Clean Water Fund Performance Report

A report of Clean Water Funds invested, actions taken and outcomes achieved

2018

CLEAN WATER LAND & LEGACY AMENDMENT

February 2018

More information about the measures summarized in this publication can be found on the Minnesota's Legacy Website at www.legacy.leg.mn/funds/clean-water-fund.

Project Team: Pam Anderson (MPCA), Matt Drewitz (BWSR), Bill Dunn (MPCA), Tannie Eshenaur (MDH), Suzanne Hanson (MPCA), Andy Holdsworth (DNR), David L. Miller (MPCA), Katie Nyquist (MDH), Emily Resseger (MCES), Lanya Ross (MCES), Margaret Wagner (MDA), Marcey Westrick (BWSR), David Wright (DNR)

Clean Water Fund Interagency Coordination Team: Chris Elvrum (MDH), Rebecca Flood (MPCA), Jeff Freeman (PFA), Barb Naramore (MDNR), Sam Paske (Met Council), Dan Stoddard (MDA), Susan Stokes (MDA), Doug Thomas (BWSR), Matt Wohlman (MDA), Guest: Will Seuffert (EQB)

Editing: Doug Schultz (MDH)

Designer: Kabao Her (MDA)

This publication can be made available in other formats, including Braille, large type, computer disk or audio tape, upon request.

lrp-f-3sy18

Minnesota Pollution Control Agency • Minnesota Department of Natural Resources • Minnesota Department of Agriculture
Minnesota Department of Health • Minnesota Board of Soil and Water Resources • Minnesota Public Facilities Authority

Table of contents

Clean Water Fund Performance Report

About this report

Minnesotans care deeply about the state's natural resources and cultural heritage. Since the first decades of statehood, Minnesota has responded to many water quality and other natural resource challenges. For instance, we have made great strides in protecting drinking water supplies and reducing industrial pollution. However, investments have not kept pace with the scope of water quality challenges.

In 2008, Minnesotans demonstrated a renewed commitment to clean water by voting to increase our sales tax and pass the Clean Water, Land and Legacy Amendment. The amendment provides 25 years of constitutionally-dedicated funding for clean water, habitat, parks and trails, and the arts.

With that vote came high expectations for results. Minnesotans want to see that investments from the Clean Water Fund are making a difference. Minnesotans want to see water quality improve and want to know that our drinking water is safe and will be available for future generations. Each year until 2034, Minnesota is investing Clean Water Funds in various water management activities— from testing and assessing the state's lakes, streams and groundwater, to implementing conservation practices to protect and restore our surface water, groundwater, and drinking water resources. Thousands of people are doing this work, from state policy makers to local landowners.

How will we know if these dollars are making a difference? How will we know how much progress has been made after 5, 10 and 25 years?

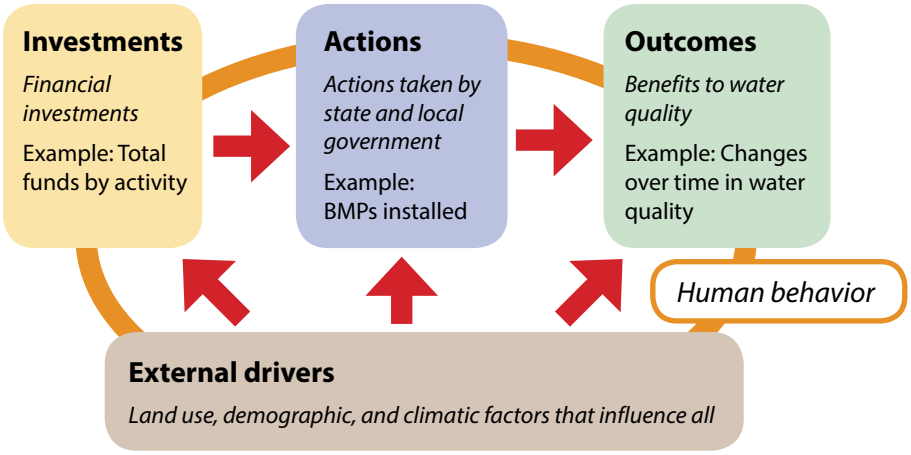
This report provides a high-level overview of Minnesota's investment to restore and protect the quality of the state's surface water, groundwater, and drinking water resources with Clean Water Legacy funds. Published every two years, the report highlights:

- Financial measures that track how Clean Water Fund money is spent and how spending patterns change over time, including other funds leveraged to extend the work done to meet Clean Water goals.
- Action measures that track state agency and partner activities that protect surface water and groundwater; including how effectively agencies are completing the work to achieve Clean Water goals.
- Outcome measures that track progress on improving the quality of our surface water and groundwater.

The report is not a complete assessment of all work achieved with Clean Water Legacy funds, either at the state or local level. Key activities were selected to represent the overall patterns of change.

The pace of progress and lag times

We recognize that people are hungry for immediate results. However, managing water resources is an ongoing task and some clean water outcomes may take several years or several decades to achieve. The lag time between action and observed environmental improvements depends on the scale of the problem and trends in external drivers. For example, reducing the inputs of phosphorus to a lake may not be reflected in lake phosphorus concentrations for years. Also, multiple years of monitoring may be necessary before an improving trend can be confirmed. As a result, after implementing best management practices, it may take years or decades before we achieve environmental improvement in a degraded river, lake or groundwater source. In cases where the goal is to maintain existing water quality conditions, no long-term change in the environmental outcome would represent success. Ongoing monitoring efforts will provide critical information to track our progress and identify where we need to adjust implementation efforts.



Measure connections

A portion of Clean Water Funds are dedicated to funding (investment measure) monitoring activities (action measure). Those monitoring activities will tell us, in time, the rate of impairments in waterbodies (outcome measure) and the changes over time in key water quality parameters (outcome measure). External drivers will influence investments, actions, and outcomes and will change the rate of progress independent of the actions implemented by Clean Water Fund activities. Human behavior influences all aspects of restoring and protecting water quality, and changing behavior is a key component of Clean Water Fund activities.

It is important to note that there are many other water resource management activities underway that do not receive Clean Water Fund dollars. These activities have various sources of funding, including private individuals and businesses in Minnesota who are dedicated to improving water quality. It is impractical, if not impossible to track and report on all these efforts. Environmental outcomes may be a result of both Clean Water Fund investments and the many other activities underway throughout the state.

Report organization

The report displays how spending and progress are occurring across Minnesota, to the extent that statewide data are available. Measure profiles provide a snapshot of how Clean Water Fund dollars are being spent and what progress has been made. These profiles are organized into three sections: investment measures, surface water quality measures, and drinking and groundwater protection measures.

Each measure profile page includes the following:

- Measure type: investment, action, or outcome.
- Measure narrative: why the measure is important, what state agencies are doing, and what progress has been made.
- A graphic that summarizes the measure's data.
- A qualitative score summarizing the current status and progress towards the long-term goal (where feasible) for action and outcome measures.

The measures used in this report are designed to remain constant over time to make it easy to identify where change is occurring. However, at times measures are modified as our scientific knowledge expands and new, more effective approaches are developed. The procedures used to produce the measures in this report and how they have changed over time are documented in a separate metadata document available on the Legacy website.

Minnesota's Clean Water Goals: Tracking the Progress Being Made

The seven agencies with Clean Water Fund (CWF) responsibility developed Minnesota's Clean Water Roadmap in 2015. The Roadmap frames and provides initial goals (see table on next page) for enhancing the state's surface water and groundwater resources. It focuses on where Minnesota wants to be in the future and how we can gauge our progress on our way there. Progress towards each of the Roadmap goals will be tracked by one or more of the outcome measures in this report series.

In February 2017, Governor Mark Dayton announced a new "25 by 25" Water Quality Goal to accelerate the pace of progress towards clean water. The goal intends to spur collaboration, action, and innovation to achieve a 25 percent improvement in water quality by the year 2025. Without additional action, the Clean Water Roadmap projects the quality of Minnesota's waters to improve by only 7 to 8 percent by 2034. Between July and October 2017, the Governor and other state agency leaders traveled across Minnesota to hear ideas for achieving this goal. Minnesotans discussed their top strategies in 10 town hall meetings and dozens of community discussions. This public input is being used to shape legislative and non-legislative initiatives at the state level and to inform the work of numerous local partners .

This Clean Water Fund Performance Report series can help track Minnesota's progress towards achieving the environmental goals in the Clean Water Roadmap and the Minnesota 25 by 25 goal. Actions taken to restore or protect the state's water resources by communities throughout the state, whether receiving Clean Water Funds or not, will be reflected in several measures in this report.

ROADMAP GOALS		
CATEGORY	**STATEWIDE GOAL**	**LINKED CWF PERFORMANCE MEASURE**
Lake water quality	8% increase in the percentage of lakes with good water quality	Percent of major watersheds intensively monitored (page 16) Local partner participation in monitoring efforts (page 19) Nonpoint BMPs implemented (page 21) Municipal point source construction projects (page 23)
River and stream water quality	7% increase in the percentage of rivers and streams with healthy fish communities	Percent of major watersheds intensively monitored (page 16) Local partner participation in monitoring efforts (page 19) Nonpoint BMPs implemented (page 21) Municipal point source construction projects (page 23)
Groundwater quality	50% decrease in the number of new wells that exceed arsenic drinking water standard, 20% decrease in nitrate levels in groundwater	Communities assisted with Source Water Protection Plans (page 36) Local partner participation in nitrate monitoring and reduction activities (page 39) Changes over time in groundwater quality (page 50) Nitrate and arsenic concentrations in new wells (page 56)
Groundwater quantity	Less than 10% of sites affected by groundwater pumping will have declining trend in groundwater levels	Completed geological atlases for groundwater sustainability (page 44) Number of long-term groundwater monitoring wells (page 46) Changes over time in groundwater levels (page 58)

2018 Clean Water Fund Report Card

Minnesotans care deeply about the state's natural resources and cultural heritage. In 2008, we voted to increase our sales tax and pass the Clean Water, Land and Legacy Amendment, providing 25 years of constitutionally-dedicated funding for clean water, habitat, parks and trails, and the arts.

The following report card highlights work done using Clean Water Land and Legacy Amendment dollars for Minnesota's many water resources. The Report Card tracks a suite of performance measures that are described in the full report that follows. It provides a qualitative assessment of how well actions are being implemented and what outcomes are being achieved.

The legend shows the symbols used to describe how measures were scored. Measures are scored according to their status as of the end of fiscal year 2017 (FY17) and for their trend over time. Scores were developed using data-informed professional judgment of agency technical staff and managers.

Report Card Legend

Action Status Scores	
●	We are making good progress/meeting the target
▲	We anticipate difficulty; it is too early to assess; or there is too much variability across regions to assess
■	Progress is slow/we are not meeting the target; or the activity or target is not commensurate with the scope of the problems

Outcome Status Scores	
●	Water quality is high – we are on track to meet long-term water resource needs and citizen expectations
▲	Water quality needs improvement or it is too early to assess – it is unclear if we will meet long-term water resource needs and citizen expectations; and/or water quality varies greatly between regions
■	Water quality is under intense pressure – long-term water resource needs and/or citizen expectations exceed current efforts to meet them

Trend	
↗	Improving trend
→	No change
↘	Declining trend

Clean Water Fund Report Card

	MEASURE	STATUS	TREND	DESCRIPTION
INVESTMENTS	**INVESTMENT MEASURES**			
	Total Clean Water Fund dollars appropriated by activity	FY10-11: $152.2M FY12-13: $179.4M	FY14-15: $182.5M FY16-17: $228.3M FY18-19: 201.4M	Appropriation levels will vary by biennium and the strength of the economy. FY10-17 funds have been allocated, while FY 18-19 allocations are in progress.
	Total Clean Water Fund dollars per watershed or statewide by activity	Most watersheds in the state are benefiting from local and statewide projects.		For FY10-17, all 80 watersheds benefited from Clean Water Fund supported activities. Implementation activities comprise the largest portion of spending in watersheds statewide.
	Total Clean Water Fund dollars awarded in grants and contracts to non-state agency partners	$361M was awarded in grants and contracts to non-state agency partners in FY10-17.		About 81 percent of grant and contract awards are for implementation activities; 48 percent of total FY10-17 appropriations were awarded to non-state agency partners.
	Total dollars leveraged by Clean Water Fund	$199M was leveraged by Clean Water Funds in FY10-17, or 73 cents for every implementation dollar invested.		Required Clean Water match funds were met and exceeded.
ACTION	**SURFACE WATER MEASURES**			
	Percent of major watersheds intensively monitored through the watershed approach	●	→	Steady progress is being made at the pace set in 2008.
	Local partner participation in monitoring efforts	●	→	As of 2017; all programs are meeting participatory goals.
	Number of nonpoint source best management practices implemented with Clean Water funding and estimated pollutant load reductions	■	↗	Although funding has increased and there is a continued increase in practices and projects being implemented, the total request for projects has remained three times greater than available funds.
	Number of municipal point source construction projects implemented with Clean Water Funding and estimated pollutant load reductions	●	→	Total applications for eligible projects is twice the amount of funds available.
OUTCOME	Rate of impairment/unimpairment of surface water statewide and by watershed	Stream/lake swimming ▲ Stream aquatic life ▲	Not enough information for a trend determination at this time.	Water quality varies greatly by region. Watersheds yet to be assessed will influence the statewide impairment/ unimpairment rate. It is unclear whether long-term goals will be met.
	Changes over time in key water quality parameters for lakes and streams	Lake clarity ●	Not enough information for a trend determination at this time.	There are improving trends in lake water clarity in more lakes than not.
		Nutrients and sediment in large rivers ▲		In general, concentrations in phosphorus and sediment are declining while nitrates are increasing in surface water.
		Pesticides in streams ▲		Detections in streams vary greatly as a result of hydrologic and agronomic conditions; concentrations above water quality standards are rare.
		Pesticides in lakes ▲		Detections in lakes vary by region; detections in lakes have been well below water quality standards.
	Number of previous impairments now meeting water quality standards due to corrective actions	■	→	Although many projects are making progress in improving water quality, more waterbodies are being listed as impaired relative to the slower rate of waterbodies being restored.
	Mercury in fish	▲	→	Mercury in game fish is not yet responding to decreases in local mercury emissions, although these reductions likely have prevented a steeper upward trend. Global emissions have increased. The time lag between emission reductions and response is likely several decades. It is too soon to see a measurable response in fish mercury levels. Long-term and consistent monitoring is necessary to track changes in fish tissue.
	Mercury emissions	▲	↗	Significant progress has been made reducing mercury emissions from power plants and is expected from the mining sector. To meet Minnesota's 2025 emissions goal, further reduction of mercury use in various products will be necessary.
	Municipal wastewater phosphorus discharge trend	●	↗	Significant phosphorus load reductions have been achieved through regulatory policy, infrastructure investments and improved technology.

	MEASURE	STATUS	TREND	DESCRIPTION
ACTION	**DRINKING AND GROUNDWATER MEASURES**			
	Number of community water supplies assisted with developing source water protection plans			It will be difficult to meet the 2020 goal for vulnerable systems because of competing demands for plan development resources.
	Number of grants awarded for source water protection			Increasing funds accelerate implementation of proven strategies for source water protection.
	Number of local government partners participating in groundwater nitrate-nitrogen monitoring and reduction activities			New local partnerships continue to be established for nitrate-nitrogen monitoring and reduction activities.
	Number of new health-based guidance values for contaminants of emerging concern			Met target for FY 16-17. On track to meet goal of ten guidance values developed each biennium.
	Number of counties completing a county geologic atlas for groundwater sustainability			Significant progress has been made completing county geologic atlases and the rate of completion has increased. Counties continue to step up to participate. Substantial work remains before all counties in Minnesota are done.
	Number of long-term groundwater monitoring network wells			Many areas of the state still lack important groundwater information. Long-term ramp-up in monitoring accelerated by Clean Water Fund investments is filling gaps.
	Number of unused groundwater wells sealed			FY16 funding was awarded to seven public water-suppliers to assist in sealing nine unused wells. FY17 funding was awarded to six local government units to assist in sealing over 200 private unused wells.
OUTCOME	Changes over time in pesticides, nitrate-nitrogen and other key water quality parameters in groundwater	Pesticides 		Variable trends for five common pesticides indicate a mixed signal. Low levels are frequently detected in vulnerable groundwater
		Nitrate-Nitrogen statewide 	No trend information available.	In many agricultural areas, drinking water supplies are not vulnerable to surficial contamination and most wells have low levels of nitrate–nitrogen. However, in vulnerable groundwater areas, nitrate contamination is a significant concern.
		Nitrate-Nitrogen southwest region 		Most agricultural areas in southwest do not have vulnerable groundwater. In areas where groundwater is vulnerable, nitrate levels can be high. Of the 11 vulnerable townships tested in southwest Minnesota (2013-2016), 100% of them were determined to have 10% or more of the wells over the nitrate-N 10 PPM standard.
		Nitrate-Nitrogen Central Sands 		Trend data from the Central Sands Private Well Network shows no change. However, Township Testing data show a high level of nitrate in some vulnerable aquifers in the Central Sands. Of the 119 vulnerable townships tested (2013-2016), 29% of them were determined to have 10% or more of the wells over the nitrate-N 10 PPM standard.
		Nitrate-Nitrogen southeast region 		Trend data from the Southeast Minnesota Domestic Well Network shows no change. However, Township Testing data show a high level of nitrate in some vulnerable areas in southeast Minnesota. Of the 46 vulnerable townships tested (2013-2016), 54% of them were determined to have 10% or more of the wells over the nitrate-N 10 PPM standard.
	Changes over time in source water quality used for community water supplies		Not enough information for a trend determination at this time.	Identifying correlations between drinking water contaminants is a significant step in trend analysis of source water quality.
	Nitrate concentration in newly constructed wells			Since 1992, there has been a general increase in the percent of new wells that have nitrate levels above the drinking water standard. Since 2014, there has been a slight decrease in the percent of new wells with nitrate higher than the drinking water standard.
	Arsenic concentration in newly constructed wells			The percentage of wells with arsenic above the drinking water standard has remained steady over the past 10 years. Evaluation of ways to reduce this percentage is ongoing and may take years before significant progress is made.
	Changes over time in groundwater levels			Most observation wells show no significant change or an upward trend (up 24% since 2014), but many areas of the state lack important groundwater information while some areas experienced groundwater level declines.
	Changes over time in total and per capita water use			There has been a slight improvement in water efficiency in recent years, although continued tracking is needed to determine the amount of impact from annual difference in weather versus changes in management.
DRIVERS	**SOCIAL MEASURES AND EXTERNAL DRIVERS**			
	Social measures		Not enough information for a trend determination at this time.	In recent years, state agencies have developed and piloted the Social Measures Monitoring System. This work integrates social science into Clean Water Fund projects.
	External drivers			The external drivers identified continue to alter land-water interactions across Minnesota, impacting how Clean Water Funds need to be invested.

Clean Water Fund Report: Highlights in the 4th Edition

Tracking spending patterns

- Legislative appropriations of Clean Water Funds focused on implementation activities and drinking water protection have increased over time, spending on monitoring/assessment and the development of watershed restoration and protection plans has remained constant (p. 10);
- When spending is tracked by watershed, a broad-based pattern across the state is seen, with project implementation funding, in particular, more concentrated in watersheds with significant water quality challenges (p. 12);
- Projects implemented with Clean Waters Funds continue to leverage substantial amounts of matching funds from local and federal sources (p. 14).

Expanding information and resources to guide local planning and implementation efforts

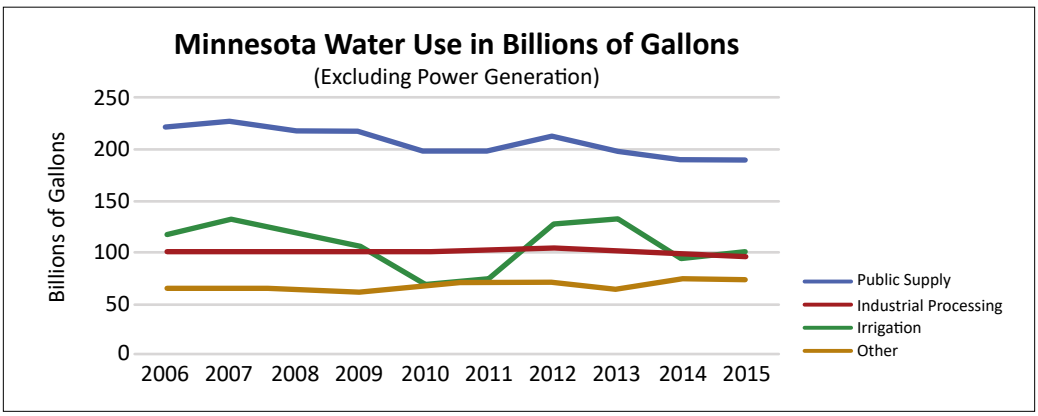
- MPCA's initial comprehensive assessment of all of the state's watersheds is on schedule to be completed in 2018 (p. 16);
- Public water suppliers have increased their source water protection efforts using Clean Water grant funds and technical assistance provided by MDH (pp. 36 & 38);
- More information on status of the state's groundwater resources (nitrate, arsenic, chloride, and pesticide concentrations, and trends in ground-water levels) is being organized and provided to local communities and land-owners to guide their decisions (pp. 39, 50, 56, & 58).

Reducing pollutants and documenting successes

- Clean Water Fund supported wastewater construction projects (p. 23) and nonpoint source BMP implementation efforts (p. 21) are each reducing the amount of phosphorus entering the state's waters by an estimated 100,000 pounds or more per year;
- Minnesota continues to make progress towards reaching its goal of a 93 percent reduction in air emissions of mercury (p. 31);
- Clean-up efforts have now allowed 46 lakes and streams to be taken off Minnesota's list of impaired waters (p. 29).

A new measure – Water Efficiency

- A new measure focused on statewide and per-person water use was added to the 2018 report (p. 60).



Investment measures

The four measures contained on pages 9-14 illustrate FY10-17 Clean Water Fund investments to restore and protect surface water and drinking water.

Investments

1. Total dollars appropriated
2. Total dollars invested by watershed or statewide
3. Total dollars awarded
4. Dollars leveraged

Total dollars appropriated

INVESTMENT

Measure: Total Clean Water Fund dollars appropriated by activity

Why is this measure important?

This measure illustrates the overall amount of Clean Water Funds allocated in a particular biennium and provides a breakdown of that funding in specific categories to demonstrate spending over time. It is the first of four financial measures, providing context for the others. It is the primary investment that enables resources to be spent on the actions that will ultimately help achieve outcomes.

What are we doing?

State agencies, local government and nonprofit organizations are spending Clean Water Funds 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.

Learn more

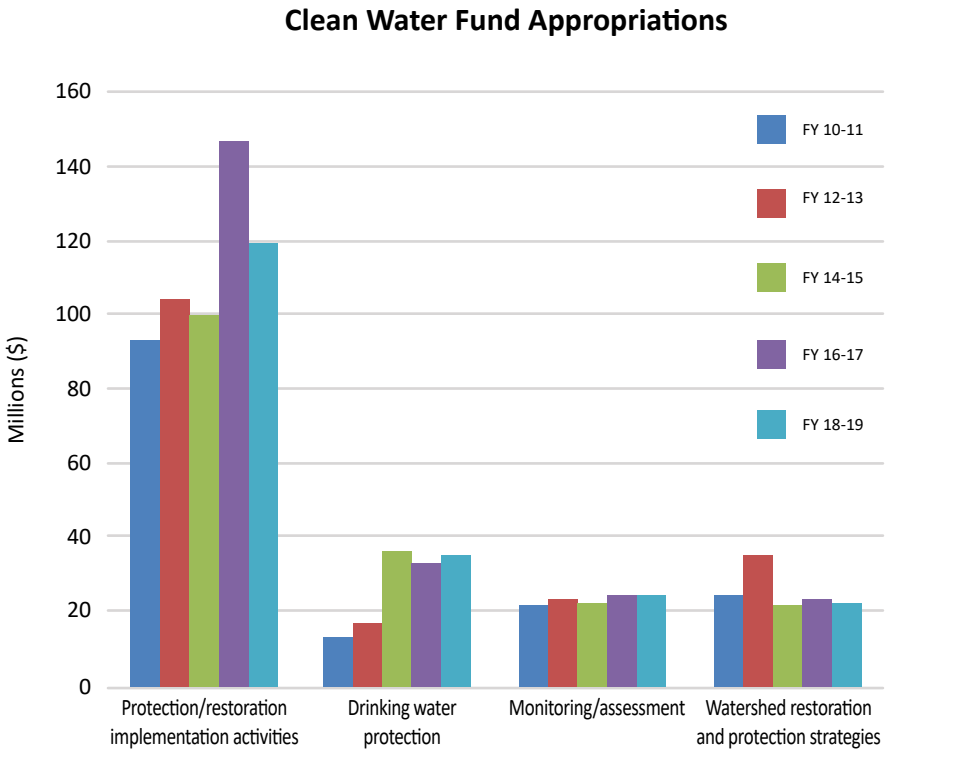
Find more information about this measure and its data at www.legacy.leg.mn/funds/clean-water-fund.

Status	Description
FY10-11: $152.2M FY12-13: $179.4M FY14-15: $182.5M FY16-17: $228.3M FY 18-19: 201.4 M	Appropriation levels will vary by biennium and the strength of the economy. FY10-17 funds have been allocated, while FY18-19 allocations are in progress.

What progress has been made?

Voter approval of the Clean Water, Land and Legacy Amendment increased the sales and use tax rate by three-eighths of one percent on taxable sales, starting July 1, 2009 through 2034. Of those funds, about 33 percent were dedicated to the Clean Water Fund.

Of the sales tax receipts received since 2009, the Minnesota Legislature appropriated approximately $152.2 million for Fiscal Years 2010-11, $179.4 million for Fiscal Years 2012-13, and 182.5million for Fiscal Years 2014-15, $228.3 million for Fiscal Years 2016-2017, and 201.4 M for Fiscal Years 2018-2019. The chart at the right shows how that was appropriated.



Total dollars invested by watershed or statewide

INVESTMENT

Measure: Total dollars invested per watershed or statewide for: 1) monitoring/assessment, 2) watershed restoration/protection strategies, 3) protection/restoration implementation activities, and 4) drinking water protection

Why is this measure important?

Many Minnesotans want to know how much money from the Clean Water Fund is being invested in their backyard. There is also Clean Water Fund work that has a statewide benefit. This measure tracks Clean Water Fund investments in each major watershed in the state, as well as investments on statewide activities that benefit all watersheds. It shows how the funds are being allocated geographically to support specific activities in four major activity categories:

- Water quality monitoring/assessment
- Watershed restoration/protection strategy development
- Restoration/protection implementation activities
- Drinking water protection

What are we doing?

Hundreds of Clean Water Fund-supported projects led largely by local governments are underway across the state. Funded activities include:

- Implementation of practices to clean up wastewater, stormwater, and agricultural runoff
- Regular testing of water quality in lakes and rivers to help gauge the effectiveness of clean water practices
- Strategy development to guide effective watershed restoration and protection, as well as protection of drinking water and groundwater

State agencies provide technical assistance and administrative oversight for all these activities. They include: Minnesota Board of Water and Soil Resources, Department of Natural Resources, Department of Agriculture, Department of Health, Metropolitan Council, Pollution Control Agency, and Public Facilities Authority.

What progress has been made?

For Fiscal Years 2010-2017, Clean Water Fund allocations to surface water and drinking water projects are benefiting most of the watersheds of the state. As noted above, these activities are being performed by local partners as well as state agencies.

