Clean Water Fund Performance Report

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

2022

CLEAN WATER LAND & LEGACY AMENDMENT

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January 2022

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.

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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

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Protecting and restoring Minnesota's waters for generations to come

Investing in clean water is money well spent. Minnesota voters clearly delivered this message when they overwhelmingly passed the Clean Water, Land and Legacy Amendment in 2008. The amendment provides 25 years of dedicated funding to strengthen and enhance Minnesota's response to water resource challenges and to protect high-quality waters. The Clean Water Fund creates opportunities for Minnesota to take innovative and collaborative approaches to improve water quality statewide.

Clean water management requires a systematic approach to address issues related to surface water, groundwater, drinking water, habitat, recreation, and more. Minnesota has adopted a watershed-based management approach that promotes increased collaboration and a common vision for planning and implementation activities. This approach is not limited by county or other jurisdictional boundaries. Partnerships between state agencies, local governments, and other stakeholders play a key role in successful resource management as they prioritize, target, and measure Clean Water Fund activities.

Between 2010 and 2021, Minnesota's Clean Water Fund:

- Awarded more than **3,631** grants to protect and restore Minnesota's water resources.
- Delisted **66 lakes and streams** from Minnesota's impaired waters list.
- Issued more than **2,087 loans** to prevent nonpoint source water pollution or solve existing water quality problems.
- Secured more than **778 easements** that will permanently protect approximately **17,034 acres** along riparian corridors and within wellhead protection areas.
- Repaired **788** imminent health threat subsurface sewage treatment systems.
- Upgraded **48 municipal wastewater treatment facilities**, which reduced phosphorus discharges by over 268,000 pounds per year.
- Delineated Drinking Water Supply Management Areas for all **500 vulnerable municipal water systems** to protect their drinking water sources.
- Engaged over **6,500 visitors** in the We Are Water MN exhibit, and of those surveyed, 94% indicated that they learned something new about our water resources.

Fund administrators faced unique challenges in 2020 and 2021. The COVID-19 pandemic made it necessary for state agencies and their local partners to adjust programming, implementation, and outreach strategies. Many state employees were assigned new job responsibilities to support Minnesota's public health response to the COVID-19 pandemic, which took priority over regular projects and activities. In-person learning and networking opportunities moved from conference rooms to webinars. For example, the Clean Water Fund-backed We Are Water MN travelling exhibit — which examines water issues throughout Minnesota via personal stories, histories, and scientific information —created virtual and outdoor versions of the exhibit and offered online interactive speaker series and events. These creative adaptations show that Clean Water Fund activities remained strong despite an unexpected transition to a largely digital world.

We know attaining our clean water goals is a marathon, not a sprint, and it will take more than the Clean Water Fund alone to address all water-related challenges across the state. We can make a difference by collaborating, innovating, and leveraging resources beyond the Clean Water Fund to support lasting impacts.

Minnesota's Clean Water mission and goals

The Clean Water Council developed the mission, goals, and objectives with stakeholder involvement in an effort to align activities implemented with Clean Water Fund dollars to the Clean Water Legacy Act. For the 2020 Performance Report, we began to better align measures with the mission, goals, and objectives the Clean Water Council developed (shown below).

Mission

Protect and restore Minnesota's waters for generations to come.

Goals and objectives

Drinking water is safe for everyone, everywhere in Minnesota

- Protect public water supplies
- Ensure private well users have safe water

Groundwater is clean and available

- Improve and protect groundwater quality
- Ensure sustainable long-term trends in aquifer levels
- Avoid adverse impacts to surface water features due to groundwater use

Surface waters are swimmable and fishable

- Prevent and reduce pollution of surface waters
- Maintain and improve the health of aquatic ecosystems
- Protect and restore hydrologic systems

Minnesotans value water and take actions to sustain and protect it

- Build capacity of local communities to protect and sustain water resources
- Encourage systems and approaches that support, protect, and improve water
- Provide education and outreach to inform Minnesotans' water choices
- Encourage citizen and community engagement on water issues

About this report

This report provides a high-level overview of Minnesota's performance so far in restoring and protecting the quality of the state's surface water, groundwater and drinking water resources using Clean Water Fund dollars. Published every two years, the report highlights:

- **Action measures** to track where agency and partner activities are occurring with Clean Water Fund dollars to protect surface, groundwater, and drinking water, including how effectively agencies are completing the work to achieve clean water goals.

- **Investment measures** to track where Clean Water Fund money is spent and how spending patterns are changing, including tracking where other funds are leveraged to extend the work done to meet clean water goals.
- **Outcome measures** to track progress on improving the quality of our surface, groundwater, and drinking water.

The report is not a complete assessment of all work achieved with Clean Water Legacy funds, either at the state or local level, but shows key activities that represent the overall Clean Water Fund investment. All of the water agencies have other performance measures, but the measures included in this report are chosen to represent progress over the 25 years of the amendment and concerns known to be of public interest.

Report organization

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. The report displays how spending and progress are occurring across Minnesota, to the extent that statewide data are available. Each measure profile includes the following:

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 may need to be 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. ,

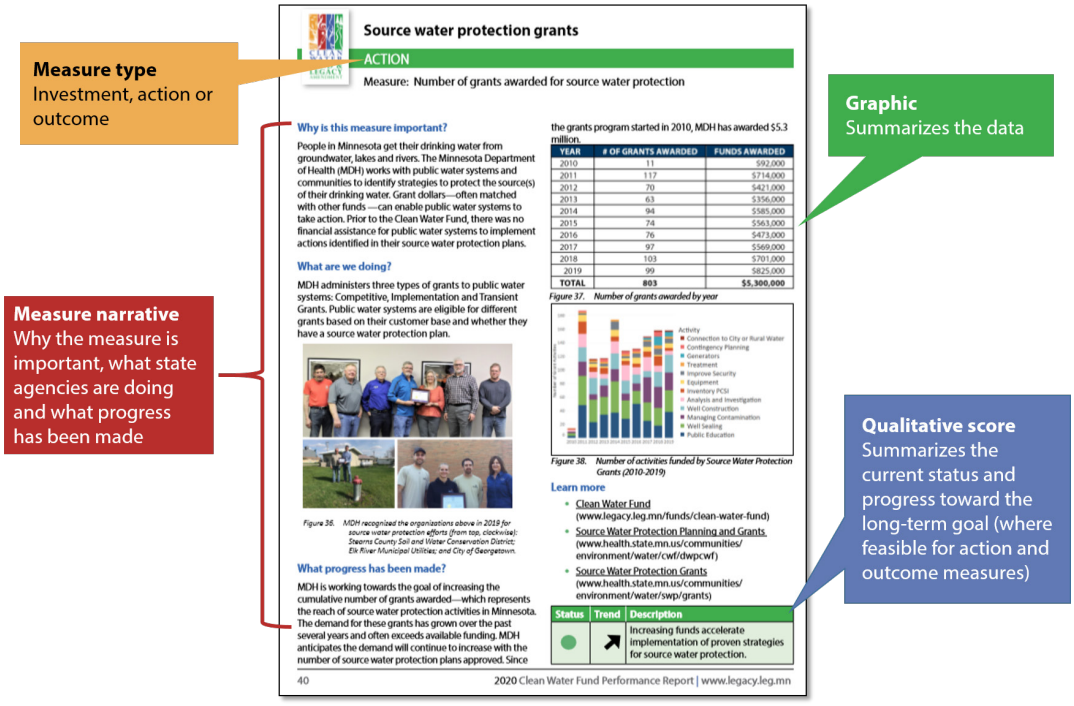


Figure 1. Each measure profile includes measure type, measure narrative, a graphic, and a qualitative score.

2022 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.

Measures are scored according to their status as of the end of fiscal year 2021 (FY21) and for their trend over time. Scores were developed using data-informed professional judgment of agency technical staff and managers. The legend shows the symbols used to describe how measures were scored.

Action status legend

Symbol	Meaning
	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 legend

Symbol	Meaning
	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 legend

Symbol	Meaning
	Improving trend
	No change
	Declining trend
NEI	Not enough information to determine trend at this time

Investment measures

INVESTMENTS

Measure	Status	Trend	Description
Total Clean Water Fund dollars appropriated by activity	$1.2B has been appropriated to the Clean Water Fund from FY10-21, ranging from $157M in FY 10-11 to $261M in FY 20-21.	FY 16-17: $228M FY 18-19: $212M FY 20-21:$261M FY 22-23: $257M	For FY10-21, 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 per watershed or statewide by activity	All watersheds in the state are benefiting from local and statewide projects.		For FY10-19, 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	$625M was awarded in grants and contracts to non-state agency partners in FY10-21.		About 83% of grant and contract awards are for implementation activities; 42% of total FY10-21 appropriations were awarded to non-state agency partners.
Total dollars leveraged by Clean Water Fund	$492M was leveraged by Clean Water Funds in FY10-21, or $1.09 for every implementation dollar invested.		Required Clean Water match funds were exceeded.

Surface Water Measures

ACTION

Measure	Status	Trend	Description
Percent of monitoring addressing state & local needs			Nearly 40% of watersheds met goals for addressing state and local needs for monitoring. Ongoing program development is aimed to ensure local needs are identified for monitoring.
Local partner participation in monitoring efforts			As of 2021, 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 significantly greater than available funds.
Number of municipal point source construction projects implemented with Clean Water Funding and estimated pollutant load reductions			Pace of awards is linked to permit cycles, compliance schedules, and available Clean Water Funds. Applications exceed currently available funds even after significant infusion of bond funds over the past several cycles.

OUTCOME

Measure	Status	Trend	Description
Rate of impairment/unimpairment of surface water statewide and by watershed: Stream aquatic life		NEI	Water quality varies greatly by region. In general, good water quality remains where land is intact; where considerable alteration has occurred, water quality is poor.
Rate of impairment/unimpairment of surface water statewide and by watershed: Stream swimming		NEI	Water quality varies greatly by region. In general, good water quality remains where land is intact; where considerable alteration has occurred, water quality is poor.
Rate of impairment/unimpairment of surface water statewide and by watershed: Lake swimming		NEI	Water quality varies greatly by region. In general, good water quality remains where land is intact; where considerable alteration has occurred, water quality is poor.
Changes over time in key water quality parameters for lakes and streams: Lake clarity		NEI	There are improving trends in lake water clarity in more lakes than not.
Changes over time in key water quality parameters for lakes and streams: Sediment in large rivers		NEI	There are more improving trends than declining trends in total suspended solids.
Changes over time in key water quality parameters for lakes and streams: Nitrate in large rivers			Nitrate concentrations are increasing in major rivers.
Changes over time in key water quality parameters for lakes and streams: Phosphorus in large rivers		NEI	There are more improving trends than declining trends in phosphorus.
Changes over time in key water quality parameters for lakes and streams: Pesticides in streams			Detections in streams vary greatly as a result of hydrologic and agronomic conditions; exceedances of pesticide water quality standards are rare. Some "surface water pesticides of concern" are showing increasing detection frequency and concentrations.
Changes over time in key water quality parameters for lakes and streams: Pesticides in lakes			With the exception of detecting chlorpyrifos in two lakes, pesticide detections have been low relative to water quality reference values and generally stable since 2007.
Changes over time in key water quality parameters for lakes and streams: Chloride in streams and rivers			Concentrations are increasing in almost all metro area rivers and streams.
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. Emissions from mercury use in various products saw a decrease for the 2020 emission inventory. Conversely, emission from the mining sector have remained relatively steady since 2017. To meet our 2025 emissions goal, significant reduction of mercury emission from the mining sector and 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, improved technology, and optimization of operations.

Drinking water and groundwater measures

ACTION

Measure	Status	Trend	Description
Number of community water supplies assisted with developing source water protection plans			On track to meet goal of protecting all vulnerable systems under Source Water Protection Plans by 2020.
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 partnerships continue to be established for nitrate-nitrogen monitoring and reduction activities.
Number of new health-based guidance values for contaminants of emerging concern			Did not meet target for FY 18-19. On track to meet goal of 10 guidance values developed next biennium.
Number of counties completing a county geologic atlas for groundwater sustainability			County atlases (including the geologic & groundwater atlases) are being completed at the planned rate, and counties continue to step up to participate. With continued and consistent funding, completion of geologic atlases for all counties is expected around 2035, and completion of groundwater atlases for all counties around 2040.
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			FY18 funding was awarded to seven public water-suppliers to assist in sealing 17 unused wells. FY 19 funding was awarded to nine local government units to assist in sealing over 300 private unused wells.
Land use in Drinking Water Supply Management Areas			There is increasing research, engagement and activity to protect vulnerable areas in DWSMAs.

OUTCOME

Measure	Status		Description
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.
Changes over time in pesticides, nitrate-nitrogen, and other key water quality parameters in groundwater: Nitrate-nitrogen statewide		NEI	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 (the southeast, Central Sands and southwest), nitrate contamination is a significant concern.
Changes over time in pesticides, nitrate-nitrogen, and other water quality parameters in groundwater: Nitrate-nitrogen southwest region		NEI	In areas where groundwater is vulnerable, nitrate levels can be high. Of the 21 vulnerable townships tested in southwest Minnesota (2013-2018), 100% of them were determined to have 10% or more of the wells over the nitrate-nitrogen 10 mg/L standard.
Changes over time in pesticides, nitrate-nitrogen, and other key water quality parameters in groundwater: Nitrate-nitrogen Central Sands			Trend data from the Central Sands Private Well Network shows a slight downward trend in the 90th percentile . However, township testing data show a high level of nitrate in some vulnerable aquifers in the Central Sands.
Changes over time in pesticides, nitrate-nitrogen, and other key water quality parameters in groundwater: Nitrate-nitrogen southeast region			Trend data from the Southeast Minnesota Volunteer Nitrate Monitoring Network shows no change. However, township testing data show a high level of nitrate in some vulnerable areas in southeast Minnesota.
Changes over time in source water quality used for community water supplies		NEI	Identifying correlations between drinking water contaminants is a significant step in trend analysis of source water quality.
Nitrate concentrations 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.
Arsenic concentrations 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 signficant change or an upward trend; many areas of the state lack important groundwater information while some areas experience 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.

Social measures and external drivers

DRIVERS

Measure	Status	Trend	Description
Social measures		NEI	In recent years, state agencies have developed and piloted the Social Measures Monitoring System — integrating 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.

Investment measures

The following four measures illustrate FY 10-21 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 non-profit organizations are spending Clean Water Funds on thousands 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, drinking water protection activities, and applied research.

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, 33% were dedicated to the Clean Water Fund.

This totals $1.5 billion since the inception of the Clean Water Fund. Figure 2 to the right shows the dollars appropriated by biennium for all funding source categories. Figure 3 shows how that was appropriated by specific categories.

Learn more

Clean Water Fund
www.legacy.leg.mn/funds/clean-water-fund

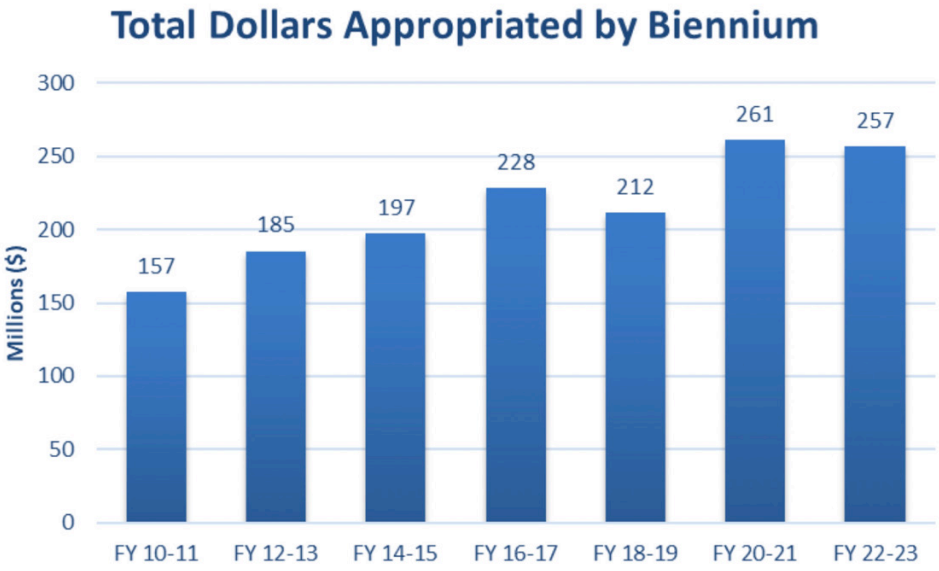


Figure 2. Total dollars appropriated by biennium

Status
FY 10-11: $157.2M
FY 12-13: $185.4M
FY 14-15: $197.4M
FY 16-17: $228.3M
FY 18-19: $211.8M
FY 20-21: $261.0M
FY 22-23: $257.0M
Description
Appropriation levels will vary by biennium due to changes in sales tax revenue. FY10-21 funds have been allocated, while FY 22-23 allocations are in progress.

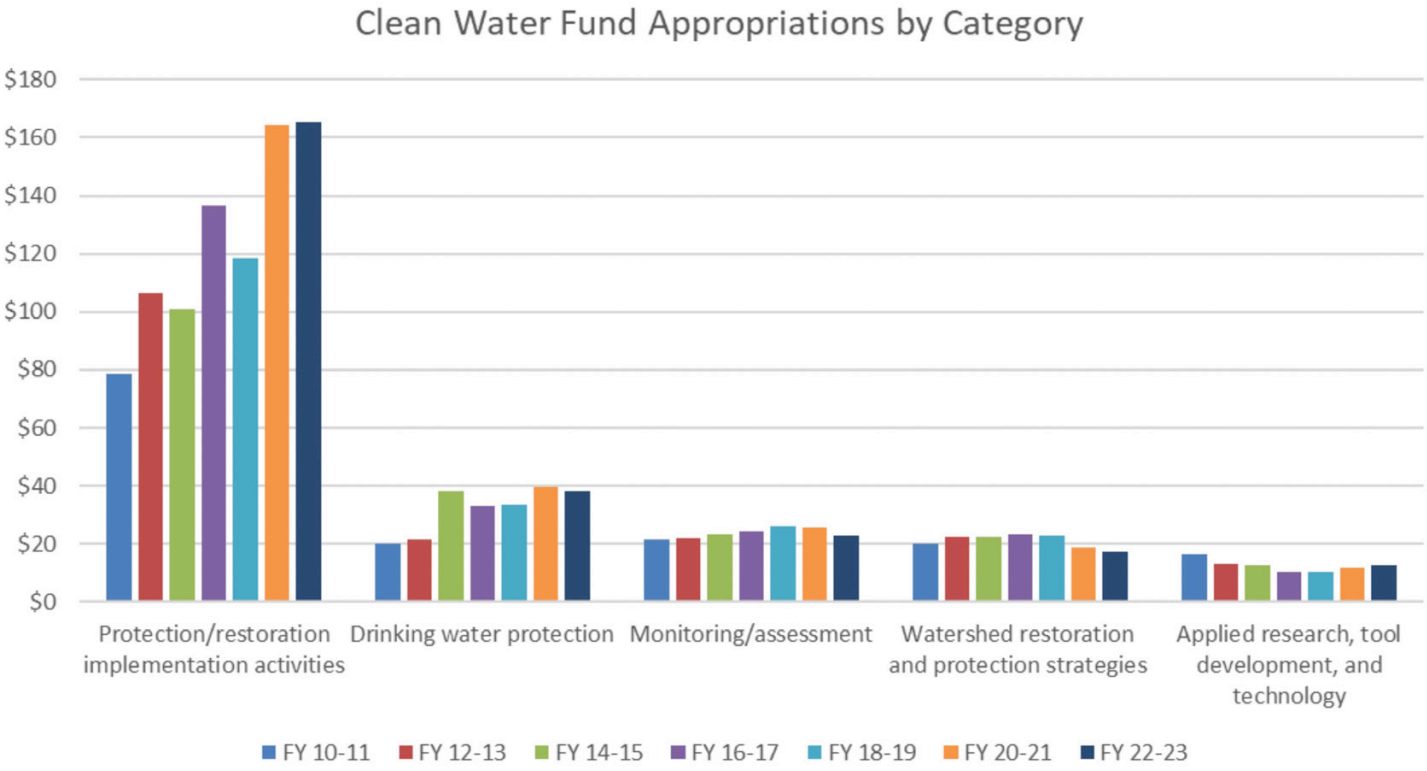


Figure 3. Clean Water Fund appropriations by category

Total dollars invested by watershed or statewide

INVESTMENT

Measure: Total dollars invested per watershed or statewide for monitoring/assessment, watershed restoration/protection strategies, protection/restoration implementation activities, and 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?

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

- Implementation of practices to clean up wastewater, stormwater, and agricultural runoff
- Regular testing, assessment, and modeling of water quality in lakes and rivers to help gauge the effectiveness of clean water practices
- Strategy development and targeting of practices 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?

A total of $529M in completed projects has been expended for all categories of funding tied directly to specific watersheds and $303M connects back to statewide and regional efforts as a whole, for a total of $832M for this measure.

Needs by watershed are variable and depend on the resources of concern, watershed size and complexity, and the technical and administrative capacities of partners in the watershed.

For Fiscal Years 2010-2021, Clean Water Fund allocations to surface water and drinking water projects are benefiting all 80 watersheds in Minnesota. As noted above, these activities are being implemented 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 projects and the problems being addressed.

Learn more

Clean Water Fund
www.legacy.leg.mn/funds/clean-water-fund

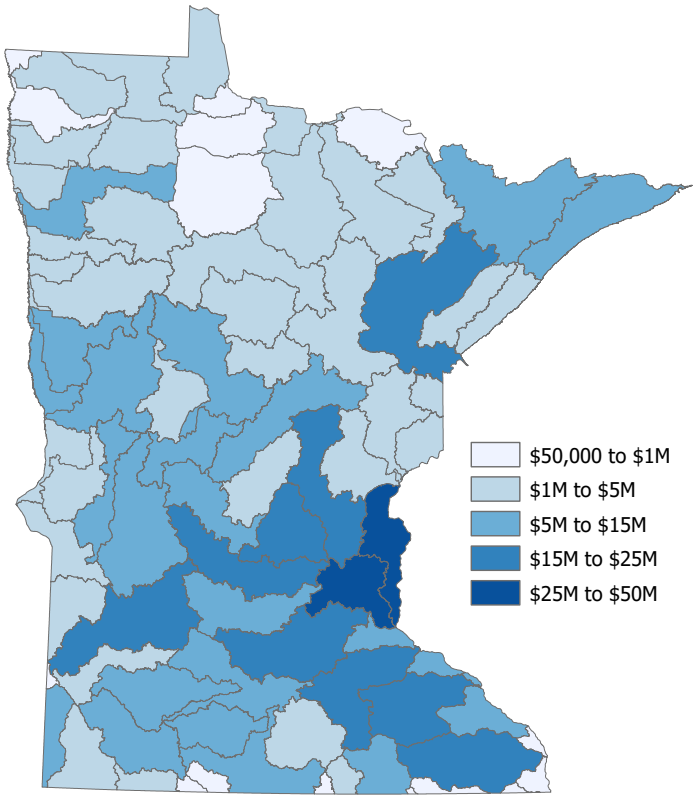


Figure 4. Combined funding for water quality monitoring, watershed restoration and protection strategies (WRAPs) development, implementation, and drinking water protection

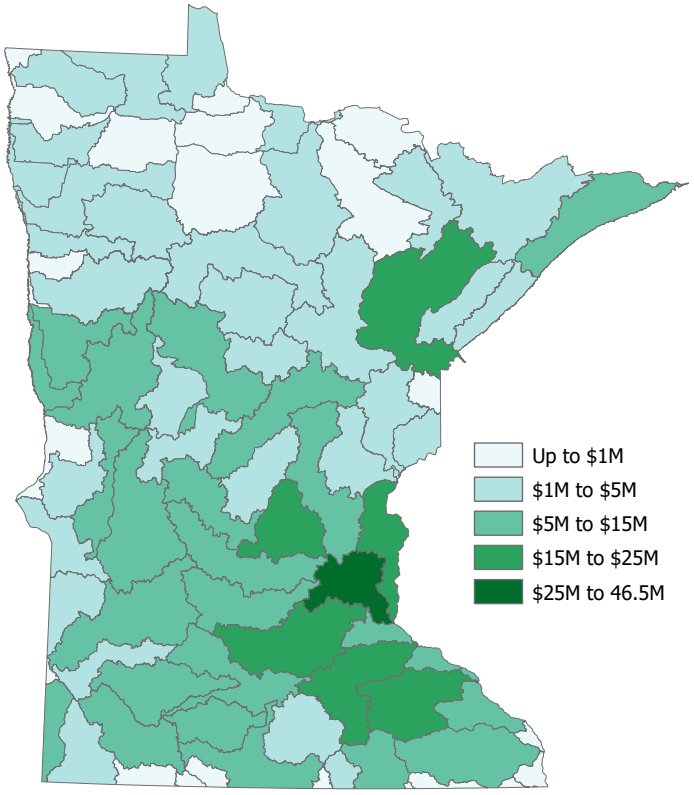


Figure 5. Funding for implementation and drinking water protection actions only

FY 10-21 Clean Water Fund Dollars by Watershed

The map on the left (figure 4) includes all reported financial information by major watershed for the following actions: water quality monitoring, watershed restoration and protection strategies (WRAPs) development, implementation, and drinking water protection. As illustrated in figure 5, the majority of the funds are going towards implementation activities, which has been increasing over time. The map on the right shows a subset of the financial information that includes only implementation and drinking water protection actions. These maps represent projects and supporting activities that have been completed to date, as there are several active grants and contracts with prior appropriations which results are not represented in figures 4 and 5. Smaller amounts of funds have been expended in some northern Minnesota watersheds where there is significant amount of protected public lands with relatively high-water quality. Also, a few watersheds in northwestern Minnesota and along the Iowa border are very small in size and as an artifact of the mapping process appear to have received less funds, but are similar in funds per unit area with adjoining watersheds.

