to receive NPS grant funds from the USEPA under Section 319 of the CWA. Any actions to be undertaken by a NPS water pollution control project must be cited in this document to be eligible for a Section 319 grant award.

The Web site for Minnesota's 2008 NSMPP is:
http://www.pca.state.mn.us/water/nonpoint/mplan.html.

Federal Clean Water Act (CWA) - Section 319
Section 319 of the CWA requires each state to assess NPSs of pollution within its boundaries. State investigations must identify NPSs of pollution that contribute to WQ problems, as well as waters or stream segments unlikely to meet WQSs without additional NPS controls. State management programs must:

- run for a specific number of years;
- identify the NPS controls necessary;
- specify the programs that will apply the controls;
- certify that the state has adequate authority to implement these measures;
- identify all sources of funding for these programs; and
- establish a schedule for implementation.

Section 319 NPS funds are made available to assist LUGs and organizations in Minnesota to implement NPS measures that reduce water pollution to lakes, rivers, wetlands and groundwater resources.

Investment in education must be considered an essential and integral part of every step in the 2008 NSMPP. In almost every chapter of this management plan, education is recognized as an important means for effecting change with respect to NPS water pollution problems.

Statewide Information and Education
Good information about the condition of waters and the health of aquatic systems on a watershed scale is absolutely critical. This is especially important as Minnesota’s clean water program continues moving to a watershed approach with a commitment to identify and address remaining WQ problems. The MPCA addresses impaired waters through TMDLs or TMDL studies. The CWA’s impaired waters provisions call for taking measures to mitigate NPS pollution, but neither state nor federal agencies have the authority to regulate much of the activity that causes such pollution. Many of the needed mitigation measures will consist of education and pollution reduction incentives. This makes it all the more important to have in place sound information and education (I&E) approaches and strategies for NPS issues.

The MPCA set five major I&E goals to address NPS water pollution in the 2008 through 2012 version of the NSMPP. They are:

1. Build and improve capacity to deliver NPS-related I&E at state and local level.
2. Raise the general public's awareness about the nature of NPS pollution, how communities and individuals contribute to it, and what governmental organizations and individuals are doing about it.
3. Foster coordination and cooperation between governmental agencies and private, nonprofit and other organizations to carry out I&E efforts.
4. Include NPS I&E in formal and informal educational curricula.
5. Effectively measure impact of NPS I&E activities.

Clean Water Partnership (CWP) Financial Assistance

The program, established in 1987, relies upon LUGs and other partners to prioritize the watersheds within their regions and subsequently submit proposals to MPCA for watershed projects. The MPCA and an interagency task force called the Project Coordination Team score the projects based on a set of scoring criteria established in state rules. The highest-scored projects are then eligible for financial and technical assistance from the state. CWP projects involve the following:

- Completing a comprehensive diagnostic study of a water body and its watershed by identifying the pollutants that cause a reduction of WQ and the origin of the pollutants,
- Developing an implementation plan that identifies the BMP needed to restore and protect WQ, and
- Implementing the BMP.

Through twenty-two annual Clean Water Partnership (CWP) funding cycles (1989 through 2010) the MPCA has awarded $37,106,180 in grant funding to 100 resource investigation projects, 62 implementation projects and 64 continuation projects.

Through sixteen annual CWP funding cycles for loans (1995 through 2010), the MPCA has awarded $44,166,538 in low-interest loans to 193 implementation and continuation projects.

In 1987, the CWA was amended to include Section 319, a new section which authorized federal assistance to the tribes and states for implementing NPS programs. Proposals are submitted and scored in a process similar to that of CWP.

Through twenty-one annual funding cycles of the Federal Section 319 program (1989 through 2010); the MPCA has awarded $50,292,538 for 487 NPS projects.

B.2.3. Stormwater Program Development

Section 402 of the CWA established the NPDES permit program to specifically control the discharge of pollutants from point source dischargers to waters of the United States (US). A 1987 amendment to the CWA required stormwater discharges from municipal, construction, and industrial sources to be permitted under the NPDES permit program. The amendment was to be implemented in two phases, Phase I in the early 1990's and Phase II in March 2003.

The Phase I federal regulations required NPDES permits for two broad categories of stormwater discharges: 1) medium and large municipal separate storm sewer systems (MS4s) serving populations of 100,000 or more, and 2) eleven categories of industrial activity, including larger construction activities disturbing five or more Acs of land. The Phase II Federal regulations expanded the scope of the existing NPDES permitting program to include discharges of stormwater from smaller MS4s in urbanized areas, from construction activities that disturb between one and five Acs, and from smaller municipally owned industrial activities.

The MPCA is the delegated NPDES authority to implement the stormwater regulatory program in Minnesota. The MPCA issues general and individual NPDES permits for each program area; municipal, construction, and industrial. These permits require permittees to control discharges of polluted stormwater runoff by implementing BMPs which are incorporated in the permittees Stormwater Pollution Prevention Program or Plan (SWPPP). The MPCA's stormwater Web page is available at:
http://www.pca.state.mn.us/water/stormwater/index.html

In implementing the Phase II requirements, the MPCA was directed by the Minnesota Court of Appeals to address Minnesota nondegradation rules stemming from federal anti-degradation policy (see 40 CFR §131.12); and to conduct review and provide opportunity for public comment and hearing on permittee's individual SWPPPs in a general permit setting. Together these have presented a considerable challenge and burden on MPCA resources.

Minnesota's nondegradation rules, Minn. R. ch. 7050, include distinct rules for discharges to all waters of the state, outstanding resource value waters (ORVW), and wetlands. These rules were written in a traditional point source setting and their application to stormwater discharges have proven difficult. The 2003 Legislature provided time for the MPCA to revise these rules to better address stormwater discharges by 2007. The MPCA initially expected to address this issue as part of the triennial review of the state's WQSs required under federal law. The MPCA is moving beyond addressing the effect of stormwater discharges only and is now undertaking a larger rulemaking effort. The broadened scope of the nondegradation rulemaking reflects changes that have occurred since the existing rules were adopted. Public notice of request for comments on planned amendments to Minnesota's anti-degradation rules was published in January 2007. The proposed timeline for completion of the rulemaking is December 2011.

Minnesota and other states have (among other issues) had courts remand the general permit for small regulated MS4s on the issue of public process within a general permit structure. At issue was how the public could comment on a municipal general permit when most of the substantive BMPs chosen by the municipality were within the application/SWPPP (not placed on public notice like the general permit).

In 2004, the Minnesota Stormwater Steering Committee (SSC) was formed; a team of public and private organizations committed to improving stormwater management in Minnesota. With various groups and entities involved in stormwater management, the SSC provides a forum for communication between different governmental units and stakeholders, and seeks to improve the effectiveness and coordination of groups involved in stormwater management. The SSC Web page is available at:
http://www.pca.state.mn.us/water/stormwater/steeringcommittee/index.html

The SSC forms work groups for specific tasks to provide technical expertise and recommendations on their specific issues to the SSC. Various SSC work groups have completed the following products: the Minnesota Stormwater Manual, the report Recommended Solutions to Enhance Compliance with the NPDES Construction Permit, and study conclusions and recommendations on Integrating Stormwater Permitting and Watershed Management which examines the feasibility of a watershed based permitting approach for MS4s in Minnesota.

The minimal impact design standards (MIDSs) work group was recently formed with a diverse group of partners. The MIDSs are funded by the 2009 Legislature to "develop performance standards, design standards or other tools to enable and promote the implementation of low impact development and other stormwater management techniques." The MIDS Web page is available at:
http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/stormwater-minimal-impact-design-standards-mids.html

Municipal Stormwater

The MPCA issued the original small MS4 general permit in June of 2002. The permit was appealed and the Minnesota Court of Appeals remanded the permit to the MPCA requiring the MPCA to provide opportunity for public comment on each permittees SWPPP, and to address anti-degradation and several other issues. The MS4 general permit was revised to meet the court remanded issues and became effective June 2006. In September 2009, the

MPCA completed meaningful review and public notice of all individual SWPPPs and applications under the 2006 MS4 general permit. Permit coverage has been issued to all 233 permit applicants.

In 2010, the municipal stormwater program will shift more work activity into technical assistance and adaptive management for stormwater systems, evaluating compliance with rules, TMDLs, and the permit conditions. Randomly selected and targeted MS4s will receive an audit evaluation of parts or all of their stormwater programs. With limited staff resources, the MPCA goal is to conduct a combination of audits and inspections on 24 MS4s during 2010.

The existing MS4 general permit will expire in May 2011. Internal work on reissuance of the permit began in 2009. In 2010, the staff will focus on the highest priority issues for permit revision and begin to obtain stakeholder input in the permit revision process.

The MPCA is trying to manage new competing demands for staff resources associated with several projects in 2009 that will carry over into 2010. These include project management of state revolving fund and federal stimulus package funding for stormwater infrastructure. Also included are tasks mandated in 2009 Legislation on polyaromatic hydrocarbons (PAHs) in stormwater ponds, inventory, and BMPs for treatment; and assistance on reissuance of the industrial general permit. Also, integration of impaired waters and TMDL implementation with the MS4 general permit requires additional staff resources for planning, communication, and compliance work with MS4 permittees.

Construction Stormwater

The Phase I rules regulated large construction activities that disturb five or more Acs of land. The Phase II rules required small construction activities disturbing one to five Acs, including construction that is part of a common plan of development or sale disturbing one Ac or more, to have NPDES permit coverage. In August 2003, the MPCA issued a revised construction stormwater general permit for construction activity over one Ac of disturbance, incorporating both the Phase I and Phase II regulations for stormwater discharges associated with construction activity. The 2003 permit provided additional environmental protection for the state's ORVWs and wetlands, better regulated construction activity within subdivisions, and provided more options for post-construction BMPs than previous permits. In August 2008, the MPCA re-issued the construction stormwater general permit with revisions that included new requirements for impaired waters covered by a USEPA approved TMDL, revised requirements for change of permit coverage, and training.

The MPCA plans to reissue the existing permit with revisions before expiration in August 2013. The MPCA will need to comply with the USEPA final rule on Effluent Guidelines for Discharges from Construction and Development Sites (December 2009) with the next permit reissuance.

Industrial Stormwater

In fall 2006, an industrial work group was formed to work with the MPCA to develop Minnesota's industrial multi-sector general permit and permit program. USEPA's permit (issued September 2008) was used as a model for Minnesota's permit. The draft industrial stormwater general permit was placed on public notice in July 2009. The MPCA expects to finalize and issue the permit in March 2010. The MPCA will begin receiving phased permit

applications by sector group soon after the permit is finalized. In 2010, the Industrial Stormwater Program will shift focus from permit guidance development to 1) monitoring, 2) local partnership development, 3) collecting data for measures, and 4) program improvements. The Industrial Stormwater Program will continue to collaborate with the University of Minnesota to provide training on the new permit requirements (several training events were held in 2009).

Stormwater Rules
Minnesota State Stormwater Rules, Minn. R. ch. 7090, were enacted August 15, 2005, combining the Phase I and Phase II Rules in one place. The rules designated 43 additional small MS4s for permit coverage, as well as the entire jurisdiction of cities and townships that are located partially within an urbanized area.

B.3. Cost/Benefit Analysis

Underlying the nation's water pollution control efforts is the assumption that the overall cost of those efforts, while considerable, is outweighed by the resulting benefit.

Cost-benefit analysis is an attempt to make this assumption explicit and testable. However, the benefits associated with environmental programs (and, to a certain extent, even the costs) are not well quantified at present. Environmental amenities, for the most part, are not traded in the marketplace, and prices, in the normal sense, are not attached to benefits such as clean water, healthy aquatic communities, or even the well-being that comes with good health. While various attempts have been made to put dollar figures on some of these, their value remains largely intangible.

As a result, environmental policy decisions are inevitably (and perhaps best) made through the political process, rather than through the strict application of a quantitative cost-benefit analysis, which would be incomplete and of debatable accuracy.

Nevertheless, the underlying purpose of cost-benefit analysis – the assurance that the public's dollars are well spent – lies at the heart of the MPCA's considerable efforts at cost control and program effectiveness. In a time of decreased funding countered by increased demand for environmental services, the MPCA has done a great deal to ensure that its programs are directed towards the most important environmental problems and that those programs are conducted as cost-effectively as possible. Ongoing process-improvement efforts addressing the efficiency of various agency programs, and the *Environmental Information Report – An Assessment of Stressors Facing Minnesota's Environment*, a tool used by the MPCA to help prioritize the environmental problems currently faced by Minnesota, are only two examples of this continuing effort.

At the same time, even if complete figures are lacking, a partial accounting – partly quantitative, partly descriptive – can be given of some of the costs and benefits associated with Minnesota's WQ programs.

Costs

The primary WQ programs at the state level are those of the MPCA and the Minnesota Board of Water and Soil Resources (BWSR). Including local assistance, the WQ budget of the former is approximately $55 million per year and of the latter approximately $20 million per year. Other costs are incurred at the local level in the regulation of land use, feedlots, and on-site sewage disposal systems. It should be noted also 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 groundwaters. The MPCA, which has primary jurisdiction for the first three of these, has an overall budget of approximately $170 million per year.

Regarding the actual implementation of point source water pollution controls, approximately $2 billion in federal, state, and local funds have been spent since the enactment of the CWA for the construction of municipal wastewater treatment facilities in the state, including the separation of combined sewers. Operating costs for Minnesota municipal sewer utilities are estimated at more than $200 million per year. 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 represent a significant portion of the above figures.

Regarding the implementation of NPS water pollution controls, the overall costs are both more diffuse and more difficult to calculate than are those for point source programs. Current estimates, however, are that it will take between $600 million and $3 billion to restore Minnesota waters on the current 303(d) list that are impaired by NPSs. Details on these estimated costs can be found at http://www.pca.state.mn.us/index.php/water/water-publications/water-publications.html.

Benefits

If the comprehensive costs of water pollution control efforts are not yet fully calculated, the benefits are even less precisely measured. Theoretical models for translating WQ improvement into economically measured benefits do exist but no attempts have been made to do this for the state as a whole.

For point source programs, even if dollar figures are not readily available, benefits can be illustrated in descriptive terms. Significant improvements in state WQ have occurred over the past several decades, especially since the passage of the CWA. 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 regulatory compliance for municipal and industrial facilities are at a high level, with more than 95 percent of major WQ permittees meeting their effluent limits.

Even more striking are the indications of WQ improvements associated with improvements in specific major wastewater treatment facilities. On the Mississippi River 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 stormwater 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 (WLSSD) 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.

While the NPS program is considerably younger than that for point sources, similar benefits are beginning to be shown. WQ projects implemented through local cooperators have led to significant improvements in specifically targeted problem areas. Improved WQ in Lake Bemidji and Lake Shokatan are examples of this. Perhaps even more impressive is the WQ improvements for the Minnesota River, with a 25 percent reduction in sediment carried by the river during typical flow conditions. Increased use of agricultural soil conservation practices in recent years appears to be the main reason behind the reductions, and is a large step towards meeting the ultimate goal of a 40 percent reduction in sediment originating from cropland in the basin. Similar improvements have been seen for phosphorous (P) and biochemical oxygen demand (BOD) concentrations in the river.

As a result of both point source and NPS programs, WQ improvements in the state have been significant. Over the last three decades, the large majority of regularly monitored streams show a decreasing pollutant trend for BOD (89 percent of sites), fecal coliform bacteria (82 percent), ammonia (83 percent), and total phosphorous (TP) (78 percent). (On the other hand, only 42 percent of the sites show a decreasing trend for Total Suspended Solids (TSS), and fully 75 percent of the sites show an increasing trend for nitrite/nitrate (NO2/NO3)).

Indicative of both the value of clean water and the success of Minnesota's clean water programs is the large total revenue of the state's tourism industry. At approximately $10 billion per year, the economic importance to the state is considerable; water is one of the state's greatest attractions and plays a critical role in those dollars. Similarly, a recent study by Bemidji State University on the socio-economic value of Minnesota lakes found a strong relationship between water clarity and lake property values, with an increase (or decrease) of one meter (m) in clarity leading to changes of tens or even hundreds of millions of dollars for given individual lakes. This matches with the results of studies elsewhere in the US demonstrating and quantifying the benefits of WQ protection and improvement.

An accounting of some of the key results regarding the MPCA's environmental programs can be found at http://www.accountability.state.mn.us/.

B.4. Special State Concerns and Recommendations

B.4.1. Restoring Impaired Waters and Protecting Unimpaired Waters

Impaired waters continue to be a special and growing concern. When a water body fails to meet WQSs because of one or more pollutants, it is considered 'impaired'. Minnesota's current inventory of all impaired waters contains 3,049 impairments -- about 300 more impairments since 2008. These pollution problems are caused by a combination of point and nonpoint sources. (See pages 38-42 for more information on impaired waters.)

To help accelerate Minnesota's efforts to address impaired waters as well as protect and improve unimpaired waters, two critical developments have occurred over the past three years. First, the Minnesota Legislature adopted the CWLA in 2006. The Act provided a policy framework and additional funding for monitoring and assessment, TMDL development, and restoration activities.

Then, in November of 2008, the voters of Minnesota approved an amendment to the state's constitution to raise the sales and use tax rate by three-eighths of one percent on taxable sales, starting July 1, 2009, and continuing through 2034. Of those funds, approximately 33 percent will be dedicated to a Clean Water Fund (CWF) to protect, enhance, and restore water quality in lakes, rivers, streams, and groundwater, with at least five percent of the fund targeted to protect drinking water sources. Annual revenues appropriated to the CWF will vary depending on the economy, but estimates range from over $150-$200 million per biennium.

The majority of CWF appropriations will be allocated to point and nonpoint-related programs governed by several state agencies, including the MPCA, the BWSR, the Minnesota Department of Agriculture (MDA), and the Minnesota Department of Health (MDH).

These agencies are coordinating closely with LUGs to implement water programs. This will be a critical boost to Minnesota's efforts. For more information, go online at http://www.pca.state.mn.us/index.php/water/water-types-and-programs/clean-water-fund/clean-water-fund.html

B.4.2. Other Contaminants of Concern in Minnesota's Environment

The MPCA is attempting to stay abreast of newly recognized environmental contaminants and other issues that have the potential to cause known or suspected adverse ecological and/or human health effects but are not well understood. These 'emerging issues' are new areas of environmental concern that are not routinely addressed by traditional environmental protection programs in Minnesota or elsewhere.

Chemical contaminants can enter the environment through consumer products, solid waste disposal, agricultural and urban runoff, residential and industrial wastewater, and long-range atmospheric transport. The release of these substances to the environment may have occurred long ago, but remained unrecognized because analytical methods to detect them at low concentrations did not exist, or the presence of the chemicals in the environment was not suspected. In other cases, the synthesis of new chemicals or changes in use and disposal of existing chemicals can create new sources of contamination.

Several studies have demonstrated that some contaminants cause adverse effects on fish and wildlife, such as the feminization of male fish. However, the risks posed to humans from exposure to these contaminants at low concentrations are not well understood. While monitoring and analytical lab advances make it possible to detect these compounds at tiny concentrations, such as parts per trillion, there are very few established environmental standards or benchmarks for comparison and risk characterization. Much research is underway around the world to better understand how these compounds behave in the environment and in the human body.

Examples of emerging contaminants of concern currently being investigated in Minnesota include:

- Pharmaceuticals, household and industrial-use products
- Endocrine-disrupting compounds
- Perfluorinated chemicals (PFCs)

Pharmaceuticals, Household and Industrial-Use Products
In 2002, the US Geological Survey (USGS) published results of the first nationwide survey of pharmaceuticals, hormones, and household and industrial products in surface waters. The compounds analyzed in the study encompassed a wide variety of compounds including: antibiotics, over-the-counter pharmaceuticals, hormones, detergents, disinfectants, plasticizers, fire retardants, insecticides and musks used in the production of fragrances. The USGS included certain compounds in their survey because they are biologically active, such as pharmaceuticals or chemicals that are suspected endocrine disruptors. These products are widely used in consumer and industrial products and are continuously released into the environment through human activities. Sources of these chemicals can include wastewater discharge, manure from confined animal feedlots, landfill leachate, and urban runoff.

The MPCA has been collaborating with researchers from the local and national USGS offices since 2000 and St. Cloud State University (SCSU) since 2004 to further monitor and define health effects associated with this suite of compounds in Minnesota's water resources. The first state reconnaissance study by USGS, the MPCA and the MDH showed that industrial and household-use compounds and pharmaceuticals are present in streams, groundwater, wastewater and landfill effluents. Steroids, nonprescription drugs and insect repellent were the chemical groups most frequently detected, with detergent degradates and plasticizers measured in the highest concentrations. The complete report may be found at: http://water.usgs.gov/pubs/sir/2004/5138/.

The MPCA has also worked since 2002 with several partner organizations and the Minnesota Hospital Association to improve environmental compliance and pollution prevention throughout healthcare facilities in Minnesota. Compliance evaluations of healthcare facilities had revealed widespread mismanagement of complex hazardous wastes such as pharmaceuticals, laboratory solvents and reagents, and Hg-containing wastes. As a result of this collaboration, hospitals have been changing their waste management methods. Fiscal year 2006 resulted in 28 metro area hospitals properly managing 75 tons of pharmaceuticals and 30 tons of laboratory wastes as hazardous waste. Twelve hazardous waste compliance training events have been presented throughout the state in fiscal year (FY) 2006 with over 500 healthcare professionals in attendance. Partner organizations participating in this effort include the Solid Waste Management Coordinating Board, the Minnesota Technical Assistance Program, and the Metropolitan Council Environmental Services (MCES). More information on these efforts can be found at: http://www.pca.state.mn.us/industry/healthcare.html.

