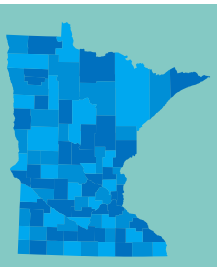
Water quality

April 2018

2018 Minnesota Water Quality: Surface Water Section (Abbreviated Narrative Report)

Report to the Congress of the United States Water Years 2016 - 2017

MINNESOTA POLLUTION CONTROL AGENCY



Authors and contributors

Pam Anderson
Ryan Anderson
Mike Bourdaghs
Jim Brist
David Christopherson
Bill Cole
Lindsay Egge
Pete Fastner
Anne Gelbmann
Mark Gernes
John Genet
Douglas Hansen
Will Haapala
Dan Helwig
Marni Karnowski
Devon Kristiansen
Sherri Kroening
Kim Laing
Brian Livingston
Aaron Luckstein
April Lueck
Celine Lyman
Bruce Monson
Miranda Nichols
Catherine O'Dell
Bill Priebe
Angela Preimesberger
Jeff Risberg
Carol Sinden
Glenn Skuta
Todd Smith
Gene Soderbeck
Laurie Sovell
Summer Streets
Bill Thompson
Wendy Turri
Melissa Wenzel

Minnesota Pollution Control Agency

520 Lafayette Road North | Saint Paul, MN 55155-4194 |

651-296-6300 | 800-657-3864 | Or use your preferred relay service. | Info.pca@state.mn.us

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Foreword

2018 Integrated Report

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

Water years 2016-2017

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 by a biennially (in even years), abbreviated narrative report.

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Acronyms

ADB	Assessment Database
AUID	Assessment Unit Identification
BEACH	Beaches Environmental Assessment and Coastal Health
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BWSR	Minnesota Board of Water and Soil Resources
CALM	Consolidated Assessment and Listing Methodology
CECs	Contaminants of Emerging Concern
CMP	Chloride Management Plan
CWA	Federal Clean Water Act
CWF	Clean Water Fund
CWLA	Clean Water Legacy Act
E. coli	*Escherichia coli*
EAC	Endocrine Active Compound
EPA	United States Environmental Protection Agency
EQuIS	Environmental Quality Information System
FQA	Floristic Quality Assessment
FY	Fiscal Year
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
ICT	CWF Interagency Coordination Team
I&E	Information and Education
ISTS	Individual Sewage Treatment Systems
LGU	Local Governmental Unit
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MGS	Minnesota Geological Survey
MIDS	Minimal Impact Design Standards
mg/L	Milligram per liter
MDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer System
N2K	Need-to-know
NHD	National Hydrography Dataset
NPDES	National Pollution Discharge Elimination System
NPS	Nonpoint Source
NPSMPP	Nonpoint Source Management Program Plan
NRCS	National Resource Conservation Service
NWCA	EPA's National Wetland Condition Assessment
NWI	National Wetland Inventory
PAH	Polyaromatic Hydrocarbons
PCB	Polychlorinated Biphenyl

PFC	Perfluorocarbon Chemicals
PFOA	Perfluorooctanic acid
PFOS	Perfluorooctanesulfonic acid
PJG	Professional Judgment Group
POC	Point of Contact
SDS	State Disposal System
SWPPP	Stormwater Pollution Prevention Plan or Program
TALU	Tiered aquatic life use
TCMA	Twin Cities Metropolitan Area
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
US	United States
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WAT	Watershed Assessment Team
WLA	Waste Load Allocations
WCA	Minnesota Wetland Conservation Act
WQ	Water Quality
WQS	Water Quality Standard

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 primarily follows a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 80 major watersheds. Some monitoring – namely monitoring of toxic parameters – continues to occur on a statewide basis. Assessment of those parameters is done statewide every two years, to reflect the monitoring design.

Sections 305(b) and 303(d) of the Federal Clean Water Act (CWA) 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 (EPA) Consolidated Assessment and Listing Methodology (CALM) integrates the 305(b) Report with the 303(d) Total Maximum Daily Loads (TMDLs) list. Data analyses determine the extent that all waters are attaining water quality standards (WQS), 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. Note that Minnesota's 303(d) List is included in a larger document called the Impaired Waters List, and will be referred to as such.

The EPA website has a significant amount of information on CALM and how it was developed at: https://www.epa.gov/waterdata/consolidated-assessment-and-listing-methodology-calm. The Federal CWA can be found in its entirety at http://www.epw.senate.gov/water.pdf.

A.1 Water quality assessments for rivers, lakes, certain wetlands, and Great Lakes shoreline beaches

Presented in Tables 1 through 6 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 EPA.

Water body specific information will be posted on the MPCA website: https://www.pca.state.mn.us/water/surface-water. For a watershed specific listing of impaired waters with links to additional information, go to the watersheds webpage: https://www.pca.state.mn.us/water/watersheds.

The methodology for determining these assessments is presented in 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 2018 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. Table 4, 5, and 6 include Minnesota's estimated portion of Lake Superior.

Table 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	**4761**
Impaired for one or more uses – Categories 4 & 5	**16787**
Reviewed but having insufficient data to assess as impaired or supporting – Category 3	**5249**
Total:	**26797**

Based on ADB 2018 Cycle data from March 7, 2018

Table 2. Individual use support summary – streams

Goals	Use	Miles Reviewed	Miles Supporting	Miles Insufficient Information to Assess	Miles Not Supporting
Protect and Enhance Ecosystems	Aquatic Life	**25955**	**7687**	**6430**	**11838**
	Limited Value Resource Waters	**451**	**0**	**296**	**155**
Protect and Enhance Public Health	Aquatic Consumption	**7146**	**0**	**660**	**6486**
	Aquatic Recreation	**14633**	**4760**	**1383**	**8490**
	Drinking Water	**3264**	**0**	**3136**	**128**

Based on ADB 2018 Cycle data from March 7, 2018

Table 3. Total miles of waters impaired by various cause/stressor categories – streams

Cause/Stressor Name	Impaired Miles
Acetochlor	**9**
Aluminum	**54**
Ammonia, unionized	**55**
Aquatic macroinvertebrate bioassessments	**5778**
Arsenic	**293**
Chloride	**221**
Chlorpyrifos	**151**
Copper	**5**
DDT	**19**
Dieldrin	**19**
Dioxin (including 2, 3, 7, 8-TCDD)	**13**
Dissolved oxygen	**1928**
Escherichia coli	**5412**
Fecal Coliform	**3207**
Fish bioassessments	**6179**
Lack of cold water assemblage	**38**
Mercury in fish tissue	**6172**
Mercury in water column	**876**
Nitrates	**128**

Cause/Stressor Name (cont.)	Impaired Miles
Nutrient/eutrophication biological indicators	**769**
PCB in fish tissue	**976**
PCB in Water Column	**85**
Perfluorooctane Sulfonate (PFOS) in fish tissue	**41**
PFOS in water column	**41**
pH	**56**
Temperature, water	**10**
Toxaphene	**13**
Turbidity	**5704**
Total suspended solids	**495**

Based on ADB 2018 Cycle data from March 7, 2018

Table 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	**220974**
Impaired for One or More Uses – Categories 4 & 5	**3733128**
Reviewed but having Insufficient Data to Assess as Supporting or Impaired – Category 3	**146681**
Total:	**4100783**

Based on ADB 2018 Cycle data from March 7, 2018

Table 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	**2664191**	**150552**	**2486539**	**27100**
Protect and Enhance Public Health	Aquatic Consumption	**3602571**	**0**	**28680**	**3573891**
	Aquatic Recreation	**2437526**	**1279687**	**531541**	**626298**
	Drinking Water	**437948**	**0**	**437948**	**0**

Based on ADB 2018 Cycle data from March 7, 2018

Table 6. Total acres of waters impaired by various cause/stressor categories – lakes*

Cause/Stressor Name	Acres
Ammonia, unionized	**3573**
Chloride	**1400**
Fishes bioassessments	**22127**
Mercury in fish tissue	**3573696**
Mercury in water column	**7555**
Nutrient/eutrophication biological indicators	**626298**
PCB in fish tissue	**1627562**
PFOS in fish tissue	**1576**

Based on ADB 2018 Cycle data from March 7, 2018
***Data includes Lake Superior**

A.2. Water quality assessments for wetlands

Minnesota's approximately 10.6 million wetland acres comprise about 19% of the state. Historically, Minnesota is believed to have supported 21 million acres 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 Minnesota 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 EPA, in 2006 Minnesota released a multi-agency framework called the Minnesota Comprehensive Wetland Assessment, Monitoring, and Mapping Strategy (CWAMMS) which was designed to measure the state's progress in meeting the 'no net loss' policy. The overall goal of the CWAMMS was to develop a broadly understood, scientifically sound strategy for monitoring and assessing the status and trends of wetland quantity and quality statewide. Three general approaches were recommended: 1) implement status and trends surveys of wetland quantity and quality, 2) develop an integrated accounting system for wetland permitting and conservation activities, and 3) update the National Wetland Inventory (NWI) in Minnesota.

To date, a number of activities have been initiated to meet the CWAMMS recommendations:

- In 2006, the MDNR began a statewide remote sensing survey that is repeated on a three-year cycle to monitor the status and trends of wetland quantity. The first cycle, completed in 2008, established the baseline estimate of 10.62 million acres of wetland that currently exist in Minnesota (Kloiber 2010). The second cycle, completed in 2010, had two primary conclusions. First, Minnesota gained an estimated 2,080 (0.02%) since the first cycle of the survey. The second conclusion was significant changes occurred in wetland type and the largest change was an increase in open water Unconsolidated Bottom or 'pond' type wetlands (Kloiber and Norris 2013). Additional results will be reported every three years in the future.
- The MPCA conducted a probabilistic statewide wetland quality survey of depressional wetlands from 2007-2009 which was reported on in 2012 (Genet 2012). Sampling for the second cycle of Minnesota's depressional wetland survey was completed in 2012. Tabular results reported here are based on results from the 2012 first depressional wetland survey as the results from the 2012 field sampling are not yet available, they are anticipated to be reported on in the 2016 consolidated report.
- The MPCA conducted a probabilistic statewide wetland quality survey of depressional wetlands from 2007-2009 which was reported on in 2012 (Genet 2012). Sampling for the second cycle of Minnesota's depressional wetland survey was completed in 2012. Tabular results reported here are based on results from the 2012 first depressional wetland survey as the results from the 2012 field sampling are not yet available, they are anticipated to be reported on in the 2016 consolidated report.

- In conjunction with EPA's National Wetland Condition Assessment (NWCA), the MPCA expanded probabilistic monitoring to include all wetland types in Minnesota by conducting the NWCA sampling in Minnesota and beginning a statewide intensification study including all wetland types in 2011 and 2012. The MPCA will continue to collaborate with the NWCA team as we report results in 2014 and anticipate continuing the next cycle of wetland quality status and trends monitoring according to the NWCA schedule in 2016.
- In 2013 the MDNR posted updated NWI data for 13 counties in the east central region of the state. New leaf-off imagery to update additional regions of the state has been acquired for approximately 74% of Minnesota. Updated NWI for 36 southern Minnesota counties is expected to be posted online by July 2015 and the update of northeastern Minnesota counties is planned to be completed by mid-2016.
- The Minnesota Board of Water and Soil Resources (BWSR) operates one of the largest wetland banking systems in the country. Currently 280 accounts have a positive balance of credit totaling approximately 3,383 acres of wetland bank credit. These are actively tracked and available online.

In 2012, the MPCA wetland monitoring staff began providing high-level wetland summary data and associated discussion in watershed monitoring and assessment reports as part of the intensive watershed monitoring program. These wetland sections have included summaries of available NWI data, estimates of historic wetland extent within the watershed based on available hydric soil data, and discussion of available wetland condition data. In 2016 and 2017 wetland section summaries have been provided for the following watersheds:

Assessed in 2016	**Assessed in 2017**
Clearwater River	Cloquet River
East Fork Des Moines River	Lac Qui Parle River
Lower Des Moines River	Minnesota River - Headwaters
Lower Minnesota River	Mississippi River - Grand Rapids
Rainy River – Headwaters	Mississippi River - La Crescent
Red River of the North – Marsh River	Mississippi River - Reno
Upper/Lower Red Lake	Roseau River
Wild Rice River	Upper Iowa River
Minnesota River (headwaters to Mississippi River)	Upper Wapsipinicon River
	Vermilion River
	Winnebago River
	Red River of the North (headwaters to Canadian border)

Point of contact (POC) is Mike Bourdaghs at 651-757-2239 or michael.bourdaghs@state.mn.us.

Presented in Tables 7 through 9 are the summary tables for wetlands assessments, using information from the ADB. An electronic update of the entire ADB is also being submitted to the EPA.

Table 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	**995**
Reviewed but Insufficient Data to Assess as Supporting or Impaired – Category 3	**908**
Total:	**1903**

Based on ADB 2018 Cycle data from March 7, 2018

Table 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	**1068**	**0**	**73**	**995**
Protect and Enhance Public Health	Aquatic Recreation	**908**	**0**	**908**	**0**

Based on ADB 2018 Cycle data from March 7, 2018

Table 9. Total acres of waters impaired by various cause/stressor categories – wetlands

Cause/Stressor Name	Acres
Aquatic macroinvertebrate bioassessments	**323**
Aquatic plant bioassessments	**878**
Chloride	**55**

Based on ADB 2018 Cycle data from March 7, 2018

A.3. Water quality assessments for Great Lakes shoreline beaches

The CWA defines Coastal Recreation Waters as the Great Lakes and marine coastal waters (including coastal estuaries) that are designated under section 303(c) of the CWA for use for swimming, bathing, surfing, or similar water contact activities. The MPCA is applying the coastal waters definition and Beaches Environmental Assessment and Coastal Health (BEACH) Act water quality standards to all bacteria monitoring sites on the Lake Superior shoreline and in the mouths of tributaries that are representative of shoreline/Lake Superior conditions. The St. Louis River and Duluth-Superior Harbor sites monitored in the BEACH Act program that extends upstream in the St. Louis River to the Boy Scout Landing Beach are also considered within the coastal recreation designation. AUIDs were established for each individual beach, which generally includes only one beach monitoring station.

Lake Superior coastal waters are subject to Escherichia coli (*E. coli*) water quality standards in the BEACH Act rule [November 2004 *Water Quality Standards for Coastal and Great Lakes Recreation Waters* rule (69 FR 67217, November 16, 2004), found at http://www.gpo.gov/fdsys/pkg/FR-2004-11-16/html/04-25303.htm].

Presented in Tables 10 through 12, are the summary tables for Great Lakes shoreline beach assessments, using information from the ADB. An electronic update of the entire ADB is also being submitted to the EPA.

Table 10. Summary of fully supporting and impaired Waters – Great Lakes shoreline beaches

Degrees of Use Support	Miles
Supporting All Assessed Uses – Category 1	**0.00**
Supporting at Least One Use and None Impaired – Category 2	**5.63**
Impaired for One or More Uses – Categories 4 & 5	**1.05**
Reviewed but Insufficient Data to Assess as Supporting or Impaired – Category 3	**0.05**
Total:	**6.73**

Based on ADB 2018 Cycle data from March 21, 2018

Table 11. Individual use support summary – Great Lakes shoreline beaches

Goals	Use	Miles Reviewed	Miles Supporting	Miles Insufficient Information to Assess	Miles Not Supporting
Protect and Enhance Public Health	Aquatic Recreation	**6.73**	**5.63**	**0.05**	**1.05**

Based on ADB 2018 Cycle data March 21, 2018

Table 12. Total miles of waters impaired by various cause/stressor categories – Great Lakes shoreline beaches

Cause/Stressor Name	Miles
Escherichia coli	**1.05**

Based on ADB 2018 Cycle data from March 21, 2018

The POC is Doug Hansen at 651-757-2406 or douglas.hansen@state.mn.us.

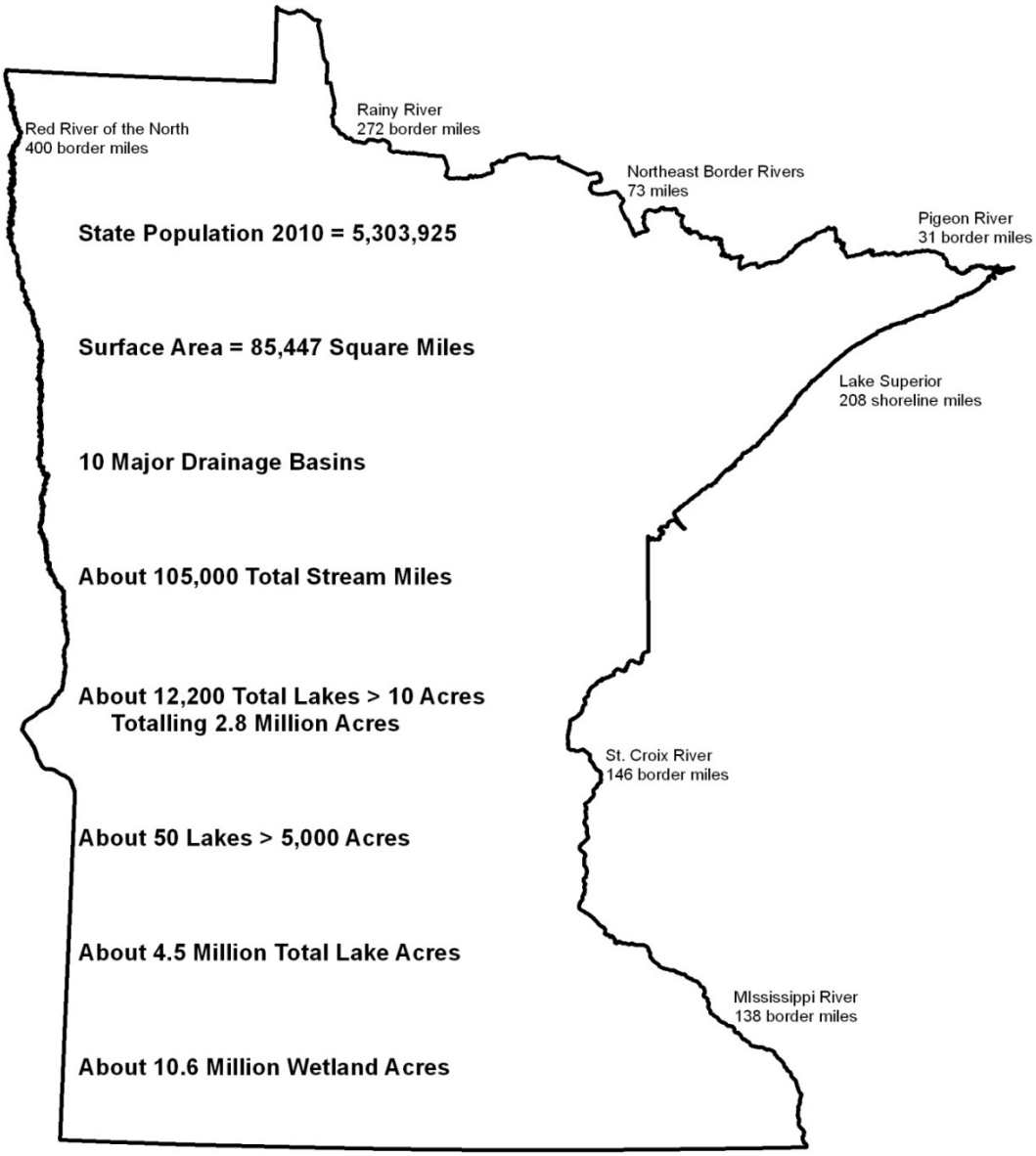
Part B. Background information

B.1. Total waters

B.1.1. State background information

The estimates of background information (in Figure 1) for water bodies were developed from 1:24,000 scale National Hydrography Dataset (NHD), with the exception of the estimate for wetland acres. The total lake acres' estimate includes the Minnesota portion of border lakes and Lake Superior. Wetland acres' 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 1. Minnesota background information and border waters



B.1.2. 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 primarily follows a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 80 major watersheds. Some monitoring – namely monitoring of toxic parameters – continues to occur on a statewide basis. Assessment of those parameters is done statewide every two years, to reflect the monitoring design.