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?

Thousands of Clean Water Fund-supported projects, led largely by local government units, are underway and being implemented across the state. Non-state agency partners include cities, counties, soil and water conservation districts, watershed management organizations, federal agencies, universities, non-profit 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 (figure 9), a total of $625 million in Clean Water Funds were awarded to non-state agency partners in FY 2010-21, with the largest share of that going to protection and restoration implementation activities. This represents 42% of the total $1.5B in Clean Water Fund appropriations for those years.

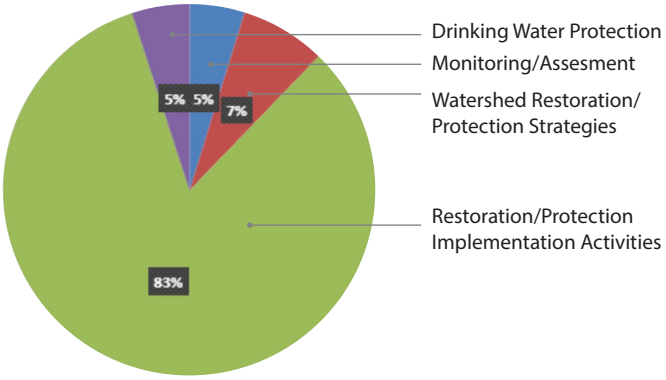


Figure 6. The percentage of total grant and contract awards ($625 million) in FY 10-21 for each major Clean Water Fund-supported activity. Allocations to implementation activities are expected to stay steady or grow in future years as more projects move from strategy.

The balance of remaining appropriations is largely used by state agencies to provide statewide monitoring, watershed protection and restoration strategy development, technical assistance, conservation easements with private landowners, and oversight on Clean Water Fund-supported projects

Learn more

Clean Water Fund
www.legacy.leg.mn/funds/clean-water-fund

Status	Description
$625M was awarded in grants and contracts to non-state agency partners in FY10-21.	About 83% of grant and contract awards are for implementation activities; 42% of total FY 10-21 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 Clean Water Fund dollars to leverage local and other funds 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 between state agencies, various local units of government, and the federal government are critical to implement these water quality improving activities.

What progress has been made?

During Fiscal Years 2020 and 2021, more than $80 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 $56 million.

During Fiscal Years 2020 and 2021, more than $17.19 million in state grants was awarded to improve municipal treatment facilities and to help small communities invest in new infrastructure. Local match and other funding sources increased the project dollars by $58.8 million.

As a result, during FY 2010-21, more than $492 million dollars was leveraged by Clean Water Fund, or $1.09 for every implementation dollar invested.

As shown in *figure 10*, total dollars leveraged has remained relatively flat from FY 2010-17 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, leveraged funding was further reduced by the elimination of the Clean Water Fund grant portion of the MPCA's Clean Water Partnership Program.

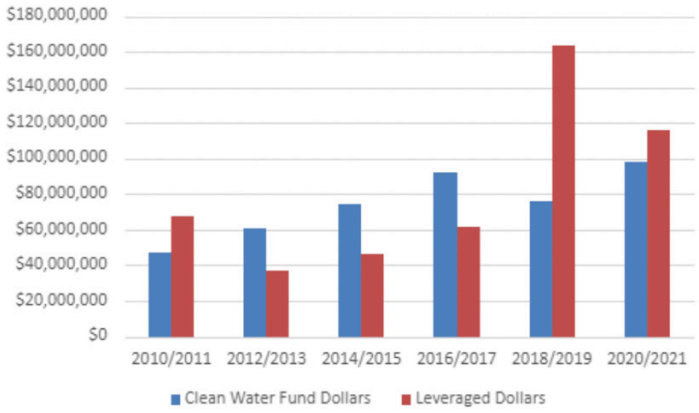


Figure 7. Total dollars leveraged by Clean Water Fund

In FY 2018-19, changes to the Public Facility Authority grant programs resulted in a significant increase in leveraged funds for the biennium. For FY 2020-21, MDA updated its formula for calculating leverage from the Agriculture BMP Loan Program and the Forever Green Initiatives to more accurately report leveraged funds.

Learn more

Clean Water Fund
www.legacy.leg.mn/funds/clean-water-fund

Status	Description
FY 2010-21, more than $492 million dollars was leveraged by Clean Water Fund, or $1.09 for every implementation dollar invested	Required Clean Water match funds were met and exceeded.

Surface water quality measures

The following eight measures 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 monitoring addressing state and local needs

Why is this measure important?

Minnesotans want to know their investments in water quality are making a difference. Thanks to the Clean Water Fund, Minnesota now has a comprehensive baseline assessment of conditions across the state. Similar to an annual visit to the doctor, this monitoring shows where work to protect or return the watersheds to healthy conditions is required. In Minnesota, the monitoring has shown that more restoration is necessary in the south and west, and more protection of resources in the north and east.

Figure 8. 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.

This data is essential to help develop local plans for targeted implementation activities and over time will measure resulting changes in water quality. By returning to these watersheds to monitor after 10 years, the Minnesota Pollution Control Agency (MPCA) can do a checkup and determine if the targeted implementation is resulting in changes in water quality. Without continued monitoring, there is no way to see if the rivers and lakes are meeting the goal of fishable and swimmable waters.

What are we doing?

The first round of watershed monitoring and assessment is complete. This provides the baseline for determining where waters need protection and restoration. The Watershed Restoration and Protection Strategy (WRAPS) document takes the monitoring data and turns it into the specific local strategies needed on the ground to protect and restore waters. This then feeds into local water planning and One Watershed One Plan (1W1P) to target local implementation activities in order to see improvement in water quality.

The MPCA is returning to watersheds to complete the second round of watershed-based lake and stream monitoring, which includes biological, fish contaminant, water quality, and pollutant load sampling. This monitoring is essential to measure progress in restoring and protecting lakes and streams. Additionally, the monitoring will fill 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, the agency has reduced essential core monitoring to provide monitoring capacity for other state and local needs; such as to support permitting decisions, to address a local monitoring need, or address a gap identified in the WRAPS or 1W1P. MPCA is using this modified approach to planning and monitoring in watersheds for the second 10-year cycles of watershed monitoring around the state.

What progress has been made?

MPCA has developed a process to solicit requests from other state and local monitoring partners and work with local and state partners to determine monitoring needs in these watersheds. The process was started in 2018 and continues to evolve as the MPCA and partners identify opportunities for improvement. Monitoring requests vary across the state due to the unique aspects and needs of each watershed. For example, some watersheds are small or have few to no lakes and there are few additional local requests. Others are very large, with extensive stream and lake networks and there are many additional local requests. In some, MPCA proposed sites meet the local needs and there are no additional local requests.

Learn more

- Clean Water Fund
  www.legacy.leg.mn/funds/clean-water-fund
- Find your watershed at Watersheds
  (www.pca.state.mn.us/water/watersheds)
- Learn when MPCA will be intensively monitoring your watershed at Watershed approach to restoring and protecting water quality
  (www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-quality)

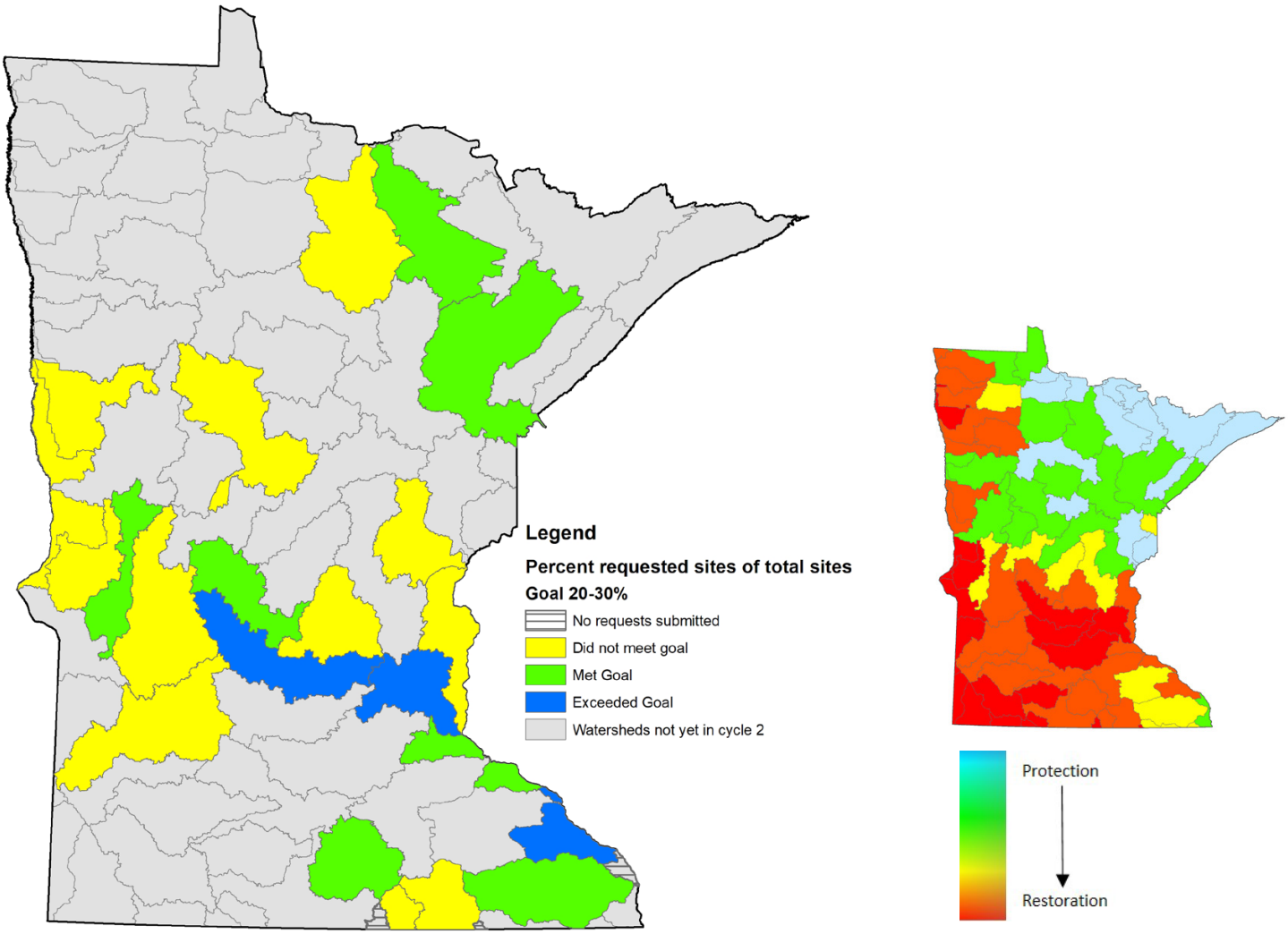


Figure 9. The entire state has completed baseline monitoring (small map). The percentage of requested and approved state and local need sites relative to the total number of sites per monitoring year is shown on the larger map. Goal is to have 20-30% state or locally identified needs addressed through monitoring.

Status	Trend	Description
▲	→	Nearly 40% of watersheds met goals for addressing state and local needs for monitoring. Ongoing program development is aimed to ensure local needs are identified for monitoring.

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, citizen volunteers, and students across Minnesota.

The Minnesota Pollution Control Agency (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 works with local partners to award contracts to cover the costs of staff, training, equipment, and lab analysis of condition monitoring.

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 engaged and well-suited to carry out future monitoring efforts, such as subwatershed pollutant load monitoring to aid in restoration and protection strategies.

In addition, MPCA supports two volunteer monitoring programs for stream and lake clarity. More than 1,300 volunteers participate annually; the data supports assessment and trend development work and provides an engaged citizenry for environmental protection and restoration.

Clean Water Fund dollars also support "River of Dreams," a large environmental education effort in the Red River Basin through the Red River Watershed Management Board. This work exposes hundreds of students to local waterways, provides watershed training to teachers, curriculum development for elementary students, and engages students in biological and continuous monitoring.

Figure 10. Local partners play a crucial role in assessing the health of lakes and streams in Minnesota. Lew Overhaug (Winona County) and Joe Coleman (Minnesota Conservation Corp) collect profile measurements on Lake Winona.

Figure 11. Bethany Chaplin with the Crow Wing SWCD fills a sample bottle after collecting water from the Gull River.

What progress has been made?

MPCA has maintained its goal of a minimum of 75% of the priority sites offered being picked up by local partners.

During 2020 and 2021, the MPCA awarded 25 contracts for monitoring activities across the state. Local partners who received contracts include one tribe, one regional policy-making council, two counties, three educational institutions, four joint powers, two watershed districts, one non-profit, and 11 soil and water conservation districts.

In the Red River Basin, programs like River of Dreams, a canoe launch program operated by the International Water Institute, are educating students about watersheds. Through Clean Water funding, staff from the institute visited 55 classrooms. In 2020, the Red River Explorers paddling program sponsored eight paddle outings with more than 60 students participating. The 25th Annual River Watch Forum was intended to be an in-person celebration. Due to COVID guidelines, the forum was held virtually with posted videos viewed more than 2,400 times. Additionally, the spring canoe release through River of Dreams was postponed until fall of 2020. Some participating schools launched as a class while others encouraged students to launch individually. A total of 381 canoes were launched.

Volunteers through the Citizen Stream and Lake Monitoring Programs provide data on more than 1,500 lake and stream locations across Minnesota. These long-term networks have allowed the state to track trends and assess water quality.

Minnesotans benefit from many other local and volunteer monitoring efforts across the state. This interest in water resources has provided information to inform local action and engagement.

Learn more

- Clean Water Fund
  www.legacy.leg.mn/funds/clean-water-fund
- Learn when MPCA will be monitoring your watershed at Watershed approach to restoring and protecting water quality
  www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-qualit)
- Surface water assessment grants www.pca.state.mn.us/water/surface-water-assessment-grants
- Watershed pollutant load monitoring grants
  www.pca.state.mn.us/wplmn/overview

Status	Trend	Description
●	→	As of 2021; all programs are meeting participatory goals.

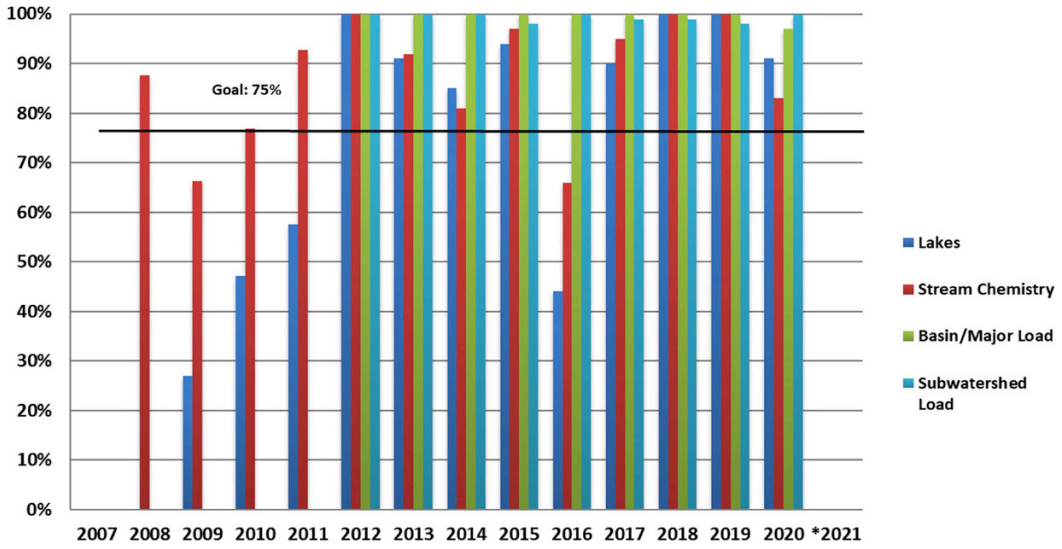


Figure 12. Percent of watershed chemistry monitoring performed by local partners.

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 Roadmap. 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 Minnesota 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. See BWSR Clean Water Fund Stories site for more information.

The Minnesota 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. The MAWQCP brings together producers with local soil and water conservation district staff and agronomy professionals to address the risks to water quality based on a whole-farm assessment. 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. Certified producers may use their status to promote their business as protective of water quality, and producers interested in becoming certified also receive priority status for technical and financial assistance. Importantly, independent analysis from Minnesota State Agricultural Centers of Excellence shows MAWQCP-certified farms also average 20% higher net profit than non-certified farms.

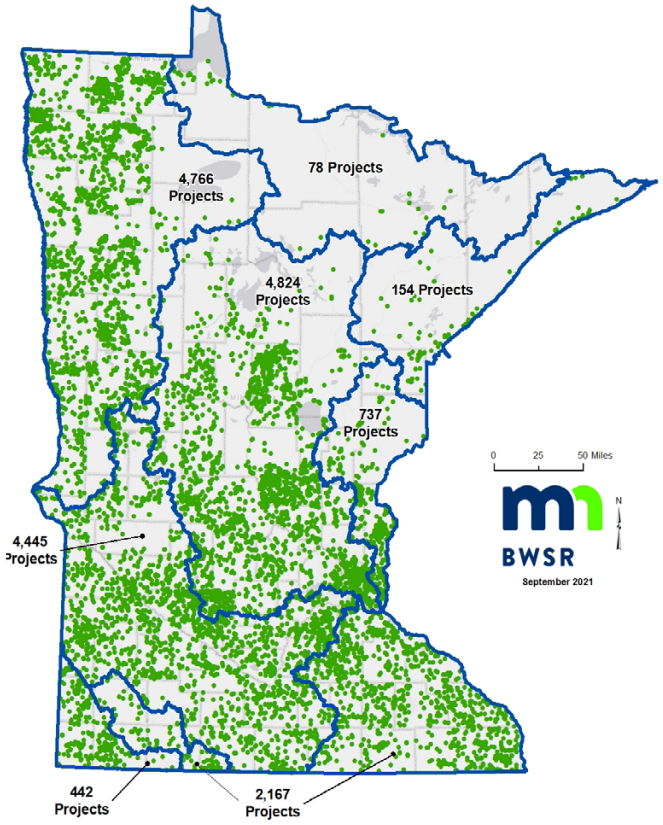


Figure 13. Clean Water Fund projects 2010-2021 (projects by major basin).

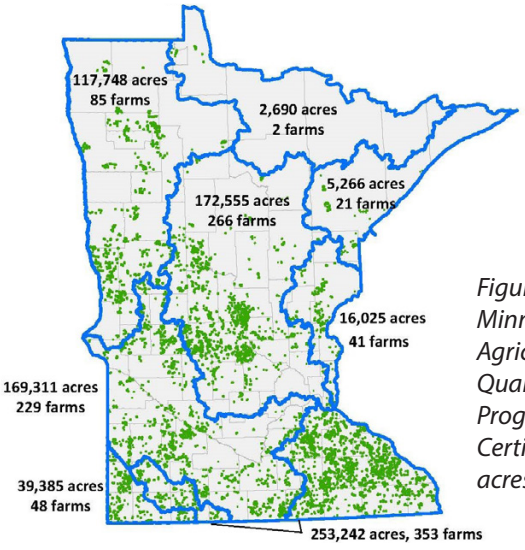


Figure 14. Minnesota Agriculture Water Quality Certification Program Certified farms & acres, FY14-21

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. However, funding is not keeping pace with demand.

From 2010 to 2021 the Clean Water Fund has:

- Funded more than 3,631 grants to protect and restore Minnesota water resources.
- Issued more than 2,087 loans to prevent nonpoint source water pollution or solve existing water quality problems.
- Secured more than 778 easements that will permanently protect approximately 17,034 acres along riparian corridors and within well head protection areas. The Clean Water Fund enabled BWSR to leverage additional funds to provided 5,473 additional acres of protection for a total of 22,507 acres.
- Repaired 788 imminent health threat subsurface sewage treatment systems.

The MAWQCP has awarded more than 350 supplemental grants directly to producers to implement conservation practices, totaling over $1.4 million. An additional $12 million in federal funding has been leveraged for conservation implementation grants through the USDA NRCS Regional Conservation Partnership Program.

- 790,000 acres and 1,100 farms have been Water Quality Certified through the MAWQCP. These certifications have added more than 2,200 new conservation practices to the landscape.

In total, more than 17,613 best management and conservation practices have been installed through BWSR grant programs, resulting in a reduction of about 271,237 pounds of phosphorus and 264,665 tons of sediment across the state.

FY 2010-2021 BWSR Grant Funded Project Outcomes

Major Basin	Number of BMPs	Sediment tons/year	Phosphorus pounds/year
Lake Superior	154	2,686	2,023
Lower Mississippi	2,167	32,875	40,980
Minnesota	4,445	53,732	84,663
St. Croix	737	4,344	6,978
Upper Mississippi	4,824	59,651	46,433
Red River	4,766	95,731	75,811
Rainy River	78	766	941
Missouri	442	14,880	13,408
Totals	**17,613**	**264,665**	**271,237**

Learn more

- Clean Water Fund www.legacy.leg.mn/funds/clean-water-fund
- BWSR Clean Water Fund Stories bwsr.state.mn.us/clean-water-fund-stories
- Agriculture Best Management Practices (AgBMP) Loan Program www.mda.state.mn.us/agbmploan
- Minnesota Agricultural Water Quality Certification Program www.MyLandMyLegacy.com

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 significantly greater than available funds.

Connection with Minnesota's Clean Water Roadmap

Goals: An 8% increase in the percentage of lakes with good water quality, and a 7% 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.

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, phosphorus discharge limits, and Water Quality Based Effluent Limits (WQBEL). These reductions are in addition to the major water quality benefits already achieved by municipalities through ongoing investments to replace aging wastewater infrastructure.

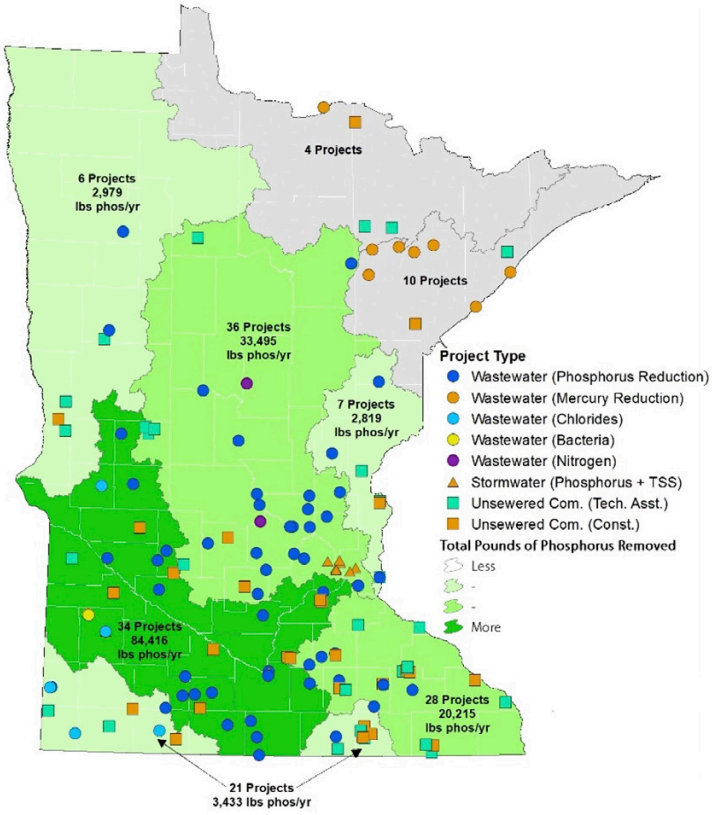


Figure 15. Municipal infrastructure projects by major basin, 2010–2021

What are we doing?

Cities are required to implement upgrades to their wastewater and stormwater infrastructure to meet tighter discharge standards and specific water quality protection and restoration goals. Small communities without adequate wastewater treatment are required to fix noncomplying individual sewage treatment systems or install community systems when new individual systems are not feasible.

The Minnesota Public Facilities Authority (PFA) and the Minnesota Pollution Control Agency (MPCA) jointly administer programs that provide grants and loans from Clean Water Funds to help municipalities pay for these infrastructure improvements. These Clean Water Funds 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 146 projects that implement wastewater and stormwater improvements, including:

- 52 wastewater construction projects to reduce phosphorus discharges to 1 milligram per liter or less, resulting in an estimated total phosphorus reduction of over 140,000 pounds per year.
- 10 wastewater construction projects to reduce mercury discharges, resulting in an estimated total reduction of 719 milligrams per year.
- 2 wastewater construction projects that will provide treatment to reduce subsurface nitrogen discharges, resulting in an estimated total reduction of 5,818 pounds per year.
- 5 construction projects to reduce chloride discharge, resulting in an estimated total chloride reduction of 27,751 pounds per year.
- 10 stormwater construction projects that will provide treatment to reduce phosphorus discharges by an estimated 1,528 pounds per year and also result in reducing total suspended solids of 97,949 pounds per year.
- 37 small community technical assistance projects to help small communities evaluate treatment alternatives to address serious water quality and public health problems from non- complying septic systems.

- 32 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, resulting in estimated annual reductions in phosphorus of 4,996 pounds and nitrogen of 2,681 pounds. More than 1,000 non-compliant systems have been fixed so far.