Endocrine Disrupting Chemicals
Endocrine disruption is a broad term referring to both natural and synthetic compounds that cause adverse effects in humans, fish, or wildlife by mimicking or altering the endocrine or hormone systems. (Some scientists are beginning to use the term “endocrine-active

chemicals" as more inclusive than "disruptors"). Originally, studies of endocrine disrupting chemicals (EDCs) focused on those chemicals affecting the estrogenic, androgenic (testosterone), or thyroid systems of humans and wildlife. However, the scope of interest has expanded to include other signaling chemicals in humans and wildlife, such as neurochemicals, in addition to other chemical signals in lower organisms and plants. Because endocrine disruption encompasses numerous sources, exposures, and organisms, it is critical to approach endocrine disruption in the context of environmental protection through a multidisciplinary and collaborative approach. MPCA has been supporting Minnesota-based EDC studies and researchers that build on national studies and perspectives.

Building on the results of the 2002 USGS survey of pharmaceuticals, household and industrial products in the aquatic environment, scientists from the USGS, SCSU, the University of Minnesota and the MPCA continue to investigate the significance, sources, and occurrence of compounds with endocrine-disrupting activity in Minnesota's waste streams and waters. This multidisciplinary team of experts has designed a phased approach from laboratory to field studies to discover what effects this diverse suite of compounds has on hormonal activity in aquatic organisms.

In January 2008, the MPCA completed a report to the Minnesota Legislature titled Endocrine Disrupting Compounds. This report summarizes what is understood about the range of EDCs and their effects on humans, fish, and wildlife, as well as reviewing possibilities for preventing the release of EDCs to the environment and the options for treatment at waste water treatment plants (WWTPs). The report is available at: http://www.pca.state.mn.us/index.php/download-document/3943-endocrine-disrupting-compounds.html.

In cooperation with USGS and SCSU, the MPCA completed the Statewide EDC Study in June 2009, which included the analysis of surface water and sediment in four of Minnesota's rivers and streams, and 12 lakes. This study also included an effects analysis of fish collected from the same locations. The results of this study can be found at http://www.pca.state.mn.us/index.php/water/water-monitoring-and-reporting/water-quality-and-pollutants/endocrine-disrupting-compounds.html

MPCA is currently pursuing three projects focused on EDCs and organic waste water compounds in the environment. The first study is a survey of 20 WWTPs across Minnesota, which includes chemical analysis of surface water and sediment as well as limited study of fish at those locations. Preliminary data from this study will be available in April 2010, with a final report due June 2011.

The second study continues the 2007-2009 Statewide EDC Study and will examine in more detail the presence and effects of EDCs on a single Minnesota lake from a variety of point and non-point sources. Results of this study will be reported in June 2011.

Finally, the MPCA is undertaking a survey of groundwater in 2010 that will include the sampling of 35 wells in the ambient monitoring network and five wells that are located downgradient of landfills. Ambient wells will be selected in areas that reflect sewered residential, residential areas with septic systems, commercial and industrial land use. Groundwater samples will be analyzed for a suite of chemicals including hormones, pharmaceuticals, EDCs, and other chemicals associated with wastewater effluent.

Perfluorinated Chemicals (PFCs)
PFCs such as PFOS, PFOA, and PFBA and others are manmade chemicals used to manufacture products that are heat and stain resistant, and repel water. PFCs used in emulsifier and surfactant applications are found in fabric, carpet and paper coatings, floor polish, shampoos, fire-fighting foam, and certain insecticides. PFCs are used to make fluoropolymers, which then are used in the production of many personal care products, textiles, non-stick surfaces, and fire-fighting foam. Perfluorocarbons are widespread and persistent in the environment and they have been found in animals and people all over the globe. However, little is known about their toxicity to humans and wildlife.

In Minnesota, 3M manufactured PFOS and PFOA from approximately 1950 until they were phased out in 2002. During that time, hundreds of tons of PFCs were released into the Mississippi River in effluent from the 3M Cottage Grove WWTP. In addition, four sites in Washington County were identified where 3M legally disposed of PFC wastes prior to the advent of modern solid and hazardous waste laws and regulations aimed at protecting groundwater.

The MPCA and the MDH testing found PFOS, PFOA and PFBA in some municipal and private drinking water wells in municipalities near former waste disposal sites. The MPCA, MDH and 3M have cooperated to quickly provide clean drinking water in those communities where private and municipal wells were contaminated.

Under a May 2007 Consent Order, 3M agreed to clean up its disposal sites in Oakdale, Woodbury and Cottage Grove, and contribute $8 million toward the cleanup of the Washington County Landfill in Lake Elmo, a former municipal solid waste landfill that received 3M wastes but is now owned by the State of Minnesota. Extensive remedial action is underway at all four sites to remove wastes and treat PFC-contaminated groundwater with granular activated carbon.

MPCA studies also have detected PFOS at elevated concentrations in fish taken from the Mississippi River near the 3M Cottage Grove plant and downstream, and in metro area lakes with no known connection to 3M's manufacturing or waste disposal. Mississippi River Pool 2, which received 3M Cottage Grove effluent during the years of PFOS and PFOA manufacturing, is listed as an impaired water, due to PFOS. This is based on fish tissue PFOS concentrations that prompted the MDH to issue a one-meal per month consumption advisory for certain species in that pool. Preliminary work in advance of a PFOS TMDL for Pool 2 also is underway.

The Consent Order also provided 3M funds for the MPCA to investigate the broader presence of PFCs in the ambient environment, and numerous studies are underway to do that. In addition to fish tissue, PFCs have been found in some shallow groundwater wells, in the influent, effluent, and sludge of WWTPs, in blood of bald eagles, and in landfill leachate and gas.

The MPCA and the MDH continue to examine potential sources of exposure to PFCs. An extensive description of all the MPCA and the MDH activities, and links to many PFC-related reports and studies, is available on the following Web pages:
http://www.pca.state.mn.us/cleanup/pfc/index.html
http://www.health.state.mn.us/divs/eh/hazardous/topics/pfcshealth.html

Part C. Monitoring and Assessment Strategy

C.1. Water Quality Standards Program

Introduction

At the heart of the assessment process are the beneficial uses we derive from our water resources and the WQS that protect these uses. The WQS are the fundamental benchmarks by which the quality of surface waters is measured. The WQS have been adopted into Minnesota's administrative rules, principally Minn. R. chs. 7050 and 7052.

Beneficial Use Classes for Surface Waters

The beneficial use classification system adopted into Minnesota's WQ Rules in the late 1960s is essentially unchanged, except that Limited Resource Value Waters (LRVW) (Class 7) were added in 1980. In the Minnesota system, all surface waters are classified and protected for fisheries and recreation, unless they are classified as LRVW. Also, all surface waters are protected for multiple beneficial uses (Minn. R. pts. 7050.0400 – 7050.0470). Surface waters include lakes, rivers, streams, wetlands, temporary pools, and man-made as well as natural water bodies.

Minn. R. ch. 7050 identifies seven beneficial uses as listed below. The use class numbers 1-7 are not intended to imply a priority rank to the uses.

Use Class	Beneficial Use
Class 1	Drinking water
Class 2	Aquatic life and recreation (swimming)
Class 3	Industrial use and cooling
Class 4A	Agricultural use, irrigation
Class 4B	Agricultural use, livestock and wildlife watering
Class 5	Aesthetics and navigation
Class 6	Other uses
Class 7	LRVW (not fully protected for aquatic life due to lack of water, lack of habitat or extensive physical alterations)

Classes 1 through 3 waters have further been divided into subclasses. Since the goal of the CWA is 'fishable and swimmable' waters, Minnesota assesses waters with respect to Class 2 subclasses as follows:

Class 2A	Cold water fisheries, trout waters
Class 2Bd	Cool and warm water fisheries, in addition these waters are protected as a source of drinking waters
Class 2B	Cool and warm water fisheries (not protected for drinking water)
Class 2C	Indigenous fish and associated aquatic community
Class 2D	Wetlands

Protection of aquatic life and recreation means the maintenance of healthy, diverse and successfully reproducing populations of aquatic organisms; and the maintenance of conditions suitable and safe for swimming and other forms of water recreation. This is consistent with the goal in the CWA that the nation's waters should be 'fishable and swimmable' wherever attainable. Class 7 waters are not able to support a fishery due to lack of water, habitat, and extensive alterations. Most are headwater channelized ditches. About one percent (approximately 900-950 miles) of Minnesota's 92,000 miles of rivers and streams are LRVW.

Both Class 2 and Class 7 waters (i.e. all surface waters of the state) are also protected for industrial (Class 3), agricultural (Class 4A&B), aesthetics and navigation (Class 5), and other uses (Class 6). For example, the St. Croix River from the dam in Taylors Falls to its mouth is classified as 1C, 2Bd, 3C, 4A, 4B, 5 and 6. This is therefore protected for all uses defined by these use classes (Minn. R. pt. 7050.0470, subp. 6). If a pollutant has numerical standards in more than one beneficial use class, the most stringent applies.

All groundwaters, but only selected surface waters, such as the St. Croix example cited above, are protected as a source of drinking water (Class 1). The federal drinking water standards apply to these waters.

Numerical Water Quality Standards (WQSs)

A numerical WQS is a safe concentration of a pollutant in water, associated with a specific beneficial use. Numerical standards are associated with all use classes except Class 6 (other uses). Ideally, if the standard is not exceeded, the use will be protected. However, nature is extremely complex and variable, and the MPCA must use a variety of tools in addition to numerical standards, such as biological monitoring, to fully assess beneficial uses.

Surface waters are assessed for this Report only with respect to Class 2 standards. However, compliance with the Class 2 standards will, with some exceptions, protect the usually less sensitive Class 3, 4, 5 and 6 beneficial uses.

All Class 2 standards for toxic pollutants have three parts[*].

- Chronic standard
- Maximum standard, and
- Final Acute Value (FAV)

The chronic standard is the highest concentration of a toxicant to which aquatic organisms can be exposed indefinitely with no harmful effects to the organism itself, or to human or wildlife consumers of aquatic organisms. The maximum standard protects aquatic organisms from potential lethal effects of a short-term "spike" in toxicant concentrations. The maximum standard is always equal to one half the FAV. The FAV is most often used as an "end-of-pipe" effluent limit to prevent an acutely toxic condition in the effluent or the mixing zone.

[*] Un-ionized ammonia, di-2-ethylhexyl phthalate, hexachlorobenzene, and vinyl chloride have only a chronic standard and no maximum standard or FAV.

Class 2 chronic standards are based on one of three 'end points', as listed below.

- Toxicity-based. The chronic standard is based on the direct toxicity of the toxicant to fish and other aquatic life.
- Human health-based. The chronic standard is based on the protection of people that eat fish from Minnesota waters (and drink the water, if the surface water is also a Class 1 water).
- Wildlife-based. The chronic standard is based on the protection of wildlife species that eat aquatic organisms (Minn. R. ch. 7052 has four wildlife-based standards; Minn. R. ch. 7050 has none).

Both toxicity-based and human health-based criterions are calculated by the MPCA, and the more restrictive of the two is adopted into Minn. R. ch. 7050 as the applicable chronic standard. Wildlife-based criteria have not been calculated outside of those adopted in Minn. R. ch. 7052. Minn. R. ch. 7052 is the Great Lakes Initiative Rule, applicable only to the Lake Superior basin. Maximum standards and FAVs are always toxicity-based, never human health or wildlife-based. Most of Minnesota's aquatic life (Class 2) standards are based on USEPA aquatic life criteria. The USEPA develops and publishes aquatic life criteria as required by Section 304(a) of the CWA.

Narrative Water Quality Standards

A narrative WQS is a standard that prohibits unacceptable conditions in or upon the water, such as floating solids, scums, visible oil film, or nuisance algae blooms. Narrative standards are sometimes called "free froms" because they help keep surface waters free from very fundamental and basic forms of water pollution. The association between the standard and beneficial use is less well defined for narrative standards than it is for numerical standards. However, most narrative standards protect aesthetic or aquatic life beneficial uses. Because narrative standards are not quantitative, the determination that one has been exceeded typically requires a 'weight of evidence' approach to data analysis showing a consistent pattern of violations. There is an unavoidable element of professional judgment involved in using narrative standards to determine impairment. The narrative standards most relevant to 305(b) assessments are found in Minn. R. pts. 7050.0150 and 7050.0222, subp. 7. These standards protect surface waters and aquatic biota from:

- Eutrophication
- Impairment of the biological community
- Impairment of fish for human consumption

Nondegradation

Nondegradation (equivalent to the federal term, antidegradation) is a third element of WQSs, in addition to numeric or narrative standards and the beneficial uses. The fundamental concept of nondegradation is the protection of water bodies whose quality is better than the applicable standards, so that the existing high quality is maintained and not allowed to degrade down to the level of the WQS.

Federal guidance establishes three levels or tiers of nondegradation. The first level is, at a minimum, waters should be in compliance with WQS, and that beneficial uses should be protected. Level two is the protection of waters that have quality better than standards so the existing high quality is maintained, unless there is a social and economic need to degrade the waters down to the level of the standards (Minn. R. 7050.0185). The third level, which provides the highest level of protection from pollution, are waters designated as outstanding, very sensitive or unique resources (Minn. R. 7050.0180). The MPCA has specifically designated a number of waters that are special for a variety of reasons. In Minnesota, these special waters are called ORVW. There are two categories of ORVW, 'prohibited' and 'restricted'. New or expanded point and NPS of pollution are entirely prohibited to the first category (examples are waters in the Boundary Waters Canoe Area Wilderness (BWCAW) and Voyagers National Park). New or expanded point and NPSs of pollution are prohibited to the restricted category unless the discharger can demonstrate there is no 'prudent or feasible alternative' to allowing the increased pollutant loading (examples in the restricted category are Lake Superior and federal and state designated scenic and recreational river segments such as the St. Croix River). In addition to designated ORVW, which are located statewide, all surface waters in the Lake Superior basin are designated as Outstanding International Resource Waters (OIRW) (Minn. R. 7052.0300). Implementation of nondegradation for OIRW waters focuses on reducing the loading of bio-accumulative pollutants to the Lake Superior basin because of the sensitivity of the Lake Superior ecosystem to these pollutants.

The agency will be revising the nondegradation portion of its WQSs. A series of stakeholder meetings will be held over the next year. Final rule revision adoption is anticipated in 2011.

C.2. Monitoring Strategy

A. Minnesota's Water Quality Monitoring Strategy and the Clean Water Legacy Act (CWLA)

The *Minnesota's Water Quality Monitoring Strategy, 2004-2014* (Monitoring Strategy), contains elements of the State's surface water and groundwater monitoring programs. The Monitoring Strategy satisfied the USEPA monitoring program strategy requirement. Although being revised, it currently serves as the guide to MPCA monitoring programs, a useful reference for communicating the MPCA's monitoring plans, and was also a key planning and budgeting tool used during the development of the 2006 CWLA, a ground-breaking policy bill. (M.S. Ch. 114D, http://www.leg.state.mn.us/leg/statutes.asp).

CWLA funds were appropriated for the MPCA and other state agencies to begin implementing the act. The MPCA began to ramp-up its water monitoring efforts, in conjunction with state and local partners. In 2007, the Minnesota Legislature appropriated funding for the full implementation of the Monitoring Strategy during the 2008-2009 biennium. The Legislature continued that funding from the CWF for the 2010-2011 biennium. The MPCA and state and local partners are on track to reach the goal of assessing Minnesota's surface water resources over a ten year period.

Minnesota's WQ monitoring strategy is available at:
http://www.pca.state.mn.us/water/pubs/wqms-report.html

Types of Monitoring

In its USEPA approved ten-year monitoring strategy, the MPCA categorizes its environmental monitoring efforts by purpose for the monitoring and how the information is assessed and used. In general, water monitoring efforts can be grouped into three 'use' categories as follows:

- **Condition monitoring:** This type of monitoring is used to identify overall environmental status and trends by examining the condition of individual water bodies or aquifers in terms of their ability to meet established standards and criteria. Condition monitoring may include chemical, physical or biological measures. The focus of condition monitoring is on understanding the status of the resource, identifying changes over time, and identifying and defining problems at the overall system level. Examples include routine surface water monitoring, basin monitoring, TMDL listing activities, and the ambient groundwater network.

- **Problem Investigation Monitoring:** This monitoring involves investigating specific problems or protection concerns to allow for the development of a management approach to protect or improve the resource. Problem investigation monitoring is used to determine the specific causes of impairments to water or groundwater and to quantify inputs/loads from various sources. It is also used to determine the actions needed to return a resource to a condition that meets standards or goals. Examples include CWP and Section 319 projects, TMDL development, site assessment, and investigation of specific groundwater issues, such as pesticides.

- **Effectiveness Monitoring:** This is used to determine the effectiveness of specific regulatory or voluntary management actions taken to remediate contaminated water. Effectiveness monitoring allows for the evaluation and refinement of the management approach to ensure it is ultimately successful. Examples include environmental monitoring associated with a permitted facility, implementation monitoring for TMDLs, CWPs and Section 319 projects, drinking water system monitoring, and monitoring associated with a particular BMP. Another example of effectiveness monitoring is effluent monitoring done to assess the compliance of a facility with a permit, rule or statute (i.e. compliance tracking) and to provide information on the effect of regulatory actions on inputs to water bodies (not the effects on the water body itself).

While there are similarities among the three monitoring types and the definitions are not meant to be exclusive and rigid, the definitions do help to distinguish between the various purposes for monitoring. Perhaps the greatest area of overlap is found between effectiveness and condition monitoring. In this case, the difference between the two monitoring types is largely a matter of scale.

Effectiveness monitoring is done at the management scale, to evaluate particular management actions. In contrast, condition monitoring can be used to track the system-wide effectiveness of environmental protection efforts. In discussing the elements of the monitoring program strategy, it will be important to distinguish among the three types of monitoring, since many elements are different depending on the type of monitoring.

B. Condition Monitoring Strategy: Watershed Approach

In recent years, the MPCA has organized components of stream and lake condition monitoring into the watershed framework at the major watershed level. Eight watersheds are intensively monitored annually and assessed in a yearly rotation expected to complete a statewide assessment every ten years. This approach coordinates with the Minnesota's impaired waters program, local groups, and citizens by laying out future work and impairment listings well in advance. For a full discussion of the benefits and components of this framework, refer to The Watershed Approach to Condition Monitoring and Assessment, August 2008 at http://www.pca.state.mn.us/index.php/download-document/10230-watershed-approach-report.html.

C. Stressor Identification Strategy

Minnesota addresses impaired biota by examining the interactions of numerous physical, chemical, and biological processes that define community composition. Biological impairments can be driven by natural or unnatural changes to one or many components of these systems. Biological impairments differ from some traditional water quality impairments in that the impaired biotic communities are indicators of disturbance rather than causes of disturbance.

Biological impairments are commonly caused by stressors that are not considered conventional pollutants within our WQ rules. These include stressors such as degraded habitat or altered hydrology. Minnesota utilizes the process of Stressor Identification developed by the USEPA to identify the dominant stressors.

The process of stressor identification draws upon a broad variety of disciplines such as aquatic ecology, biology, geology, geomorphology, statistics, chemistry, environmental risk assessment, and toxicology.

D. Effectiveness Monitoring Strategy

Much like problem investigation monitoring, the state's effectiveness monitoring strategy relies on monitoring activities by a variety of parties. On a project scale, regulated parties, local implementers, MPCA contractors, other organizations and MPCA conduct effectiveness monitoring to evaluate specific management practices or groups of practices in a specific area. As in problem investigation monitoring, project-scale effectiveness monitoring will be targeted to the priorities of Minnesota's impaired waters list, as those projects are implemented.

E. Surface Water Monitoring Purposes, Designs and Indicators

Tables 1, 2 and 3 (Appendix C.I. starting on page 61) describe current Condition, Problem Investigation and Effectiveness Monitoring activities, respectively. Each table provides information on the monitoring activity: activity start date, purpose, description of monitoring with an indication of the type of monitoring design to meet the specific monitoring purpose, and indicators.

F. Drinking Water Assessments

The MPCA does not assess groundwater (Class 1A) for potential impairment of the drinking water use. However, beginning with the 2010 reporting cycle, the MPCA is assessing Class 1B and Class 1C listed surface waters for potential impairment by nitrate nitrogen (NO_3-N). This step was taken in recognition of the trend of increasing nitrate concentrations in Minnesota streams and the public health and economic impact arising from elevated nitrate concentration in drinking water (a particular concern in Southeast Minnesota's karst region, where many Class 1B and 1C waters are located). More information about the assessment of Class 1B and 1C waters for nitrate nitrogen is available in the 2010 Guidance Manual http://www.pca.state.mn.us/index.php/download-document/8264-guidance-manual-for-assessing-the-quality-of-minnesota-surface-waters-for-determination-of-impairment-305b-report-and-303d-list.html.

The MPCA and the MDH staff have discussed assessing the drinking water use more broadly. Both agencies are investigating the possibility of making such assessments, and staff of both agencies are interested in the implementation of Source Water Protection Plans (http://www.umrswpp.com/) that have been developed by the municipal water suppliers for the major metropolitan cities of Minneapolis, St. Paul, and St. Cloud, Minnesota. These three cities all use surface waters in their municipal supplies and provide drinking water to a large portion of the state's population. They have identified priority areas for implementation and their contaminants of concern in intake waters that presently fall within current monitoring strategies of the state and others which are not currently being monitored.

G. Source Water

The MDH is the lead agency in Minnesota working on source water protection with USEPA. For groundwater-based public water supplies, source water protection is the state's wellhead protection program. For surface water supplies, source water assessment is being approached in various ways, depending on the size and circumstances of each source water and watershed. Where possible, these assessments and MPCA's basin and watershed assessments are being coordinated.

In the past, the MPCA has worked closely with the MDH on source water protection, through a Memorandum of Agreement (MOA). As part of this effort, the MPCA provides data on potential contaminant sources in source water protection areas and provides technical assistance to the MDH and public water suppliers on managing contaminant sources. The MDH and the MPCA continue to coordinate on special projects, such as Upper Mississippi Source Water Protection, that involve both source water protection and basin and watershed management. The MDH can now electronically access many of the MPCA's electronic databases to obtain information it needs on potential contaminant sources. The MPCA also has a representative on the MDH Ad Hoc Committee on Source Water Protection for Surface Water Systems.

