



Acetochlor Response Plan for Silver Creek

2024

Pesticide Technical Unit
Pesticide and Fertilizer Management Division

PTU.MDA@state.mn.us

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Purpose

This acetochlor response plan has been developed by the Minnesota Department of Agriculture (MDA) as a framework to address water quality concerns related to elevated concentrations of the herbicide acetochlor in Silver Creek (Carver County, MN). As a result of elevated acetochlor concentrations detected in the lower reach of Silver Creek this water body has been added to the United States Environmental Protection Agency (USEPA) 303(d) impaired waters list.

Introduction

In 2016, the Minnesota Pollution Control Agency (MPCA) added Silver Creek to the state's 303(d) impaired waters list for violations of the acetochlor chronic water quality standard. Acetochlor is an active ingredient in several agricultural herbicides that are commonly used to control a range of annual weeds in several Minnesota crops such as corn and soybeans. This response plan describes specific activities to be completed or evaluated in response to this water quality impairment.

Problem statement

Water quality samples collected from Silver Creek in 2012 and 2014 indicated acetochlor concentrations in excess to the MPCA chronic water quality standard, resulting in placement on the USEPA 303(d) impaired waters list in 2016. The chronic water quality standard for acetochlor in surface waters is 3,600 ng/L as a time-weighted average over four days. The standard needs to be exceeded twice during a three-year period to trigger a violation of the standard and support an impairment listing. This occurred in Silver Creek in May of 2012 and in June of 2014. The detection of acetochlor above the standard is a concern due to toxicity to aquatic organisms including aquatic plants. Removal of the acetochlor impairment on the USEPA 303(d) impaired waters list is possible with several consecutive years of monitoring without a detection over a chronic water quality standard.

Goal and specific objectives

The goal of the efforts detailed in this response plan is the removal of Silver Creek from the USEPA 303(d) impaired waters list by reducing the amount of acetochlor leaving the landscape and preventing drift [although drift is not a major contributor in surface water contamination]. The MDA plans to accomplish this through education and outreach, promotion of voluntary Best Management Practices (BMPs), and compliance assistance. This strategy can help growers maintain access to acetochlor products for weed management. State and federal law allows for restrictions on the use of acetochlor products to address unreasonable adverse impacts on the environment and, thus, if this response plan does not meet its goal the state and federal law can require that the use of a pesticide be limited or reduced to prevent adverse impacts on humans or the environment. Specific objectives of this response plan include,

- 1) Collect sufficient information about acetochlor use within the watershed and watershed characteristics to assist the MDA to make informed decisions about specific strategies for reducing movement from the landscape.
- 2) Identify acetochlor management strategies that are practical and demonstrate potential for reducing acetochlor transport into Silver Creek.
- 3) Provide education and outreach to landowners, farmers, pesticide applicators and other stakeholders related to the impairment of Silver Creek regarding acetochlor label requirements, acetochlor-specific BMPs, and general herbicide BMPs.
- 4) Continue monitoring Silver Creek for acetochlor.
- 5) Conduct label requirements compliance assistance and inspections.

Background

MDA's water monitoring program

The MDA collects water samples from agricultural and urban areas of Minnesota and analyzes water for up to approximately 180 different pesticide compounds that are widely used and/or pose the greatest risk to water resources. Surface water monitoring is conducted by the MDA and a variety of cooperators. All monitoring is completed following annual work plans and standard operating procedures (SOPs) developed by the MDA. Water quality pesticide data collected by the MDA is assessed by the MPCA for compliance with state water quality standards. The MDA releases an annual water quality monitoring report that includes a summary of available pesticide data and long-term trends. The report is available at [Agricultural Chemical Monitoring and Assessment](#).

There have been two previous acetochlor impaired waters listings in Minnesota. In 2008, the MPCA listed the Le Seuer River and Beauford Ditch in Blue Earth County as impaired for acetochlor. In cooperation with the Acetochlor Registration Partnership (ARP), local farmers and cooperatives, the MDA coordinated a response that resulted in delisting of the two water bodies in 2014. A report detailing the actions taken can be found at [Acetochlor Herbicide: Le Sueur River and Little Beauford Ditch Acetochlor Impairment Response Report](#).

Silver Creek watershed

The Silver Creek watershed is located at the western edge of the Twin Cities Metropolitan Area including portions of Carver and Sibley Counties. The Silver Creek watershed represents a drainage area of approximately 35.2 square miles (25,344 acres). The watershed is generally flat with medium to fine textured soils. Subsurface tile drainage is common in the area. A [2014 assessment of Bevens Creek](#) conducted by the Metropolitan Council estimated 36% of the agricultural land is likely tile drained based on soil type and slope.

Silver Creek is a tributary to Bevens Creek which is comprised of two major sub watersheds: the Bevens Creek main stem and Silver Creek. The land elevation gently slopes from west to east across the watershed. The headwaters of Silver Creek are generally located in Sibley County and flow northeasterly until it joins the

mainstem of Bevens Creek in northeastern San Francisco Township in Carver County (Figures 1 & 2). Bevens Creek then flows to the Minnesota River. The MDA also monitors pesticide water quality in Bevens Creek below the confluence with Silver Creek and in Sand Creek, located across the Minnesota River in Scott County.

Land use in the Silver Creek watershed is primarily comprised of cropland (90%) with forested lands being the second most abundant. Corn and soybeans are the major crops grown (United States Department of Agriculture (USDA) Cropscape).