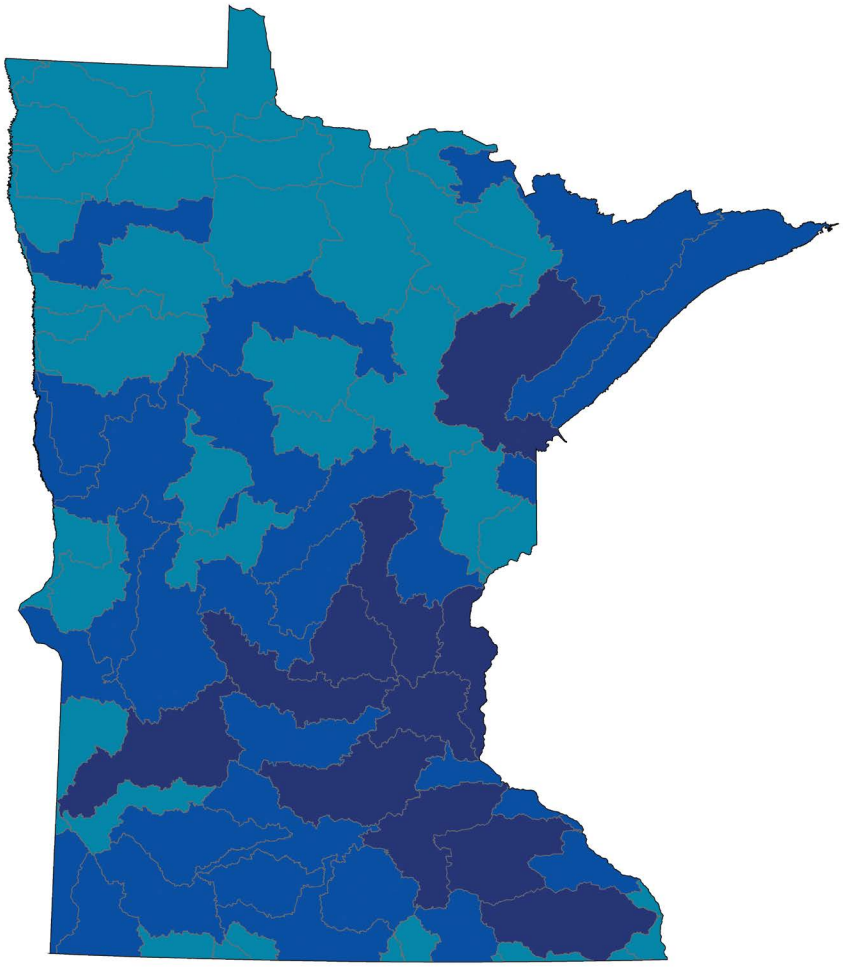
Of the four activity categories, funding for implementation activities comprised the largest portion of spending statewide. However, the costs of implementation can vary significantly by watershed, depending on the type of project and the problem being addressed.

Learn more

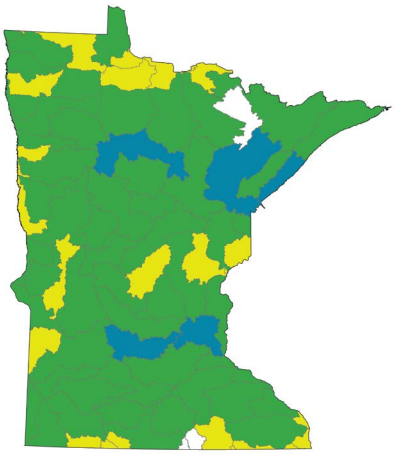
- Find information on activities funded by the Clean Water Fund at: www.legacy.leg.mn/funds/clean-water-fund

Status	Description
Most watersheds in the state are benefiting from local and statewide projects.	For FY10-17, all 80 watersheds benefited from Clean Water Fund supported activities. Implementation activities comprise the largest portion of spending in watersheds statewide.

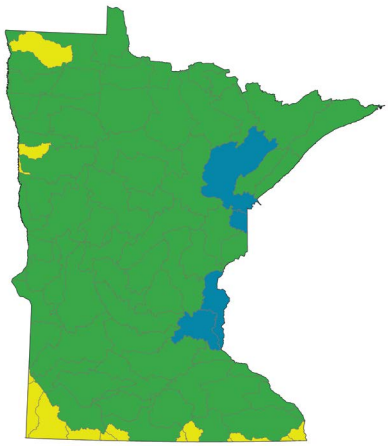
Total FY 10-17 Clean Water Fund Dollars by Watershed



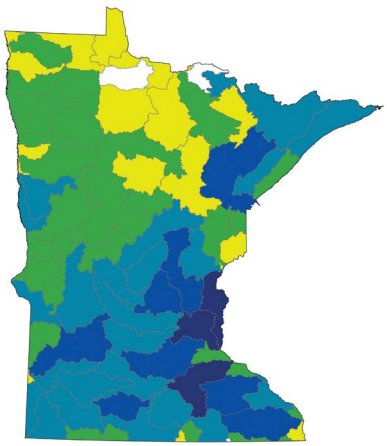
Combined watershed-specific projects, statewide activities, and technical assistance that benefit all watersheds



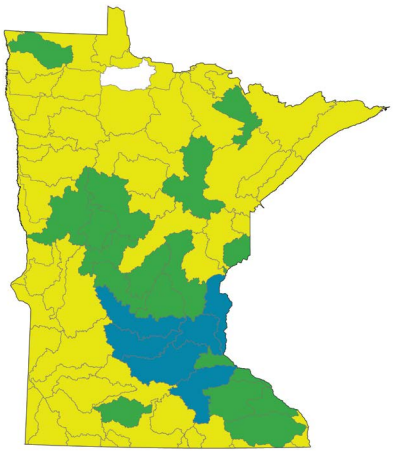
Monitoring and assessment



Watershed restoration/ protection strategies



Protection/restoration implementation activities



Drinking water protection

Total dollars awarded

INVESTMENT

Measure: Total Clean Water Fund dollars awarded in grants and contracts to non-state agency partners

Why is this measure important?

This measure tracks the amount of Clean Water Funds awarded in grants and contracts to external, non- state agency partners to conduct a wide range of clean water activities. The measure provides context on funding distribution between state, federal and local agencies to perform Clean Water Fund-supported work.

What are we doing?

Hundreds of Clean Water Fund-supported projects, led largely by local government units, are underway across the state. Non-state agency partners include cities, counties, soil and water conservation districts, watershed management organizations, federal agencies, universities, nonprofit organizations, and private consulting firms working with local and state agencies.

Funded activities include implementation of practices to clean up wastewater, stormwater and agricultural runoff. They also include testing water quality to determine the health of lakes and rivers, strategy development to guide effective watershed restoration and protection, and implementation of source water protection plans for drinking water. Groundwater monitoring is also funded through Clean Water Fund dollars and is used to ensure drinking water and groundwater protection.

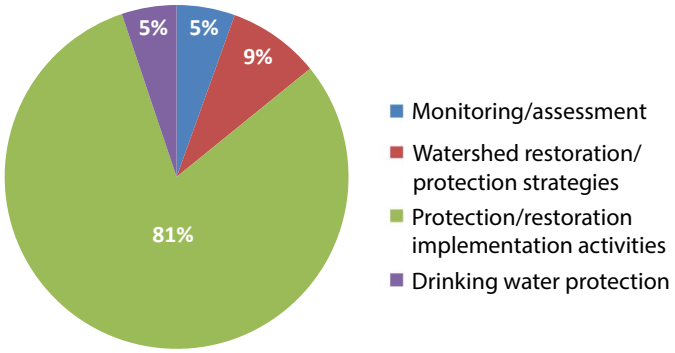
For all actions taken by local government units and other partners, state agencies provide monitoring activities, development of watershed protection and restoration strategies, as well as technical assistance and administrative oversight. The agencies include Minnesota Board of Water and Soil Resources, Department of Natural Resources, Department of Agriculture, Department of Health, Metropolitan Council, Pollution Control Agency, and Public Facilities Authority.

What progress has been made?

As shown in the pie chart, a total of $361 million in Clean Water Funds were awarded to non-state agency partners from Fiscal Year 2010-17, with the largest share of that going to protection and restoration implementation activities. This represents 48 percent of the total $742 million in Clean Water Fund appropriations for those years.

The balance of remaining appropriations is largely used by state agencies to provide statewide monitoring, watershed protection and restoration strategy development, technical assistance, and oversight on Clean Water Fund-supported projects. Note: Due to law, some funds are allocated in phases, and thus, over time the information in this measure will change.

FY10-17 grant and contract awards by major activity



The percentage of total grant and contract awards ($361 million) in FY 10-17 for each major Clean Water Fund-supported activity. Allocations to implementation activities are expected to stay steady or grow in future years as more projects move from strategy development to implementation.

Learn more

Find more information about this measure and its data at www.legacy.leg.mn/funds/clean-water-fund.

Status	Description
$361M was awarded in grants and contracts to non-state agency partners in FY10-17.	About 81 percent of grant and contract awards are for implementation activities; 48 percent of total FY10-17 appropriations were awarded to non-state agency partners.

Dollars leveraged

INVESTMENT

Measure: Total dollars leveraged by Clean Water Fund implementation activities

Why is this measure important?

This measure describes how many total dollars supplement the Clean Water Fund dollars invested in projects in a given year. Throughout Minnesota the demand for funding to protect and restore the water resources far exceeds the available dollars. The ability to use state funds to leverage local and federal dollars means millions more dollars are available – increasing the number of projects that are implemented and making projects more cost effective for communities.

What are we doing?

Clean Water Fund grant programs fund actions to prevent polluted runoff from fields, streets, lawns, roofs and other similar sources. They also fund improvements to municipal wastewater and stormwater treatment. Partnerships with state agencies and various local units of government are critical to implement these water quality improving activities.

What progress has been made?

During Fiscal Years 2016 and 2017, more than $50 million in state grants and loans was awarded to local governments (watershed management organizations, SWCDs, counties, etc.) for projects to reduce runoff from agricultural fields, streets, lawns and other similar sources. Local match and leveraged federal funds increased the project dollars available by $21 million.

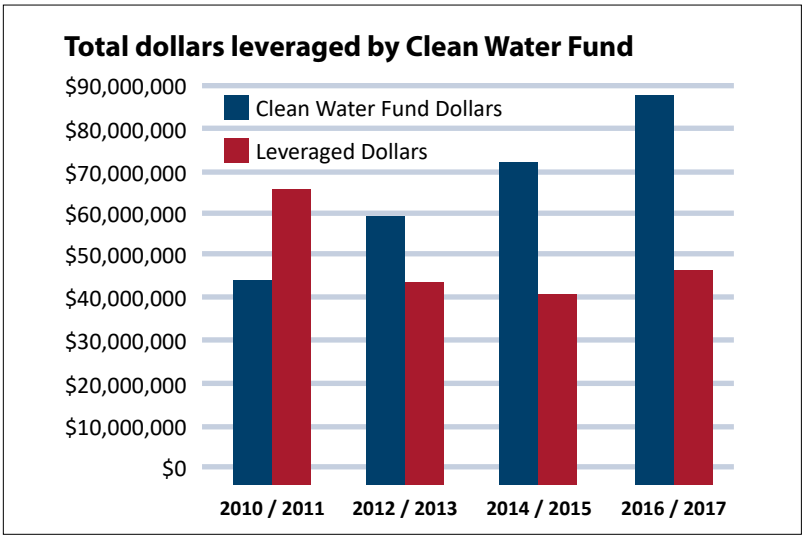
During Fiscal Years 2016 and 2017, more than $38.8 million in state grants was awarded to improve municipal treatment facilities and to help small communities invest in new infrastructure. Local match and leveraged federal funds increased the project dollars by $23.6 million.

As a result, during FY10-17, more than $199 million dollars was leveraged by Clean Water Fund, or 73 cents for every implementation dollar invested.

As shown in the chart below, total dollars leveraged has remained relatively flat in the last three biennia compared to the increase of Clean Water Fund implementation funds. This is in part because BWSR has provided additional clarification to grantees on match requirements and tracking, which has resulted in more moderate amounts of leveraged funds being reported over time. During the first reporting cycle for this report (FY 10-11), the ratio of leveraged funds for BWSR grant programs was much higher than it is today. In addition, leverage funding was further reduced by the elimination of the Clean Water Fund grant portion of the Minnesota Pollution Control Agency's Clean Water Partnership Program.

Learn more

Find information on activities funded by the Clean Water Fund at www.legacy.leg.mn/funds/clean-water-fund.



Status	Description
$199M was leveraged by Clean Water Funds in FY10-17, or 73 cents for every implementation dollar invested.	Required Clean Water match funds were met and exceeded.

Surface water quality measures

The nine measures contained on pages 15-34 illustrate important Clean Water Fund supported actions and outcomes undertaken to protect Minnesota's surface water quality.

Actions

1. Major watersheds monitored
2. Watersheds monitored by local partners
3. Nonpoint source BMP implementation
4. Municipal infrastructure project implementation

Outcomes

5. Surface water health
6. Lake and stream water quality
7. Waters restored
8. Mercury trends
9. Municipal wastewater phosphorus trend

Major watersheds monitored

ACTION

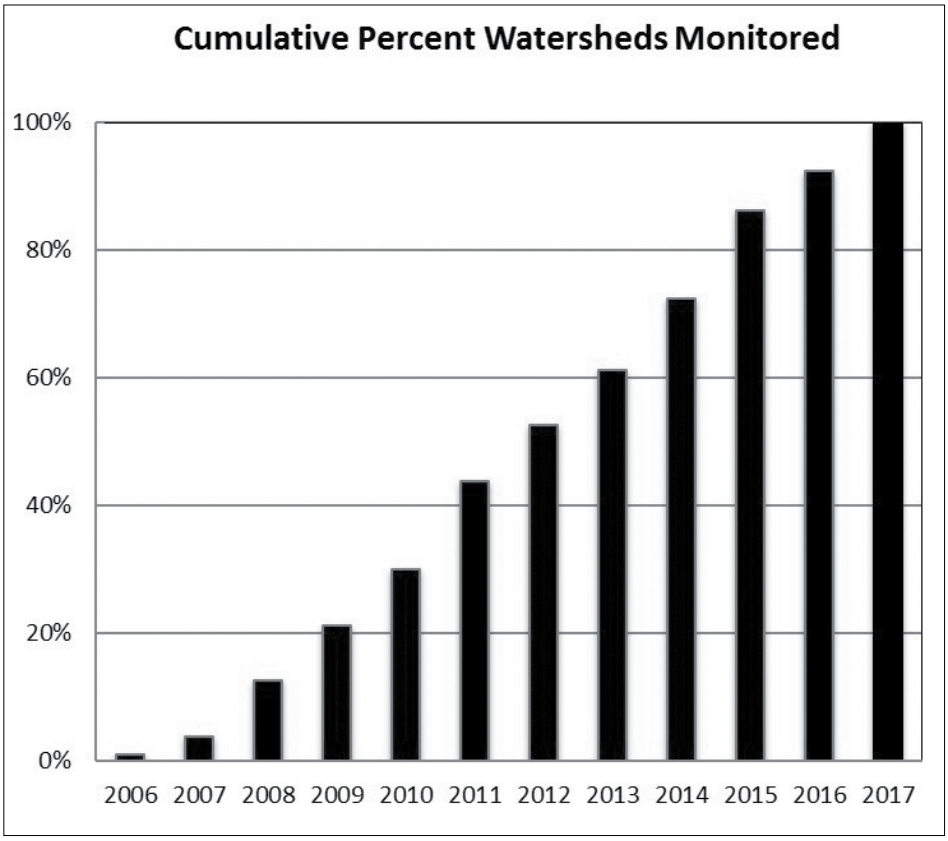
Measure: Percent of state's major watersheds intensively monitored through the Watershed Approach

Why is this measure important?

As of 2006, only 18 percent of Minnesota lakes and 14 percent of streams were monitored for basic water quality. The information gathered from monitoring is vital in determining if water quality standards to protect public health, recreation and aquatic life are being met.

To gain a better understanding of what was going on with Minnesota waters, as well as assess and monitor a larger number of water bodies, the Watershed Approach was created. This is a more strategic approach to water management.

Utilizing Clean Water Fund dollars, state and local partners do intensive sampling and assessment of lakes and streams in all 80 major watersheds. This allows for better protection of Minnesota's healthy waters, and restoration of the polluted ones.



The MPCA and partner organizations evaluate water conditions, establish improvement goals and priorities, and take actions designed to restore or protect water quality on a 10-year cycle.

What are we doing?

The approach is a 10-year rotational cycle where an average of eight of Minnesota's 80 major watersheds are intensively monitored each year for stream water chemistry, biology, and lake chemistry. These data from monitoring activities determine if thresholds to protect public health, recreation and aquatic life for any number of pollutants, including bacteria, nutrients, and sediment, are being met.

Once water quality assessments are made, the monitoring data gathered serves as a starting point in determining the sources and magnitude of pollution reductions needed for polluted waters, or as a baseline to set protection measures for those waters that are not polluted.

What progress has been made?

The first 10-year cycle began in 2008 with the goal to be completed in 2017. To date, watershed monitoring is on track.

- 93 percent of major watersheds are completely monitored.
- The 6 final watersheds began monitoring in 2017.

The Minnesota Pollution Control Agency is embarking on our second 10-year cycle of watershed-based lake and stream monitoring, which includes biological, fish contaminant, water quality, and pollutant load sampling. The purpose of this next 10 years of monitoring is to gather and evaluate sufficient data to measure progress in restoring and protecting lakes and streams, fill monitoring gaps to guide local planning and implementation efforts, and track long-term changes in water quality and biological communities over time. As the MPCA returns to watersheds, we will reduce core monitoring to provide monitoring capacity for other state and local needs, such as to support permitting decisions or to address a local monitoring need. To date, MPCA has begun implementing this modified approach in three watersheds with monitoring underway and an additional five watersheds with monitoring planned to begin in 2018.

Learn more

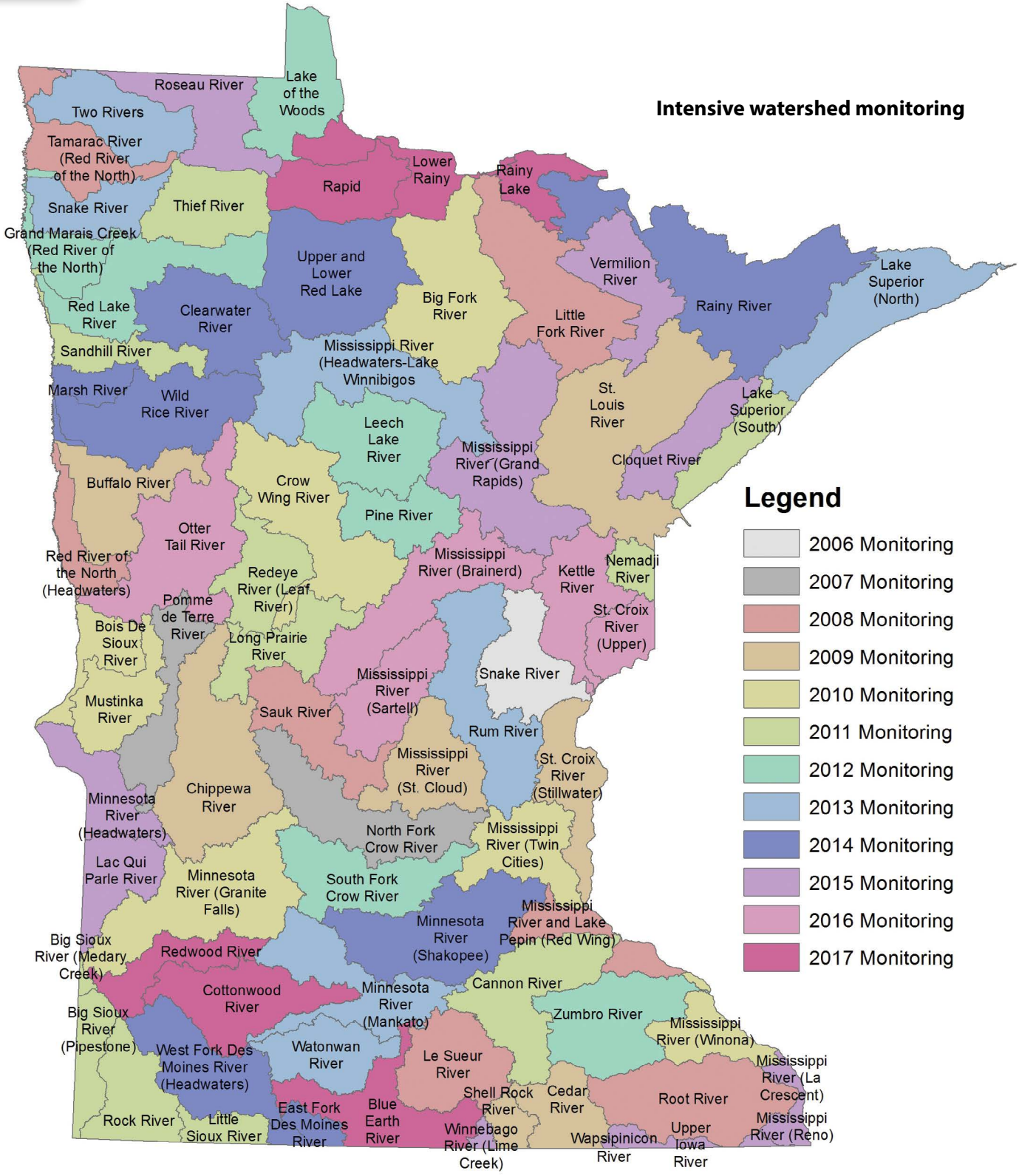
- Find more information about this measure and its data at: www.legacy.leg.mn/funds/clean-water-fund.
- Find your watershed at: www.pca.state.mn.us/ index.php/water/water-types-and-programs/ watersheds/ watershed-overview-map.html
- Learn when the MPCA will be intensively monitoring your watershed: www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/watershed-approach/index.html

Status	Trend	Description
●	→	Steady progress is being made at the pace set in 2008.

Connection with Minnesota's Clean Water Roadmap

Goals: An 8 percent increase in the percentage of lakes with good water quality, and a 7 percent increase in the percentage of rivers and streams with healthy fish communities.

This measure will support the Roadmap goals by aiding the targeting of actions to protect and improve water quality. Monitoring changes in environmental conditions provides the information to direct protection and restoration activities in watersheds. Monitoring also measures changes as practices are implemented or as more land is developed.



State's major watersheds intensively monitored through the Watershed Approach through 2017.

Watersheds monitored by local partners

ACTION

Measure: Local partner participation in monitoring efforts

Why is this measure important?

Clean Water Fund dollars enable intensive sampling and assessment of lakes and streams in all 80 major watersheds. This allows for better protection of Minnesota's clean waters and restoration of the polluted ones. As noted in statute, one of the purposes of the Clean Water Fund is to provide "…grants, loans, and technical assistance to public agencies and others testing waters…"This measure shows the participation of local partners and citizen volunteers through two agency-run ambient monitoring grant programs.

The Minnesota Pollution Control Agency (MPCA) monitors lakes, streams, and rivers across the state. However, the MPCA alone cannot complete all of the monitoring necessary to comprehensively assess the waters in the state. Local partner participation is crucial to meet water monitoring strategy goals and to build a base of engaged participants for restoration and protection activities that follow the monitoring and assessment of waters.

What are we doing?

MPCA works with local organizations across the state to build capacity for monitoring efforts. Each year, MPCA prioritizes certain lake, river, and stream sites and invites local partners to apply for funding to cover the costs of staff, training, equipment, and lab analysis of condition monitoring. Since 2012, MPCA has focused funding opportunities to those watersheds that are due for condition monitoring under the agency's 10-year intensive watershed monitoring cycle, so the efforts of local partners are coordinated with efforts at the state level. In this way, MPCA is ensuring that the most current and comprehensive dataset is available for assessment and for the development of protection and restoration strategies. By bolstering local capacity, expertise, and equipment inventory, these partners become well suited to carry out future monitoring efforts, such as subwatershed pollutant load monitoring to aid in restoration and protection strategies.

Local partners and volunteers place a crucial role in assessing the health of lakes and streams in Minnesota. Redwood Cottonwood Recreation Control Area staff sample the Cottonwood River near Leavenworth (top) in southwest Minnesota (photo credit: Pauline Wohnoutka). Volunteer Mary Jo Patton in the North Fork Crow River Watershed collects an integrated sample from George Lake (bottom).

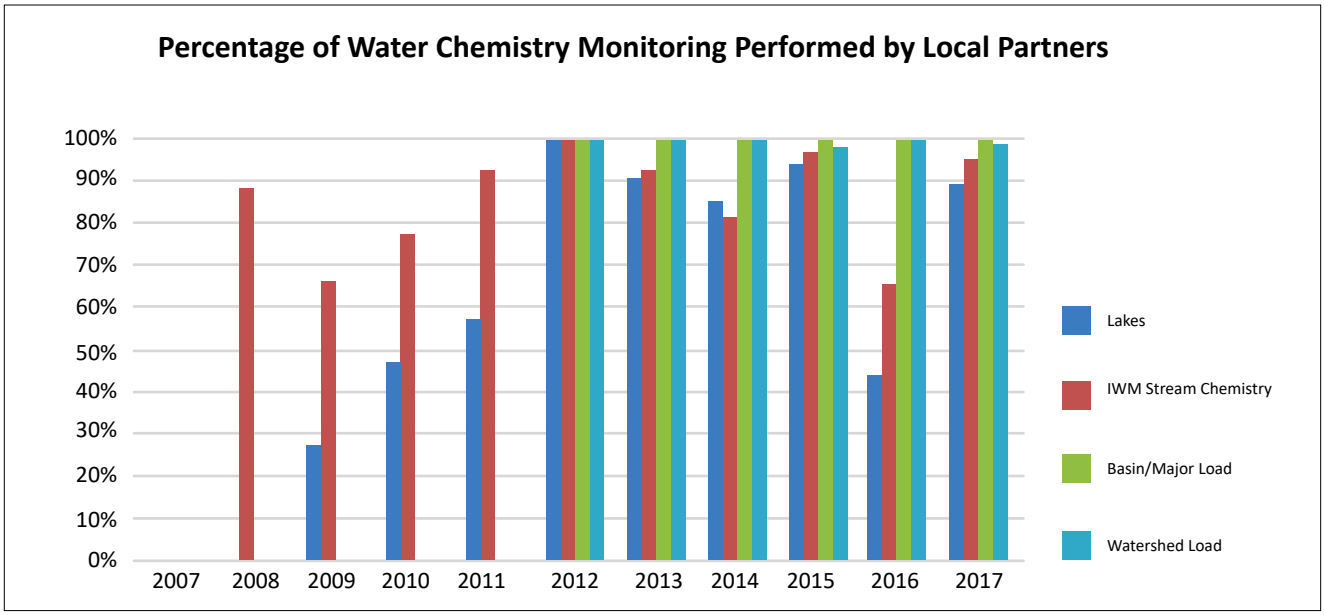
Status	Trend	Description
●	→	As of 2017, all programs are meeting participatory goals.

What progress has been made?

Through advertising and expansion of the contract opportunities to include load monitoring, MPCA has been able to meet its goal of a minimum of 75 percent of the sites offered being picked up by local partners.

Learn more

- Find more information about this measure and its data at www.legacy.leg.mn/funds/clean-water-fund
- Find out when the MPCA will be intensively monitoring your watershed: www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/watershed-approach/index.html
- Surface Water Assessment Grants: www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/surface-water-financial-assistance/surface-water-assessment-grants.html
- Watershed Pollutant Load Monitoring Grants: www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/streams-and-rivers/watershed-pollutant-load-monitoring-network.html#grants



Connection with Minnesota's Clean Water Roadmap

Goals: An 8 percent increase in the percentage of lakes with good water quality, and a 7 percent increase in the percentage of rivers and streams with healthy fish communities.

This measure will support the Roadmap goals by aiding the targeting of actions to protect and improve water quality. Monitoring changes in environmental conditions provides the information to direct protection and restoration activities in watersheds. Monitoring also measures changes as practices are implemented or as more land is developed.