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 being implemented across the state, and Clean Water Funds are vital in helping to finance the required treatment upgrades. Continued appropriations will be needed to meet the increasing municipal demand for funding to improve treatment facilities across Minnesota.

Status	Trend	Description
●	→	Pace of awards is linked to permit cycles, compliance schedules, and available Clean Water Funds. Applications exceed currently available funds.

Learn more:

- Clean Water Fund
  www.legacy.leg.mn/funds/clean-water-fund
- Minnesota Public Facilities Authority
  https://mn.gov/deed/pfa
- Minnesota Pollution Control Agency
  www.pca.state.mn.us

Figure 16. As part of the Ford Motor Assembly Plant redevelopment, the City of Saint Paul used Clean Water Funds to create a stormwater treatment system as part of a central water feature that filters stormwater runoff from more than 60 acres and removes 75% of phosphorus and 94% of total suspended solids (TSS) prior to discharging into the Mississippi River. This innovative biofiltration project, going above and beyond redevelopment standards, will clean 64 million gallons annually, preventing an estimated 145 pounds of phosphorus and over 55,000 pounds of total suspended solids from reaching the river while creating an amenity surrounded by green space that will provide multiple types of recreational opportunities for the community.

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 and assess the resulting monitoring information to develop restoration and protection plans, and assess progress toward water quality goals.

Figure 17. MPCA staff sample streams and lakes across Minnesota to determine if recreation and aquatic life are supported.

What progress has been made?

As of January 2020, all 80 watersheds have been assessed. As monitoring and assessment continues across the state, the focus is on measuring progress. The assessment results are located on the MPCA's Minnesota Watershed webpage at www.pca.state.mn.us/water/watersheds.

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.

Minnesota is working to increase the number of lakes meeting acceptable recreation values and the number of rivers and streams meeting their potential for a healthy fish community by 8% and 7% respectively. These goals were developed as a part of the Clean Water Fund Roadmap. This projects the estimated improvement anticipated with the funding made available for targeted implementation over the course of the Clean Water Fund.

While monitoring alone does not yield changes in environmental condition, it does provide the information necessary to target protection and restoration activities in the watershed. It also allows for progress to be measured, as practices are implemented (improvements) or as more land is developed (degradation).

Completion of the first cycle of monitoring resulted in healthy fish communities at 60% of the stations visited. As work is completed to improve conditions

on the landscape, the goal is to have 67% healthy fish communities at the stations visited during the span of the Clean Water Fund. Due to COVID-19, fish sampling was suspended in 2020. The surveys were completed in 2021 and the data is not yet available. Similarly, work to improve conditions in lakes across Minnesota is expected to yield 70% of lakes supporting recreation activities.

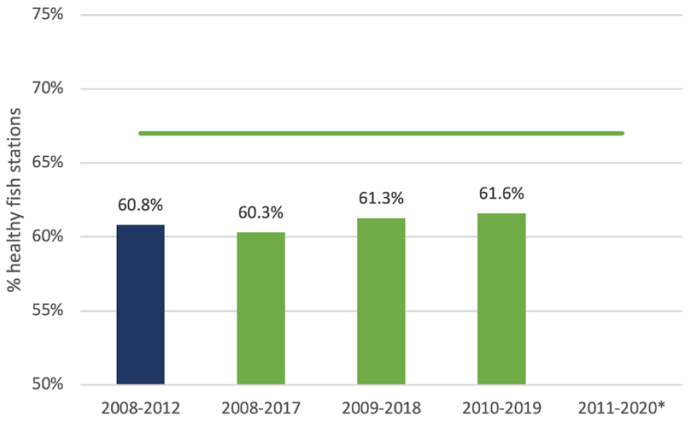


Figure 18. Percent of fish stations that are healthy

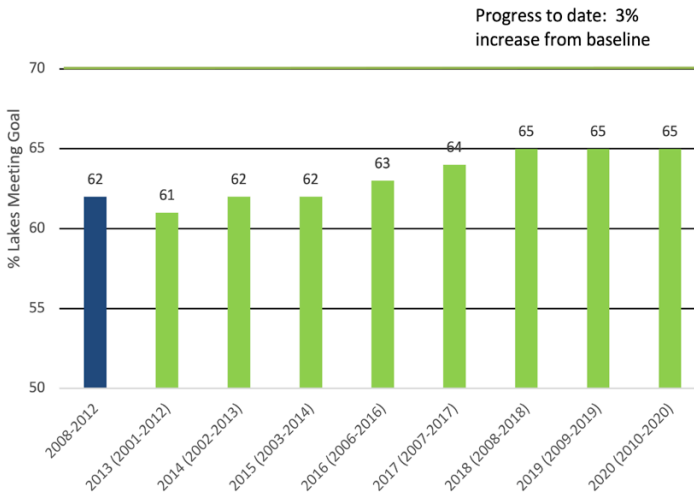
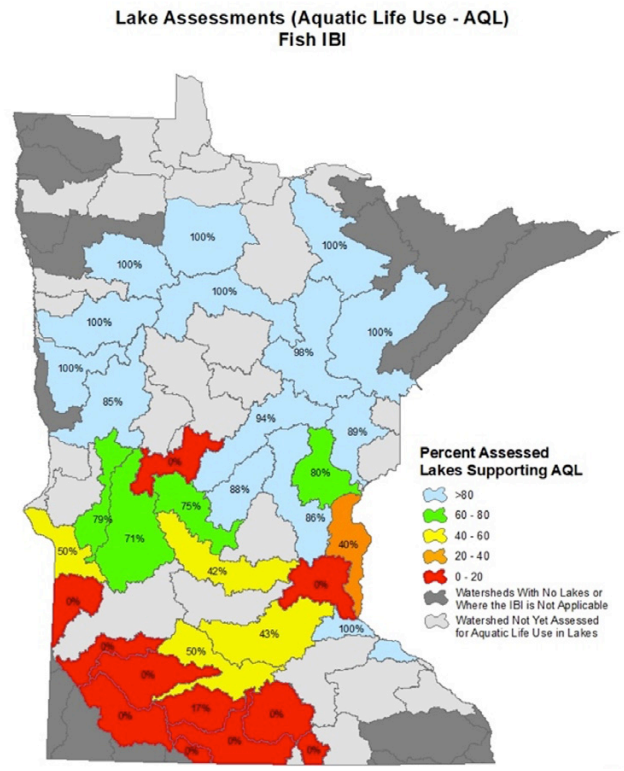


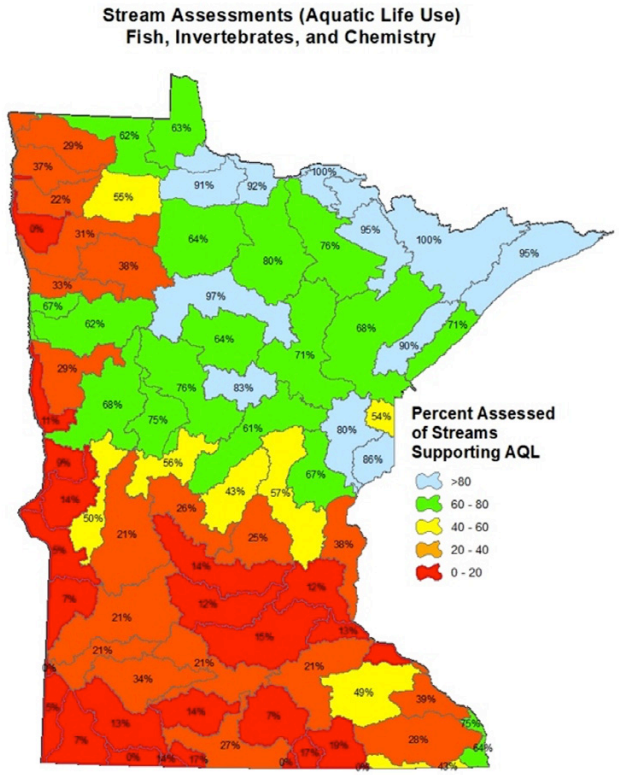
Figure 19. Percent of lakes meeting goal for recreation activities

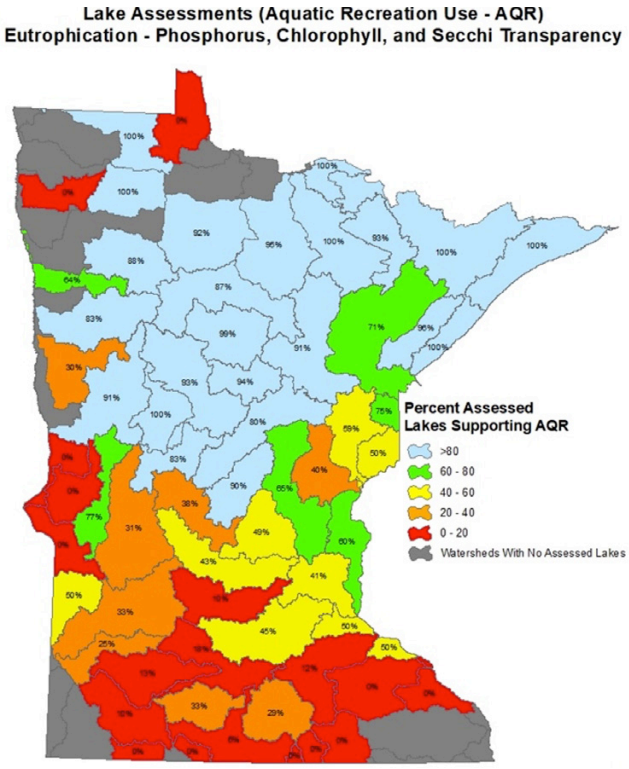
Learn more

- Clean Water Fund
  www.legacy.leg.mn/funds/clean-water-fund
- Learn when MPCA will be monitoring your watershed at Watershed approach to restoring and protecting water quality
  www.pca.state.mn.us/water/watershed-approach-restoring-and-protecting-water-quality
- Search for water quality information on specific lakes at streams at Surface water data
  www.pca.state.mn.us/surface-water-data

Status	Trend	Description
Stream aquatic life ▲	NEI	Water quality varies greatly by region. In general, good water quality remains where land is intact; where considerable alteration has occurred, water quality is poor.
Stream swimming ▲	NEI	Water quality varies greatly by region. In general, good water quality remains where land is intact; where considerable alteration has occurred, water quality is poor.
Lake swimming ▲	NEI	Water quality varies greatly by region. In general, good water quality remains where land is intact; where considerable alteration has occurred, water quality is poor.







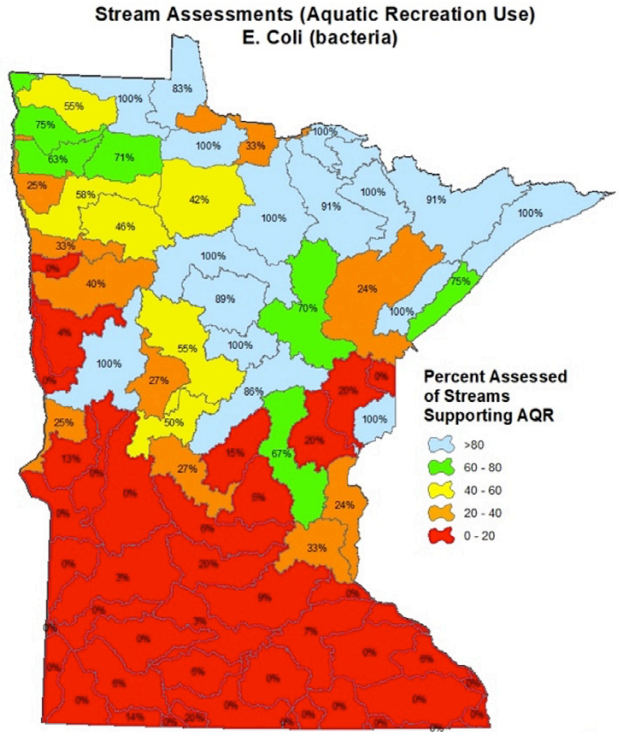


Figure 20. Streams are monitored for water chemistry, fish, and aquatic insects to determine if a stream has healthy aquatic ecosystems. Water monitoring information is also evaluated to determine if lakes and streams are suitable for swimming and other water recreation, and to determine whether consumption 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.

Rivers and streams

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

Phosphorus, nitrate, suspended solids, chloride, 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 fish populations and aquatic ecosystems.

The pesticide data will focus on the five pesticides designated as "surface water pesticides of concern" by the Minnesota Department of Agriculture (MDA), including the herbicides acetochlor and atrazine, and the insecticides chlorpyrifos, clothianidin and imidacloprid. Clothianidin and imidacloprid are neonicotinoid insecticides that were designated as "surface water pesticides of concern" in 2020. The MDA analyzed for 178 different pesticide compounds, with many compounds not detected at all and others detected infrequently.

Acetochlor, atrazine, and chlorpyrifos have MPCA water quality standards available. Currently, there is one river with an acetochlor impairment, and one lake and 12 rivers with a chlorpyrifos impairment. There are currently no atrazine impairments. The MPCA does not have water quality standards available for clothianidin and imidacloprid. To evaluate these compounds, the MDA used the recently updated USEPA chronic aquatic invertebrate benchmarks. These updated benchmarks were significantly lower than previous benchmarks. MPCA water quality standards are needed for the determination of impaired waters.

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.

Minnesota water quality trends

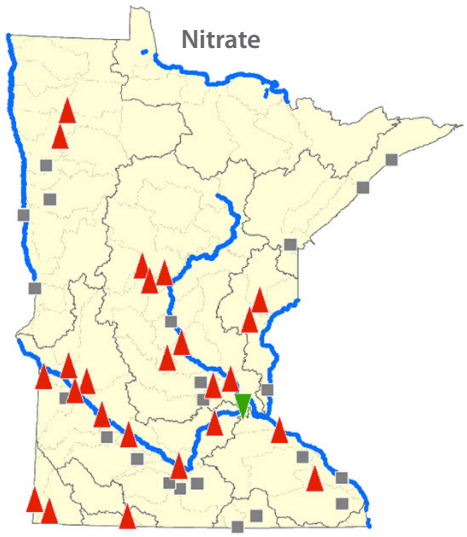


Figure 21. Nitrate trends are generally increasing throughout the state.

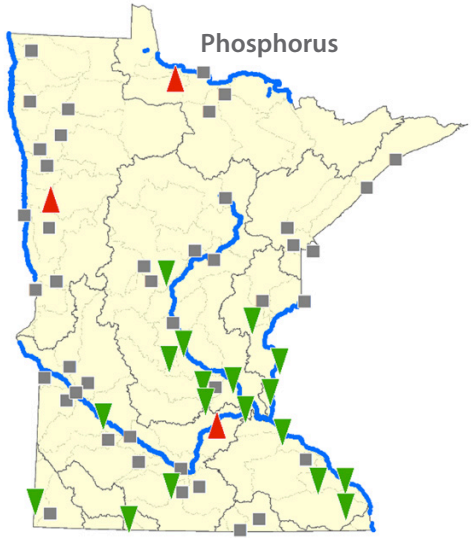


Figure 22. Phosphorus trends are generally decreasing across the state, especially in central and southern MN.

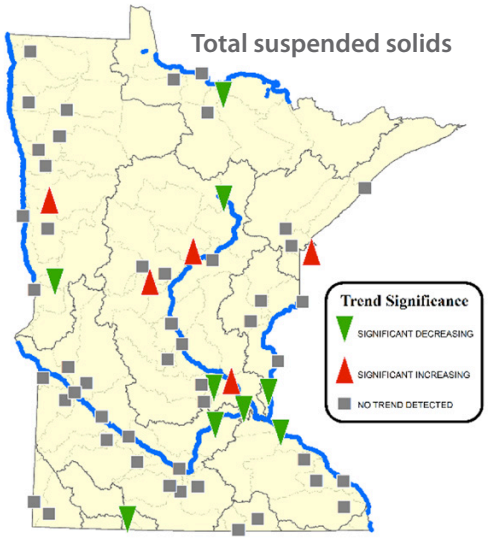


Figure 23. There are few total suspended solids concentration trends detected across the state, but major rivers in the metro area are generally decreasing.

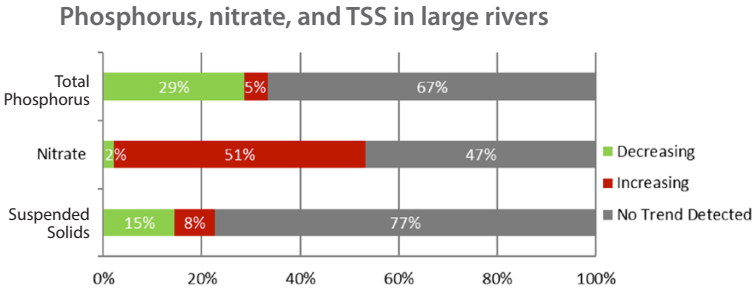


Figure 24. Where approximately 10 years of streamflow and water quality data are available, phosphorus and total suspended solids concentrations in Minnesota's larger rivers are generally decreasing or staying the same, while nitrate concentrations are staying the same or increasing.

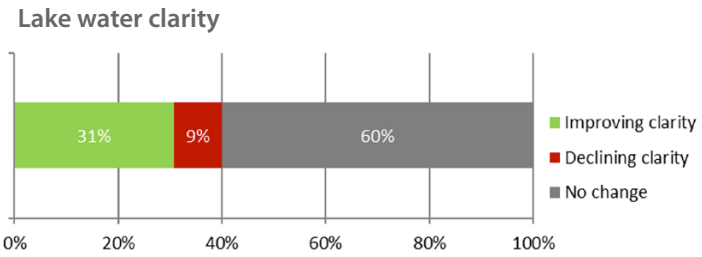


Figure 25. Trends in lake water clarity between 1973 and 2020. While water clarity, in general, is poorer in southern Minnesota, increasing and decreasing lake clarity trends are fairly evenly scattered through north and south-central Minnesota

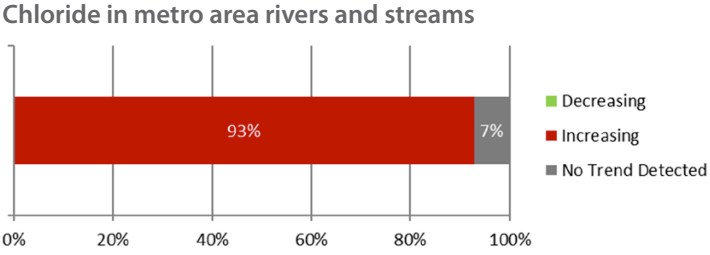


Figure 26. Among 28 rivers and streams in the Twin Cities metro area, including the Mississippi, Minnesota, and St. Croix Rivers, almost all are seeing a long-term increasing concentration trend in chloride.

The following activities are key highlights:

- The MPCA's Watershed Pollutant Load Monitoring Network began in 2008 to understand long-term trends in water quality concentration and load around the state and currently includes 195 sites.
- The Minnesota Department of Agriculture conducts pesticide monitoring at approximately 60 agricultural and urban river and stream sites each year. Although low levels of some pesticides are detected frequently in some waterbodies, exceedances of standards are rare.

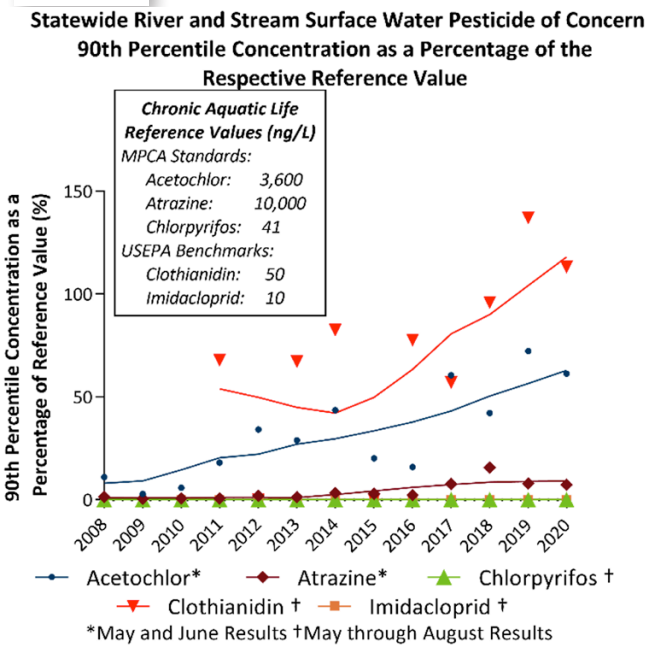


Figure 27. Long-term pesticide monitoring is needed to assess concentrations relative to water quality reference values due to variability in climate, pesticide use, and agronomic factors. The MDA is presenting the 90th percentile concentration as a percentage of the applicable MPCA standard or USEPA benchmark to allow for comparison amongst each "surface water pesticide of concern". Clothianidin has the highest 90th percentile concentration relative to the reference value of all pesticides monitored in rivers. In recent years, the acetochlor 90th percentile concentration has been above 50% of the standard. Chlorpyrifos and imidacloprid have low detection frequencies (below 10%), however, both compounds are detected above their reference value each year. Most atrazine detections are well below their water quality standard.

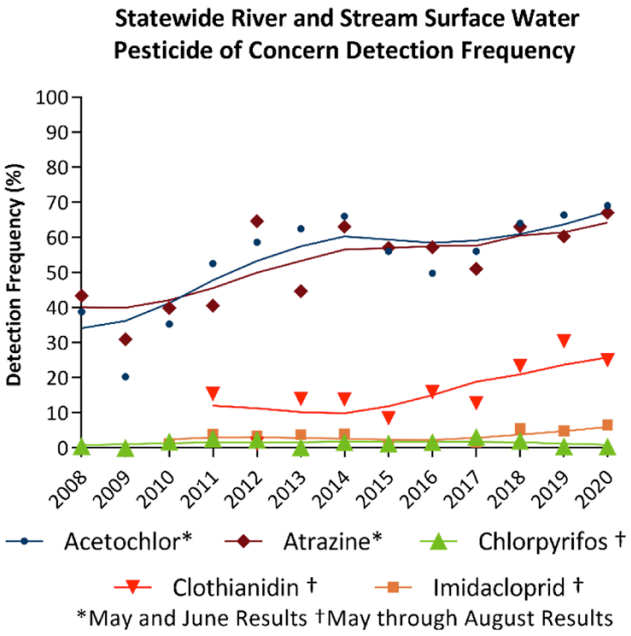


Figure 28. Long-term pesticide monitoring has allowed the MDA to assess detection frequency trends over time. The two herbicides, acetochlor and atrazine, have been detected more frequently than the three insecticide "surface water pesticides of concern".

- Metropolitan Council monitors and analyzes water quality within the seven-county metropolitan area on lakes, river segments, and area streams. In 2021, the council completed an assessment of chloride in metro area streams, examining concentrations, loads, and long-term trends.

- Volunteers in the Citizen Lake and Stream Monitoring programs have collected lake and stream water clarity information for decades. These volunteer programs are vital in gathering data for long-term trend analyses.

- 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 watershed monitoring began in 2018 and will provide information to measure progress.

- The MPCA participates 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 (more than 20 years) against the short-term trend (five to 15 years) for a given lake or stream.

Learn more

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 Clean Water Fund (www.legacy.leg.mn/funds/clean-water-fund).

Status	Trend	Description
Lake clarity	NEI	There are improving trends in lake water clarity in more lakes than not.
Sediment in large rivers	NEI	There are more improving trends than declining trends in total suspended solids.
Nitrate in large rivers	↘	Nitrate concentrations are increasing in major rivers.
Phosphorus in large rivers	NEI	There are more improving trends than declining trends in phosphorus.
Pesticides in streams	NEI	Detections in streams vary greatly as a result of hydrologic and agronomic conditions; exceedances of pesticide water quality standards are rare. Some "surface water pesticides of concern" are showing increasing detection frequency and concentrations.
Pesticides in lakes	NEI	With the exception of detecting chlorpyrifos in two lakes, pesticide detections have been low relative to water quality reference values and generally stable since 2007.
Chloride in streams and rivers	↘	Concentrations are increasing in almost all metro area rivers and streams.

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).

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 1992. Since 2002, the agency has delisted 66 impaired lakes and river segments because they are now meeting water quality standards due to corrective actions.

For example, the south branch of the Buffalo River near Barnesville is clearing up, thanks to work of several organizations in the area. The Buffalo-Red River Watershed District worked with the Wilkin and West Otter Tail county soil and water conservations districts, and the Minnesota Department of Natural Resources to implement a number of projects that reduced sediment in the stream. The projects included expanding buffer strips, restoring prairies and wetlands, changing drainage practices, and restoring a trout stream. Sediment levels in the stream are now low enough in the stream to meet water quality standards. The MPCA plans to remove that impairment from the 2022 list.

Many other waters are improving

In most cases, the 66 success stories are the result of several years of diligent efforts at the local level both prior to and with Clean Water Funds.

Though not ready for delisting yet, many more lakes and streams are making restoration progress. Statewide, many 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.

Learn more

- Clean Water Fund
  www.legacy.leg.mn/funds/clean-water-fund
- Find your watershed and restoration projects at Watersheds
  www.pca.state.mn.us/water/watersheds
- Minnesota's Impaired Waters List
  www.pca.state. mn.us/water/minnesotas-impaired-waters-list
- Learn about delistings and recent success stories
  www.pca.state.mn.us/water/impaired-waters-delisting-decisions

Figure 29. Local organizations restored Lawndale Creek's naturally meandering channel to reduce erosion and improve habitat in the trout stream in the Buffalo River Watershed.

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) and Minnesota Department of Health (MDH) select sites, with input from DNR, where samples should be collected, with the Minnesota Department of Agriculture (MDA) providing laboratory analysis of the samples.