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 10-year Intensive Watershed Monitoring Schedule see the Watershed Approach webpage at: https://www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-quality.

The POC for this is Lee Engel at 651-757-2339 or lee.engel@state.mn.us.

B.2. Water program areas

B.2.1. Wastewater overview

B.2.1.1. Background

The overall goal of the wastewater programs to assure that discharge of treated wastewater to surface waters and groundwater is protective of public health and the environment, and that the following the MPCA Strategic Plan objective is met:

W2a) Point Source discharges are regulated to protect uses and are consistent with major watershed strategies.

Find the MPCA Strategic Plan at this link https://www.pca.state.mn.us/about-mpca/agency-strategy. To meet these overall goals, 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 (LGU), EPA, other funding agencies and pumpers, installers, and inspectors of individual sewage treatment systems (ISTS).

The POC is Aaron Luckstein at 507-206-2606 or aaron.luckstein@state.mn.us.

B.2.1.2. Accomplishments

B.2.1.2.1. TMDLs

As of July 2016, the Agency has completed 74 TMDL projects containing 434 wastewater Waste Load Allocations (WLAs) assigned to industrial and municipal dischargers. The agency ensures that water quality based effluent limits included in NPDES permits are consistent with EPA approved TMDL WLAs. Multiple individual TMDLs are frequently associated with each TMDL project.

B.2.1.2.2. Permitting

- Reissued general permits for Non-Contact Cooling Water (MNG25 and MNG255)
- Continued to evaluate and develop process improvement projects to meet the statutory goal of reissuing permits within 150 days of permit application receipt. The trend continues to show permit timeliness meeting the goals for 90% of permit actions.
- Developed a Metallic Mining Permit Priority List and reissuance implementation plan, in conjunction with EPA Region 5, to address expired metallic mining permits.
- Continued address impaired waters through pre-TMDL water quality based effluent limits and effluent limits that are consistent with TMDL WLAs.
- Issued the Met Council Mississippi Basin overlay permit on September 11, 2015. This permit established a total phosphorus limit for five Met Council Wastewater Treatment Plants that complies with the state's river eutrophication standards and Wisconsin's WQS.
- Developed a permitting implementation plan to achieve the point source nitrogen reduction goals established in the Statewide Nutrient Reduction Study. As a first step towards achieving the reduction goals, influent and effluent total nitrogen monitoring started being required in NPDES/SDS (State Disposal System) permits.
- The permitting program contributed to a continuous improvement for handling chemical addition approvals, which will result in a more defined process that should increase timeliness of approvals.
- The permitting program contributed to the development and implementation of a new TEMPO database for issuing and tracking permits.

B.2.1.2.3. Pretreatment

- Routine program oversight, including review of annual reports, annual inspections of the delegated publicly owned treatment plants, and three audits.
- One reissued wastewater treatment permit has a compliance schedule for the development of delegated pretreatment programs.
- Enforcement support.
- Added one new delegated pretreatment program and in the process of requiring the development of two more delegated pretreatment programs as individual permits are reissued
- Completed all pretreatment annual report reviews.

B.2.1.2.4. Financial assistance program and policy development/implementation

- Completed our Clean Water Revolving Fund Project Priority Lists and associated support to the satisfaction of those seeking financial assistance as well as to the satisfaction of our funding partner, the Public Facilities Authority.
- Completed required legislative report on Future Wastewater Infrastructure Needs and Capital Costs (January 2016).

- Continued to implement requirements included in Water Resources Reform and Development Act of 2014 to comply with all State Revolving Fund requirements to manage the funds which provided a significant amount of wastewater and stormwater infrastructure funding assistance, state match or leveraging and related project activity.
- Completed 2014 and 2015 Project Priority List to the satisfaction of our Clean Water Revolving Fund partner, the Public Facilities Authority.
- Completed required legislative report on Future Wastewater Infrastructure Needs and Capital Costs.
- Completed report on Fiscal Year 2016 (FY16) New Wastewater Treatment Facilities.

B.2.1.2.5. Municipal engineering

- Completed review and preliminary approval of 52 project planning documents (Facilities Plans, Preliminary Engineering Reports or Community Assessment Reports).
- Completed review and approval of 71 projects plans and specifications.

B.2.1.2.6. Municipal hydrogeology and LSTS Systems management

- Completed report entitled *Best Practices Improvements: Nitrogen Pretreatment Performance of Land Based Wastewater Treatment Systems* (June 2016).
- Completed internal guidance on geoscience/hydro reviews which standardize base requirements for reviews on permitting, and enforcement assistance.
- Continued support to permitting and enforcement issues for NPDES/SDS facilities

B.2.1.2.7. Training and certification

- Continued success with the Need-to-Know (N2K) Certification Implementation.
- Successful Collection System Operators and Wastewater Treatment Plant Operation Annual Conferences had a combined attendance of almost 800 people.
- The Wastewater Training Team conducted approximately 28 learning events, which trained over 1,200 operators, and led our annual conferences.
- Completed: Subsurface Sewage Treatment System working with the Department of Labor and Industry to design a better system of processing combination bonds.
- The Wastewater Training Advisory Committee continues to review current courses and complete a needs assessment for new wastewater courses.
- 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 facilities, and small business personnel.
- The Wastewater Training Team has reviewed and updated the Wastewater Collection System Operator Exams. This review will be conducted again as the Wastewater N2K is completed.
- Wastewater Training is working on fine tuning the Type IV Certification Course and working on possible hours of credit rule change.

The POC is Aaron Luckstein at 507-206-2606 or aaron.luckstein@state.mn.us.

B.2.2. Nonpoint source pollution control

B.2.2.1. 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. It is important to protect the good condition of many water bodies, while also addressing degraded water resources.

Minnesota has adopted a watershed approach to address the state's 80 major watersheds on a 10-year cycle. Each major watershed will have a Watershed Restoration and Protection Strategy (WRAPS) report that summarizes work done as part of the watershed approach and includes: water quality monitoring and assessment, watershed characterization, civic engagement/public participation, and restoration and protection strategy development.

The CWLA requires that the WRAPS reports summarize priority areas for targeting actions to improve water quality, identify point sources, and identify nonpoint sources of pollution with sufficient specificity to prioritize and geographically locate watershed restoration and protection actions. In addition, the CWLA requires including an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources.

The implementation strategies, including associated scales of adoption and timelines, are based on what is likely needed to meet the water quality goals for restoration and protection. The strategies are the result of previous watershed reports completed in the Watershed Approach context, watershed modeling efforts, and professional judgment based on what is currently known and they should be considered approximate. Also, many strategies are predicated on building social readiness and sufficient resource support including needed funding being secured. As such, the proposed actions outlined are subject to adaptive management—an iterative approach of implementation, evaluation and course correction.

B.2.2.2. Nonpoint source management

The Minnesota Nonpoint Source Management Program Plan (Plan) focuses on addressing nonpoint source (NPS) pollution, including phosphorus, nitrogen, sediment, bacteria and other contaminants. This Plan is required by the Federal CWA, Section 319(b) to describe a management program for nonpoint source pollution. The purpose of the Plan is two-fold:

1. Ensure compliance with Section 319 requirements of the Federal CWA for providing a long-term programmatic direction of Minnesota's overall approach to addressing NPS pollution.
2. Provide a "one-stop" resource to understand the state's multiple efforts, overall goals and programs, and connections among them for addressing this pollution source.

Statewide Watershed Approach

Several state agencies are involved in carrying out Minnesota's multiple programs addressing NPS pollution. Much of the effort has been integrated into a framework that is referred to as the Minnesota Water Quality Framework. In addition, there is extensive ongoing coordination among the various public agencies and other entities.

The Minnesota Legislature passed a law in 2013 requiring BWSR to prepare and post on its website (http://www.bwsr.state.mn.us/planning/npfp/) a Nonpoint Priority Funding Plan to prioritize potential NPS restoration and protection actions based on available WRAPS, TMDL implementation plans, and local water plans. The Nonpoint Priority Funding Plan is a criteria-based, systematic process to prioritize Clean Water Fund (CWF) NPS implementation investments.

There are numerous funding sources for NPS pollution implementation for landowners, producers, and LGUs from local, state, federal, and private sources. Minnesota's Plan highlights some important state and federal agencies' grants and other programs for funding water quality improvement projects.

The website for Minnesota's Plan is: https://www.pca.state.mn.us/water/minnesota-nonpoint-source-management-program-plan.

The POC is Celine Lyman at 651-757-2541 or celine.lyman@state.mn.us.

B.2.2.4. Federal Clean Water Act - 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
- Establish a schedule for implementation

Section 319 NPS funds are made available to assist LGUs 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 2013 Plan. 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.

Through 25 annual funding cycles of the Federal Section 319 Program (1989 through 2013), the MPCA has awarded $58,315,478 for 525 NPS projects.

The POC is Teresa McDill at 651-757-2303 or teresa.mcdill@state.mn.us.

B.2.2.5. Clean Water Partnership financial assistance

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 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.

Civic engagement

Public outreach has been done through meetings, presentations, and discussions with partners on the Minnesota Watershed Approach. MPCA has invested staff time and resources in researching and creating effective approaches for integrating citizen participation, active citizenship and civic governance into watershed projects, including WRAPS. The objective is to make the volumes of data and analysis useful for targeting, prioritizing and measuring water quality, and have it be understandable to local stakeholders so they can own and influence effective conservation practices. These new approaches are a synthesis of the best social science frameworks, tools, and techniques available. Civic engagement is fully integrated into all steps of the Minnesota Watershed Approach, from the earliest stages of a project through monitoring, assessment, strategic planning, implementation and adaptive management. Citizen involvement is not seen as an add-on or parallel activity, but rather is seen as an embedded activity.

In Minnesota, implementation of conservation practices is ongoing and include both restoration and protection projects. While implementation continues throughout the cycle, it would be expected that more practices would be funded and implemented in year 6 through 10 for any watershed going through the 10-year cycle.

The MPCA set five major information and education (I&E) goals to address NPS water pollution in the 2013 version of the NSMPP. They are:

- Build and improve capacity to deliver NPS-related I&E at state and local level.
- 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.
- Foster coordination and cooperation between governmental agencies and private, nonprofit and other organizations to carry out I&E efforts.
- Include NPS I&E in formal and informal educational curricula.
- Effectively measure impact of NPS I&E activities.

The POC is Celine Lyman at 651-757-2541 or celine.lyman@state.mn.us.

B.2.3. Stormwater program

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. 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 1990s 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) 11 categories of industrial activity, including larger construction activities disturbing five or more acres 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 acres, 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 best management practices (BMPs) which are incorporated in the permittees Stormwater Pollution Prevention Program or Plan (SWPPP). The MPCA's stormwater webpage is available at: https://www.pca.state.mn.us/water/stormwater.

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 http://www.epa.gov/lawsregs/regulations); 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.

The MPCA received legislative funding in 2011 to update and append the *Minnesota Stormwater Manual*. Since the last Manual update in 2008, the MPCA and Minimal Impact Design Standards (MIDS) technical teams have identified several additional areas where new information and/or updates are needed if the Manual is to continue to be a primary resource for Minnesota's stormwater practitioners. The MPCA has completed transitioning the manual into a web-based Wiki format which provides enhanced functionality. The manual will be routinely updated as necessary. *Minnesota's Stormwater Manual* is available at: https://www.pca.state.mn.us/water/minnesotas-stormwater-manual.

The POC is Anne Gelbmann at 651-757-2384 or anne.gelbmann@state.mn.us.

B.2.3.1. 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 was issued to all 233 permit applicants.

Internal work on reissuance of the 2006 MS4 General Permit began in 2009, well before its expiration date of May 2011. Staff focused on the highest priority issues for permit revisions and began to obtain stakeholder input in the permit revision process in early 2010. The draft MS4 General Permit was first placed on public notice May 31, 2011, for a total of 66 days. Multiple large group meetings with stakeholders were held to discuss key issues identified in their comments submitted. A revised draft permit was public noticed on May 21, 2012, for a total of 63 days. The MPCA held additional meetings with stakeholders and made additional revisions to the permit. On May 21, 2013, the MPCA's Municipal Stormwater Program made two recommendations to the MPCA Citizens' Board: 1) that the Board deny two contested case hearing requests, and; 2) that the Board approve reissuance of the MS4 permit.

Ultimately, the Board denied the contested case hearing requests, and approved the reissuance of the permit on May 22, 2013, with an effective date of August 1, 2013. Notable conditions new to the MS4 Permit include post-construction management of stormwater discharge volume and required compliance schedules and reporting related to WLAs in EPA-approved TMDLs.

In 2012, the Municipal Program reassessed its MS4 compliance evaluation process (audits) through a Kaizen exercise. Results include improvements in audit efficiency (less demand on MPCA and MS4 staff resources), consistency (improved expectations and fairness among regulated MS4s), and effectiveness (improved communication related to technical assistance or non-compliance). Despite Municipal Program staff resources being largely dedicated to reissuing the small MS4 permit, 2013 has proven to be one of the most productive auditing years with 19 audits of small MS4s and 1 audit of a large MS4.

The MPCA is managing new and competing demands for staff resources associated with priority projects highlighted in 2012. These priorities continue to evolve and require stormwater staff resources. These priorities include project management and completion of the previously identified MIDS project and the ongoing *Stormwater Manual* update effort. The Stormwater Program has also supported changes to the State Revolving Fund program to include new protection criteria. The rules for wastewater and stormwater treatment assistance (Minn. R. ch. 7077) have been amended to incent additional stormwater projects in the future. Stormwater staff played a critical role with this rulemaking. The Stormwater Program also completed tasks mandated as part of 2009 Legislation regarding Polycyclicaromatic Hydrocarbons (PAHs) in stormwater ponds. This statewide priority includes language amended into the MS4 General Permit that was reissued in 2013. The MS4 General Permit requires a stormwater pond inventory. Minnesota has also developed BMP guidance for sediment removal projects to help municipalities throughout the state. Minnesota also passed a statewide ban on the use of coal tar-based sealants which contain high concentrations of PAHs. The new state law went into effect on January 1, 2014. Information about the new law and completed work efforts to date (including a model ordinance), is available at: https://www.pca.state.mn.us/water/restriction-coal-tar-based-sealants.

Additional information on Minnesota's Municipal Stormwater Program can be found at https://www.pca.state.mn.us/water/municipal-stormwater-ms4.

The POC is Ryan Anderson at 651-757-2222 or ryan.anderson@state.mn.us.

B.2.3.2. Construction stormwater

The Phase I rules regulated large construction activities that disturb five or more acres of land. The Phase II rules required small construction activities disturbing one to five acres, including construction that is part of a common plan of development or sale disturbing one acre or more, to have NPDES permit coverage.

In August 2003, the MPCA issued a revised construction Stormwater General Permit for construction activity over one acre 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 Outstanding Resource Value Waters 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 an EPA approved TMDL, revised requirements for change of permit coverage, and training. The MPCA partners with the University of Minnesota and Department of Transportation in providing construction stormwater certification courses.

In August 2013, the MPCA reissued the construction Stormwater General Permit to comply with the EPA final rule on *Effluent Guidelines for Discharges from Construction and Development Sites* (December 2009). In addition, the revised permit requires electronic applications and one-inch volume control from new impervious surfaces. With the new volume control requirement, the MPCA will have a concerted effort to ensure the resulting green infrastructure (mostly infiltration basins) will be designed, built, and operated correctly. This will be done through education, compliance/enforcement, and partnering with local governments. Additional information on Minnesota's Construction Stormwater Program can be found at https://www.pca.state.mn.us/water/construction-stormwater.

The POC is Tanya Maurice at 651-757-2555 or tanya.maurice@state.mn.us.

B.2.3.3. Industrial stormwater

On April 5, 2015, the Industrial Stormwater General Permit (Permit) was re-issued and remained mostly unchanged from the previous 2010-2015 permit. The Permit is effective until April 5, 2020. The Permit regulates 29 sectors of industrial activity and required all Permittees to sample their stormwater runoff and send the results to the MPCA. Sampling requirements continue to be a key indicator for Permittees successes and deficiencies; it is a feedback loop to alert permittees if their chose stormwater management practices are working or not. Sampling requirements started over for all Permittees, regardless of their outcomes of sampling results during the 2010-2015 permit cycle. Beginning July 2015 for renewing Permittees (and next full calendar quarter for new applicants), Permittees are required to sample their stormwater discharges for a minimum of four quarters. Over time, the Industrial Stormwater Program has shifted focus from education/outreach and local partner development, to responding to sampling results and compliance/enforcement strategies. The Industrial Stormwater Program continues to collaborate with the University of Minnesota to provide training on permit requirements. Staff are also working more closely with industrial and municipal permit writers to ensure appropriate stormwater language is being written into their individual permits. The Industrial Stormwater Program's website is updated at least monthly with frequently-asked-questions, steps to compliance, quarterly newsletters, and more: https://www.pca.state.mn.us/water/industrial-stormwater.