Figure 1. A map showing Bevens Creek and Silver Creek

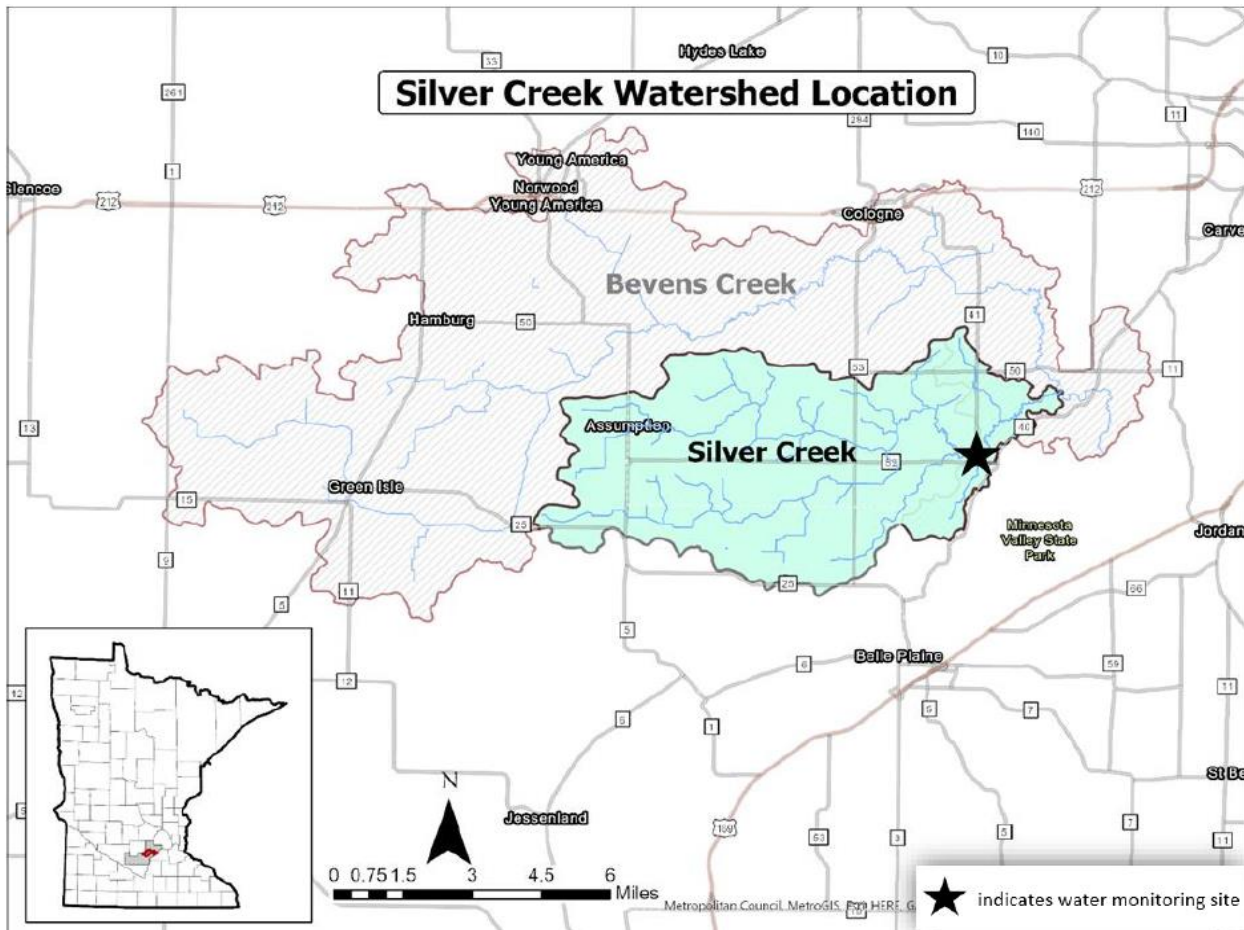
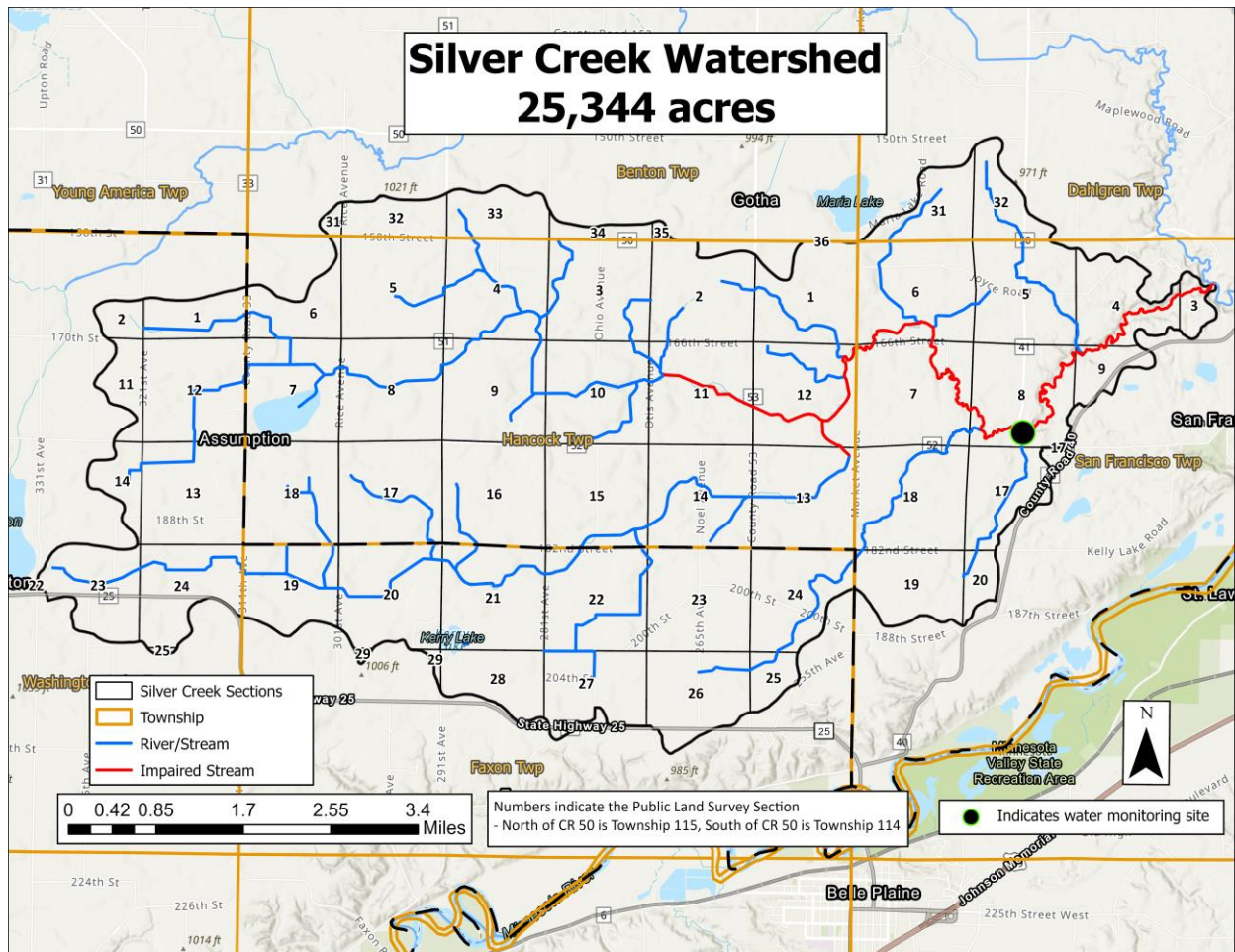