Decades of monitoring show that:

- Most fish contain some mercury
- The average mercury level generally increases from south to north in Minnesota
- Panfish have lower mercury levels than top predator fish

This monitoring 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. The trend analysis initially focused on 1982 to the present, and has been reported 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 , 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 33) is the same as reported since 2018, because the trend is updated every five years and thus has not been updated yet. Data from lakes starting with 1990 as the baseline year show an upward trend in average mercury concentration. The increase, 0.37% per year on average, is small but statistically significant from zero slope. 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 considered impaired. The standard protects humans for consumption of one meal per week of fish caught in Minnesota.

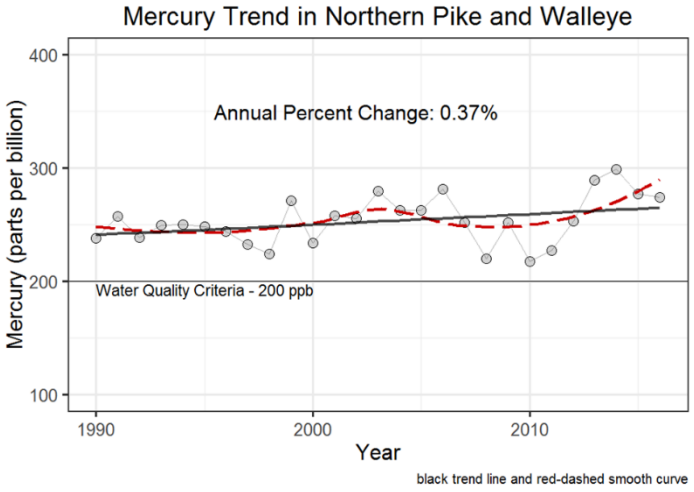
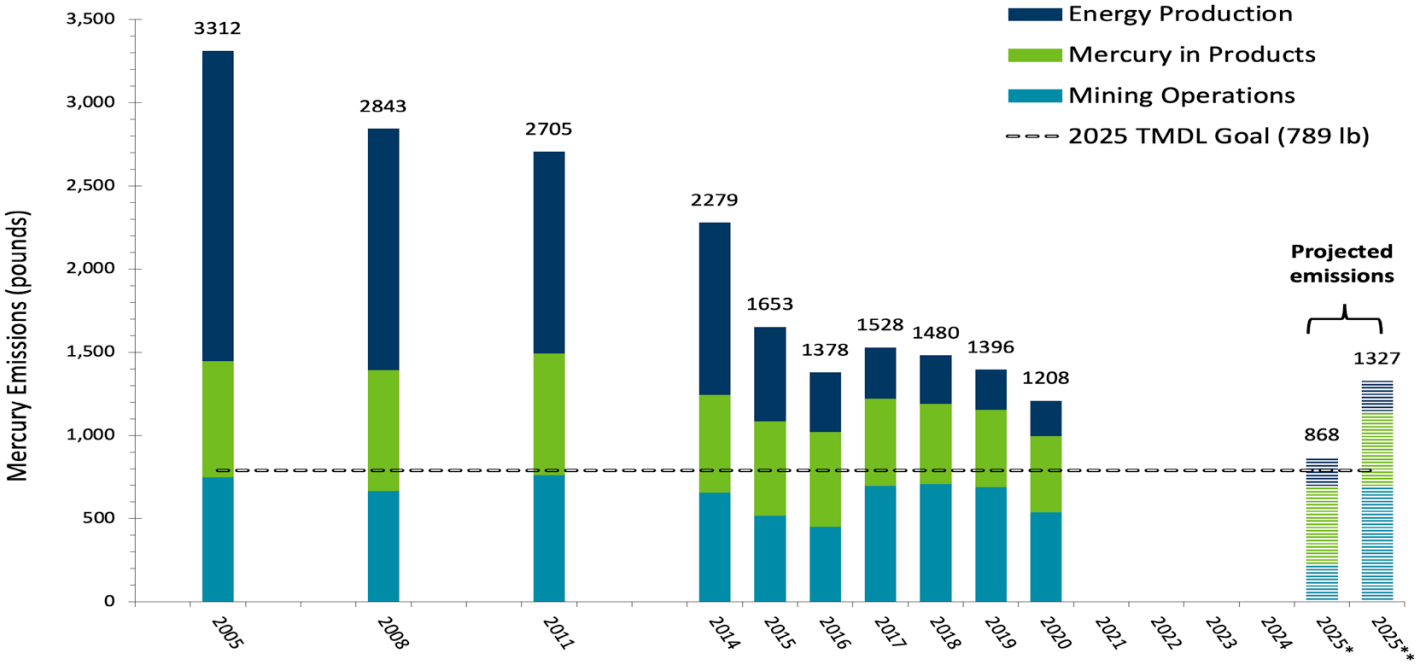


Figure 30. Mercury trend in northern pike and walleye

The fish-mercury trend is not tracking the trend in mercury emissions. Although there have been substantial decreases in mercury emissions in Minnesota (see figure 34 below), the United States, and Europe, the estimated global mercury emissions between 2010 and 2015 increased 22%. Many monitoring studies have reported increasing mercury levels in fish and wildlife, especially at higher latitudes. The increase has been most commonly attributed to climatic changes in temperature and precipitation leading to increasing availability of mercury to food webs.

To achieve the necessary reductions of mercury in the fish, Minnesota's Statewide Mercury TMDL established a goal of a 93% reduction in mercury input from all human sources, both those inside and outside Minnesota's borders. Minnesota is implementing the TMDL to achieve the goal within the state by 2025. However, mercury pollution from outside the state still impacts fish and waterbodies in Minnesota, and reductions outside of Minnesota remain important. While the baseline year for Minnesota's Statewide Mercury TMDL is 1990, the year 2005 is used as the baseline year in the Implementation Plan for the TMDL.

In order to apply Minnesota's reduction goals to national and regional emissions, the MPCA used 2005 as a baseline in its calculation due to the poorer quality and availability of emissions data for 1990. Within the TMDL implementation plan the final goal of 789 pounds is a 76% reduction from the 2005 baseline. There is also an interim 2018 goal of 1,464 pounds, a 56% (average) reduction from the 2005 baseline. These percentages (56% and 76% respectively) were applied to the 2005 regional and national emissions estimates to develop comparable regional and national goals. Minnesota met its 2018 reduction goals, but more work is needed to meet the 2025 goal. Regional/national mercury emission reductions have also surpassed the interim 2018 goal and nearly meet the 2025 goal already. Regionally, meaning the states of Minnesota, Michigan, Wisconsin, North Dakota, South Dakota, and Iowa, there has been a 74% reduction from the 2005 baseline (22,170 pounds in 2005 compared to 5,715 pounds in 2017). Nationally, there has been a 71% reduction from the 2005 baseline (225,491 pounds in 2005 compared to 65,668 pounds in 2017).



* This projection is based on the ferrous mining/processing industry in northern MN meeting the required 72% reduction specified in Minn. R. 7007.0502.
** This projection is based on the ferrous mining/processing industry's proposed reductions in each mercury reduction plan applied to the baseline emissions as calculated by MPCA.

Figure 31. Mercury emissions from Minnesota sources; 2025 emission projections are based on measured and calculated inventories in previous years and the emission estimates contained in the mercury reduction plans submitted by the ferrous mining/processing facilities in northern Minnesota.

The Minamata Convention, entered into force in July 2017, provides the foundation for reducing mercury emissions 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 85%.

To reach the 93% reduction goal, air emissions of mercury from all sources in Minnesota must be reduced to 789 pounds per year (Figure 34).

Learn more

- Clean Water Fund (www.legacy.leg.mn/funds/clean-water-fund)
- Mercury Research (www.pca.state.mn.us/water/mercury-research)
- Choose Which Fish to Eat (www.health.state.mn.us/communities/environment/fish/eating/)
- LakeFinder (www.dnr.state.mn.us/lakefind/)
- Global Mercury Assessment 2018 (www.unenvironment.org/resources/publication/global-mercury-assessment-2018)

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. Emissions from mercury use in various products saw a decrease in emissions for the 2017 emission inventory, but it is too early to determine if this is a downward trend or simply variability between years. Conversely, emissions from the mining sector have risen by roughly 270 pounds as a result of an overall production increase across the industry between 2016 and 2018. To meet Minnesota's 2025 emissions goal, significant reduction of mercury emission from the mining sector and 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.

What are we doing?

Regulatory policies implemented over the past 17+ years (see figure 33) 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 Funds have 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, almost $52 million in Clean Water Fund grants have helped finance 52 municipal wastewater treatment upgrades to meet required phosphorus reductions. These grants leveraged an additional $108 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.

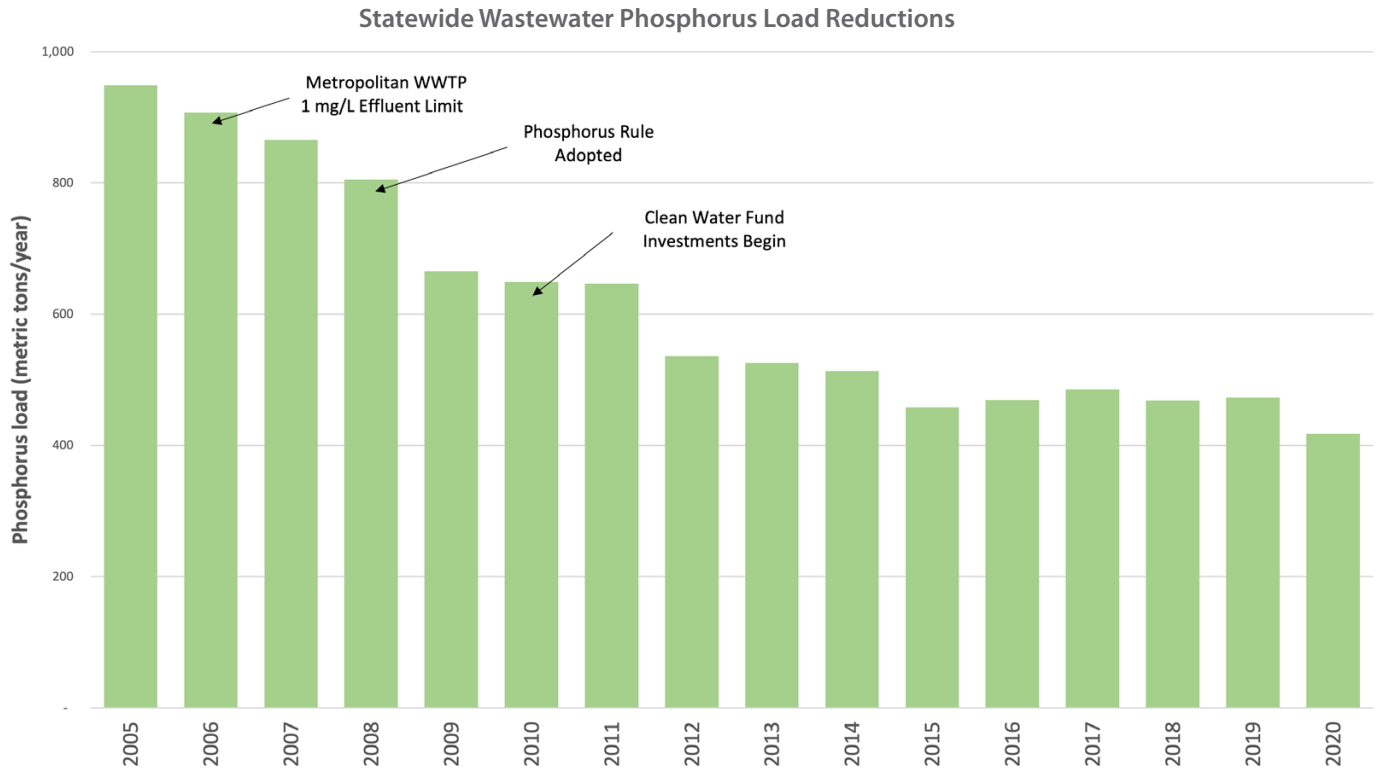


Figure 32. Reported statewide effluent phosphorus loads from wastewater sources since the year 2005. The reductions in phosphorus discharged to Minnesota waters reflect the cumulative effect of permitting policies, implementation of Total Maximum Daily Loads (TMDLs), Clean Water Fund Investments, and local efforts and investments for the protection and restoration of Minnesota's water resources.

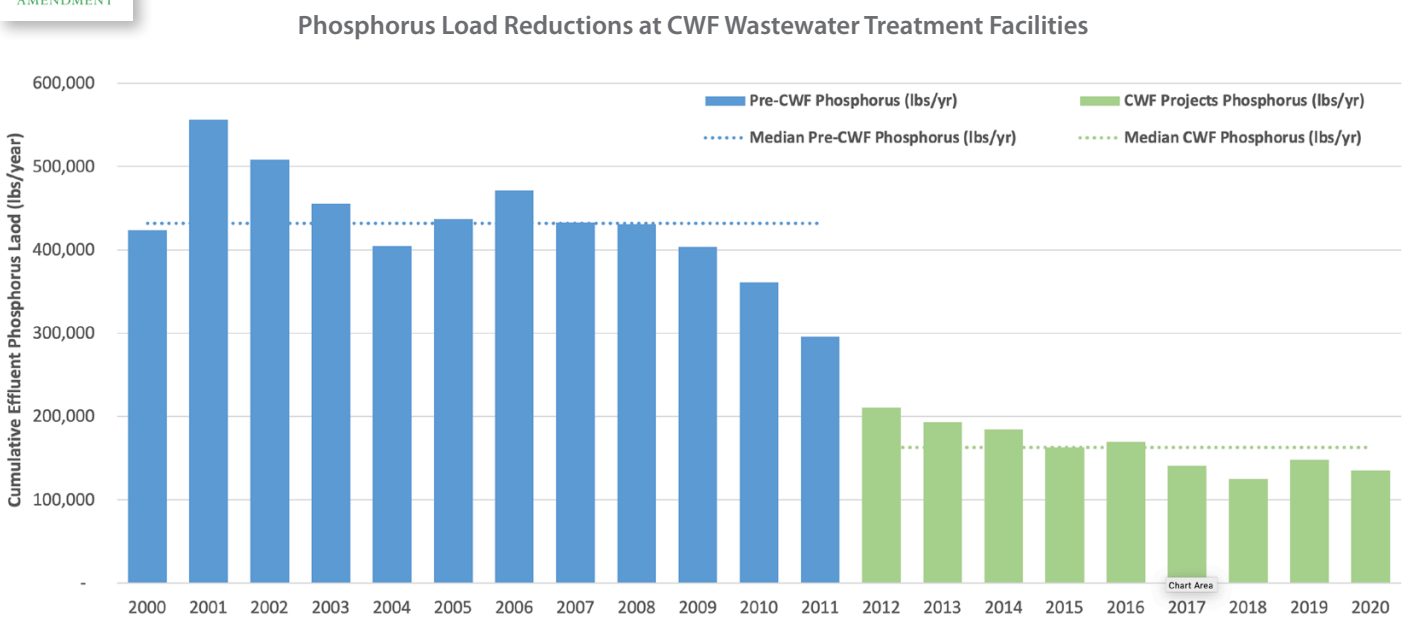


Figure 33. Phosphorus load reductions at Clean Water Funded wastewater treatment facilities

What progress has been made?

Over the past 10 years, municipal wastewater phosphorus discharges statewide have been reduced by 37% 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. Continued implementation of river nutrient standards is expected to result in further reductions in wastewater phosphorus loads in coming years.

Fifty-two of those CWF awards have funded upgrades, consolidation projects or unsewered area connections affecting 48 wastewater treatment facilities. Figure 37 shows cumulative effluent phosphorus loads discharged by those WWTFs. The blue columns represent phosphorus discharged by that select group of facilities in the years before the first CWF projects came online. The green columns represent phosphorus discharged by that select group of facilities in the years after the first CWF project came online. The dotted lines represent the median cumulative effluent phosphorus load discharged by these facilities during those two respective time periods. The gap between the two dotted lines represents a cumulative effluent phosphorus reduction of 268,777 pounds per year.

Learn more

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

- Clean Water Fund
  www.legacy.leg.mn/funds/clean-water-fund
- Minnesota Public Facilities Authority
  www.mn.gov/deed/pfa
- Minnesota Pollution Control Agency
  www.pca.state.mn.us,

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

Drinking water and groundwater measures

The 13 measures contained on pages 38-69 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
8. Land use in Drinking Water Supply Management Areas

Outcomes

9. Groundwater quality
10. Source water quality for community water supplies
11. Nitrate and arsenic concentrations in new wells
12. Groundwater levels
13. 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 systems 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 and treatment)
- Ensures sustainable water supplies for future generations

What are we doing?

MDH requires source water protection planning for all community and noncommunity water systems that use groundwater, although the level of engagement varies based on their population. Additionally, some systems that use surface water have voluntarily developed Source Water Protection Plans. MDH is expanding the surface water program to provide more support to those systems.

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 approximately 1.2 million acres or 2% of the state's total land area. Within the protection areas, approximately 473,000 acres are vulnerable (at higher risk for contamination).

What progress has been made?

In June 2020, the Source Water Protection Program achieved its strategic goal of engaging all vulnerable community water systems using groundwater in source water protection planning. The program delineated Drinking Water Supply Management Areas for all 500 community water systems in the state with vulnerable wells. An approved Drinking Water Supply Management Area is the first step on the ladder of progressive steps a system can take to protect the land area that supplies water to its source.

Having met its 2020 goal, the Source Water Protection Program has new targets, which are also included in the Clean Water Council Strategic Plan:

- Conduct ongoing source water protection planning and implementation for the state's 500 vulnerable community water systems
- Complete first-generation Source Water Protection Plans for the remaining 420 community water systems by 2025
- Complete revised Source Water Assessments for all 23 surface water systems by 2025

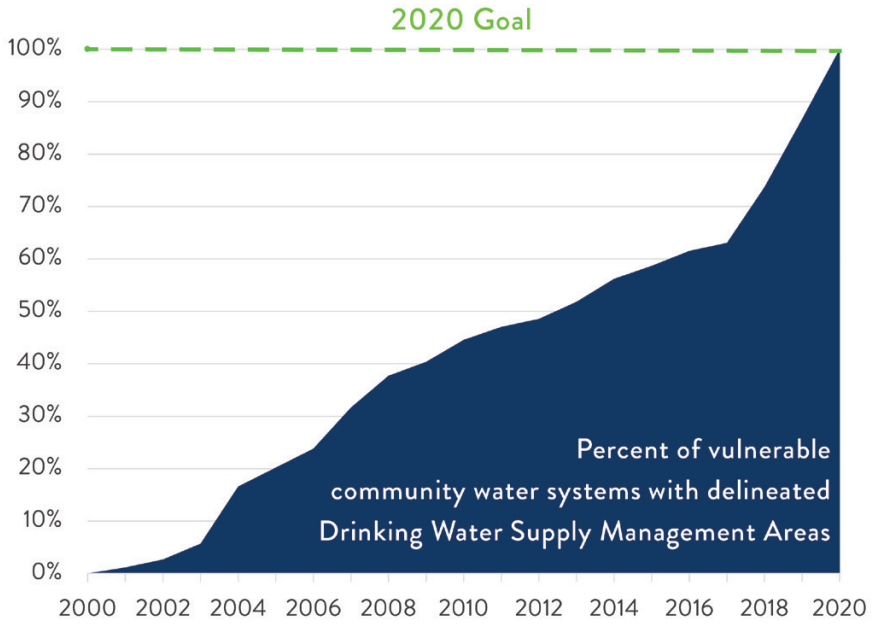


Figure 34. The Source Water Protection Program achieved its strategic goal in 2020.

- Complete source water intake protection planning by 2027
- Complete pilot source water protection planning for 10 non-community water systems with at-risk populations by 2027

Progress toward these strategic goals can be seen in figure 38 below. The Source Water Protection Program has long been engaged in planning for vulnerable and nonvulnerable community water systems using groundwater. Surface water planning is a newer effort and its progress has been hampered by staffing reassignments due to the COVID-19 pandemic. While there are few completed Source Water Assessments and Surface Water Intake Protection Plans, progress is accelerating, as several communities are currently preparing these plans with MDH.

Learn more

- Clean Water Fund www.legacy.leg.mn/funds/clean-water-fund
- Source Water Protection www.health.state.mn.us/communities/environment/water/swp/

Status	Trend	Description
●	↗	On track to meet new planning goals for groundwater and surface water systems.

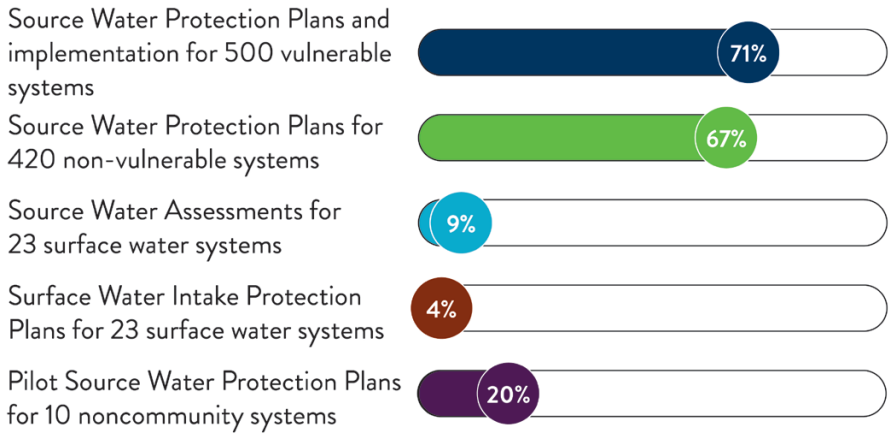


Figure 35. Progress on source water protection planning goals

Source water protection grants

ACTION

Measure: Number of grants awarded for source water protection

Why is this measure important?

People in Minnesota get their drinking water from groundwater, lakes, and rivers. The Minnesota Department of Health (MDH) works with public water systems 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 systems to take action. Prior to the Clean Water Fund, there was no financial assistance for public water systems to implement actions identified in their Source Water Protection Plans.

What are we doing?

MDH administers three types of grants to public water systems: Competitive, implementation, and transient grants. Public water systems are eligible for different grants based on their customer base and whether they have a Source Water Protection Plan.

Figure 36. Number of grants awarded by year

YEAR	# OF GRANTS AWARDED	FUNDS AWARDED
2010	11	$92,000
2011	117	$714,000
2012	70	$421,000
2013	63	$356,000
2014	94	$585,000
2015	74	$563,000
2016	76	$473,000
2017	97	$569,000
2018	103	$701,000
2019	99	$825,000
2020	108	$754,000
2021	112	$902,000
TOTAL	**1,023**	**$6.9 million**

Figure 37. MDH recognized the communities above in 2020 for source water protection efforts (from top): City of Balaton, City of Annandale.

What progress has been made?

MDH continues to work toward its goal of meeting community demand for Source Water Protection Grants. The demand for these grants has grown over the past several years and often exceeds available funding. MDH has leveraged other resources to meet increasing community demand for grants. MDH anticipates the demand will continue to increase with the number of Source Water Protection Plans approved. Since the grants program started in 2010, MDH has awarded $6.9 million.

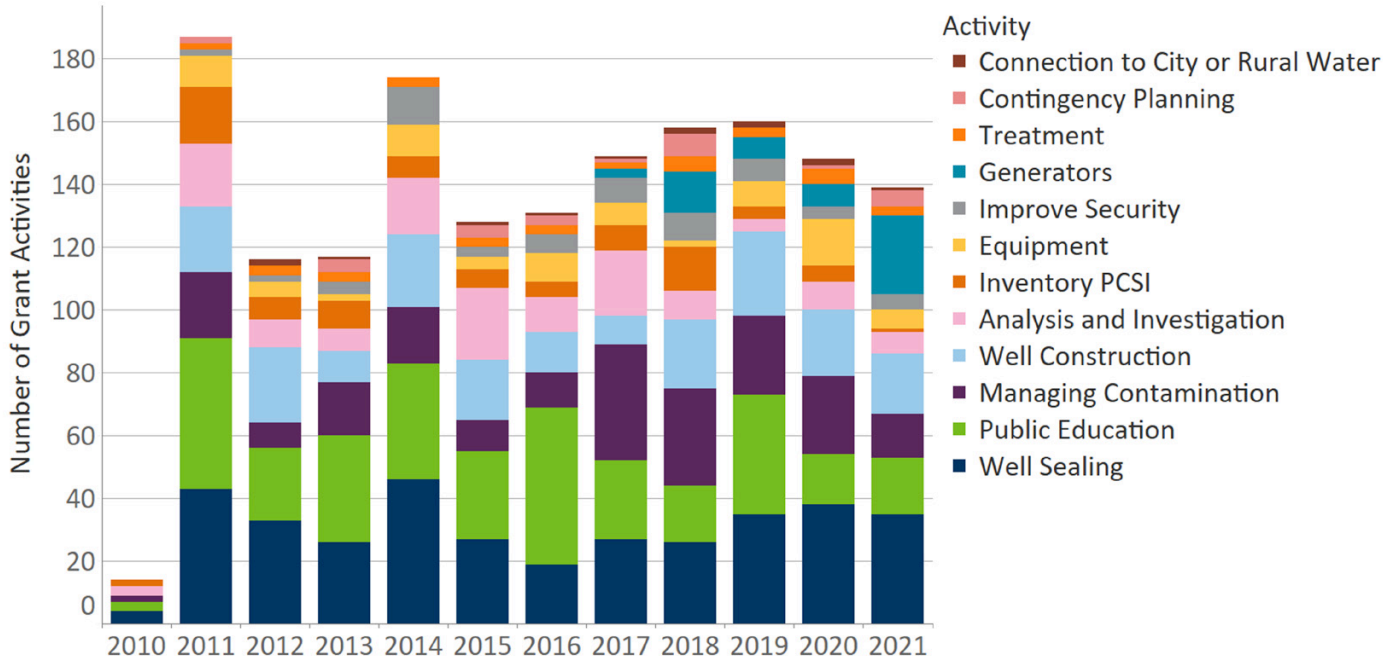


Figure 38. Number of activities funded by Source Water Protection Grants (2010-2021)

Learn more

- About source water protection grants at www.health.state.mn.us/communities/environment/water/cwf/dwpcwf.html
- Grant information for applicants at www.health.state.mn.us/communities/environment/water/swp/grants.html

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

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

Nitrate comes from many sources, including fertilizers, manure, septic systems, landfills, and natural decomposition of organic matter. Nitrate-nitrogen 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-nitrogen is 10 mg/L. Nitrate-nitrogen above this level 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. Southeastern Minnesota is 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 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 elevated nitrate-nitrogen in groundwater. The MDA has worked with more than 50 local partners on nitrate monitoring and reduction projects, a total of 26 in the last two years. In general, the MDA provides technical support, and the local partners provide coordination and contribute knowledge, skills, and expertise about local conditions and 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.