The POC is Melissa Wenzel at 651-757-2816 or melissa.wenzel@state.mn.us.

B.2.3.4. Stormwater rules

Minnesota state stormwater rules, Minn. R. ch. 7090 (https://www.revisor.mn.gov/rules/?id=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. Federal stormwater rulemaking is currently underway with final action on the rules expected in late 2012. The MPCA will need to comply with the new federal rules according to the applicable schedules identified in the rules. For more information see https://www.pca.state.mn.us/water/stormwater-program-rulemaking.

The POC is Ryan Anderson at 651-757-2222 or ryan.anderson@state.mn.us.

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, estimating the benefits associated with environmental programs (and, to an extent, even the costs) is challenging. While the influence of environmental factors on market prices and the positive value that people place

on environmental improvements is at this point fairly well established, it remains extremely difficult to estimate environmental values with precision. As a result, environmental policy decisions continue to be 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.

A partial accounting – partly quantitative, partly descriptive – of some of the costs and benefits associated with Minnesota's water quality program is given below.

B.3.1 Costs

The primary water quality programs at the state level are those of the MPCA, MDNR, Minnesota Department of Agriculture (MDA), Minnesota Department of Health (MDH) and BWSR. Including local assistance, the WQ budget of the MPCA is approximately $74 million per year* and of BWSR approximately $68 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 groundwater. The MPCA, which has primary jurisdiction for the first three of these, has an overall budget of approximately $196 million per year.

Regarding the actual implementation of point source water pollution controls, more than $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. The estimated infrastructure investment needs and annual operating costs for water treatment statewide is $3.98 billion over the next five years.‡ Note, however, that municipal facilities treat industrial as well as municipal wastes and that industrial contributions represent a significant portion of the above figures.

In addition to government agency costs, some regulated parties might incur costs in order to adhere to permitting restrictions, such as permit application fees, changes in management practices, investment in water treatment technology, and other costs. Depending on market conditions, firms might incur costs from reducing production and thus become less competitive, and the economy could experience indirect effects to employment.

The overall costs of NPS water pollution control implementation are both more diffuse and more difficult to calculate than are those for point source programs. Due to changing economic circumstances, such as crop prices, it is not possible to estimate the indirect costs of BMPs to control runoff statewide.

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* MMB. 2015. 2016 – 17 Governor's Budget – Pollution Control Agency.

† Mohr, Jonathan. 2015. BWSR executive director outlines proposed budget for upcoming biennium. MN House of Representatives Public Information Services.

‡ MPCA. 2014. *2014 Biennial Survey of Wastewater Collection and Treatment*.

For example, reduced crop production as a result of buffer strips is a considerable cost, but the economic impact varies by soil quality, type of crop, and many other factors.

One proxy for the cost of non-point pollution abatement is the amount of state funding dedicated towards watershed conservation projects. Between 2009 and 2015, $37.84 million was awarded by the MPCA to fund watershed load reduction projects.[§] Current estimates predict that as much as $3 billion will be needed to restore Minnesota waters on the current 303(d) list that are impaired by NPSs. Details on these estimated costs can be found https://www.pca.state.mn.us/water/water-publications.

B.3.2. Benefits

While it is difficult to fully account for all costs of the CWA in Minnesota, the true measurement of benefits is subject to even higher uncertainty. Theoretical models for translating WQ improvement into economically measured benefits have been applied in numerous contexts in the United States and in Minnesota, but no attempts have been made to do this for the state as a whole.

A recent study performed an economic valuation of the ecosystem services of the St. Louis Watershed,[**] which valued the water resources of the St. Louis Watershed at $2 to $5 billion per year. Though the resulting estimate describes the total annual flow of ecosystem goods and services rather than the benefit caused by improvements in water quality, it is an important starting point to conceptualize the economic benefits the water resources of Minnesota offer continually to the economic health of the state.

The MPCA has also made progress towards its turbidity reduction goals for the Minnesota River and the southern basin of the Mississippi River by identifying sediment sources and designing an action plan for an interim goal of 25% reduction of sediment loads by 2020, and 50% reduction by 2030. In conjunction with the sediment TMDL for Lake Pepin, a full cost accounting study estimated that a 50% reduction in sediment and phosphorus loading could lead to net zero economic loss to society when balancing reductions in agricultural production with the increased provision of ecosystem services, including carbon sequestration, recreational hunting, flood prevention, and biodiversity existence value. The results suggest that the most cost efficient strategy to reduce sediment and phosphorus loading is to convert conventional crop production to forest or to crop production using half as much phosphorus fertilizer.[††]

For point source programs, even if dollar figures are not readily available, benefits can be illustrated in descriptive terms. Significant improvements in state water quality have occurred over the past several decades, especially since the passage of the CWA. While only 20% of the state's sewered population was served by facilities capable of at least secondary treatment in 1952, fully 99.9% are so served at present. In a similar vein, rates of regulatory compliance for municipal and industrial facilities are at a high level, with 99% of permittees meeting their effluent limits. As a result of the MPCA's efforts, phosphorus loads from wastewater treatment plants have decreased by 57% since 2006.

Our agency has continued to make progress improving the water quality of our lakes and streams, in part due to increasing our monitoring efforts over the last eight years. We have completed assessments in 86% of watersheds, up from 52% in 2007. We anticipate completing assessments of all watersheds by

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[§] MPCA. 2015. *Watershed Achievements Report 2015*. Retrieved from https://www.pca.state.mn.us/sites/default/files/wq-cwp8-18.pdf on June 8th, 2016.

[**] Fletcher, A., Christin, Z. 2015. *The Value of Nature's Benefits in the St. Louis River Watershed*. Earth Economics, Tacoma, WA.

[††] Dalzell, B., Pennington, D., Polasky, S., Mulla, D., Taff, S., and Nelson, E. 2012. *Lake Pepin Watershed Full Cost Accounting Project*.

2017. Sixty percent of lakes and stream are meeting water quality standards, and 24% of lakes and streams have been improving over the last eight years.

As a result of both point source and NPS programs, water quality 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 Biochemical Oxygen Demand (BOD) (89% of sites), fecal coliform bacteria (82%), ammonia (83%), and total phosphorus (78%). (On the other hand, only 42% of the sites show a decreasing trend for total suspended solids (TSS), and fully 75% of the sites show an increasing trend for nitrite/nitrate).

Numerous site-specific projects have already resulted in remarkable improvements in water quality. For example, due to decades of remediation efforts, the St. Louis River Area of Concern is on track to be delisted from its nine beneficial use impairments by 2025. Among many noticeable achievements, the first evidence of sturgeon population recovery occurred in 2011, when four young sturgeons were collected. Since 1978, at least $420 million dollars has been invested in this area of concern for infrastructure updates, restoration, and remediation of historic industrial contaminants. The restoration of the St. Louis River is essential for protecting the ever-growing tourism industry in Duluth, for which water resources and natural scenery are major assets. Duluth tourism tax revenues have nearly doubled since 2006 to more than $10 million in 2015, and lodging capacity will grow by 13% within the next two years.[‡‡]

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, which generates approximately $13.6 billion per year.[§§] More than $2 million comes from expenditures related to fishing and wildlife viewing alone, according to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Minnesota's water resources are a considerable attraction for this economically important industry, and provide habitat for wildlife that also attract tourists.

Similarly, a study by Bemidji State University on the economic value of Minnesota lakes found a strong relationship between water clarity and lake property values, with an increase of one meter in water clarity associated with additional total property value of tens or even hundreds of millions of dollars for given individual lakes. The results of this study, along with numerous similar studies across the United States, emphasize that individuals express a preference for high water quality in the real estate market, and gain a direct economic benefit from improved water resources.

In addition to the tourism and property values benefits of clean water, numerous studies have demonstrated that clean water provides many other environmental services, all of which have significant economic value. These services include safe drinking water, agricultural uses (irrigation and raising livestock), commercial fishing, use in manufacturing, use in mining, use in electrical power generation, navigation, and hydropower. The protection of water quality also plays an important role in mitigating the damages associated with floods, human health risks from accidental ingestion or contact with water, and reduced treatment or other damages downstream. In addition, Minnesotans receive non-market benefits from experiencing positive aesthetic properties of clean water bodies, knowing that pristine ecosystems are kept intact, and protecting surface waters' assimilative capacity for the use of future generations.

[‡‡] Passi, Peter. (2016, February 2). Duluth's tourism industry continues to grow. *Duluth News Tribune*. Retrieved from http://www.duluthnewstribune.com/ on June 6th, 2016.
[§§] Explore Minnesota. 2016. *Tourism and Minnesota's Economy*. Retrieved from www.exploreminnesota.com on June 9, 2016.

While the economic value of all the services provided by maintaining clean surface waters and groundwater in Minnesota have not been estimated, numerous studies have shown that clean water is essential to the U.S. economy, that the economic value of clean water is significant and that the benefits of having clean water generally outweigh the costs of maintaining clean water.

An accounting of some of the key results regarding the MPCA's environmental programs can be found at https://www.pca.state.mn.us/about-mpca/dashboard-environmental-and-performance-measures.

The POC is David Bael at 651-757-2528 or david.bael@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. As of April 4, 2018, the 2018 proposed Impaired Waters List has 5,086 impairments. The largest sources of the increases include additional water bodies with excess bacteria, additional water bodies with eutrophication excesses, and additional water bodies with excess mercury in fish. These pollution problems are caused by a combination of point and NPSs. 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 1% on taxable sales, starting July 1, 2009, and continuing through 2034. Of those funds, approximately 33% will be dedicated to a CWF to protect, enhance, and restore WQ in lakes, rivers, streams, and groundwater, with at least 5% of the fund targeted to protect drinking water sources. Revenues appropriated from the CWF will vary depending on the economy, but estimates range from $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 MDA, the (MDNR) and the MDH. These agencies are coordinating closely with LGUs to implement water programs. This will be a critical boost to Minnesota's efforts. For more information, see https://www.pca.state.mn.us/water/clean-water-fund.

The POC is Miranda Nichols at 651-757-2614 or miranda.nichols@state.mn.us.

B.4.2. Other contaminants of concern in Minnesota's environment

Over the past several years, the MPCA has invested significant resources to investigate and evaluate other contaminants now known to be widely present in the environment that are not included in regular monitoring activities. These contaminants are often referred to as contaminants of emerging concern (CECs) and include pharmaceuticals, household and industrial-use products; endocrine active compounds (EACs); brominated flame retardants; and perfluorinated chemicals (PFCs). The work done by the MPCA and others is important to inform lawmakers, regulators, the public and industry about the presence and extent of these contaminants in Minnesota's waters, and to evaluate when and how to address the contaminants through agency protection programs. The following paragraphs provide an overview of recent MPCA activities and other developments related to CECs.

B.4.2.1. Pharmaceuticals, household and industrial-use products

The MPCA has been collaborating on an ongoing basis with researchers from the U.S. Geological Survey (USGS) to monitor the presence of pharmaceuticals, personal care products, and other wastewater-associated chemicals in Minnesota's groundwater, lakes, and flowing waters. In general, these studies show that industrial and household-use compounds and pharmaceuticals are present in streams, groundwater, wastewater, and landfill effluents. Steroidal hormones, prescription and non-prescription drugs, insect repellent, detergents and detergent degradates, and plasticizers are widespread at low concentrations in Minnesota's rivers, lakes, and streams. The chemicals are typically found downstream of sources such as wastewater treatment plants. However, they are also present in more remote surface water where sources of these chemicals are not clear. Two large monitoring campaigns in conjunction with EPA's National Aquatic Resource Survey – one of 150 river and stream locations and one that included a random selection of 50 lakes - revealed that these chemicals are surprisingly widespread in Minnesota's ambient surface water. The results of many of these studies can be found in reports located at https://www.pca.state.mn.us/water/endocrine-active-compounds.

B.4.2.2. Endocrineactive chemicals

Building on the results of the study referenced above and other surveys of pharmaceuticals, household, and industrial products in the aquatic environment, scientists from the USGS, St. Cloud State University, the University of Minnesota, the University of St. Thomas, and the MPCA conducted a series of investigations into the significance, sources, and occurrence of EACs in Minnesota's waste streams and waters. EACs mimic hormones causing adverse behavioral and physiologic effects, including impairment of the reproductive system or the disruption of growth and development of an organism. Many of the pharmaceuticals, personal care products, and other wastewater-associated chemicals included in MPCA's monitoring studies are considered EACs.

Three studies have focused on the presence and effect of EACs in Minnesota waters. The 2008 statewide study of selected streams and lakes showed that, in addition to wastewater treatment plant effluent, EACs are present in Minnesota lakes not influenced by wastewater plants. A subsequent, intensive study of 25 wastewater treatment plants greatly refined our understanding of the chemicals that are introduced into surface water via treated wastewater, and revealed that surface water upstream of these facilities contained pharmaceutical and personal care products and EACs that were detected downstream of the plants and at similar concentration (https://www.pca.state.mn.us/sites/default/files/lrp-ei-1sy11.pdf). Analysis of fish from both of these studies showed evidence of exposure to estrogenic compounds (i.e. EACs), in many instances at lake or river locations unaffected by obvious sources of wastewater. Finally, an intensive study of one lake revealed that the effects of EACs on fish appears to vary between microhabitats within a single lake that are influenced by various land uses. It is not known if these chemicals pose a risk to human health at the low concentrations being detected.

Beginning in 2010, the MPCA began collecting groundwater samples from its Ambient Groundwater Monitoring Network for analysis of over 100 contaminants of emerging concern, which included EACs. The primary objective of the first year of sampling was to determine the magnitude of contamination in the groundwater; consequently, the sampling focused on areas with a high relative potential for groundwater contamination. The results from the 2010 survey are available here: https://www.pca.state.mn.us/sites/default/files/wq-cm4-03.pdf. The MPCA is continuing to monitor Minnesota groundwater for EACs and other emerging contaminants in partnership with the USGS, with a report of results published in 2017 (https://www.pca.state.mn.us/sites/default/files/tdr-g1-20.pdf).

The MPCA will continue monitoring for EACs and other emerging contaminants in Minnesota surface waters in conjunction with statewide and nationally based probabilistic surveys to build trend

information over time. Locations that were sampled for the 2008 Statewide Study were again sampled in 2013, this time with an expanded list of pharmaceuticals and personal care products. In 2014, the MPCA sampled surface water at 50 randomly selected river locations in collaboration with the National Aquatic Resource Survey.

B.4.2.3. Perfluorinated chemicals

PFCs such as PFOS, perfluorooctanic acid, (PFOA), perfluorobutyric acid 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. PFCs are widespread and persistent in the environment and they have been found in animals and people all over the globe.

In Minnesota, 3M manufactured PFOS and PFOA from approximately 1950 until they were phased out in 2002. During that time, large volumes of PFCs were released into the Mississippi River in effluent from the 3M Cottage Grove Wastewater Treatment Plant. In addition, four sites in Washington County were identified where 3M disposed of PFC wastes prior to the advent of modern solid and hazardous waste laws and regulations aimed at protecting groundwater. These are in Oakdale, Woodbury and Cottage Grove, and at the former Washington County Landfill in Lake Elmo.

Initial work by the MPCA and MDH focused on identifying contaminated drinking water wells in these areas, and making sure residents had access both in the short and long term to safe drinking water. While these more immediate concerns were addressed by the MPCA, MDH and 3M, investigations and negotiations with 3M led to a formal Consent Order in 2007 between the MPCA and 3M regarding the release and discharge of PFCs from these sites. The consent decree set forth specific steps required of 3M to remediate its disposal sites and ongoing PFC releases. As of February 2012, all major excavation work was complete at the 3M disposal sites and the former Washington County Landfill. Additional long-term work remains to contain, pump and treat PFC-contaminated ground water, and monitoring their effectiveness over time.

The MPCA investigations also detected PFOS at elevated concentrations in fish taken from Pool 2 of the Mississippi River and downstream, as well as in metro area lakes, most 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 impaired due to PFOS. Follow-up testing of fish and water has shown an overall decline in Pool 2 PFOS concentrations in fish, with elevated levels remaining in the lowest reach of the pool. (See 2012 report on fish, water, sediment, and invertebrate sampling at https://www.pca.state.mn.us/sites/default/files/wq-cm4-03.pdf.)

The MPCA will continue to evaluate conditions in PFOS-affected waters to determine if further regulatory or prevention activity is needed to assure that these waters fully support their beneficial uses. More information can be found at https://www.pca.state.mn.us/waste/perfluorochemicals-pfcs.

The POC is Cathy O'Dell 651-757-2621 or catherine.odell@state.mn.us.

Part C. Monitoring and assessment strategy

C.1. Water quality standards development

At the center of the assessment process are the beneficial uses we derive from our water resources and the water quality standards that protect these uses. The water quality standards are the fundamental tool by which the quality of groundwater and surface waters is measured. The water quality standards listed in Minn. R. chs. 7050 and 7052 consist of three elements:

- Classifying waters with designated beneficial uses
- Narrative and numeric standards to protect those uses
- Nondegradation (antidegradation) policies to maintain and protect existing uses and high quality waters

For a full discussion on WQSs, see MPCA's WQSs webpage at https://www.pca.state.mn.us/water/water-quality-standards. Minn. R. chs. 7050 and 7052 can be found at https://www.revisor.mn.gov/rules.

The POC is Angela Preimsberger at 651-757-2656 or angela.preimesberger@state.mn.us.

C.2. Monitoring strategy

C.2.1 Minnesota's water quality monitoring strategy

The Minnesota's Water Quality Monitoring Strategy, 2011-2021 (Monitoring Strategy), describes elements of the state's surface water and groundwater monitoring programs. The Monitoring Strategy satisfies the EPA monitoring program strategy requirement and serves as the guide to MPCA monitoring programs.

Minnesota's WQ monitoring strategy is available at: https://www.pca.state.mn.us/sites/default/files/p-gen1-10.pdf.

The POC for this is Lee Engel at 651-757-2339 or lee.engel@state.mn.us.

C.2.2. 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. An average of 8 to 10 watersheds are intensively monitored annually and assessed in a yearly rotation expected to complete a statewide assessment every 10 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 the watershed approach, refer to the Watershed Approach webpage (https://www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-quality and https://www.pca.state.mn.us/sites/default/files/wq-s1-27.pdf).

The POC for this is Lee Engel at 651-757-2339 or lee.engel@state.mn.us.