Nonpoint source BMP implementation

ACTION

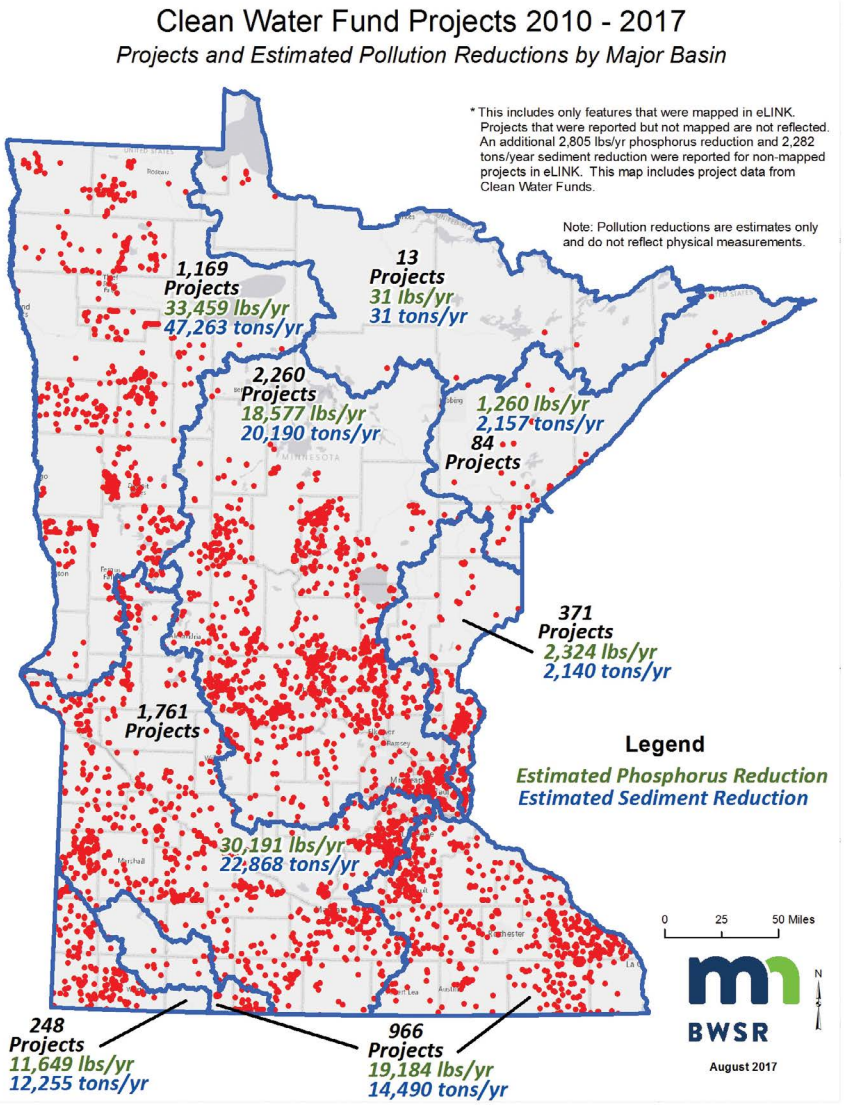
Measure: Number of nonpoint source best management practices implemented with Clean Water funding and estimated pollutant load reductions

Why is this measure important?

Minnesotans want their water resources protected and restored. Unfortunately, it can take many years for pollution control practices to result in clean water, particularly at the scale outlined in the Clean Water Road map. This measure helps us monitor progress toward the long-term goal of clean water by tracking the actions of people and organizations to implement best management practices, in cities and on the farm. This measure also tracks the estimated amount of pollution those management and conservation practices are expected to reduce.

What are we doing?

The Board of Water and Soil Resources (BWSR) is the primary state agency responsible for nonpoint source implementation and operates in partnership with local governments. Local governments– cities, watershed districts, counties, and soil and water conservation districts–are leading both cleanup and protection efforts across the state. They are working directly with communities, individual landowners and various non-profit organizations to implement best management practices. These practices include reducing polluted runoff from city streets, agricultural fields and feedlots; stabilizing stream channels; and upgrading septic systems.



The Minnesota's Agricultural Water Quality Certification Program (MAWQCP) is a statewide voluntary opportunity for farmers and agricultural landowners to take the lead in implementing conservation practices that protect our water. Farmers and landowners who implement and maintain approved farm management practices are certified and in turn obtain regulatory certainty for a period of 10 years. Producers interested in becoming certified also receive priority status for technical and financial assistance. In practice, the MAWQCP brings together producers with local soil and water conservation district staff and agronomy professionals to address risks to water quality when they're found via a whole-farm assessment.

Estimating the environmental benefit of specific management practices can be done many ways. The most common are to develop computer models, use values from scientific literature, or base estimates on the best professional judgment of experts. Regardless of the method used, some uncertainty remains in every estimate. As a result, there are several ongoing research efforts to better quantify the environmental benefits of conservation practices.

What progress has been made?

With funding from the Clean Water Fund, the implementation of practices to improve and protect Minnesota's water resources has accelerated, as has the completion of Total Maximum Daily Load (TMDL) and Watershed Restoration and Protection Strategy (WRAPS) assessments that outline water quality needs. As a result, funding is not keeping pace with demand.

From 2010 to 2017 the Clean Water Fund has:

- Funded more than 1,487 grants to protect and restore Minnesota water resources
- Issued more than 789 loans to prevent nonpoint source water pollution or solve existing water quality problems
- Secured more than 490 easements that will permanently protect approximately 7,279 acres along riparian corridors and within well head protection areas
- Repaired 617 imminent health threat Subsurface Sewage Treatment Systems and
- The Minnesota Agricultural Water Quality Certification Program has certified over 300,000 acres on 500 farms across Minnesota, adding 900 new conservation practices to the landscape in approximately two-years of statewide operations.

In total, more than 6,872 best management and conservation practices have been installed, resulting in a reduction of about 116,675 pounds of phosphorus and 121,394 tons of sediment across the state.

Learn more

- Find more information about this measure and its data: www.legacy.leg.mn/funds/clean-water-fund.
- BWSR clean water stories: www.bwsr.state.mn.us/clean water stories
- AgBMP Loan Program: www.mda.state.mn.us/grants/loans/agbmploan.aspx.
- Minnesota Agricultural Water Quality Certification Program: MyLandMyLegacy.com
- Clean Water Funded projects: www.legacy.leg.mn/funds/clean-water-fund

Status	Trend	Description
		Although funding has increased and there is a continued increase in practices and projects being implemented, the total request for projects has remained three times greater than available funds.

Connection with Minnesota's Clean Water Roadmap

Goals: An 8 percent increase in the percentage of lakes with good water quality, and a 7 percent increase in the percentage of rivers and streams with healthy fish communities.

This measure will support the Roadmap goals by tracking reductions in phosphorus and sediment as a result of implementation activities. State-funded nonpoint implementation projects and associated pollutant reductions are tracked and will be analyzed on the major river basin scale.

Municipal infrastructure project implementation

ACTION

Measure: Number of municipal point source construction projects implemented with Clean Water funding and estimated pollutant load reductions

Why is this measure important?

Municipalities across Minnesota are required to upgrade treatment facilities, increase treatment of stormwater runoff, and replace failing septics in order to protect or restore our state's waters. These construction projects help meet required wasteload reductions through implementation of Total Maximum Daily Loads (TMDLs), phosphorus discharge limits and Water Quality Based Effluent Limits (WQBEL). These reductions are in addition to the major water quality benefits already being achieved by municipalities through ongoing investments to replace aging wastewater infrastructure.

What are we doing?

Cities are required to implement expensive upgrades to their wastewater and stormwater infrastructure to meet tighter discharge standards and specific water quality protection and restoration goals. Small unsewered communities are required to fix noncomplying individual sewage treatment systems or install community systems when new individual systems are not appropriate.

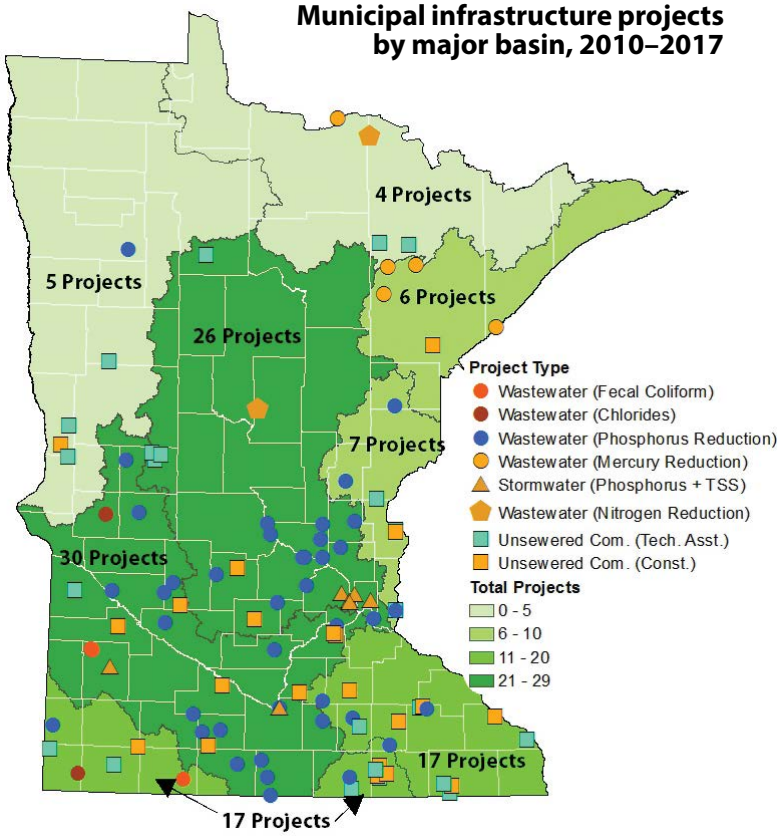
The Minnesota Public Facilities Authority (PFA) and the Minnesota Pollution Control Agency (MPCA) jointly administer programs that provide grants and loans from Clean Water Legacy Funds to help municipalities pay for these infrastructure improvements. These Clean Water Legacy programs supplement existing state and federal funding so that municipalities can implement these important upgrades more quickly.

What progress has been made?

Since 2010, Clean Water Fund dollars have helped 108 municipalities implement wastewater and stormwater projects, including:

- 37 wastewater construction projects to reduce phosphorus discharges to 1 milligram per liter or less, resulting in a total phosphorus reduction of more than 135,000 pounds per year.
- 5 wastewater construction projects to reduce mercury discharges, resulting in a total reduction of 4,610 milligrams per year.

Municipal infrastructure projects by major basin, 2010–2017



- 2 wastewater construction project that will provide treatment to reduce subsurface nitrogen discharges, resulting in a total reduction of 4,356 pounds per year.
- 1 construction project to reduce chloride discharge, resulting in a total chloride reduction of more than 27,751 pounds per year.
- 7 stormwater construction projects that will provide treatment to reduce phosphorus discharges by 1,358 pounds per year and also result in reducing total suspended solids of 43,550 pounds per year.
- 29 small community technical assistance projects to help small unsewered communities evaluate treatment alternatives to address serious water quality and public health problems from non-complying septic systems.

- 24 wastewater construction projects to help small unsewered communities solve their wastewater problems by connecting to existing municipal systems or building their own treatment systems such as community cluster mound systems.

Clean Water Funds are targeted to high priority projects based on the MPCA's Project Priority List which ranks projects based on water quality impacts and public health factors. Projects are designed to achieve specific effluent limits and wasteload reductions, and discharges are monitored to verify compliance.

The majority of projects to date have focused on reducing phosphorus discharges from wastewater treatment facilities.

Phosphorus is a nutrient which, when present in excessive amounts, is responsible for water quality impairments due to excess algal growth. River nutrient standards are rolling out across the state in the coming years and this funding source will be vital in helping to finance the required treatment upgrades.

Changes to program statutes in the 2017 Legislative Session increased grant assistance and enacted administrative streamlining measures which have resulted in a jump in projects seeking funding. Continued appropriations will be needed to meet the increasing municipal demand for funding to improve treatment facilities across Minnesota.

The City of Waterville upgraded its wastewater treatment facility to meet a more stringent discharge limit fpr phosphorus based on a WQBEL for Upper Sakatah Lake, which resulted in a total phosphorus reduction of 10,452 lbs per year.

For information on activities funded by the Clean Water Fund visit:

- www.legacy.leg.mn/funds/clean-water-fund.
- Minnesota Public Facilities Authority (PFA): www.mn.gov/deed/pfa
- Minnesota Pollution Control Agency (MPCA): www.pca.state.mn.us

Status	Trend	Description
●	→	Total applications for eligible projects is twice the amount of funds available.

Connection with Minnesota's Clean Water Roadmap

Goals: An 8 percent increase in the percentage of lakes with good water quality, and a 7 percent increase in the percentage of rivers and streams with healthy fish communities.

This measure will support the Roadmap goals by tracking reductions in phosphorus and sediment as a result of implementation activities. State-funded point implementation projects and associated pollutant reductions are tracked through permit limits and will be analyzed on the major river basin scale.

Surface water health

OUTCOME

Measure: Rate of impairment/unimpairment of surface water statewide and by watershed

Why is this measure important?

Many Minnesotans want to know if they can swim and fish in their favorite lake or stream. Until recently, a relatively small percentage of lakes and streams had enough water quality information to determine if Minnesota's water goals were being met. In order to determine a waterbody's health, state agencies need basic water quality information that is obtained through monitoring. Without this basic information, work to develop strategies to reverse water pollution and to protect high quality lakes and streams has been delayed.

What are we doing?

Clean Water Funding significantly increased water monitoring and assessment activities. In 2008, the MPCA implemented the Watershed Approach. This is a 10-year cycle where approximately eight of Minnesota's 80 major watersheds are intensively monitored each year for stream and lake water chemistry and biology. These data from monitoring activities are then assessed to determine if goals to protect recreational activities such as fishing and swimming, as well as to safeguard fish and aquatic ecosystems, are being met. By considering all lake and stream data for a given watershed at one time, a complete picture of the watershed's overall health develops. State agency and local partners are working together to conduct the intensive monitoring, assess the resulting monitoring information and to develop restoration and protection plans.

What progress has been made?

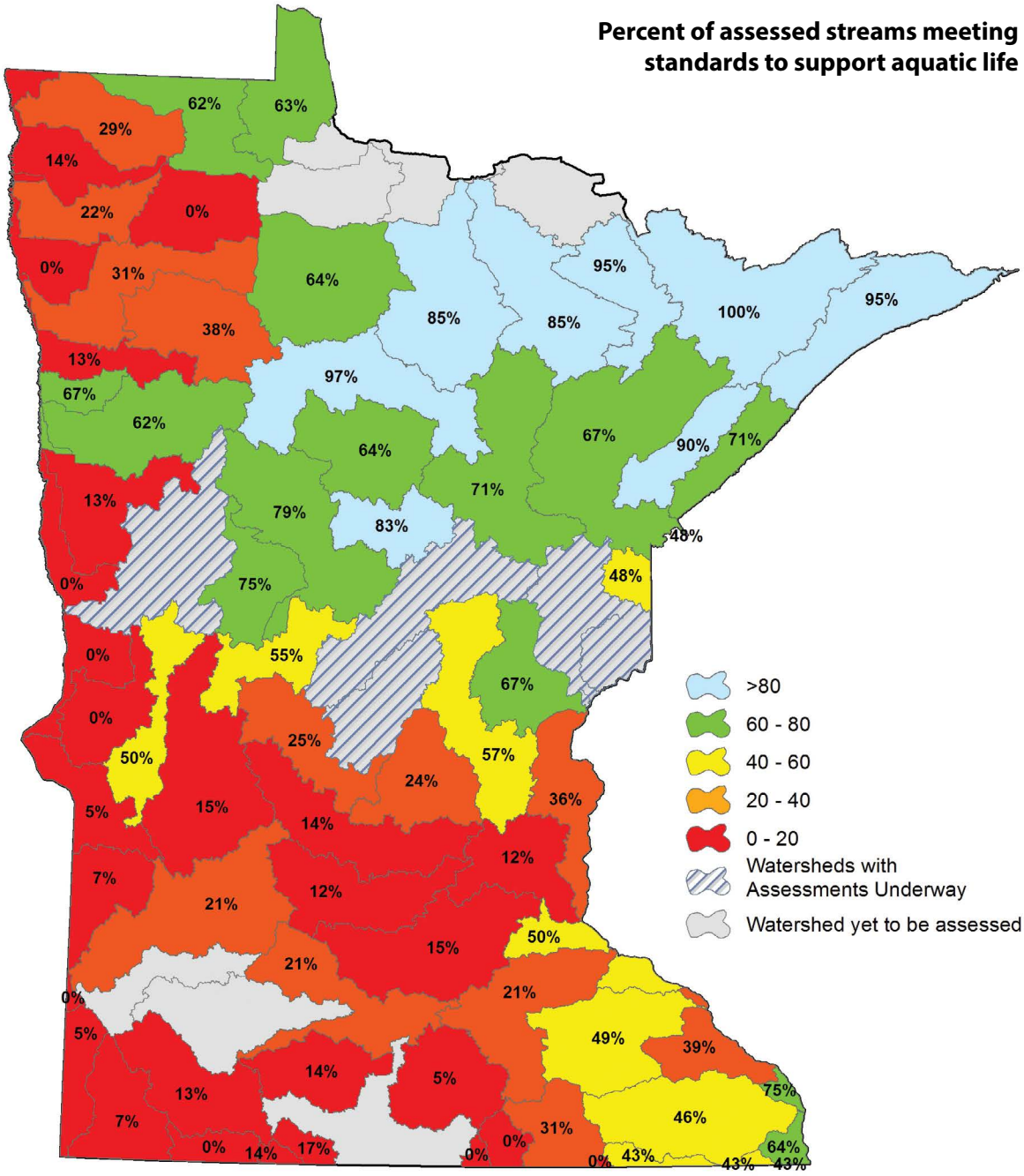
As of January 2018, 69 out of 80 watersheds have been assessed. An additional five watersheds will be assessed in 2018. The assessment results are located on the MPCA's Minnesota Watershed web page at www.pca.state.mn.us/index.php/water/water-types-and-programs/watersheds/watershed-overview-map.html.

MPCA water chemistry crews sample streams and lakes across Minnesota to determine if recreation and aquatic life are supported.

Learn more

- Find more information about this measure and its data at www.legacy.leg.mn/funds/clean-water-fund.
- Find water quality assessment results for specific lakes and streams at www.pca.state.mn.us/index.php/data/surface-water.html.
- Visit www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/watershed-approach/index.html to find out when your watershed will be monitored.

Status		Trend	Description
▲	Stream aquatic life	Not enough information for a trend determination at this time.	Water quality varies greatly by region. Watersheds yet to be assessed will influence the statewide impairment/unimpairment rate. It is unclear whether long-term goals will be met.
▲	Stream swimming		
▲	Lake swimming		



Streams are monitored for water chemistry, fish, and aquatic insects to determine if a stream has healthy aquatic ecosystems. Water monitoring information is also evaluated to determine if lakes and streams are suitable for swimming and other water recreation, and to determine whether consumption of fish should be limited.

Lake and stream water quality

OUTCOME

Measure: Changes over time in key water quality parameters for lakes and streams

Why is this measure important?

Water quality in a lake or stream can change depending on a variety of factors ranging from rain quantity or temperature to runoff from agricultural areas, parking lots, roads and lawns. Because of factors like these, waters must be sampled for many years to detect water quality trends. Information gathered over the years is valuable because it gives insights into general water quality patterns and trends across the state. This helps determine where to target restoration and protection efforts and the effectiveness of current activities to restore polluted waters and protect those that have good water quality.

What are we doing?

Federal, state and local organizations have been monitoring Minnesota's lake and stream water quality for decades. Data were collected statewide, and the results of this work were widely reported to support various program goals. Taken together, Minnesota's water quality data paint a picture of general condition and changes in Minnesota's lakes and streams.

This measure tracks those water quality factors that tend to be the largest sources or indicators of pollution. Some of these parameters include:

Lakes

- Total phosphorus
- Chlorophyll-a (algae pigment)
- Secchi (transparency)
- Pesticides

Phosphorus, chlorophyll-a, and Secchi combined indicate whether lake water quality is good for recreation, such as swimming and wading. Pesticides can affect the survival rate of fish, insects, and their food sources.

Streams

- Total phosphorus
- Nitrate
- Total suspended solids (sediment)
- Fish and invertebrates (aquatic insects)
- Pesticides

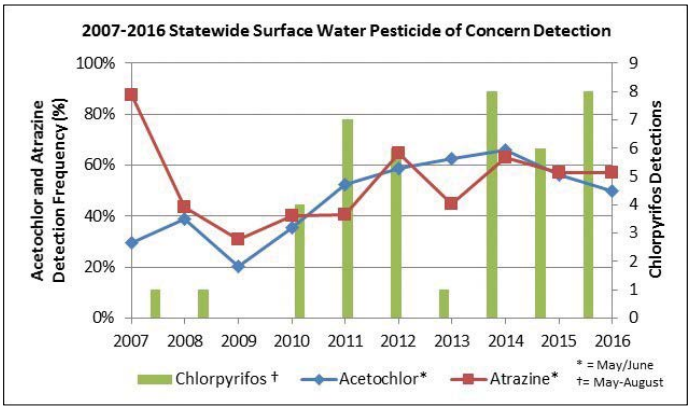
Phosphorus, nitrate, suspended solids, and pesticides in high concentrations affect the survival rate of fish and their food source, aquatic insects. All of these parameters combined measure the ability of the stream to support healthy aquatic ecosystems.

In addition to analyzing data from existing sites, state and local partners are expanding the monitoring network to provide information in new areas or places facing new threats.

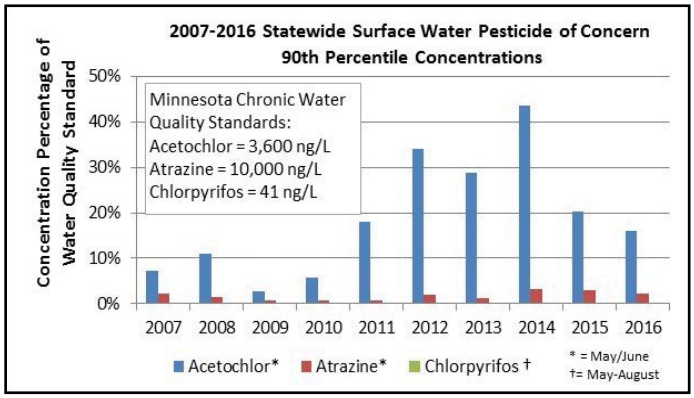
What progress has been made?

Expansion of the monitoring network is critical to evaluating water quality trends in the state of Minnesota. The following activities are key highlights:

- The MDA has been monitoring for the presence and concentration of pesticides in the state's groundwater and surface water since 1985 and 1991, respectively. In recent years, the MDA expanded its laboratory capability and has the ability to detect approximately 145 different pesticide compounds at very low concentrations.
- MPCA's Watershed Pollutant Load Monitoring Network began in 2008 and ramped up to 199 sites by 2015. In 2017, trends were calculated for stations with long-term data records located on large rivers.

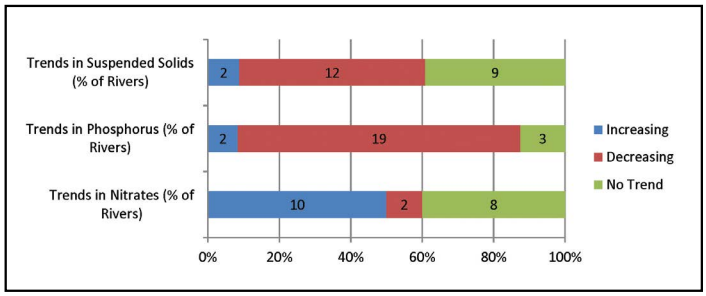


Long-term monitoring of pesticides has allowed MDA to assess detection and concentration trends over time. Detections of certain herbicides are frequent, while other pesticides are rarely, if ever, detected.



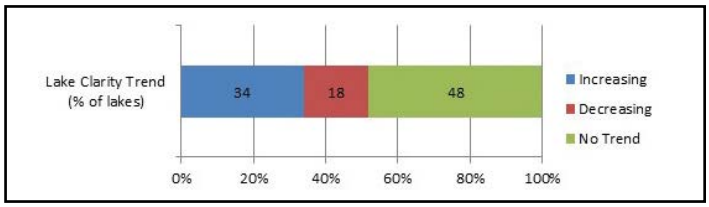
Long-term monitoring of pesticides is needed to assess concentrations relative to water quality standards due to variability in climate, pesticide use, and agronomic factors. Most detections are well below water quality standards.

- Volunteers in the Citizen Lake and Stream Monitoring Programs have collected lake and stream water clarity information for over 19 years. These volunteer programs are vital in gathering data for long-term data analysis.



Where long-term (>20 years) streamflow and water quality data are available, phosphorus and total suspended solids concentrations in Minnesota's larger rivers are generally decreasing or staying the same, while nitrate concentrations are staying the same or increasing. Because flows have been increasing in some rivers, the total amount of phosphorus, total suspended solids, and nitrate may be increasing even when concentrations stay the same.

- All of the watersheds have been comprehensively monitored, providing baseline data for assessments and a starting point for future trends. The second 10-year rotation of intensive watershed monitoring begins in 2018.



Trends in lake water clarity between 1973 and 2016. While water clarity, in general, is poorer in southern Minnesota, increasing and decreasing lake clarity trends are fairly evenly scattered through north and south central Minnesota.

- The MPCA participated in the National Aquatic Resources Surveys for lakes, including a partnership with MDA for pesticide work, and conducted state probabilistic surveys for streams, rivers, and wetlands, providing baseline information.

Though it is tempting to make sweeping statements, most often the story is a complicated mix of seeing improvements in some aspects of water quality and declines in others. There can also be striking differences in water quality trends when comparing the long-term trend (>20 years) against the short term trend (5-15 years) for a given lake or stream.

Learn more

- The MPCA has a rich array of graphics that can be produced for multiple combinations of waterbody types, pollutants/parameters, and monitoring approaches to provide a comprehensive picture of the state of Minnesota's water resources. See www.legacy.leg.mn/funds/clean-water-fund.

Status	Trend	Description
Lake clarity ●	Not enough information for a trend determination at this time.	Lake clarity: There are improving trends in lake water clarity in more lakes than not.
Nutrients and sediment in large rivers ▲		Nutrients and Sediment in Large Rivers: in general, concentrations in phosphorus and sediment are declining while nitrates are increasing in surface water.
Pesticides in streams ▲		Pesticides in streams: Detections in streams vary greatly as a result of hydrologic and agronomic conditions; concentrations above water quality standards are rare.
Pesticides in lakes ▲		Pesticides in lakes: Detections in lakes vary by region; detections in lakes have been well below water quality standards.

Waters restored

OUTCOME

Measure: Number of previous impairments now meeting water-quality standards due to corrective actions

Why is this measure important?

This measure tracks how actions taken on the ground lead to successful restoration of impaired waters. "Impaired waters" are lakes, streams or rivers that fail to meet water quality standards due to one or more pollutants such as nutrients, bacteria, mercury and sediment. High levels of pollution in impaired waters can be unsafe for public health, fish and other aquatic life, as well as damaging to recreational opportunities.