These partnerships continue to grow and offer new opportunities to further the work addressing nitrate in groundwater.

This profile focuses on three current activities — private well testing, research and demonstration at the Rosholt Farm, and a local partnership strengthening regional relationships.

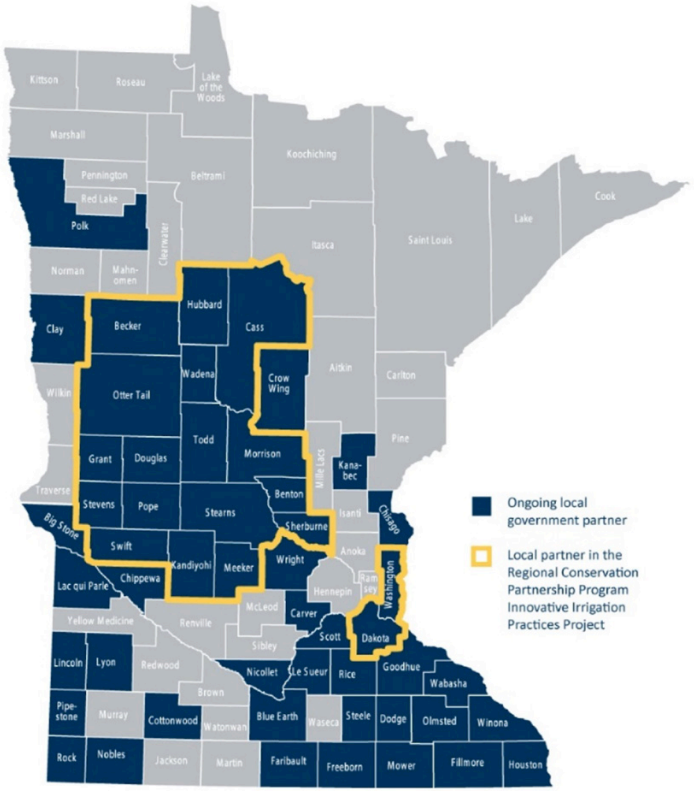


Figure 39. The MDA works with local government partners to address nitrate in groundwater.

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 where the groundwater is

vulnerable to contamination and have significant row crop production (see map included with the Groundwater quality measure). These are the areas prioritized for private well testing.

This work was done in partnership with local governments across the state between 2014 and 2019. Results from all sampled wells in a participating township are summarized and help guide the type of response necessary to address nitrate in groundwater.

Rosholt Farm
The MDA partners with the Pope Soil and Water Conservation District (SWCD) and University of Minnesota (U of M) to support on-farm research, educational outreach, and increase adoption of nitrogen fertilizer best management practices (BMPs) in the Central Sands region of Minnesota.

The Rosholt Farm is dedicated to agricultural research and education that addresses regional issues and agricultural practices that are typical in the area. The farm's coarse-textured soils and need for supplemental irrigation typifies the challenges that many farmers face in this area. The Pope SWCD owns the farm and coordinates day-to-day activities, weekly sampling and analysis of water samples, crop and soil moisture monitoring and management of the irrigation system.

There are currently three studies at the Rosholt Farm supported by Clean Water Funds:

- Evaluation of Four Irrigation Scheduling Methods led by Dr. Vasu Sharma, U of M
- Nitrogen, Cover Crop, and Water Quality Research led by Dr. Fabian Fernandez, U of M
- Variable Irrigation and Nitrogen Research led by Dr. Vasu Sharma, U of M

Local partnership with East Otter Tail SWCD

The MDA began working with East Otter Tail SWCD in 2011. This long-term relationship has strengthened regional partnerships, and continues to raise awareness of local groundwater concerns, provide access to needed weather information, and improve nutrient management education and adoption. Specifically, MDA supports a portion of a position to directly work with farmers and other regional SWCDs to coordinate many programs and assist with implementing the Nitrogen Fertilizer Management Plan and the Groundwater Protection Rule.

What progress has been made?

Township Testing Program
Through 2019, the MDA has sampled private wells in 344 townships in 50 counties. Local partners assisted with program coordination in all but three counties. Sampling was completed in Becker, Benton, Blue Earth, Big Stone, Brown, Carver, Chippewa, Chisago, Clay, Cottonwood, Dakota , Dodge, Douglas, Faribault, Fillmore, Freeborn, Goodhue, Houston, Hubbard, Kandiyohi, Kanabec, Lac Qui Parle, Le Sueur, Lincoln, Lyon, Meeker, Morrison, Mower, Nicollet, Nobles, Olmsted, Otter Tail, Pipestone, Polk, Redwood, Scott, Steel, Swift, Pope, Rice, Rock, Sherburne, Stearns, Todd, Wabasha, Wadena, Washington, Watonwan, Winona, and Wright counties.

While monitoring alone does not yield changes in environmental conditions, it does provide the information necessary to target protection and restoration activities and inform homeowners about the water quality in their wells. Local data are essential when talking about groundwater contamination and promoting BMPs. It is the starting point for all implementation activities.

The results from Township Testing have further defined vulnerable groundwater areas, highlighted nitrate variability, and identified focus areas for implementation projects to reduce nitrate leaching.

Nitrogen and water quality
Rosholt Farm in Pope County is a local "educational hub" for providing technical information to area farmers, crop advisors and agronomists about nitrogen BMPs, new fertilizer recommendations, irrigation frequency and timing, cover crop management, emerging crop production technologies and their water quality impacts. For example, information from previous Clean Water Fund supported work at Rosholt led to the development of new nitrogen rate guidelines for irrigated corn by U of M Extension ("Fertilizing Corn Grown on Irrigated Sandy Soils").

In 2020 and 2021, the Pope SWCD hosted three annual events (field days and workshops) reaching more than 200 participants, including farmers, crop advisers, and other local government partners. One of these three events was held in a virtual format due to COVID-19 restrictions. COVID-19 forced the cancellation of one additional event.

Local partnership strengthens regional relationships

The partnership with East Otter Tail SWCD has built capacity to lead programing in Otter Tail County as well as the larger Central Sands Region of the state.

The highlights listed below will be ongoing in the next biennium.

- **Weather network stations**: Expanded the ag weather network to provide producers with needed weather information to efficiently schedule irrigation water applications and other farm management practices. Thirteen stations are integrated and supported in the North Dakota Ag Weather Network crop modeling, mapping, and air temperature inversion applications.
- **Nutrient management**: Worked with farmers on nutrient management projects to guide education on local best management practices. A dedicated staff manages on-farm trials for the Nutrient Management Initiative.
- **Leveraging funds to remove barrier**: Convened work groups to gain farmer and ag industry input on barriers to adopting new practices. This information is directing future work and has led to additional funding to advance cover crops and irrigation technologies. The large regional partnership (30 partners) was awarded $3.5 million by the USDA Natural Resources Conservation Service (NRCS) Regional Conservation Partnership Program (RCPP), plus additional match by all project partners. Work for this project will begin in 2022.

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

> "Funding through this partnership has helped build relationships with neighboring SWCDs, state agencies, and most importantly the constituents of our districts (farmers and ag industry in particular). The partnership has helped build capacity within our district and neighboring districts by providing staff training and technical resources that may not have been available otherwise." — *Darren Newville, District Manager E Otter Tail SWCD*

Figure 40. Speakers included in the February 2020 Irrigation and Nutrient Management Clinic, organized by the East Otter Lake SWCD. Luke Stuewe (MDA), Dr. Karl Rosen, Dr. Vasu Sharma and Dr. Lindsay Pease (U of M), and Darren Newville (EOT SWCD).

Learn more

- Clean Water Fund
  www.legacy.leg.mn/funds/clean-water-fund
- Township Testing Program
  www.mda.state.mn.us/townshiptesting
- Water Quality and Irrigation Research at Rosholt Farm www.mda.state.mn.us/rosholtfarm
- Local Weather Data and Irrigation Scheduler
  www.eotswcd.org/irrigation-scheduler
- Nutrient Management Initiative
  www.mda.state.mn.us/nmi
- Irrigation Partnerships to Protect Groundwater (RCPP Project)
  agcentric.org/rcpp-precision-irrigation

Contaminants of emerging concern

ACTION

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

Why is this measure important?

Water is especially susceptible to contamination from human activities. Whether it is household products, personal care products, and pharmaceuticals washed down the drain, or chemicals released to the environment through manufacturing, contaminants are found across Minnesota. Monitoring of water sources finds contaminants from products or sources we never suspected in places we never expected, like our lakes, rivers, ground water, and drinking water.

Contaminants of emerging concern (CECs) are chemicals released into the environment, often from consumer products and personal care products, that may not have been previously assessed for risk to human health. Understanding the risk from these types of chemicals when they are present in Minnesota's waters is critical to preventing health effects in people and for mitigation of contamination. The CEC Initiative staff in the Health Risk Assessment unit at the Minnesota Department of Health study CECs in water and develop risk assessments and health-based water guidance values. These values aid state agencies in their work to protect and maintain clean water for all Minnesotans, and to provide context for private well owners and the general public for CEC exposures through water.

The development of water guidance values represents a meaningful indicator of public health protection. Hundreds of CECs have been found in Minnesota waters. The vast majority of these CECs have no health-based water guidance values that allow risk managers and Minnesotans to understand any health risks associated with exposures to these compounds, and whether there is a need for actions to reduce exposures. Without this toxicological and risk assessment information, Minnesotans may not be informed of these new risks. While the federal Safe Drinking Water Act provides major public health protection, no standard for a single chemical has been added for over 20 years. The CEC Initiative can develop Minnesota-specific guidance values in a fraction of the time that it takes a federal program to respond, better protecting public health. Very few states have similar programs.

The need for new guidance is enormous and ongoing as there are tens of thousands of chemicals in commerce and the vast majority have little or no toxicology information publicly available. These chemicals find their way into Minnesota waters and are more frequently being detected there, in part because new analytical capabilities can measure them at very low concentrations. Historically, approximately 70% of all health-based guidance values developed by the CEC Initiative lack federal water guidance values.

What are we doing?

Chemical nominations are accepted on an ongoing basis. An annual workplan is completed based on nominations submitted by stakeholders, including the general public. The nominations are evaluated to determine which chemicals pose the largest threat to Minnesotans based on both toxicological and exposure concerns. Accepting nominations from all stakeholders allows the program to address emerging contaminants that can be specific to Minnesota communities and private well owners.

Staff toxicologists and exposure scientists research chemicals from the workplan with a goal to develop CEC health-based water guidance. Staff calculate levels of a chemical in water that does not pose a risk to human health, even for sensitive populations such as fetuses, infants, pregnant women, and children. We are enhancing the chemical review process to include concerns about health equity and environmental justice to ensure that the guidance is protective of all populations in Minnesota.

What progress has been made?

During Fiscal Years 20-21, COVID-19 was a serious public health threat creating an urgent need for all Minnesota Department of Health staff to assist in the statewide emergency response. Staff from the Health Risk Assessment Unit's CEC Initiative were reassigned from their duties to COVID-related work for nearly half of the biennium. Despite the decreased time available for CEC-related work, a number of full reviews and nomination screenings were completed. Strong toxicological and risk assessment support for communities, private well owners, and the general public affected by water contamination also continued, especially related to poly- and perfluoroalkyl chemicals (PFAS).

Through the FY20-21 biennium, more than 165 contaminants were nominated to the MDH CEC Initiative through a nomination process open to all. Some nominated contaminants were ineligible for CEC review, typically because the nomination did not identify a specific contaminant, or because a different program within the department reviewed it. MDH compiled screening information for 34 new or re-nominated contaminants.

Health-based guidance was developed for six contaminants. MDH also completed re-evaluations of three contaminants with existing health-based guidance values. Re-evaluating existing health-based guidance ensures Minnesota guidance is up to date with the latest risk assessment methodology and includes the most recent available scientific data. Importantly, none of the contaminants that were subject to full review had federal water guidance available.

MDH Health-Based Guidance Values FY 20-21
micrograms per liter (µg/L) in water

Contaminant	MDH Guidance
Benzophenone *UV Inhibitor*	100
1H-Benzotriazole *anticorrosive*	20
5-methyl-Benzotriazole *anticorrosive*	20
Biphenyl *industrial chemical*	10
Tolytriazole *anticorrosive*	20
Tris(2-butoxyethyl) phosphate (TBEP) *plasticizer*	30

Figure 42. MDH guidance values for contaminants FY 20-21

Toxicologists and research scientists regularly provide expert technical assistance to risk managers to aid in proper application of health-based guidance values in their work and to the general public to support safer and better choices for chemical use and disposal.

- More than 40 expert technical assists for external partners were completed in FY20-21, including presentations, emails, phone conversations, and technical documents.
- Staff also provided more than 20 technical assists to internal MDH programs dealing with CEC-related concerns.
- Staff regularly attended and presented information at meetings for communities affected by CECs in their drinking water.
- Staff presented novel risk assessment methods to the greater risk assessment and toxicology communities.
- Staff also represented Minnesota in CEC-related state and federal work groups.

A major obstacle in developing 10 full chemical reviews each biennium is lack of publicly available toxicity information. The CEC Initiative is meeting this obstacle head on by partnering with U.S. Environmental Protection Agency (EPA) scientists. MDH is working to identify new tools and nontraditional sources of data to identify and screen chemicals for both toxicity and exposure risk. This is a multi-year project focusing on emerging contaminants that lack available data and/or may not be easily identified through standard risk assessments.

One accomplishment of the CEC Initiative in the last biennium was to partner with other programs within the Environmental Health (EH) Division at MDH to help better understand and communicate health risk from elevated levels of manganese in Minnesota drinking water, especially for formula-fed infants. CEC toxicologists quantified manganese levels in common brands of formula and added that to monitoring results from the Drinking Water Protection Section. Additional study by others in EH provided information on consumer attitudes about drinking water with elevated manganese levels. This collaboration described risk from manganese for Minnesota infants fed formula made with tap water. It resulted in several scientific publications and dozens of different types of technical assistance, ranging from presenting at public meetings to collaborating with partners around the globe.

Learn more

- MDH Contaminants of Emerging Concern (CEC) program information: www.health.state.mn.us/cec.

Status	Trend	Description
●	→	Completed 6 of 10 full reviews plus 3 reevaluations. On track to meet goal of 10 guidance values developed next biennium.

County atlases

ACTION

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

Figure 43. Groundwater sampling for the County Atlas Program

Why is this measure important?

A stable, long-term and reliable source of high quality groundwater is an economic benefit to communities. Approximately 75% of Minnesotans get their water for drinking and other needs from groundwater. County atlases provide detailed information about an area's geology and groundwater that helps communities find reliable water sources and manage them to maintain availability and quality for generations. Without informed water supply planning, groundwater pumping or land-use changes could impact public water quality and availability and degrade surface waters (wetlands, lakes, rivers and unique resources, such as trout streams and fens).

The county atlases are routinely used to make informed decisions related to water, natural resources, and land-use planning. Typical applications include:

- Long-term water supply planning and well construction design
- Wellhead protection planning
- Groundwater modeling
- Identification of valuable natural resources and planning for their use and protection
- Planning for landfills, septic systems, industrial sites, and feedlots
- Emergency response to contaminant releases
- Research and community education

When completed, the county atlases are an economic benefit for a county and communities within the county. This measure tracks the extent to which county atlases are available in Minnesota.

What are we doing?

The Minnesota Geological Survey (MGS) and the Department of Natural Resources (DNR) prepare the county atlases to convey valuable geologic and groundwater information and interpretations to private organizations, agriculture, industry, academia, citizens and government units at all levels, particularly to local governments. MGS focuses on the county geology, and

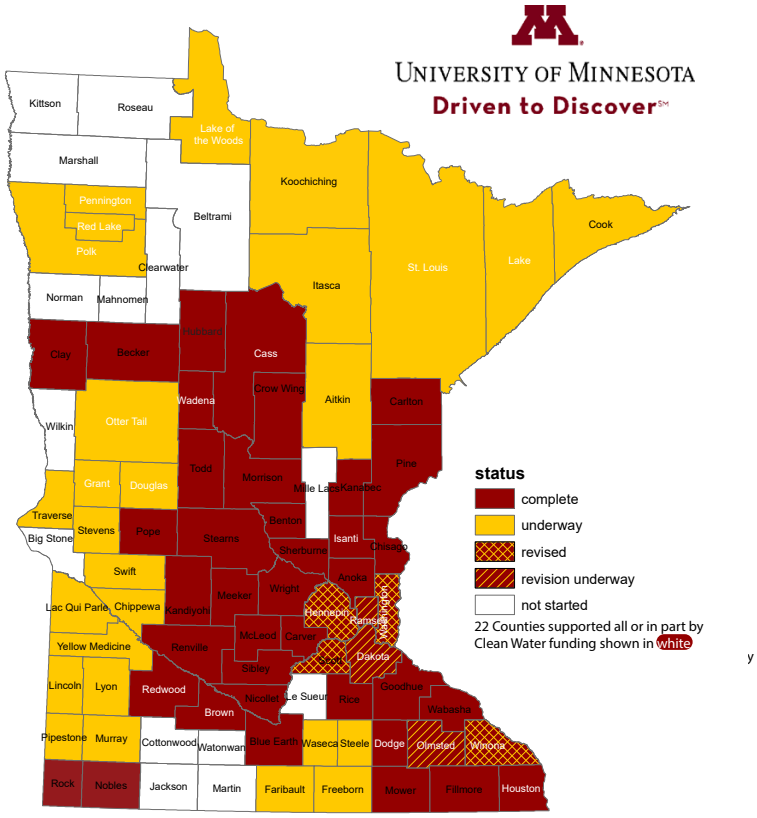


Figure 44. Status of geologic atlases (used with permission from MGS).

DNR focuses on county groundwater resources.

The Clean Water Fund supports enhanced research to improve the quality of county atlases and to accelerate their completion. Local participation is a primary factor in determining which counties are chosen for this work, while groundwater sensitivity, water demand and the size of the population served are also considerations. The counties are asked to provide in-kind services in support of the atlas.

What progress has been made?

In total, MGS County Geologic Atlases are complete or underway for 71 counties and groundwater atlases are complete or underway for 44 counties.

The completion of special high-quality drilling and coring to obtain detailed geologic information was supported in Lincoln, Pipestone, Yellow Medicine and Chippewa counties.

The long-term goal is to complete an atlas (both geologic and groundwater) for every county in Minnesota. Approximately four atlases are being completed each year. The Clean Water Fund supports expanded data collection for atlases, such as the use of sophisticated geological coring.

With Clean Water Fund support, DNR County Groundwater Atlas staff conducted specialty groundwater dye tracing work at McCarthy Beach State Park and YMCA Camp du Nord, as well as public water supply projects in Pequot Lakes and Riverton in support of a Minnesota Department of Health pathogen study to identify the source of biological contaminants in water supply wells. Clean Water Funds also supported specialized dye tracing at locations in southeastern Minnesota to understand the groundwater sources of trout streams, state fish hatcheries and other surface water bodies, and the impact of different land uses on the quality of those water bodies.

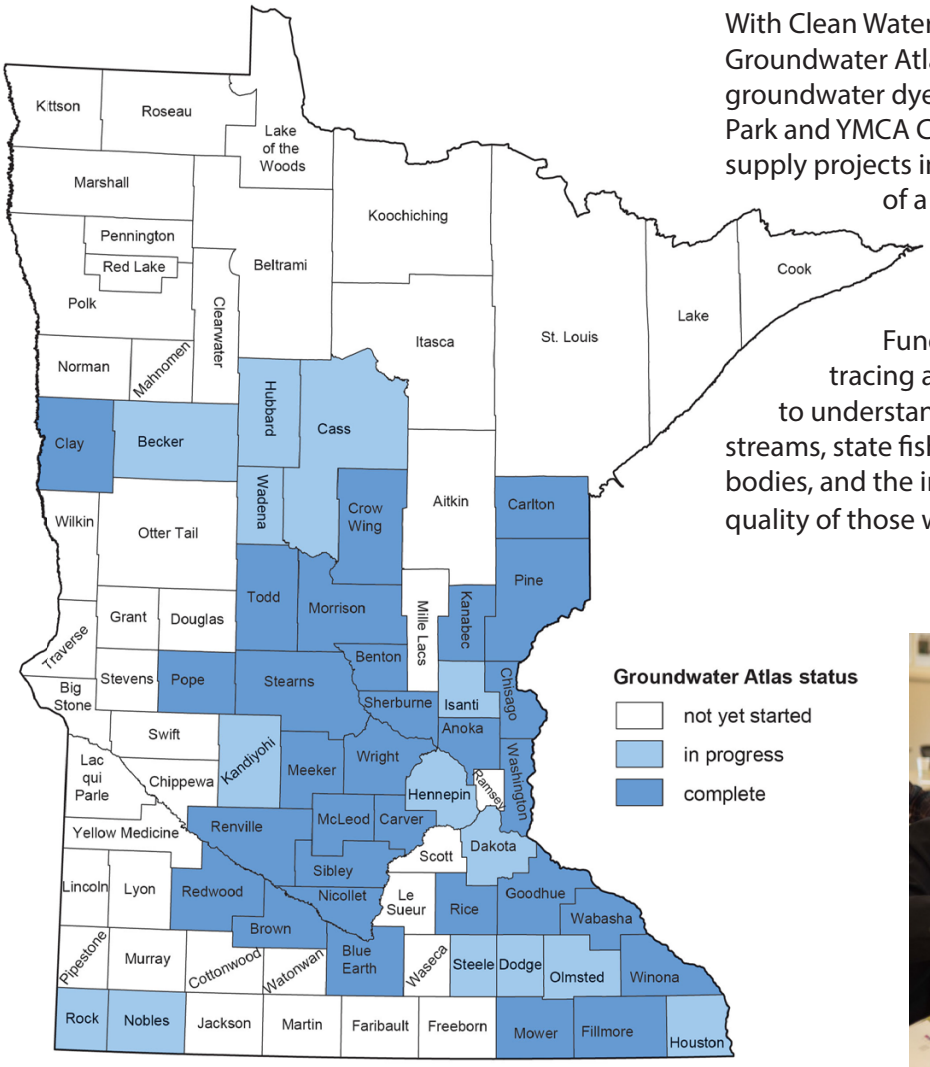


Figure 45. Status of groundwater atlases

Figure 46. County Atlas Stakeholder workshop, Stillwater, MN

Figure 47.
County Atlas Stakeholders field trip — Fairy Falls, Stillwater, MN

John Ringle Director, Cass County Environmental Services. "Within a month of receiving copies of our new Cass County Geologic Atlas, we utilized it to develop a well sampling program for a selected region of the county."

Kristi Anderson, hydrogeologist, Northwest AqwaTek Solutions. "The majority of what I do is working with the agricultural community on water appropriation permits for crop irrigation systems, which are critical to successful farming in Minnesota. I typically look to the County Geologic Atlas (CGA), where available, as the starting point in my work."

Peter K. Kang, Ph.D., assistant professor, Department of Earth & Environmental Studies, University of Minnesota Twin Cities. "My research group develops predictive models for groundwater systems, and the County Atlas provides critical information for those models. Recently, our team studied the feasibility of aquifer storage and recovery in four Minnesota study areas. Thanks to the County Geologic Atlas, my research team was able to successfully estimate the amount of water that can be safely stored in groundwater systems. Also, the atlases are excellent resources for groundwater-related courses that I teach at the University of Minnesota."

Learn more

- Clean Water Fund www.legacy.leg.mn/funds/clean-water-fund
- MGS County Geologic Atlas Mapping https://www.mngs.umn.edu/county_atlas/countyatlas.htm
- DNR Groundwater Mapping www.dnr.state.mn.us/waters/groundwater_section/mapping

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.

Long-term monitoring network wells

ACTION

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

Why is this measure important?

About 75% 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 (DNR) 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. DNR monitors aquifer levels in 1,093 wells with an ultimate goal of 1,500 total wells monitored. The Minnesota Pollution Control Agency manages a statewide network of about 262 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 about 223 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. The MDA network also includes 13 domestic wells and 13 springs.

What progress has been made?

The current statewide groundwater monitoring network includes about 1,578 wells. The ultimate goal is a network of about 2,000 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 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.