C.3.1. Assessment Methodology and Summary Data

Assessment Units

Use support assessments in Minnesota are made for individual water bodies called 'assessment units'. The assessment unit for river systems is the stream segment (previously

referred to as river reach or 'assessment reach'. In the past, Minnesota used USEPA's Reach File 1 (RF1) to define stream reaches. Many of our current assessment stream segments are still RF1 reaches, or sub-segments of RF1 reaches. As Minnesota gathers data, stream reaches will be redefined as stream segments.

The MPCA uses the MDNR Public Waters Inventory (PWI) as the primary basis for identifying lakes and reservoirs. The MPCA assessments for the 303(d) list will only consider lakes of ten Acs or greater, as determined by the NHD. However, there are many waters in the PWI that are classified as wetlands; these will be considered Class 2D wetlands. Class 2D wetlands will be protected for the maintenance of a healthy aquatic community, for boating and other forms of aquatic recreation for which they are suitable. This may exclude swimming because the shallow water, soft bottom substrates and plentiful vegetation make many wetlands unattractive for swimming.

The MPCA now uses the 1:24,000 scale high resolution NHD to identify stream segment locations and lake acreage because it provides more accurate lake acreage and a much more complete accounting of all the streams in the state. Each water body is identified by a unique water body identifier code, comprised of the USGS eight digit hydrologic unit code (HUC) plus the three digit assessment stream segment. It is for these specific stream segments that the data are evaluated for potential use impairment. As such the state of Minnesota is using estimates of about 105,000 stream miles and about 4.5 million lake Acs for totals. (See Figure II-1, Minnesota Background Information and Border Waters.)

For more detail on how the MPCA determines stream and lake area assessment units see page 21 of the Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List, 2010 Assessment Cycle at http://www.pca.state.mn.us/index.php/download-document/5967-guidance-manual-for-assessing-the-quality-of-minnesota-surface-waters.html.

C.3.2. Data Management

The MPCA stores surface water monitoring data 'the state's Storage and Retrieval System (STORET) Database', and regularly uploads the data to USEPA's National Data Warehouse. The USEPA will continue to support the Warehouse, but will no longer support STORET. The MPCA is transitioning to a new WQ data management system that fully supports Minnesota's needs. As of January 2010, the MPCA has purchased the necessary licenses for EQuIS, a database management system that will replace STORET, and is working to transition from STORET to this new database system over the next twelve to eighteen months.

It is the MPCA policy that all WQ monitoring data required or paid for by the MPCA be entered into STORET. This includes projects funded by the MPCA such as Section 319 projects, CWP projects, and more recently, TMDL projects.

It is also the MPCA policy to use all credible and relevant monitoring data collected by others for its assessment activities. Because of this policy, many local projects not funded by the MPCA choose to submit data to the MPCA in STORET-ready format. These projects then also have their data accessible to a variety of users through the MPCA's Environmental Data Access Initiative.

C.3.3. Integrated Assessment Process

Integrated Assessment Methodology
The fundamental data and information requirements for the 305(b) and 303(d) use support and impairment determinations for all categories of pollutants are summarized in Tables 16 and 17 in Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List, 2010 Assessment Cycle. The Tables can be found on pages 76 through 78 at http://www.pca.state.mn.us/index.php/download-document/5967-guidance-manual-for-assessing-the-quality-of-minnesota-surface-waters.html. Pre-assessments are made following the methodology reflected in the tables. The professional judgment review of the pre-assessment determines the final assessment.

Lake eutrophication is now covered by numeric WQSs. These are broken down by ecoregion, depth, and presence of trout in the waters. Specific standards can be viewed in Table 11 on page 54 of the 2010 Guidance Manual for Assessing the Quality of Minnesota Surface Waters. A minimum of eight TP, chlorophyll-a (chl-a), corrected for pheophytin, and Secchi measurements must be collected over a minimum of two years in the ten-year assessment window.

Professional judgment is a formal process step in assessment decision-making. No assessment guidance and protocol, no matter how detailed, can address all the unforeseen aspects of the multi-step assessment process. A professional judgment team is formed for each basin and may consist of regional MPCA basin coordinator knowledgeable about local WQ issues, MPCA monitoring and data assessment staff, and staff from organizations outside the MPCA whose data were used in the assessments, if appropriate. Professional judgment teams meet to review how the data were used and interpreted, and whether outside data were used appropriately. They determine whether the data (possibly data combined from more than one source) are adequate and appropriate for making statements about use-support and about causes of impairment (such as low dissolved oxygen (DO) or high phosphorous (P), etc).

For more detail on the professional judgment process and decision-making considerations see section V. E. of Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List, 2010 Assessment Cycle beginning on page 24.

Each water body is assigned to an integrated assessment report category, as shown here in the flow chart in Figure III-2 on page 37. The state of Minnesota elects to not only use the USEPA categories in this flow chart, but also assigns sub-categories to better identify waters with insufficient information to make an assessment. The state categories may be found on page 28 of Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List, 2010 Assessment Cycle.

Figure III-1
Professional Judgment Group "Transparency" Form

Example

Transparency Documentation

Assessment Unit Identification (**AUID):** 07010202-545

Assessment Cycle: 2010

Aquatic Life Assessment: NS

Swimming Assessment: NA

Review For Delisting: No

More Monitoring: No

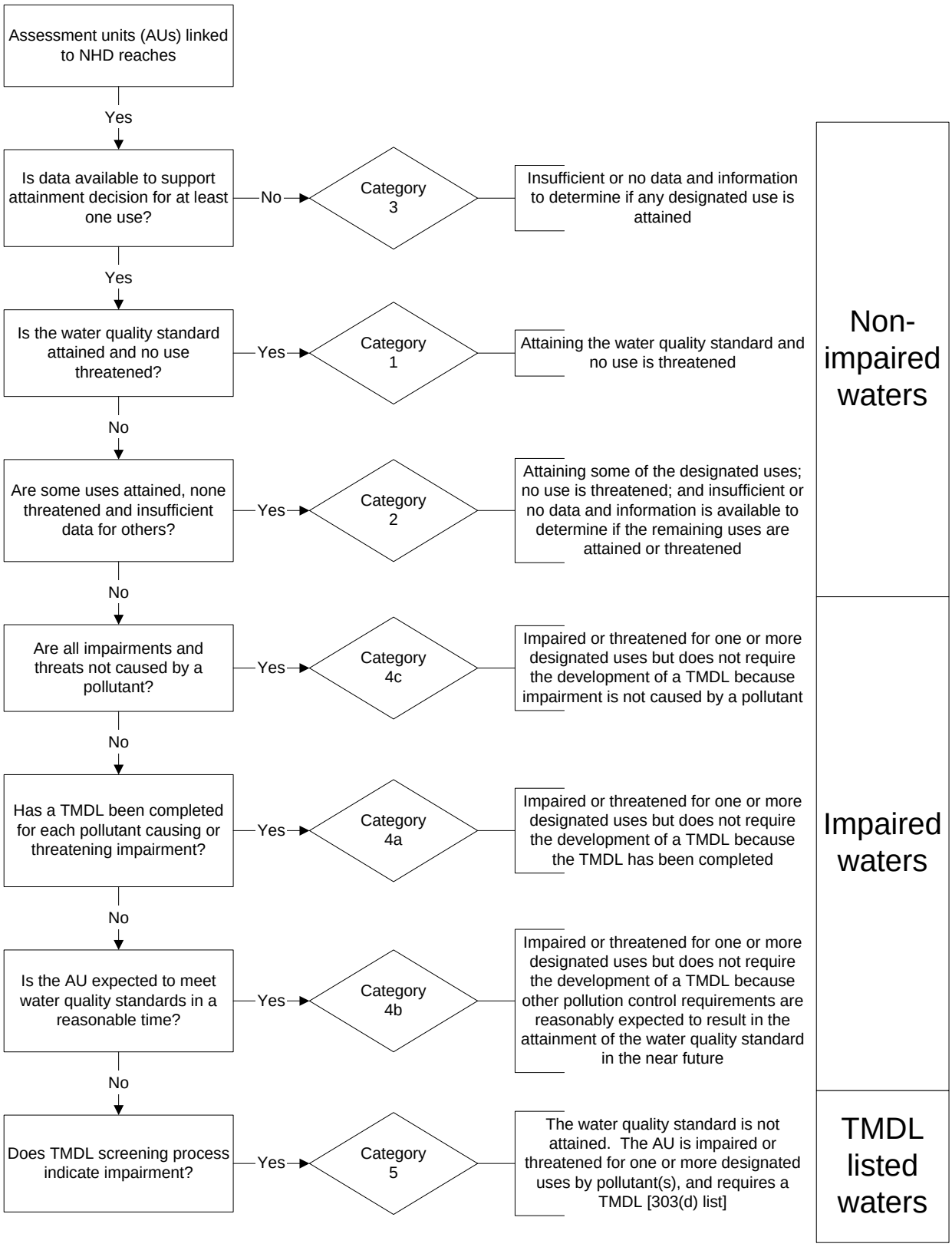
Comments:
Professional Judgment Group (PJG) comment: Recommend that the impairment for dissolved oxygen be evaluated for a natural source (Category 4D) rather than include on the 303(d) list (Category 5).

Natural Background Review: (09/03/09) CALM Category 5 for DO impairment based on high percentage of land use disturbance, presence of feedlots in watershed and upstream lake nutrient impaired (Eden Lake 73-0150). See evaluation form for detailed information.

Impairment ID: 322

Impairment Name: Dissolved Oxygen

Figure III-2. Flowchart of Non-Impaired Waters, Impaired Waters and TMDL Listed Waters



C.3.4. Data Analysis Procedures - Lakes

Data Age and Quality for Assessments

Assessed Data
Lakes with summer data (defined as the time period from June through September) collected between calendar years 1999 and 2008 were considered for this assessment. Summer data are required for assessments to better represent the maximum productivity of a lake and yield the best agreement among trophic variables.

Data Quality
Data used to make assessments are generally of good or excellent quality. Requirements for different quality datasets can be found in the Guidance Manual for Assessing Minnesota Surface Waters at: http://www.pca.state.mn.us/index.php/download-document/5967-guidance-manual-for-assessing-the-quality-of-minnesota-surface-waters.html.

Procedures
Lakes in the Red River Valley (RRV), Driftless Area (DA), and Northern Minnesota Wetlands (NMW) ecoregions were assessed using the North Central Hardwood Forest (NCHF) and Northern Lakes and Forests (NLF) standards, respectively, since there were too few lakes to establish reference conditions and standards in the RRV, DA or NMW ecoregions.

Candidates for non-support assessment required the minimum 8 paired samples over a minimum of two years for TP, chl-a, and Secchi.
Candidates for full support assessment could meet the full data set requirements of non-support waters or a reduced dataset of 4 TP, chl-a, and Secchi and an extended Secchi record.
For waters wholly in the Boundary Water Canoe Area Wilderness, remotely sensed Secchi was used to determine full support. These waters with reduced datasets were held to a more stringent standard (0.8 x standard) to be considered fully supporting.
The remainder of reviewed waters were placed in the insufficient data category.

More detailed information on the process used to assess lakes for the 2010 cycle can be found in the Guidance Manual for Assessing Minnesota Surface Waters at: http://www.pca.state.mn.us/index.php/download-document/5967-guidance-manual-for-assessing-the-quality-of-minnesota-surface-waters.html.

C.4.1. Impaired Waters List

Current Status
The table below contains the pollutants listed in the MPCA's Draft 2010 TMDL List and the number of impairments in streams and lakes caused by each. The MPCA estimates the cumulative percents of surface waters assessed over the last two reporting cycles to be about 17 percent of the state's streams miles and about 28 percent of lakes greater than ten Acs in size. Minnesota is currently on track to intensively monitor all the state's major watersheds

on a ten-year cycle, including all of the lakes 500 Acs and larger and priority stream sites (identified using a "pour point" method). Slightly more than 20 percent of the watersheds have been intensively monitoring to date. Details on the draft 2010 impaired waters list is contained in the second column.

Bioaccumulative toxics include polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane, Dieldrin, dioxin, PFOS, and toxaphene. Impairments due to Hg in water and fish tissues account for 62 percent of the bioaccumulative total and 20 percent of all the impairments on the draft 2008 TMDL List.

Pollutant	2008 Approved List # impairments	2010 Draft List # impairments
Ammonia	**5**	**7**
Bioaccumulative toxics & Mercury	**478**	**525**
Chlorides	**6**	**18**
Excess nutrients	**329**	**424**
Bacteria	**147**	**191**
Impaired biotic communities	**154**	**171**
Low dissolved oxygen	**62**	**97**
pH	**10**	**8**
Temperature	**1**	**1**
Turbidity	**283**	**321**
TOTAL	**1475**	**1763**

A separate 303(d) impaired waters list is being submitted to USEPA, but it is MPCA's intent to use Version 2.3.1 of the USEPA ADB for integrated reporting. The Category 5 AUs in the ADB will match with the submitted impaired waters list.

C.4.2. Total Maximum Daily Loads (TMDLs) and Impaired Waters

For each pollutant that causes a water body to fail to meet applicable WQSs, the CWA requires the states to conduct a study called a TMDL Study.

A TMDL study determines the assimilative capacity of a water body, and identifies both point and nonpoint sources of each pollutant that violates standards. WQ sampling and computer modeling determine how much each pollutant source is contributing to the problem. An allocation process involving stakeholders determines how much each source must reduce its contribution to assure the standards are again met.

An impaired water body may have several TMDL studies, each one determining reductions for a different pollutant. After a TMDL study is written, a detailed implementation plan is developed to meet the TMDL's pollutant load allocation and achieve the needed reductions to restore WQ. Depending on the severity and scale of the impairment, restoration may require many years and millions of dollars.

Minnesota has completed TMDLs on 1,163 impairments – 998 for Hg and 172 for conventional pollutants – out of the more than 3,000 lakes, river and stream segments that are currently impaired. The state is currently on schedule to complete TMDL studies by their target dates. There are approximately 100 TMDL projects underway. To date, 12 water body impairments have been fully restored to again meet WQ standards.

C.4.2.1. Strategies the MPCA Employs in the Impaired Waters Restoration Process

State Funding
CWLA funding that began in FY07 and continued in the FY08-09 biennium enabled Minnesota to reach its goal for beginning TMDL studies on schedule. However, that funding was not permanent. Collection of funds from the Clean Water, Land, and Legacy Constitutional Amendment began in the current FY2010. Currently $9M has been allocated to TMDL development in each of FY10 and FY11. These funds should enable us to keep on track with state goals. For more information on current funding see http://www.pca.state.mn.us/index.php/water/water-types-and-programs/clean-water-fund/clean-water-fund.html.

Partnering with Local Government
LUGs – cities, counties, soil and water conservation districts, and watershed management organizations – play a large and growing role in NPS pollution abatement across the state. The MPCA is ultimately responsible for completing and submitting TMDLs to the USEPA. However, these stakeholders play a critical role in the development and implementation of TMDLs. Our first priority is to use ready and qualified local government and watershed organizations with jurisdiction in the impaired watershed to develop TMDLs to lead a project. These entities need to have the expertise to do the work, especially for monitoring, land use inventory, choosing reduction scenarios, developing implementation plans and public outreach.

Locally-driven projects are most likely to succeed in achieving WQ goals because communities often best understand the sources of WQ problems and effective solutions to those problems. Through grant contracts with the MPCA, local governments and watershed organizations are leading over three-fourths of Minnesota's TMDL projects. The remaining projects, particularly the most complex ones, will often be led by MPCA or other state agencies. The MPCA provides oversight, technical assistance, and training to ensure regulatory and scientific requirements are met.

Using Private Consultants
The MPCA and local government often use private consultants to perform specific steps of TMDL studies where needed and where they will be most effective. Consultants are helpful in supplementing MPCA and local staff resources, particularly for technical work. In many cases, consultants assist with data collection, modeling and development of draft reports.

Strategies for Waters Impaired by Mercury (Hg) and Other Toxic Pollutants
Hg can be carried great distances on wind currents before it eventually falls on our land and water bodies. In fact, about 90 percent of the Hg deposited from the air in Minnesota comes from other states and countries. Therefore, the traditional TMDL approach to addressing impairments will not work for Hg, as Minnesota can not control the many sources of this toxic pollutant outside our borders.

The MPCA's statewide Hg TMDL was approved by USEPA in March 2007 and an implementation plan was completed in October 2009. The implementation plan includes measures to reduce Hg from airborne sources such as coal-fire power plants. For more information on the Hg TMDL and implementation plan, go to: http://www.pca.state.mn.us/water/tmdl/tmdl-mercuryplan.html

Strategies to Increase the Effectiveness and Efficiency of Total Maximum Daily Load (TMDL) Development and Implementation
Given the growing number of TMDL studies, limited staffing, and available funding, the MPCA has made important strides to increase the efficiency and effectiveness of its impaired waters activities, including:

- Watershed Approaches: The MPCA has completed or has underway several TMDL projects that cover multiple impairments within a major watershed (several stream reaches or lakes) or across an entire region (several watersheds or an entire basin). In addition, as noted elsewhere in this report, the MPCA has launched a rotating, comprehensive watershed approach in approximately 10 percent of the 81 major watersheds per year. This includes completing monitoring and assessment activities, TMDLs and protection plans, and beginning implementation activities. For more information on the watershed approach, go online at: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/basins-and-watersheds/watershed-approach.html

- Protocol Development: The MPCA is working to provide technical expertise to MPCA staff and stakeholders on technical work related to TMDLs and restoration projects. For example, guidance or protocol documents have been written by the MPCA to create more standardized approaches to TMDLs in Minnesota. Guidance documents that are on the agency's Web site include bacteria, DO, turbidity, excess nutrients in lakes, and biotic impairments. The MPCA is also applying these protocols to TMDL projects through standing technical staff teams called "parameter teams." The MPCA is also making great progress on challenging issues related to stormwater TMDLs and the incorporation of TMDL requirements into stormwater permits.

- Coordination with state and federal agencies: The cornerstone strategies of Minnesota's CWLA is to better fund and utilize existing state and federal programs with WQ programs. On the state level, the MPCA is coordinating closely with the MDNR, BWSR, and the MDA on many of these programs. On the federal level, the MPCA is working with the Natural Resource Conservation Service, the USGS, and other agencies. Finally, the MPCA has worked with the USEPA on direct assistance on some TMDLs.

Goal Setting and Performance Measurement

The MPCA currently uses measures for its impaired waters effort that are based on both shorter term organizational performance targets and longer term environmental outcomes. As required by the CWLA, a more comprehensive set of measures are being developed by a team of five state agencies to better measure the progress of work receiving state funding. The initial report of this effort resulted in an effectiveness measures framework which can be found online at http://wrc.umn.edu/randpe/policy/cwlatrackandreport. This initial framework was refined in 2009 and is being piloted in select watersheds in 2010.

C.4.2.2. Relationship of 305(b) Report to 303(d) List

A complete description of the integration of the 305(b) report with the 303(d) listings, the levels of use support, how data are used and data quality are determined may be found in Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List, 2010 Assessment Cycle, Chapter VI Elements of the Integrated Report, pages 27 through 31. This report may be found at http://www.pca.state.mn.us/index.php/download-document/5967-guidance-manual-for-assessing-the-quality-of-minnesota-surface-waters.html.

C.4.3. Wetlands Update

Even after nearly 50 percent of its historic wetlands were drained, Minnesota leads the conterminous US in inland (Lacustrine, Palustrine and Riverine) wetland area with over ten million Acs of nontidal and non-estuarine wetland. Minnesota's wetland resource is not only large, but also is diverse and regionally very different. Regional differences have been important considerations in developing the state's regulatory, monitoring, restoration and management practices.

With passage of the WCA of 1991by the Minnesota Legislature followed soon thereafter by adoption of narrative state wetland WQSs in 1993, Minnesota codified state policy to achieve no net-loss in wetland quantity, quality and biological diversity and to increase the quantity, quality and biological diversity of Minnesota's wetlands. Since the early nineties, in part with USEPA Wetland Program Development Grant support, Minnesota has developed a widely respected comprehensive wetland regulatory and monitoring and assessment program.

C.4.4. Wetland Regulatory Program

The State WCA continues to be the principle wetland protection and regulatory program in Minnesota. Central to the WCA is the enactment of state policy to achieve a 'no net loss' and to increase the, "quantity, quality and biological diversity of wetlands in the state" (Minn. Stats. 103A.201). Several non-wetland specific regulatory programs including the 404/401 certification permit program, the MDNR Public Waters Permit Program and the NPDES Permit Program (including stormwater) align with the WCA to provide broad oversight of most types of direct and indirect physical wetland alteration in Minnesota.

C.4.4.1. Adoption of New Minnesota Wetland Conservation Act (WCA) Rules

Since the WCA was enacted and the initial administrative rules were adopted, several statutory and rule revisions to the WCA have occurred. The most recent rounds of changes were fairly extensive. After a multi-year WCA rules and program administration assessment and review, statutory changes were enacted in May 2007. Following these statutory changes the BWSR enacted exempt (emergency) WCA rules to conform to the new statutory requirements. After the exempt rules were adopted in August 2007, a permanent rule revision process began. New WCA Rules subsequently were adopted by the BWSR and went into effect in August 2009. The new rules resulted in numerous changes but were drafted and adopted with intent to streamline and clarify a complicated set of regulatory oversight of wetland protection at local, state and federal levels. In addition, efforts were made to integrate wetland protection under the WCA with other programs and authorities. Extensive changes were made to the following sections of WCA administrative rules:

- Application procedures and exemptions
- Banking credit certification and administration replacement credits monitoring
- WCA decision appeal actions and process
- Enforcement and comprehensive wetland planning

More details on the rule revision process and a copy of the permanent WCA Rules are available online at the following address:
http://www.bwsr.state.mn.us/wetlands/index.html

C.4.4.2 Reinstatement of Active 401 Certification Program

Due to budget reductions by Minnesota state government in 2001, the MPCA suspended actively administering Section 401 WQ certification reviews for most federal permit actions. The majority of WQ certifications were waived, though there were a small number of high profile project activities in which the MPCA issued certifications either with or without conditions.