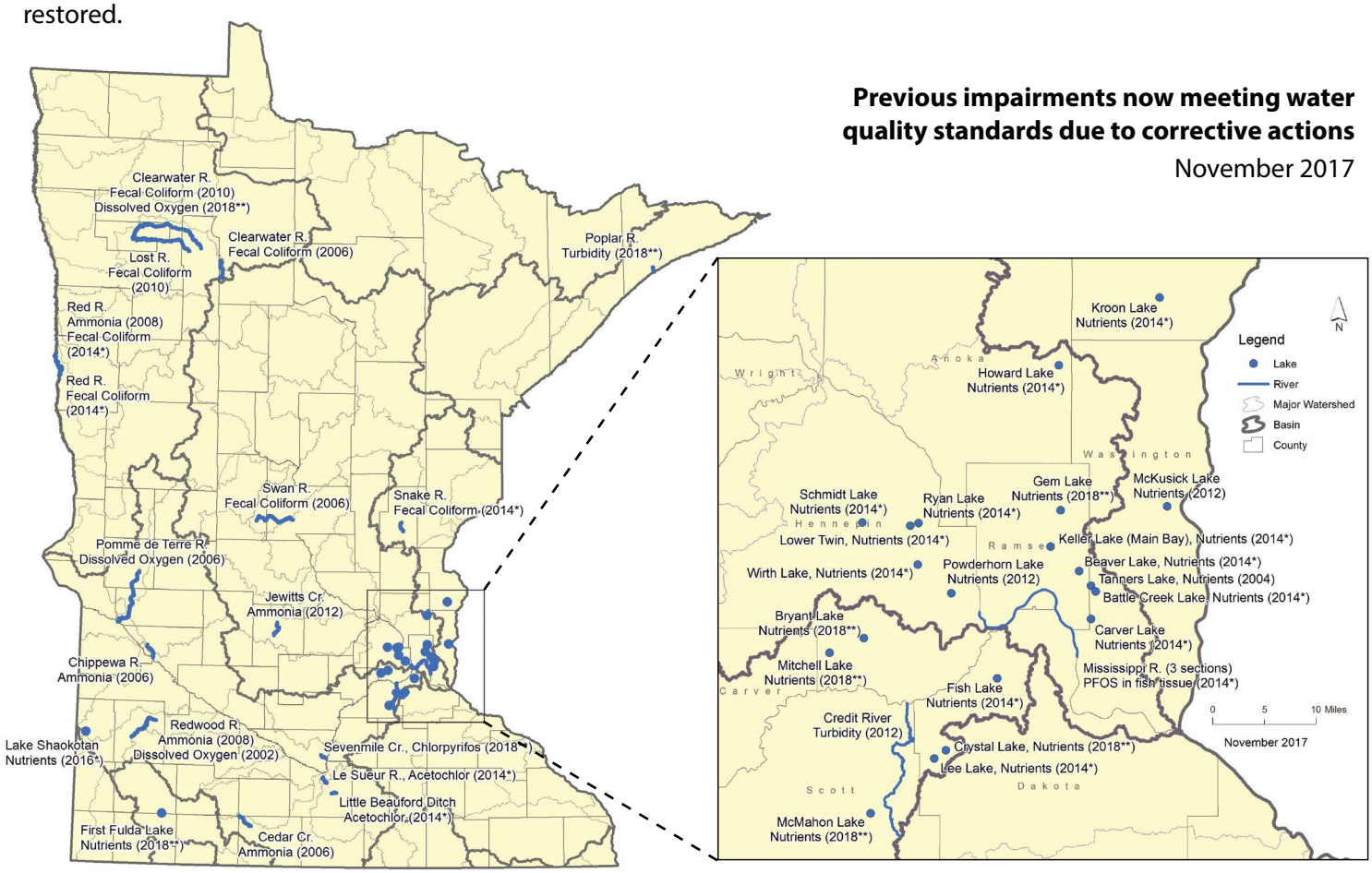
Although Minnesota's impaired waters list is growing as the state monitors and assesses more watersheds, so too is the list of waters that are improving. Cleanup efforts can take several years to decades to complete, but there are many examples of impaired waters that have been restored.

What are we doing?

Pollution problems are initially identified through water quality monitoring, followed by studies and plans to determine what corrective actions are needed. Local governments – cities, watershed management organizations (WMO), counties and soil and water conservation districts (SWCDs) – are leading these cleanup efforts, working closely with organizations, landowners and citizens. These actions include upgrading wastewater treatment plants and septic systems; reducing polluted runoff from city streets, agricultural fields and feedlots; and implementing other on-the-ground best management practices (BMPs).

Previous impairments now meeting water quality standards due to corrective actions

November 2017



**Waters proposed for delisting in the 2014 and 2016 listing cycles are currently under review for EPA approval.*

***Waters proposed for delisting in the 2018 listing cycle are subject to public comment and EPA approval.*

What progress has been made?

Ultimately, the target is to restore all impaired waters in Minnesota. The Minnesota Pollution Control Agency (MPCA) began listing impaired waters in 1998; since that time 46 previously impaired lakes and river segments are now meeting water quality standards due to corrective actions.

One notable success story is the restoration of Lake Shaokatan in Lincoln County. The lake was listed for not meeting aquatic recreation and aquatic life designated uses due to excess nutrients in 2002 as a result of excess phosphorus loading which leads to increased algae growth and reduced transparency.

Due to corrective actions, the lake was removed from the impaired waters list in 2016. Efforts included rehabilitation of three feedlots, four wetland areas, and shoreline septic systems. These actions resulted in a 58 percent reduction in phosphorus loading to the lake. Phosphorus levels in the lake dropped significantly, with concentrations near the state standard of 90 parts per billion, down from 200 to 350 parts per billion in previous summers. This decrease resulted in reductions in the frequency and severity of algal blooms.

Many other waters are improving

In most cases, the 46 success stories depicted on this map are the result of several years of diligent efforts at the local level both prior to and with Clean Water Funds. However, the map does not give a sense of the many lakes and streams making restoration progress. Statewide, many lakes and streams have realized considerable improvements in recent years from work ranging from restoring wetlands and stabilizing streambanks to addressing septic system and feedlot issues. These actions result in improvements such as greater clarity and reduced algae.

Although full restoration of Minnesota's waters will take time, Clean Water Fund investments are helping to accelerate the pace of these activities.

Lake Shaokatan in Lincoln County was successfully removed from the Impaired Waters List in 2016

Learn more

- Find more information about this measure and its data at www.legacy.leg.mn/funds/ clean-water-fund
- Find your watershed and restoration projects at: ww.w.pca.state.mn.us/water/watersheds
- Lake Shaokotan: www.pca.state.mn.us/featured/lake-shaokatan-prairie-lake-improving-water-quality
- Minnesota's Impaired Waters List: www.pca.state.mn.us/water/minnesotas-impaired-waters-list

Status	Trend	Description
■	→	Although many projects are making progress in improving water quality, more waterbodies are being listed as impaired relative to the slower rate of waterbodies being restored.

Mercury trends

OUTCOME

Measure: Trends of mercury in fish and mercury emissions in Minnesota

Why is this measure important?

Many Minnesota lakes and rivers contain contaminants, primarily mercury, which accumulate in fish and may pose a risk to humans as well as fish-eating wildlife. Because air pollution is the primary source of mercury, reducing mercury in fish requires large reductions in mercury emissions from sources in Minnesota and throughout the world. To evaluate if Minnesota waters are getting cleaner, we can track mercury emission levels over time through periodic emissions inventories and then measure how fish mercury levels respond. Because of the large variation in mercury concentrations from year to year within and among lakes, long-term trends of mercury in fish are necessary to see if pollution control efforts are sufficient.

What are we doing?

The Minnesota Department of Natural Resources (DNR) is leading efforts to track mercury levels in fish. The DNR collects fish from approximately 150 lake and river sites annually throughout Minnesota and prepares samples for testing. Each year, thousands of walleyes, northern pike, panfish, and other species are tested; Clean Water funding has expanded the number of sites tested each year. The Minnesota Pollution Control Agency (MPCA), Minnesota Department of Health (MDH), and U.S. Forest Service provide input on where samples should be collected; the Department of Agriculture's (MDA) laboratory analyzes the samples.

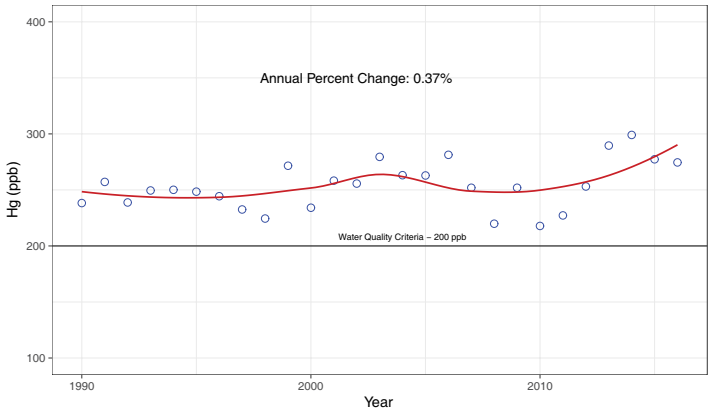
Decades of monitoring has shown that (1) most fish contain some mercury, (2) the average mercury level generally increases from south to north in Minnesota, and (3) panfish have lower mercury levels than top predator fish. This is the basis for MDH statewide guidelines for eating fish.

MPCA scientists have also evaluated whether the average concentration of mercury in walleyes and northern pike in Minnesota lakes is changing with time. That trend analysis initially focused on 1982 to the present and has been reported on in previous versions of the Clean Water Fund Performance Report. However, a re-examination of the data showed that fish sampling efforts prior to 1990 were concentrated on lakes in northern Minnesota, a region where mercury concentrations are generally higher than the state average (see #2 above), and that a long-term trend analysis could be biased if the pre-1990 samples were included. As a result, MPCA scientists are now only using walleye and northern pike collected since 1990 to determine how mercury concentrations in lakes are changing over time.

What progress has been made?

The current 27-year fish-mercury trend (Figure 1) shows a different pattern than has been reported in previous versions of this report. Data from lakes sampled starting with 1990 as the baseline year show an upward trend in average mercury concentration.. The increase, 0.37% per year on average, is significant. Minnesota's water standard for mercury in edible fish tissue – 200 parts per billion (ppb) – is shown for reference on the figure, because it is the threshold above which lakes and streams are impaired. The standard protects humans for consumption of one meal per week of fish caught in Minnesota. MPCA scientists plan to update the fish mercury trend analysis after an additional five years of data are available.

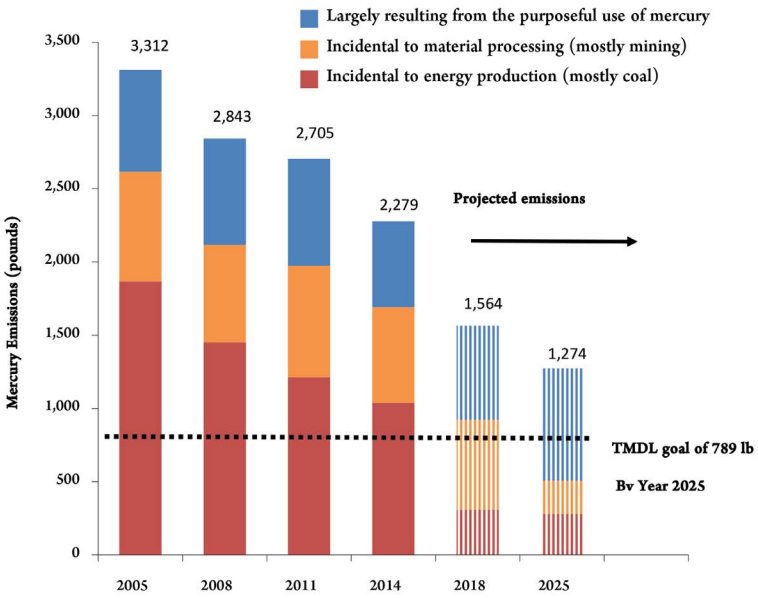
Trend of mercury in northern pike and walleye from Minnesota lakes: 1990 – 2016



Why the shift in the fish-mercury trend? Although there have been substantial decreases in mercury emissions in Minnesota (see below), the United States, and Europe, the overall global mercury emissions inventory has continued to increase; between 2010 and 2015, estimated global mercury emissions increased 12 percent. In addition, many scientists have observed increasing mercury levels in fish and wildlife, which has been attributed to increasing availability of mercury to food webs due to climatic changes in temperature and precipitation.

To achieve the necessary reductions of mercury in the fish, Minnesota's Statewide Mercury TMDL established a goal of a 93 percent reduction in mercury input from all human sources, both those inside and those outside Minnesota borders. Minnesota is implementing the TMDL to achieve the goal within the state by 2025. However, 90 percent of its mercury pollution is from outside the state. The Minamata Convention, entered into force in July 2017, provides the foundation for anticipating mercury emissions reductions globally.

Rapid economic growth in Asia and India since 1990 has contributed to increased global emissions of mercury, despite mercury emissions in North America and Europe being cut in half since 1990. The United Nations Environment Program is negotiating reductions among all countries of the world through the Minamata Convention. Minnesota is doing its part, and has taken significant steps towards achieving the identified mercury air emission reductions. Since 1990, removing mercury from latex paint, requiring mercury controls on municipal waste combustors, banning small onsite incinerators, mercury in batteries, and disposal of mercury-containing products has reduced mercury emissions in Minnesota by more than 70 percent.



Mercury emissions from Minnesota sources; 2005 and 2008 are based on measured and calculated inventories.

To reach the 93 percent reduction goal, air emissions of mercury from all sources in Minnesota must be reduced to 789 pounds per year (Figure 2). Minnesota's Statewide Mercury TMDL Plan has set a strategy and timeline to achieve that goal by 2025.

Learn more

- Mercury research and reduction initiative: www.pca.state.mn.us/quick-links/mercury-research-and-reduction-initiative
- Fish Consumption Advice: www.health.state.mn.us/divs/eh/fish/ (MDH) www.dnr.state.mn.us/lakefind/index.html (DNR)
- Mercury TMDL: www.pca.state.mn.us/water/statewide-mercury-reduction-plan
- UNEP Mercury Emissions Inventory: public.tableau.com/views/GlobalMercuryEmissions/Dashboard1?:embed=y&:display_count=no&:showVizHome=no#1

	Status	Trend	Description
Mercury in fish	▲	→	Mercury in game fish is not yet responding to decreases in local mercury emissions, although these reductions likely have prevented a steeper upward trend. Global emissions have increased. The time lag between emission reductions and response is likely several decades. It is too soon to see a measurable response in fish mercury levels. Long-term and consistent monitoring is necessary to track changes in fish tissue.
Mercury emissions	▲	↗	Significant progress has been made reducing mercury emissions from power plants and is expected from the mining sector. To meet Minnesota's 2025 emissions goal, further reduction of mercury use in various products will be necessary.

Municipal wastewater phosphorus trend

OUTCOME

Measure: Municipal wastewater phosphorus discharge trend

Why is this measure important?

Phosphorus continues to be a significant challenge for meeting Minnesota's water quality goals. This measure shows trends in the amount of phosphorus being discharged from municipal wastewater treatment facilities. These regulated entities provide treatment for contaminated water from homes, businesses and industries. Wastewater treatment facilities are required to remove phosphorus and many other pollutants to levels that protect water quality.

In 2015, the Mora Wastewater Treatment Facility received Clean Water Funds to construct upgrades that reduced phosphorus discharge to the Snake River by 74 percent.

What are we doing?

Regulatory policies implemented over the past 15 years (see graph next page) have resulted in the reduction of phosphorus discharged by wastewater treatment facilities. The treatment plant improvements needed to achieve these reductions are expensive, particularly for smaller cities. Clean Water Legacy funding has helped cities make the required infrastructure investments to meet phosphorus wasteload reductions mandated through the implementation of Total Maximum Daily Loads (TMDLs) and Water Quality Based Effluent Limits (WQBELs).

Since 2010, $40.2 million in Clean Water Fund grants have helped 37 municipalities finance wastewater treatment upgrades to meet required phosphorus reductions. These grants leveraged an additional $41 million in other funding for these infrastructure improvements. The availability of these Clean Water Fund grants help cities implement these treatment improvements on an expedited time schedule.

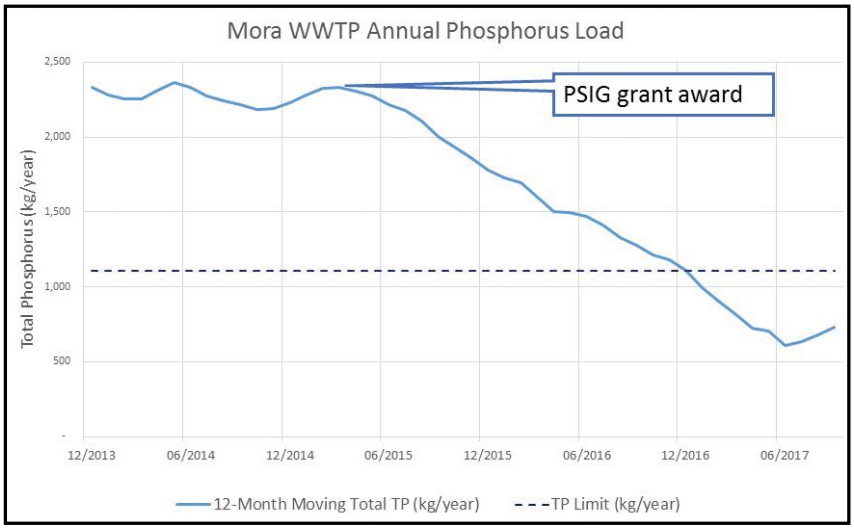
What progress has been made?

Over the past 17 years, municipal wastewater phosphorus discharges statewide have been reduced by 70 percent, and it is estimated that effluent phosphorus loads have been reduced by 84 percent compared to the projected effluent loads that would have resulted from previous permitting policies. Overall, these combined efforts have led to a steady decline of phosphorus pollution and major improvements in water quality. Implementation of newly adopted river nutrient standards is expected to result in further reductions in wastewater phosphorus loads in coming years.

Learn more

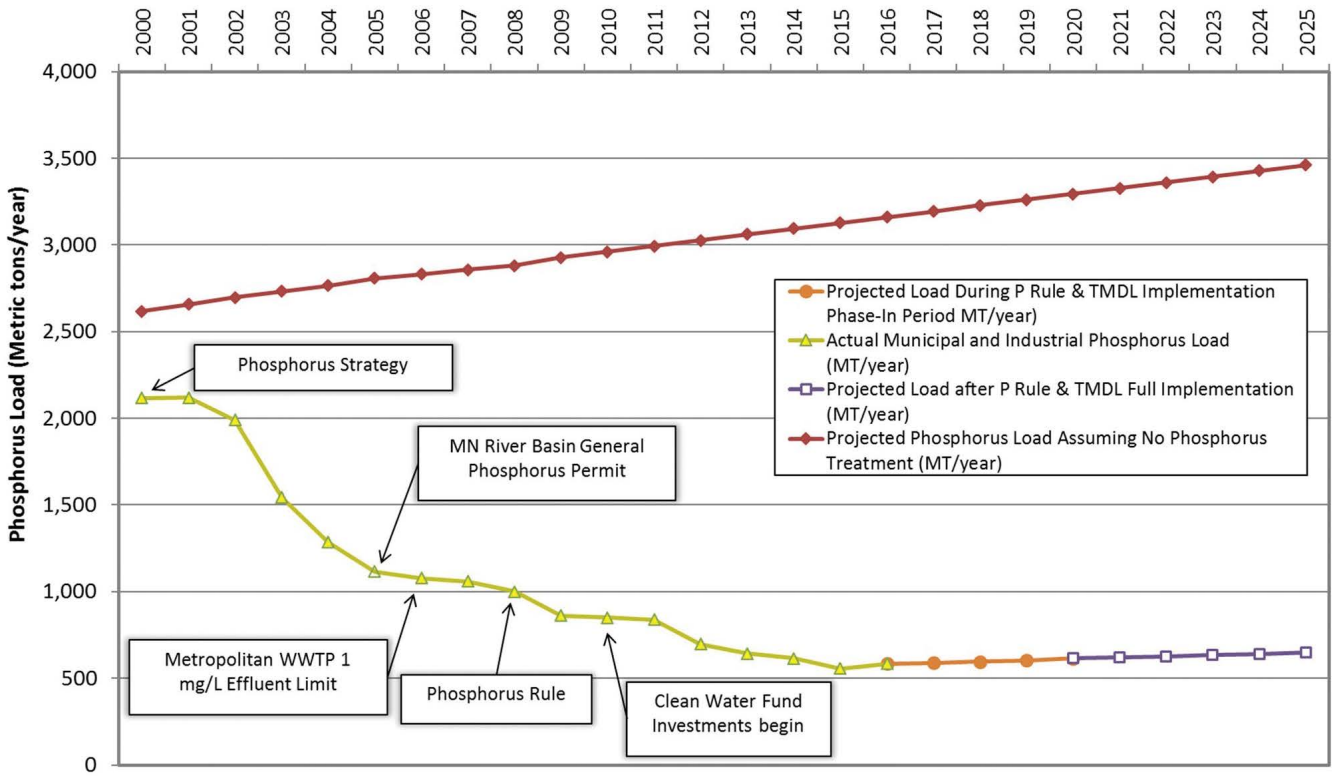
For information on activities funded by the Clean Water Fund visit:

- www.legacy.leg.mn/funds/clean-water-fund
- Minnesota Public Facilities Authority (PFA): www.mn.gov/deed/pfa
- Minnesota Pollution Control Agency (MPCA): www.pca.state.mn.us



The Mora Wastewater Treatment Facility has reduced its effluent phosphorus load by over 1,700 kilograms per year to meet a new permit limit.

Municipal and Industrial Wastewater Phosphorus Trends & Projections



Estimated statewide reductions in phosphorus from municipal wastewater treatment facilities since the year 2000 and projections of future reductions based on current permitting policies, implementation of Total Maximum Daily Load (TMDL) requirements , and Clean Water Fund Investments.

Status	Trend	Description
●	↗	Significant phosphorus load reductions have been achieved through regulatory policy, infrastructure investments and improved technology.

Drinking and groundwater measures

The 12 measures contained on pages 36-61 illustrate important Clean Water Fund-supported actions and outcomes undertaken to protect Minnesota's drinking water supplies.

Actions

1. Source water protection plans and implementation
2. Source water protection grants
3. Nitrate monitoring and reduction by local partners
4. Contaminants of emerging concern
5. County geologic atlases
6. Long-term monitoring network wells
7. Unused groundwater wells sealed

Outcomes

8. Groundwater quality
9. Source water quality for community water supplies
10. Nitrate and arsenic concentrations in new wells
11. Groundwater levels
12. Water efficiency

Source water protection plans and implementation

ACTION

Measure: Number of community water supplies assisted with developing source water protection plans

Why is this measure important?

People in Minnesota obtain drinking water from groundwater, lakes, and rivers. The Minnesota Department of Health (MDH) works with public water suppliers and communities to protect the sources of their drinking water. Some examples of threats to drinking water sources include unused wells, urban pollutants, agricultural nutrients, storage tanks, lawn nutrients and chemicals, hazardous waste, and uncontrolled land development. Source water protection is important because it:

- Protects human health
- Keeps costs down (i.e., pollution prevention is often less expensive than remediation)
- Ensures sustainable water supplies for future generations

What are we doing?

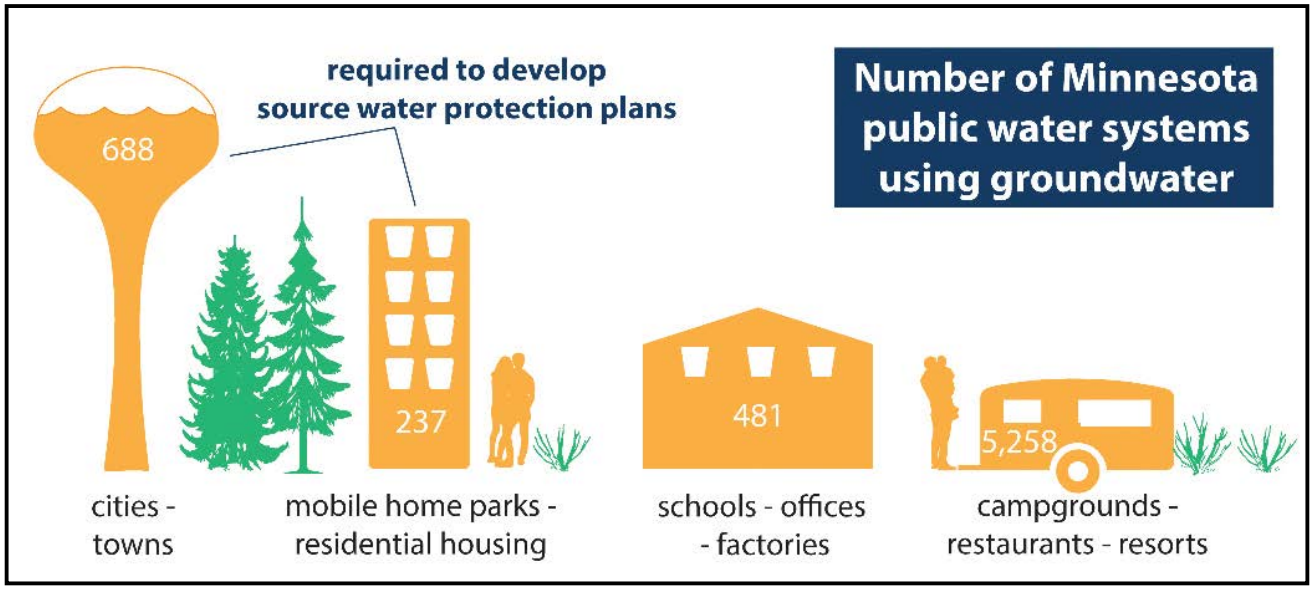
MDH requires source water protection plans for all community and some noncommunity public water systems that use groundwater. Some systems that use surface water have voluntarily developed source water protection plans. MDH is looking to expand the surface water program in the upcoming years.

Source water protection plans identify the land area that supplies water, assess the vulnerability of that area to contamination, and identify actions to reduce the risk of threats. Protection areas, also known as drinking water supply management areas, cover 1.28 million acres or 3 percent of the state's total land area. Within the protection areas, 360,000 acres are vulnerable (i.e., at higher risk for contamination).

What progress has been made?

MDH is working toward the goal of engaging all vulnerable community systems using groundwater in source water protection planning by 2020. Targeting these high-risk, high-population systems addresses the greatest public health need. There are approximately 931 community groundwater systems in the state, 510 of which are considered vulnerable. The source water protection plans for these systems are called wellhead protection plans.

Figure 1 shows the progress of community public water systems in Minnesota with approved wellhead protection plans. As of fiscal year 2017, 331 vulnerable and 182 nonvulnerable systems have approved plans. While consistent progress is being made, it will be difficult to meet the 2020 goal for vulnerable systems

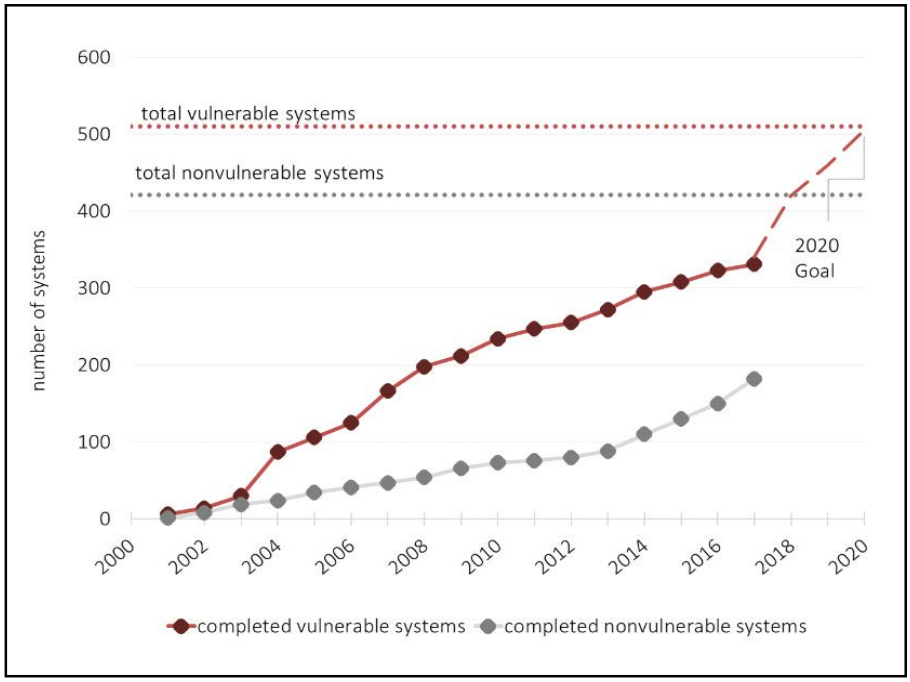


because of competing demands for plan development resources. Plan amendments make up a significant portion of staff workload, but do not increase the total number of systems with approved plans. Minnesota's Wellhead Protection Rule requires plans to be amended every 10 years to address current issues and concerns. Additionally, the remaining workload is largely comprised of smaller public water systems with fewer resources and staff, requiring extra assistance from MDH staff.