C.2.3. 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 WQ 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 EPA 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. For information and reports can be found at https://www.pca.state.mn.us/water/your-stream-stressed.

The POC is Kim Laing at 651-757-2515 or kimberly.laing@state.mn.us.

C.2.4. Effectiveness monitoring strategy

Much like problem investigation monitoring, the state's effectiveness monitoring strategy relies on monitoring activities by a variety of parties. For individual projects, a variety of groups (regulated parties, local implementers, agency contractors, other organizations and the MPCA) can be involved in conducting effectiveness monitoring to evaluate specific management practices in a project area. With the MPCA's adoption of the watershed approach, the condition monitoring conducted in the first two years of the 10-year cycle becomes dual purpose monitoring in subsequent cycles, since at this point the WRAPS has been developed and implementation is underway. As a result, the second round of monitoring can server as a measure of the effectiveness of the implemented practices from the previous cycle.

The POC for this is Lee Engel at 651-757-2339 or lee.engel@state.mn.us.

C.2.5. Surface water monitoring purposes, designs and indicators

The MPCA's current Condition, Problem Investigation and Effectiveness Monitoring activities are described in detail in Section 2.4 of the Monitoring Strategy, from pages 33 - 44. The information provided includes monitoring activity start date, purpose, and description, including the type of monitoring design that is used to meet the specific monitoring purpose, and indicators. The Monitoring Strategy is available here: https://www.pca.state.mn.us/sites/default/files/p-gen1-10.pdf.

The POC for this is Lee Engel at 651-757-2339 or lee.engel@state.mn.us.

C.2.6. Drinking water assessments

The MPCA does not assess groundwater (Class 1A) for potential impairment of the drinking water use. However, the MPCA is assessing Class 1B and Class 1C listed surface waters for potential impairment by nitrate nitrogen. 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 Section VI., Part D, of the 2016 Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List, 2014 Assessment Cycle (also known as the Guidance Manual and available here: https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list).

As part of the latest Triennial Standards Review, the MPCA has taken the first step to engage the MDH and the public on needed improvements to the approach for designating and setting Class 1, Domestic

Consumption, water quality standards for drinking water protection. The basis for current Class 1 designation and standards needs revisions to improve consistency with other statutes and rules that protect groundwater and drinking water. This project is a priority for work in the coming three years following the Triennial Standards Review. The discussions with the MDH will include consideration of monitoring and assessment approaches.

The POC for this is David Christopherson at 651-757-2849 or david.christopherson@state.mn.us.

C.2.7. Source water

The MDH is the lead agency in Minnesota working on source water protection with the EPA. 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 Watershed Assessment Teams (WAT) are being coordinated.

In the past, the MPCA has worked closely with the MDH on source water protection, through a Memorandum of Agreement. 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 that involve both source water protection, and basin and watershed management. The MDH can now electronically access some of the MPCA's electronic databases to obtain information on potential contaminant sources, and the MPCA is continuing to work on the expansion of data access. The MPCA also has a representative on the MDH Ad Hoc Committee on Source Water Protection for Surface Water Systems.

The POC is Angela Preimsberger at 651-757-2656 or angela.preimesberger@state.mn.us.

C.3. Assessment methodology and summary data

Minnesota's water quality assessment methodology is fully documented in the *MPCA's Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List*, (available here: https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list).

C.3.1. Assessment units

Assessments of use support in Minnesota are made for individual water bodies. The water body unit used for river systems, lakes, and wetlands is called the "assessment unit". A river assessment unit usually extends from one significant tributary to another or from the headwaters to the first significant tributary and is typically less than 20 miles in length. The river may be further divided into two or more assessment units when there is a change in the use classification (as defined in Minn. R. ch. 7050), or when there is a significant morphological feature such as a dam, or a lake within the river.

The MPCA uses the 1:24,000 scale high resolutions NHD to create geospatial data to represent stream and lake assessment units. All of our assessment units are indexed to the NHD, or have had custom shapes created for addition to the NHD. The high resolution NHD was created from 1:24,000 scale USGS Digital Line Graphs and MDNR stream and lake data.

Each water body is identified by a unique water body identifier code called an assessment unit identification (AUID). For streams, the code is comprised of the USGS 8-digit subbasin code plus a three-character code that is unique within each subbasin. It is for these specific reaches that the data are

evaluated for potential use impairment. The MPCA consults with border states during the assessment process and documents reasons for any discrepancies in assessment determination between Minnesota and the specific border state.

The Protected Waters Inventory (MDNR) is the source for lake and wetland identifiers. The MDNR uses an 8-digit identifier for water bodies, consisting of a 2-digit prefix that represents county, 4-digit number identifying a lake, and a 2-digit suffix that represents either a whole lake (-00) or representing a specific bay of a lake (-01, -02, etc.). This 8-digit identifier is used by MPCA to represent an assessment unit for lakes and wetlands. Water bodies determined to be wetlands will not be assessed using the eutrophication factors discussed in the Water Quality Trends for Minnesota Lakes section in this report. Factors the MPCA uses to identify wetlands can be found in Table 11 of the *Lake TMDL Protocols and Submittal Requirements* document (online at https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list).

Typically, the listing of impaired waters is by individual assessment unit. The major exception to this is the listing of rivers for contaminants in fish tissue. Over the time it takes fish, particularly game fish, to grow to "catchable" size and accumulate pollutants to unacceptable levels, there is a good chance they have moved considerable distance to the site where they were sampled. The impaired reach is defined by the location of significant barriers to fish movement such as dams upstream and downstream of the sampled reach. Thus, the impaired reaches often include several assessment units, and for lakes, will include all bays on the lake (may be listed under the -00 suffix, representing the entire water body).

The POC for this is Lee Engel at 651-757-2339 or lee.engel@state.mn.us.

C.3.2. Data management

The MPCA stores surface water monitoring data in an Environmental Quality Information System (EQuIS) database management system, which the MPCA has been using since 2010. It is the MPCA policy that all WQ monitoring data required or paid for by the MPCA be entered into EQuIS. This includes projects funded by the MPCA such as Section 319 projects, Clean Water Partnerships 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 EQuIS-ready format. A few agencies, such as USGS and Metropolitan Council, and neighboring states do not submit data into EQuIS but their data are still used for water quality assessments.

More information about EQuIS is available on the MPCA's website: https://www.pca.state.mn.us/water/surface-water-data-submittal-review-and-reports.

The POC is David Vaaler at 651-757-2400 or david.vaaler@state.mn.us.

C.3.3. Integrated assessment process and methodology

Until 2010, the MPCA assessed the condition of the state's waters via a biennial, statewide assessment process. With the advent of the intensive watershed monitoring approach, which was piloted in 2006, and adopted in earnest beginning in 2007, the MPCA faced a need to revise the assessment process to align with the watershed monitoring approach, including the 10-year schedule and the increased volume of data generated during watershed monitoring.

An annual assessment process has been designed to keep up with the monitoring work and reflect the more detailed monitoring data available in the watersheds where intensive watershed monitoring has been completed. The development of an annual assessment process has been critical to the MPCA's implementation of the overall watershed approach. With assessments taking place immediately

following completion of intensive watershed monitoring, the entire process of monitoring-assessment-restoration-protection can be completed within 10 years, at which time the watershed comes up for monitoring again as part of the next scheduled 10-year rotation. In addition, the revised process encourages earlier and more meaningful local involvement in assessment.

More recently (2013), a large river monitoring strategy was initiated to complement the watershed approach for the monitoring, assessment, and CWA reporting of water resources within Minnesota. For the purposes of fulfilling our monitoring and assessment objectives, large rivers are defined as large mainstem rivers that flow through multiple major watersheds and, therefore, were not satisfactorily represented within the watershed approach. In Minnesota, these include the St. Croix, Minnesota, Upper Mississippi, Red, and Rainy rivers. These rivers will be monitored and assessed longitudinally on a rotating basis once every five years. The Lower Mississippi (below Upper St. Anthony Falls) also meets the definition of a large river but is treated separately due to ongoing interstate efforts to develop a consistent and comprehensive monitoring strategy to fulfill CWA objectives for interstate waters of the Mississippi River.

Additionally, MPCA and MDNR piloted the assessment of aquatic life in lakes utilizing a lake fish index of biotic integrity and a review of existing plant data. Sampling has been aligned so that aquatic life assessments will be completed annually following the watershed monitoring approach.

Some monitoring – namely monitoring of toxic parameters – continues to occur on a statewide basis. Assessment of those parameters is done statewide every two years, to reflect the monitoring design. Watershed assessments focus primarily on the aquatic life and recreation beneficial uses. Statewide assessments focus primarily on aquatic consumption and aquatic life toxicity.

The redesigned process expands upon the data analysis steps of the previous assessment process. While this new process focused on the aquatic life use assessments in rivers and streams, concepts of the redesigned process have also influenced how other designated uses (e.g., aquatic recreation) are assessed. Additional reviews at the parameter level and the addition of an internal comprehensive review, prior to the professional judgment group meeting, are the largest changes. These changes reflect the increased volume and complexity of the data gathered during the intensive watershed monitoring effort, and help ensure a robust decision about the appropriate management actions to be pursued for each assessment unit (water body, or AUID) in the planning and implementation phases of the watershed approach (i.e. restoration for impaired waters, and protection for unimpaired waters). Further detail on the specific steps in the process is included below. A note should be made that the aquatic consumption (fish) assessment at this time utilizes only the first two steps in the process.

1. **Data compilation**

   The initial step in the process is a computerized screening that identifies monitoring results collected on AUIDs over the appropriate period of record and compares each data point to WQ criteria, summarizes the number of data points that exceed the criteria, the total number of data points, and the number of years of data. This step produces a parameter-specific summarization (e.g., Dissolved Oxygen, Fish Index of Biotic Integrity (IBI) and *E. coli*).

2. **Quality assurance/quality control review**

   This stage involves a review of the data for quality assurance that the computerized screening captured the appropriate data and is properly calculating the summaries (particularly important when new assessment methods or new parameters are added). Also included in this stage are additional analysis and review steps required for several parameters (e.g., *E. coli*, chloride, un-ionized ammonia, and nitrate).

3. **Desktop assessment**

   The desktop assessment involves a review of data and summaries by resource-specific staff (e.g., water quality staff review chemistry data, biologists review stream biological data, MDNR review lake biology) for water bodies within a specific 8-digit hydrologic unit code watershed (HUC-8). This review considers multiple lines of evidence – review of flow conditions, precipitation, land use, habitat, etc. – in addition to the summarizations to ascertain the quality of the dataset (temporal and spatial completeness, etc.) and whether the parameter is meeting or exceeding the criterion. During this process any candidates for delisting or natural background review are identified and work begins to determine if those AUIDs meet the criteria to be removed from the Impaired Waters List.

4. **Watershed Assessment Team**

   Joint internal meeting of the MPCA personnel involved in the individual desktop assessments, the regional watershed project manager and stressor identification staff for a specific HUC-8. In this meeting each AUID is reviewed, considering comments and parameter-level evaluations from the desktop assessment as well as supplemental information, to reach an overall use-support decision. Delisting and natural background candidates may also be identified at this time.

5. **Professional Judgment Group**

   The Professional Judgment Group (PJG) meeting is a joint meeting of the WAT and external parties (local data collectors, LGUs, etc. as determined by the MPCA regional watershed project manager) to discuss the results of the WAT meeting for a specific HUC-8. Prior to the PJG meeting, the results of the WAT meeting are distributed to all invitees, including parameter-level evaluations, overall use-support recommendations and all comments (Figure 2 below). Invitees are asked to identify AUIDs they wish to discuss; an agenda is developed based on these submissions. The format of this meeting, instead of an exhaustive review of each AUID, is an overview of the process, a general discussion of the watershed and major subwatersheds and a review of requested AUIDs, delisting and natural background candidates. The results of this meeting are the final use-support determinations.

   The analyses and recommendations for each AUID are documented in a database that is archived following the completion of the assessments. Throughout the annual assessment process, care is taken to maintain consistency among the HUC-8 assessment meetings and decisions. This is accomplished via internal training and quality control, the assignment of individual staff to multiple HUC-8 data sets for the expert review and desktop assessments, and the oversight and guidance provided by a technical team and a management team charged with ensuring quality data analysis and consistency among watershed assessment discussions and decisions.

Each water body is assigned to an integrated assessment report category, as shown here in the flow chart in Figure 3. The state of Minnesota elects to not only use the EPA 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 in Appendix A of the *Guidance Manual*.

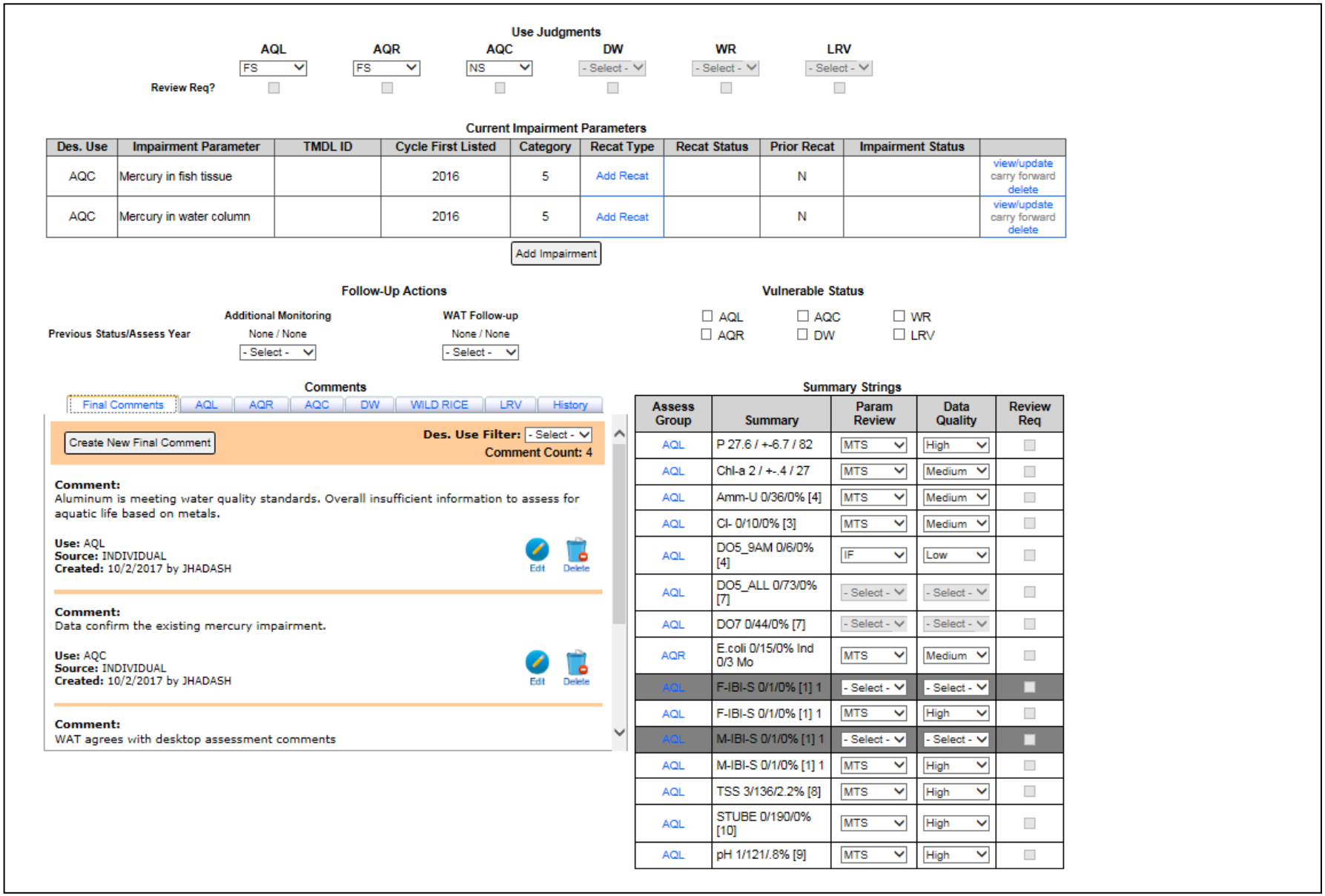
C.3.4. Data age and quality for assessments

The data used in assessment decisions must be of reliable quality and quality assurance/quality control protocols must be carefully followed for each step along the way from field sampling to lab analysis to data management in order to reduce the introduction of errors. Monitoring and data management at the MPCA are performed in accordance with the requirements specified in a Quality Management Plan approved by the EPA and available for review on the MPCA website at https://www.pca.state.mn.us/about-mpca/mpca-quality-system.

While preforming assessments, the evaluator also makes a determination of the quality of the assessment, assigning a low, medium, or high quality rating. These results are stored in a working database and used in the WAT reviews and PJG meetings, with supporting information, to make the final use-support determinations.

The POC for this is Lee Engel at 651-757-2339 or lee.engel@state.mn.us

Figure 2. Example of assessment document



Use Judgments

	AQL	AQR	AQC	DW	WR	LRV
	FS	FS	NS	- Select -	- Select -	- Select -
Review Req?	☐	☐	☐	☐	☐	☐

Current Impairment Parameters

Des. Use	Impairment Parameter	TMDL ID	Cycle First Listed	Category	Recat Type	Recat Status	Prior Recat	Impairment Status	
AQC	Mercury in fish tissue		2016	5	Add Recat		N		view/update carry forward delete
AQC	Mercury in water column		2016	5	Add Recat		N		view/update carry forward delete

Add Impairment

Follow-Up Actions

	Additional Monitoring	WAT Follow-up
Previous Status/Assess Year	None / None	None / None
	- Select -	- Select -

Vulnerable Status

☐ AQL ☐ AQC ☐ WR
☐ AQR ☐ DW ☐ LRV

Comments

Final Comments | AQL | AQR | AQC | DW | WILD RICE | LRV | History

Create New Final Comment

Des. Use Filter: - Select -
Comment Count: 4

Comment:
Aluminum is meeting water quality standards. Overall insufficient information to assess for aquatic life based on metals.

Use: AQL
Source: INDIVIDUAL
Created: 10/2/2017 by JHADASH

Edit Delete

Comment:
Data confirm the existing mercury impairment.