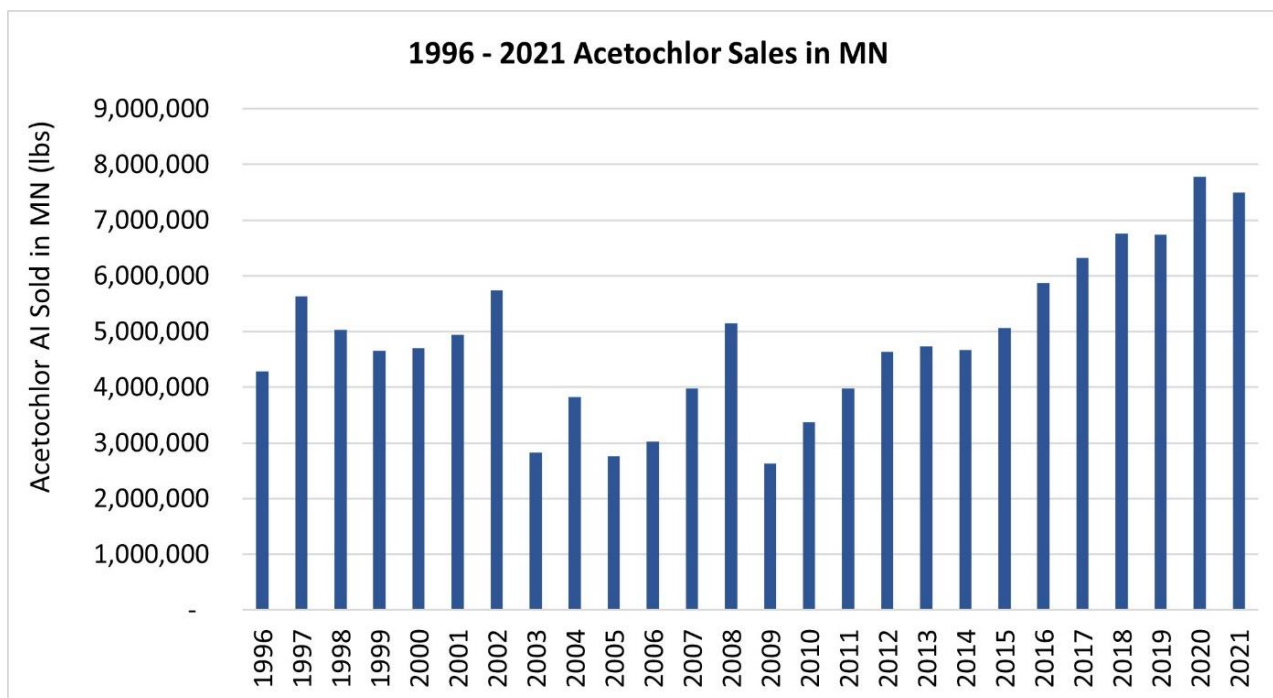
Figure 2. Silver Creek watershed overlaid on aerial photograph



Acetochlor use

Acetochlor is an active ingredient in several commonly used herbicides labelled for agricultural use. Since its introduction in 1994, acetochlor has been widely used as a pre-emergence herbicide on corn and soybeans. It controls many annual grass weeds, yellow nutsedge, and a limited number of annual broadleaf weeds such as pigweed and black nightshade. Some examples of products that contain acetochlor are Tripleflex, SureStart, Harness and Warrant. Statewide acetochlor sales doubled between 2010 and 2021 (Figure 3). In 2021, acetochlor was applied to 59% of Minnesota corn acres, making it the second-most-used corn herbicide in the state in terms of acres covered.¹

Figure 3. Statewide acetochlor sales in Minnesota, 1996 – 2021



Acetochlor is available both as standalone herbicide and as an active ingredient in herbicide mixtures. Acetochlor is often combined with atrazine, mesotrione, clopyralid and flumetsulam to enhance weed control effectiveness and manage herbicide resistance. A standalone acetochlor product is not a restricted use pesticide (RUP), but if acetochlor is used in combination with an RUP such as atrazine, the combined product has a RUP status.

Acetochlor has a water solubility of 223 mg/L and K_{oc} values of 28 to 369 mL/g suggesting that it has the potential to runoff to surface water.² The possibility of acetochlor leaving the field is more likely if weather and field conditions result in surface water runoff soon after application. Surface runoff of acetochlor can be reduced by shallow soil-incorporating the herbicide which increases pesticide-soil contact.³ The properties of acetochlor also suggest that it has potential to leach to groundwater, but leaching losses are generally thought to be less significant than surface runoff on most Minnesota soils. Acetochlor has a half-life of 8 – 20 days depending on soil types.² When acetochlor breaks down in the environment, some of its degradation products are more soluble and mobile than the parent compound and therefore have greater potential to be detected in surface water and groundwater. The most common acetochlor degradates detected are acetochlor ESA (ethanesulfonic acid) and acetochlor OXA (oxanilic acid), which are considered to be less toxic to aquatic life than the acetochlor parent compound.

Acetochlor monitoring in Silver Creek

Silver Creek has been monitored for pesticides including acetochlor since 2005. The 2012 and 2014 detections of acetochlor in back-to-back samples resulted in a violation of the chronic state water quality standard and led to

Silver Creek being designated as impaired for acetochlor in 2016 (Figure 4). The MDA has detected acetochlor over the chronic state water quality standard in nine samples between 2012 and 2022. It is common in Minnesota rivers and streams to have a temporary, short duration spike of herbicides in the first runoff event each year. But it is unusual to have acetochlor detected in any single river or stream over the chronic standard nearly every year like in the Silver Creek.