Learn more

Source Water Protection: www.health.state.mn.us/divs/eh/water/swp/index.htm

Figure 1. Community Public Water Systems with Approved Wellhead Protection Plans; FY 2001-2017



Status	Trend	Description
■	↘	It will be difficult to meet the 2020 goal for vulnerable systems because of competing demands for plan development resources.

Connection with Minnesota's Clean Water Roadmap

Goals: 20 percent decrease in nitrate levels in groundwater, 50 percent decrease in the number of new wells that exceed arsenic drinking water standard.

This measure will support the Roadmap goals by identifying actions that will prevent nitrate and arsenic contamination of groundwater sources of drinking water. These plans include information that public water suppliers need to know, including the area on the land surface that contributes water to the well, potential sources of contamination, and steps that can be taken to prevent contamination.

Source water protection grants

ACTION

Measure: Number of grants awarded for source water protection

Why is this measure important?

People in Minnesota obtain their drinking water from groundwater, lakes, and rivers. The Minnesota Department of Health (MDH) works with public water suppliers and communities to identify strategies to protect the source(s) of their drinking water. Grant dollars – often matched with other funds – can enable public water suppliers to take action. Prior to the Clean Water Fund, there was no financial assistance for public water suppliers to implement actions identified in their source water protection plans.

MDH recognized the public water suppliers (PWS) above in 2017 for source water protection efforts. PWS and grant-funded activities include (from top left, clockwise): Rock County Rural Water, incentive program for nitrogen best management practices; City of St. Cloud, water quality monitoring equipment; City of Brandon, education and outreach; and Elk River Municipal Utilities, well sealing.

What are we doing?

MDH administers three types of grants to public water suppliers: competitive, implementation, and transient. Public water suppliers are eligible for different grants based on their customer base and if they have a source water protection plan.

Status	Trend	Description
●	↗	Increasing funds accelerate implementation of proven strategies for source water protection.

What progress has been made?

MDH is working towards the goal of increasing the cumulative number of grants awarded—which represents the reach of source water protection activities in Minnesota. The number of grants awarded increased over the past two years (see Figure 1). MDH anticipates the demand for grants will continue to increase with the number of source water protection plans approved. MDH has awarded $4.1 million since the grants program started in 2010.

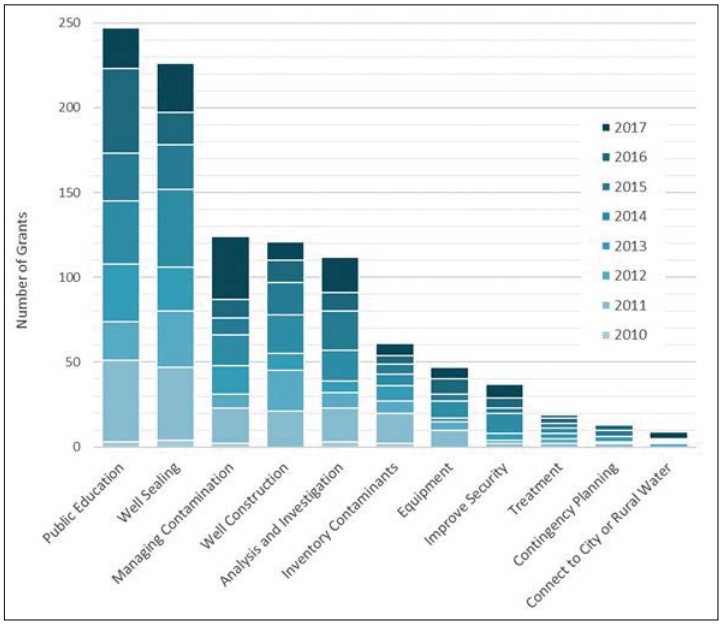
Figure 1.

YEAR	# OF GRANTS AWARDED
2010	14
2011	187
2012	117
2013	116
2014	174
2015	127
2016	131
2017	151
TOTAL	1,017

Learn more

- About source water protection grants at www.health.state.mn.us/divs/eh/water/dwp_cwl/index.html
- Source water protection grant information for applicants at www.health.state.mn.us/divs/eh/water/swp/grants/

Figure 2. Number of Grants Awared by Activity Type (2010–2017)



Nitrate monitoring and reduction by local partners

ACTION

Measure: Number of local government partners participating in Clean Water Fund supported groundwater nitrate-nitrogen monitoring and reduction activities

Why is this measure important?

Nitrate-nitrogen is one of the most common pollutants in Minnesota's groundwater. In some areas of the state, a large number of private wells can have elevated nitrate levels.

Nitrate comes from many sources, including fertilizers, manure, septic systems, landfills and natural decomposition of organic matter. Nitrate occurs naturally in groundwater at levels typically in the range of 0 to 3 milligrams per liter (mg/L). Human activities can raise the level of nitrate in groundwater. The drinking water standard for nitrate is 10 mg/L, above this level it can have negative effects on human health, specifically infants under the age of six months.

Groundwater is most vulnerable to nitrate contamination in the central and southeast regions of Minnesota. Areas in central Minnesota are vulnerable because of widespread sandy soil. Southeast Minnesota counties are vulnerable because of shallow bedrock, sinkholes and underground caves (referred to as karst geology). Also certain types of wells - shallow wells, hand-dug wells, tile wells and improperly grouted wells - are more vulnerable to nitrate contamination.

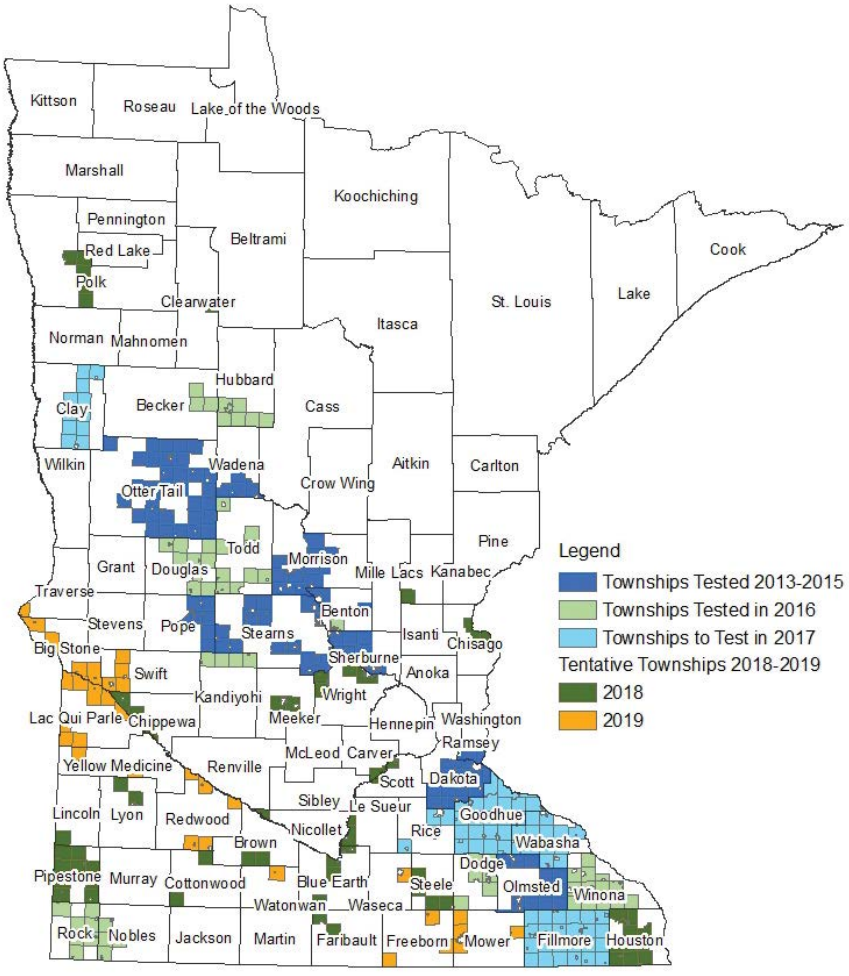
Minnesota's Clean Water Fund is being used for activities that help identify the severity and magnitude of nitrate contamination. Funds are also used to evaluate and implement practices at the local level to reduce nitrate in groundwater. State agencies work closely with many partners on nitrate monitoring and reduction activities. Building and maintaining these partnerships is essential to effectively address groundwater concerns.

What are we doing?

The Minnesota Department of Agriculture (MDA) focuses its work in areas where there is nitrate contamination of groundwater from nitrogen fertilizer use. The MDA is working with 25 local partners on nitrate monitoring and reduction projects. In general, the MDA provides technical support and the local partners provide coordination and contribute knowledge, skills and expertise about local issues.

The goal of our partnerships is to increase knowledge and awareness about nitrate issues and foster a greater willingness by farmers to adopt and maintain best management practices.

This profile focuses on two main activities- private well testing and a regional education and outreach program.



Township Testing Program

The MDA designed a Township Testing Program to determine current nitrate concentrations in private wells on a township scale. The MDA identified townships throughout the state that are vulnerable to groundwater contamination and have significant row crop production (see map on previous page). These are the areas prioritized for private well testing.

The MDA plans to offer nitrate testing to more than 70,000 private well owners, in more than 300 townships, between 2014 and 2019.

Results from all wells in a participating township are summarized and help guide the type of response necessary to address nitrate in groundwater.

University of Minnesota staff collect corn stalks for whole plant nitrogen analysis. This is offered as a service to participating farmers and can help identify opportunities to increase nitrogen-use efficiency.

Southeast Minnesota Nitrogen BMP Outreach Program

The MDA partners with the University of Minnesota Extension and the Southeast Soil and Water Conservation District Technical Support Joint Powers Board to support on-farm demonstrations, educational outreach, and increase adoption of Nitrogen Fertilizer Best Management Practices (BMPs) in six counties in Southeast Minnesota. This program generates regional information that farmers can use to inform management decisions. It also supports farmer-to-farmer learning groups that encourage participants to compare results and talk about ways to modify and improve farming practices.

On-farm field trials are at the heart of this program. Project partners work with cooperating farmers and their crop advisers to compare different nitrogen rates, nitrogen sources or timing of application. For nitrogen rate trials, farmers compare their normal nitrogen rate with a 30 lb. reduction and evaluate crop yields. The MDA and project partners collect additional data (basal stalk nitrate tests, soil nitrate sampling, whole plant nitrogen analysis and chlorophyll readings) to help farmers identify opportunities to increase nitrogen use efficiency. In partnership with the University of Minnesota (U of M) researchers, this program also supports three advanced nitrogen rate trials. The goal is to collect data that can be used to refine U of M nitrogen fertilizer guidelines and encourage broader adoption of those guidelines in the southeast region.

What progress has been made?

Township Testing Program

A total of 241 townships in 24 counties were sampled by the end of 2017. Counties that have participated include Becker, Benton, Clay, Dakota, Dodge, Douglas, Fillmore, Goodhue, Hubbard, Kandiyohi, Olmsted, Otter Tail, Morrison, Nobles, Pope, Rice, Rock, Sherburne, Stearns, Todd, Wabasha, Wadena, Washington, and Winona. While monitoring alone does not yield changes in environmental condition, it does provide the information necessary to target protection and restoration activities and inform homeowners about the water quality in their wells. Local data is essential when talking about groundwater contamination and promoting nitrogen best management practices. It is the starting point for all implementation activities.

Southeast Minnesota Nitrogen BMP Outreach Program

The Southeast Minnesota Nitrogen BMP Outreach program engages both farmers and crop advisers knowing that this trusted relationship is essential in on-farm decision making. Participation in the program has grown steadily since it began in 2015. On average, 37 farmers and 12 crop advisers participate each year and demonstrations are held on 135 fields across six counties.

There is now a strong farmer-to-farmer learning group that meets each winter to share information, build relationships and discuss nitrogen management results. A 2016 evaluation of 22 participants indicated that 47 percent plan to decrease their nitrogen fertilizer rate. In addition, all participants were considering other changes like using sidedress applications, properly counting nitrogen credits, and using nitrification inhibitors or nitrogen stabilizers. Also, 96 percent of attendees say that based on their experience in the program, they plan to continue to explore new or different nitrogen management practices. These numbers are an indication that information provided by the program is having an impact on farmer's knowledge and behavior. A core value is to enhance the capacity of all stakeholders (farmers, conservation organizations and government agencies) to work together and address groundwater concerns.

Learn more

- Township Testing webpage: www.mda.state.mn.us/townshiptesting

Status	Trend	Description
●	↗	New local partnerships continue to be established for nitrate-nitrogen monitoring and reduction activities.

Connection with Minnesota's Clean Water Roadmap

Goals: 20 percent decrease in nitrate levels in groundwater, 50 percent decrease in the number of new wells that exceed arsenic drinking water standard.

This measure will support the Roadmap goals by tracking partnerships that support nitrate reduction activities in the most vulnerable areas of the state. Nitrate testing in private wells provides information to target protection and restoration activities. Private well testing allows for change to be measured, as programs and practices for managing nitrogen fertilizer are implemented.

Contaminants of emerging concern

ACTION

Measure: Number of new health-based guidance values for contaminants of emerging concern

Determining how much of a contaminant is safe to drink over a lifetime is an essential step in ensuring our drinking water protects people's health.

Why is this measure important?

Individuals and industry use tens of thousands of chemicals in a vast array of products and applications, including household products and cleaners, personal care products, medications, pesticides, and manufacturing ingredients. Most contaminants of emerging concern do not enter our environment through purposeful or careless pollution—they enter our environment when we use products that contain these chemicals. Water quality studies and monitoring in Minnesota find contaminants from products or sources we never suspected in places we never expected, like our lakes, rivers, and drinking water.

The science and technology required to detect and measure contaminants in the environment has also improved, giving us new information about which chemicals are in the environment and at what levels. For many of these contaminants, it is unknown how much is safe to drink, raising questions and causing uncertainty among Minnesotans. The Minnesota Department of Health (MDH) seeks to answer these questions by evaluating the safety of contaminants of emerging concern in drinking water.

What are we doing?

MDH investigates the likelihood of exposure to and potential health risks of contaminants of emerging concern in water and provides information needed to determine if contaminants in Minnesota waters pose a health risk. MDH develops health based-guidance for contaminants of emerging concern that tell Minnesotans the level of a contaminant (micrograms per liter [parts per billion] in water) that can be consumed in water with little or no health risk. Guidance is developed to protect even the most sensitive or highly exposed people, such as pregnant women and infants. For each contaminant reviewed, a plain language information sheet is published that describes the contaminant and the health-based guidance value, how Minnesotans might be exposed, and action that can reduce exposure. MDH conducts or awards contracts and grants for special projects intended to fill information gaps so that MDH can evaluate and communicate about chemicals even when the science and available data are still emerging.

MDH Health-Based Guidance Values FY16-17
micrograms per liter (µg/L) in water

Contaminant	MDH Guidance
Aminomethylphosphonic acid (AMPA) *pesticide degradate*	1,000 µg/L
Anatoxin-a *algal toxin*	0.1 µg/L
Dichlorofluoromethane *refrigerant*	20 µg/L
2,4-Dichlorophenoxyacetic acid (2,4-D) *pesticide*	30 µg/L
17a-Ethinylestradiol *synthetic estrogen*	0.0002 µg/L
Mestranol *synthetic estrogen*	0.0002 µg/L
Microcystin (LR) *algal toxin*	0.1 µg/L
Perfluorooctane Sulfonate (PFOS) *perfluorochemical (PFC)*	0.027 µg/L
Perfluorooctanoic Acid (PFOA) *perfluorochemical (PFC)*	0.035 µg/L
Octylphenol (4-tert-) *industrial chemical*	100 µg/L
Tetrahydrofuran *solvent*	600 µg/L

Partnerships have been formed with other state agencies, including the Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Agriculture (MDA), to help these agencies evaluate the results of their water monitoring studies. MPCA is monitoring for contaminants of emerging concern in Minnesota surface waters and groundwater using Clean Water Fund dollars.

What progress has been made?

Through the 2016-2017 fiscal years (FY16-17), 140 contaminants were nominated to the MDH Contaminants of Emerging Concern (CEC) Initiative through a nomination process open to all Minnesotans. Some nominated contaminants are ineligible for CEC review because there is insufficient data for a review or because a different program within the department will review those contaminants. In FY16-17, MDH compiled screening information for 24 newly nominated contaminants and a few previously assessed chemicals for which new information was available. MDH evaluates contaminants based on the best available toxicity and exposure data.

Factors included in the toxicity evaluation are:

- the chemical's potency,
- the severity of associated health effects, and
- other concerns, such as carcinogenicity.

Factors included in the exposure evaluation are:

- the likelihood of the chemical to be present in drinking water,
- the volume of the chemical that is produced and/or released, and
- any available monitoring data.

Based on the results of the toxicity and exposure evaluation or due to program need, 11 contaminants were selected for comprehensive review in FY 16-17 and health-based guidance was developed for each.

Data availability and scientific understanding of contaminants of emerging concern can change rapidly. In FY16, MDH began efforts to re-evaluate existing health-based guidance values to ensure guidance is up to date with MDH risk assessment methodology and with the available scientific data. Guidance developed by MDH in 2008 or later is included in this effort, and guidance re-evaluations occur on a four- or five-year cycle.

In FY16-17, MDH completed re-evaluations for 19 contaminants with existing health-based guidance values. Six re-evaluations resulted in lower guidance values as a result of updated methods, two resulted in higher guidance values as a result of updated methods, and seven had no changes to the guidance value when updated methods were applied. Three contaminants were recommended for a comprehensive review based on the discovery of new studies and data. Guidance for one contaminant remained unchanged when no applicable new data resulted from the information search.

Learn more

- Find more information about this measure and its data at www.legacy.leg.mn/funds/clean-water-fund.
- MDH Contaminants of Emerging Concern (CEC) program information: www.health.state.mn.us/cec.

Status	Trend	Description
●	→	Met target for FY 16-17. On track to meet goal of ten guidance values developed each biennium.

County geologic atlases

ACTION

Measure: Number of counties completing a county geologic atlas for groundwater sustainability

Why is this measure important?

Minnesotans rely on groundwater for drinking water as well as industrial and agricultural uses. Spring-fed wetlands, streams and lakes – and the plants and animals that call them home – depend on healthy groundwater too. Groundwater and surface water are linked, forming a large, interconnected water system. While surface water is easy to observe and monitor, the groundwater part of the system is more challenging. Because it lies beneath the surface and can't be seen, understanding groundwater requires specialized study of geology (underground soils and rock) and aquifers (layers of permeable rock and soil materials that hold water which can be extracted from a well or support ecosystems). In many parts of Minnesota, these studies have not been completed. The Department of Natural Resources (DNR) is charged with ensuring long-term sustainable use of Minnesota's groundwater. This means allowing for human uses while ensuring enough groundwater to sustain ecological systems, surface waters and future generations. Without good information, managing this important resource is challenging.

A county geologic atlas is a report with accompanying series of maps, figures, and tables that describes the location and size of an area's aquifers and other important information like direction of water flow, sensitivity to pollution, and connection to surface water resources. Atlas information is used in planning and environmental protection efforts at all levels of government. Source water protection and feedlot planning are examples of local programs that need geologic and groundwater information. Other typical uses include providing information for permit applications and plans and emergency response to contaminant releases.

This measure tracks the extent to which information about geology and aquifers in county geologic atlases is available in Minnesota.

What are we doing?

County geologic atlases are a cooperative effort between the Minnesota Geological Survey (MGS) and the DNR. The MGS completes Part A (geology) which is followed by the DNR completing Part B (groundwater). Funding for the work comes from multiple sources and has varied over time. The Clean Water Fund supports enhanced research to improve the quality of county geologic atlases and to accelerate their completion in areas where they are needed most. Individual counties self-select for completing a county geologic atlas by making a commitment to provide in-kind services such as confirming well locations from Minnesota Department of Health well records.

What progress has been made?

The MGS has completed geologic atlases (Part A) for approximately 38 counties (42 percent of counties). The DNR has completed geologic atlases (Part B) for 26 counties (30 percent of counties). Twelve more are underway or under revision. Additionally, the DNR has completed six Regional Hydrogeologic Atlases (RHAs) and three statewide Minnesota Hydrogeologic Atlases (MHAs) as shown in the figure on the next page.

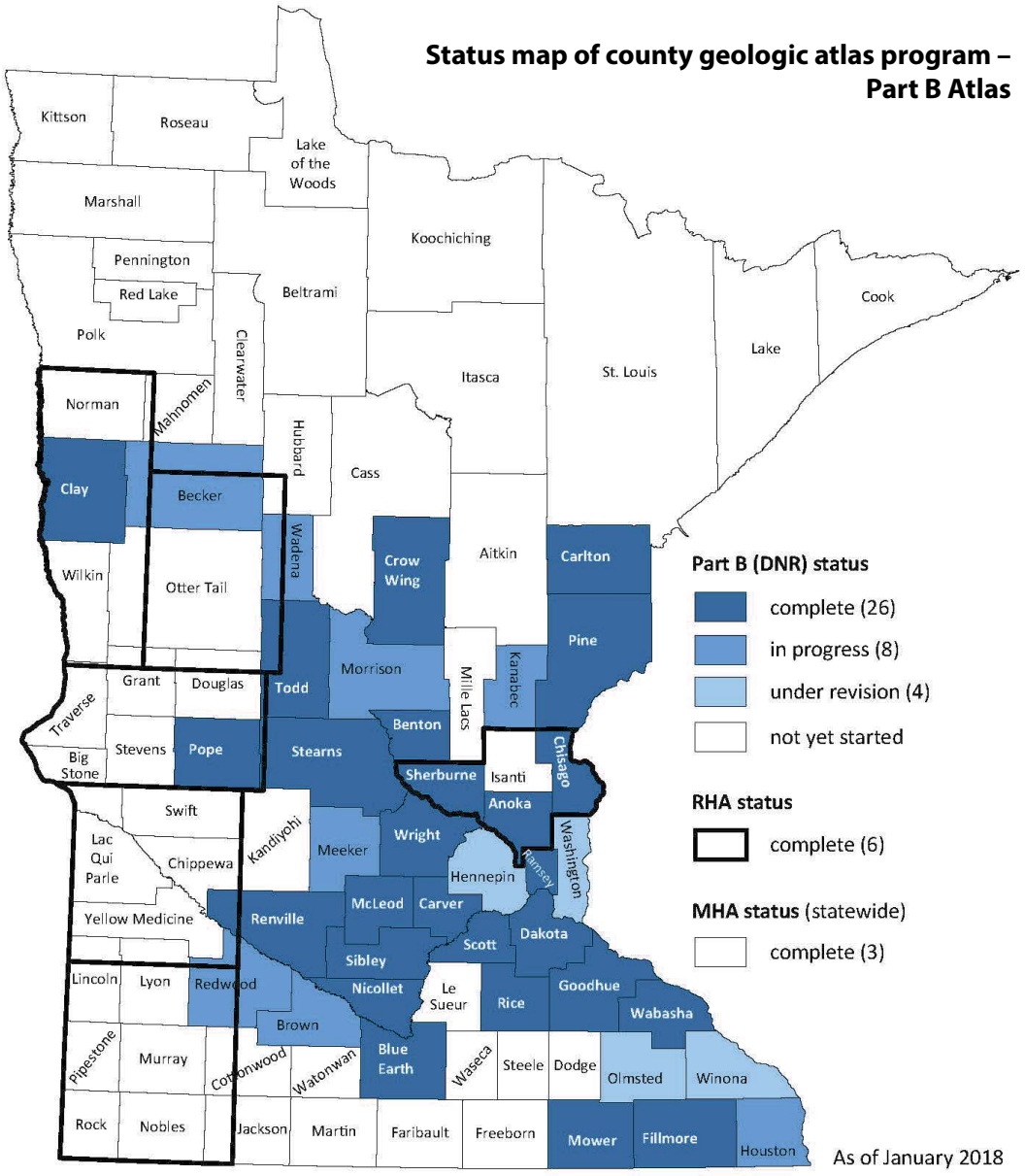
The long-term goal is to complete a county geologic atlas (Parts A and B) for every county in Minnesota. Approximately four Part B Atlases are being completed each year. The Clean Water Legacy funding supports expanded data collection for atlases such as the use of sophisticated geological coring.

Learn more

- Find more information about this measure at www.www.dnr.state.mn.us/waters/groundwater_section/mapping/index.html
- Point of Contact: Paul F. Putzier, P.G., Supervisor, County Geologic Atlas Program. Contact information: paul.putzier@state.mn.us

Status	Trend	Description
●	↗	Significant progress has been made completing county geologic atlases and the rate of completion has increased. Counties continue to step up to participate. Substantial work remains before all counties in Minnesota are done.

Status map of county geologic atlas program – Part B Atlas



As of January 2018

Connection with Minnesota's Clean Water Roadmap

Goal: Less than 10 percent of sites affected by groundwater pumping will have declining trend in groundwater levels.

This measure will support the Roadmap goals by tracking Minnesota's progress toward every county having comprehensive descriptions of geology and groundwater. County geologic atlases provide critical information for regulating groundwater pumping so that its availability is sustainable with no long-term declines.

Long-term monitoring network wells

ACTION

Measure: Number of long-term groundwater monitoring network wells in Minnesota

Why is this measure important?

About 75 percent of Minnesota's drinking water comes from groundwater, which is pumped from the state's many and varied aquifers. Groundwater also supports agriculture, industry, and natural resources that define Minnesota's quality of life. Minnesota is relying more and more on groundwater to meet its growing needs, but many parts of the state lack basic information about the availability and quality of groundwater.

Since it is underground, people can't see groundwater to observe its condition. Monitoring wells provide a "window" into aquifers, providing a way to see groundwater levels and measure water quality. This information is essential to better inform investments in water supply infrastructure and efforts to protect public health and natural resources.

To provide a safe and reliable drinking water supply at the lowest cost, well drillers and well owners should know the depth of the closest safe-quality groundwater. They should also know how much groundwater levels and quality fluctuate during wet and dry seasons, to ensure that pumps in wells don't go dry and to understand potential health risks. Groundwater monitoring information is also important for protecting wetlands, developing Total Maximum Daily Loads (TMDLs) for streams, and for preventing the migration of contamination plumes.

This measure tracks the number of wells used for long- term monitoring of groundwater conditions. Well installation, water quality sampling, and water level measurement are coordinated among state agencies, and wells are used for multiple purposes whenever feasible. Other monitoring wells exist, but they are used for short-term contamination or remediation events.

What are we doing?

While Minnesota's groundwater monitoring network is still inadequate for understanding groundwater conditions in portions of the state, it is improving. Clean Water Fund investments accelerate efforts to fill gaps in understanding aquifer conditions across the state, and improve local capacity to improve private and public drinking water supply infrastructure development.

The Minnesota Department of Natural Resources manages a statewide network of water level observation wells, in partnership with Soil and Water Conservation Districts and various volunteers. Data from these wells are used to determine long-term trends, interpret impacts of pumping and climate, plan for water conservation, and otherwise manage the water resource. Aquifer levels are being monitored in 1,035 wells, an increase of 50 wells since the last Performance Report. An estimated 7,000 wells are needed to adequately monitor levels across the state.