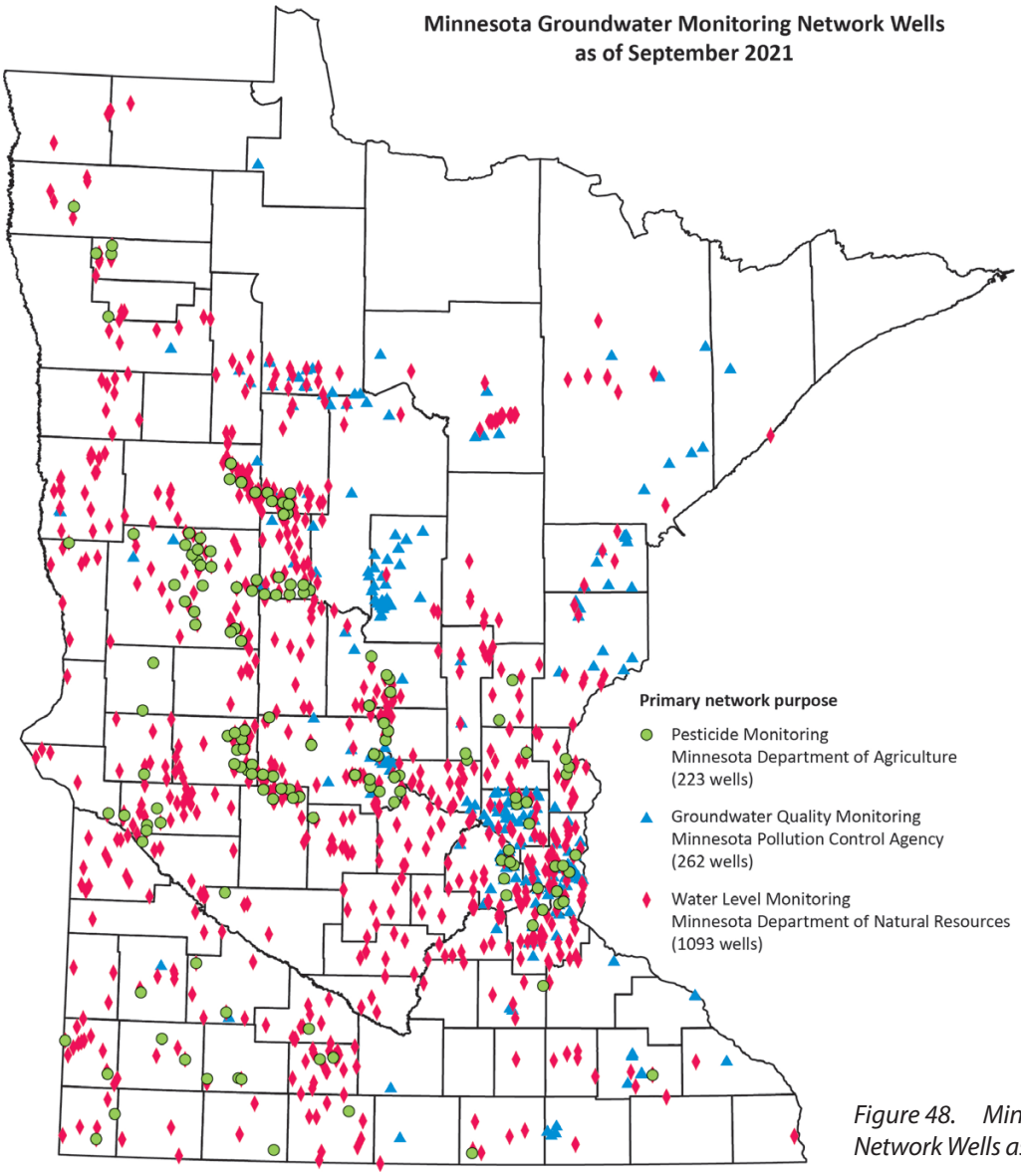


Figure 48. Minnesota Groundwater Monitoring Network Wells as of September 2021.

Learn more:

- Clean Water Fund
  www.legacy.leg.mn/funds/clean-water-fund
- Groundwater Monitoring www.pca.state.mn.us/water/groundwater-monitoring
- DNR Groundwater Level Monitoring Program: Cooperative Groundwater Monitoring CGM
  www.dnr.state.mn.us/waters/cgm
- Agricultural Chemical Monitoring and 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.

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 water quality in municipal wells, private business wells, and residential wells. Groundwater is the main source of drinking water for three out of four Minnesotans.

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

- It no longer operates properly or provides enough water.
- It became contaminated.
- It was replaced by extension of public water supplies.

A well may be "lost" or abandoned when:

- New buildings or additions are constructed.
- Property changes hands.
- 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 provided financial assistance to help seal wells. This assistance increased the number and rate at which wells were sealed in the state.

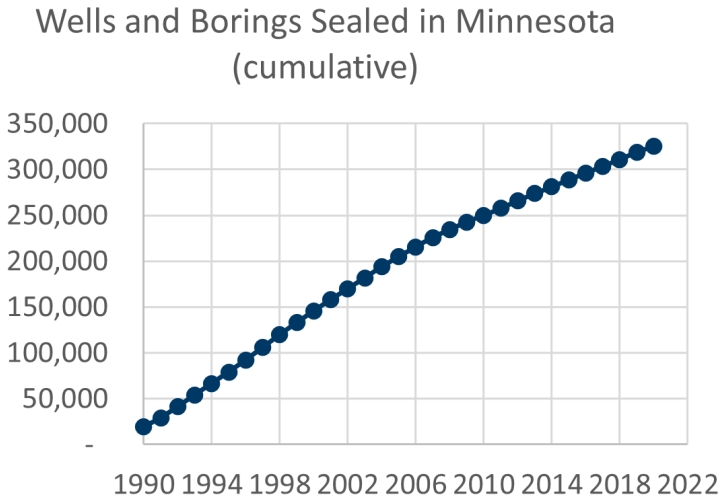


Figure 49. Number of wells and borings sealed in Minnesota.

What are we doing?

Clean Water Funds provided 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 for FYs 2012, 2014, 2017, and 2019. These funds were awarded to local governments, that could provide a 1:1 matching grant to well owners to seal their unused wells. Priority was given to sealing wells in areas near public water supply wells; large diameter, multi-aquifer wells; and wells in areas with known groundwater contamination.

Clean Water Funds were made available through the Minnesota Department of Health to seal unused public water supply wells for FYs 2013, 2015, 2016, and 2018. These wells tend to be larger and deeper than private wells and can be much more expensive to seal. They also pose a significant threat to public water supplies because they are typically near active public water supply wells.

What progress has been made?

A total of 64 unused public water supply wells and 1,189 private wells were sealed with Clean Water Funds.

Forty-three different public water supply owners were awarded funds across Minnesota. Thirty-four local governments were awarded funds through BWSR's Competitive Grant program.

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 over 325,000 wells since 1990, continued effort is needed to address the estimated 250,000 to 500,000 unused unsealed wells remaining.

Learn more:

- Clean Water Fund
  www.legacy.leg.mn/funds/clean-water-fund
- Sealing of Wells and Borings
  www.health.state.mn.us/communities/environment/water/wells/sealing

Figure 50. Abandoned wells pose a risk to groundwater.

Status	Trend	Description
●	→	This initiative is completed.

Land use in Drinking Water Supply Management Areas

ACTION

Measure: Land use changes over time in Drinking Water Supply Management Areas

Why is this measure important?

In many parts of Minnesota, public water systems can pump and deliver water to households with minimal treatment. However, activities or features on the land can affect the quality of drinking water sources. Certain land uses, such as forested land or wetlands, are more protective of water quality than others.

Protection of drinking water sources is particularly important within Drinking Water Supply Management Areas (DWSMAs), areas that contribute groundwater used for drinking water. There are approximately 1.2 million acres of land in DWSMAs in Minnesota, and about 39% (472,900 acres) is vulnerable to contamination. The total number of vulnerable acres changes over time as community DWSMAs are delineated and amended.

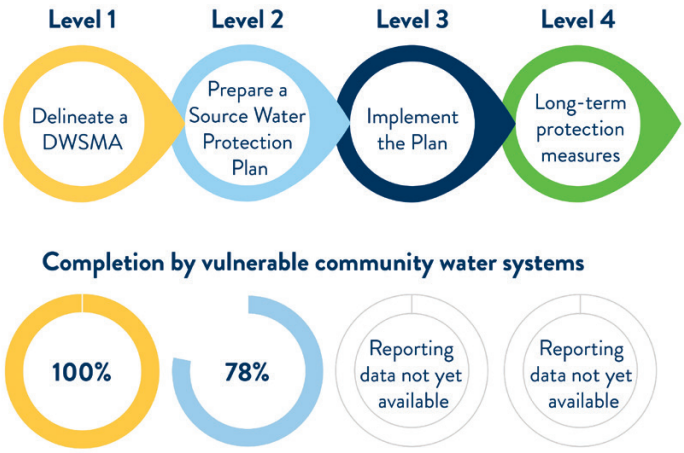


Figure 51. Levels of protection and completion by community water systems

Land use within DWSMAs is a useful indicator to assess risks to drinking water sources and their level of protection. Yet MDH and public water systems have limited ability to influence land use in DWSMAs, since much of the land within DWSMAs is privately owned and outside of municipal jurisdiction.

MDH has a long-term goal to promote land use that is beneficial to water quality in DWSMAs. This measure reports on the amount of land in protective land use in DWSMAs.

What are we doing?

MDH works with communities, public water systems, and other state and local partners to promote land use that is mutually beneficial to stakeholders. MDH helps communities identify vulnerable areas within their DWSMAs and plan and implement activities that prevent contamination. Strategic partnerships with other stakeholders in DWSMAs, such as private landowners, can also create opportunities to protect drinking water sources.

The Source Water Protection program at MDH has created a framework defining four levels of protection: 1) Delineating a DWSMA; 2) Preparing a SWP Plan; 3) Implementing the plan; and 4) Securing long-term protection of the DWSMA. Most public water systems progress through these levels sequentially. By encouraging protective land use in DWSMAs, MDH and public water systems can prevent or mitigate contamination of drinking water sources.

What progress has been made?

MDH provides direct programmatic support to communities through Levels 1 and 2 of the framework but relies on communities and partners to implement Level 3 and 4 activities. MDH is currently able to report on Levels 1 and 2 and is developing metrics and processes to track systems' progress through Levels 3 and 4.

MDH is assessing available data sources to measure and evaluate long-term protection of the vulnerable areas within DWSMAs. MDH will work with state and local partners to create the tools and plans needed to advance this initiative. These resources will allow MDH, public water systems, and other stakeholders to identify and prioritize appropriate protection measures for the diverse DWSMAs in the state, and measure progress accordingly.

Looking at land use in vulnerable DWSMAs provides a snapshot of the long-term protection measures of Level 4. Approximately 29% of land in DWSMAs statewide has protective uses that benefit water quality. This is a slight decrease from 30% in 2020. Since 2020, the area in vulnerable DWSMAs has increased by 39,000 acres due to new and updated delineations. Of these 39,000 acres gained, only 8,500 acres have protective land uses.

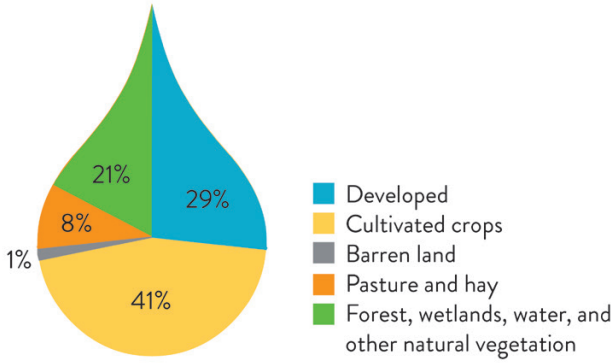


Figure 52. Land use in vulnerable DWSMAs.

However, the number of vulnerable acres in permanent protection has increased in recent years, rising from 9,000 acres in 2016 to 15,000 acres currently. Planning and implementing land use changes with decision-makers is a locally led process that takes time.

This measure is expected to change over time as partnerships are made and different sources of data become available.

What are the challenges and limitations?

A challenge in tracking changes in land use over time is the availability of data. Statewide data on land use is available through the National Land Cover Database (NLCD). These data show generalized land uses such as forestry, wetlands, agriculture, and urban development. These land use categories are an insufficient indicator for drinking water protection since they do not account for the array of best management practices (BMPs), activities, and programs that are targeted to safeguard drinking water sources. For example, conservation practices can mitigate contamination in agricultural areas but may not change land use classification in the NLCD. This is also true for stormwater BMPs that can reduce contamination from runoff in urban areas. Additionally, updated NLCD data is typically released every five years.

While MDH will be working with partners to develop reporting metrics, a recommendation is to support policy initiatives among Minnesota executive branch agencies and their partners to share data on land use protections in DWSMAs. Making these data available would help local implementers plan activities to protect Minnesota drinking water now and in the future.

Learn more

- Protecting vulnerable drinking water sources: www.health.state.mn.us/communities/environment/water/cwf/protecting.html

Status	Trend	Description
●	↗	There is increasing research, engagement, and activity to target and protect vulnerable areas in DWSMAs.

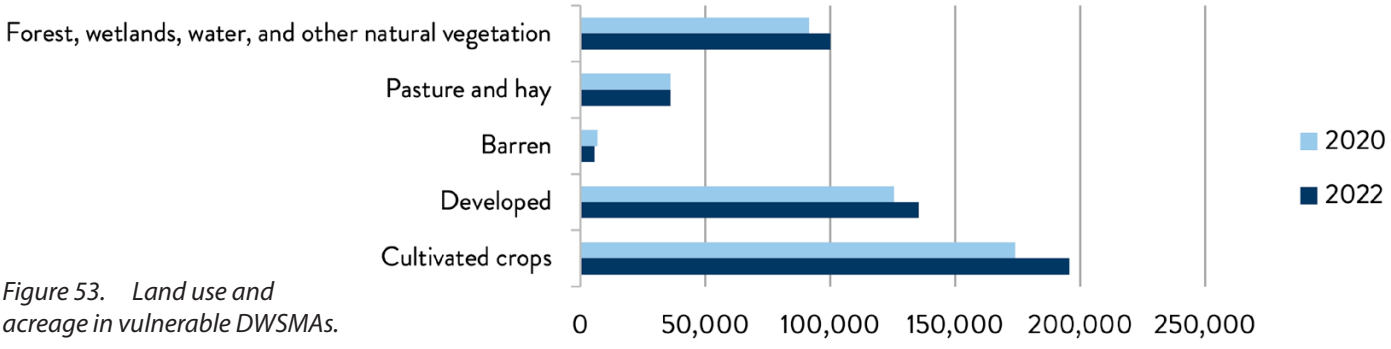


Figure 53. Land use and acreage in vulnerable DWSMAs.

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. The MDA water samples are analyzed for many pesticides (178 in 2020) 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 its monitoring program in 1985 and currently samples more than 166 monitoring wells, naturally occurring springs, and private drinking water wells throughout the state. Pesticide concentrations in groundwater rarely exceed drinking water standards in

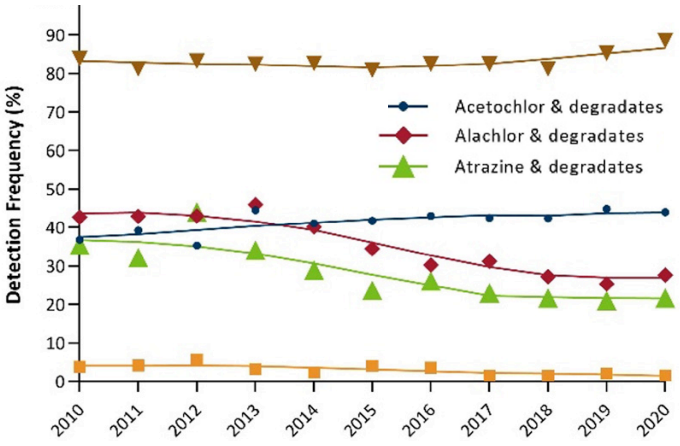


Figure 54. Statewide groundwater common detection pesticide and degredate detection frequency

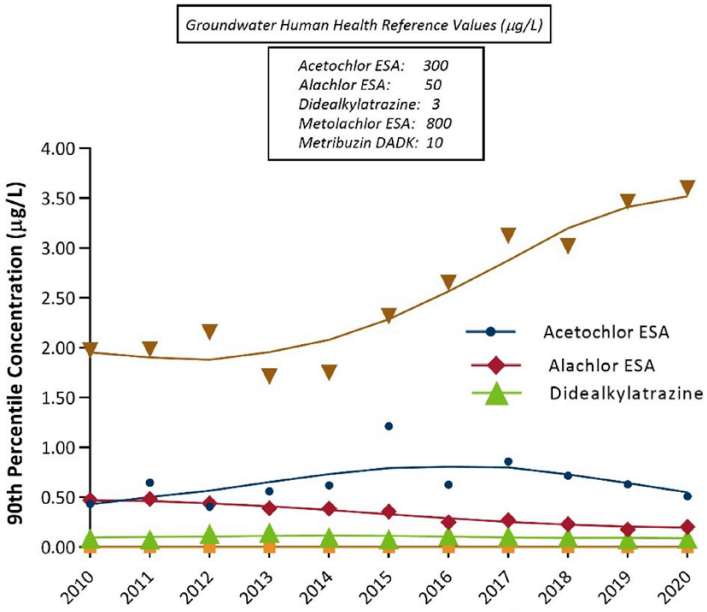


Figure 55. Statewide groundwater common detection pesticides degradates 90th percentile concentration

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.

In 2008, the Southeast Minnesota Water Resources Board and the MPCA, MDA and MDH established the Southeast Minnesota Volunteer Nitrate Monitoring 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 2020, 6,159 samples have been analyzed for nitrate, and an average of 10.1% of the wells exceeded the drinking water standard of 10 milligrams per liter (mg/L). The percentage of wells exceeding the drinking water standard for each sampling round ranged between 7.5% and 14.6%. 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 has been sampled annually since that time. Through 2020, 4,084 samples have been collected as part of the annual monitoring, and an average of 3.1% of wells have water with a nitrate concentration equal to or greater than the drinking water standard of 10 mg/L There is a slight downward trend in the 90th percentile of this network.

In 2013, the MDA began sampling private wells on a township scale as part of the Township Testing Program. Through 2019, the MDA has sampled private wells in 344 townships in 50 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 2019, about 217 wells have been sampled, and 9.1% of the wells have nitrate exceeding the drinking water standard, although this percentage 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 wells as part of the Township Testing Program may have their wells sampled for nitrate and pesticides. The MDA has sampled about 6,350 wells in 50 counties from 2014 to 2020. Samples were collected from 1,841 wells across 35 counties between 2019 and 2020, and pesticides and/or pesticide degradates were detected in 76% of the wells sampled. Concentrations were generally low and were below the drinking water standards; however, 3% were found to have a pesticide concentration above the human health reference value for total cyanazine. Cyanazine degradates were added to the analytical list in 2019. Beginning in 2021, the MDA will revisit counties sampled prior to 2019, to evaluate private drinking water wells in these areas for atrazine and cyanazine degradates. Cyanazine is a corn herbicide that has not been registered for use in Minnesota since 2002.

MPCA continues to track chloride concentration trends in groundwater. The agency's continued commitment to annual monitoring has increased its ability to determine whether groundwater quality has changed. The number of wells that have enough data to determine trends in the MPCA's monitoring network increased from 35 in 2011 to 60 in 2018. Analysis of data from 2008-2018 continued to show that chloride contamination is seeping into the aquifers used for drinking water. Chloride concentrations increased in 38% of the sampled water supply wells, which primarily provided water to individual residences. Most of the water supply wells with upward trends were located in the bedrock aquifers underlying the Twin Cities metropolitan area or southeastern Minnesota.

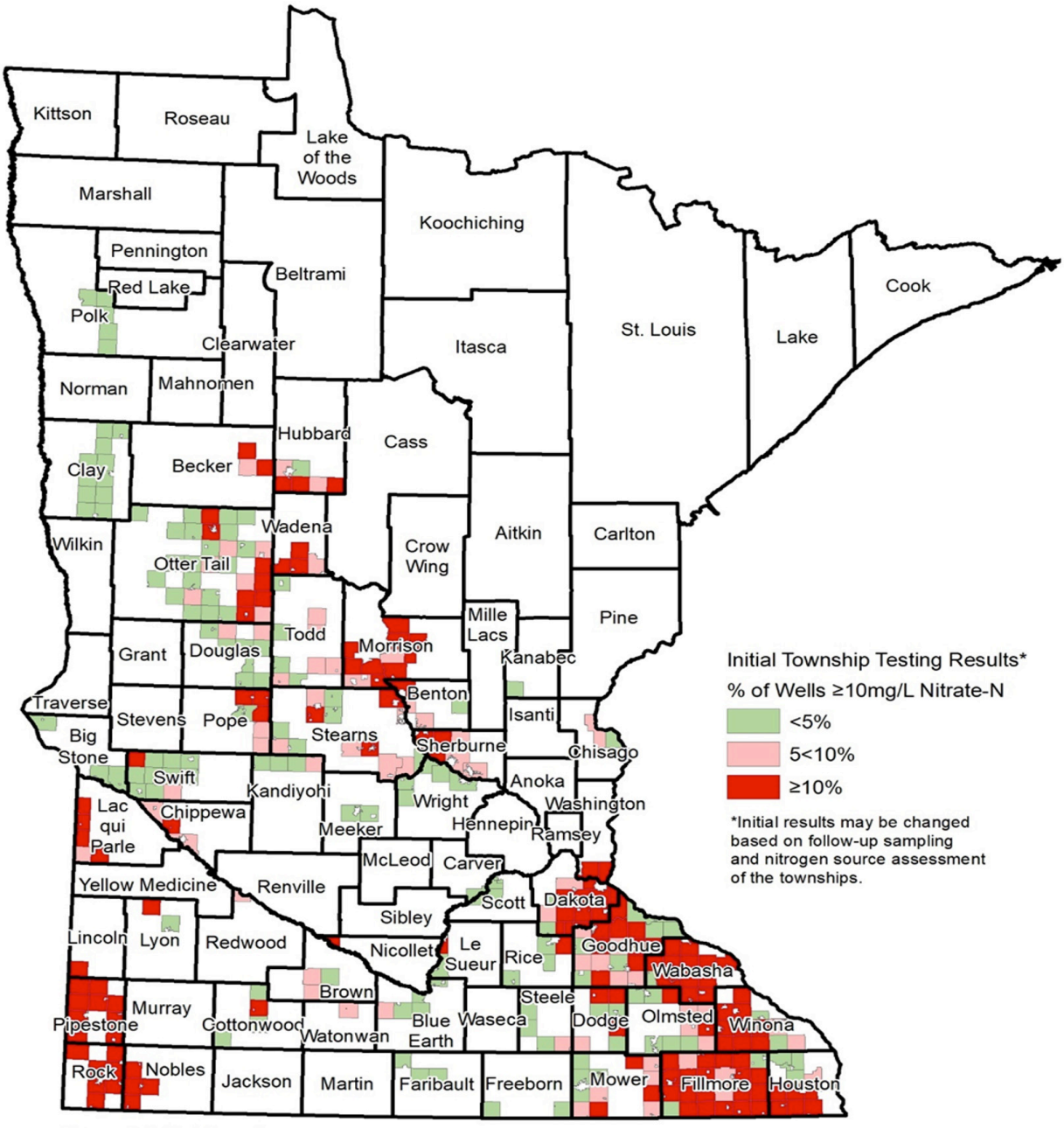


Figure 56. Initial Township Testing results (2020)

Learn more

- Clean Water Fund
  www.legacy.leg.mn/funds/clean-water-fund
- The MDA Pesticide Monitoring Programs
  www.mda.state.mn.us/environment-sustainability/water-monitoring-programs
- Southeast Minnesota Volunteer Nitrate Monitoring Network www.mda.state.mn.us/southeast-minnesota-volunteer-nitate-monitoring-network
- Central Sands Private Well Network www.mda.state.mn.us/central-sands-private-well-network
- Township Testing Program
  www.mda.state.mn.us/township-testing-program
- The MDA groundwater data through the Water Quality Portal www.waterqualitydata.us
- Private Well Pesticide Sampling Project
  www.mda.state.mn.us/pesticide-fertilizer/private-well-pesticide-sampling-project

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	NEI	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	NEI	In areas where groundwater is vulnerable, nitrate levels can be high. Of the 21 vulnerable townships tested in southwest Minnesota (2013-2019), 100% of them were determined to have 10% or more of the wells over the nitrate-nitrogen 10 mg/L standard.
Nitrate-nitrogen Central Sands	→	Trend data from the Central Sands Private Well Network shows a slight downward trend in the 90th percentile. However, Township Testing data show a high level of nitrate in some vulnerable aquifers in the Central Sands.
Nitrate-nitrogen southeast region	→	Trend data from the Southeast Minnesota Volunteer Nitrate Monitoring Network shows no change. However, Township Testing data show a high level of nitrate in some vulnerable areas in southeast 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 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 pollutants that can contaminate source water.

What are we doing?

Minnesota Department of Health (MDH) has several projects to supplement routine SDWA monitoring that are supported by Clean Water Funds. Under the federal SDWA, EPA establishes drinking water quality standards. These are called maximum contaminant levels (MCLs). MCLs are enforceable limits for water delivered by public water systems. EPA has established MCLs for approximately 100 contaminants.

Thousands of other chemicals are used in our modern, industrial world. Some end up in the environment and in drinking water sources. Contaminants that do not have MCLs are unregulated contaminants. There are no enforceable standards for unregulated contaminants under the SDWA. Many of these unregulated contaminants have not been evaluated for the risks they pose to human health or the environment. MDH has several programs and activities to support partners with risk management for unregulated contaminants. These include the Contaminants of Emerging Concern (CEC) Framework, which provides guidance on CEC detections in drinking water, as well as the CEC Initiative, which investigates the health risks of CECs in water.