Figure 4. Acetochlor detections patterns by date in Silver Creek

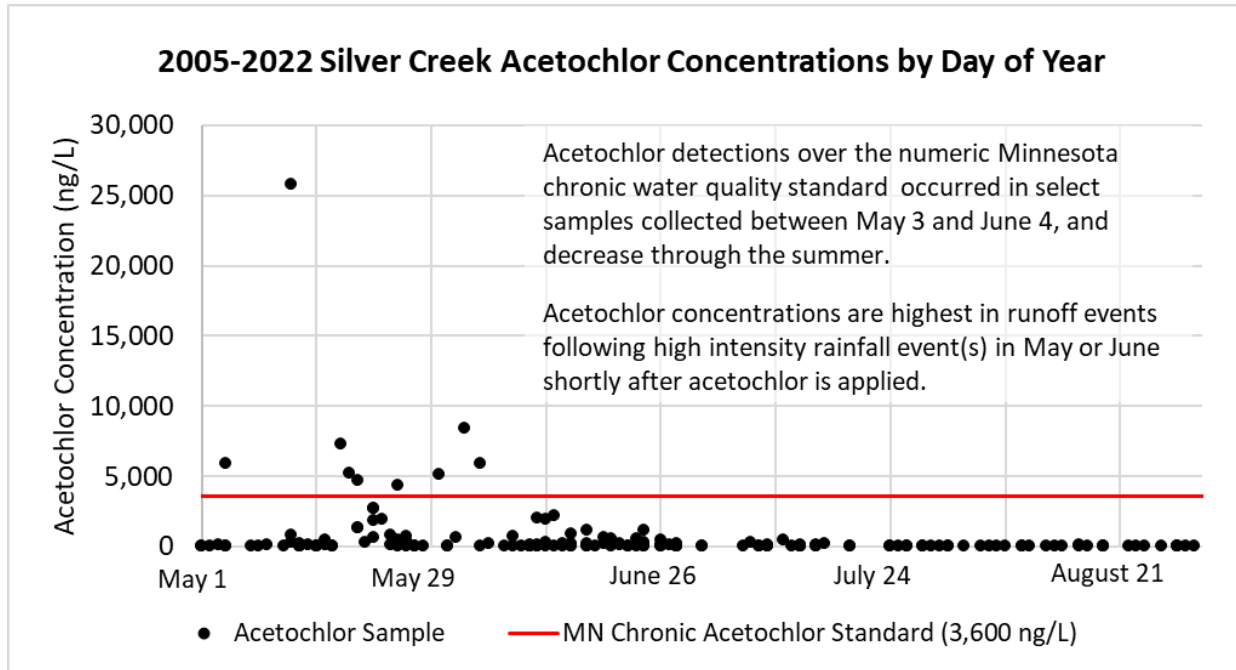
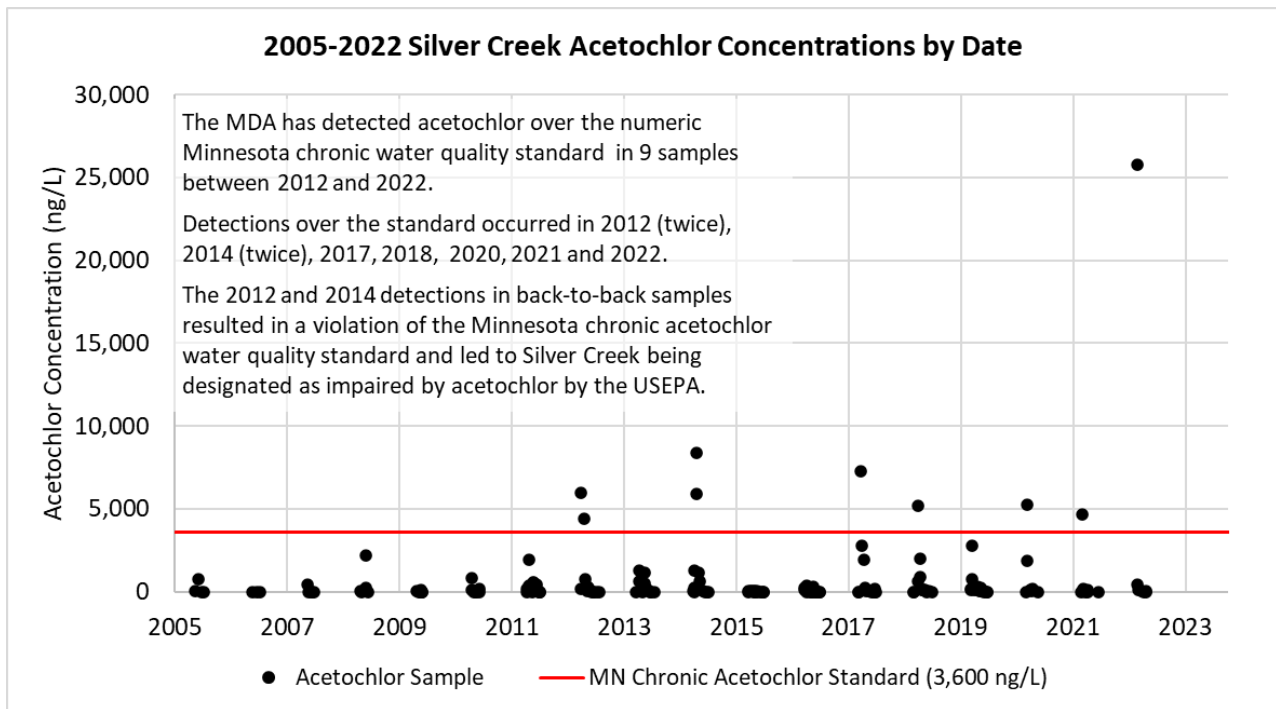


Figure 5. Acetochlor detections patterns by day of year in Silver Creek



From 2012 through 2022, all the acetochlor detections over the chronic water quality standard in Silver Creek occurred between May 3rd to June 4th (Figure 5). The majority of the elevated detections in Silver Creek occur during storm flow periods following acetochlor application to crop fields [storm flow conditions represent increased stream level (i.e., increased flow) and generally have lower stream transparency. Storm flow conditions occur most frequently following periods of rainfall-generated run-off and are the periods when detections of elevated herbicide concentrations typically occur]. This suggests that acetochlor is likely moving to Silver Creek with overland flow and potentially with subsurface tile drainage. Acetochlor levels detected during the remainder of the growing season are typically low relative to the standard. This is likely due to an absence of additional acetochlor applications after planting and the degradation of the acetochlor applied earlier in the season. Flow in Silver Creek can get very low in July and August as the maturing crops in the watershed use more water. No-flow conditions have been observed during late summer in some years, resulting in fewer pesticide samples being collected as pesticide sampling only occurs when the stream is flowing. The MDA’s water quality data suggests that removal of Silver Creek from the USEPA 303(d) impaired waters list for acetochlor would be largely tied to reducing the concentration of acetochlor in May and early June.

Acetochlor detection patterns in Silver Creek and nearby Creeks

Comparing water quality monitoring results from two watersheds near Silver Creek with similar land use, Bevens Creek, and Sand Creek, shows that Silver Creek appears to have a low diversity of key herbicide active ingredients compared to Bevens Creek and Sand Creek. Since 2008, acetochlor has dominated the composition

of the cumulative herbicide concentration in the Silver Creek samples. Acetochlor represents greater than 60% of the maximum herbicide concentration in Silver Creek for nine out of the last 15 years (Figures 6 & 7). In addition, acetochlor was detected over the Minnesota chronic standard in nine samples between 2012 and

Figure 6. 2005 - 2022 evaluation of acetochlor herbicide in the sample with the annual maximum herbicide concentrations for Silver Creek