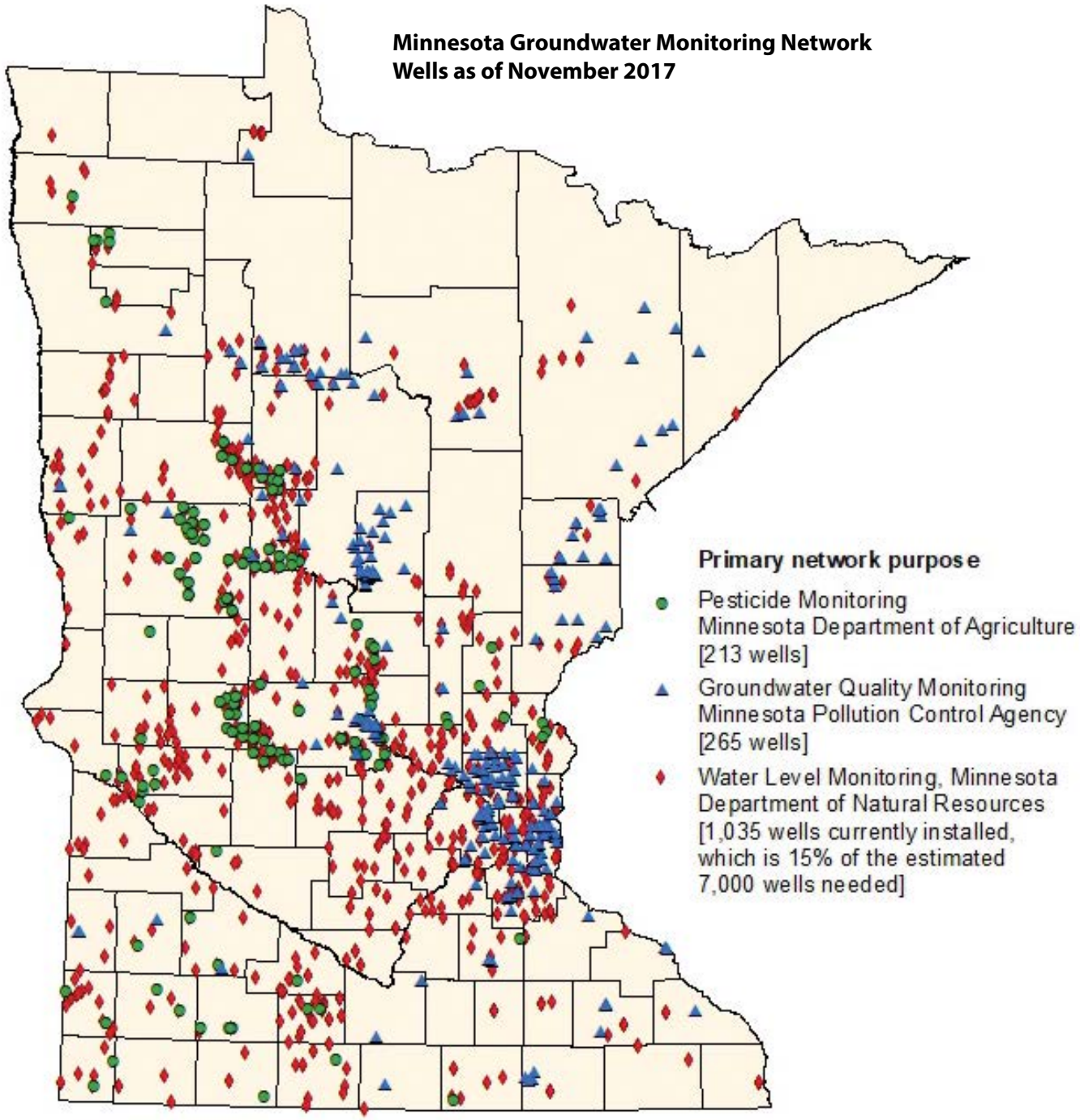
The Minnesota Pollution Control Agency manages a statewide network of about 260 groundwater quality monitoring wells to determine whether non-agricultural pollutants are present and to track trends in pollutant concentrations. These wells are primarily installed in urban aquifers that are most susceptible to pollution from human activities. Water samples are collected annually to determine the concentrations of more than 100 regulated and unregulated chemicals, including nitrate, chloride, and volatile organic compounds. The agency is still adding wells to the network, which will have about 275 wells when complete.

The Minnesota Department of Agriculture (MDA) manages a network of 213 groundwater quality monitoring wells across the state, primarily in agricultural areas, with the purpose of determining the impacts of pesticides and fertilizers on vulnerable groundwater.

What progress has been made?

The current statewide groundwater monitoring network includes 1,513 wells. The ultimate goal is a network of approximately 7,400 state-owned and managed long-term groundwater monitoring wells.

Information from the long-term monitoring network has been used to target Clean Water Fund investments in high-priority areas. For example, MDA has developed a strategy to fill gaps in the long-term monitoring network by partnering with private well owners to monitor about 70,000 wells in 300 townships by 2019


Minnesota Groundwater Monitoring Network
Wells as of November 2017
Primary network purpose
Pesticide Monitoring
Minnesota Department of Agriculture
[213 wells]
Groundwater Quality Monitoring
Minnesota Pollution Control Agency
[265 wells]
Water Level Monitoring, Minnesota
Department of Natural Resources
[1,035 wells currently installed,
which is 15% of the estimated
7,000 wells needed]

Learn more:

- Find information on activities funded by the Clean Water Fund at www.legacy.leg.mn/funds/clean- water-fund.
- MPCA groundwater monitoring and assessment: www.pca.state.mn.us/gp0r93f
- DNR groundwater level monitoring program: www.dnr.state.mn.us/waters/groundwater_section/obwell/index.html
- MDA monitoring & assessment: www.mda.state.mn.us/monitoring

Status	Trend	Description
■	↗	Many areas of the state still lack important groundwater information. Long-term ramp up in monitoring accelerated by Clean Water Fund investments is filling gaps.

Connection with Minnesota's Clean Water Roadmap

Goal: Less than 10% of sites affected by groundwater pumping will have declining trend in groundwater levels.

This measure will support the Roadmap goals by tracking long-term monitoring well networks that measure progress in reducing nitrate and avoiding arsenic in groundwater used for drinking water. Sampling results from these established networks, along with volunteer private well networks and related studies, also advance scientific understanding of nitrate and arsenic concentrations across Minnesota.

Unused groundwater wells sealed

ACTION

Measure: Number of unused groundwater wells sealed

Why is this measure important?

Unused wells that are not properly sealed can be a source of groundwater contamination, potentially affecting nearby drinking water wells. They may threaten the quality of the water in municipal wells, private business wells, and individual home wells. Groundwater is the main source of drinking water for three out of every four Minnesotans.

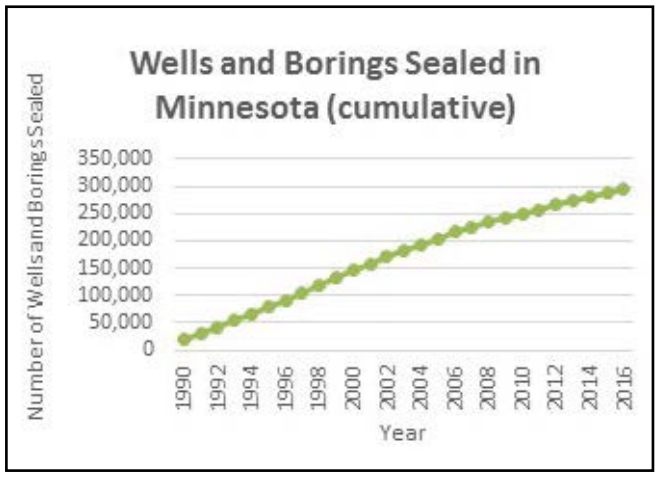
A well may be taken out of service for a variety of reasons:

- It may no longer operate properly or provide enough water;
- May have become contaminated; or
- Has been replaced by extension of public water supplies.

A well may be "lost" or abandoned when:

- New buildings or additions are constructed;
- Property changes hands; or
- When use of the land changes, such as from agricultural to industrial or residential.

The layers of rock and soil that lie between an aquifer and the land surface, or between aquifers, typically act as natural barriers against the spread of contamination. However, an unused, unsealed well can provide an open pathway between the surface and an aquifer or between a shallow aquifer and a deeper aquifer. This open pathway allows surface water runoff, contaminated water, and improperly disposed waste to reach an aquifer.



The Clean Water Funds provide financial assistance to help seal wells. This assistance increases the number and rate at which wells are sealed in the state.

What are we doing?

Clean Water Funds provide an incentive for sealing unused wells. Funds for sealing private wells were made available as part of the Board of Water and Soil Resources (BWSR) Clean Water Fund Competitive Grant program in FY17. These funds were awarded to local governments so they can provide a 1:1 matching grant to well owners to seal their unused wells. Priority is given to sealing wells in areas near public water supply wells; large diameter, multi-aquifer wells; and wells in areas with known groundwater contamination.

FY16 Clean Water Funds were provided directly to well owners as a 1:1 match to seal unused public water supply wells. These wells tend to be larger and deeper than private wells and can be much more expensive to seal. They can also pose a significant threat to public water supplies because they are typically near active public water supply wells.

What progress has been made?

Nine unused public water supply wells were sealed with FY16 funds. It is estimated that over 200 private wells will be sealed with FY17 funds.

Ultimately, the goal is to seal all unused wells in Minnesota to protect public health and groundwater resources. Unused wells continue to be identified on a regular basis through property transfers and other activities. While Minnesota has sealed nearly 300,000 wells since 1990, continued effort is needed to address the estimated 250,000 to 500,000 unused unsealed wells remaining.

Learn more:

Find information on this measure at Sealing of Wells and Borings (www.health.state.mn.us/divs/eh/wells/sealing/).

Status	Trend	Description
●	→	FY16 funding was awarded to seven public water-suppliers to assist in sealing nine unused wells. FY17 funding was awarded to six local government units to assist in sealing over 200 private unused wells.

Groundwater quality

OUTCOME

Measure: Changes over time in pesticides, nitrate-nitrogen and other key water quality parameters in groundwater

Why is this measure important?

Chemicals are commonly used to control pests, support food production, manage lawns, protect human health, and keep our roadways free of ice and snow. People also use many chemicals for cleaning clothes, maintaining cars and homes, and improving lives.

Unfortunately, the benefits of pesticides, fertilizers and other chemicals are balanced against potential impacts to the state's sensitive groundwater resources. It is only with highly detailed and sophisticated monitoring that the impacts of chemical use to groundwater resources can be understood and managed.

What are we doing?

The Minnesota Department of Agriculture (MDA) samples groundwater wells in urban and agricultural settings. MDA water samples are analyzed for many (150 in 2017) pesticides as well as nitrate. Results are used as feedback in the fertilizer and pesticide management process and are reported to farmers and the general public. The MDA and advisory committees use monitoring results to inform management decisions.

The Minnesota Pollution Control Agency (MPCA) samples a network of wells primarily in urban settings that measure ambient (or background) conditions for a large number of non-agricultural chemicals, including nitrate, chloride, volatile organic compounds, and emerging contaminants. The network is focused on two aquifers that are especially vulnerable to man-made contamination—the sand and gravel and Prairie du Chien-Jordan aquifers.

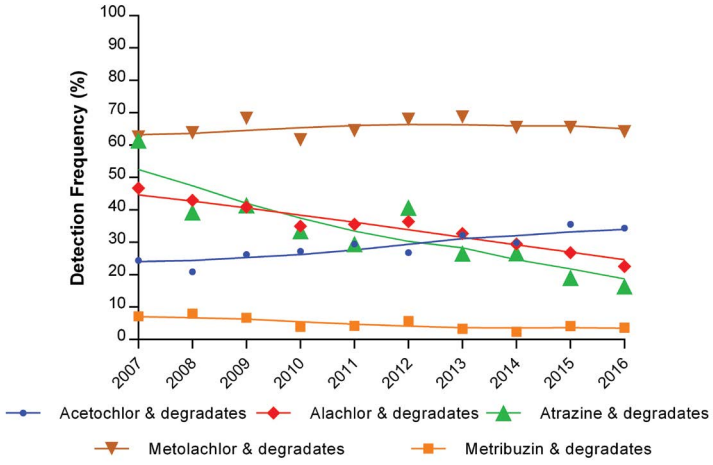
The Minnesota Department of Health (MDH) has many roles in protecting groundwater from contamination. MDH's primary roles include monitoring drinking water to ensure the state's public water systems meet federal and state guidelines, evaluating contaminated sites to determine what chemicals are present, and whether exposure to those chemicals may pose risks to human health.

What progress has been made?

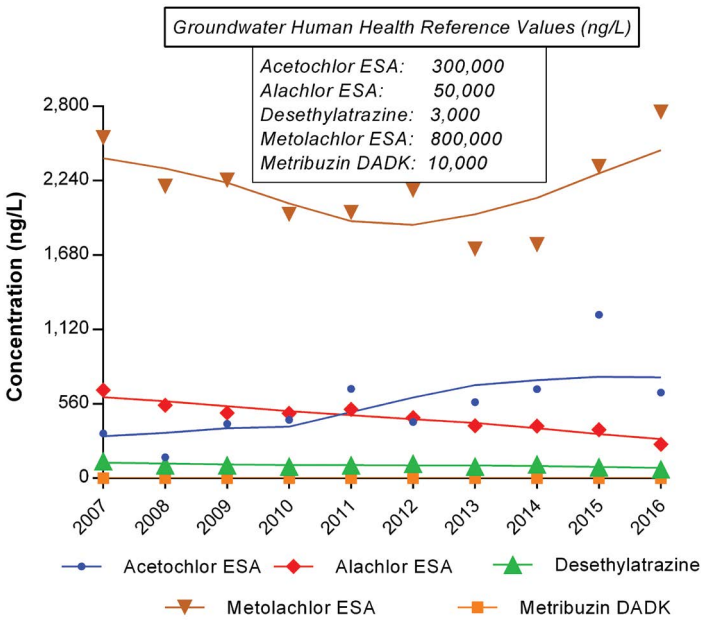
The MDA began it's monitoring program in 1985. The MDA currently samples more than 160 monitoring wells, naturally occurring springs, and private drinking water wells throughout the state. Pesticide concentrations in groundwater rarely exceed drinking water standards in monitoring wells or private drinking water wells. Five pesticides have been detected frequently enough to be placed in the "common detection" category: acetochlor, alachlor, atrazine, metolachlor and metribuzin. These pesticides are being tracked and best management practices are promoted to minimize environmental impacts.

The MDA's groundwater monitoring program was not designed to determine nitrate concentration status and trends. Nitrate concentrations in the very shallow, highly sensitive groundwater monitoring wells sampled in this program exceed health risk levels at many locations. However, this is not the situation with every well or all the regions monitored. The MDA's groundwater monitoring program is an early detection system. To more accurately determine nitrate trends across the state, the MDA relies on regional and township monitoring programs.

Statewide Groundwater Common Detection Pesticide Detection Frequency



Statewide Groundwater Common Detection Pesticide Primary Degradates 90th Percentile Concentration



In 2008, the Southeast Minnesota Water Resources Board and the MPCA, MDA and MDH established the Southeast Minnesota Domestic Well Network. This region was selected because of its sensitive and complex geology. This network of 675 private drinking water wells, representing nine counties and several aquifers, was designed to provide nitrate concentration data. Through 2015, 4,304 samples have been analyzed for nitrate and an average of 10.1 percent of the wells exceeded the drinking water standard (10 mg/L). The percentage of wells exceeding the drinking water standard for each sampling round ranged between 7.6 and 14.6 percent. This work continues as an ongoing effort.

In 2011, homeowners in 14 counties in Central Minnesota (an area of the state with sandy soil that is vulnerable to nitrate contamination) participated in a monitoring project and a subset of these wells have been sampled annually since that time. Results from 2015 are similar to previous years with less than 4 percent of the 550 wells tested having nitrate levels above 10 mg/L.

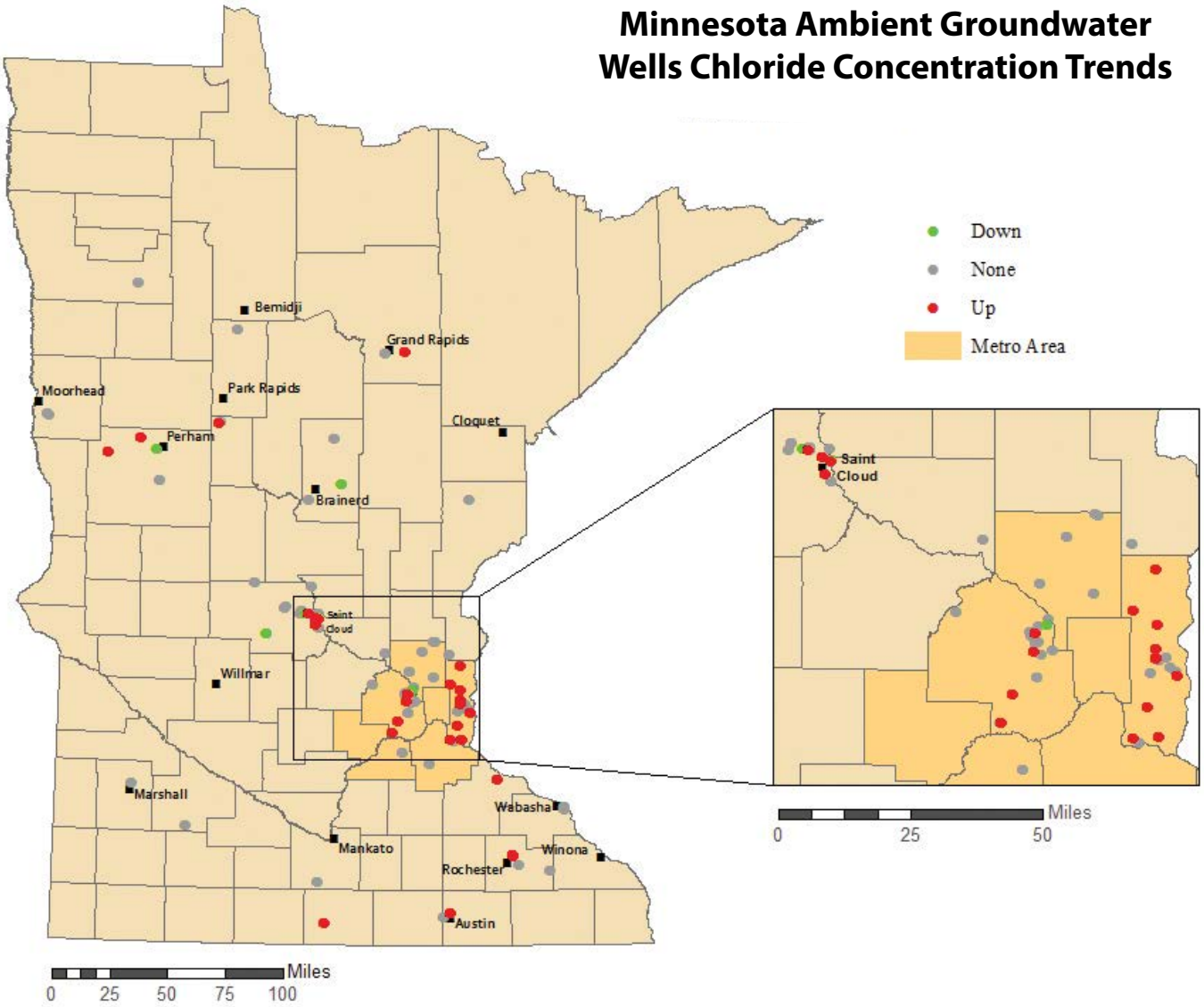
In 2013, the MDA began sampling private wells on a township scale as part of the Township Testing Program. Through 2016, the MDA has sampled private wells in 167 townships in 19 counties in cooperation with local partners. The goal of the project is to sample wells throughout the state in areas where groundwater is most vulnerable to contamination. Through 2016, approximately 20,042 wells have been sampled and 9.5 percent of the wells have nitrate exceeding the drinking water standard, although this can be much higher in some townships.

The Private Well Pesticide Sampling (PWPS) Project is a follow-up program to the Township Testing Program. The primary goal of the PWPS Project is to provide information to homeowners and the general public about the presence of pesticides in private drinking water wells. Homeowners who had nitrate detections in their well as part of the Township Testing Program have the opportunity to have their well sampled for nitrate and pesticides. The MDA has sampled approximately 3,765 wells in 19 counties from 2014-2016. Pesticides and/or pesticide degradates were detected in 76 percent of the wells sampled in 2016. One well in Sherburne County exceeded the drinking water standard for diuron in 2016. However, three confirmation samples indicated that diuron (general use pesticide used to control a wide variety of broadleaf and grassy weeds) was not detected above laboratory reporting limits. The analytical results from the samples collected in 2017 are not yet available. The MDA anticipates sampling approximately 5,800 wells in 52 counties by the time the PWPS Project is complete in 2020.

The MPCA continues to monitor its enhanced monitoring network to track salt contamination in groundwater. Since 2010, approximately 150 new monitoring wells were added to the network, and it now includes about 260 wells. The MPCA's monitoring has discovered that salt contaminates many of Minnesota aquifers, especially in the Twin Cities Metropolitan Area (TCMA). Too much chloride (a part of salt) makes drinking water taste salty and the state's streams, lakes, and wetlands unsuitable for certain types of aquatic life. Since 2004, the MPCA has tested more than 650 wells across the state for chloride. This work documented that the sand and gravel aquifers in the TCMA were contaminated and had concentrations as high as 8,900 mg/L. This is almost 40 times greater than

the amount recommended by the U.S. Environmental Protection Agency for drinking water and 27 percent of the wells tested in the TCMA exceeded this limit.

The MPCA continues to track chloride concentration trends in groundwater. The most recent analysis found that chloride concentrations have increased in 41 percent of the analyzed wells in the agency's network. Fifty-five percent of the analyzed wells had no trend in concentrations, and the remaining 4 percent of wells had a downward trend. The MPCA's work shows that the chloride contamination is beginning to seep into the aquifers used for drinking water. About 68 percent of the analyzed wells with an upward trend in chloride concentrations were domestic wells that primarily supply water to individual residences.



Chloride concentration trends in the state's ambient groundwater, 1987-2016.

Learn more

- MDA's Pesticide Monitoring and Assessment: www.mda.state.mn.us/chemicals/pesticides/
- Central Sands Private Well Network: www.mda.state.mn.us/centralsandsnetwork
- Township Testing Program: www.mda.state.mn.us/townshiptesting
- MDA and MPCA groundwater data portal (Environmental Data Access or EDA): http://cf.pca.state.mn.us/data/edaGwater/index.cfm#
- Private Well Pesticide Sampling (PWPS) Project: http://www.mda.state.mn.us/pwps

Status	Trend	Description
Pesticides ▲	→	Variable trends for five common pesticides indicate a mixed signal. Low levels are frequently detected in vulnerable groundwater.
Nitrate-Nitrogen statewide ▲	No trend information available.	In many agricultural areas, drinking water supplies are not vulnerable to surficial contamination and most wells have low levels of nitrate–nitrogen. However, in vulnerable groundwater areas, nitrate contamination is a significant concern.
Nitrate-Nitrogen southwest region ■		Most agricultural areas in southwest do not have vulnerable groundwater. In areas where groundwater is vulnerable, nitrate levels can be high. Of the 11 vulnerable townships tested in southwest Minnesota (2013-2016), 100% of them were determined to have 10% or more of the wells over the nitrate-N 10 PPM standard.
Nitrate-Nitrogen Central Sands ■	→	Trend data from the Central Sands Private Well Network shows no change. However, Township Testing data show a high level of nitrate in some vulnerable aquifers in the Central Sands. Of the 119 vulnerable townships tested (2013-2016), 29% of them were determined to have 10% or more of the wells over the nitrate-N 10 PPM standard.
Nitrate-Nitrogen southeast region ■	→	Trend data from the Southeast Minnesota Domestic Well Network shows no change. However, Township Testing data show a high level of nitrate in some vulnerable areas in southeast Minnesota. Of the 46 vulnerable townships tested (2013-2016), 54% of them were determined to have 10% or more of the wells over the nitrate-N 10 PPM standard.

Connection with Minnesota's Clean Water Roadmap

Goals: 20 percent decrease in nitrate levels in groundwater, 50 percent decrease in the number of new wells that exceed arsenic drinking water standard.

This measure will support the Roadmap goals by tracking long-term monitoring well networks that measure progress in reducing nitrate and avoiding arsenic in groundwater used for drinking water. Sampling results from these established networks, along with volunteer private well networks and related studies, also advance scientific understanding of nitrate and arsenic concentrations across Minnesota.

Source water quality for community water systems

OUTCOME

Measure: Changes over time in source water quality used for community water systems

Why is this measure important?

Minnesotans use both surface water and groundwater as drinking water sources. When this untreated source water does not meet the standards of the Safe Drinking Water Act (SDWA), community water systems (CWSs) add treatment to make the water safe to drink.

Testing the source water before it goes through a treatment process is one measure of our efforts to protect drinking water at the source, whether it's surface water or groundwater. Understanding source water quality and chemistry also improves our understanding of groundwater aquifers, variables that might affect the treatment process, and the potential for pollutants to contaminate source water.

What are we doing?

On a regular basis, a CWS or a Minnesota Department of Health (MDH) engineer submits treated water to a certified laboratory to be tested for more than 100 contaminants. Although there is no similar requirement for testing the source water, testing should be done on a regular basis to manage the source and determine what treatment may be necessary.

In the 1980s, MDH conducted a baseline study to understand source water quality statewide. From 2010-2014, MDH conducted the General Water Chemistry Project to provide updated source water quality data. The project focused on the source water for 919 groundwater systems and 23 surface water systems. MDH engineers tested for more than 25 contaminants at nearly 2,300 CWS wells.

As a result of this project, MDH identified the following information and trends:

80% of Minnesota residents rely on public water systems instead of private wells. Public water systems supply our homes, schools, hospitals, and workplaces.

Ammonia

- Ammonia in source water is likely to be variable over time and is variable in geography. This project provided baseline data that can be used with future data to understand this variability and develop management approaches.
- Ammonia was found in 77 percent of the wells tested. Seventy-seven CWSs have source ammonia over 2 mg/L, and the highest concentration found was 8 mg/L. Levels over 2 mg/L are considered very high and treatment should be considered. The highest concentrations are found primarily in the central, southwest, and northwest Minnesota.
- In CWSs with groundwater sources, elevated levels of ammonia, total organic carbon (TOC), and lead/copper in the distribution system often occur at the same time.

Nitrate

- Nitrate concentrations in source water vary by region, with the highest concentrations occurring in central, southwest, southern, and northern Minnesota (MDH found maximum concentrations of 27 mg/L, 22 mg/L, 14 mg/L, and 12 mg/L, respectively).
- Nitrate in source water is also likely to be variable over time. This project provided baseline data that can be used with future data to understand this variability and develop management approaches.
- Prior to this project, there was no formal tracking mechanism to capture the number of CWSs that have had to respond to nitrate in their source water, because the SDWA only requires testing treated water. MDH found that since 1994, at least 56 CWSs had taken, or planned to take, action to address nitrate in their source water.
- In general, the challenges associated with treatment to remove elevated nitrate include, but are not limited to: elevated lead and copper concentrations at the tap, significant energy use, and disposal of water treatment waste.

Arsenic

- Arsenic is naturally occurring. Arsenic concentrations in the wells serving CWSs are usually relatively stable, though there is the potential for upward trending in finished drinking water.
- Prior to this project, there was no formal tracking mechanism to capture the number of CWSs that have had to respond to arsenic in their source water, because the SDWA only requires testing treated water. MDH found that since 1994, 144 CWSs had taken, or planned to take, action to address arsenic in their source water.
- Arsenic concentrations vary by region, with the highest concentrations occurring in central, northwest, and southwest Minnesota (MDH found maximum concentrations of 48 mg/L, 43.8 mg/L, and 90.6 mg/L, respectively).
- In general, the challenges associated with treatment to remove elevated arsenic include, but are not limited to: elevated lead and copper concentrations at the tap, disinfection by-product occurrences due to the required addition of disinfection, and disposal of water treatment waste.