In late 2006, MPCA management approved a proposal to reinstate a focused 401 certification program and in early 2007 staff began active targeted 401 WQ review permit actions which meet the following criteria:

1. Drain directly to - impaired waters, trout waters or ORVW
2. Private road projects affecting more than three Acs, or public road projects affecting more than five Acs of wetland which are within ½ mile of impaired waters
3. Projects which have the potential to deepen or inundate two Acs or more of wetland and which are not regulated by the WCA, and
4. Result in typically large wetland fills or drainage (e.g., linear projects, mining activities, multi-purpose roads with new bed alignments, new judicial ditching that have the potential to affect downstream waters, flood impoundment or diversion projects, large development and projects that may have adverse impacts on the watershed.

This level of 401 WQ Certification has effectively reinstated an important regulatory tool which has contributed measurable protection of Minnesota's valuable wetlands and watersheds.

C.4.4.3. Northeast Mitigation Strategy

In 2005, the St. Paul District Corps of Engineers (COE) acted to restrict wetland mitigation to geographically focused (Wetland Mitigation Service Areas (Figure III-3). These service areas are mostly bounded by major watershed boundaries. This policy change and the fact that wetland mitigation opportunities in Northeastern (NE) Minnesota is often difficult due to the fact that much of that region of Minnesota is currently wetland, in fact that part of Minnesota retains 80 percent or greater of the historic wetlands. Since mitigation opportunities are strongly limited in NE Minnesota, a NE Minnesota Wetland Management Strategy was developed in 2006 to address mitigation options for this region. The strategy resulted in five recommendations:

1. Establish a regional wetland mitigation cooperative,
2. Conduct a regional wetland mitigation inventory,
3. Conduct a regional mitigation-siting study
4. Research non-traditional wetland mitigation methods, and
5. Update the NWI in NE Minnesota.

In 2007, the Minnesota Legislature appropriated funding to complete two of these recommendations and in 2008 and early 2009 the BWSR undertook a NE Minnesota wetland mitigation inventory and mitigation study to identify and prioritize potential mitigation opportunities. This work resulted in nearly 8,000 Acs of potential wetland mitigation opportunities being identified in four mitigation credit categories:

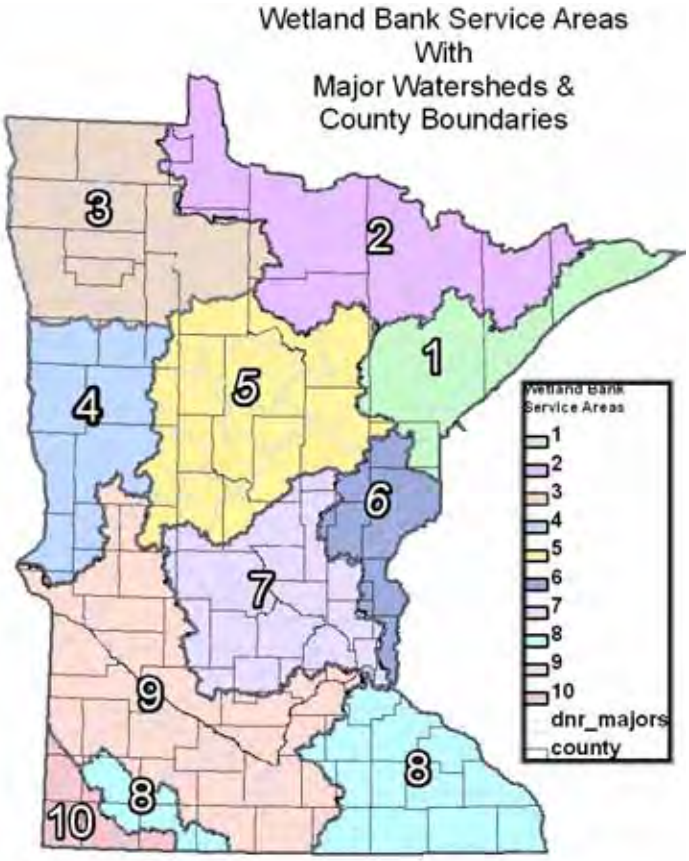


Figure III-3. Wetland bank service areas with major watersheds and counties

1. Restoration = 7,500 Acs
2. Preservation of Exceptional Natural Resource Value (ENRV) areas = 100 Acs
3. Enhancement = 100 Acs
4. Creation = 300 Acs

A technical committee and stakeholders oversaw the inventory and review process. Ground-truthing visits verified the suitability and landowner cooperation of these areas for mitigation.

C.4.4.4 Wetland Restoration Strategy

At the request of the Governor's Office in 2007 the BWSR initiated development of a Wetland Restoration Strategy and Framework to guide wetland restoration in Minnesota. A committee of agency staff, academic community representatives and wetland stakeholders was convened to oversee this project. The Restoration Strategy and Framework were formally adopted by the BWSR Administrative Board in January 2009. Key elements of this statewide wetlands restoration strategy are:

- Prioritize restorations based on desired outcomes – specifically water quality improvements, habitat gains, flood damage reduction, and other hydrologic benefits
- Improve coordination of wetlands restoration efforts
- Design and produce better wetland restorations that stand the test of time, and provide lasting functional benefits

The strategy recommended identifying and prioritizing wetland restorations based on: wildlife benefits, floodwater reduction and WQ improvement. For more information a copy of the restoration strategy is available at:
http://www.bwsr.state.mn.us/wetlands/Restoration_Strategy.pdf

The strategy promotes coordination of partners interested in maximizing restoration outcomes since financial resources are limited. To improve prioritization, the strategy recommends using potentially restorable wetlands as a base layer in planning restorations. One base layer identified is the Restorable Wetland Inventory (RWI) which is focused on Minnesota counties in the prairie pothole region. The RWI includes historically drained wetland polygons mapped from aerial photo interpretation focused on relict soil mottles. The RWI is available by county tiles at:
http://prairie.ducks.org/index.cfm?&page=minnesota/restorablewetlands/home.htm. A second method for deriving a base wetland restoration layer is Geographic Information System (GIS)-based analysis approaches of digital elevation models (DEMs). One such approach is the Compound Topographic Index (CTI). The CTI identifies depressions in the landscape based on slope and catchment area. Digital soil survey data (SSURGO) can be used to refine the CTI depression profiles. Ideally the CTI would be derived from high resolution DEMs (Light Detection and Ranging (LiDAR) derived) though they can be run on currently available statewide conventional resolution DEMs (30 m grid cells). In June 2009, the Minnesota Legislature appropriated $5.6 million toward completion of a statewide, high-resolution elevation dataset derived using LiDAR technology. The money was funded from the Clean Water portion of the Minnesota Conservation Legacy Amendment passed by the citizens of Minnesota in November 2008.

In addition, the strategy identifies 21 specific strategies for prioritization, coordination and sustainability roles assumed by local, state, federal and nonpublic agencies or organizations to direct and support the recommended restoration prioritization approach.

The Wetland Restoration Strategy recommended developing improved GIS models for prioritizing wetland restorations based on WQs. A proposal to improve wetland WQ models for prioritizing wetland restorations at a watershed scale was submitted to the Legislative Citizen Commission on Minnesota Resources but was not selected for funding recommendations to the full Legislature. The MPCA sees this as a critical need as the targeted wetland restorations become a greater part of watershed restorations.

C.4.5. Wetland Mapping, Monitoring and Assessment

C.4.5.1. Updating State National Wetland Inventory (NWI) Coverage

The original Minnesota coverage of the NWI was based on aerial photographs taken in the late 70's and early 80's. As a result of changes in land use and various land management actions since that time, the original wetland maps have become inaccurate and in some areas nearly unusable. Updating the NWI was identified as a key component of Minnesota's CWAMMS (2006)
http://files.dnr.state.mn.us/eco/wetlands/wetland_monitoring.pdf.

The MDNR (in collaboration with the BWSR, the MPCA, the US Fish and Wildlife Service, the MCES, the Minnesota Land Management Information Center and the University of Minnesota) has received initial funding from the Minnesota Environment and Resources Trust Fund to begin a statewide update of the NWI. A technical advisory committee made up of stakeholder agency representatives is overseeing the update process. The update will be conducted in phases over several years, beginning with the 13 county East Central region of Minnesota including the Twin Cities metro area and three counties in NE Minnesota (Figure III-4). Contingent on continued phased funding, current plans have the statewide NWI update being completed by 2019. NWI updates will be made publicly available as they are completed.

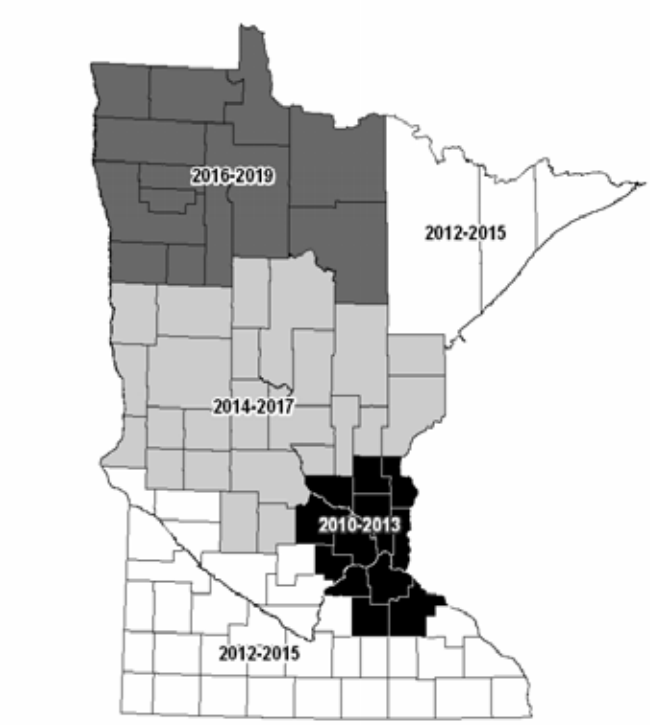


Figure III-4. Provisional mapping phases for updating the Minnesota National Wetland Inventory

The mapping work will fully comply with the new federal geographic data standard http://www.fgdc.gov/standards/projects/FGDC-standards-projects/wetlands-mapping/FinalDraft_FGDC_WetlandsMappingStandard_2009-01.pdf] for wetland mapping. When possible the ½ acre Federal Geographic Data Commission (FGDC) targeted mapping unit standard will be exceeded. A detailed comprehensive plan and quality assurance plan for the NWI update process is available at http://www.dnr.state.mn.us/eco/wetlands/nwi_proj.html.

C.4.5.2. Impaired Wetland Listing

The 2010 MPCA Guidance Manual for Assessing the Quality of Minnesota Surface Waters: Determination of Impairment 305(b) Report and 303(d) List (http://www.pca.state.mn.us/index.php/download-document/5967-guidance-manual-for-assessing-the-quality-of-minnesota-surface-waters.html) includes guidelines for wetland biological assessment. In this reporting cycle, the MPCA had appropriate wetland monitoring data to assess biological condition for 106 depressional wetland basins. As discussed in the 2008 MPCA Guidance Manual per stakeholder recommendations, the MPCA will only propose listing impaired wetlands under 303(d) when monitoring data: 1) demonstrated an impaired condition, and 2) the assessed wetland was hydrologically

connected to a known impaired lake or stream. Eleven depressional wetlands met these criteria and are included on the draft 2010 Section 303(d) list (Table III-1). Most of these wetlands are located in Southwestern Minnesota (Figure III-5) because it was the focus area of wetland Index (or Indices) of Biotic Integrity (IBIs) development work in 2002-2003 and that was the primary dataset considered in this listing cycle.

Table III-1. Indices of Biotic Integrity results for impaired depressional wetlands proposed on the 2010 303(d) list. Bolded IBI results indicate aquatic life impairment.

AUID	MPCA ID	MN DNR WB name	Area (acres)	County	Invertebrate IBI Impairment Criteria	Invertebrate IBI Result	Plant IBI Impairment Criteria	Plant IBI Result
21-0692-00	07Doug001	Unnamed	12	Douglas	47	**46**	42	**14**
12-0013-00	Franco WMA	Unnamed	59	Chippewa	59	**20/21**	51	**13/16**
75-0375-00	Lee	Unnamed	27	Stevens	59	**52/35**	51	**41/39**
75-0175-00	Golden WPA	Unnamed	55	Stevens	59	**47/49**	51	**33/32**
41-0128-00	03Linc019	Unnamed	34	Lincoln	59	**35**	51	**16**
51-0128-00	03Murr028	Unnamed	21	Murray	59	**26**	51	**42**
51-0124-00	03Murr066	Unnamed	71	Murray	59	**21/30/42/43/37**	51	**41**
42-0092-00	03Lyon099	Weltz Slough	24	Lyon	59	**30**	51	**21**
59-0008-00	03Pipe055	Unnamed	7	Pipestone	59	**33**	51	**41**
42-0080-00	03Lyon146	Pochardt Slough	40	Lyon	59	**14**	51	64
87-0121-00	05Yell001	Unnamed	16	Yellow Medicine	59	60/**54**	51	**22**

Assessing and listing individual wetlands with a limited watershed context similar to what has been done with stream segments and lakes is proving to be somewhat impractical and resource intensive given Minnesota's extensive wetland resource. Alternatively, Minnesota is moving toward better integrating wetland assessment outcomes into higher order watershed contexts. The results from the Minnesota Wetland Status and Trends Monitoring Program (MWSTMP) are one such example. In addition, the MPCA is investigating ways in which wetland monitoring data and assessments can be integrated into the intensive watershed design to inform and prioritize watershed assessment, restoration planning and protection.

Figure III-5. Locations of impaired wetlands on the 2010 draft 303(d) list

C.4.5.3. Indicator Development – Floristic Quality Assessment (FQA) and Remote Sensing

The MPCA has devoted significant resources to developing field sampling protocols and assessment criteria to enable the agency to assess depressional wetlands using invertebrate and plant IBIs. Though IBIs are robust assessment indicators, the development process is fairly time intensive. Many other wetland assessment end points could be used to effectively assess wetland biological condition. One such plant-based indicator is FQA. FQA relies on coefficients of conservatism which are attributed to individual plant species. These coefficients range from 0 to 10 with 0 being assigned to non-native species, and 1, 2 or 3 being assigned to opportunistic or aggressive species which are often pioneering ruderals often called 'weeds'. At the other end of the coefficient scale (8, 9 and 10) are plant species that have a high fidelity to unique or high quality habitats. Many of these species are often sensitive to stress and may be listed as state or federal Special Concern, Threatened or Endangered Species. In 2007, the MPCA published coefficients of conservatism (*C*-values) for Minnesota's roughly 1266 aquatic and near aquatic (wetland) plant species http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/wetlands/floristic-quality-assessment-for-minnesota-wetlands.html. Completion of *C*-values being assigned enable the MPCA staff ecologists to assess wetlands using the Floristic Quality Assessment Index (FQAI) or related floristic metrics which have been demonstrated to be responsive to stress such as mean *C*.

The MPCA is now working to develop standardized sampling protocols and assessment criteria based on an FQA framework. Since the Minnesota wetland IBIs only apply to depressional wetlands, the MPCA is interested in expanding the ability to assess the biological condition of other wetland classes (types) in Minnesota. Plans are to use FQA as a biological assessment framework for assessing all other Minnesota wetland classes. The MPCA is using wetland plant data collected by the MDNR Natural Heritage and County Biological Survey Programs to develop FQA sampling approaches and assessment criteria. In addition, the MPCA collected supplemental wetland plant data in 2009 for wetland meadow communities, shrub communities, forested wetlands and bogs to augment the MDNR data. Additional field work by the MPCA in these wetland communities is planned in 2010 to fill data gaps. Following this field work, the MPCA plans to have FQA wetland assessment development work completed by 2011.

The MPCA is working on developing landscape wetland assessment techniques (level 1) using remote sensing data and methods to interpret plant community integrity remotely. A preliminary investigation was completed in 2007. In 2009, the agency began a small scale watershed pilot in Browns Creek Watershed, located in Washington County, in East Central Minnesota. Initial field data and imagery for this pilot were collected in September 2009 and are currently being analyzed.

C.4.5.4. Minnesota Wetland Status and Trends Monitoring Program (MWSTMP) First Cycle

Wetland status and trends in Minnesota remain poorly understood, and progress toward reaching the no net-loss goal has been difficult to assess. Funding from the USEPA's Wetland Demonstration Pilot (WDP) Grant Program enabled the state to initiate the MWSTMP.The MWSTMP is a statistically valid statewide survey to assess status and trends in wetland area (quantity) and condition (quality). Vital assistance with survey design and sample selection was provided by the USEPA Environmental Monitoring and Assessment Program (EMAP) at the Western Ecology Division of the Office of Research and Development.

The survey sampled 4,990 randomly selected 1 mi^2 permanent plots over a three-year survey cycle. In each year, 1,580 different panel plots were sampled by aerial photography. Two hundred and fifty annual plots were similarly sampled by aerial photography each year to estimate between-year variability. Air photo interpretation was completed for all sample plots delineating and classifying wetland polygons within each plot following the MWSTMP wetland classification presented in Table III-2. This classification was a modification of the Cowardin et al. wetland and deep water habitat classification system. In future three-year cycles, Minnesota will be able to estimate trends in wetland quantity. A second phase probabilistic sample frame was developed from the wetland quantity results and enabled wetlands to be selected for field sampling to estimate wetland condition (quality).

Table III-2. Conversion system used for comparing data from the NWI (Cowardin System) and the wetland types used in the Minnesota Wetland Status and Trends Monitoring Program

NWI (Cowardin) System				MWSTMP
System	Subsystem	Class	Modifier	Code
L	L1	UB		DW
L	L2	AB		AB
L	L2	EM		EM
L	L2	RS		UB
L	L2	UB		UB
L	L2	US		UB
P		AB		AB
P		EM		EM
P		FO		FO
P		SS		SS
P		UB		UB
P		US		UB
R	R2	EM		EM
R	R2	UB		UB
R	R2	US		UB
R	R3	UB		UB
R	R3	US		UB
R	R4	SB		UB
Any	Any	Any	f	CW

The first three-year cycle of the MWSTMP estimated 10.6 million Acs of wetland occur in Minnesota. This is similar to the summation of wetland area reported by the NWI Table III-3. Minnesota's NWI has been fully digitized since the early 1990s, though the NWI data originates from 1979 to 1988 imagery, depending on region of the state. As a percentage of state area, wetlands comprised 19.6 percent and an estimated 4.95 percent of Minnesota was covered by deepwater habitats. Forested wetlands were the most common wetland class at 4,392,198 Acs; emergent wetlands were the second most common wetland class covering an estimated 3,170,665 Acs. Shrub-scrub wetlands were the third most common wetland class occupying an estimated 2,348,689 Acs. Aquatic bed, unconsolidated bottom and cultivated wetlands totaled an estimated 694,633 Acs (Table III-3). In future three year cycles, Minnesota will be able to estimate trends in wetland quantity.

Table III-3. Total estimated wetland area (Acs) by wetland class and deep water class by Omernick Level II Ecoregions as calculated from wetland quantity sample result from the Minnesota Wetland Status and Trends Monitoring Program

Ecoregion	Aquatic Bed	Emergent	Cultivated	Forested	Scrub-Shrub	Unconsol Bottom	Deep Water	Total Wetland
MWP	108,538	996,694	39,709	290,432	340,459	128,452	555,408	1,904,284
MWS	104,389	1,498,529	14,046	3,902,825	1,833,125	106,452	1,867,201	7,459,367
TP	32,864	673,736	83,628	165,371	161,702	77,926	243,099	1,195,227
State Totals*	245,570	3,170,665	136,804	4,392,198	2,348,689	312,259	2,676,970	10,606,186

*Sum of ecoregions are not expected to equate to statewide total estimates, since each ecoregion result is an independent estimate of average area within wetland class from all sample plots within that ecoregion. Because some sample plots straddle ecoregion boundaries the statewide estimate is calculated independent of the ecoregion plots and includes all plots.

Minnesota also implemented a statewide wetland condition survey designed to collect wetland quality data state-wide in a three-year rotating ecoregion schedule as part of the MWSTMP. Results for two of the Omernick Level II Ecoregions (Figure III-6), the Mixed Wood Plains Ecoregion (MWP) and the Temperate Prairies Ecoregion (TPE) are included here. Results from the MWP were based on a sample of 61 depressional wetlands and represented an estimated 352,251 Acs of depressional wetland in the MWP. Estimates of depressional wetland area within the MWP in 'Good', 'Fair', and 'Poor' condition as assessed by either invertebrate or plant-based IBI

Figure III-6. Level II Ecoregion boundaries (Omernick 2005) in Minnesota with county boundaries in the background

are provided in Table III-4a. 'Good' condition represents wetlands scoring at or above the 25th percentile of the reference site results. 'Fair' condition includes those sites scoring between the 25th and 5th percentile of the reference site results. 'Poor' condition represents those sites scoring below the fifth percentile of reference site results. The invertebrate IBI assessment of the MWP was dominated by 'Good' (57 percent) quality wetlands. In contrast, the plant IBI found 'Poor' quality wetlands dominated (41.1 percent) in the MWP. These two indicators respond differently to a suite of stressors and therefore it is not surprising the assessment results are somewhat opposite.