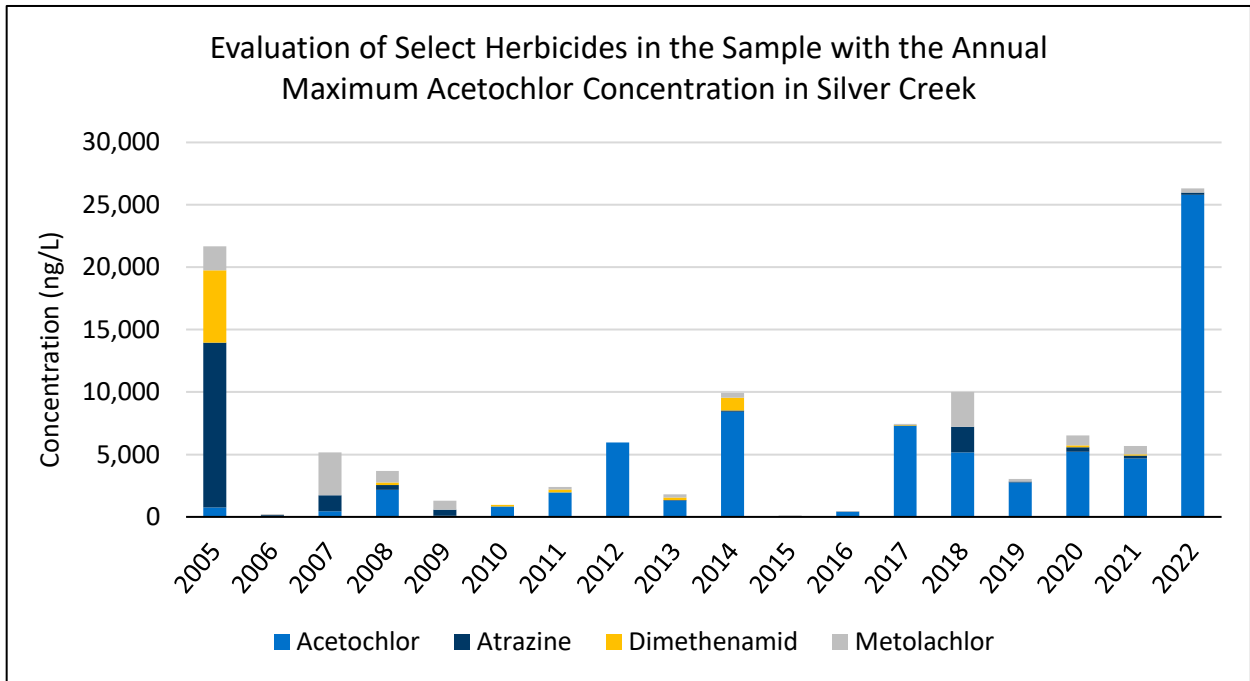
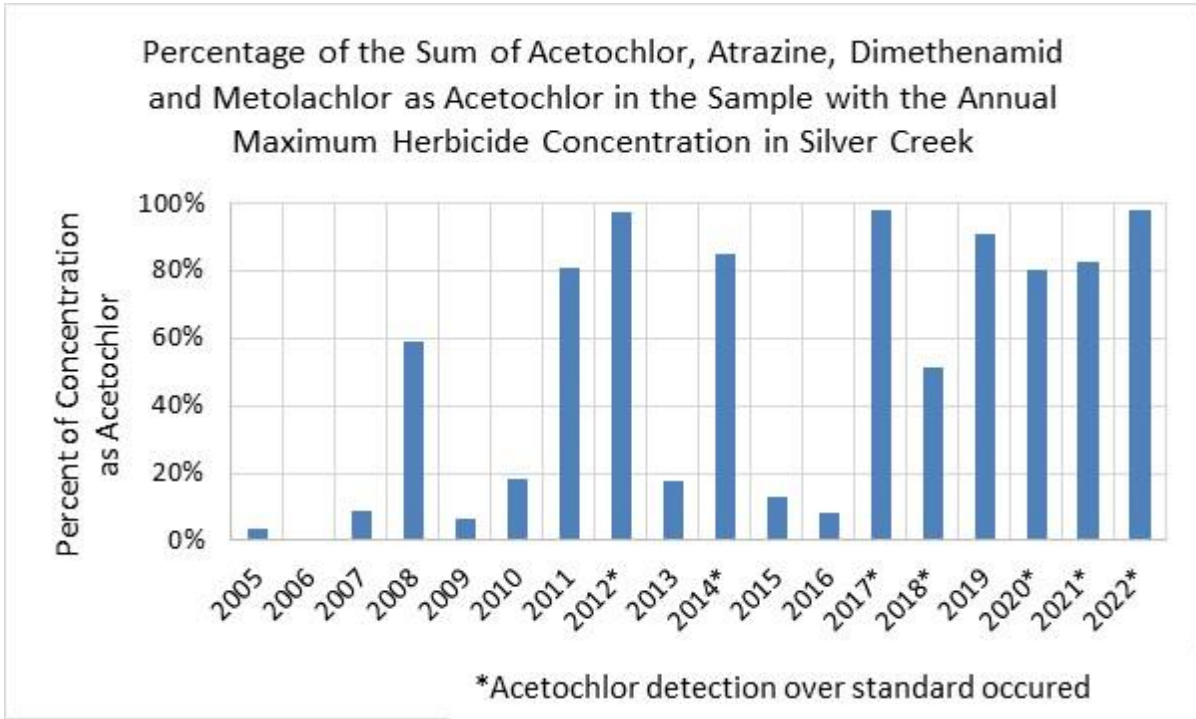


Figure 7. 2005 - 2022 percent of the sum of acetochlor, atrazine, dimethenamid and metolachlor as acetochlor in the sample with the annual maximum herbicide concentration in Silver Creek



Water samples from Bevens and Sand Creeks have a higher diversity of herbicide active ingredients than the samples from Silver Creek. In Bevens and Sand Creeks, acetochlor represents more than 60% of the maximum concentration in the samples for four and one out of 15 years, respectively (Figures 8, 9 10 & 11). Bevens and Sand Creek have a higher percentage of metolachlor, and to a lesser extent atrazine, in the annual maximum sample compared to Silver Creek. Bevens Creek has had two acetochlor detections over the Minnesota chronic standard (2014 and 2022) and Sand Creek has had one acetochlor detection over the Minnesota chronic standard (2014). Based on these water quality results, diversifying the herbicide active ingredients applied in the Silver Creek watershed would likely result in lower acetochlor concentrations in Silver Creek.