This data will help state and federal agencies target limited resources in assisting the CWSs that are most vulnerable to ammonia, nitrate, and arsenic in their drinking water sources. Future monitoring is essential to better understand trends in contaminants.

Although this study was not funded by the Clean Water Fund, it provides data about the condition of source waters and helps measure the effectiveness of other activities financed through the Clean Water Fund, such as wellhead protection planning and nitrogen reduction practices in agriculture.

What progress has been made?

As a result of this study, MDH now has

- a snapshot of current source water quality;
- a better understanding of water quality throughout Minnesota's aquifers, lakes, and rivers;
- increased knowledge of changes to water chemistry during treatment, filtration, and distribution;
- enhanced ability to determine proper treatment options and best management practices for drinking water; and
- data that can be used to respond to potential contamination events.

Year after year, Minnesota has an outstanding record of ensuring safe drinking water through compliance with the Safe Drinking Water Act. However, we cannot take safe drinking water for granted. We must protect our drinking water sources for future generations.

MDH has secured some funding for periodic source water monitoring. However, additional and on-going resources are needed for regular source water quality monitoring for regulated and unregulated contaminants. This will help MDH identify opportunities to respond to and improve drinking water quality.

Learn more

- MDH website on monitoring and testing of drinking water in Minnesota: www.health.state.mn.us/divs/eh/water/factsheet/com/sampling.html

Status	Trend	Description
●	Not enough information for a trend determination at this time	Identifying correlations between drinking water contaminants is a significant step in trend analysis of source water quality.

Nitrate and arsenic concentrations in new wells

OUTCOME

Measure: Nitrate and arsenic concentrations in newly constructed wells

Why is this measure important?

Groundwater is the main source of drinking water for three out of every four Minnesotans. About 20 percent of Minnesotans rely on private wells for their primary drinking water source. Both arsenic and nitrate are sometimes detected in Minnesota groundwater at levels that can cause short-term and long-term health effects. If an infant is fed water or formula made with water that is high in nitrate, a condition called methemoglobinemia (also known as blue baby syndrome) can develop. Methemoglobinemia can cause skin to turn a bluish color and can result in serious illness or death. Arsenic at the levels found in some Minnesota groundwater can increase the risk of cancer and cause other health problems if consumed over several years.

Nitrate is a naturally occurring chemical made of nitrogen and oxygen. Natural levels of nitrate in Minnesota groundwater are usually quite low: 1-3 milligrams of nitrate-nitrogen per liter of water (mg/L). However, where fertilizers, animal wastes, or human sewage are concentrated on the ground surface, nitrate may seep down and contaminate the groundwater. Elevated nitrate levels in groundwater are often caused by runoff from barnyards or feedlots, excessive use of fertilizers, or malfunctioning or failing septic systems. Shallow wells in areas of the state with sandy soils or karst geology are more susceptible to nitrate from these sources. Improper well construction or a damaged well can also allow nitrate to reach otherwise protected groundwater sources.

Arsenic occurs naturally in rocks and soil across Minnesota and can dissolve into groundwater. The way glaciers moved across Minnesota affects where arsenic is found in sediment and groundwater. Because of the complex nature of arsenic occurrence, it is very difficult, and in some cases impossible, to avoid arsenic when constructing a new well.

What are we doing?

Nitrate

Current laws require that wells be located and constructed in a way that provides a sanitary source of drinking water and protects groundwater quality.

In addition, Minnesota Department of Health (MDH), Minnesota Department of Agriculture (MDA) and other partner agencies help well owners and farmers properly manage nitrate sources (such as fertilizers and septic systems) to help reduce input of nitrate into groundwater. Each time a new well is drilled, nitrate levels (along with arsenic and coliform bacteria) are measured to verify that the water is safe to use. If nitrate levels exceed the drinking water standard of 10 mg/L, MDH informs the well owner of options to reduce their risk. MDA and local governments occasionally offer clinics for residents to have their well water tested for nitrate.

With Clean Water Funds, MDA is testing for nitrate in townships that have vulnerable geology and a large percentage of row crop agriculture (Township Testing Program). The results of this testing will be used to guide efforts to reduce nitrate in groundwater through MDA's Nitrogen Fertilizer Management Plan. Other activities funded by the Clean Water Fund are intended to reduce input of nitrate to groundwater through implementing best management practices and other means.

Arsenic

If arsenic is detected in the initial well sample after a well is constructed, MDH informs the well owner of options to reduce their risk. In cooperation with the United States Geological Survey, Clean Water Funds are being used to better understand the occurrence of arsenic in order to help well contractors avoid constructing wells with high levels of arsenic if possible. The work is also helping to understand if initial well water samples and sampling methods result in an accurate measure of long-term arsenic concentrations.

What progress has been made?

Nitrate

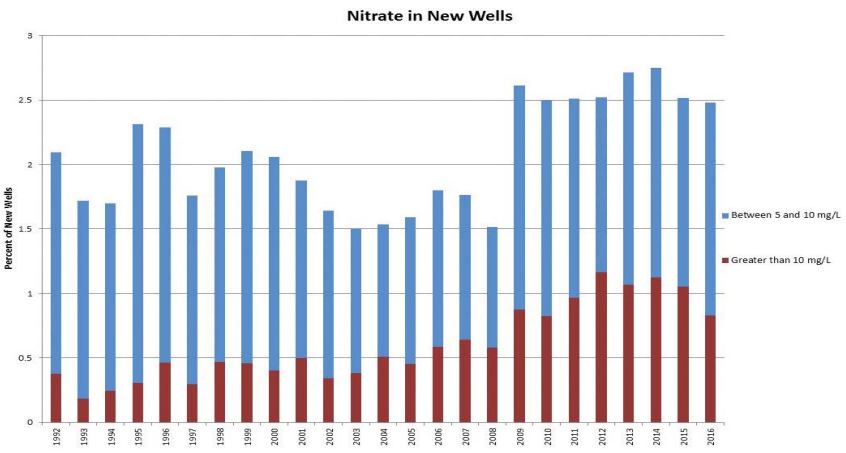
The goal is that all new wells have no to low levels of nitrate. The percentage of new wells in Minnesota with nitrate detected above 5 mg/L is small, around two percent. New wells with concentrations above the drinking water standard of 10 mg/L is even less, near one percent. However, the Township Testing Program found a much higher percentage of wells in the central

and southeastern regions of the state that have elevated levels of nitrate. The geology in these regions make it easier for nitrate to travel into groundwater.

The low state-wide percentages of new wells with nitrate show that the well code is effective in reducing nitrate contamination risks for most wells. However, it is important that the owners of wells with elevated nitrate take actions to reduce their risk. Because concentrations of nitrate can change over time, well owners should periodically test their water, even if their water only had low levels of nitrate initially. There are also many older wells that may have never been tested.

As shown in the graph below, there has been a general upward trend in the percent of new wells with nitrate levels exceeding the drinking water standard over the past 14 years. However, since 2014, there has been a slight decrease. It is not clear if there is a relationship between this trend and actual nitrate levels in groundwater as new well construction is not uniformly distributed across the state and the number of new wells is not consistent from year to year.

This measure cannot tell us the specific causes of nitrate contamination or measure the overall trend in groundwater nitrate. However, through many of the activities funded by the Clean Water Fund, which aim to address and manage nitrate sources such as agricultural best management practices, nitrate concentrations in groundwater across the state eventually should decline and the effects should be reflected in this measure.



Arsenic

The goal is to reduce the percentage of new wells with arsenic and for those that do have arsenic, ensure that well owners have the tools they need to reduce their risk. Approximately 10 percent of new wells in Minnesota have arsenic levels above 10 micrograms per liter (µg/L)—the drinking water standard for community water systems. About 40 percent have arsenic levels above 2 ug/L (the detection limit). Work has just begun to improve understanding of arsenic occurrence in groundwater, and no current activities have a direct influence on reducing this percentage. As this understanding grows, guidance will be developed for well contractors to reduce the likelihood that arsenic is found in a new well. Clean Water Funds are being used to improve education and outreach to private well owners. The goal is to increase testing, treatment where necessary, or other actions to reduce risk.

Learn more

- Find more information about this measure and its data at Clean Water Fund (www.legacy.leg.mn/funds/clean-water-fund).
- Learn more about Nitrate in Drinking Water (www.health.state.mn.us/divs/eh/water/contaminants/nitrate.html).
- Learn more about Arsenic in Drinking Water (www.health.state.mn.us/divs/eh/water/contaminants/arsenic.html).

Status	Trend	Description
▲	↘	Since 1992, there has been a general increase in the percent of new wells that have nitrate levels above the drinking water standard. Since 2014, there has been a slight decrease in the percent of new wells with nitrate higher than the drinking water standard.
▲	→	The percentage of wells with arsenic above the drinking water standard has remained steady over the past 10 years. Evaluation of ways to reduce this percentage is ongoing and may take years before significant progress is made.

Groundwater levels

OUTCOME

Measure: Changes over time in groundwater levels

Why is this measure important?

About 75 percent of Minnesota's drinking water comes from groundwater, which is pumped from the state's many and varied aquifers. Groundwater also supports agriculture, industry, and natural resources that define our quality of life. Minnesota is relying more and more on groundwater to meets its growing needs, but many parts of the state lack basic information about the availability of groundwater.

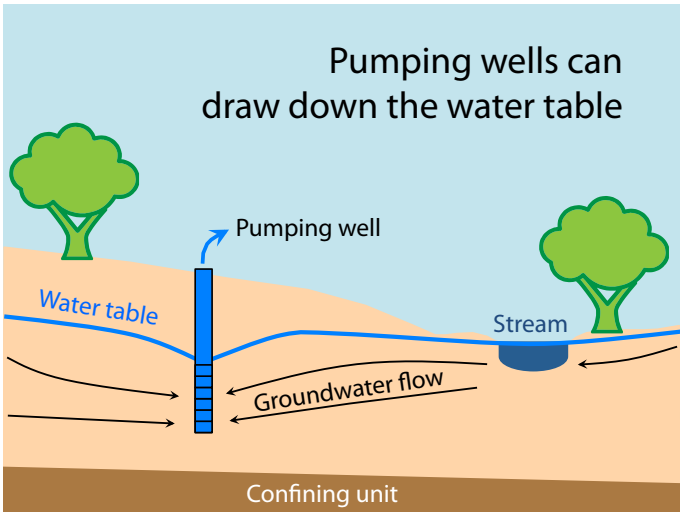
This information supports the evaluation of water supply planning efforts to protect natural resources, prevent well interference, and sustain drinking water sources.

Groundwater levels are affected by several stresses including drought and floods, changes in land use, and pumping by wells. Changes in groundwater levels cause changes in the streams, fens and wetlands, springs, and lakes connected to them. Wells are also affected. When groundwater levels decline, pumps in wells may go dry, causing local water supply emergencies and costing private and public well owners money.

Decisions about water supply development and appropriation, watershed management, and land use are made daily. The success of these decisions depends, in part, on knowledge about seasonal and long-term changes in groundwater levels – to efficiently manage water supplies and to protect surface waters.

What are we doing?

Minnesota Department of Natural Resources (DNR) manages a statewide network of groundwater-level observation wells, in partnership with Soil and Water Conservation Districts and volunteers. The statewide network of groundwater level observation wells provides information about seasonal water level fluctuations and long-term water level changes. Data from these wells are used to determine long term trends, interpret impacts of pumping and climate, plan for water conservation, and manage the water resource. Results are published in a variety of publications that can help water managers evaluate water supply questions at local and regional scales.



Data are insufficient to assess Minnesota's groundwater conditions in portions of the state, but the number of monitoring wells is being expanded to enhance our ability to detect trends. About 40-60 new wells are being installed per year and there are currently 1,026 monitoring wells operated by the Department of Natural Resources.

What progress has been made?

To evaluate progress, the groundwater level trend analysis completed for the 2014 Clean Water Performance Report was rerun. The analysis uses the annual minimum water level, the lowest water level recorded for the year in an observation well, for determining trends. Statewide, 81 percent of 341 observation wells in the groundwater level monitoring network with sufficient data showed no significant change in water levels or an upward trend over the 20-year analysis period, a 24 percent increase since 2014. In contrast, 19 percent of the groundwater wells analyzed had a significant downward trend, a 16 percent reduction since 2014. It is important to note that some of the change observed may reflect the addition of new wells in the

Status	Trend	Description
▲	↗	Most observation wells show no significant change or an upward trend (up 24% since 2014), but many areas of the state lack important groundwater information while some areas experienced groundwater level declines.

analysis. Since 2014, 46 additional wells with the required 20 years of record were added. Downward trends can result from drier climate conditions in the later years of the analysis period or to increased groundwater use.

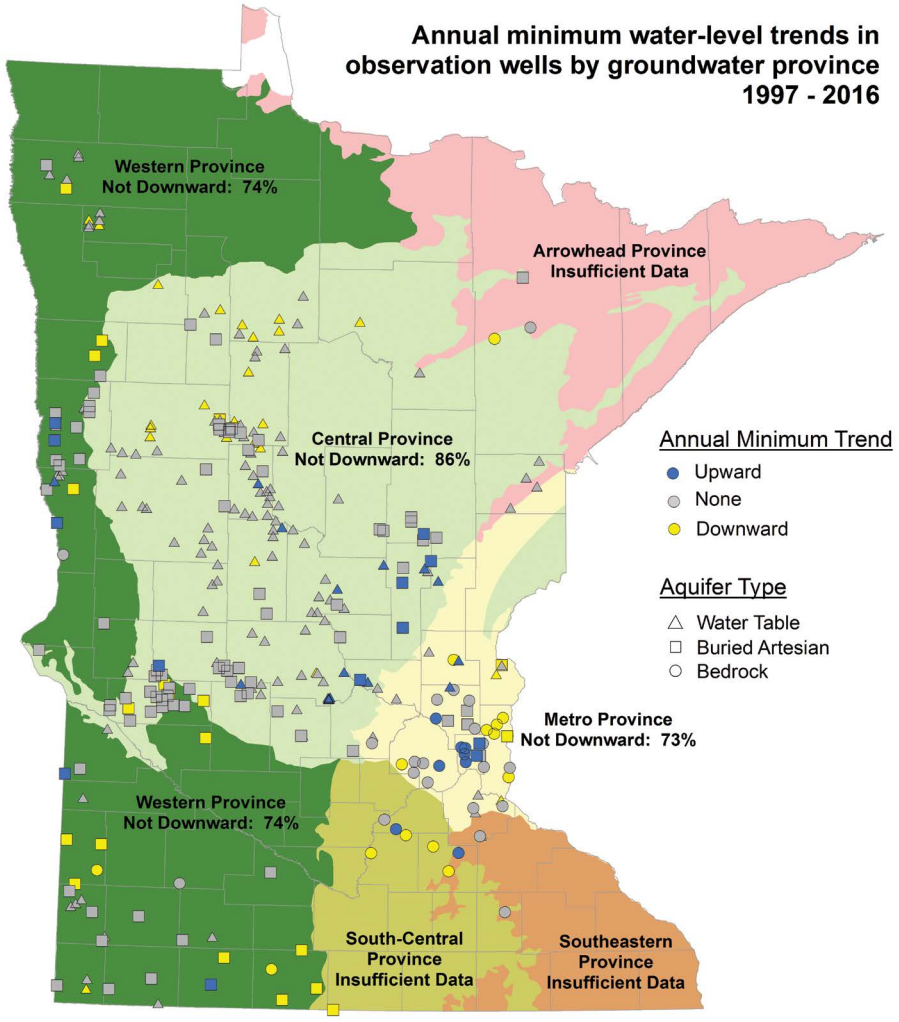
Groundwater-level information is becoming better integrated into water supply planning, which supports work to reduce the environmental, economic, and public-health risks that unsustainable aquifer decline creates. In the Twin Cities Metropolitan Area, regional planning policies are being revised to address declining aquifer levels. Statewide, the DNR is establishing Groundwater Management Areas (GMAs) where additional planning is needed to ensure that growing water demands do not cause unsustainable seasonal or long-term groundwater declines. Clear standards for sustainability of aquifers and the surface water features they support are being established.

The emerging GMA program is creating new partnerships between DNR, Pollution Control Agency, Department of Health, Department of Agriculture, Board of Water and Soil Resources, Metropolitan Council and many local stakeholders. Efforts are underway in the North and East Metro, the Straight River, and the Bonanza Valley area of West-Central Minnesota.

As shifts in land use and related water use occur, groundwater- level monitoring networks will document how water levels respond. Where predictive groundwater models exist, such as in the Twin Cities Metropolitan Area, measured groundwater levels can be compared against predicted water levels to understand how management changes can shift the long-term outlook for our groundwater conditions. Groundwater models are in development or are planned for GMAs and other areas of groundwater-quantity concern.

Learn more:

- Find more information on activities funded by the Clean Water Fund at www. legacy.leg.mn/funds/clean- water-fund.
- DNR groundwater level monitoring program: www.dnr.state.mn.us/waters/groundwater_ section/obwell/index.html
- Metropolitan Council's water supply planning program: www.metrocouncil.org/Wastewater-Water/Planning/Water-Supply-Planning.aspx
- The Groundwater Provinces map can be found online at www.dnr.state.mn.us/groundwater/provinces/data.html



Water Efficiency

OUTCOME

Measure: Changes in total and per capita water use

Why is this measure important?

This measure describes how much water (groundwater and surface water) is used in Minnesota – as an annual statewide total and per person.

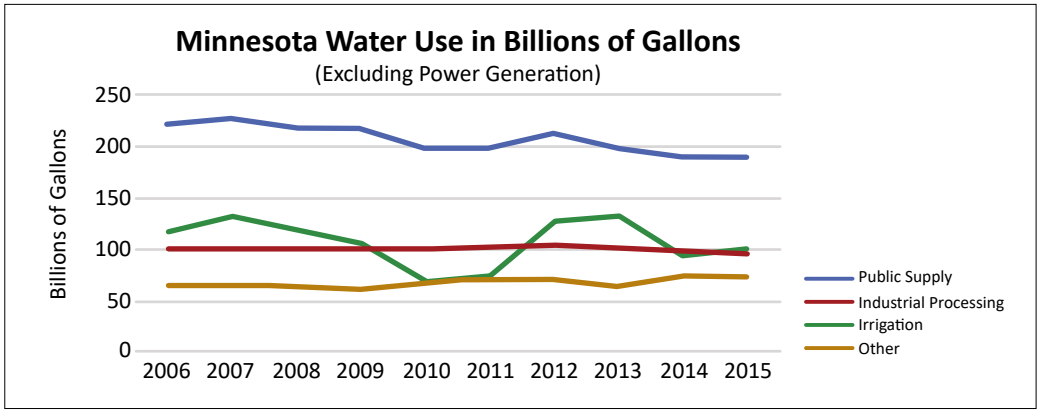
As Minnesotans, we get much more from our water than drinking and washing. Water also helps to provide power, irrigate crops, run industrial processes, and support our state's rich natural environment. And every drop of water that people move from one place to another for a variety of uses come with a cost—such as the energy to move it, the infrastructure to treat it, and the impact to the source from which it was taken.

Being good stewards means getting the most value out of the water we use, taking care not to waste it, and putting it back into the environment sustainably.

What are we doing?

The Minnesota Department of Natural Resources (DNR) is responsible for managing water withdrawal (appropriation) permits in Minnesota. Current laws require those who use large amounts of water (like cities or irrigators) to take actions to reduce their water use. Various water efficiency targets, established since the Clean Water, Land and Legacy Amendment was passed, are listed below. The DNR includes the following in the local water supply plan template for public water suppliers:

- Unaccounted water loss < 10%
- Residential water use < 75 gallons/person/day
- At least 1.5% reduction in institutional, industrial, commercial, and agricultural water use over 10 years
- Decreasing trend in total per capita water use
- Maximum daily use vs. average daily use < 2.6



In the Twin Cities metropolitan area, the Metropolitan Council has identified a regional target of 90 gallons per person per day, on average, for community water systems.

In addition, the DNR, the Minnesota Department of Agriculture (MDA), the University of Minnesota (U of M), and the Metropolitan Council (MC) are using the Clean Water Fund to accelerate the implementation of water efficiency measures. Examples:

- DNR Water Conservation Reporting System
- MDA Irrigation Workshops
- U of M Technical Assistance Program Water Conservation Program
- MC Water Efficiency Grant Program

Year	Total MN Water Use (Gal/Day)	Total MN Population	Gallons per person per day
2010	3,704,591,268	5,303,925	698
2012	3,682,228,800	5,368,972	685
2014	3,474,456,459	5,453,218	637
2016	3,372,221,158	5,528,630	609

What progress has been made?

Between 2010 and 2016, the water used for public supply has gone down about 15 percent and the average amount of total water used per person (for all purposes in the state) has gone down approximately 10 percent. This is likely due to a combination of factors like wet summers (less irrigation) and more efficient industrial processes and residential appliances.

Status	Trend	Description
▲	↗	There has been a slight improvement in water efficiency in recent years, although continued tracking is needed to determine the amount of impact from annual difference in weather versus changes in management.

Learn more:

- Find more information about this measure and its data at www.legacy.leg.mn/funds/clean-water-fund
- Water use in Minnesota: www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html
- Great Lakes Compact: www.dnr.state.mn.us/waters/watermgmt_section/great_lakes_compact/index.html
- Irrigation Outreach & On Farm Nitrogen Management in Central Minnesota: www.mda.state.mn.us/protecting/cleanwaterfund/gwdwprotection/irrigationworkshops.aspx
- Minnesota Technical Assistance Program – Water Conservation: www.mntap.umn.edu/focusareas/water/projects/
- Metropolitan Council Water Efficiency Grant Program: metrocouncil.org/Wastewater-Water/Funding-Finance/Available-Funding-Grants.aspx

Social measures and external drivers

Social measures

Social measures track how Clean Water Fund investments affect people and communities, specifically their ability to support and engage in local projects. Tracking social measures provides valuable information about how well education, outreach and civic engagement strategies are working.

External drivers

External drivers are changing factors influencing the quality and quantity of water in Minnesota's lakes, rivers, wetlands, and aquifers that may impact our ability to achieve our Clean Water goals. External driver trends on pages 67-71 were selected to represent areas where major change is occurring in Minnesota.

1. Land-use changes
2. Demographic changes
3. Climatic changes

Social measures

Building local capacity to support and engage in water restoration and protection

Why are social measures important?

The science is clear: the actions people and communities take on land have the greatest impact on the health of our water resources. While some land use activities are required by regulation, many are voluntary. In Minnesota, about 75 percent of the land is privately owned and we rely on the voluntary actions of landowners to protect and restore lakes, rivers, streams, and groundwater. We need to better understand and address what motivates people and communities to take positive actions, as well as the barriers and constraints that prevent or limit action.

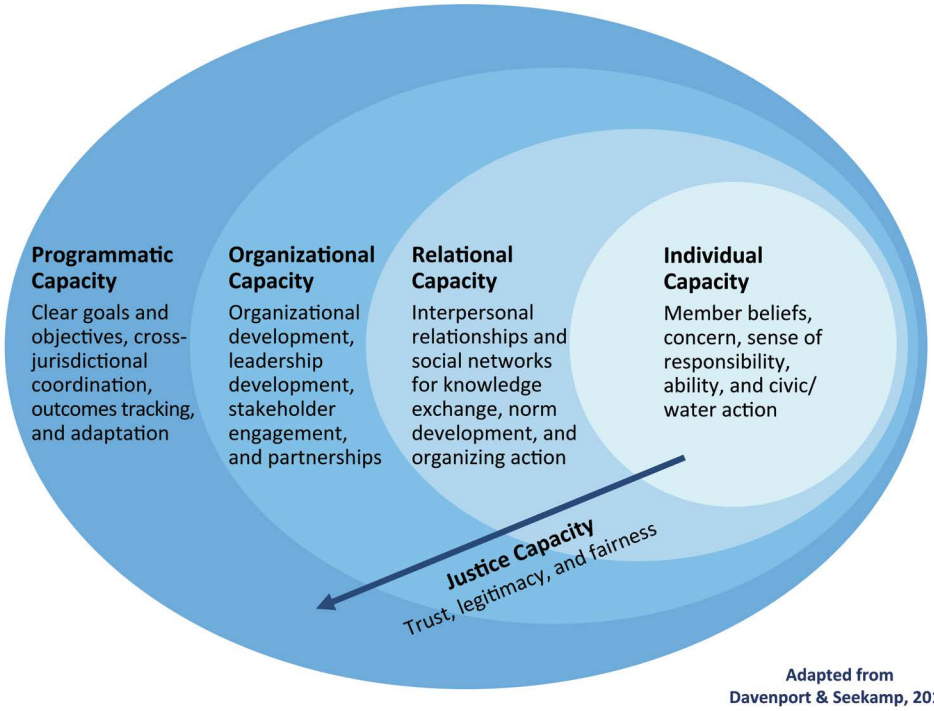
Within water resource management, social and biophysical sciences complement each other. Biophysical data describe the extent and nature of water quality problems and suggest technical solutions. Social science data provide information about public perceptions; individuals' knowledge, skills, and abilities; community values; economics; and societal norms. These factors define acceptable, feasible, and expected behaviors within communities and influence whether or not people will take voluntary actions to protect and restore Minnesota's waters. Understanding and measuring these social factors help state agencies to be more strategic when engaging and partnering with the public to address water quality and evaluating the success of those efforts.

Social Measures Monitoring System (SMMS)

State agencies are piloting the use of the Social Measures Monitoring System (SMMS) to strategically integrate social science into Clear Water funded projects. The SMMS is a scientific approach that outlines a common set of goals or results that provide a starting point for state agency projects. They help direct project planning and can guide the selection of social science tools, methods, and performance measures.

The SMMS includes different levels of community capacity, as depicted in the figure at right, and integrates justice as an overarching principle.

Community capacity model



Adapted from Davenport & Seekamp, 2013

The purpose of the SMMS is to introduce scientific rigor to the human dimension of water resource management and to standardize data collection and ways of measuring progress. Social data collected at the beginning of a project provide a baseline understanding of the social, cultural, or economic context of a water resource issue. Baseline social data can be used to adjust project goals or activities to meet the specific needs of a community, narrow the focus of project goals, or support later evaluation so we can track progress similar to the way we track progress in biophysical

measures. Social data collected during a project can be used to evaluate progress or help to adapt project activities to better fit the needs of those served and/or affected. Data collected after a project ends can be used for final evaluation and to inform and improve future projects in the same community or other communities in Minnesota.

What are we doing?

State agencies, in partnership with the University of Minnesota, have been applying the Social Measures Monitoring System (SMMS) to a project within each agency. Agency staff meet to share information and support science-based efforts to improve public participation, civic engagement, and the application of the social measures in water protection and restoration efforts. The two projects below have different goals and scale, but the SMMS provides a common framework for consistency across agencies.

What progress has been made?

Skill development and training for building "Teams that Work"

The success of clean water projects depends on participation from a variety of partners and the ability of those partners to work together and reach a common goal. In the Nitrogen Fertilizer Management Plan (NFMP), the Minnesota Department of Agriculture (MDA) is building partnerships by forming local advisory teams in areas of the state with elevated nitrate-nitrogen levels in drinking water sources. These teams will engage in problem solving activities at the local level. The MDA uses the SMMS to design staff training, set goals, and conduct evaluations for the NFMP local advisory team process.

By focusing on partnerships and relationships, we hope to create more local support for clean water work and partner effectively with team members. The overall goal is to initiate and support a locally-driven process in which participants feel open and empowered to adopt additional nitrogen management practices.