Table III-4a. Wetland condition results from the Minnesota Wetland Status and Trends Monitoring Program for the Mixed Wood Plains Ecoregion (Omernick Level II)

State	Ecoregion	Cycle	Resource Assessed	Size Unit	Total Depressional Wetland Area (ac)	Total # of sites
MN	Mixed Wood Plains	1st - 2007	Depressional Wetlands	Acres	352,251	61

Indicator	Attainment Category	Area (ac) by Attainment Category	% of Depressional	Conf. Level	L. Conf. Level (ac)	U. Conf Level (ac)
Invert. IBI	Good	200898	57.0%	95%	141527	260269
Invert. IBI	Fair	131279	37.3%	95%	84989	177568
Invert. IBI	Poor	8301	2.4%	95%	2541	14060
Invert. IBI	not assessed	11773	3.3%	95%	0	30348

Indicator	Attainment Category	Area (ac) by Attainment Category	% of Depressional	Conf. Level	L. Conf. Level (ac)	U. Conf Level (ac)
Plant IBI	Good	114225	32.4%	95%	67006	161445
Plant IBI	Fair	93279	26.5%	95%	47191	139366
Plant IBI	Poor	144747	41.1%	95%	95114	194380

Table III-4b. Wetland condition results from the Minnesota Wetland Status and Trends Monitoring Program for the Temperate Prairies Ecoregion (Omernick Level II)

State	Ecoregion	Cycle	Resource Assessed	Size Unit	Total Depressional Wetland Area (ac)	Total # of sites
MN	Temperate Prairies	1st - 2008	Depressional Wetlands	Acres	156,791	62
Indicator	Attainment Category	Area (ac) by Attainment Category	% of Depressional	Conf. Level	L. Conf. Level (ac)	U. Conf Level (ac)
Invert. IBI	Good	48374	30.9%	95%	29504	67244
Invert. IBI	Fair	38121	24.3%	95%	20398	55844
Invert. IBI	Poor	64972	41.4%	95%	42464	87480
Invert. IBI	not assessed	5324	3.4%	95%	0	14675
Indicator	Attainment Category	Area (ac) by Attainment Category	% of Depressional	Conf. Level	L. Conf. Level (ac)	U. Conf Level (ac)
Plant IBI	Good	30021	19.1%	95%	11818	48225
Plant IBI	Fair	15045	9.6%	95%	5136	24953
Plant IBI	Poor	106401	67.9%	95%	84289	128513
Plant IBI	not assessed	5324	3.4%	95%	0	14675

Depressional wetland condition assessment field work in 2008 focused on the TPE, sampling 62 wetlands to represent an estimated 156,791 Acs of depressional wetlands in the TPE. Similar to the MWP condition results, the assessment results for the TPE estimated wetlands in 'Good', 'Fair' and 'Poor' condition based on invertebrate and plant IBIs are provided in Table III-4b. This Ecoregion was dominated by 'Poor' quality wetlands, 41.4 percent and 67.9 percent as assessed by invertebrate and plant based IBIs, respectively. Results from the 2009 sampling of the Mix Wood Shield Ecoregion (MWS) are currently being analyzed and are expected to be completed by early Summer 2010.

Initiation of a state-wide survey to assess status and trends in wetland quantity and quality would likely not have been possible without support and WDP funding from USEPA. By implementing this survey, Minnesota is well positioned to continue to collect statistically valid data that will be invaluable in future wetland related management and policy decisions. In implementing this statewide survey, the MPCA expects to be able to meet its goal, set forth in the Agency 2008 Strategic Plan for Objective W2c) Beginning in 2010, evaluate the overall state-wide quality of Minnesota's wetlands using probabilistic surveys every three years to determine if wetland programs are meeting the goal of no net-loss of wetland quality and to assist the MDNR and the BWSR in their evaluation of wetland quantity.

C.5. Trends Analysis

C.5.1. Pollutant Trends for Minnesota Rivers and Streams

The best available information on pollutant trends in rivers and streams comes from Minnesota Milestone sites. These are a series of 80 monitoring sites across the state with high quality, long-term data, in some cases going back to the 1950's. While the sites are not necessarily representative of Minnesota's rivers and streams, as a whole they do provide a valuable historical record for many of the state's waters.

Statistical trends analysis for the Milestone sites, done in 2000, showed significant reductions across the state for BOD, TSS, P, ammonia and fecal coliform bacteria. These results reflect the considerable progress made during that time in controlling municipal and industrial point sources of pollution. NO_3-N levels, on the other hand, showed increases at many of the sites, perhaps reflecting continuing NPS problems. Appendix C.II. (Tables 1 and 2, pages 67 through 76) provides further detail.

More recently, trend analysis of stream water clarity data has been done using transparency-tube measurements collected by volunteers through the Citizen Stream Monitoring Program (CSMP). For streams with sufficient data, statistical analysis was performed using a linear-regression model. Of the 529 assessed stream sites, 134 of them exhibited a statistically significant improvement in transparency over time. In contrast, 69 exhibited a statistically significant decline in transparency. No clear WQ trend was exhibited in 326 of the assessed stream sites.

See http://www.pca.state.mn.us/water/csmp-reports.html for state-wide and site-specific CSMP annual reports.

Table III-5. Trends in Minnesota Stream Water Clarity

Description	Number of Streams
Assessed for Trends	529
Improving	134
Declining	69
No Clear Trend	326

See Appendix C.II. for additional information on Trends at Minnesota Milestone Sites.

C.5.2. WQ Trends for Minnesota Lakes

Detecting changes (trends) in WQ over time is a primary goal for many lake monitoring programs. Detecting trends requires many measurements each summer and several years' worth of data. Secchi transparency is a preferred parameter for monitoring WQ trends for many reasons: it is relatively low-cost, it is easily incorporated into volunteer monitoring programs, and it allows for the collection of a large number of samples in a given sampling period on many lakes. A variety of statistical tests can be used to perform trend analysis on historical Secchi readings. Kendall's tau-b is a statistical test that has been used in previous MPCA 305(b) reports to Congress (MPCA, 1990 and 1992) for assessing trends in Secchi transparency over time. In 2008, the Seasonal Kendall test was used to determine whether the historic Secchi data for each lake in Minnesota exhibited increasing or decreasing trends. All Secchi readings were assigned a 'season' based on their ecoregion. Medians were calculated for the readings in each season/year. The statistical software package Systat[U] then ran the Seasonal Kendall test on these medians. Only lakes with more than eight years of data were included in the trend analysis.

There were 1,201 lakes in Minnesota that met the minimum requirements for trend analysis in 2008. Of the 1,201 assessed lakes, 455 of them exhibited a statistically significant improvement in transparency over time. In contrast, only 231 lakes exhibited a statistically significant decline in transparency. Five hundred fifteen of the assessed lakes exhibited no clear WQ trend.

See http://www.pca.state.mn.us/water/clmpfactsheets.html for lake and county-specific trend information.

Table III-6. Trends in Minnesota Lake Water Quality

Description	Number of Lakes	Acres of Lakes
Assessed for Trends	1201	-
Improving	455	-
Declining	231	-
No Clear Trend	515	-

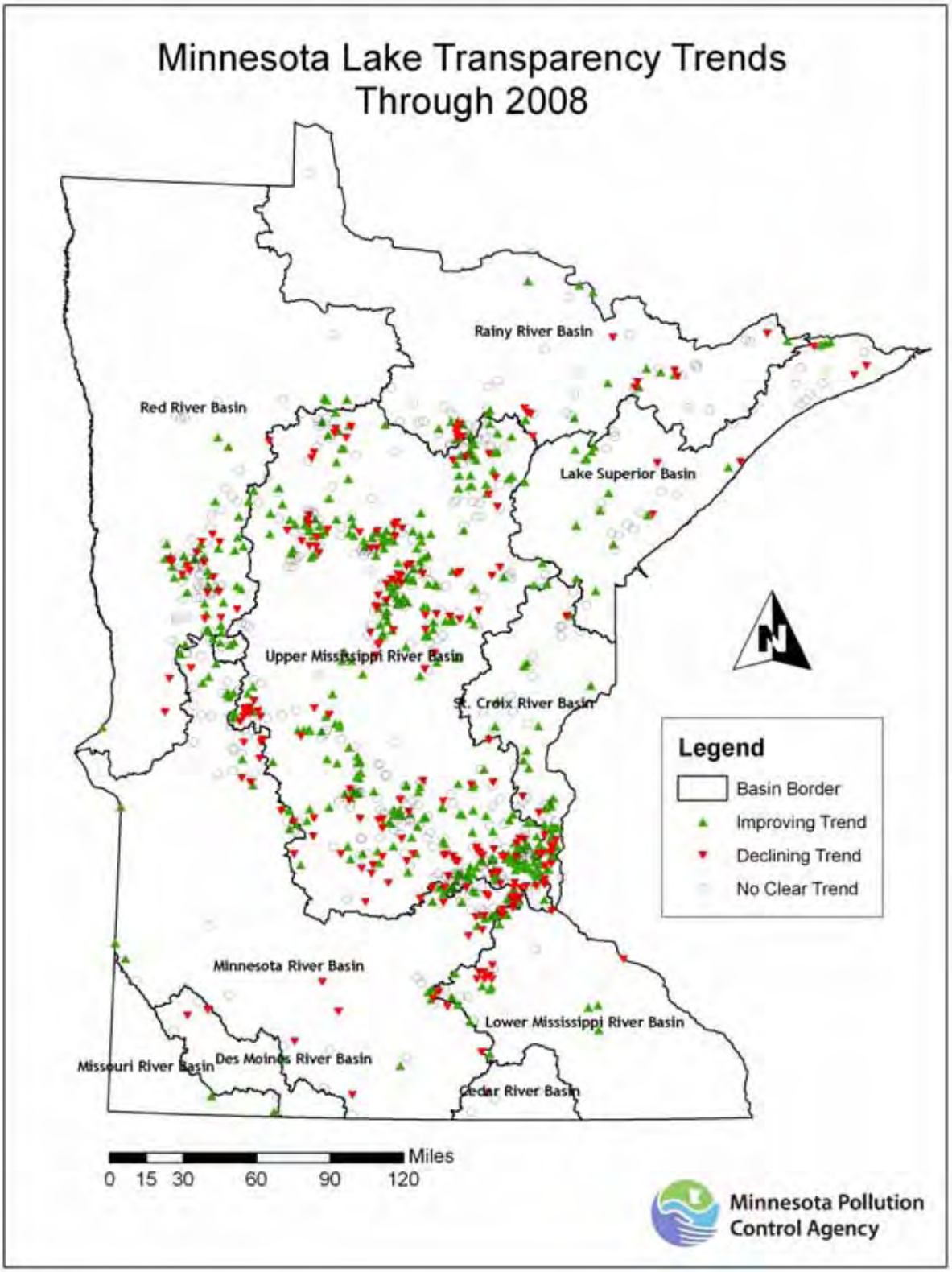

Minnesota Lake Transparency Trends
Through 2008
Rainy River Basin
Red River Basin
Lake Superior Basin
Upper Mississippi River Basin
St. Croix River Basin
Minnesota River Basin
Lower Mississippi River Basin
Missouri River Basin
Des Moines River Basin
Cedar River Basin
Legend
Basin Border
Improving Trend
Declining Trend
No Clear Trend
Miles
0 15 30 60 90 120
Minnesota Pollution Control Agency

Figure III-7

Part D. Groundwater Monitoring and Assessment

Groundwater monitoring policy and plans can be found in Appendices D.I. and D.II., pages 79 through 94.

Part E. Public Participation

In general, public participation is critical throughout Minnesota's TMDL process. Minnesota expects advisory groups to be involved from the earliest stages of the project. At a minimum, the USEPA requires that the public must be given an opportunity to review and comment on TMDLs before they are formally submitted to USEPA for approval. Every TMDL is formally public-noticed in Minnesota with a minimum 30-day comment period. See MPCA's Protocol for Lake TMDLs (page 57 of "Lake Nutrients" at http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesota-s-impaired-waters-and-tmdls/project-resources/tmdl-policy-and-guidance.html,) for more detailed information on the agency's public participation process for the development of TMDLs. In addition, the MPCA recently submitted a report to the Minnesota Legislature, 'Legislative Report on Civic Engagement in Total Maximum Daily Load (TMDL) Development, November 2009' (http://www.pca.state.mn.us/index.php/download-document/3919-civic-engagement-in-total-maximum-daily-load-tmdl-development.html) which outlines Minnesota's efforts to create an interactive planning tool for local government agencies to facilitate civic engagement in the TMDL development.

Finally, in addition to the TMDL development, the MPCA has an active public participation process during the development of biennial updates to the 303(d) List of Impaired Waters, including public meetings throughout the state on the draft List and a 30-day public comment period.

For the draft 2010 Impaired Waters List, the draft List was placed on the MPCA Web site in September 2009. The public was informed by a state-wide MPCA press release and letters to over 500 individuals and groups on the MPCA TMDL mailing list. Seven public meetings were held between September 28 and October 7, 2009. The 30-day formal public comment period was between October 19 and November 19, 2009.

A description of the public participation process and a copy of all letters, e-mails, etc. received from the public and a responsiveness summary was included along with the draft TMDL List sent to USEPA on April 1, 2010.

The draft 2010 TMDL List can be found on the MPCA Web site at:
http://www.pca.state.mn.us/water/tmdl/tmdl-303dlist.html

The final TMDL List is not included here but it will be added as Appendix C.IV. once USEPA provides MPCA with final approval.

Appendices

Appendix C.I.

Table 1. Current Minnesota Condition Monitoring Efforts

Activity Name Rivers and Streams	*Start*	*Monitoring Design/Description*	*Purpose*	*Indicators*
MPCA Major Watershed Intensive Stream Monitoring	2006	Progressive watershed design of sample collection at the outlet reaches of watersheds working upstream from (8-digit HUC) outlets. Indicators for aquatic life, recreation, and fish consumption. Use support collected at appropriate frequency and watershed tiers.	Assessing use support for aquatic life, aquatic recreation, and aquatic consumption in the context of hydrologic relationships within watersheds and to provide information for the completion of TMDL studies on impaired waters.	Composite index of fish and invertebrate community characteristics; DO, conductivity, pH, nutrients, turbidity, transparency, Escherichia Coli (E. coli) bacteria, qualitative habitat assessment, stream flow, and fish tissue.
Remote Sensing Lakes	2003	Statewide determination of lake clarity using satellite imagery that has been ground-truthed based on Citizen Lake Monitoring Program (CLMP) Secchi measures.	Determine clarity of lakes > 20 acres using Landsat. Used for 305(b) and for monitoring prioritization.	Lake transparency. Trophic state index.
MPCA Major Watershed Pollutant Load Monitoring (formerly called Basin Assessments)	2002	Statewide network of fixed stations at outlets of major watersheds (8-dig. HUC) with continuous flow monitoring and grab or continuous sampling for pollutant concentrations. Sampling frequency designed to capture flow-driven concentration variations to derive loadings. Finer scale monitoring is conducted as basin needs are defined and resources allow.	Assess condition of basin tributaries and main stem rivers. Used to identify trends and exceedances of standards. Also serves as effectiveness monitoring on a basin scale.	Nonpoint parameters: nutrients, TSS, BOD and fecal bacteria, and other region-specific concerns.
MPCA Integrated Basin-Scale Monitoring in Streams	1990	Statistically-based design with random site selection at the major river basin scale. Fish and benthic macroinvertebrate collections to score with IBI are made at each site, along with a quantitative habitat assessment and grab samples for basic WQ measurements. Field collection is completed statewide and resources will now be devoted to completing reports and the intensive watershed program.	Used for biocriteria development, trend monitoring, 305(b) and 303(d) assessments and reporting, evaluation of water quality permit limits, and evaluating WQSs.	Composite index of fish and invertebrate community characteristics; DO, conductivity, nutrients, turbidity, stream flow, bottom type, bank stability.

Activity Name Rivers and Streams	*Start*	*Monitoring Design/Description*	*Purpose*	*Indicators*
MPCA Milestone Monitoring	1953 (some sites)	Fixed station design with periodic grab sampling for a suite of conventional chemical/physical parameters. Samples collected monthly for ten months of the year, two years in each five year period. About 30 sites monitored each year on a rotating basin basis. Currently a total of 80 sites, 20 with flow, all with observations of water level.	Compare basic water chemistry to WQSs, looking at trends at a consistent set of sites.	DO, temperature, pH, nitrite/nitrate nitrogen, ammonia nitrogen, conductivity, turbidity, and E. coli bacteria. Added during open water months at all sites in 2007: TP, chl-a, pheophytin, 5-day BOD, residue, total non-filterable (TSS), and suspended volatile solids, with total Hg sampled three times per year.
MPCA River Nutrient Studies (w/USGS and DNR)	1999	Fixed station with periodic grab sample, physical/chemical parameters. Combined with USGS and DNR flow records. These indicators are now collected as part of Milestone and watershed intensive water chemistry sampling.	Data set used to provide basis for standards, nutrient criteria. Also used for research, model development.	Nutrients, chl-a and related data.
MPCA Trace Metals in Streams	1996	Stream monitoring with fixed station design collected on a rotating basin basis. Samples collected at locations to represent basin characteristics. Basin-focused measurement of metals in whole water and dissolved-phase of streams. Completion of sampling in all basins in 2009.	Used for water body assessments, including 305(b) use assessments and 303(d) listing, assist in the development of WQSs and effluent limits, and to estimate typical metal concentrations in surface waters of the basin.	Hg, As, cadmuium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), Zinc (Zn) and hardness in whole water and dissolved-phase of streams.
CSMP	1998	Self-selected volunteer effort, periodic sampling. Citizen monitoring of river water clarity using a transparency tube. Approximately 500 volunteers sample almost 800 stream locations.	Monitor the transparency of Minnesota rivers and streams for baseline conditions, goal setting, trend identification, targeting more intensive monitoring and as a surrogate for turbidity for 303(d) assessments in specific situations.	Transparency.

Activity Name Lakes	*Start*	*Monitoring Design/Description*	*Purpose*	*Indicators*
MPCA Intensive Study Lakes (with DNR and MDH)	Fish tissue sampling began in 1968	Collect predator fish and one-year-old panfish for mercury and other contaminants. About 100 lakes, monitored approximately every five years.	Identify trends in fish-tissue mercury concentrations. Also used for 305(b) and 303(d) assessments.	Hg.
MPCA Lake Trend Analysis	1985	Ecoregion-based monitoring design using fixed-station reference lakes. Lakes chosen based in part on CLMP trends.	Characterize trophic status for each ecoregion in Minnesota. Used to develop status and trend reports for Minnesota lakes, and also for 305(b) and 303(d) assessments. Used to develop WQ criteria for lakes.	pH, conductivity, SD, temperature (profile), DO (profile), TP, total Kjeldahl nitrogen, nitrate/nitrite nitrogen, residue, total non-filterable (TSS), alkalinity, chloride, color, turbidity, chl-a.
MPCA Lake Assessment Program (with local lake associations)	1985	Fixed station design; monthly sampling May-September. Collect nutrient, chl-a and related data at lakes. More than 200 studies since 1985.	Used to develop status and trend reports for Minnesota lakes and for 305(b) reporting. Also used to recommend actions for local lake management efforts.	SD transparency, nutrients, chl-a, solids, pH, color, plus a depth profile of oxygen and temperature. Fisheries and lake level measures provided by MDNR.
CLMP	1973	Self-selected volunteer effort, periodic sampling. Citizen monitoring of lake water clarity using SD. Approximately 1200 volunteers monitor approximately 1250 lakes. Limited chemistry at approximately 15 lakes/year.	Monitor the transparency of Minnesota lakes for baseline conditions, goal setting and targeting, and trend identification.	SD transparency, P, chl-a, DO and temperature profiles at approximately 15 lakes/year.
MPCA Short-term Special Studies	Varies	Lake, stream and biota studies to look at emerging issues (perfluorinated compounds, endocrine disrupting chemicals, wastewater compounds, etc.), other critical toxic pollutants (e.g., mercury) or special areas (Lake Superior streams). Designs vary based on the conditions studied.	Used to provide understanding of identified issues, advise citizens of potential exposures, guide regulatory efforts to address impairments.	Indicators vary depending on conditions being studied, e.g. fish tissue and water concentrations are used for perfluorinated compounds.

Table 2. Problem Investigation Monitoring Designs and Indicators

Activity Name	*Start*	*Description/Monitoring Design*	*Purpose*	*Indicators*
TMDL studies	1999	Monitoring associated with completing TMDL studies. Monitoring conducted by local groups and MPCA. Designs vary depending on parameter.	Develop TMDL allocations.	Fecal coliform, turbidity, DO, ammonia, chloride, pH, temperature, impaired biota, excess nutrients, mercury and PCBs in water, mercury and PCBs in fish tissue, various toxics in the St. Louis River.
Clean Water Partnership Phase I	1987	Locally-based monitoring projects, funded through MPCA. Flow-based monitoring of watershed inputs to a lake, river or wetland to determine loadings in areas of local concern.	Determine the major sources of WQS concerns develop goals and identify strategies for achieving goals. Provide input data for models.	Depends on project. Most common are those related to runoff – nutrients, nitrogen, P, sediment, flow and hydrological modifications.
Special studies	1998	Small, short-term projects providing needed timely information. Sites and designs vary by year.	To develop short-term, timely information needed for decision-making.	
Fishkill investigations and discharge violations	1950s	Case-specific monitoring designs, usually involving upstream and downstream sampling and sampling of candidate cause, if suspected. WQ and released material sample collection. Fish and wildlife collections made in conjunction with DNR and/or the U.S. Fish and Wildlife Service.	Incident response, WQ impact documentation and enforcement case development (supporting emergency response, NPDES and feedlot programs).	Case-specific parameters. For manure & wastewater releases: general chemistry (pH, conductivity, TSS, turbidity, chloride, sulfate, BOD5 [BOD5 for wastewater releases], nutrients, metals and E. coli bacteria). For industrial or releases of unknown origin: most of above plus more comprehensive metals, Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs) and pesticides. Others as case requires.
Waste Load Allocations to Support NPDES Program	1977	Monitor chemical or physical parameter of concern on selected streams and rivers receiving discharges from municipal wastewater treatment plants. Typically two, two to three day surveys under low-flow conditions. Approximately 100 surveys, 500+ stations.	Determine appropriate effluent limits for a discharge so that WQS are maintained and the designated uses protected. Effluent limits incorporated into NPDES permits.	Diurnal DO, temperature, pH, flow, time of travel, physical measure of stream channel, carbonaceous biochemical oxygen demand (CBOD), nutrients, chl-a, TSS, turbidity, conductivity, alkalinity, chloride, sometimes metals. Also composite sampling of wastewater effluent.
MPCA Lake Superior Beach Monitoring Project (with MDH, local organizations)	2003	Tiered monitoring at 39 Lake Superior beaches for bacteria.	Used to assure safe and healthy aquatic recreation and inform the public about risks of contracting waterborne diseases from exposure to contaminated water.	E. coli.