Figure 8. 2005 - 2022 evaluation of acetochlor herbicide in the sample with the maximum herbicide concentrations for Bevens Creek

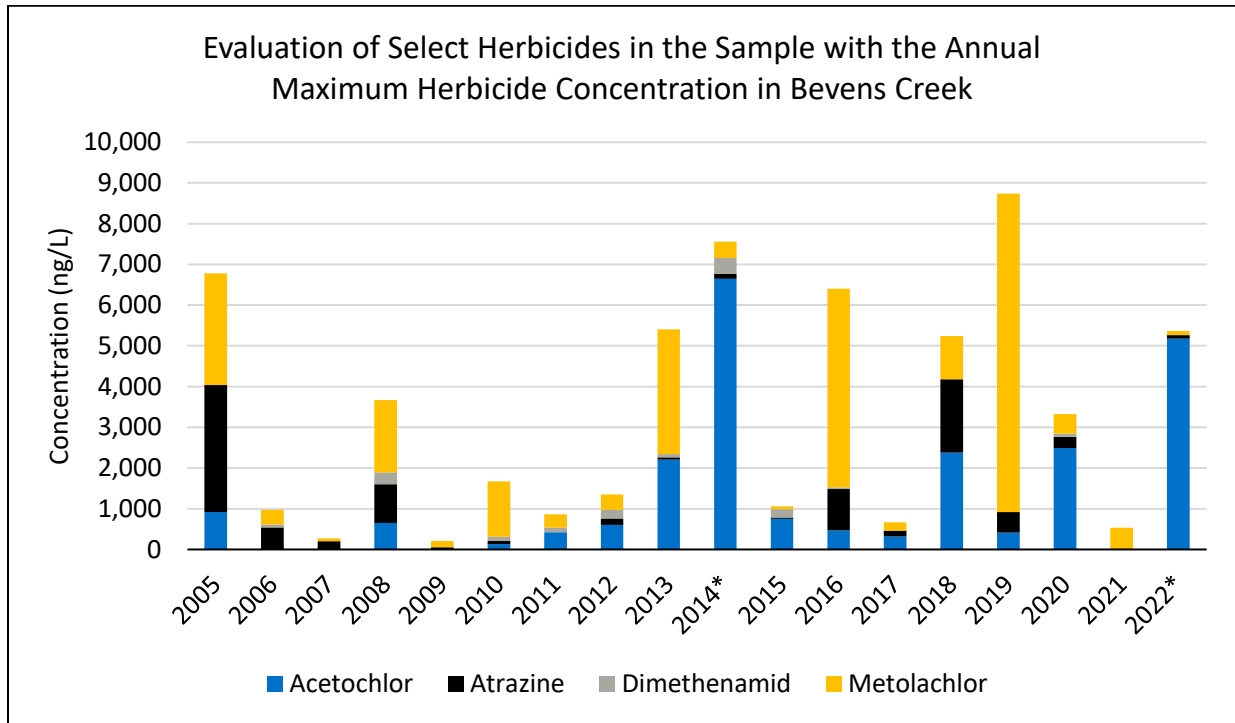


Figure 9. 2005 - 2022 percent of the sum of acetochlor, atrazine, dimethenamid and metolachlor as acetochlor in the sample with the annual maximum herbicide concentration in Bevens Creek

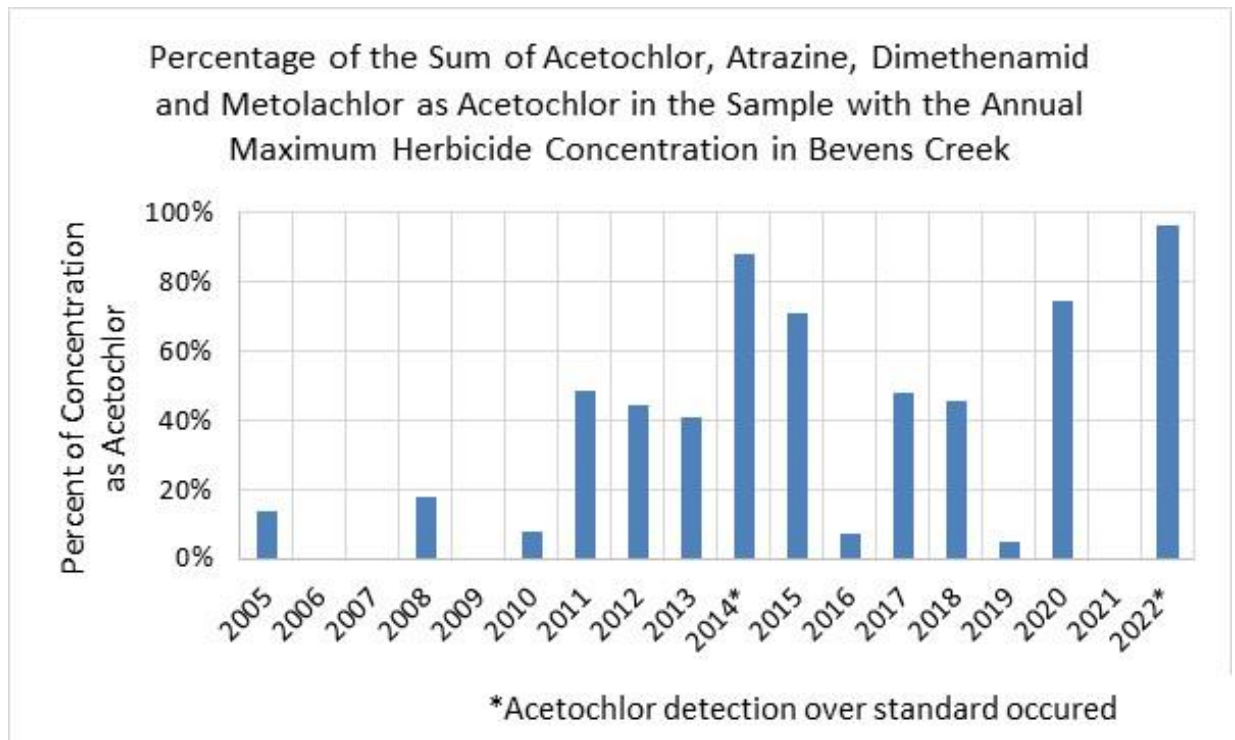


Figure 10. 2005 - 2022 evaluation of acetochlor herbicide in the sample with the maximum herbicide concentrations for Sand Creek