While there is often crossover between the different areas of community capacity, the MDA selected relational capacity as the one to inform the design and development of the local advisory team process. Relational capacity is the degree of social networks and relationships within a community that promote information sharing and trust building. The choice to focus on partnerships is based on knowledge and experience that working with advisory teams and building consensus around environmental issues can be challenging. Strong relationships and the ability to work together will be important to the success of the NFMP. Local advisory teams will be in townships and source water protection areas that have elevated nitrate levels in groundwater. Membership will include farmers, agricultural professionals, local government staff, and community members.

In 2016-2017, the MDA worked with the University of Minnesota Extension to design and deliver training on group facilitation and team building skills for MDA staff convening the local advisory teams.

Five training sessions covered topics such as stakeholder analysis, conflict management, facilitation, and group decision making. Each session combined formal training along with time for staff to ask questions, discuss emerging issues, and work together on meeting materials. Skills learned in these training sessions will be used and modeled for local advisory team members. After the initial training was complete and before local advisory teams were convened, the U of M Extension used components of the SMMS to conduct an evaluation. This evaluation measured how MDA staff changed their approach to meeting management or developed new skills and how staff were working together in new ways as a result of the training. Results are being used to address gaps identified in the initial training and identify the most effective approach for working with local advisory teams

Starting in the winter of 2017, MDA will begin local advisory team meetings in townships with elevated nitrate levels. U of M Extension will help facilitate this first series of local advisory team meetings. This allows MDA staff to apply their new skills and observe and learn from professionals that have facilitated community meetings and decision-making processes for decades.

The MDA will also use the SMMS to document changes within local advisory teams. MDA staff will use small group discussions and surveys to track indicators related to connectedness of team members, trust, shared identity, common awareness, and collective action. The MDA will monitor changes and help track outcomes such as:

- Do local advisory team members feel they are a valued member of the team?
- Does the local advisory team process support a shared awareness of local nitrate issues and potential solutions?
- Do local advisory team members have the resources and support they need to work together with organizations and agencies to protect water resources?

Social measures provide short-term feedback on the advisory team process before changes in water quality may be observed. Using the SMMS will help the MDA refine and improve their approach to convening and facilitating local advisory groups. We acknowledge that it is not enough to just host a meeting. In order to "build teams that work," attention to the quality and content of the discussion, how participants feel about the process, and skills of people leading the process are all very important. Success in these elements provides the base for strong relationship building and the relationships influence group member participation and commitment to developing locally-driven solutions.

Using social measures to inform how to build local capacity to protect Minnesota's groundwater

Groundwater is mostly invisible, yet three out of four Minnesotans rely on this vital resource for drinking water. Based on monitoring data, Minnesota's groundwater resources are at risk from overuse and contamination. City and county governments own part of the responsibility for protecting and managing Minnesota's groundwater. Over the past several years, the DNR has partnered with University of Minnesota and local government organizations to use the Social Measures Monitoring System (SMMS) to better understand local capacity to protect groundwater, and to use this information to design educational workshops to address identified needs.

In 2014, the Minnesota Association of Soil and Water Conservation Districts (MASWCD) requested that the DNR provide education for SWCD staff to help them better understand local groundwater quality and quantity issues and guide efforts with their clientele. The DNR partnered with the University of Minnesota and used the SMMS to design a survey. The goals of the survey were 1) to understand current capacities of SWCD staff to address local groundwater issues and 2) to determine what was needed by SWCD staff in different districts to better manage local groundwater supply and quality.

The baseline survey indicated that SWCD staff in different parts of the state had variable knowledge about groundwater conditions and issues. This information was used to design workshops and customize them for the specific information gaps and professional needs of each SWCD. The DNR designed seven interagency all-day workshops with speakers from each SWCD district, focused on local groundwater quality and quantity issues. The workshops occurred in 2015 and 2016 in Marshall, St. Peter, Rochester, St Cloud, Thief River Falls, Ottertail, and Duluth. A total of 175 SWCD staff participated.

In 2016 the University of Minnesota's Regional Sustainable Development Partnership provided additional funding to conduct a post workshop survey of all SWCD participants. Post-workshop surveys indicated considerable improvement in individual and relational capacities compared to the 2015 baseline surveys.

A few of the key capacity findings for the SWCD districts:

1. Individual capacity improved for 80 to 87 percent of SWCD workshop participants, reflected by a better understanding about groundwater's connection to surface water and land use impacts to groundwater.
2. Relational capacity improved for 63 to 78 percent of SWCD staff after the workshops, with enhanced ability to engage with primary clientele, including local decision-makers, landowners, and agricultural service providers.
3. A measure of individual and relational capacity was improved for 88 to 98 percent of SWCD staff who reported improved confidence to implement best management practices that protect groundwater.
4. Programmatic capacity for SWCD staff was improved with greater clarity about the role of others in groundwater protection provided by the interagency speakers.

The DNR worked with project partners to use the SMMS approach in another groundwater protection research effort funded by the U of M's Serendipity Grant Program. The partners included the U of M, DNR, Minnesota Department of Health (MDH), League of Minnesota Cities, Metro Cities, and the Freshwater Society. This survey allowed project partners to reach a much broader local audience that included staff of cities and counties throughout Minnesota.

Of the 468 survey respondents, 67 percent were city staff and 33 percent were county staff. There were many significant differences between city and county responses on groundwater capacity questions. This suggests that both cities and counties are very important in water planning and local groundwater protection and decision-making, but their initial knowledge and interest in this topic varies. The U of M and the DNR will share the final local government findings with city and county associations.

Social measures and the framework designed by the U of M were beneficially used: 1) to generate new data on groundwater protection capacities of SWCD staff; 2) to tailor and design learning events for staff in different districts of the state; 3) to learn how capacities were changed in different districts as a result of the workshops; and 4) to clarify how different governmental units have different groundwater issues to address.

Conclusion

The SMMS provides a strategic, social science-based approach for planning, implementing, and evaluating outreach, education, and civic engagement activities. Social science data can help clarify what information is needed to address clean water issues, who is responsible for what water protection or restoration actions, and how to engage with partners to achieve success. In the absence of data about community capacities to address clean water efforts, state agencies may be limited to carrying out technical solutions without local support. For this reason, collecting and using social science data and analysis are critical to meeting Minnesota's clean water goals.

Learn More

- Davenport, M.A., & Seekamp, E. (2013). A multilevel model of community capacity for sustainable watershed management. Society and Natural Resources: An International Journal, 26(9), 1101-1111
- Social Measure Metadata and a list of Social Outcomes Statements are located at: www.legacy.leg.mn/funds/clean-water-fund/clean-water-fund-performance-reports
- Sharon Pfeifer, Minnesota Department of Natural Resources, sharon.pfeifer@state.mn.us, 651-259-5723
- Margaret Wagner, Minnesota Department of Agriculture, margaret.wagner@state.mn.us, 651-201-6488

Status	Trend	Description
▲	Not enough information for a trend determination at this time.	In recent years, state agencies have developed and piloted the Social Measures Monitoring System. This work integrates social science into Clean Water Fund projects.

External drivers

Important land use, population and climate trends

The trends outlined in this section represent important land use, population, and climate-related changes that may influence the quality and quantity of water in Minnesota's lakes, rivers, wetlands, and aquifers. Because these factors are changing in ways that may impact our ability to achieve our Clean Water goals, they are referred to as external drivers. The external drivers highlighted in this report track changes occurring within Minnesota as a result of regional, national, or even international activities. The broad scale at which these external drivers operate means that they cannot be solely managed through the Clean Water planning process, yet they can have a significant impact on the quality and quantity of Minnesota's water resources.

External driver categories

Land-use changes:

- Agricultural land use
- Impervious surface urban/suburban communities
- Wetland coverage

Demographic changes:

- Population size and proportion in urban/suburban counties

Climatic changes:

- Average Minnesota temperature
- Average Minnesota precipitation

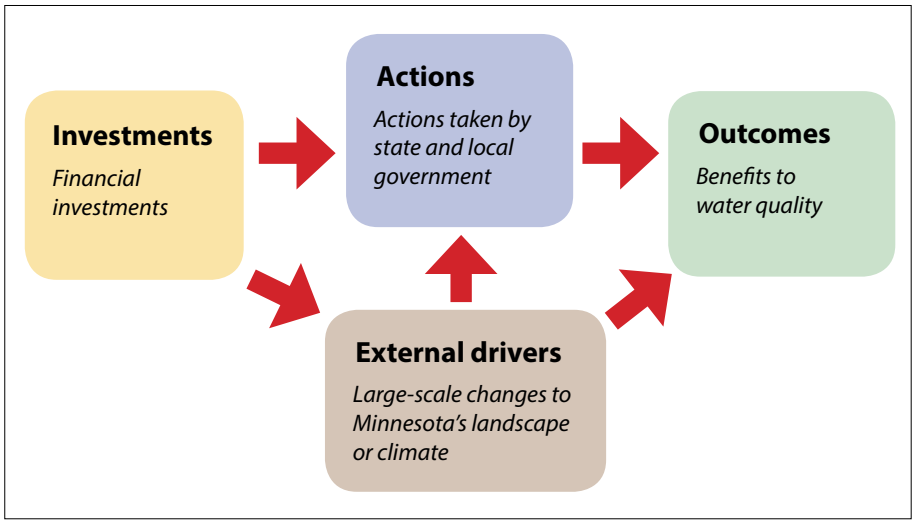


Figure 1. Expected relationships of external drivers to investments, actions, and outcomes

Understanding how external drivers are changing over time provides important context for many of the Clean Water outcome measures highlighted in this report because those trends may increase or hamper Minnesota's ability to achieve its Clean Water goals. Tracking external drivers can also provide important information to help enhance the effectiveness of protection and restoration actions that are implemented. By understanding how Minnesota's landscape and climate are changing, Clean Water partners can fine-tune where money is invested and what actions are taken to enhance successful outcomes (see figure above). Tracking external drivers will help Clean Water partners adapt their actions over time, enhancing water quality and drinking water outcomes.

It is important to note that the relationship between the external driver and the water quality or drinking water outcome of interest is often complex and may vary from location to location. Just because one of the external driver categories highlighted in this section increases over time does not mean that water resource quality will decline. For example, increased adoption of BMPs or other actions by state and local governments may more than offset the change.

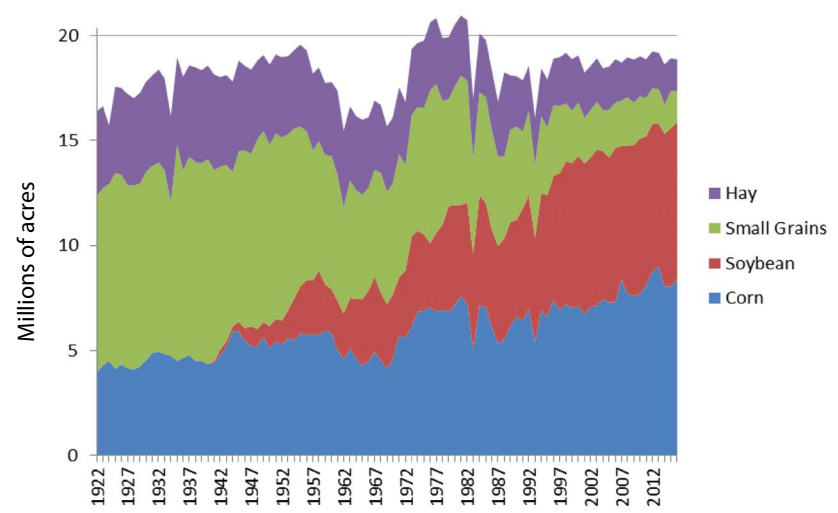
Of the many categories of external drivers that could be highlighted, this section focuses on a few selected land use, population, and climate changes. The specific trends represented on the following pages were chosen because they represent major external driver categories and are reliably and routinely updated at a state-wide scale over time.

Land-use changes

How land in Minnesota is used is critical to understanding how much of the precipitation that falls reaches the state's lakes, rivers, and wetlands or percolates into the state's aquifers. Likewise, land use has a major influence on the quantity and quality of runoff. The major land-use categories highlighted below were chosen to reflect agriculture's

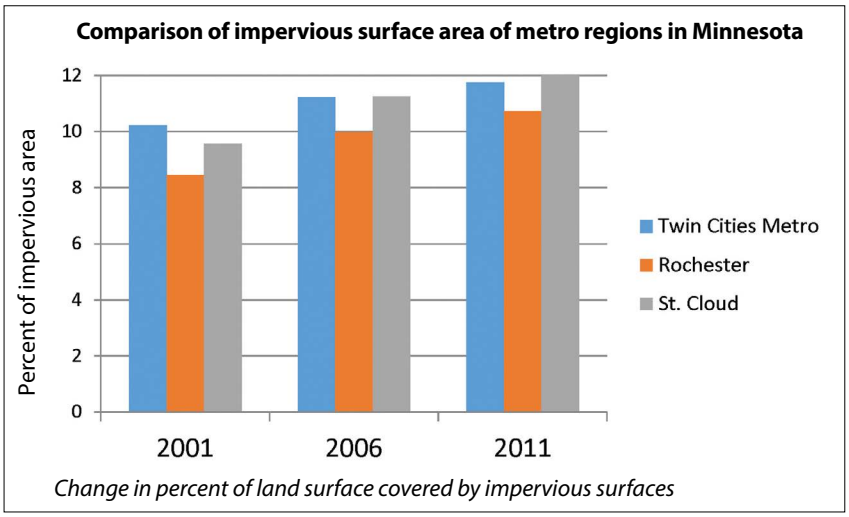
major role in the Minnesota landscape, the continued growth of urban/suburban centers and the water quality challenges associated with impervious surface, and Minnesota's desire to stop the loss of additional wetland acres.

Agricultural land use: Though the total acres of agriculture land use in Minnesota has remained relatively constant over time, the crops grown (land cover) have undergone a significant transformation. As shown inthe figure at right, there have been major shifts in land cover in Minnesota over the last 70 years. The number of acres planted in small grains or hay has declined and been replaced by increases in corn and soybean acreage. The roughly 9 million acres where agricultural land use has changed represents about 16 percent of the state. These cropping changes have altered the time of year and extent the land is covered by a growing crop. This impacts soil erosion risk, fertilizer needs, nutrient capture, and soil moisture management. These changes in agricultural land cover can result in impacts to water quality in the form of nutrient and/or sedimentation into surface waters or leaching into groundwater.



Agricultural land use trends; only major crop acreage shown

Impervious surface in metropolitan area: Water quality impacts associated with impervious surfaces are often particularly significant. Because precipitation that falls on impervious surfaces typically does not soak into the ground, runoff volumes are high and the moving water has a greater potential to carry pollutants and cause erosion. Although on a statewide scale the amount of impervious surface makes up only a small percentage of the land area, in urban/suburban watersheds it is much more significant. Currently, well over half of Minnesota's population lives in the corridor between Rochester, the Twin Cities metropolitan area, and St. Cloud. The figure at left shows trends of impervious surfaces for the three areas from 2001 to 2011. For each community, the amount of impervious surface present has increased, amplifying water quality pollution risks. The impervious surface area graph for Minnesota metro regions will be updated when the 2016 National Land Cover Data is published and available for analysis.



Change in percent of land surface covered by impervious surfaces

As Minnesota's population continues to increase and becomes more urban/ suburban (see Demographic Changes Section below) further increases in the amount of impervious surface are likely. The amount of impervious surface in other Minnesota communities can be assessed at mndnr.gov/whaf/explore.

Change in wetland acreage: Wetlands provide water quality and drinking water benefits. Wetlands are important because they provide water storage, hold back runoff and reduce the intensity of flood peaks, reduce the concentration of various pollutants in runoff water, and contribute to groundwater recharge. The abundance of wetlands has changed significantly in many parts of Minnesota. Since the 1800s, it has been estimated that about half of the state's wetlands have been lost and in many parts of southern Minnesota well over 90 percent of the original wetlands have been drained. Because of the benefits associated with wetlands, Minnesota adopted a "no net loss" of wetland policy in 1991, and in 2006 initiated a rigorous, long-term monitoring program to track changes in wetland quality and quantity over time. Between 2006 and 2008 the monitoring effort assessed wetland abundance in almost 5,000 plots across Minnesota to serve as a baseline.

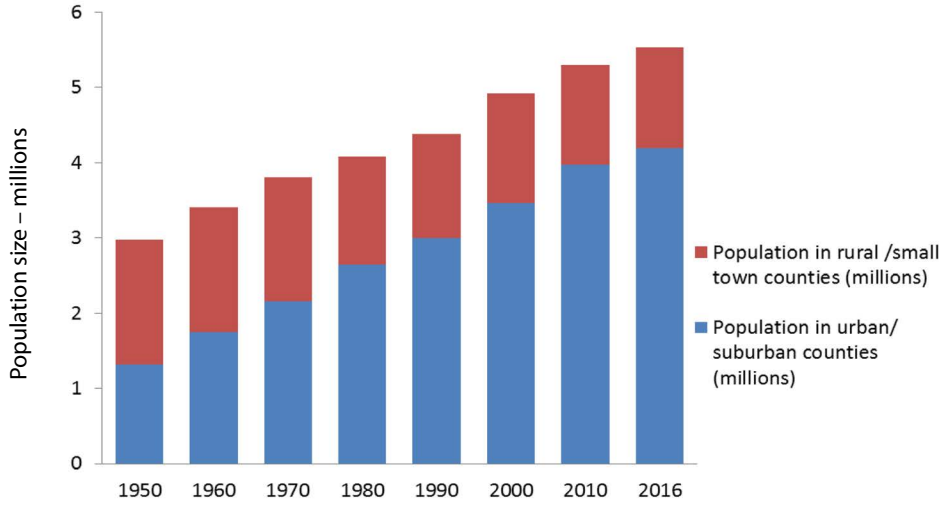
Those same sites are reassessed every three years to track the amount of change that is occurring.

Results through 2014 indicate that Minnesota had a net gain of 2,430 acres (an increase of 0.023 percent of overall state wetland acreage) of wetland from 2006 to 2011 and a net gain of 6,550 acres (an increase of 0.060 percent) from 2009 to 2014. In spite of nominally achieving the state's no-net loss goal with respect to wetland quantity, the data suggest important reasons to be concerned about the state of wetlands in Minnesota. First, much of the observed gains were unconsolidated bottom type wetlands (ponds) that typically have limited wildlife habitat value. Second, there are conversions between wetland types, such as emergent wetlands converted to cultivated wetlands or to unconsolidated bottom wetlands that, while not a loss of wetland area, undoubtedly represent a loss of wetland function.

Restoring wetlands may be an important practice in Minnesota to slow down runoff and trap pollutants before they reach downstream lakes and streams. . Results from the wetland tracking effort described above suggest that historical patterns of outright wetland loss may be leveling off, but there is a need to focus on restoring and maintaining wetland functional quality.

Demographic changes

The size and makeup of Minnesota's population can stress water resource quality, in terms of demand for water and how those uses impact the quality and quantity of water that is returned to the environment. As shown in the figure at right, Minnesota's population has increased steadily since 1950 along with the proportion of the population living in urban/suburban counties. This shift reflects more impervious surface that has the potential to impact surface water quality and quantity, increased water demand and associated impacts to groundwater and surface water supplies, and an expanded volume of treated wastewater being discharged back into the environment. As Minnesota's population continues to increase, so too will the demands placed on the state's water resources, changes that may require modifications to current water quality actions and strategies.



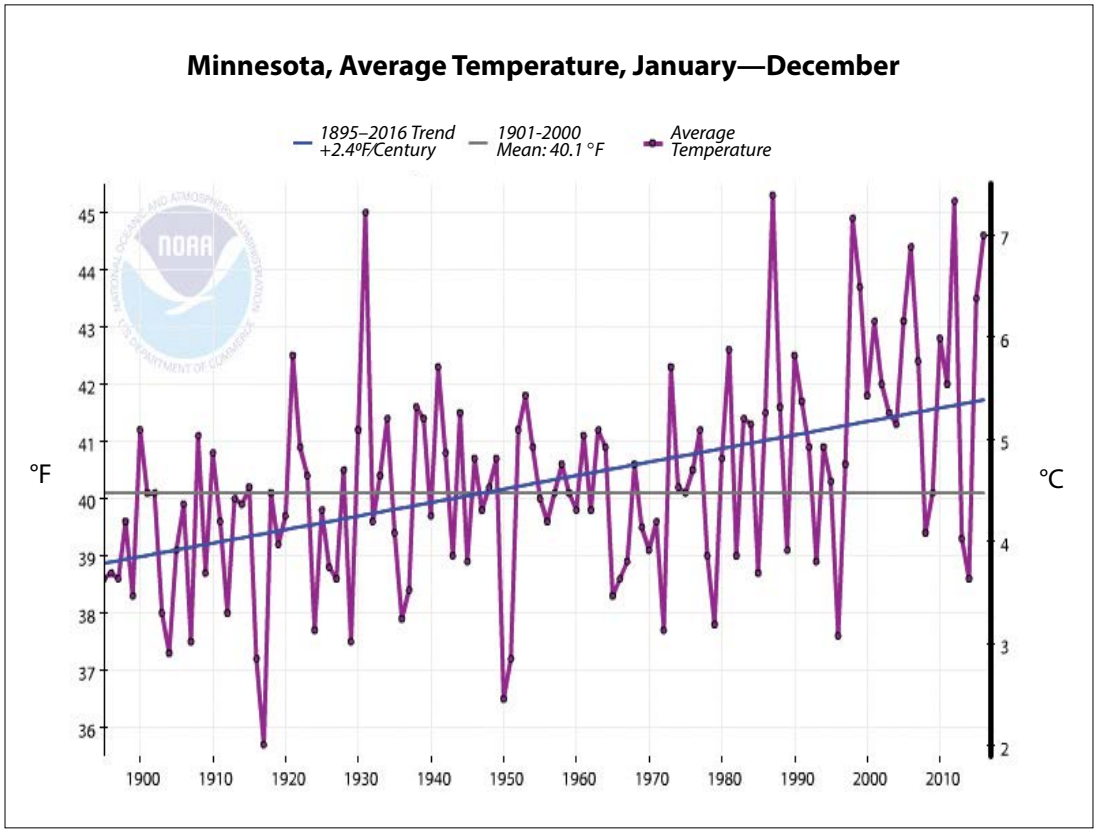
Change in Minnesota's population and urban/suburban vs. rural distribution since 1950

Changing climate patterns

Climate has a significant influence on the condition of Minnesota's water resources, as well as the strategies that Minnesotans will need to employ to achieve restoration and protection goals. The amount and timing of precipitation influences how much water soaks into the ground – changing whether it can be taken up by plants, replenish soil and groundwater resources, or runs off directly into the nearby lakes, rivers, and wetlands. Precipitation patterns also control water demand for outdoor uses such as agricultural and residential irrigation. Likewise, Minnesota's temperature patterns affect the length of Minnesota's winter - controlling the period when lakes and streams are covered by ice, the length of the summer growing season, how warm surface waters become, as well as many of the chemical, physical, and biological processes that shape how the state's aquatic resources behave.

There are many indications that Minnesota's climate patterns are changing. This document highlights how temperature and precipitation have changed between 1895 and 2012 . These figures below and on the following page emphasize that weather in Minnesota may vary dramatically from year to year. For example, almost a 10-degrees Fahrenheit difference in statewide average temperature has been observed between the coldest years and the warmest. Likewise, average statewide precipitation for the wettest years recorded is more than double that measured for the driest years.

The figures also show long-term trends that need to be accounted for as we develop plans and make investments to protect and restore Minnesota's aquatic resources. Over the period shown, the average statewide temperature has increased at a rate of 2.4 degrees Fahrenheit per century; average statewide precipitation has increased at a rate of 2.50 inches per century. Examining these statewide patterns in more detail, both seasonally and geographically,



Year-to-year changes and long-term trend in average annual Minnesota temperature from 1895 to 2016

will likely be necessary to help inform the development of protection and restoration strategies and the selection of implementation projects to anticipate changes in climatic patterns. For example, according to Minnesota's state climatologist, much of the temperature increase observed in Minnesota has been caused by a rapid warming of our coldest temperatures. Winter temperatures are warming considerably faster than summer temperatures, and daily minimum temperatures are warming faster than daily maximum temperatures. The trend is most pronounced in Minnesota's northernmost counties.

The land use, population, and climatic external driver categories listed above may all influence the patterns of water flow and water use in Minnesota. Nevertheless, adding a category that directly measures those changing hydrologic flow patterns would be valuable because of the key role of hydrology in determining water quality status. For example, knowing the proportion of precipitation that runs off the landscape in rivers and streams is critical for making many water resource decisions. If sources of hydrological data are identified that are reliably and routinely updated at the state-wide scale and that reflect how hydrological flows are changing, an additional external driver category may be added to future editions of this report.

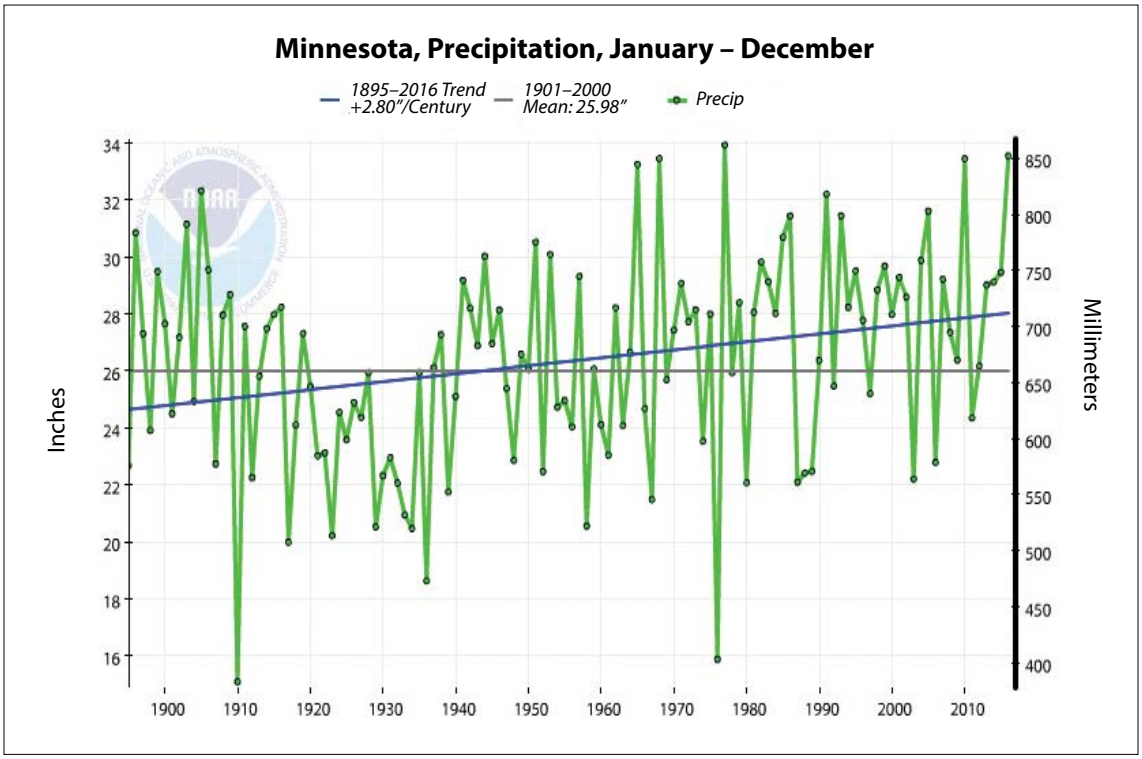


Fig 6. Year-to-year changes and long-term trend in average annual Minnesota precipitation from 1895 to 2016

Status	Trend	Description
▲	→	The external drivers identified continue to alter land-water interactions across Minnesota impacting how Clean Water funds need to be invested.

This report and future updates can be found on the Minnesota's Legacy website:

www.legacy.leg.mn/funds/clean-water-fund