Table 3. Effectiveness Monitoring Designs

Activity	*Start*	*Description/Monitoring Design*	*Purpose*	*Indicator*
Stormwater Monitoring	2004	The Metropolitan Twin Cities urban monitoring group of regional management organizations and MPCA formed a working group in 2008 to improve monitoring methods, data reduction and storage and general assessment capabilities. Approximately 100 urban stream and stormwater sites are monitored each year.	To evaluate effectiveness of MPCA's stormwater permitting programs and BMP.	Flow and chemistry.
Monitoring associated with TMDL implementation plans	2003	Monitoring by local groups or MPCA to evaluate effectiveness. At a minimum, monitoring meets delisting guidance in MPCA's *Guidance for Assessing WQ Impairments*. In addition, monitoring design is customized, based on parameter or BMP implemented.	To assess effectiveness of TMDL implementation plan/BMP and ultimately to delist water body.	Dependent on impairment: Fecal coliform, turbidity, DO, ammonia, chloride, pH, temperature, impaired biota, excess nutrients, Hg and PCBs in water, Hg and PCBs in fish tissue, or various toxics in the St. Louis River.
NPDES effluent monitoring	1970s	Monitoring by permittees for parameters required in permits. Monitoring frequency varies by parameter and by size and type of facility, from continuous to a few samples per year. Includes tile-line discharge monitoring at NPDES feedlots.	Used for compliance determination, standards development and enforcement.	Parameters identified in individual permits. Typical parameters for domestic wastewater include: flow, CBOD, TSS, pH, P, DO, fecal coliform, chlorine residual. Typical for industrial include flow, TSS, temperature. May be additional parameters based on situation.
Up/down stream monitoring to support NPDES permit program	On-going	Approximately 110 permittees do this monitoring, at 270 stations. Monitoring design based on permit issues, frequency of sampling ranges from once per week to conditional monitoring during low-flow conditions.	Used to evaluate effluent limits for an NPDES permit, compliance determination, and requirement of variance process.	A number of parameters depending on situation (about 30 total for all permits). Typically includes DO, temperature, pH, ammonia, P.
Monitoring associated with feedlot regulatory activities		Case-specific monitoring design as part of enforcement case development.	To verify information for enforcement cases.	Fecal and BOD.
Monitoring associated with ISTS regulatory activities	1980s	Occasional monitoring at cluster systems or large, multi-party drainfield systems in shoreland areas. Fixed station design, periodic sampling. Part of State Disposal System permit.	Impact of system on lake or other water body.	P.

Activity	*Start*	*Description/Monitoring Design*	*Purpose*	*Indicator*
Monitoring to evaluate Clean Water Partnership implementation projects, Section 319 projects, etc.	Late 1980s	Locally-based projects, jointly funded through MPCA and external organization. Monitoring designs vary by project and BMP implemented. An example is the Whitewater River Watershed National Monitoring Project.[7]	To assess the effectiveness of NPS water-pollution-control efforts.	Depends on project. Most common are those related to runoff – nutrients, nitrogen, P, sediment, flow and hydrological modifications**.**
Basin Assessment	2002	See description under "Condition Monitoring."	To evaluate effectiveness of implementation projects at a basin scale.	See Condition Monitoring.
Monitoring to support Closed Landfill discharge between groundwater and surface water	1994	Monitor surface water points for closed landfills where groundwater discharges to a surface water body (river, wetland, lake). Monitoring frequency ranges from seasonal to annual.	Used to determine compliance with WQ rules for nonpoint discharge.	Primarily VOCs and metals.
Monitoring of stormwater and surface water bodies adjacent to permitted solid waste facilities	1990s	Designs vary by site. Monitoring may involve routine WQ sampling for stormwater ponds, wetlands, streams, rivers or other surface water features in the vicinity of solid waste facilities.	To evaluate effectiveness of storm-water BMPs.	Stormwater related contaminants: turbidity, specific conductance, etc. Occasionally also for inorganics.
MCES compliance monitoring	1994	Monthly sampling of leachate, gas condensate, and contaminated groundwater discharged to MCES. Seven metro-area landfills.	Used to determine compliance with MCES standards.	Metals, VOCs, SVOCs, PCBs and 2, 3, 7, 8 – TCDD.

[7] In *2002 Annual Report to the U.S. Environmental Protection Agency on Clean Water Act Section 319 and Clean Water Partnership Projects in Minnesota* (attached).

Appendix C.II.

Table 1. Pollutant Trends at Minnesota Milestone Sites

Basin	Station	Length of Record	Biochemical Oxygen Demand	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Unionized Ammonia	Fecal Coliforms
Cedar - Des Moines	CD-10	1967 - present	decrease	no trend	decrease	increase	decrease	decrease
	CD-24	1967 - present	decrease	no trend	decrease	no trend	decrease	no trend
	OK-25.6	1973 - present	decrease	insuf data	increase	increase	decrease	insuf data
	SR-1.2	1961 - present	decrease	decrease	no trend	increase	decrease	no trend
	WDM-3	1967 - present	no trend	no trend	decrease	increase	decrease	decrease
Lake Superior	BRU-0.4	1973 - present	decrease	insuf data	decrease	insuf data	insuf data	insuf data
	BV-4	1973 - present	no trend	decrease	decrease	no trend	increase	decrease
	KN-0.2	1973 - present	insuf data	decrease	decrease	increase	insuf data	decrease
	LE-0.2	1973 - present	insuf data	decrease	decrease	insuf data	insuf data	decrease
	POP-0	1973 - present	insuf data	insuf data	decrease	insuf data	increase	insuf data
	SLB-1	1974 - present	decrease	decrease	decrease	decrease	no trend	decrease
	SL-9	1953 - present	decrease	decrease	decrease	no trend	decrease	decrease
	SL-38	1953 - present	decrease	no trend	decrease	no trend	decrease	decrease
	SL-110	1967 - present	decrease	no trend	decrease	no trend	no trend	decrease
Minnesota	BE-0	1967 - present	decrease	no trend	decrease	increase	decrease	decrease
	CEC-23.2	1974 - present	decrease	no trend	decrease	increase	decrease	decrease
	CO-0.5	1967 - present	decrease	no trend	no trend	increase	decrease	decrease
	MI-3.5	1974 - present	decrease	no trend	no trend	no trend	decrease	no trend
	MI-64	1955 - present	decrease	no trend	decrease	no trend	decrease	decrease
	MI-88	1955 - present	decrease	no trend	decrease	no trend	decrease	decrease
	MI-133	1957 - present	decrease	no trend	decrease	increase	decrease	decrease
	MI-196	1967 - present	decrease	no trend	decrease	increase	decrease	decrease
	MI-212	1957 - present	insuf data	insuf data	insuf data	increase	decrease	insuf data
	PT-10	1971 - present	decrease	decrease	decrease	increase	decrease	decrease
	RWR-1	1974 - present	decrease	no trend	decrease	increase	decrease	no trend
	WA-6	1968 - present	decrease	no trend	decrease	increase	decrease	decrease
	YM-0.5	1967 - present	decrease	no trend	no trend	increase	decrease	decrease
Missouri	PC-1.5	1963 - present	decrease	no trend	decrease	increase	decrease	decrease

Table 1. Pollutant Trends at Minnesota Milestone Sites (Continued)

Basin	Station	Length of Record	Biochemical Oxygen Demand	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Unionized Ammonia	Fecal Coliforms
	RO-0	1962 - present	decrease	no trend	decrease	increase	decrease	no trend
Rainy	BF-0.5	1971 - present	insuf data	decrease	decrease	increase	insuf data	decrease
	KA-10	1967 - present	decrease	decrease	decrease	no trend	no trend	decrease
	LF-0.5	1971 - present	insuf data	insuf data	insuf data	increase	insuf data	decrease
	RA-12	1958 - present	decrease	decrease	decrease	increase	no trend	decrease
	RA-83	1953 - present	decrease	decrease	decrease	increase	no trend	decrease
	RA-86	1974 - present	decrease	decrease	decrease	increase	insuf data	insuf data
	RP-0.1	1971 - present	insuf data	decrease	decrease	increase	decrease	insuf data
	WR-1	1958 - present	insuf data	insuf data	decrease	increase	decrease	insuf data
Red	OT-1	1953 - present	decrease	no trend	decrease	increase	decrease	decrease
	OT-49	1967 - present	decrease	decrease	decrease	insuf data	decrease	decrease
	RE-298	1953 - present	decrease	no trend	no trend	increase	decrease	decrease
	RE-403	1967 - present	decrease	no trend	no trend	increase	no trend	decrease
	RE-452	1971 - present	no trend	increase	no trend	increase	decrease	decrease
	RE-536	1953 - present	no trend	no trend	no trend	increase	decrease	decrease
	RL-0.2	1953 - present	decrease	decrease	decrease	no trend	decrease	decrease
	RL-23	1955 - present	decrease	insuf data	decrease	insuf data	decrease	decrease
	SK-1.8	1971 - present	decrease	insuf data	insuf data	insuf data	decrease	insuf data
	TMB-19	1971 - present	decrease	insuf data	decrease	insuf data	decrease	decrease
St. Croix	KE-11	1967 - present	decrease	decrease	decrease	no trend	decrease	decrease
	SC-17	1967 - present	decrease	decrease	decrease	increase	no trend	decrease
	SC-23	1953 - present	decrease	decrease	decrease	insuf data	insuf data	decrease
	SC-111	1957 - present	decrease	decrease	decrease	no trend	no trend	decrease
	SN-10	1971 - present	decrease	decrease	decrease	insuf data	insuf data	decrease
	SUN-5	1974 - present	decrease	insuf data	insuf data	insuf data	increase	insuf data
Upper Miss -- Lower Portion	CA-13	1953 - present	decrease	decrease	decrease	no trend	decrease	decrease

Table 1. Pollutant Trends at Minnesota Milestone Sites (Continued)

Basin	Station	Length of Record	Biochemical Oxygen Demand	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Unionized Ammonia	Fecal Coliforms
	GB-4.5	1981 - present	decrease	no trend	no trend	increase	decrease	no trend
	RT-3	1958 - present	decrease	no trend	decrease	increase	decrease	decrease
	ST-18	1955 - present	decrease	no trend	decrease	no trend	decrease	decrease
	UM-698	1958 - present	decrease	no trend	decrease	increase	decrease	no trend
	UM-714	1962 - present	decrease	decrease	decrease	no trend	decrease	decrease
	UM-738	1974 - present	decrease	no trend	decrease	increase	decrease	no trend
Upper Miss -- Lower Portion (continued)	UM-815	1958 - present	decrease	no trend	decrease	increase	decrease	decrease
	UM-826	1975 - present	decrease	increase	decrease	increase	decrease	decrease
	UM-840	1973 - present	decrease	increase	no trend	increase	decrease	decrease
	VR-32.5	1981 - present	increase	decrease	no trend	increase	decrease	no trend
	WWR-26	1974 - present	decrease	no trend	no trend	increase	decrease	no trend
	ZSF-5.7	1973 - present	decrease	no trend	decrease	increase	decrease	no trend
Upper Miss -- Upper Portion	CR-0.2	1953 - present	decrease	no trend	no trend	increase	decrease	decrease
	LPR-3	1974 - present	no trend	no trend	no trend	increase	decrease	decrease
	RUM-0.6	1953 - present	decrease	decrease	decrease	insuf data	insuf data	decrease
	RUM-34	1955 - present	decrease	decrease	decrease	increase	decrease	decrease
	SA-0	1953 - present	no trend	no trend	no trend	no trend	decrease	decrease
	UM-859	1953 - present	decrease	no trend	decrease	increase	decrease	decrease
	UM-895	1976 - present	no trend	no trend	decrease	increase	decrease	no trend
	UM-914	1967 - present	decrease	no trend	no trend	increase	no trend	decrease
	UM-930	1953 - present	decrease	decrease	decrease	increase	decrease	no trend
	UM-982	1967 - present	decrease	no trend	decrease	increase	decrease	decrease
	UM-1172	1974 - present	decrease	no trend	decrease	increase	decrease	decrease
	UM-1186	1967 - present	decrease	decrease	decrease	increase	decrease	decrease
	UM-1292	1967 - present	decrease	decrease	decrease	increase	decrease	decrease
	UM-1365	1965 - present	decrease	decrease	decrease	increase	decrease	decrease

Table 1. Pollutant Trends at Minnesota Milestone Sites (Continued)

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

(Insufficient data means p>.05 and n<80)
((Logs of) TSS, TP, BOD, and fecal coliforms analyzed using Pearson's correlation coefficient and p values; NH_3 and NO_2/NO_3 analyzed using Kendall's Tau B and p values)
(Nov, Dec, Jan, and Feb data not used; NH3 data prior to 1979 not used)

Table 2. Trends at Minnesota Milestone Sites

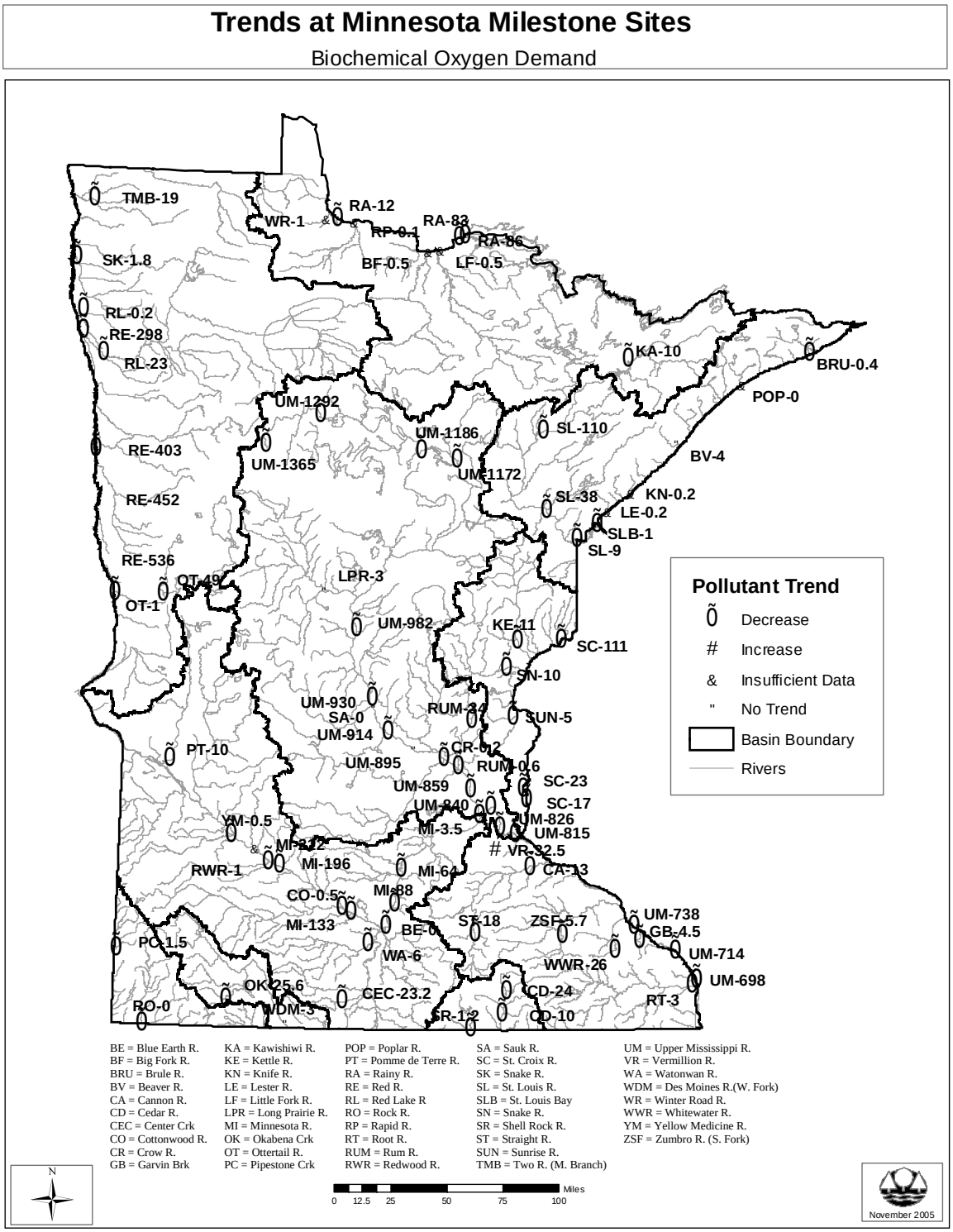


Table 2. Trends at Minnesota Milestone Sites (Continued)

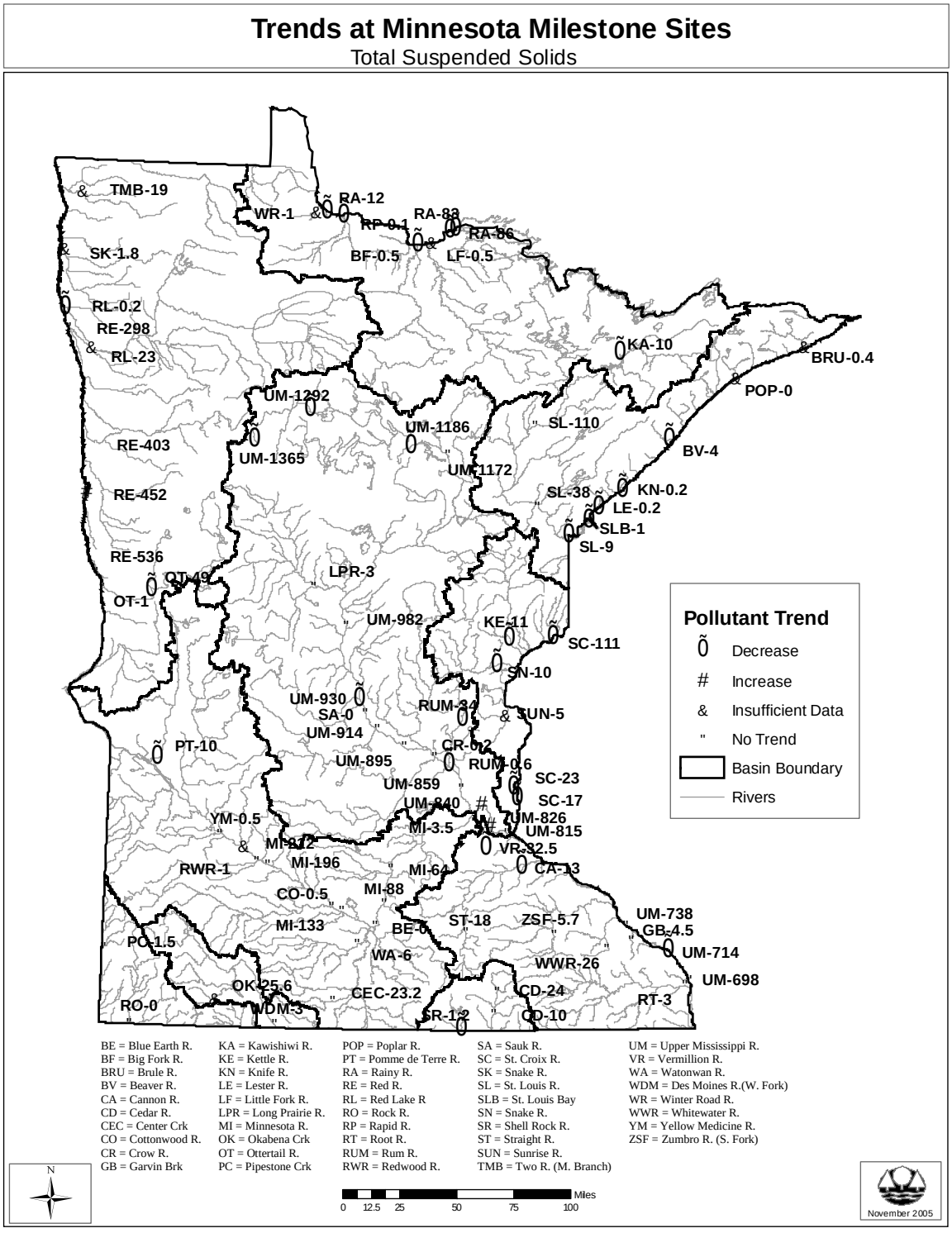


Table 2. Trends at Minnesota Milestone Sites (Continued)