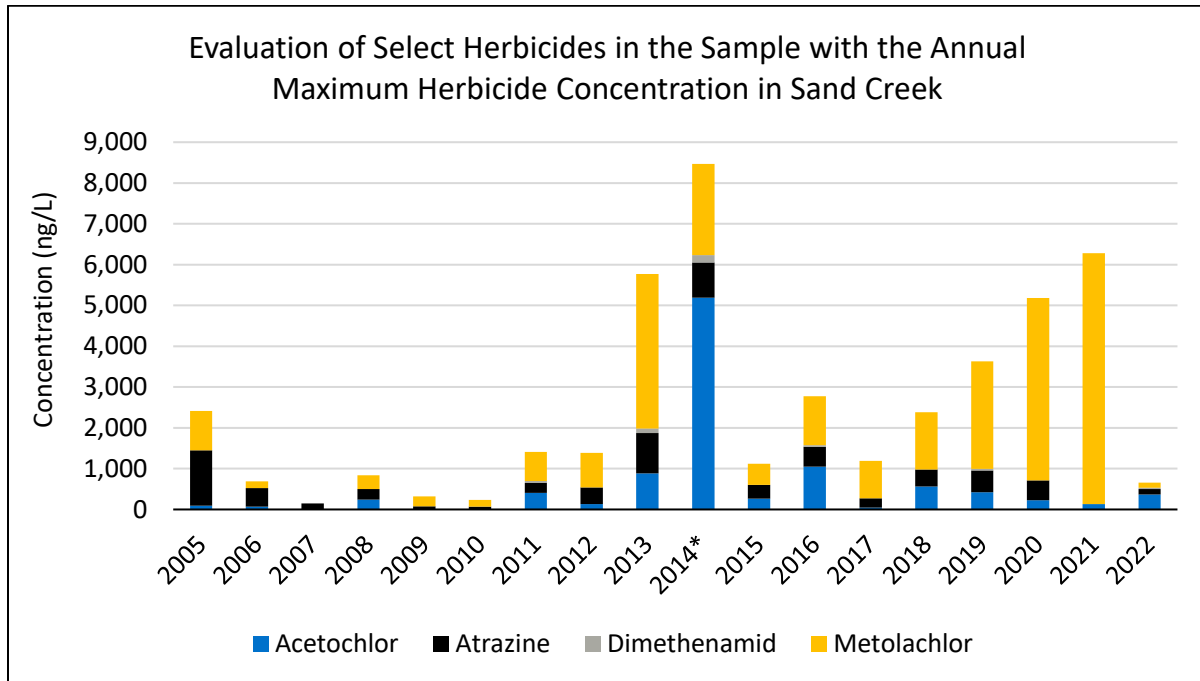
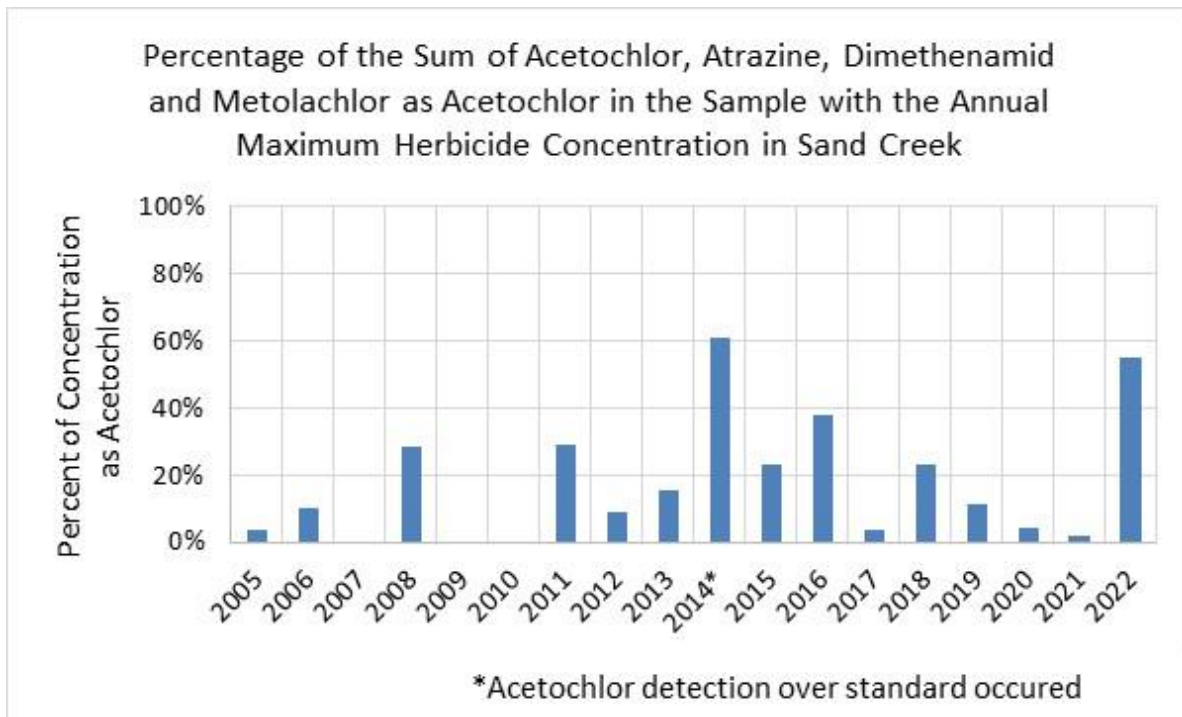


Figure 11. 2005 - 2022 percent of the sum of acetochlor, atrazine, dimethenamid and metolachlor as acetochlor in the sample with the annual maximum herbicide concentration in Sand Creek



Activities

Activity 1: Collect basic information about acetochlor use, site characteristics and key implementing partners including acetochlor management strategies

Sub activity 1.1: Develop partnerships with stakeholders

Collaborators	Carver County Water Management Organization, UMN Extension, Cooperatives/Dealers, Carver County Soil and Water Conservation District, Acetochlor Registration Partnership (ARP)
Scope	A list of potential collaborators located in the Silver Creek watershed area will be created.
Output	Regular meetings and communication with collaborators, stakeholder contact information
Timeline	2023 onward

Sub activity 1.2: Collect basic information on local acetochlor use practices

Collaborators	Cooperatives/dealers, crop consultants, UMN Extension, Carver County Water Management Organization
Scope	Local acetochlor sale/distribution data will be collected. Information on acetochlor use practices will be collected from cooperatives, dealers and/or growers.
Output	Summary of findings for internal use
Timeline	2023

Sub activity 1.3: Collect basic information about the Silver Creek watershed including site characteristics that may influence acetochlor movement and detections

Collaborators	Carver County Soil and Water Conservation District, Carver County Water Management Organization, UMN Extension, Cooperatives/Dealers
Scope	Information on local land use and site characteristics will be collected to better understand the potential environmental transport and movement of acetochlor.
Output	Local land use and site information

Timeline	2023/2024
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Sub activity 1.4: Identify acetochlor management strategies that are practical and demonstrate potential for reducing acetochlor transport to Silver Creek

Collaborators	Cooperatives/Dealers, UMN Extension
Scope	Acetochlor management strategies in reducing acetochlor transport to Silver Creek will be identified in consultations with local partners and based on the information collected in sub-activities 1.2 and 1.3 above. Le Sueur River and Little Beauford Ditch acetochlor impairment response report will also be consulted.
Output	Summary of findings for internal use
Timeline	2023/2024

The MDA has already started work to implement some of the above-listed sub activities. In consultation with Carver County Water Management Organization, UMN Extension, and Carver County Soil and Water Conservation District, three cooperatives, two crop consultants, and one seed dealer that serve the growers in the Silver Creek watershed were identified as important stakeholders in the area. The MDA is also exploring collaboration with Acetochlor Registration Partnership. In February and March of 2023, the MDA visited three cooperatives, one seed dealer and one independent crop consultant based in Brownton, Belle Plaine, Cologne, and Norwood Young America, informed them about the acetochlor impairment in Silver Creek and discussed potential acetochlor management collaboration opportunities. These stakeholders expressed a desire and willingness to work together to address the acetochlor impairment in Silver Creek. Information on acetochlor use practices and adoption of the MDA’s recommended acetochlor BMPs was also collected from the agronomists (15) during the visits.