Use: AQC
Source: INDIVIDUAL
Created: 10/2/2017 by JHADASH

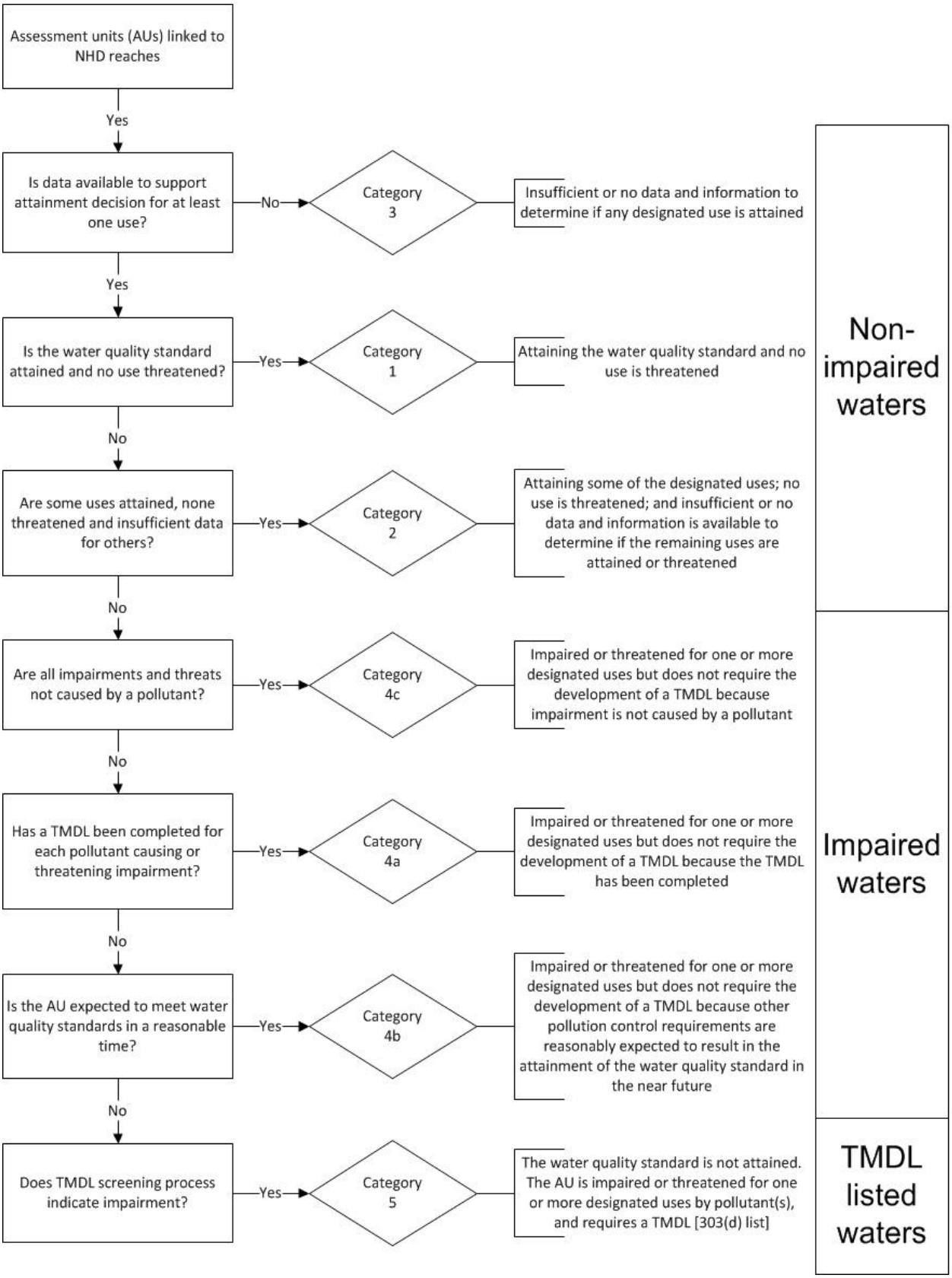
Edit Delete

Comment:
WAT agrees with desktop assessment comments

Summary Strings

Assess Group	Summary	Param Review	Data Quality	Review Req
AQL	P 27.6 / +-6.7 / 82	MTS	High	☐
AQL	Chl-a 2 / +-.4 / 27	MTS	Medium	☐
AQL	Amm-U 0/36/0% [4]	MTS	Medium	☐
AQL	Cl- 0/10/0% [3]	MTS	Medium	☐
AQL	DO5_9AM 0/6/0% [4]	IF	Low	☐
AQL	DO5_ALL 0/73/0% [7]	- Select -	- Select -	☐
AQL	DO7 0/44/0% [7]	- Select -	- Select -	☐
AQR	E.coli 0/15/0% Ind 0/3 Mo	MTS	Medium	☐
AQL	F-IBI-S 0/1/0% [1] 1	- Select -	- Select -	☐
AQL	F-IBI-S 0/1/0% [1] 1	MTS	High	☐
AQL	M-IBI-S 0/1/0% [1] 1	- Select -	- Select -	☐
AQL	M-IBI-S 0/1/0% [1] 1	MTS	High	☐
AQL	TSS 3/136/2.2% [8]	MTS	High	☐
AQL	STUBE 0/190/0% [10]	MTS	High	☐
AQL	pH 1/121/.8% [9]	MTS	High	☐

Figure 3. Flowchart of non-impaired waters, impaired waters and TMDL listed waters



C.4. Impaired waters

C.4.1. Impaired Waters List

Minnesota's Impaired Waters List can be found on the MPCA website at: https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list. The Impaired Waters List is considered final until EPA provides MPCA with approval. The MPCA will use the ADB for integrated reporting. The Category 5 Assessment Units in the ADB will match what is in the submitted Impaired Waters List. Pollutants listed in the MPCA's 2018 proposed Impaired Waters List are in Table 13. These are the number of impairments, caused by each, in streams, lakes and wetlands.

Table 13. Impaired waters and TMDL-listed waters

Pollutant in 2016 draft Impaired Waters List	Total number of impairments	Number of impairments requiring a TMDL
Mercury in fish tissue/water column	1654	406
Nutrient/eutrophication biological indicators	696	303
Escherichia coli/Fecal Coliform	731	304
Aquatic macroinvertebrate bioassessments	621	560
Fishes bioassessments	637	599
Total suspended solids/Turbidity	371	196
PCB in fish tissue/water column	91	91
Dissolved oxygen	140	98
Chloride	50	9
Nitrates	18	3
Aquatic plant bioassessments	12	12
Perfluorooctane Sulfonate (PFOS) in fish tissue/water column	11	11
Arsenic	8	0
pH	6	4
Aluminum	4	0
Ammonia, unionized	4	4
DDT	5	5
Dieldrin	5	5
Chlopyrifos	9	9
Lack of a cold water assemblage	4	2
Dioxin (including 2,3,7,8-TCDD)	3	3
Toxaphene	3	3
Acetochlor	1	1
Temperature, water	1	0
Copper	1	0
Total	**5086**	**2628**

Based on Minnesota's 2018 draft Impaired Waters List from April 4, 2018.

C.4.2. Total maximum daily loads 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 NPSs of each pollutant that violates standards. Water Quality 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.

As of March 2018, Minnesota has 2,222 non-mercury impairments in development for TMDLs and 1,164 TMDLs approved, or in implementation, and 45 impairments for which a TMDL is not required. There are also 1,248 mercury impairments included in Minnesota's statewide Mercury TMDL. The state is currently on schedule to complete TMDL studies by their target dates. Forty-six previously impaired waters are now meeting WQS due to corrective actions.

The POC is Miranda Nichols at 651-757-2614 or miranda.nichols@state.mn.us.

C.4.2.1. Strategies the MPCA employs in the impaired waters restoration process

C.4.2.1.1. State funding

The CWLA was passed in 2006 to protect, restore, and preserve the quality of Minnesota's surface waters. An initial one-time appropriation for FY2007 was followed by another one-time appropriation for FY2008-2009 to increase monitoring and assessment, and start a number of new TMDL studies and restoration and protection projects. Additional funding was needed to maintain the ability of MPCA and local partners to assess the quality of lakes, rivers and streams, and complete TMDL studies.

Minnesota voters approved the Clean Water, Land and Legacy Amendment in 2008, which increased the sales and use tax rate by three-eighths of 1% on taxable sales starting July 1, 2009 through 2034. Approximately 33% of those funds are dedicated to the CWF. Of the sales tax receipts received since 2009, the Minnesota Legislature appropriated approximately $152.2 million for FY2010-2011, $179.4 million in FY2012-2013, $182.5 million in FY2014-2015, and $228.3 million in FY2016-2017. The MPCA is using these funds to meet the requirements of the federal CWA and the state CWLA which focuses on existing restoration and protection programs. These funds should enable us to keep on track with state goals. More information on current funding can be found on the following websites:

- CWA: https://www.epa.gov/laws-regulations/summary-clean-water-act
- CWLA: https://www.revisor.mn.gov/statutes/?id=114D
- CWF: http://www.legacy.leg.mn/funds/clean-water-fund

Minnesota state agencies, local government, and nonprofit organizations are spending CWFs on hundreds of projects to protect and restore the state's surface water, groundwater, and drinking water. Project categories include water-quality monitoring and assessment, watershed restoration and protection strategies, protection and restoration implementation activities, and drinking water protection activities.

C.4.2.1.2. Partnering with local government

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 EPA. 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.

C.4.2.1.3. Working with private consultants

The MPCA and local government often employ 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.

The POC is Celine Lyman at 651-757-2541 or celine.lyman@state.mn.us.

C.4.2.1.4. Strategies for Waters Impaired by Mercury and Other Toxic Pollutants

Mercury can be carried great distances on wind currents before it eventually falls on our land and water bodies. In fact, about 90% of the mercury deposited from the air in Minnesota comes from other states and countries. Therefore, the traditional TMDL approach to addressing impairments will not work for mercury, as Minnesota cannot control the many sources of this toxic pollutant outside our borders.

The MPCA's statewide Mercury TMDL was approved by EPA in March 2007, and an implementation plan was completed in October 2009. The implementation plan includes measures to reduce mercury from airborne sources such as coal-fired power plants. For more information on the Mercury TMDL and implementation plan, go to: https://www.pca.state.mn.us/water/statewide-mercury-reduction-plan.

The POC is Bruce Munson at 651-757-2579 or bruce.monson@state.mn.us.

The MPCA has undertaken a Metropolitan Area Chloride Project, partnering with local and state experts in the seven-county metro area to evaluate and address chloride impairments. This project included extensive data analysis, a literature review, a telephone survey of local municipalities, and analysis of potential strategies for further research, public education, and potential regulation. The Twin Cities Metropolitan Area (TCMA) Chloride Management Plan (CMP) was also developed as part of this effort. The CMP incorporates water quality assessment, source identification, implementation strategies, monitoring recommendations, and measurement and tracking of results into a performance-based adaptive approach for the TCMA. While this plan was developed to address chloride impacts specifically to waters in the TCMA, the restoration and protection goals, implementation strategies, and monitoring and tracking recommendations can be applied statewide. For more information, see https://www.pca.state.mn.us/water/road-salt-and-water-quality.

The POC is Brooke Asleson at 651-757-2205 or brooke.asleson@state.mn.us.

C.4.2.1.5. Strategies to increase the effectiveness and efficiency of total maximum daily load 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:

Minnesota watershed approach on the 10-year cycle

The state of Minnesota has adopted a Watershed Approach (https://www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-quality) on a 10-year cycle to address the water quality of the state. The scale is based on the major watershed, or more specifically the 8-digit hydrologic unit code or HUC. Minnesota has 80 HUC8 watersheds. In a 10-year period, all 80 watersheds will be intensively monitored or sampled, assessed for impaired waters and waters in need of protection, modeled with USGS Hydrological Simulation Program-FORTRAN, and investigated for biological stressors. Using this data, the needed TMDLs will be developed according to the 10-year cycle.

The Minnesota Watershed Approach has two parts: impaired waters will have strategies for restoration, and waters that are not impaired will have strategies for protection. The analysis of the data from MPCA and their partners are relayed to the local partners and citizens for each watershed through advanced community engagement techniques. The end result for local stakeholders is the WRAPS report that highlights the problem subwatersheds and sets out strategies for implementation in local watershed plans.

The WRAPS report summarizes current water quality conditions from the technical data; identifies the stressors and sources; and lists impaired water bodies with associated TMDLs, as well as water bodies needing protection. In the WRAPS, the critical section is the strategies table, where each impairment/protection need is assigned a list of strategies or types of conservation practices that will effectively address the problem. Similar information is shared with EPA in the annual Environmental Performance Partnership Agreement reporting cycle.

The Minnesota Watershed Approach will implement *Minnesota's TMDL Priority Framework*. MPCA has prioritized TMDLs for the years 2016-2022 as part of EPA's **Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program**. These TMDL priorities are a subset of our Section 303(d) list and reflect our priorities identified by the TMDL Start and Completion dates on the list. Minnesota's TMDL priorities identified for the prioritization goal of EPA's Long-Term Vision are those water bodies listed for conventional pollutants with an estimated TMDL Completion date of 2021 or earlier. Waterbodies listed for nonconventional pollutants (chloride and mercury for example) will continue to be done according to the 303(d) list dates, but they will be done through a separate process rather than through the watershed approach. A small number of water bodies listed for conventional pollutants have been deferred to later dates when Cycle 2 of the watershed approach is in progress.

- 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 MNDNR, BWSR, and the MDA on many of these programs. BWSR is working with other state and local water resource agencies to develop One Watershed, One Plan. The purpose is to align local water planning on major watershed boundaries with state strategies towards prioritized, targeted and measurable implementation plans. One Watershed, One Plan will result in plans with prioritized, targeted, and measurable implementation actions that meet or exceed current water plan content standards.

- Agency roles and responsibilities – a 2013 report to the Minnesota Legislature entitled Water Governance Evaluation and summarizes the roles and responsibilities of Minnesota's state agencies engaged in water management.
- The CWF Interagency Coordination Team (ICT) is a group of assistant commissioners and senior managers from state agencies that receive and administer appropriations from the CWF. At the request of state agency commissioners and directors, Environmental Initiative facilitated Clean Water Roadmap meetings with this group. ICT members were responsible for drafting proposals and providing technical assistance as clean water goals were developed. The ICT received input and guidance from state agency leadership, the Clean Water Council, and other stakeholders throughout the process.
- A Clean Water Fund ICT was established in 2006 for the purposes of:
  - Coordinating state agency clean water activities
  - Coordinating and leveraging funding opportunities
  - Enhancing institutional knowledge for future water management activities, and
  - Providing consistent information for public use, reporting and administrative procedures.
- The ICT oversees the interagency subteams to achieve sustainable management and protection of the state's surface water and groundwater resources.
- On the federal level, the MPCA is working with the Natural Resource Conservation Service (NRCS), the USGS, and other agencies. The MPCA has also worked with the EPA on direct assistance on some TMDLs. The Minnesota Agricultural Water Quality Certification Program is the product of a state-federal partnership that includes the MDA, MPCA, BWSR, MNDNR, NRCS, and EPA. A Memorandum of Understanding was signed on January 17, 2012, by Minnesota Governor Mark Dayton, U.S. Agriculture Secretary Tom Vilsack, and EPA Administrator Lisa Jackson. This document formalizes the state-federal partnership and confirms the joint commitment to developing and implementing the program. For more information, see: http://www.bwsr.state.mn.us/planning/1W1P/index.html.
- Documents:
  - Minnesota's TMDL Priority Framework: https://www.pca.state.mn.us/sites/default/files/wq-iw1-54.pdf
  - EPA's Long-Term Vision: https://www.epa.gov/sites/production/files/2015-07/documents/vision_303d_program_dec_2013.pdf
  - Water Governance Evaluation: https://www.pca.state.mn.us/sites/default/files/lrwq-gen-1sy13.pdf

The POC is Celine Lyman at 651-757-2541 or celine.lyman@state.mn.us.

C.4.2.1.6. Goal setting and performance measurement

2016 Clean Water Fund Performance Report

Minnesota agencies released their third collaborative report in February 2016, as required by the CWLA to help Minnesotans clarify connections between CWFs invested, actions taken and outcomes achieved. Twenty-seven measures in the report provide a snapshot of how CWF dollars are being spent and what progress has been made. The measures are organized into four categories: investment, surface water quality, drinking water protection, and external drivers and social measures. Each measure has detailed status ranking and trend information.

The report, the summary document and the metadata sheets can be found at Minnesota's Legacy website (http://www.legacy.leg.mn/funds/clean-water-fund).

The POC is Pam Anderson at 651-757-2190 or pam.anderson@state.mn.us.

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 the *Guidance Manual*. This report, along with Minnesota's past and present versions of the Impaired Waters List, may be found at: https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list.

C.5. Wetlands update

Even after nearly 50% of its historic wetlands were drained, Minnesota leads the conterminous US in inland (Lacustrine, Palustrine, and Riverine) wetland area with over 10 million acres of nontidal and non-estuarine wetlands. Minnesota's wetland resource is not only large, but also is diverse and regionally very different. Regional differences require consideration in developing the state's regulatory, monitoring, restoration, and management practices. Minnesota is committed to monitoring wetlands throughout the state through statewide probabilistic wetland quantity and quality surveys. Recent results of these two surveys have been released (see Kloiber 2010, Kloiber and Norris 2013, Genet 2012, & Section C.4.5.3).

C.5.1. Wetland regulatory program

The 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. Stat. § 103A.201). Several non-wetland specific regulatory programs including the 404/401 certification permit program, the MNDNR Public Waters Permit Program and the NPDES Permit Program (including stormwater) align with the WCA and the Federal Food Security Act "Swampbuster", to provide broad oversight of most types of direct and indirect physical alteration to Minnesota wetlands.

Minnesota actively implements Section 401 of the federal CWA (401 certification) based on state water quality standards (Minn. R. ch. 7050), including the wetland WQ standards. Many, though not all, of the Section 401 certification actions, in Minnesota, involve wetland waters.

Figure 4 illustrates the number of MPCA individual Section 401 certifications by industry category from 2012-2013. Infrastructure projects, such as road construction, trails, airports, pipelines, waste management, and stormwater and power lines represent the most common project type affecting wetlands. These data generally do not include agricultural land improvement projects. Figure 5 presents the number of statewide Section 401 WQ certifications by the type of determination action; certify, deny and wave. During this time period the MPCA issued slightly more waivers than certifications. The MPCA recognizes that 401 WQ Certification as an important regulatory tool which has contributed measurable protection to Minnesota's valuable wetlands and watersheds.