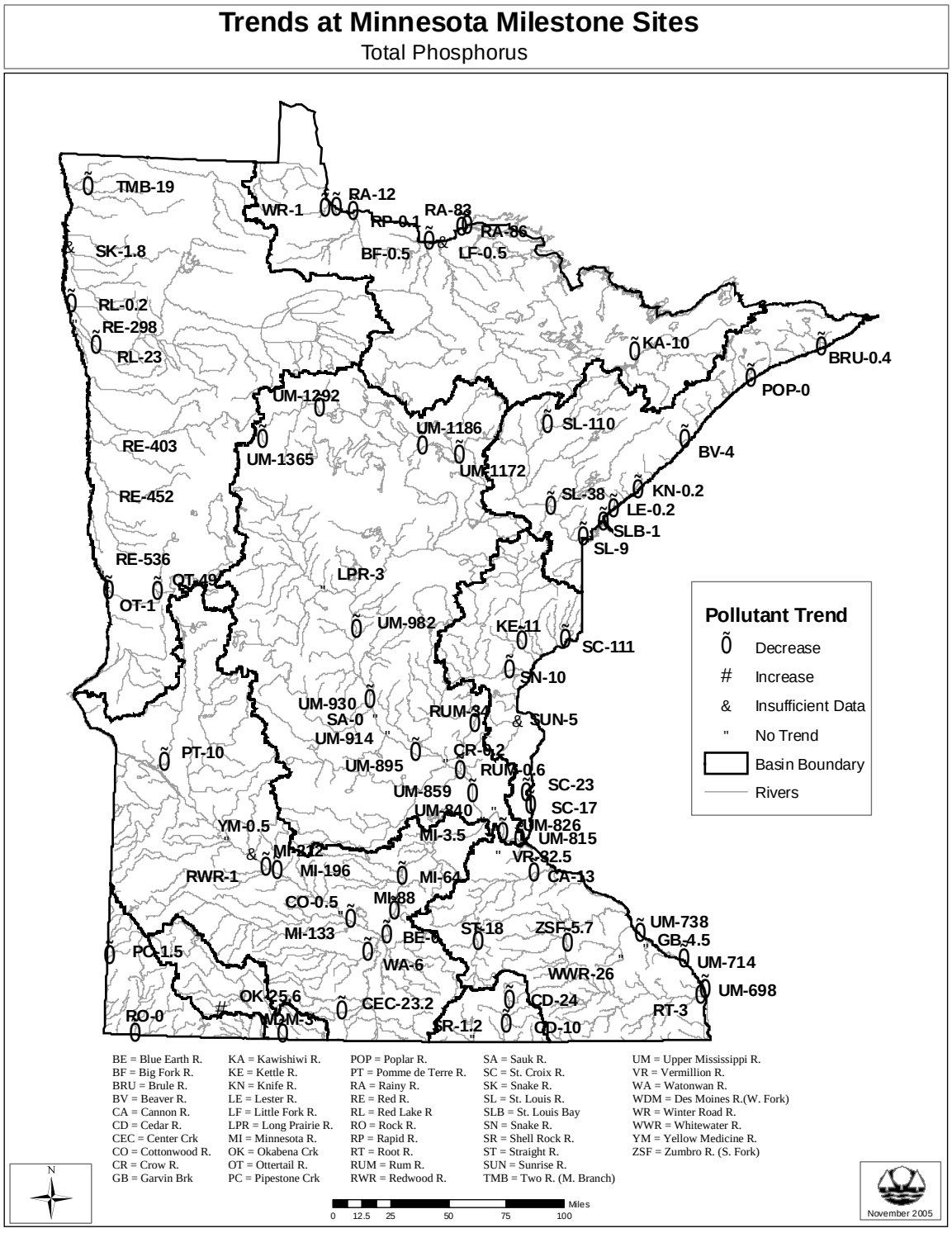


Table 2. Trends at Minnesota Milestone Sites (Continued)

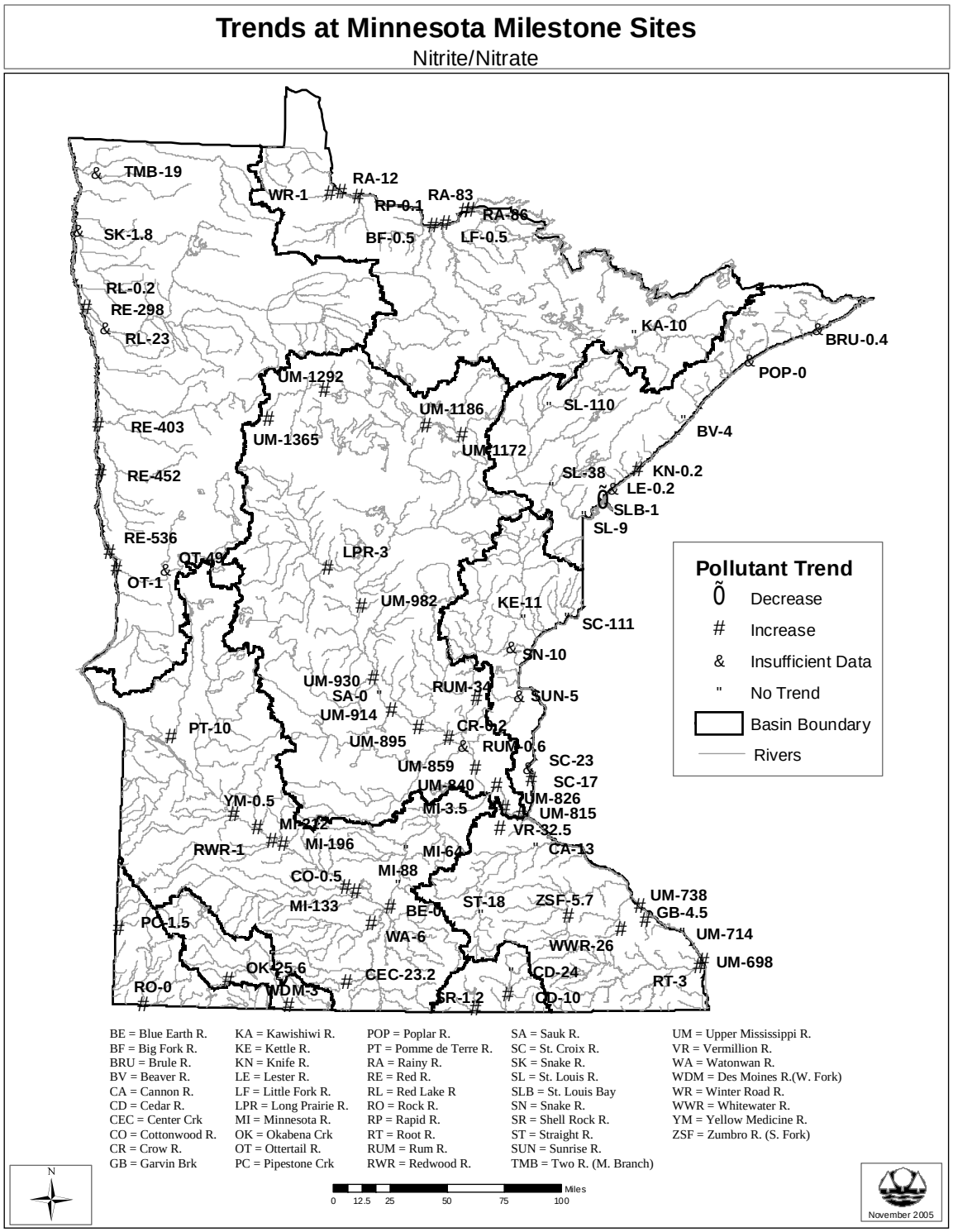


Table 2. Trends at Minnesota Milestone Sites (Continued)

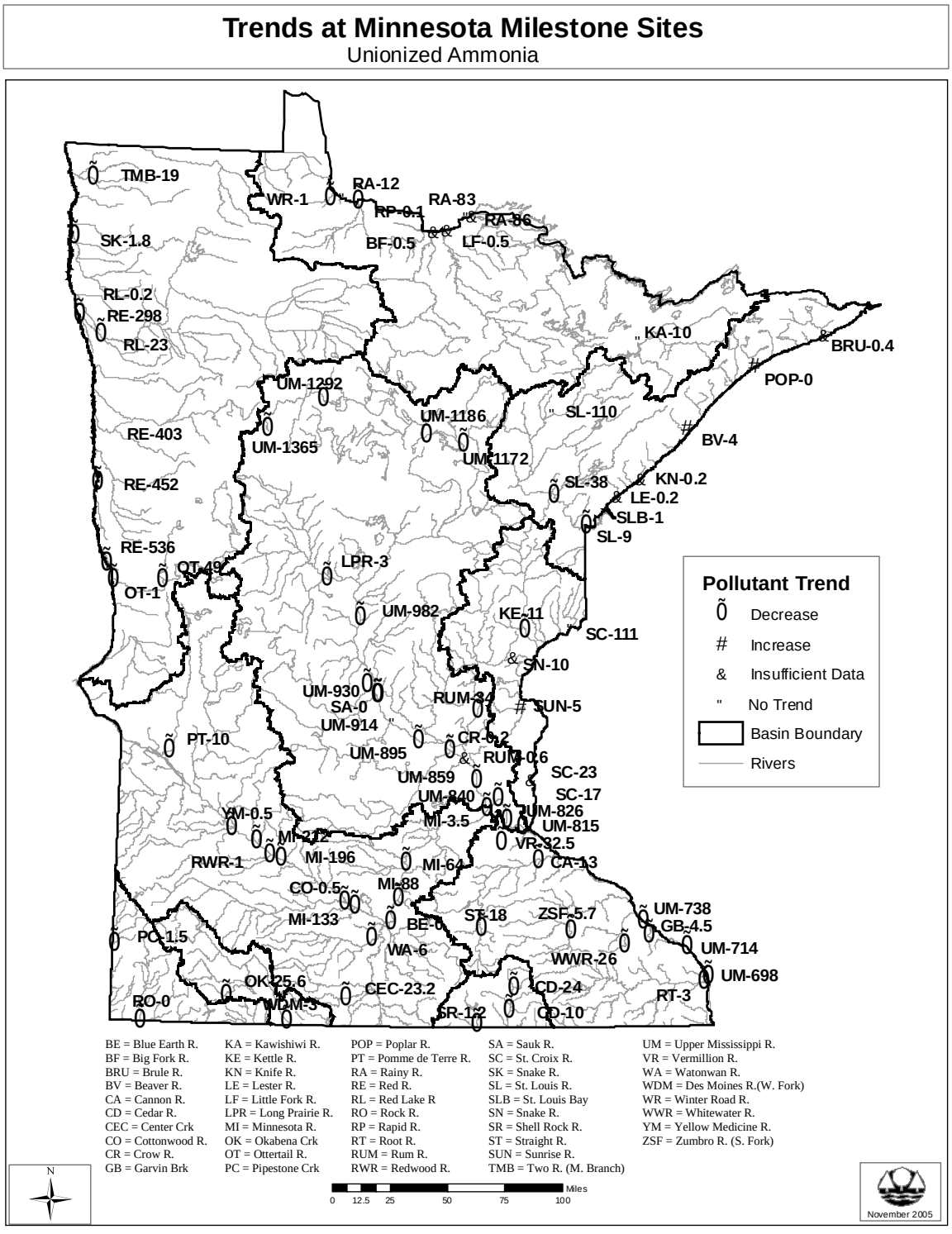
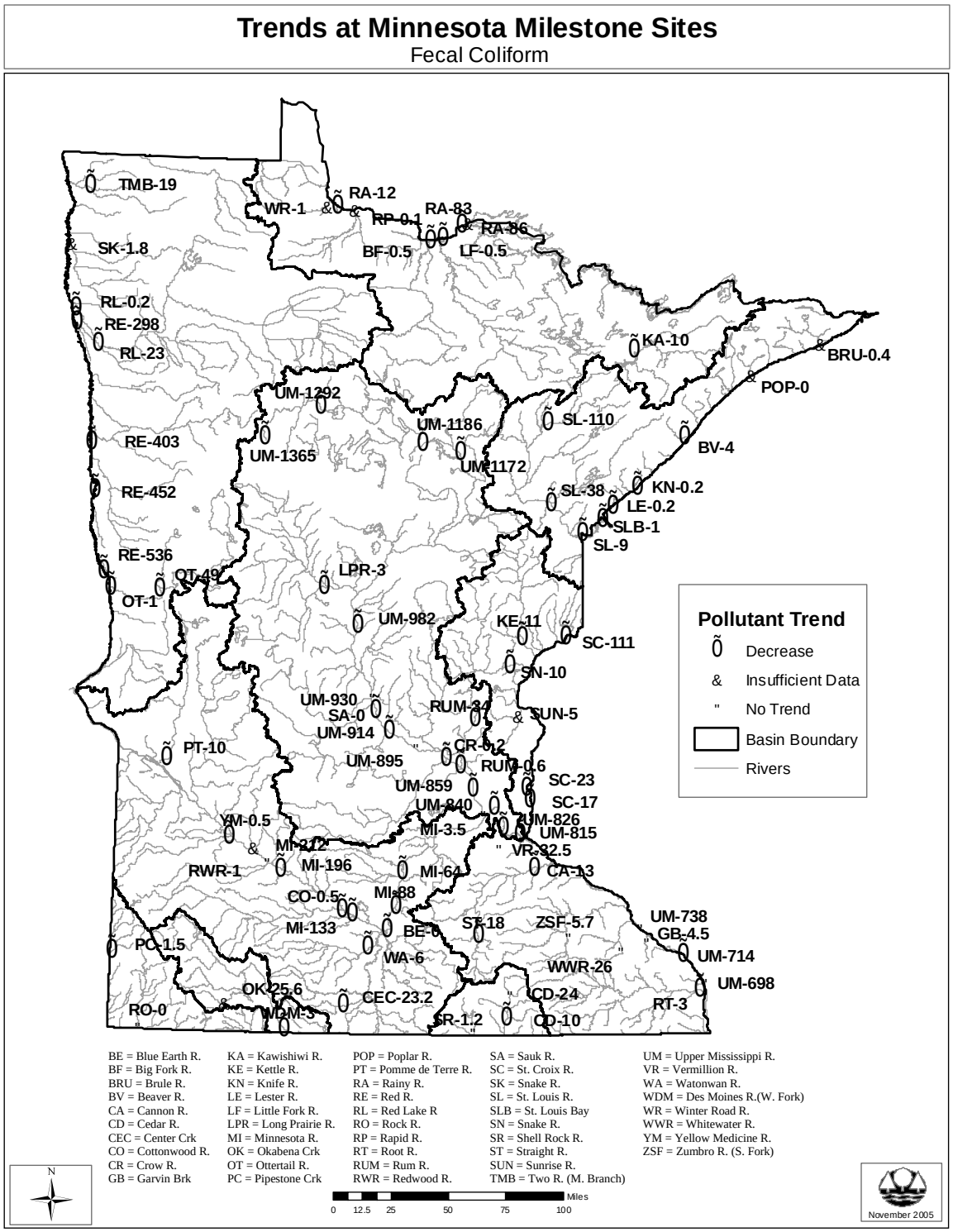


Table 2. Trends at Minnesota Milestone Sites (Continued)



Appendix C.III. Assessment Guidance

The MPCA will follow the Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List: 2010 Assessment Cycle found at the link below.

http://www.pca.state.mn.us/index.php/download-document/5967-guidance-manual-for-assessing-the-quality-of-minnesota-surface-waters.html

Appendix C.IV. Final 2010 Impaired Waters List

The MPCA will not have 'final' approval of the Impaired Waters list by USEPA in time to meet the IR's April 1, 2010, deadline. Subsequently, the list is not included here but will be added once USEPA provides MPCA with final approval.

http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesota-s-impaired-waters-and-tmdls/assessment-and-listing/303d-list-of-impaired-waters.html

Appendix D.I. 2008 Groundwater Monitoring Status Report

D.1. Introduction

The amended 1989 Groundwater Protection Act (GWPA) (Minnesota Statutes, Chapter 103H.175) required the Minnesota Pollution Control Agency (MPCA), in cooperation with other agencies participating in the monitoring of water resources, to provide a draft report on the status of groundwater monitoring to the Environmental Quality Board (EQB) for review in each even-numbered year. The EQB in turn was required by Minn. Stat. ch. 103A.43 to consider the information provided by the MPCA as it evaluates and reports to the House of Representatives and Senate committees with jurisdiction over the environment, natural resources and agriculture.

Beginning in 1994 and in succeeding even-numbered years through 2006, the MPCA has prepared a report to meet the statutory requirements of the GWPA. Reports have been submitted to the EQB and the Legislative Water Commission and, following its dissolution, to the Legislative Commission on Minnesota Resources (LCMR). This report fulfills the MPCA's 2008 GWPA reporting requirements.

D.2. Groundwater Monitoring and Assessment

The state provided a multiagency approach to monitor and assess groundwater due to the wide range of technical expertise required to evaluate the resource. Not all agencies have roles or responsibilities in all areas, but they work together to provide a coordinated approach to groundwater monitoring and protection in Minnesota.

D.2.1. Roles of the State and Federal Water Agencies

Several state agencies and a federal earth science agency have a role or responsibility in monitoring, protecting, and evaluating Minnesota's groundwater resources. Eight state agencies and the Metropolitan Council, a regional planning agency for the Twin Cities Metropolitan Area (TCMA), have a part in various aspects of groundwater monitoring and protection, including ensuring safe drinking water supplies from groundwater sources; statewide, regional, and site-specific monitoring and assessment; developing standards or regulations; providing geologic and hydrogeologic information on the state's aquifers; and developing state groundwater policy and priorities (table 1). State groundwater resource planning and water quality assessments are coordinated and evaluated by the EQB as directed by Minnesota Statutes, Sections 103A.43 and 103B.151. The U.S. Geological Survey (a federal earth science agency with an office in Mounds View, Minnesota) works cooperatively with state, local, and tribal governments to provide impartial information on the state's groundwater resources.

Monitoring to determine statewide ambient groundwater quality conditions is jointly conducted by the MPCA, Minnesota Department of Agriculture (MDA), and Minnesota Department of Health (MDH). These three agencies collect and use monitoring data to provide information necessary to assess, and ultimately protect or restore, the quality of Minnesota's groundwater resources. A 2004 MOA between the MPCA, MDA, and MDH clarified the agencies' respective roles (as specified in state statute) in operating a statewide integrated ground-water-quality monitoring system.

The agencies' different roles in the integrated groundwater quality monitoring system are based on their individual state and federal authorities and requirements. As part of the agreement, the MPCA is responsible for monitoring non-agricultural contaminants in the state's groundwater, and the MDA is responsible for monitoring agricultural chemicals such as pesticides and fertilizers. Monitoring by the MDH focuses on groundwater used as public water for either public or private water supplies to ensure contaminants are below concentrations which present a threat to human health. To ensure efficiencies in the system, the MOA establishes interagency cooperation in shared monitoring design, sample collection, sampling location selection, evaluation of sensitive areas, and data management. Additionally, the MOA provides for an annual review of the groundwater quality monitoring system to allow for modifications. A five-year evaluation in 2009 is stipulated, at which time the agreement will be updated.

D.2.2. Water Quality Monitoring and Assessment

Groundwater quality monitoring in Minnesota was conducted as part of National, Statewide, multi-county, and site-specific efforts from 2006-2008. National ground-water-quality monitoring was conducted by the U.S. Geological Survey (USGS) as part of the National Water Quality Assessment (NAWQA). This assessment evaluated water quality conditions in 19 aquifers across the U.S which accounted for 75 percent of groundwater withdrawls for potable use. Assessments focused on issues of concern within a particular aquifer and addressed one or more general issues. Statewide ambient ground-water-quality monitoring networks sampled a greater number of wells in the state compared to National efforts, and these networks continued to be conducted cooperatively by the MPCA, Minnesota Department of Agriculture (MDA), and Minnesota Department of Health (MDH) through the 2004 MOA. Two multi-county assessments of ground-water-quality conditions were initiated, including citizen volunteer monitoring of nitrate concentrations in southeastern Minnesota and a reconnaissance of perfluorochemicals in the State's ambient groundwater. A considerable amount of ground-water monitoring in the state continued to assess known contaminant spills. Site specific monitoring was performed by the MPCA and MDA, and the MDH assessed public health impacts at some of these locations.

D.2.2.1. National Water Quality Monitoring

The USGS monitored the water-quality of two heavily used aquifers of interest in Minnesota as part of the NAWQA-- the glacial deposit aquifers (commonly referred to as the surficial aquifer within the State) and the Cambrian-Ordovician aquifer system. The Cambrian-Ordovician aquifer system is a complex multiaquifer system with individual aquifers separated by leaking confining units. The Prairie du Chien-Jordan was the aquifer assessed within this system in Minnesota (Fong et al, 1998). Approximately 90 wells from the surficial and Prairie du Chien-Jordan aquifers were sampled in Minnesota from 2006-2007 to determine concentrations of a wide variety of naturally-occurring and anthropogenic contaminants. Two USGS reports also were released during this timeframe describing the occurrence and distribution of arsenic, uranium, and radon in the glacial deposit aquifers throughout the Nation (Ayotte et al, 2007; Thomas, 2007).

D.2.2.2. Statewide Water Quality Monitoring

The MPCA's Statewide ambient water quality monitoring continued to focus on assessing water-quality conditions underlying non-agricultural areas according to the joint interagency plan. Approximately 275 wells representing conditions underlying non-agricultural areas were sampled in 2006 and 2007. About 25 percent of these wells were located in the shallow part of the surficial aquifer, and the remainder was located in deeper parts of the surficial or Paleozoic aquifers. Water samples generally were collected once each year to determine nitrate, chloride, or volatile organic compound (VOC) concentrations.

The MDA continued to assess ambient water quality conditions underlying agricultural areas throughout the state according to the MOA. The primary focus of this effort is to determine the presence and distribution of pesticides in groundwater considered susceptible to contamination, typically the upper part of the surficial aquifer system (Minnesota Department of Agriculture, 2007). The MDA's monitoring network consisted of 85 shallow monitoring wells located in the central sand plains and approximately 50 wells located in agricultural areas outside of the central sand plains. Approximately 10-15 springs were sampled in the southeastern part of the state in lieu of wells since springs integrate water-quality conditions in karstic areas (Katz et al, 1999). Eight additional monitoring wells were installed for the network during this period, mainly in areas north of the Twin Cities metropolitan area and outside of the central sand plains.

The MDH water-quality monitoring efforts continued to focus on assessing public water supplies, which often utilize groundwater. The MDH sampled the quality of finished drinking water in cooperation with the State's public water supply systems to determine contaminant concentrations as part of the Safe Drinking Water Act regulations. Private drinking water wells were not assessed as part of this effort; however, the MDH reviewed nitrate and coliform bacteria data collected by well drillers from newly-installed drinking water wells to determine the potability of the water. Investigative monitoring also was conducted to assist public water suppliers in finding wells with lower concentrations of arsenic, radionuclides, and nitrate. In addition, the MDH measured tritium values in

selected groundwater wells to identify locations with recently-recharged groundwater which are very susceptible to contamination. The MDH also administered the State's wellhead protection program which was designed to protect sources of groundwater from contamination. States were required to have wellhead protection programs under the provisions of the federal Safe Drinking Water Act.