Unregulated Contaminants Monitoring Project

Approximately 70 community water systems participated in Phase I of this project. Three monitoring networks were established to characterize occurrence and levels of unregulated contaminants. The three networks were based on potential impacts from nearby land use. The networks included surface water systems (17 CWS), agriculture-impacted systems (30 CWS), and wastewater-impacted systems (30 CWS). Some systems were included in both the agriculture-impacted and wastewater-impacted networks.

MDH selected a set of over 600 unregulated contaminants to sample for based on detection in previous studies and public health interest. Different parameters were analyzed at each of the networks. MDH collected 1,876 samples from the participating CWSs.

What progress has been made?

MDH has completed a preliminary analysis of the Phase I data. The samples were analyzed for over 600 contaminants across different contaminant classes. The majority of contaminants were not detected.

The 10 most frequently detected contaminants in the project included perfluoroalkyl substances (PFAS), pesticides, inorganic compounds, benzotriazoles, and wastewater indicators. Benzotriazoles are chemicals used in a wide variety of industrial, commercial, and consumer products. Most detections were at very low levels.

Based on preliminary Phase I results, MDH will expand its sampling and analysis in Phase II:

1. Since PFAS were commonly detected, MDH will sample for PFAS at additional systems in Phase II.
2. Several contaminants were commonly detected at low levels in vulnerable wells. In Phase II, MDH will sample non-vulnerable wells for these contaminants to better understand if they are susceptible to contamination.

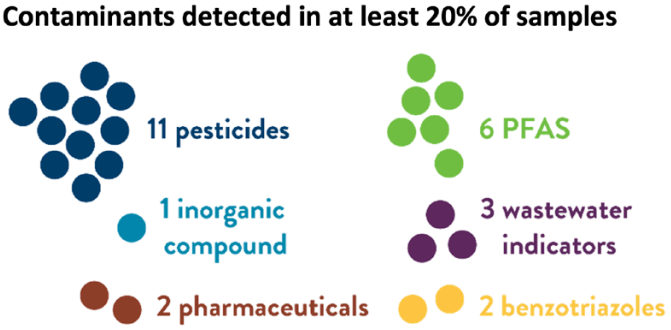


Figure 57. Contaminants detected in at least 20% of samples

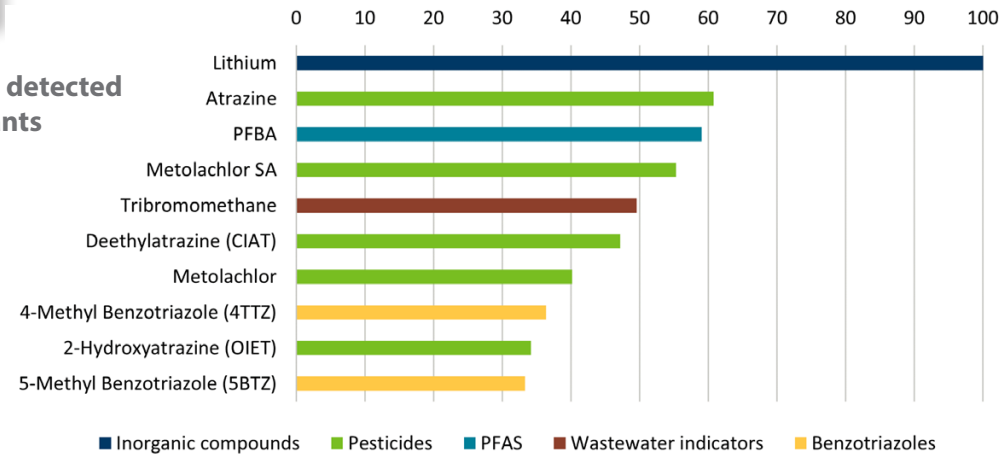


Figure 58. Contaminants detected in community water systems

3. Other monitoring projects in Minnesota have shown that cyanazine and its degradates pose potential threats to drinking water and public health. MDH has gained access to analytical methods for cyanazine and its degradates, allowing MDH to sample for these pesticides in Phase II.

MDH will use the Phase I and II results to inform:

- **Setting priorities for developing health-based guidance** on unregulated contaminants. MDH has nominated several contaminants from this project for guidance development through its CEC Initiative. MDH nominated these contaminants because they were detected in at least 10% of finished drinking water samples. Guidance values help public water systems, consumers, and other stakeholders make informed decisions about managing health risks of contaminants in drinking water.
- **Ongoing and future monitoring needs** for drinking water source surveillance at MDH, as well as for partners such as Minnesota Department of Agriculture or Minnesota Pollution Control Agency. Additional monitoring data can inform risk management for contaminants with widespread occurrence and/or potential health effects.
- **Risk management approaches** for unregulated contaminants. MDH will assess potential risk management solutions that public water systems, local partners, and other stakeholders could use to address unregulated contaminants. These may include regulatory actions, treatment or engineering solutions, or eliminating sources of contamination, and can be incorporated into the CEC Framework.

Additional projects

MDH has started a project to test for PFAS, or "forever chemicals," in drinking water sources. MDH began sampling for the Statewide PFAS Monitoring Project in 2021.

In the future, MDH will incorporate regular, proactive sampling for unregulated contaminants and CECs in its Drinking Water Source Surveillance program.

Learn more

- Clean Water Fund (www.legacy.leg.mn/funds/clean-water-fund)
- Basics of Monitoring and Testing of Drinking Water in Minnesota (www.health.state.mn.us/communities/environment/water/factsheet/sampling)

Status	Trend	Description
●	↗	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 four Minnesotans. About one in five Minnesotans (1.2 million people) get their drinking water from a private well. Both arsenic and nitrate are found in Minnesota groundwater at levels that can cause short-term and long-term health effects.

Consuming water high in nitrate can affect how blood carries oxygen and can cause a condition called methemoglobinemia (also known as blue baby syndrome). This condition can result in serious illness or death. Bottle-fed babies under six months old are at the highest risk of getting methemoglobinemia. Drinking water with arsenic in it over many years can increase the risk of cancer and other serious health effects.

Nitrate is a naturally occurring compound made of nitrogen and oxygen. Natural levels of nitrate in Minnesota groundwater are usually below 3 milligrams per liter milligrams (mg/L). Levels of nitrate greater than 3 mg/L are associated with human-made sources of nitrate. Sources include fertilizers, animal wastes, and human sewage. These sources can contaminate the groundwater. Shallow wells in areas with sandy soils or karst geology are more vulnerable to nitrate. 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.

Radium is a naturally occurring radionuclide in rocks and soil that can get into groundwater. Radium is found in public water supply wells, commonly in the Mount Simon and Jordan aquifers. There is no information for radium in private wells. Radium in well water puts private well users in contact with low doses of radiation that can lead to a higher cancer risk over many years.

What are we doing?

Nitrate

Current laws require that wells are 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 are higher than 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, the MDA Township Testing Program tests for nitrate in townships that have vulnerable geology and a large percentage of row crop agriculture. The results of this testing will guide efforts to reduce nitrate in groundwater through the Nitrogen Fertilizer Management Plan. Other activities funded by the Clean Water Fund, including the Agriculture Water Quality Certification Program, nutrient management assistance

and funding for cover crops, and other best management practices reduce input of nitrate to groundwater.

Arsenic
If arsenic is detected in the initial water sample after a well is constructed, MDH informs the well owner of options to reduce their risk. Clean Water Funds made it possible for MDH to collaborate with the U.S. Geological Survey (USGS) to better understand the occurrence and distribution of arsenic in groundwater. The project helps identify the best approach for collecting the initial well water sample to get an accurate measure of long-term arsenic concentrations. Understanding how the arsenic concentration changes over time helps homeowners plan water treatment options.

Radium
This Clean Water Fund project will investigate whether radium is an issue for private well owners and how to protect homeowner health from radiation exposure.

Education and outreach
MDH is also using Clean Water Funds to improve education and outreach to private well owners. The goal is to increase private well testing and help private well owners take action to reduce their exposure to unsafe levels of contaminants, such as arsenic and nitrate.

What progress has been made?

Nitrate
The goal is that all new wells have nitrate levels below 3 mg/L. About 3% of new wells in Minnesota have nitrate levels above level of 3 mg/L and below the drinking water standard of 10 mg/L. About 1% of new wells have a nitrate level above the drinking water standard. However, the MDA Township Testing Program, which tests wells that are vulnerable to groundwater contamination, found a much higher percentage of wells in the central and southeastern regions of the state that have elevated levels of nitrate. The townships tested had a high percentage of land in row crop agriculture, and the geology in these regions makes it easier for nitrate to travel into groundwater.

The low statewide percentages of new wells with nitrate shows 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 had a low level of nitrate initially. There are also many older wells that may have never been tested.

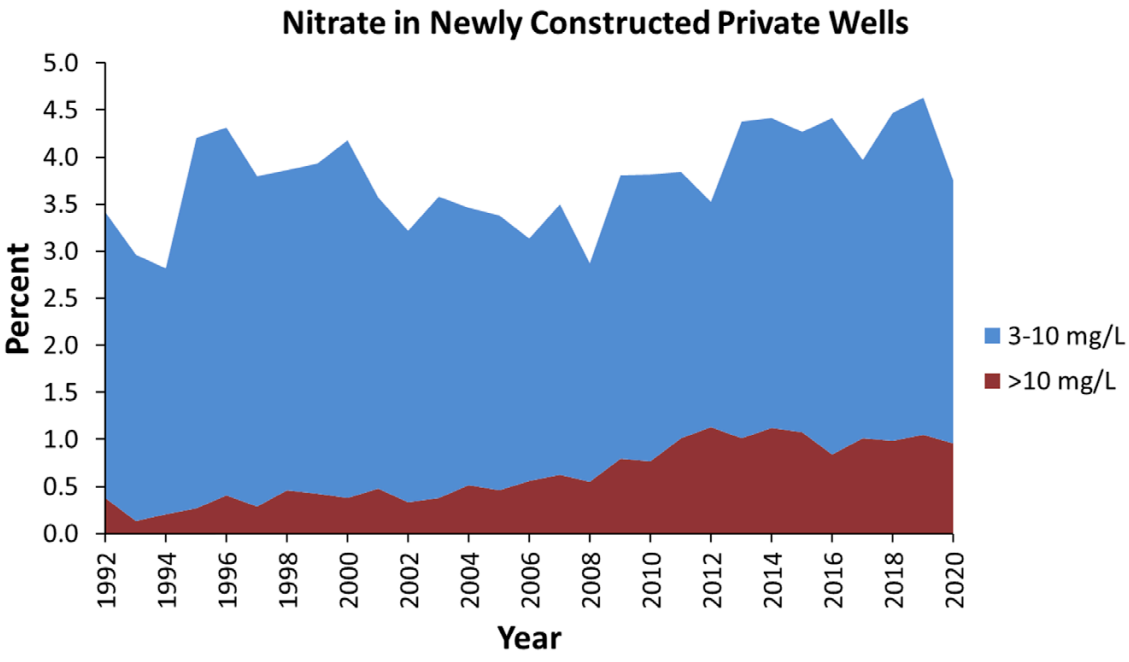


Figure 59. Nitrate concentrations in new drinking water wells

As shown on previous page, there has been a general upward trend in the percent of new wells with nitrate levels higher than the drinking water standard over the past 16 years.

It is not clear if there is a relationship between this trend and actual nitrate levels in groundwater since 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. However, through Clean Water Fund activities that address and manage nitrate sources, nitrate concentrations in groundwater across the state should eventually decline. This measure should reflect that decline.

Arsenic

The goal for this measure is to reduce the percentage of new wells with arsenic. Forty-eight percent of new wells in Minnesota drilled since 2008 have arsenic. About 11% of new wells have arsenic levels above 10 micrograms per liter (µg/L) — the drinking water standard for community water systems.

In 2014, MDH and USGS started collaborating to better understand the occurrence and distribution of arsenic in groundwater. No activities to date have had a direct influence on reducing the percentage of new wells with arsenic. As we learn more about arsenic in groundwater, MDH will develop guidance for well contractors to reduce the likelihood that arsenic is in a new well.

Learn more

- Clean Water Fund
  www.legacy.leg.mn/funds/clean-water-fund
- Nitrate in Drinking Water
  www.health.state.mn.us/nitrate
- Arsenic in Drinking Water
  www.health.state.mn.us/communities/environment/water/contaminants/arsenic

Status	Trend	Description
Nitrate	→	Since 1992, there has been a general increase in the percent of new wells that have nitrate levels above the drinking water standard.
Arsenic	→	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.

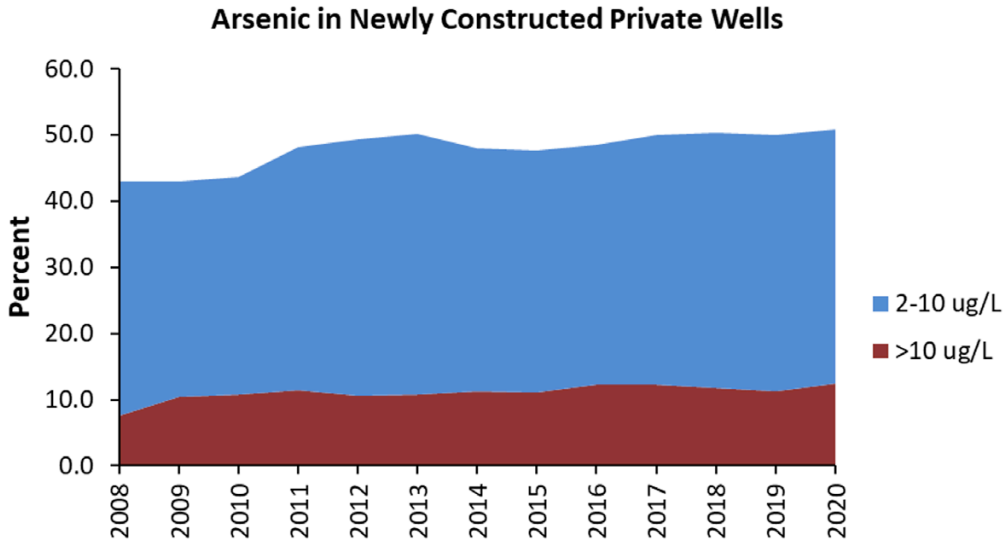


Figure 60. Arsenic concentrations in new drinking water wells

Groundwater levels

OUTCOME

Measure: Changes over time in groundwater levels

Why is this measure important?

Approximately three out of every four Minnesotan's rely on groundwater for their drinking water. Minnesota's numerous aquifers also support agriculture, industry, and the natural resources (streams, wetlands and lakes) that define Minnesota's quality of life. While the state's reliance on groundwater increases, many areas 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 for future generations.

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 management decisions relies in part on understanding how weather and man-made stresses impact groundwater levels on both a seasonal and long-term basis.

What are we doing?

To monitor this "hidden" resource the Minnesota Department of Natural Resources (DNR) manages a statewide network of groundwater-level observation wells. Traditionally water levels were measured monthly by Soil and Water Conservation Districts and other volunteers, however this network is being converted to continuous monitoring using automated sensors that measure levels every hour and then store the data until retrieved by staff. 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. The water level data are available online and are noted 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. While the number of observation wells in the network (1,094 wells) has decreased by 11 wells since the last Clean Water Fund Performance Report in 2020, the geographic coverage of the network has expanded. Besides drilling wells into aquifers that previously were not monitored, many old or redundant wells have been sealed and replaced with wells that better suit future monitoring needs.

What progress has been made?

To evaluate progress, the DNR compiled water level data from observation wells with at least 20 years of data. An analysis is then completed that uses the annual minimum water level, i.e., the lowest water level recorded for the year in an observation well, for determining trends. The latest analysis, covering the period from 2000-2019, includes 310 wells (figure 64). Statewide, 94% of the observation wells exhibited upward or no clear trend whereas only 6% showed a downward trend. This is an increase in upward/no trend of 13% and a 13% decrease of downward trends over the last analysis. It is important to note that some of the change observed may reflect the addition of new or removal of sealed wells from the analysis.

New wells are being installed each year and once these wells have 20 years of data, their groundwater trends will be included in the analysis.

To date this analysis has been performed three times for the following 20-year periods: 1993-2012, 1997-2016, and 2000-2019. A comparison of the three periods offers a view of how groundwater trends have changed over time. The original analysis, completed for the period from 1993-2012, indicated that statewide, water levels in 63% of the selected wells showed rising or no clear trend, while 37% indicated a downward trend. Analysis of water levels from 1997-2016 showed 81% of observation wells included in the analysis showed upward or no clear trend, while 19 percent exhibited a downward trend. By comparison, the latest analysis showed 94% of the wells with rising or no

trend and only 65 of the wells with a downward trend. Figure 65 highlights both the change in trends observed statewide and by groundwater province during the three periods of analysis. In general, water level trends have been rising, resulting in a significant drop in the percentage of wells showing a downward trend. Downward trends can result from a combination of factors, such as drier climate conditions in the later years of the analysis period, increased groundwater use, or changes in land use and groundwater recharge.

Groundwater-level information is becoming better integrated into water supply planning, which supports work to reduce the environmental, economic, and public-health risks created by unsustainable aquifer decline. 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 (GWMAs) 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

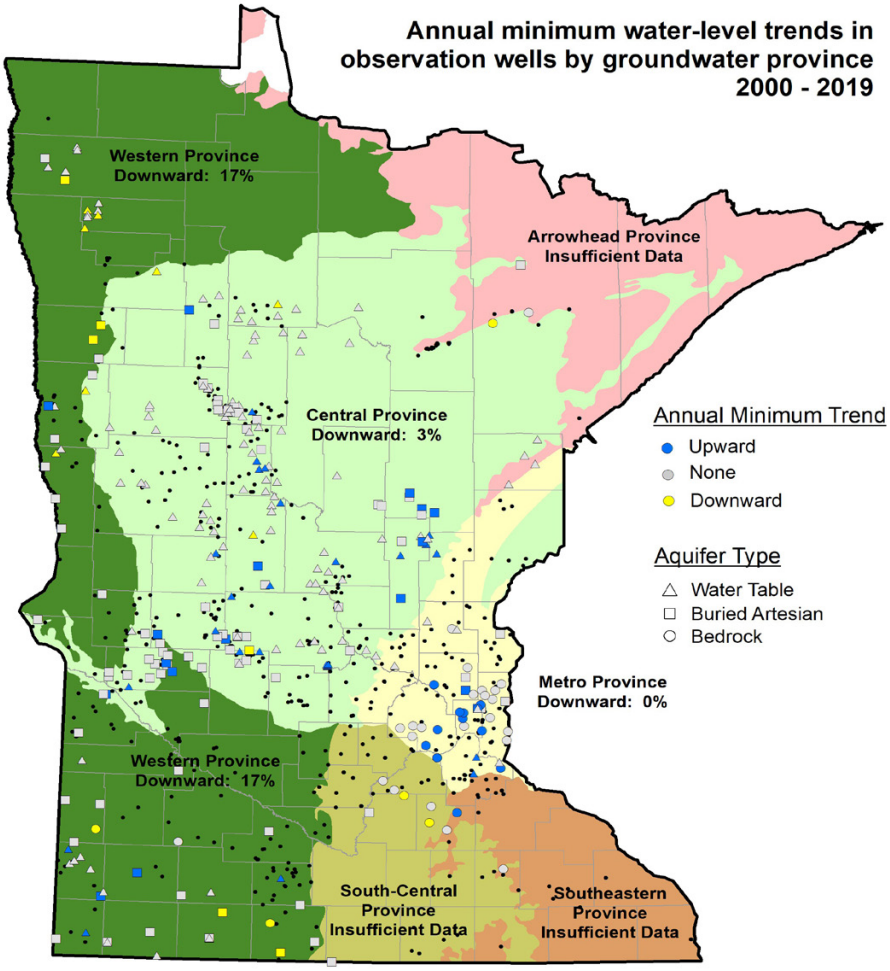


Figure 61. Water level trends in DNR observation wells for the period from 2000-2019

Period (dates) of analysis	**Statewide** percent of wells with upward or no clear trend	**Metro** province percent of wells with upward or no clear trend	**Central** province percent of wells with upward or no clear trend	**Western** province percent of wells with upward or no clear trend
1993-2012	63%	44%	66%	76%
1997-2016	81%	73%	86%	74%
2000-2019	94%	100%	97%	83%

Figure 63. Comparison of water level trend data by analysis period and location. South-Central, Arrowhead and Southeast Provinces not displayed due to insufficient data

of aquifers and the surface water features they support are being established.

The emerging GWMA 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, Straight River in north-central Minnesota, and the Bonanza Valley area of west-central Minnesota.

As more groundwater models are developed, 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 GWMAs and other areas of groundwater-quantity concern.

Learn more:

- Clean Water Fund
  www.legacy.leg.mn/funds/clean-water-fund
- DNR Groundwater Level Monitoring Program:
  Cooperative Groundwater Monitoring CGM
  www.dnr.state.mn.us/waters/cgm
- Metropolitan Council's Water Supply Planning
  www.metrocouncil.org/Wastewater-Water/Planning/Water-Supply-Planning.aspx
- Groundwater Provinces
  www.dnr.state.mn.us/groundwater/provinces

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.

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, service health care facilities, 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 comes 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 to take practical actions to use water efficiently. Various water efficiency targets have been established since the Clean Water, Land and Legacy Amendment was passed. The following metrics and results are from the DNR Water Conservation Reporting System for public water suppliers statewide:

- In 2020, statewide unaccounted for water loss for all water suppliers was 8%. Large utilities report a 7% water loss, while small utilities have a slightly higher percentage at 11%, but these may be due to metering or water accounting issues.
- In 2020, over 87% of the reporting large cities met the goal of residential water use less than 75 gallons/person/day.
- The statewide aggregate for residential gallons per capita daily (GPCD) was 56 GPCD.
- In 2020, 67% of utilities met the goal of maximum daily use being less than 2.6 times that of average daily use.
- Statewide, non-residential water use is always less than residential use. But the change in water use

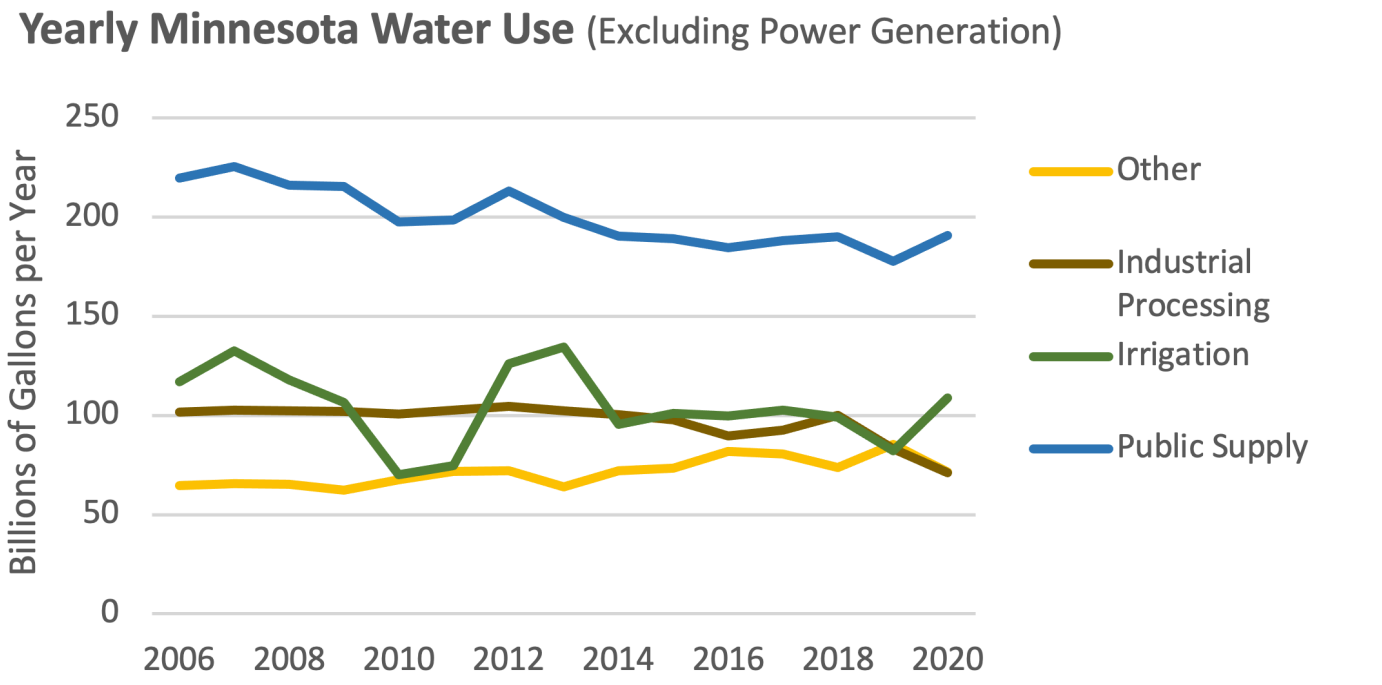


Figure 64. Minnesota water use in billions of gallons, excluding power generation.

patterns during the pandemic is fairly dramatic. From 2019 to 2020 residential water use increased approximately 8% in Minnesota and non-residential water use decreased nearly 5%.

- Approximately 34% of the water distributed by water suppliers is to non-residential water users.