Figure 4. Minnesota Section 401 water quality certifications by category between 2014-2015

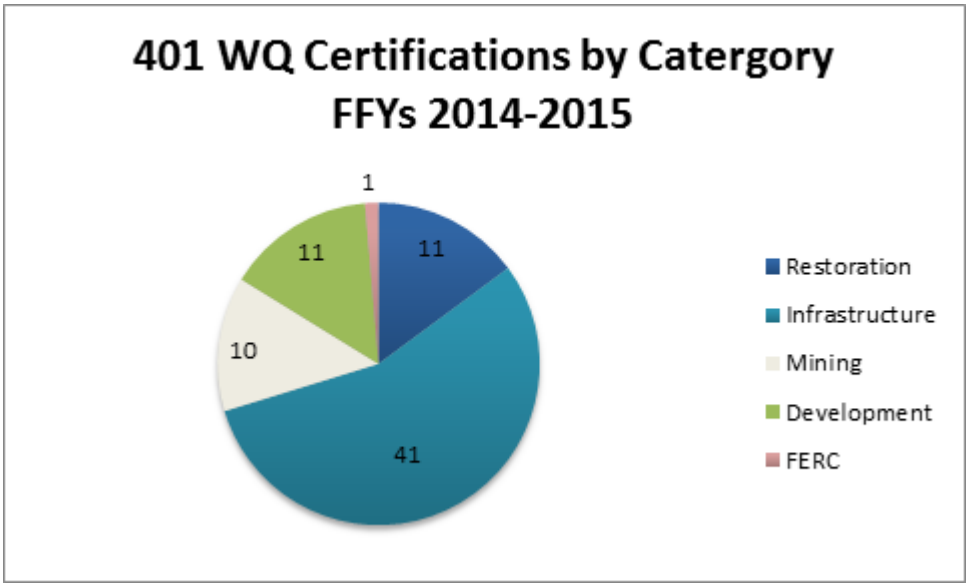
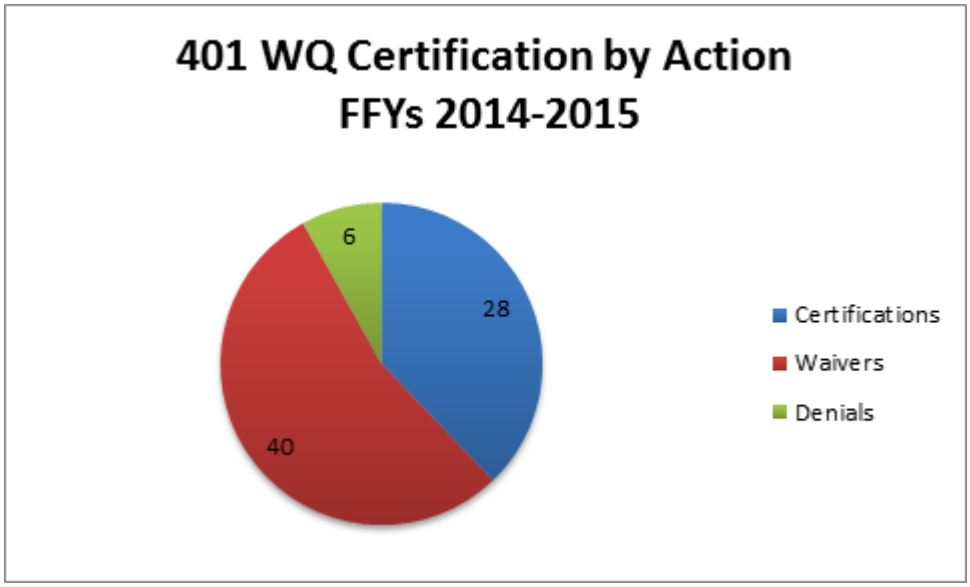


Figure 5. Minnesota Section 401 water quality certification by action between 2014-2015



The POC is Jim Brist at 651-757-2245 or jim.brist@state.mn.us.

C.5.2 Wetland mapping, monitoring and assessment.

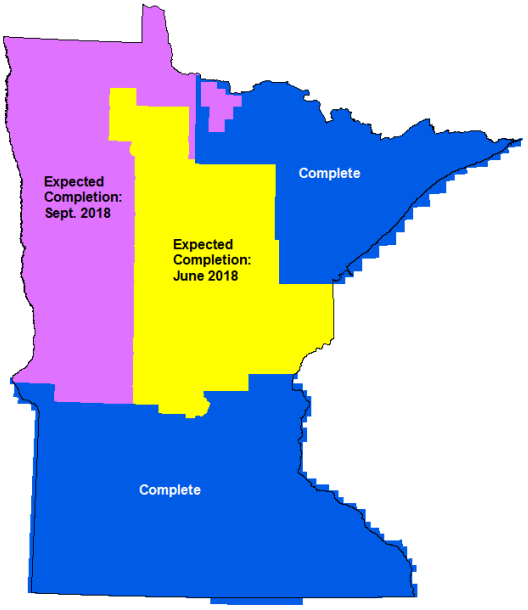
C.5.2.1. Updating state National Wetland Inventory coverage

Minnesota's original coverage of the national wetland inventory (NWI) dates to the late 1970's and early 1980's. The state is about ¾ way through a multiple phased plan to update the NWI (Figure 6) under the direction of the MN Department of Natural Resources. Financial support for Minnesota's NWI update has mostly come from the Legislative Citizen's Commission on Minnesota's Resources with funding originating from the Minnesota Environment and Natural Resources Trust Fund. Minnesota's NWI mapping procedures and products comply with the Federal Geographic Data Committee wetland mapping standards.

Updated NWI data for the East Central Region were released August 2013, updates for southern Minnesota and three special project updates in northern MN were posted for public use in June 2015 and Updated wetland data for NE MN became available in July 2016. Figure III 5 illustrates published updated wetland data for Minnesota as of November 2017.

Updated wetland data for North Central Minnesota are planned for June 2018. The NW region of the state should be available September 2018. The last phase of the update including edge-matching line-work across the multiple phases and a statewide mosaic are to be delivered by December 2018. Updated wetland data are available from the Minnesota Geospatial Commons https://gisdata.mn.gov/ and from the U. S. Fish and Wildlife Service NWI Mapper https://www.fws.gov/wetlands/data/mapper.HTML. Updates include current wetland polygons classified in accordance with federal standards, NWI plus Hydrogeomorphic functional attributions and also attributions of the regional wetland plant community classification known as Eggers and Reed.1

Figure 6. Status of Minnesota's National Wetland Inventory as of November 2017.



More information about the status of and the process used for the Minnesota NWI update is available at http://www.dnr.state.mn.us/eco/wetlands/nwi_proj.html.

C.5.2.2. Indicator development – floristic quality assessment 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 effective assessment indicators, Floristic Quality Assessment (FQA) provides another robust approach to assessing wetland integrity based on plant communities. MPCA's Biological Monitoring Program has committed significant resources toward developing standardized FQA sampling protocols and science derived, defensible FQA assessment criteria suitable for use in all 14 of Minnesota's common wetland plant communities. Minnesota used FQA indicators in their fieldwork for the state wetland intensification survey during 2011 and 2012. Recently a standardized Rapid FQA assessment method manual (MPCA 2012) and Rapid FQA assessment Calculator was published

[1] Steve D. Eggers, Donald M. Reed. 2014. Wetland Plants and Plant Communities of Minnesota and Wisconsin, Version 3.1. U.S. Army Corps of Engineers, St. Paul District, 478 pp.

(https://www.pca.state.mn.us/water/floristic-quality-assessment) to facilitate effective use of FQA by agency and outside users.

C.5.2.3. Minnesota wetland status and trends monitoring

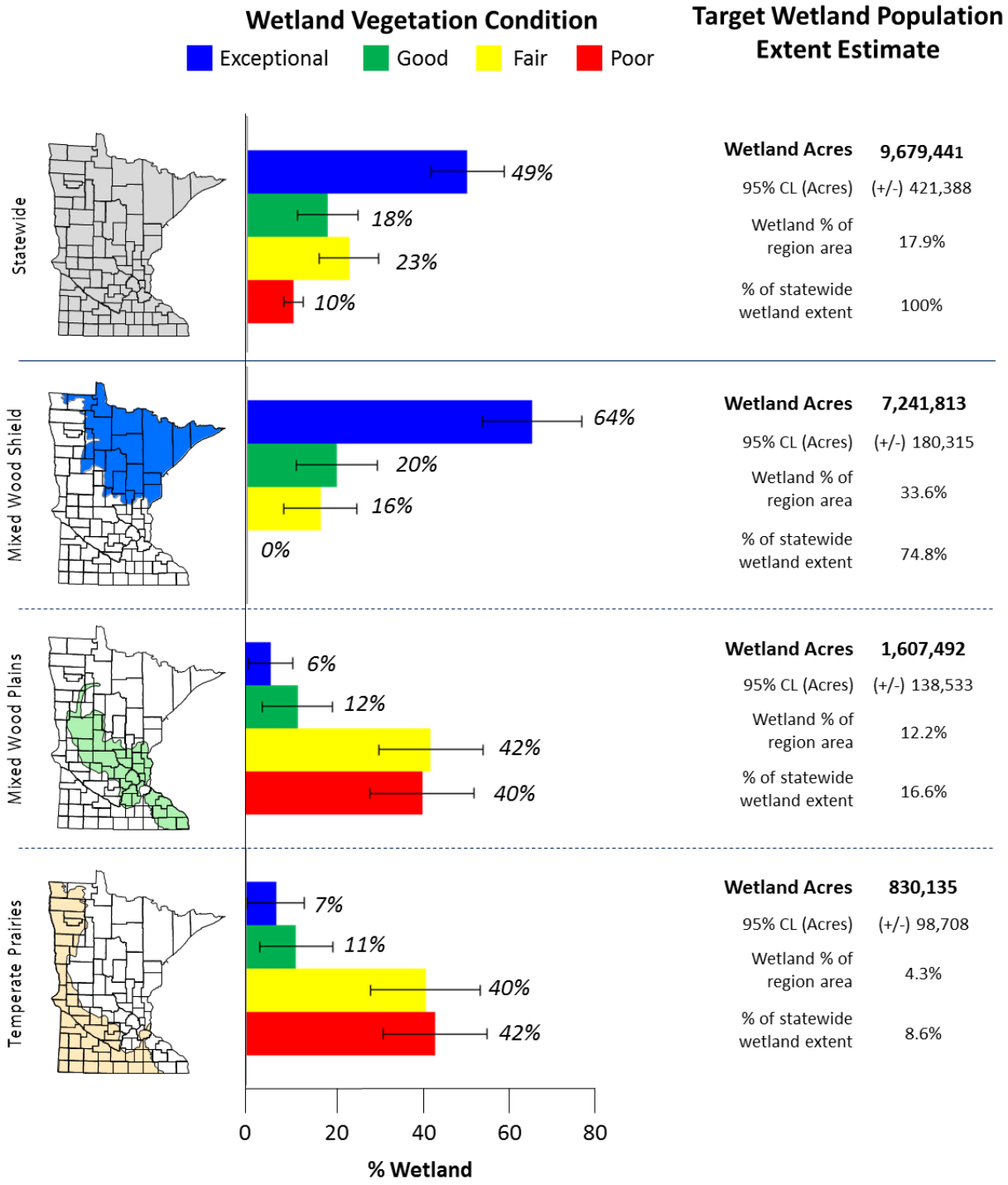
In 2006, Minnesota initiated a comprehensive status and trends Minnesota Wetland Status and Trends Monitoring Program to begin tracking wetland quantity and quality changes over time. Implementation of the program is accomplished using statewide and regional probabilistic surveys to quantify broad changes. These surveys are done with assistance and (in one case) in conjunction with EPA.

The MN Department of Natural Resources is the lead agency for the quantity survey. Data collection is completed on 3-year cycle and results from two cycles (2006-08 and 2009-11) have been completed and reported. The initial cycle established the modern statewide wetland quantity baseline at 10.62 million acres with large regional differences in the state (Kloiber 2010). The large majority of Minnesota's wetlands occur in the northern forested region. The remainder of the state, where agricultural development is widespread, has had significant (40-95%) historical wetland losses. The second survey cycle, showed a very small (but significant) increase in wetland acreage in Minnesota (Kloiber and Norris 2013. However, there was also significant conversion of vegetated wetlands to farmed wetlands and the majority of the wetland gains were open water wetlands. While the acreage stayed the same (or slightly increased) the changes may represent a decrease in wetland quality (Kloiber and Norris 2013). For more information on the status and trends of wetland quantity please visit http://www.dnr.state.mn.us/eco/wetlands/wstm_prog.html.

The MPCA is the lead agency for wetland quality status and trends monitoring. In 2011-12, the MPCA worked in conjunction with EPA on the National Wetland Condition Assessment (NWCA). An intensification of the NWCA was completed to establish a vegetation condition baseline for all wetland types at statewide and regional scales (MPCA 2015). Overall, Minnesota's wetland vegetation condition is high; however, condition varies widely in different parts of the state (Figure 7). In the Mixed Wood Shield (i.e., northern forest) ecoregion, wetland vegetation is predominately in exceptional to good condition. The exact opposite is true in the largely agriculturally developed Mixed Wood Plains (i.e., hardwood forest) and Temperate Prairies ecoregions—where > 80% of the wetland extent is in fair or poor condition. These regional differences explain the statewide results. As approximately 75% of Minnesota's wetlands occur in the Mixed Wood Shield, the high levels of condition found there largely mask the smaller wetland extent—but widespread degraded conditions—found in the remainder of the state. Non-native invasive plants—which are associated with all other types of stressors observed—is the most widespread wetland vegetation condition stressor. For the full report, please visit https://www.pca.state.mn.us/water/wetland-quality-status-and-trends-monitoring. The MPCA anticipates continuing this survey on a 5-year basis in conjunction with the NWCA. The second iteration of sampling was completed in 2016. We anticipate reporting results by 2019.

In addition, the MPCA is conducting a similar iterative probabilistic survey of depressional wetland quality. Depressional wetlands that have open water and marsh vegetation are a small (6% of the statewide wetland extent over approximately 160,000 wetland basins) but iconic portion of Minnesota's wetland resource. Two depressional survey iterations have been completed (2007-09 and 2012) that measure both vegetation and invertebrate condition in the Mixed Wood Plains and Temperate Prairie ecoregions—where depressional wetlands are more common. The 2007-09 depressional wetland baseline vegetation condition (based on the number of basins) in these two ecoregions was 18% good/23% fair/59% poor. The invertebrate condition baseline was 41% good/35% fair/24% (Genet 2012). No significant changes in condition were detected between 2007-09 and 2012 (Genet 2015). For more information, please visit https://www.pca.state.mn.us/water/wetland-quality-status-and-trends-monitoring. The third iteration of sampling was completed in 2017. We anticipate reporting results by 2019.

Figure 7. Biological condition of Minnesota's depressional wetlands and ponds according to macroinvertebrate and plant IBIs, including the estimated number of wetlands within each condition category. Bracketed lines represent the width of the 95% confidence interval associated with each estimate. Percentages may not add up to 100% due to rounding.



The POCs are Michael Bourdaghs at 651-757-2239 or michael.bourdaghs@state.mn.us; John Genet at 651-757-2386 or john.genet@state.mn.us.

Wetland literature cited

Genet, John. 2012. Status and Trends of Wetlands in Minnesota: Depressional Wetland Quality Baseline. wq-bwm1-06. Minnesotat Pollution Control Agency, St. Paul, MN. http://www.pca.state.mn.us/index.php/view-document.html?gid=17741

Genet, John. 2015. Status and Trends of Wetlands in Minnesota: Depressional Wetland Quality Assessment (2007-2012). wq-bwm1-08. Minnesota Pollution Control Agency, St. Paul, MN. https://www.pca.state.mn.us/sites/default/files/wq-bwm1-08.pdf

Kloiber, S.M. 2010. Status and Trends of Wetlands in Minnesota: Wetland Quantity Baseline. Minnesota Department of Natural Resources. St. Paul, MN.

Kloiber, S.M. and Norris, D.J. 2013. Status and Trends of Wetlands in Minnesota: Wetland Quantity Trends from 2006 to 2011. Minnesota Department of Natural Resources. St. Paul, MN.

Minnesota Pollution Control Agency (MPCA). 2015. Status and Trends of Wetlands in Minnesota: Vegetation Quality Baseline. wq-bwm-1-09. Minnesota Pollution Control Agency, St. Paul, MN. https://www.pca.state.mn.us/sites/default/files/wq-bwm1-09.pdf

C.6. Trends analysis

C.6.1. Water quality trends for Minnesota rivers and streams

Long-term trend analysis of 7 different water pollutants measured at 80 locations across Minnesota for more than 30 years shows consistent reductions in five pollutants, but consistent increases in two pollutants. Concentrations of TSS, phosphorus, ammonia, BOD, and bacteria have significantly decreased, but nitrate and chloride concentrations have risen, according to data from the MPCA's "Milestone" monitoring network. Recent, shorter-term trends are consistent with this pattern, but are less pronounced. Pollutant concentrations show distinct regional differences, with a general pattern across the state of lower levels in the northeast to higher levels in the southwest.

These trends reflect both the successes of cleaning up municipal and industrial pollutant discharges during this period, and the continuing challenge of controlling the more diffuse "nonpoint" polluted runoff sources and the impacts of increased water volumes from artificial drainage practices.

Detailed information regarding the water quality trends at the Milestone sites is available at: https://www.pca.state.mn.us/sites/default/files/wq-s1-71.pdf. Information specifically on nitrogen trends at the Milestone sites is available at: https://www.pca.state.mn.us/sites/default/files/wq-s6-26c1.pdf. Changes to the methodology for the stream trend analysis are currently underway. Updated results through 2017 will be available in spring 2018.

The POC is Dave Christopherson at 651-757-2849 or david.christopherson@state.mn.us.

In 2010, the Minnesota Milestones effort was replaced by the Watershed Pollutant Load Monitoring Network, which consists of permanent flow and chemistry monitoring sites on a basin, major watershed, and subwatershed scale. A number of the load monitoring sites are located at former Minnesota Milestones sites. The load monitoring stations will, in the future, be used to provide information about long-term water quality trends in Minnesota rivers. Information about the Watershed Pollutant Load Monitoring Network is available at: https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring-network.