The information collected by the MPCA, MDA, and MDH, as well as results from National and local monitoring efforts, were integrated in a report published by the MPCA in 2007 (O'Dell, 2007). The report indicated elevated concentrations of chloride, nitrate, and VOCs were common beneath urban areas. Nitrate concentrations frequently exceeded standards set for drinking water in the shallow groundwater underlying agricultural areas. Pesticides and their degradates also were commonly detected in the shallow groundwater underlying agricultural areas; however, concentrations generally were less than applicable drinking water standards. Information on water quality trends generally was not reported because of insufficient available data to conduct most of these analyses.

D.2.2.3. Regional Water Quality Monitoring

A citizen volunteer monitoring network was implemented in southeastern Minnesota in 2008 to assess the occurrence of nitrate in drinking water supplies, which primarily utilize groundwater sources. The network was developed by the Southeast Minnesota Water Resources Board, MDA, MDH, and MPCA to assess the practicality of establishing a cost-effective, locally driven means of obtaining long-term data on nitrate concentrations in private drinking water supplies and implemented in nine counties. In each of the participating counties, approximately 50 - 100 citizen volunteers were recruited and trained to collect nitrate samples. A total of approximately 600 private drinking water wells were monitored to determine the impact well construction and local land use have on drinking water quality, and describe the regional distribution of nitrate concentrations and any temporal trends. Data collected from this network will allow counties to: 1) evaluate the feasibility of continued citizen volunteer monitoring of groundwater, 2) determine the efficacy of their water quality protection programs, 3) identify emerging trends in nitrate concentrations, and 4) target water management resources for program implementation.

The MDH and MPCA continued to assess the occurrence and distribution of perfluorinated chemicals (PFCs) in the groundwater. PFCs, such as PFOS, PFOA, and PFBA, are manmade chemicals used since the 1950s to manufacture industrial and consumer products which are heat and stain resistant and water repellant. The MDH continued monitoring public and private water supply wells in southern Washington and eastern Dakota Counties for these chemicals to assess public health impacts. The MPCA assessed the occurrence and distribution of perfluorinated chemicals (PFCs) in the ambient groundwater in 2006 and 2007 as part of its ongoing investigation of the fate of these chemicals in the environment. Water samples were collected from 17 shallow monitoring wells during fall 2006 and analyzed for 13 PFCs. One or more PFCs were detected at or above the reporting limit of 25 ng/L at nine of the 17 sample

locations. PFBA was the most commonly detected compound, and usually was detected at the highest concentration (30 - 922 ng/L). PFCs typically were detected in well water samples collected in the Twin Cities metropolitan area, and all concentrations were below MDH drinking water guidance levels. Ambient groundwater samples collected in the Twin Cities metropolitan area in November 2007 had similar or lower PFC concentrations. Fifteen monitoring wells and 3 springs in agricultural areas of the state were sampled for PFCs in October 2007 in cooperation with the MDA. PFBA was the only PFC detected in agricultural areas at a reporting limit of 25 ng/L and was detected at two of the 18 sites at concentrations ranging from 32 to 62 ng/L.

The Minnesota Department of Natural Resources (DNR) conducted groundwater quality sampling in selected counties. This monitoring was done to determine the natural water quality in selected wells to support groundwater sensitivity mapping done as part of the county geologic atlases and regional hydrogeologic assessments. These assessments were completed in cooperation with the Minnesota Geological Survey (MGS). Approximately 80 wells were sampled in each investigated county to determine major ion and trace element concentrations and tritium values. Data were published from Pope and Crow Wing counties in 2006 and 2007.

D.2.2.4. Site-Specific Monitoring

A large amount of groundwater quality information continued to be collected as part of investigations at contaminant spill or release sites. The MPCA has collected data at approximately 19,000 sites as part of remediation efforts or facility permits, including petroleum product spill sites, hazardous waste sites, landfills, or abandoned industrial and commercial properties. Petroleum product spill sites were assessed most frequently. The most common constituents measured at remediation sites were volatile organic compounds, and major and trace inorganic elements. MDA site specific monitoring activities focused on fertilizer and pesticide spill sites. The MDH also collected data at some hazardous waste sites to assess potential health risks. Results of these assessments reported in public health assessments or health consultations, which are available online at: http://www.health.state.mn.us/divs/eh/hazardous/sites/index.html

D.2.3. Groundwater Level/Flow Assessment

The Minnesota Department of Natural Resources (DNR) continued to maintain a groundwater level monitoring network across the state. There were approximately 750 wells in the network. The collected data were used to assess groundwater resources, determine long term trends in water levels, interpret impacts of pumping and climate, plan for water conservation, and evaluate water conflicts. Water level readings were measured monthly in cooperation with soil and water conservation districts or other local units of government. Site specific monitoring is required of 123 permittees. An ongoing water supply planning effort is guiding establishment or improvement of monitoring plans for all public water suppliers. Over 650 communities in the state have public water supply systems, and 320 of these are currently involved in the planning effort.

The Metropolitan Council constructed a groundwater flow model of aquifers within the TCMA with the cooperation of the Barr Engineering Company, a technical workgroup, and other stakeholders. The model simulated all major aquifers underlying the TCMA, including the glacial drift or recent alluvium, St. Peter, Prairie du Chien Group, Jordan, St. Lawrence, Upper Franconia, Ironton-Galesville, Eau Claire, and Mount Simon-Hinckley. The model was designed to determine: 1) the maximum pumping capacity of a proposed wellfield, 2) the drawdown from a proposed wellfield and if any existing wells may be impacted, 3) future groundwater levels, 4) the effect of pumpage on ecological resources such as trout streams and calcareous fens, and 5) the effect of land use on recharge and groundwater levels.

The USGS measured groundwater levels in three principal aquifers within the TCMA in cooperation with the DNR, MPCA, and Metropolitan Council. Water levels have declined in these aquifers since the 1880's due to increased groundwater withdrawls. This effort fills a gap in water level data collection within in the TCMA which has seriously limited the development of potentiometric surface maps and accurate modeling. Water levels were measured once in March and August 2008 in the Prairie du Chien-Jordan, Franconia-Ironton-Galesville, and Mount Simon-Hinckley aquifers. The report is expected by the end of 2008.

D.3. Current and Emerging Issues

Many of the groundwater issues identified in previous reports were still relevant from 2006-2008, such as nitrate and pesticide contamination in selected areas. A few new emerging issues also were identified during this time period, such as the infiltration of stormwater-related contaminants to the groundwater and the occurrence of pharmaceuticals and other personal care products in groundwater.

D.3.1. Groundwater Quality

D.3.1.1. Nitrate

Nitrate contamination of groundwater continued to be a substantial issue within the State. Several Minnesota communities, including Mankato, St. Peter, Perham, and Hastings, had municipal water supplies impacted by nitrate contamination (O'Dell, 2007). Statewide assessments of groundwater quality during the 1990's have shown increased nitrate concentrations in southeastern, southwestern, and central Minnesota (Minnesota Pollution Control Agency and Minnesota Department of Agriculture, 1991). Studies conducted by the MPCA and USGS in the late 1990s showed nitrate concentrations in groundwater varied with land use (Trojan et al, 2003; Fong, 2000). Land uses which may result in nitrate concentrations exceeding health risk limits set by the MDH included irrigated row crop agriculture, residential development on small lots served by individual sewage treatment (septic) systems, and new residential developments on previously farmed land.

Current Monitoring Status
Nitrate continued to be widely monitored in the State's groundwater. Networks that measured nitrate concentrations included the ambient groundwater monitoring networks of the MDA and MPCA, USGS NAWQA, and the southeastern Minnesota citizen volunteer monitoring network. The MPCA, MDH, and USGS networks also continued to collect nitrate concentration data which can be used to identify any temporal trends. Nitrate concentration data were collected by the MPCA annually at approximately 100 wells from 2006-2008, and about 15 of these wells had been sampled since 2004. The MDA sampled approximately 85 wells on quarterly basis in the central sand plains since 2000, and the USGS has monitored selected wells since 1995 as part of the NAWQA.

D.3.1.2. Infiltration of Road Salt and Other Stormwater-Related Contaminants

Stormwater infiltration practices are becoming more common as more attention is being directed to developing stormwater volume controls to reduce both the rate and volume of runoff to urban water bodies. Typical infiltration practices (e.g, rain gardens, infiltration basins/trenches, porous pavements, constructed wetlands) can infiltrate effectively but are also prone to rapid loss of permeability if not runoff is not pretreated to remove suspended sediment burdens. There is the potential for contaminant introduction into the groundwater from improperly sited, designed, operated and maintained systems. Hence, the Minnesota Stormwater Steering Committee and its Research and Monitoring Committee have been working with cities and the University of Minnesota to better define risks.

Current Monitoring Status
The MPCA is working with municipalities and other partners via two contracts (one with state funding and a newly awarded 319 federal grant) with the University of Minnesota to define potential risks and applied management practices that can be used to minimize groundwater pollution risks from stormwater. Several associated partnered studies are also underway with the University of Minnesota's St. Anthony Falls Laboratory pertaining to trout stream infiltration (Vermillion River and Miller Creek), contamination by road salt deicers and stormwater best management practices operation and maintenance conducted by municipalities. The University of Minnesota, is also assessing the fate and transport of stormwater-associated contaminants in the groundwater using a combination of laboratory experiments, a regional groundwater model of the TCMA and a more detailed model to assess potential risks to wellhead protection zones.

The USGS in cooperation with the Metropolitan Council assessed the groundwater quality underlying selected rain gardens in the TCMA (Tornes, 2005). Selected constituents expected to be present in stormwater, including nitrate, chloride, and trace elements, were monitored by the MPCA's ambient groundwater monitoring network from 2006-2008. Trace elements only were analyzed from samples collected from approximately 15 shallow wells in 2007.

D.3.1.3. Perfluorochemicals in the Groundwater in Southern Washington County

Perfluorochemicals were first measured in drinking water supplies in the eastern TCMA in 2004. Most of the known contamination was traced to several landfills and dumps that are located in southern Washington County. Although predicting the transport of these contaminants is difficult in a karsted aquifer system, the contaminant levels appear to remain constant over time.

Current Monitoring Status
The MPCA and MDH continued to monitor the groundwater to determine PFC concentrations. Groundwater samples collected in the vicinity of active and closed landfills that may have accepted PFC waste were analyzed to determine PFC concentrations. More than 1,700 private and municipal drinking water wells have been assessed for PFCs in the eastern TCMA. The MPCA also monitored the ambient groundwater for PFCs from 2006-2007 as described in section D.2.2.3. of this report.

D.3.1.4. Pesticides and Their Degradates in Groundwater

Several studies have documented contamination from pesticides and pesticide degradates within the State. The MDH and MDA detected commonly-used herbicides in the groundwater underlying agricultural land use on areas considered susceptible to contamination (Minnesota Department of Agriculture and Minnesota Department of Health, 1985; Klaseus and Hines, 1989). Assessments using data collected by the MDA and USGS indicated pesticides or pesticide degradates were detected in the shallow groundwater underlying agricultural (O'Dell, 2007; Ruhl et al, 2000) and urban-residential land uses (Andrews et al, 1998).

Current Monitoring Status
The MDA continued to monitor the state's groundwater to determine pesticide and pesticide degradates concentrations. Approximately 150 wells and springs were sampled as part of this effort in 2006-2007. Well water samples were analyzed for a suite of approximately 50 pesticides and pesticide degradates. The MDA, in cooperation with the MPCA, collected samples for pesticides and pesticide degradates at approximately 40 wells located in urban areas in 2006-2007. The USGS also continued to analyze samples from selected wells for a wide suite of pesticides and pesticide degradates through the NAWQA.

D.3.1.5. Pharmaceuticals and Personal Care Products

Pharmaceuticals and personal care products include synthetic hormones, over-the-counter and prescription medication, and ingredients found in cosmetics, toiletries, detergents, and cleaning products. Some of these compounds were identified as endocrine-disrupting compounds, and prenatal exposure to natural and synthetic hormones was associated with increased occurrence of tumors in humans and animals. Sources of pharmaceuticals and personal care products to groundwater include wastewater treatment plant effluent discharged to land, septic waste, confined animal feeding operations, and landfill leachate.

Current Monitoring Status
The USGS determined the occurrence of pharmaceuticals, antibiotics, and household, industrial, and agricultural use compounds and sterols at selected groundwater wells from 2002-2004 (Lee et al, 2004). Wells sampled for this study were selected based on proximity to contaminant sources and surrounding land-use characteristics. A total of 31 compounds were detected in the ground-water samples. The greatest number of contaminants was detected in two wells installed to characterize the water-quality underlying a waste dump. This study sampled a small number of wells, making it difficult to extrapolate the results across Minnesota.

D.3.1.6 Naturally Occurring Contaminants

Arsenic and radium are naturally-occurring carcinogens found throughout Minnesota. Arsenic is most commonly found in the northwestern and west central parts of the state, and radium is found in southern and central Minnesota. The federal drinking water standard for arsenic was lowered from 50 parts per billion (ppb) to 10 ppb in 2005. This change resulted in violations for approximately 20 community public water systems. Many of these suppliers have or will be installing arsenic treatment systems, interconnections to other public water suppliers, or new wells with lower arsenic concentrations. In addition, the standard for radium was set at 5.4 picoCuries/liter, resulting in a total of approximately 40 violations.

Current Monitoring Status
All community public water supply systems were monitored on a routine basis for radium and all community and noncommunity nontransient public water supply systems were monitored on a routine basis for arsenic as part of the Safe Drinking Water Act. The revision to Minn. R. ch. 4725 required all new drinking water supply wells be sampled for arsenic. The MDH also participated with the MDA in nitrate clinics that also offered free arsenic analyses. As monitoring data becomes available, the extent and magnitude of arsenic and radium in Minnesota aquifers will be better understood. Where feasible, these data will assist some public water suppliers with installing new wells in aquifers with less arsenic or radium, therefore reducing treatment costs.

D.3.1.7. Volatile Organic Compounds

Over the past 20 years, MPCA's remediation programs including the petroleum remediation, Superfund, and voluntary investigation and cleanup programs, have addressed contamination from VOCs at thousands of chemical release sites. Assuming these programs addressed the major sources of VOC contamination to soil and groundwater and there are no further VOC inputs to groundwater, concentrations of VOCs in urban groundwater should gradually decrease with time.

Current Monitoring Status
Sampling for VOCs at individual chemical release sites is conducted through the MPCA's remediation programs. Monitoring generally was conducted by a state contractor or by a responsible party, and involved either investigating known contamination problems or measuring the effectiveness of remediation or containment measures. The MPCA's ambient groundwater monitoring program included VOC analyses, and the data will be examined to determine long-term trends in groundwater underlying urban areas. The USGS continued to collect VOC data through the NAWQA.

D.3.2. Groundwater Level/Flow

There was a renewed interest in understanding groundwater quantity and flow issues within Minnesota. This interest was partly due to the increase in the construction of biofuel-producing facilities and concerns regarding groundwater resource limitations. Although the biofuel manufacturing processes have improved rapidly in recent years, most facilities still required three to four gallons of water per gallon of fuel produced, and much of this demand to date was provided by groundwater. In addition, many of the plants were located in the southwestern part of the state where groundwater resources were less plentiful.

Current Monitoring Status
Water level measurements in wells are required for all ground-water hydrology investigations. The DNR monitored groundwater levels in about 750 wells statewide to determine long-term trends in the balance between recharge and water consumption. Water level monitoring is required at all biofuel production facilities by the DNR, and site specific monitoring is required of over 100 other permittees. More groundwater level data is anticipated to be collected in the future by water suppliers as part of ongoing planning efforts. The USGS was establishing a real-time groundwater level monitoring network that will allow a better understanding of the relations between land use, climate and groundwater recharge.

D.4. Data Reporting

Groundwater quality data from selected MPCA programs was available through the Environmental Data Access (EDA) system beginning in January 2008. The EDA system was developed to improve access to environmental data and is available online at the following Web address (URL): http://www.pca.state.mn.us/data/eda/index.cfm

Data from the MPCA's ambient groundwater monitoring network, Groundwater Monitoring and Assessment Program (the predecessor program to the ambient monitoring network), and the open, closed, and demolition landfill programs are available through EDA. Groundwater quality data collected by other programs including the feedlot, National Pollutant Discharge Elimination System permitting, petroleum remediation, Resource Conservation and Recovery Act cleanup, Superfund, and Voluntary Investigation and Cleanup programs are not available in EDA; however, information on how to access water-quality data from these programs was available through the MPCA's Groundwater Catalog, available online at the following Web address (URL): http://www.pca.state.mn.us/data/edaGWcatalog/gwSearch.cfm

D.5. Needs

A long-term commitment to collecting and analyzing groundwater data is necessary since most groundwater moves and changes slowly. Any trends in the groundwater system may not be quantifiable for at least five to ten years. Current groundwater monitoring programs will be limited in their ability to determine if the quality and quantity of Minnesota's groundwater resources are at risk without a long-term commitment to these efforts.

Establishing a mechanism for state and local agencies to share groundwater data, including water quality, water level, geophysical logs, and aquifer test information, needs to be established and maintained so effective use of this information among all agencies with groundwater responsibilities is achieved. A standardized format for data transfer needs to be agreed upon, and a common server for agency access to groundwater information is needed.

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Appendix D.II. Agency Roles in Groundwater Monitoring, Protection and Evaluation

Agency	*Responsibilities/Authority*	*Role in Groundwater Monitoring*	*Statewide and Regional Monitoring Activities*	*Site-Specific, including Regulatory and Effectiveness Monitoring Activities*	*Information Available*
Minnesota Department of Agriculture	Regulations to protect groundwater from agricultural chemical contaminants, Water-quality monitoring, Development of agricultural best management practices to protect water quality, Development of sustainable agriculture and integrated pest management	Water-quality monitoring in agricultural areas susceptible to contamination, Monitoring in response to agricultural chemical spills	Monitors ground- and spring-water quality in agricultural areas throughout the State, Assesses adoption rates of agricultural best management practices	Monitors agricultural chemical spill sites, Compliance monitoring at regulated facilities, Monitors sites implementing field-scale best management practices	Nitrate and pesticide data from well and spring samples, Statewide pesticide management plans and best management practices, Fertilizer management plans and best management practices
Minnesota Planning/Land Management Information Center	Compiles geographic data sets required to evaluate the ground-water resources from several state and federal agencies.	Provides geographic information, such as land use/cover and soils data, required to evaluate contaminant detections	None	None	Aerial photography, land use/land cover, soils, surface water hydrography, utilities and telecommunication infrastructure, Data Compatibility Standards, Geographic Metadata Guidelines
Board of Water and Soil Resources	Local water planning and management, Provides financial and technical assistance for local implementation of soil and water conservation programs, Education and outreach to local units of government	Utilizes monitoring data from other agencies to support local water planning efforts	Rainfall Monitoring in cooperation with Soil and Water Conservation Districts	None	eLINK database
Environmental Quality Board	Coordinates state ground-water protection programs, Develops state ground-water policy and priorities, Coordinates reports on ground-water quality and quantity.	Evaluates and reports on state ground-water research needs	None	None	Biennial state water policy and priorities report; Biennial state water availability assessment, State Water Plan
Minnesota Department of Health	Ensuring the safety of public drinking water supplies, Development of health risk limits, Regulation of wells and borings, Wellhead-protection measures for public water supplies	Assessment of public drinking water supplies	Regional studies to assess natural contaminants in the groundwater, Assessment of drinking water supplies near metropolitan landfills	Public Water Supply Monitoring	Health risk limits for selected contaminants, Nitrate probability maps for 16 counties, source water assessments for the State's public water supply systems, wellhead protection plans

Minnesota Geological Survey	Provides geologic and hydrogeologic information on the State, Maintains database on over 340,000 wells drilled in the State	Provides essential geologic and hydrogeologic information needed to characterize ground-water availability and water-quality conditions	Assessments of the hydrogeologic framework for selected counties or regions in the state.		Geologic and hydrogeologic information for selected counties, County Well Index database
Minnesota Department of Natural Resources	Water-quantity monitoring and regulation, Ground-water sensitivity mapping, Development of plans for integrated pest management and sustainable agriculture on state-owned lands	Water-quantity monitoring, Guiding groundwater level monitoring efforts in all communities with a population greater than 1000 with a public water supply, Limited ground-water-quality data collected as part of ground-water sensitivity mapping efforts	Monitors groundwater, stream flow, and lake levels and meteorological conditions throughout the state, Monitors fen water levels and chemistry	Well interference assessments, Contamination Pumpouts, Aquifer tests, Calcareous fen management studies, Protected flows	Lake and groundwater level data, Streamflow data, Precipitation data, Water appropriation permit data, Ground-water sensitivity maps
Minnesota Pollution Control Agency	Regulations to protect groundwater from non-agricultural contaminants, Water-quality monitoring, Development of best management practices to protect groundwater from non-agricultural contaminants	Water-quality monitoring in non-agricultural areas susceptible to contamination across the State, Monitoring in response to non-agricultural chemical releases	Monitors ambient groundwater quality in non-agricultural parts of the state; Monitors PFCs in the ambient groundwater	Assesses remediation or natural attenuation at sites with known contaminant releases in cooperation with responsible parties, Assesses groundwater as part of Clean Water Partnership projects and other special studies	Ground-water-quality data from ambient monitoring network sites and wells associated with landfills, feedlots, or remediation sites
Metropolitan Council	Development of a water-supply plan for the Twin Cities metropolitan area, Review water supply plans prepared by local units of government within the Twin Cities metropolitan area	Utilizes monitoring data from other agencies to support water-supply planning efforts	None	Wastewater Treatment Plant Monitoring (Discharges & Groundwater)	Ground-water flow model of the Twin Cities metropolitan area
U.S. Geological Survey	Provide reliable, impartial information needed to understand the United State's water resources	Works cooperatively with state and local government on regional and local-scale groundwater hydrology and water quality studies, and continuous monitoring of groundwater levels. Monitors groundwater quality conditions across the Nation.	National ground-water-quality assessments as part of the National Water Quality Assessment, multi-county monitoring as part of State, and local cooperative programs	Limited to studies which have transfer value to other regions	Groundwater quality and level data, Interpretive reports on ground-water quality and hydrology.