In the Twin Cities metropolitan area, the Metropolitan Council (Met Council) has identified a regional target for total per person water use of 90 gallons/day, on average, for community water systems. The DNR, the Minnesota Department of Agriculture (MDA), the University of Minnesota (U of M), and the Met Council are using the Clean Water Fund to accelerate the implementation of water efficiency measures and progress toward these goals. Examples:

- U of M Technical Assistance Program Water Conservation Program
- U of M Extension Turfgrass Science Program
- Freshwater Society Water Stewards Program (with resources for water conservation)
- Met Council Water Efficiency Grant Program

What progress has been made?

Between 2010 and 2020, the water used for public supply has gone down about 4%, and the average amount of total water used per person (for all purposes in the state) has gone down approximately 27%. This is likely due to a combination of factors like changes in summer irrigation and shifts in industrial processes and residential appliances. Water use for power generation has decreased by 40% since 2010, reflecting the transition to renewable energy.

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 differences in weather versus changes in management.

Year	Total MN Water Use (gallons per 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
2018	3,178,799,171	5,629,416	564
2019	2,904,713,342	5,680,337	511
2020	*2020 population estimates not yet available (census)*		

Learn more:

- Clean Water Fund (www.legacy.leg.mn/funds/clean-water-fund)
- Minnesota Water Use Data (www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse)
- Great Lakes Compact (www.dnr.state.mn.us/waters/watermgmt_section/great_lakes_compact/)
- Irrigation Outreach & On-Farm Nitrogen Management in Central Minnesota (www.mda.state.mn.us/irrigation-outreach-farm-nitrogen-management-central-minnesota)
- U of M Technical Assistance Program Water Conservation (www.mntap.umn.edu/focusareas/water/projects/)
- Met Council Water Efficiency Grant Program (https://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 75-79 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

What are 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.

Social measures are a way of integrating social science into Clean Water activities. They can help answer questions about what motivates people and communities to take positive actions as well as the barriers and constraints that prevent or limit action. Understanding and measuring these factors helps state agencies and their partners be more strategic when engaging and partnering with the public to address water quality and quantity, and evaluating the success of those efforts. Previous reports (2016, 2018, and 2020) provide a description of the Social Measures Monitoring System (SMMS) and how state agencies have worked together to pilot the application of this framework to Clean Water Fund projects.

Below is a graphic that illustrates the four main components of social measures — individual, relational, programmatic, and organizational capacity.

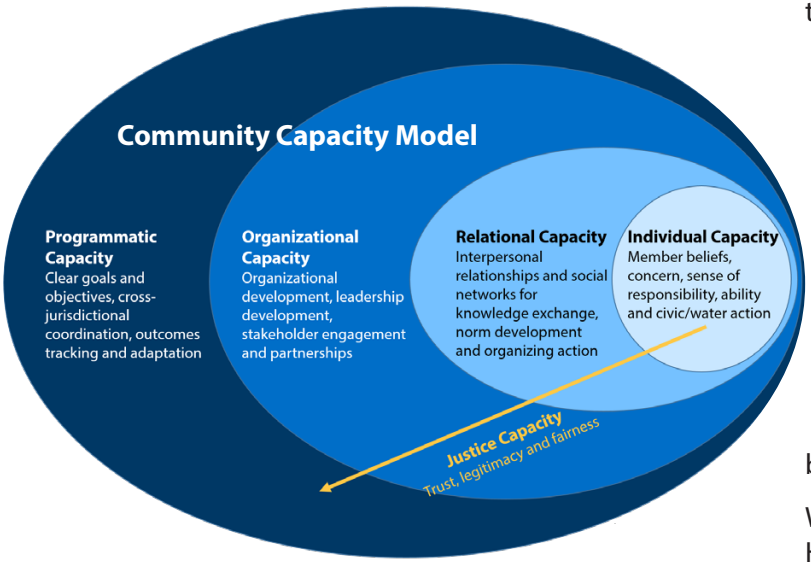


Figure 65. Four main components of social measures: Individual, relational, programmatic, and organizational capacity.

We Are Water MN is the Clean Water Fund's only dedicated community capacity-building program. Communities are also connecting to protect water resources and plan for the future through local water management plans and the One Watershed, One Plan process. The Clean Water Council's vision is to increase the number of Minnesotans who understand their own role in achieving and maintaining healthy lakes, rivers and wetlands and act accordingly. Early engagement provides opportunity to influence policy decisions, implementation plans, and increase ownership, or buy-in to actions needed to meet water quality goal

We Are Water MN

Why is this measure important?

We Are Water MN is the Clean Water Fund's only dedicated community capacity-building program. It builds individual and relational capacity for participation in clean water through education and network building at the local level.

The program is built upon the theory that building community capacity to protect water requires building relationships between community members, organizations, and sectors. We Are Water MN achieves these goals through three key activities:

- Building a network of partnerships
- Hosting a traveling exhibit
- Designing public events

The program is a partnership of the Minnesota Humanities Center, Minnesota Pollution Control Agency, Minnesota Historical Society, University of Minnesota Extension, and the Minnesota Departments of Agriculture, Health, and Natural Resources. It is hosted by local organizations that participate in 6-12 months of support and planning before the traveling exhibit arrives in their location.

We Are Water MN began in 2016 and uses the Minnesota Humanities Center's (MHC's) equity-based approach to community engagement, the Absent Narratives Approach™, that increases partnerships with communities and fosters equitable practices within systems.

Figure 66. In response to COVID-19 safety concerns, the Hmong Museum worked with the state partners to create an outdoor version of the exhibit which was displayed at Little Mekong Plaza (January-March), Lake Phalen (June), and the 2021 Minnesota State Fair Hmong Minnesota Day (August).

Figure 67. The University of Minnesota-Morris hosted the exhibit in the Morrison Art Gallery from Aug. 20-Oct. 19, 2021.

Practicing the Absent Narratives Approach™ as a framework for building relationships leads to the outcomes for water protection and restoration described in the Social Measures Monitorin System (SMMS), such as:

- Positive interpersonal relationships within communities that promote information exchange, build trust, foster shared identity and promote common awareness, concern and sense of responsibility for water.
- Networks that can promote positive social norms and share a vision for and participate in water stewardship.
- An increased and broadened community awareness of local water issues, because visitors to the exhibit and public programming come from more diverse backgrounds than one host organization could convene on its own.

What are we doing?

In 2020-2021, the state partners worked with six local organizations, located in diverse regions of the state:

- Morris: University of Minnesota-Morris
- Mankato: Blue Earth County Historical Society
- Rochester: City of Rochester
- St. Paul: Hmong Museum
- Chisholm: North St. Louis County Soil and Water Conservation District
- Pipestone: Meinders Community Library and Arts & Mentoring Project

The pandemic had significant impact on this group of host communities. Exhibit dates needed to be changed; relationship building and programming were more virtual. Despite these disruptions, many successful outcomes were accomplished.

What progress is being made?

We Are Water MN was able to continue its engagement work through the pandemic. There has been consistent delivery and statewide reach with this capacity building and water education program.

Host communities – Building relational capacity

While in the program, the host organizations are focused on developing their own local networks. The program encourages them to connect with organizations outside their existing partnerships and with individuals or organizations representing traditionally absent narratives.

Together, these local networks design a minimum of four public events that build people's relationship with and responsiblites to water.

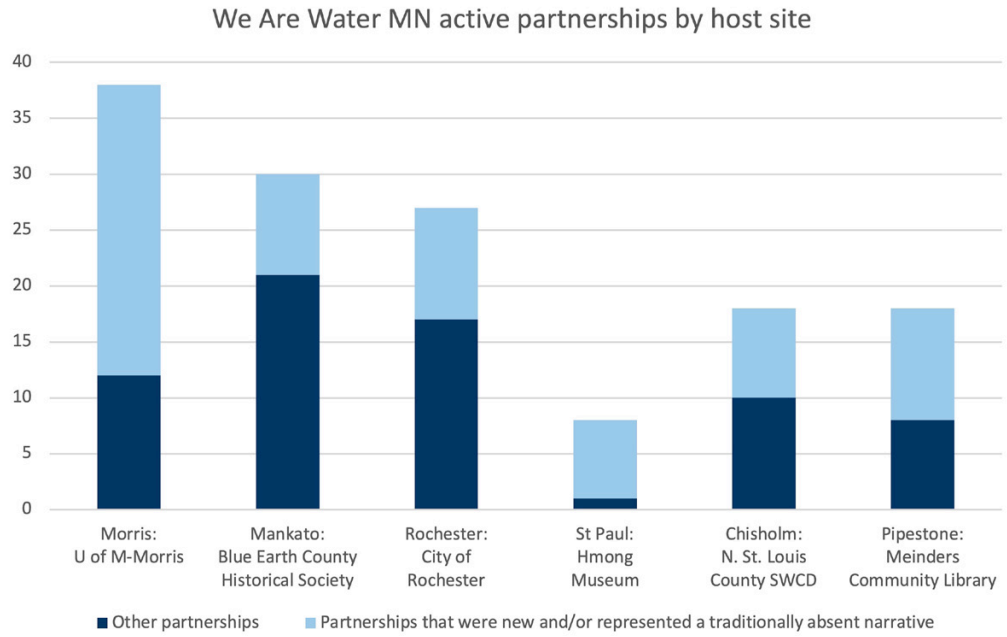


Figure 68. Number of active community partnerships for We Are Water MN hosts sites in the 2020-2021 tour (August 2020-September 2021). Host sites are encouraged to form new partnerships and include partnerships from organizations that represent one or more traditionally absent narrative. (Data taken from preliminary interim reports)

Despite their successes, relationship building in 2020-2021 was impacted by the pandemic. We observed that host sites relied heavily on their existing relationships and networks during the crisis. These established relationships proved critical to the success of their event series. It was more challenging to meet with organizations and develop new partnerships during this time.

Visitors – Building individual capacity

More than 6,500 visitors attended the exhibit in 2020-2021. Visitors to the exhibit are asked to complete a survey describing how their awareness of water issues changed after viewing the exhibit and their willingness to adopt pro-environmental behaviors. For both questions, visitors could select all responses that applied to them.

Overall, the traveling exhibit provides a way to engage visitors and increase knowledge and awareness about local water resources. Survey results from five of the six host sites indicate that the vast majority of visitors learned something new and reported they are going to take action for water resources. Data for the sixth site was not ready for publication at the time this report was written.

We Are Water Survey results

Awareness of water issues response options	% of respondents
I learned something new about our water resources	94%
I increased awareness regarding threats to our water resources	91%
I was exposed to a perspective different from their own regarding water resources	78%

Willingness to adopt pro-environmental behaviors	% of respondents
I will change how I personally use water	75%
I will share what I learned with others	90%
I will get involved with local organizations working to protect water resources	52%

Figure 69. Local events engaged more than 4,200 attendees in 2020-2021. In Pipestone, the Arts and Mentoring Project (AMP) summer youth theater camp performed Disney's Moana, Jr. at Hiawatha Pageant Park, July 23-25, 2021. The theater camp included lessons about water quality, provided by the Pipestone County Soil and Water Conservation District and cultural context lessons from a local community member.

Measure: Number of We Are Water MN host communities

Status	Trend	Description
●	→	There is consistent delivery and statewide reach with this capacity building and education program.

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

Status	Trend	Description
▲	NEI	In recent years, state agencies have developed and piloted the Social Measures Monitoring System. This work integrates social science into Clean Water Fund projects.

Learn more:

- A multilevel model of community capacity for sustainable watershed management. Davenport, M.A., & Seekamp, E. (2013). Society and Natural Resources: An International Journal, 26(9), 1101-1111
- We Are Water MN | Minnesota Humanities Center mnhum.org/we-are-water-mn
- One Watershed, One Plan | MN Board of Water, Soil Resources bwsr.state.mn.us/one-watershed-one-plan
- Civic engagement in watershed projects | MN Pollution Control Agency pca.state.mn.us

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

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 below). 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 best management practices 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 statewide scale.

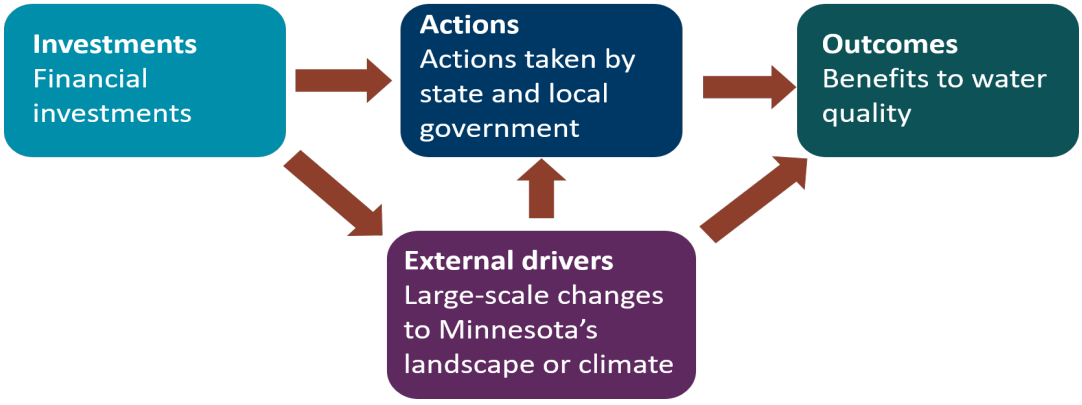


Figure 70. Expected relationships of external drivers to investments, actions, and outcomes.

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 agricultural land use in Minnesota has remained relatively constant over time, the crops grown (land cover) have undergone a significant transformation. As shown in the figure below, 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 nine million acres where agricultural land use has changed represents about 16% of the state. These cropping changes have altered the time of year and extent to which 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.

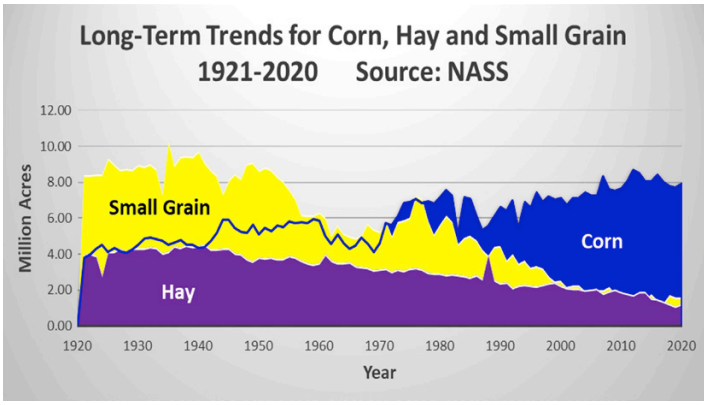


Figure 72: Agricultural land use trends.

Impervious surface in metropolitan area

Water quality impacts associated with impervious surfaces are often particularly significant. Precipitation that falls on impervious surfaces typically does not soak into the ground, resulting in high runoff volumes and 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 a much larger proportion. Currently, well over half of Minnesota's population lives in the corridor between Rochester, the Twin Cities metropolitan area, and St. Cloud. The figure below shows trends of impervious surfaces for the three areas from 2001 to 2019. For each community, the amount of impervious surface present has increased, amplifying water quality pollution risks.

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 www.mndnr.gov/whaf.

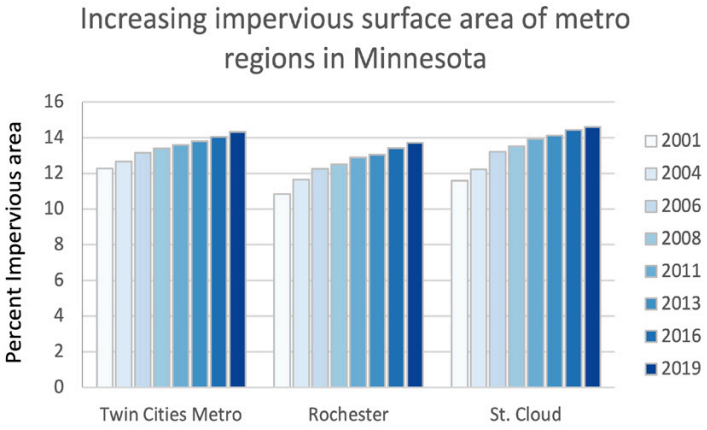


Figure 73: Change in percent of land surface covered by impervious surfaces.

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. In many parts of southern Minnesota, well over 90% 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 2017 indicate that Minnesota had:

- A net gain of 2,430 acres (an increase of 0.023% of overall state wetland acreage) of wetland from 2006 to 2011
- A net gain of 6,550 acres (an increase of 0.060%) from 2009 to 2014
- A net gain of 484 acres (0.0044%) from 2015 to 2017

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.

- Much of the observed gains were unconsolidated bottom type wetlands (ponds) that typically have limited wildlife habitat value.
- 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.

Note: No new data on changes in wetland acreage was collected since 2019 as a result of Covid restrictions. The data included here is the same as was included in the 2020 Performance Report.

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 below, Minnesota's population has increased steadily since 1950, and nearly all of that growth can be attributed to urban or 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. These changes may require modifications to current water quality actions and strategies.

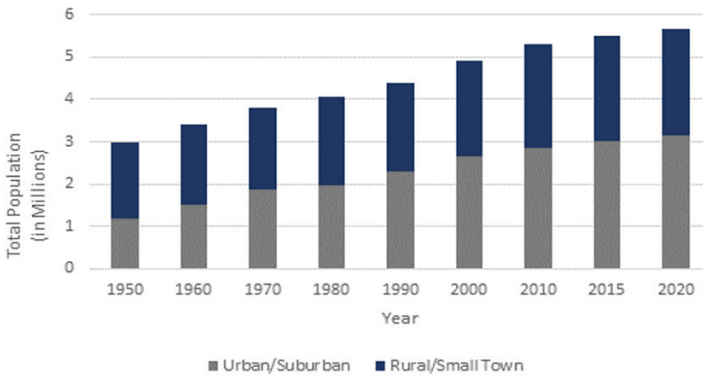


Figure 74: Change in Minnesota's population and urban/suburban versus rural distribution since 1950

Changing hydro-climatic patterns

Minnesota's climate exhibits large season-to-season, and year-to-year variations that influence the condition of the state'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.

Minnesota's historical climate record, covering 1895-2020, shows that the state is becoming both warmer and wetter. Minnesota's average annual temperature has increased at a rate of + 0.23° F per decade or by a total of approximately 3° F during this period. Average annual precipitation has increased at a rate of 0.27 inches per decade or by a total of 3.4 inches since 1895.

The warming in Minnesota has become even faster since 1970, increasing to a rate nearly 0.5° F per decade. This sharp uptick in warming has been driven by milder winters, fewer cold weather extremes, and higher daily minimum temperatures. Winter is by far Minnesota's fastest-warming season, followed by fall, spring, and then summer. Northern Minnesota is now beginning to see increasing average summertime daily maximum (or "high") temperatures, but central and southern Minnesota are not yet experiencing these increases. Instead, most of summer's warming trend is from increasing overnight minimum temperatures. Warming rates have been faster in northern Minnesota than southern Minnesota.

As with temperature, precipitation in Minnesota has been increasing for many decades. Part of this increase was the natural rebound expected after the major drought episode of the 1920s and 1930s, when annual precipitation decreased to the lowest levels on record. However, in the past few decades, precipitation has continued increasing beyond what would be expected from typical wet/dry variations. The period from the 1990s through the 2010s was the most consistently wet period on record, and the 2010s finished as Minnesota's wettest decade back to the 1890s. The wetter conditions have coincided with increases in heavy and extreme precipitation.

The Minnesota State Climatology Office has noted that days with one, two, and three inches of precipitation were 22%, 33%, and 60% more common, respectively, from 1990 to 2020 than in the entire record up to that point.

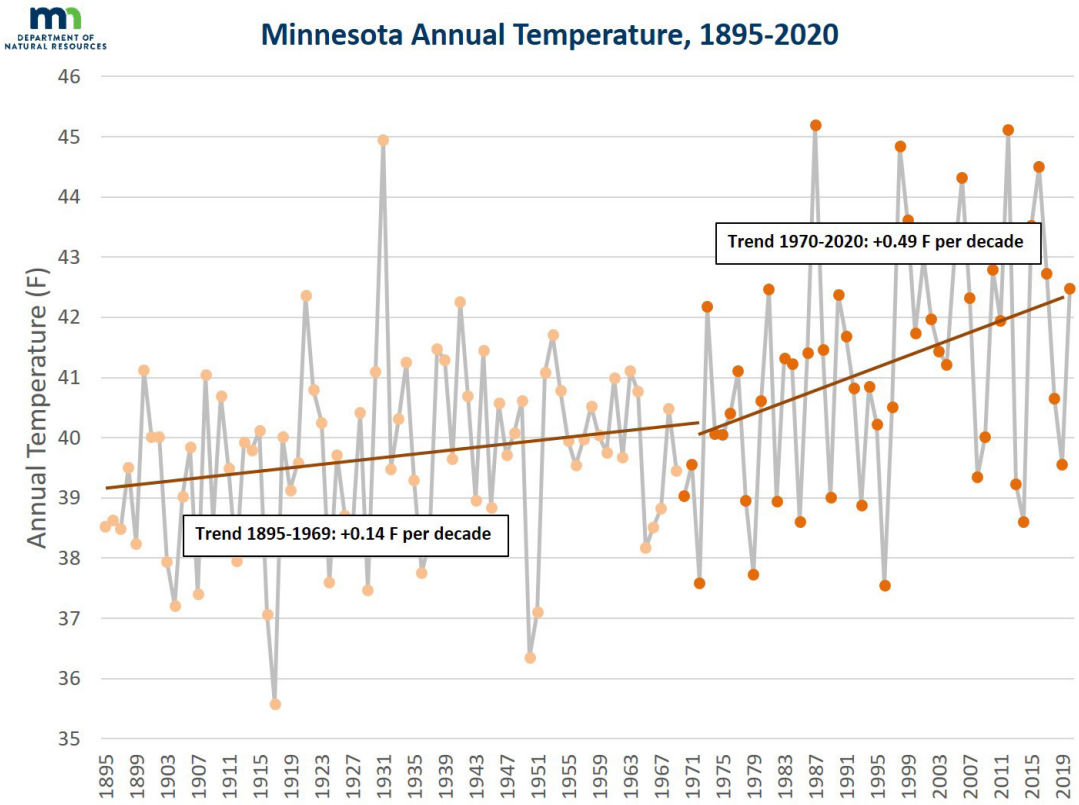


Figure 75: Minnesota annual temperature, 1895-2020

In 2018, the Minnesota Department of Natural Resources created a climate trend analysis tool that allows resource managers and planners to examine these statewide climatic changes in more detail, both seasonally and geographically. Using this tool will help inform the development of protection and restoration strategies, and the selection of implementation projects to anticipate changes in climatic patterns. The tool is available at Minnesota Climate Trends (https://arcgis.dnr.state.mn.us/ewr/climatetrends/#).

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.

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

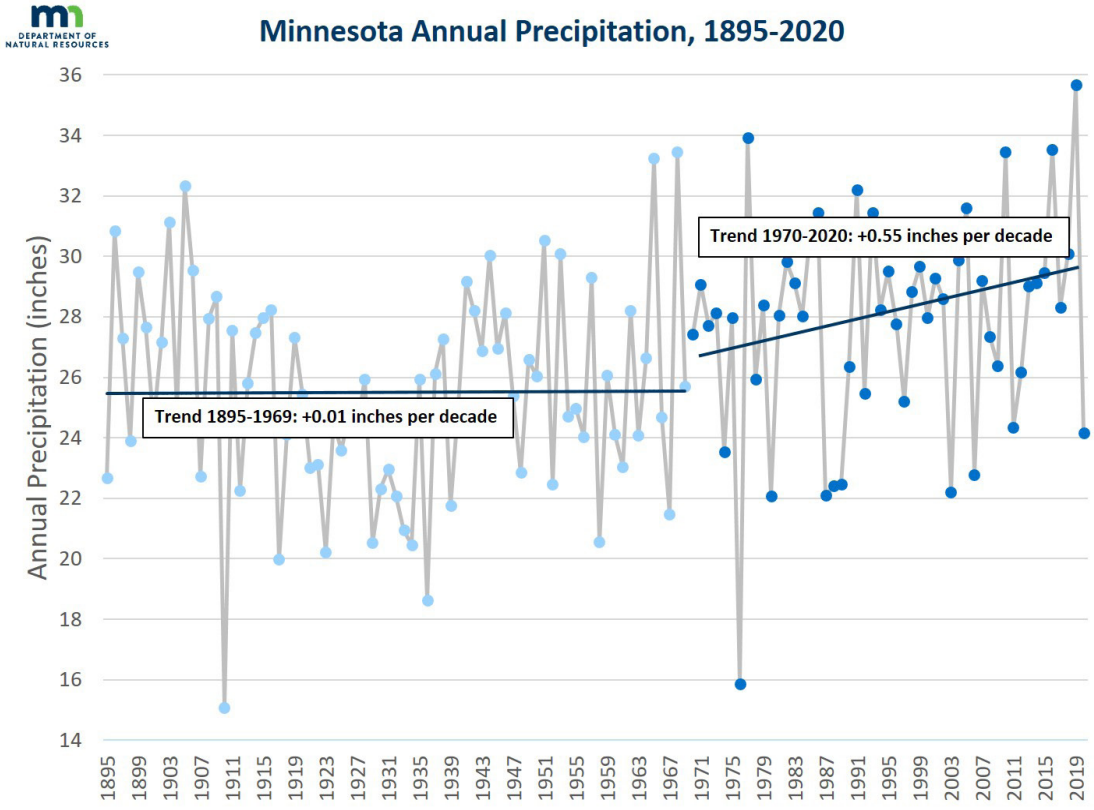


Figure 76: Minnesota average annual precipitaion, by decade

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

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