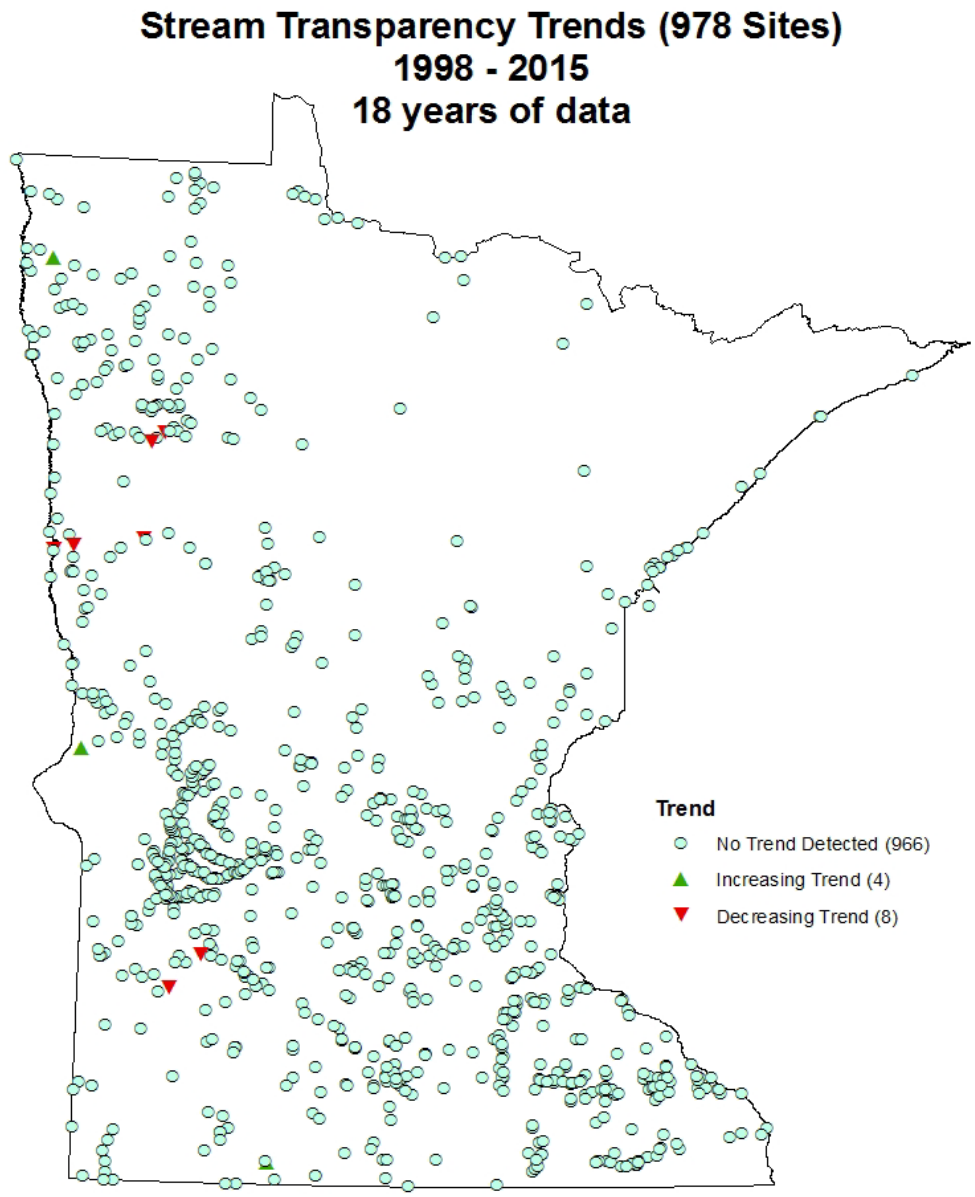
Trend analysis of stream water clarity data has also recently been done using all stream and river transparency measurements available in EQuIS, including those collected by volunteers through the

Citizen Stream Monitoring Program. For data collected through 2015, of the 968 stream sites with sufficient data, four exhibited a statistically significant increase in transparency over time. In contrast, eight exhibited a statistically significant decrease in transparency. Nine hundred fifty-six of the assessed stream sites showed no evidence of a trend in either direction.

Table 14. Trends in Minnesota stream water clarity

Description	Number of Stream Sites
Assessed for Trends	968
Increasing Trend	4
Decreasing Trend	8
No Evidence of Trend	956

Figure 8. Secchi transparency trends 1998 – 2015



The POC is Laurie Sovell at 651-757-2750 or laurie.sovell@state.mn.us.

C.6.2 Biology

Every five years the MPCA conducts a statewide probabilistic survey of rivers and streams in Minnesota to evaluate biological condition. The latest iteration of this survey was completed in 2015, the results of which are presented here. Each site sampled was evaluated using an IBI based on fish community and aquatic invertebrate community attributes, independently. These IBI scores were compared to thresholds unique to each stream class that are based on characteristics of the sampling location including region (e.g., northern vs. southern), drainage area, and gradient (see Table 15). There are nine fish and nine invertebrate IBI classes used by the MPCA to assess the aquatic life designated use of rivers and streams. Within five of the fish IBI classes and four of the invertebrate IBI classes there are distinct thresholds for general and modified (i.e., channelized) aquatic life use streams. These thresholds, along with those for exceptional use streams (not used in this analysis), represent criteria for use in a tiered aquatic life use (TALU) framework that was adopted into water quality standards in November 2017. Therefore, the IBI results from each survey site were compared to the appropriate threshold in relation to stream classification and channel condition, providing an approximation of its aquatic life use support status.

Table 15. Fish and invertebrate IBI thresholds used for exceptional, general, and modified aquatic life use streams

Class #	Class Name	Exceptional Use	General Use	Modified Use
		Fish		
1	Southern Rivers	71	49	NA
2	Southern Streams	66	50	35
3	Southern Headwaters	74	55	33
4	Northern Rivers	67	38	NA
5	Northern Streams	61	47	35
6	Northern Headwaters	68	42	23
7	Low Gradient Streams	70	42	15
10	Southern Coldwater	82	50	NA
11	Northern Coldwater	60	35	NA
		Macroinvertebrates		
1	Northern Forest Rivers	77	49	NA
2	Prairie Forest Rivers	63	31	NA
3	Northern Forest Streams RR	82	53	NA
4	Northern Forest Streams GP	76	51	37
5	Southern Streams RR	62	37	24
6	Southern Forest Streams GP	66	43	30
7	Prairie Streams GP	69	41	22
8	Northern Coldwater	52	32	NA
9	Southern Coldwater	72	43	NA

Figure 9. Estimated percent of stream miles that meet (i.e., Yes) invertebrate IBI TALU criteria

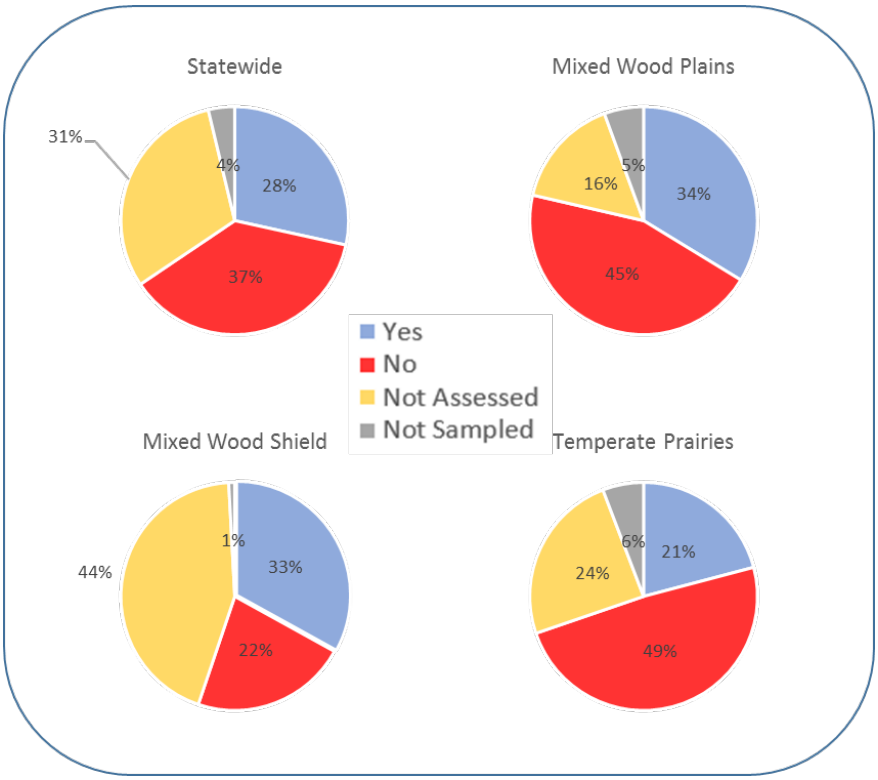
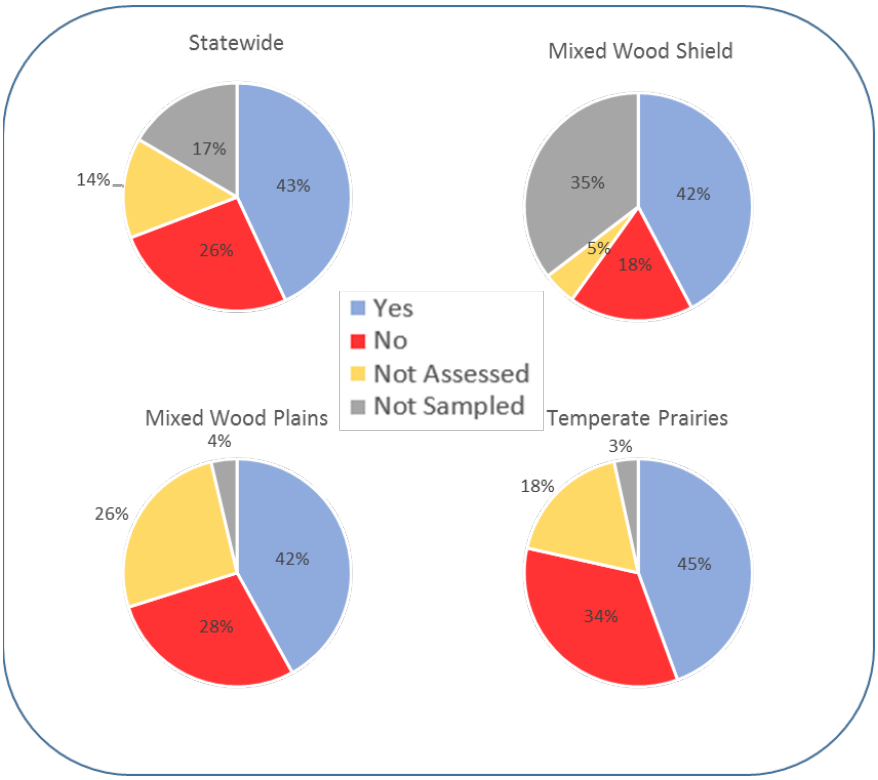
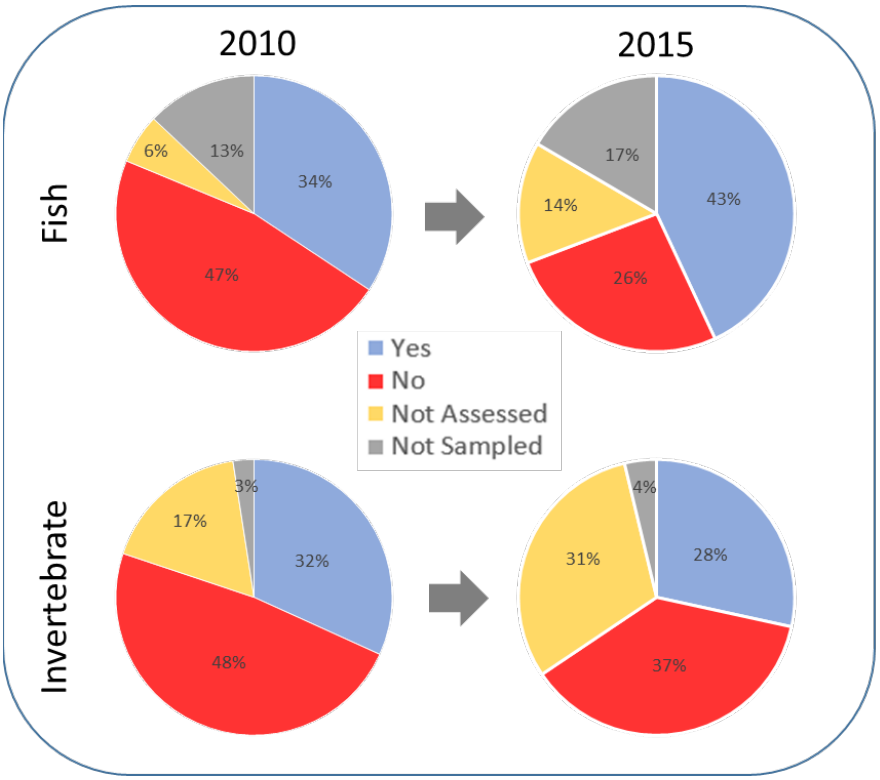


Figure 10. Estimated percent of stream miles that meet (i.e., Yes) fish IBI TALU criteria



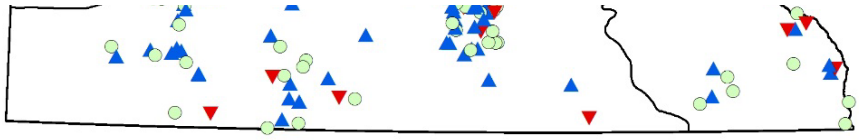
The 2015 results indicate that about 43% of the stream miles statewide support aquatic life (general or modified) based on fish IBI results, and 28% support aquatic life based on invertebrate IBI results. These percentages shown in Figures 9 and 10 also demonstrate some ecoregion dissimilarity; for example, the percentage of streams supporting invertebrate aquatic life criteria (i.e., Yes) in the Temperate Prairie region is less than the corresponding statewide estimate while the Mixed Wood Plains and Mixed Wood Shield both exceed the statewide estimate. Estimates of the percentage of stream miles in Minnesota supporting aquatic life use did not change significantly between 2010 and 2015 regardless of the community type used to derive the estimates. Fish IBI results did yield a significant change in the estimated percent of stream miles not supporting aquatic life, decreasing by ~20% in the 5-year period (Figure 11). However, this decrease was partially due to increases in the percentage of not sampled and not assessed stream miles. Therefore, it is premature to draw conclusions at this early stage of the long-term status and trends monitoring program. Future iterations of the survey will provide a clearer picture of aquatic life condition trends in Minnesota resulting from the implementation of watershed restoration and protection strategies.

Figure 11. Comparison of 2010 and 2015 statewide condition estimates based on fish and aquatic invertebrate IBI results



C.6.3. Water quality trends for Minnesota lakes

Detecting temporal water quality trends requires many measurements each summer and several years' worth of data. In Minnesota, Secchi transparency is the best measurement for this purpose because of the large number of lakes with Secchi measurements and the long records on numerous lakes. While a variety of statistical tests may be used to perform trend analysis, we have long used the seasonal Kendall's tau-b. In our analysis we include all lakes with June through September Secchi data that has a minimum of 8 years and 25 pairs of data. The process is automated using a routine in the statistical software package R.



).

Table 16. 2015 Lake transparency trend assessment

Description	Number of Lakes	% of lakes
Lakes with Secchi data	**4,520**	
Assessed for Trends	**1,624**	**36%**
Increasing trend	**400**	**25%**
Decreasing trend	**155**	**10%**
No evidence of trend	**1,069**	**65%**

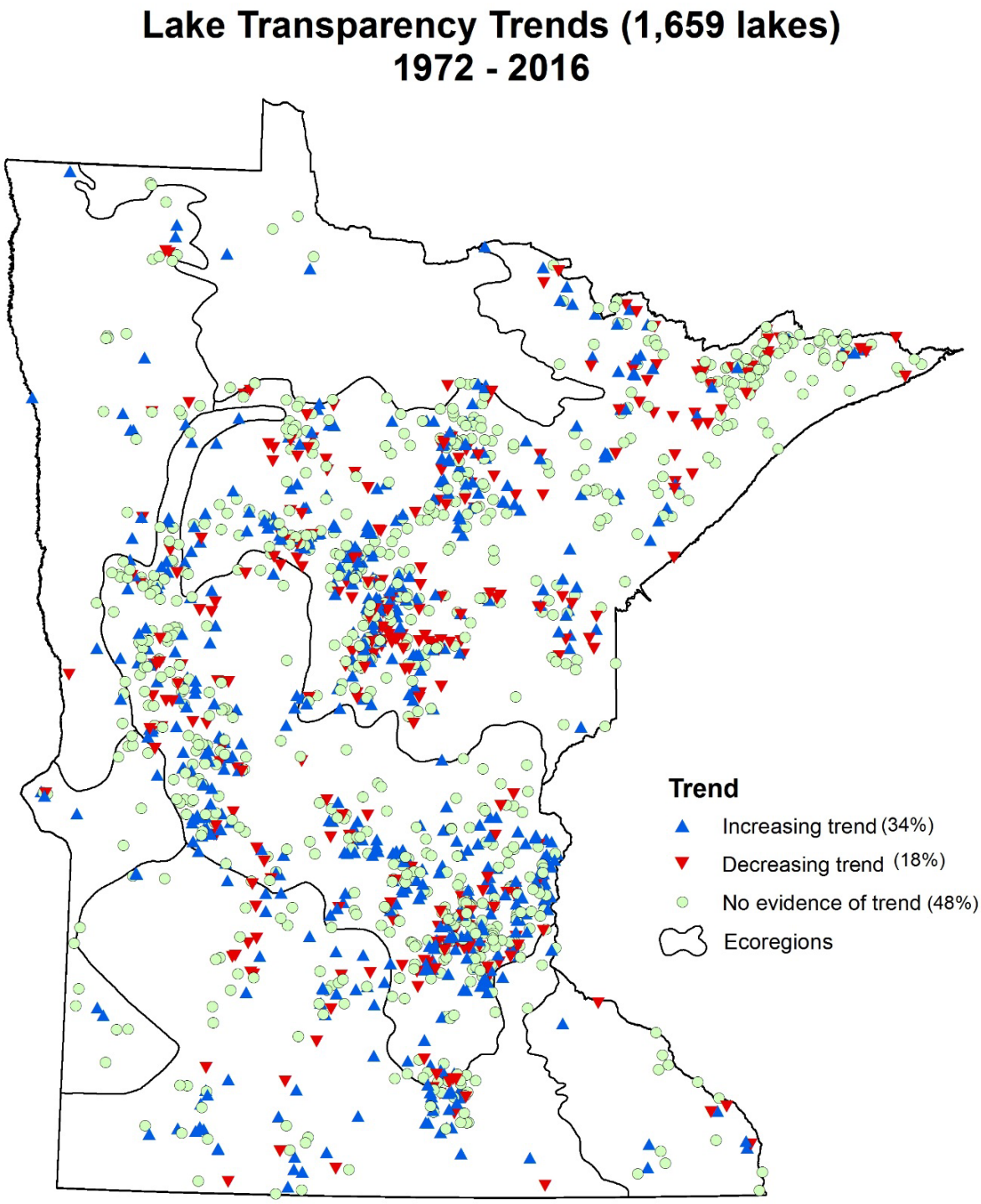
The report "A review of Secchi transparency trends in Minnesota lakes" (Heiskary, S. and Egge, L. 2016) examines trend information and provides insights into factors that affect the transparency and quality of Minnesota's lakes. To view the report in its entirety, visit https://www.pca.state.mn.us/water/secchi-transparency-trends-minnesota-lakes.

In addition, the Sentinel Lakes Monitoring Program, a component of Sustaining Lakes in a Changing Environment, which is a long-term collaborative monitoring effort, led by the MDNR, involves long-term monitoring of water chemistry, fisheries, habitat and other factors. The MPCA is a partner in the effort with the primary focus on collection and assessment of water quality data for these lakes. More information about the Sentinel Lakes Monitoring Program is available here: https://www.pca.state.mn.us/water/sentinel-lakes.

Probabilistic (or random) surveys have become an important tool for monitoring the condition of Minnesota's water resources. These surveys provide data sets that yield statistically sound, unbiased estimates of the condition of the state's water bodies, and are very helpful in determining trends in water resource condition over time. Reports developed from Minnesota's participation in the 2007 and 2012 National Lakes Assessment may be found here https://www.pca.state.mn.us/water/national-lakes-assessment-project-nlap.

The POC is Shannon Martin at 651-757-2874 or shannon.martin@state.mn.us.

Figure 12. Lake transparency trends for 1972-2015



C.6.3.1 National Lakes Assessment Survey

Minnesota's participation in the EPA's 2012 National Lake Assessment involved a collaborative approach with other agencies. A total of 1,000 lakes were included in the national survey. Minnesota drew 42 lakes as a part of the initial draw for this statistically-based national survey effort and added 8 lakes to allow for state-based assessment. All 50 lakes received the national level of assessment and contributed to both the state-based and national assessments. In addition, 100 lakes were added from EPA's randomized list of lakes to allow for ecoregion-based assessments (50 per major ecoregion) in Minnesota.

While the data collected are not sufficient for broad, state-scale, assessment of temporal trends, they are valuable for assessing spatial trends (patterns) and provide valuable insight on a variety of lake management issues. Further details may be found at https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring-network.

Part D. Groundwater monitoring and assessment

The state agencies work together to provide a coordinated approach to groundwater monitoring and protection in Minnesota.

D.1. Minnesota's groundwater resources

Minnesota's groundwater is contained within 14 principal aquifers that are composed of unconsolidated sand deposits and a series of bedrock units. The uppermost aquifers in the state are sand and gravel aquifers that are generally of glacial origin. Twelve bedrock aquifers, which generally are composed of sedimentary rocks, underlie the sand and gravel aquifers.

The sand and gravel aquifers are important sources of water supply throughout the state. These aquifers occur throughout Minnesota but are concentrated in the central and western parts. These aquifers primarily were formed by materials deposited during a period of continental glaciation, which occurred about 10,000 to 350,000 years ago. The sand and gravel aquifers are found near the land surface or buried within more impermeable materials. The surficial sand and gravel aquifers are most prevalent in the central part of the state. The buried sand and gravel aquifers occur in areas with thick glacial deposits where multiple glaciations occurred. The sand and gravel aquifers yield moderate to good amounts of water in the central and western parts of the state; elsewhere the yields from these aquifers are limited. For example, northeastern Minnesota has a relatively thin covering of glacial materials overlying crystalline bedrock.

The Prairie du Chien-Jordan, Tunnel City/Wonewoc, and Mount Simon Hinckley are the three main bedrock aquifers used for water supply in Minnesota. These aquifers are composed of limestone, dolostone, and sandstones that generally were deposited when seas covered Minnesota about 500 million years ago. The Prairie du Chien-Jordan is the uppermost of these three aquifers and is highly developed in the Twin Cities Metropolitan Area (TCMA). The Tunnel City/Wonewoc aquifer underlies the Prairie du Chien-Jordan and is an important source of water supply in parts of southeastern Minnesota where the Prairie du Chien-Jordan aquifer is either near the land surface or not present. The Mount Simon/Hinckley aquifer underlies all of southeastern Minnesota and extends as far north as the city of Duluth, Minnesota. Groundwater withdrawals from the Mount Simon/Hinckley aquifer increase substantially north of the TCMA.

Groundwater resources are limited in southwestern and northeastern Minnesota. Surficial sand and gravel aquifers that yield moderate amounts of water are the main groundwater resources in southwestern Minnesota. In this part of the state, the sand and gravel aquifers often are located near streams. Northeastern Minnesota has the most limited groundwater resources in the state because this area is composed of very old crystalline rocks with a thin veneer of glacial materials that yield little water.

D.2. Groundwater protection programs

Minnesota's groundwater protection programs primarily are shared among four state agencies—the MPCA, MDA, MDH, and MDNR (Table D-1), with regional coordination in the TCMA by the Metropolitan Council. The MPCA's programs focus on protecting the state's groundwater from non-agricultural chemical contamination. The MDA's programs protect the groundwater from agricultural chemicals. The MDH is charged with protecting the state's drinking water supplies from groundwater contamination. The MDNR's manage groundwater quantity by regulating water allocation and withdrawals.

The MPCA administers regulatory and monitoring programs that protect the groundwater from contamination by non-agricultural chemicals. The agency's regulatory programs identify, regulate, and remediate spills of non-agricultural contaminants. These include the state's Brownsfields, Emergency Response, Landfills/Dumps, Petroleum Remediation, Resource Conservation and Recovery Act Corrective Action, Superfund, Voluntary Investigation and Cleanup, Subsurface Sewage Treatment System, Feedlot, and Stormwater programs. The MPCA also maintains an ambient groundwater monitoring network to determine the presence and distribution of non-agricultural chemicals and identify any trends. This monitoring also includes an "early warning network" of shallow monitoring wells. The main goal of the "early warning network" is to identify trends in groundwater quality early, so BMPs to reduce contamination can be put in place rather than more-costly remediation.

The MDH administers several programs that protect the public's health from waterborne contaminants. The agency administers the state's Well Management Program that regulates the construction of new wells and the proper sealing of unused ones. The agency also administers the state's Drinking Water and Source Water Protection programs and develops human health-based guidance for groundwater.

The MDA is the lead state agency for regulating pesticides and fertilizers in the state and administers programs, which protect the groundwater from agricultural chemical contamination. The MPCA approves new pesticide products for use in the state in cooperation with the EPA. The MPCA also monitors the groundwater to determine that pesticides are used properly and do not have a harmful impact on the state's groundwater. The MPCA also takes enforcement actions when improper disposal or application of pesticides is found. The MDA also develops BMPs for pesticide use and regulates the sale, use, and disposal of pesticides.

The MDNR administers programs related to groundwater appropriations. The agency permits groundwater withdrawals, performs aquifer vulnerability assessments, resolves water use conflicts, and monitors groundwater levels across the state.

Table 17. Summary of Minnesota groundwater protection programs

Programs or Activities	Check (ü)	Implementation Status	Responsible State Agency
Active Sara Title III Program	ü	Established	MPCA, MN Dept. of Public Safety
Ambient groundwater monitoring system	ü	Continuing Effort	MPCA, MDA
Aquifer vulnerability assessment	ü	Continuing Effort	MNDNR
Aquifer mapping	ü	Continuing Effort	MGS
Aquifer characterization	ü	Continuing Effort	MPCA, MDA, MNDNR, MGS
Comprehensive data management system	ü	Continuing Effort	MPCA, MDA, MNDNR, MDA, MGS
Consolidated cleanup standards	ü	Continuing Effort	MPCA, MDH
Groundwater Best Management Practices	ü	Continuing Effort	MPCA, MDA
Groundwater legislation	ü	Continuing Effort	All agencies
Groundwater classification	ü	Established	MPCA
Groundwater quality standards	ü	Continuing Effort	MDH, MPCA, MDA
Interagency coordination for groundwater protection initiatives	ü	Established	All agencies
Nonpoint source controls	ü	Established	MPCA, MDA
Pesticide State Management Plan	ü	Established	MDA
Resource Conservation and Recovery Act Primacy	ü	Established	MPCA
Source Water Assessment Program	ü	Continuing Effort	MDH
State Property Clean-up Programs	ü	Established	MPCA, MDA
Susceptibility assessment for drinking water/wellhead protection	ü	Established	MDH
State septic system regulations	ü	Established	MPCA
Underground storage tank installation requirements	ü	Established	MPCA
Underground Storage Tank Remediation Fund	ü	Established	MPCA/Dept. of Commerce
Underground Injection Control Program	ü	Established	MDH
Underground Storage Tank Permit Program	ü	Established	MPCA
Well abandonment regulations	ü	Established	MDH
Wellhead Protection Program (EPA-approved)	ü	Established	MDH
Well Installation Regulations	ü	Established	MDH

D.3. Groundwater monitoring programs

Four state agencies jointly conduct groundwater quantity and quality monitoring in Minnesota. The MDNR maintains the state's groundwater level monitoring network (quantity). The MPCA, MDA, and MDH jointly conduct groundwater quality monitoring based on their individual state and federal authorities and requirements. The MPCA monitors non-agricultural chemicals, and the MDA monitors agricultural chemicals such as pesticides and fertilizers. The MDH monitors the groundwater used by the public to ensure any chemicals are below concentrations that present a threat to human health. Further information on this multi-agency approach to groundwater monitoring is contained in Minnesota's Water-Quality Monitoring Strategy document (Minnesota Pollution Control Agency 2011).

Several state agencies have integrated the storage of their groundwater data into shared data management systems. The MPCA and MDA both store the data collected by their groundwater condition monitoring networks in a commercial data management system called EQuIS, which is maintained by the MPCA. The MDNR also plan to store groundwater quality data collected by their County Geologic Atlas Program in the same data management system. These advances in data management will facilitate the analysis and interpretation of groundwater data collected across state agencies.

D.4. MPCA's monitoring and assessment strategy

The MPCA's monitoring and assessment strategy continues to focus on aquifers that are vulnerable to human contamination and underlie the urban and undeveloped parts of Minnesota. The MPCA's ambient groundwater network currently focuses on the surficial sand and gravel and the Prairie du Chien-Jordan aquifers. Approximately 246 wells representing conditions underlying non-agricultural areas were sampled in 2016. About 70% 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 annually to determine concentrations of over 100 chemicals, including nitrate, chloride, trace elements, and volatile organic compounds (VOCs).

D.5. MDA's monitoring and assessment strategy

The MDA continues to monitor groundwater to provide information about the impacts to the State's groundwater from the routine application of agricultural chemicals. The primary focus of this monitoring is to assess the presence and distribution of pesticides in the groundwater (Minnesota Department of Agriculture, 2007). The network typically monitors the upper part of the sand and gravel aquifers and consists of about 250 monitoring wells. Seventy-eight of these locations are located in central Minnesota. The remaining wells (approximately 80) are located in agricultural areas in other parts of the state. In addition, the southeastern part of the state, approximately 15 springs and 12 domestic wells are sampled. These are used in lieu of monitoring wells since springs integrate water-quality conditions in karstic areas and domestic wells are a good alternative in places where monitoring wells are expensive to install. Additional information about the program can be found at the MDA's website here: http://www.mda.state.mn.us/monitoring.

In 2013, the MDA began a Township Testing Program to determine current nitrate-nitrogen concentrations in private wells on a township scale. The MDA has identified townships throughout the state that are vulnerable to groundwater contamination and have significant row crop production.

The MDA plans to offer nitrate testing to 70,000 private well owners, within approximately 250-300 townships, over the next six years. As of March 2016, over 13,500 wells had been sampled. The MDA has also now added pesticide analysis to many of the wells sampled as part of this program. Additional information concerning this program can be found at the MDA's website here: http://www.mda.state.mn.us/townshiptesting.

D.6. MDH's monitoring and assessment strategy

The MDH continues to monitor the condition of the state's public water supplies, which often utilize groundwater. The MDH samples the state's finished drinking water in cooperation with the public water supply systems to determine whether contaminant concentrations meet Safe Drinking Water Act regulations. Private drinking water wells are not assessed as part of this effort; however, the MDH reviews nitrate, arsenic, and coliform bacteria data collected by well drillers from newly installed drinking water wells to determine the potability of the water. The MDH also conducts investigative monitoring to assist the public water suppliers in locating wells in aquifers with lower concentrations of arsenic, radionuclides, and nitrate. In addition, the MDH measures the tritium values in some wells to identify locations with recently recharged groundwater which are very susceptible to contamination. The MDH also administers the state's wellhead protection program to protect the groundwater from contamination.

D.7. MDNR's monitoring and assessment strategy

The MDNR continues to maintain a groundwater level monitoring network across the state. The MDNR uses the collected data 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 are measured on an approximately monthly schedule in cooperation with soil and water conservation districts or other LGUs.

D.8. Minnesota's groundwater quality

The MPCA's 2013 condition monitoring report integrated data on nitrate, chloride, iron, manganese, arsenic, sulfate, VOCs, and CECs in the groundwater (Kroening 2013). This information was collected by several state agencies and national monitoring efforts. The monitoring data from the 2013 report indicated elevated nitrate concentrations were common beneath agricultural and urbanized parts of Minnesota. The highest nitrate concentrations generally occurred in the agricultural areas in central and southwestern Minnesota. Nitrate concentrations exceeded the standard set for drinking water (10 mg/L as nitrogen) in about 40% of the wells tapping the shallow groundwater in central Minnesota and about 20% of the wells in southwestern Minnesota. The elevated nitrate concentrations that occur throughout Minnesota, likely resulted from several sources, including fertilizers applied agricultural fields and urban lawns, animal manure, wastewater discharged to the land, or atmospheric deposition. The MPCA's monitoring data showed the greatest chloride concentrations generally occurred in the TCMA. About 30% of the wells had concentrations exceeding the drinking water guidance in the TCMA.

About one-third of the wells in the MPCA's condition monitoring network have sufficient data to determine the long-term temporal trends in groundwater quality. Each year, the MPCA quantifies long-term trends in chloride concentrations in the state's groundwater as part of a review of its environmental work. In 2016, about chloride data from 86 of the MPCA ambient groundwater monitoring network wells were used to determine chloride trends. There was at least 10 years of data from each of these wells.

The available condition monitoring data from the MPCA showed that chloride concentrations increased in over 40 percent of the wells that had sufficient data for trend analysis. Sixty-eight percent of the wells with upward trends were deep wells that provide drinking water to individual residences. This result suggests the chloride applied in the State is beginning to seep downward into the groundwater used for drinking.

The MPCA has collected samples from its condition monitoring network for analysis of over 100 CECs since 2009. The most recent assessment of these data was completed in 2014 and incorporated data collected from 2009-2012 (Erickson et al 2014). The results from this study showed 35 different CECs were detected in about one-third of the 40 sampled wells. The most frequently-detected chemical was the antibiotic sulfamethoxazole, which was detected in 14 of the 123 samples. *N,N*-Diethyl-*meta*-toluamide (DEET) was detected at the highest concentration of any CEC, at 7.9 micrograms per liter. The presence of CECs in the state's water resources continues to concern the public. The MPCA's monitoring of these chemicals supports work by the MDH to determine what level of these contaminants in drinking water presents a risk to human health.

D.9. Groundwater contamination sources

Monitoring of Minnesota's groundwater has identified contamination from non-point sources from agricultural fertilizers and pesticides, urban runoff, manure applications, septic systems, road salt and stormwater infiltration, in many vulnerable aquifers (Minnesota Pollution Control Agency and Minnesota Department of Agriculture 2015). The most common contaminants detected include nitrate, pesticides, and road salt in urban areas. In addition, chemicals that are not commonly monitored or regulated are being identified at low concentrations in groundwater. These include antibiotics, fire retardants, detergents, and plasticizers. This group of chemicals is referred to as contaminants of emerging concern (CECs) and includes endocrine active chemicals.

Sources of groundwater contamination in Minnesota were listed in appendix A of the Environmental Quality Board's 2015 water policy report (Minnesota Pollution Control Agency and Minnesota Department of Agriculture 2015). Most nitrate enters the groundwater from anthropogenic sources such as animal manure, fertilizers used on agricultural crops, failing subsurface sewage treatment systems, fertilizers used at residences and commercially, and nitrous oxides from the combustion of coal and gas. Roadway deicing chemicals and water softeners were identified as the primary sources of chloride to groundwater. The disposal of fluorochemical manufacturing wastes prior to the advent of modern solid and hazardous waste laws and regulations caused the most well-known perfluorochemical contamination in Minnesota's groundwater. In contrast, naturally-occurring soil and rock are the main sources of arsenic in the state's well water.

The POC is Sharon Kroening at 651-757-2507 or sharon.kroening@state.mn.us.

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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 EPA requires that the public must be given an opportunity to review and comment on TMDLs before they are formally submitted to EPA for approval. Every TMDL is formally public-noticed in Minnesota with a minimum 30-day comment period.

In addition, the MPCA has a comprehensive effort underway to build civic engagement into watershed projects. The MPCA is trying to build greater civic engagement in watershed planning by encouraging more citizens to become leaders for change in their communities and holding individuals personally responsible for making needed changes that could reduce water pollution. The MPCA is engaged in several activities to promote civic engagement in watershed plans and has developed several civic engagement products and services for use by local partners and citizens. See more information at: https://www.pca.state.mn.us/water/civic-engagement-watershed-projects.

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, including public meetings throughout the state on the draft List and a 60-day public comment period.

The draft 2018 Impaired Waters List was placed on the MPCA website in October 2017. The public was informed by a statewide MPCA press release and emails to individuals and groups on the MPCA 303(d) distribution list. Four public meetings were held in November 2016. The formal public comment period was between November 27, 2017 and January 26, 2018.

Minnesota's Impaired Waters List, the comments received during the public comment period, and the MPCA's Response to Comments are posted on the MPCA website at: https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list.

The POC is Miranda Nichols at 651-757-2614 or miranda.nichols@state.mn.us.