According to the United States Department of Agriculture (USDA) Cropscape layer, there were approximately 10,000 acres of corn and 9,000 acres of soybeans grown in the watershed in the 2022 season, which accounts for about 87% of the total land use. Acetochlor was used on both field corn and soybean acres in the watershed. It was used as a pre-emergence herbicide for control of grass and broadleaf weeds. Surestart, Tripleflex, Resicore, Harness Max and Warrant were commonly applied in the area in 2022 growing season (acetochlor products use details are given in Table 1; source: coops/dealer agronomists). All products used in corn acres were premixes, while only one standalone acetochlor product was used on soybeans in 2022 growing season. The agronomists present in the meetings estimated that approximately 7,500 (77%) of corn acres and 600 (7%) of soybeans acres received some application of acetochlor in 2022. Not all farmers had all of their acres within the watershed and not all farmers reported to the dealer/coop the location of the applications.

Table 1. Acetochlor use details in corn and soybean in the Silver Creek watershed

Crop	Acres	Product	% of AI	Timing	Rate Range/average
Corn	5800	Tripleflex	Acetochlor: 41.67 Clopyralid: 4.27 Flumetsulam: 1.3	Before planting incorporated and after planting not incorporated	2 – 2.5 pints
Corn	600	Surestart	Acetochlor: 41.67 Clopyralid: 4.27 Flumetsulam: 1.3	Preplant incorporated	1.75 pints
Corn	800	Resicore	Acetochlor: 31 Clopyralid: 2.7 Mesotrione: 3.3	Preplant and post emergence	1.75-2 quarts
Corn	300	Harness Max	Acetochlor: 39.1 Mesotrione: 3.7	Post emergence	2 quarts
Soybeans	600	Warrant	Acetochlor: 33	Post emergence with glyphosate	1.5 quarts

Pesticide dealers and crop consultants were aware of [the MDA recommended acetochlor BMPs](#). They informed that growers in the watershed were also aware of many of these BMPs, and BMPs such as vegetative setbacks, filter strips, conservation tillage, and preplant incorporation were already in use in the watershed. All preplant acetochlor was incorporated, but there was no post-plant incorporation of acetochlor [pre-plant application includes acetochlor that is applied prior to crop planting. Post-plant application includes acetochlor that is applied post crop emergence]. Crop fields were scouted for weed pressure in some capacity. There was no in-season cultivation such rotary hoe or row cultivator used for weed management.

The Silver Creek watershed is generally flat with medium to fine soils, and it has a slightly rolling terrain with coarser soils on the eastern edge. Agricultural lands are drained through a network of ditches, and several large, shallow wetlands are present. Subsurface tile drainage is common in the area. Approximately 50% of the agricultural land is likely tile drained. An acetochlor response plan report for the Le Sueur River and Little Beauford Ditch impairments suggested that acetochlor was primarily lost through runoff and tile drainage. Based on field studies and computer modelling, soil incorporation, buffer strips, use of non-acetochlor herbicides, reduced application rates, and application of acetochlor well in advance of spring rainstorms were found to be good management strategies to reduce the acetochlor loss. Strategies such as soil incorporation,

buffer strips, and use of non-acetochlor herbicides could be applicable to reduce the acetochlor from reaching the Silver Creek.

Activity 2: Provide education and outreach to local acetochlor users on the impairment of Silver Creek, acetochlor label requirements, and best management practices (BMPs)

Sub activity 2.1: Update acetochlor BMPs and develop additional outreach materials

Collaborators	UMN extension, Acetochlor Registration Partnership
Scope	Acetochlor BMPs will be updated as needed and will be promoted in the watershed in cooperation with local partners. Additional outreach materials on acetochlor will be developed as needed.
Output	Acetochlor BMPs, additional outreach material
Timeline	2024

Sub activity 2.2: Conduct education and outreach about the Silver Creek impairment, acetochlor label requirements, BMPs, and other related topics

Collaborators	Carver County Water Management Organization, Carver County Soil and Water Conservation District, UMN Extension, crop producers, cooperatives/dealers, pesticide applicators, crop consultants, Acetochlor Registration Partnership, and other interested parties
Scope	An informative letter will be sent to local partners including landowners/growers to aware them about the impairment. The MDA’s acetochlor BMPs, which include both mandatory label requirements and voluntary practices will be promoted through partners’ outreach and educational activities including UMN extension activities, local events/fairs, and available media platforms such as presentations, webinars, social media etc.
Output	Informative letters, outreach emails and messages, newsletter articles, social media postings, presentation slides and recordings
Timeline	2023-2028

The MDA met with an UMN Extension educator and representatives from Carver County Water Management Organization and Carver County Soil and Water Conservation District in 2022 and 2023 to discuss opportunities for acetochlor outreach and education. In 2022, an article on acetochlor setback requirements was shared with landowners/growers in Silver Creek watershed through local UMN extension newsletter. Articles on the acetochlor impairment in Silver Creek and acetochlor BMPs were shared through the PFMD newsletter in 2023.⁴ Messages were shared through the MDAs’ official twitter and Facebook sites to promote acetochlor BMPs. An informative letter along with the acetochlor BMPs was mailed to more than 300 landowners in Silver Creek watershed in summer 2022, and spring and fall 2023 to inform them about the acetochlor impairment and to promote acetochlor BMPs including the rotation of acetochlor products with non-acetochlor herbicides. A similar letter was also sent in July 2023 to the cooperatives, crop consultants and dealers that were visited in spring 2023.

Activity 3: Continue acetochlor monitoring in Silver Creek to determine if it is meeting state water quality standards

Collaborators	Carver County Water Management Organization
Scope	The MDA will continue to partner with Carver County Water Management Organization to collect samples from Silver Creek as part of its statewide monitoring program. The MDA will provide training, supplies, shipping logistics and analysis of the samples. The MDA will explore adding more monitoring sites, increasing sampling frequency and analyzing extra samples from Silver Creek.
Output	Water quality monitoring reports
Timeline	On-going activity

Activity 4. Conduct label requirements compliance assistance and inspections

Collaborators	Coops/dealers, applicators
Scope	Label requirements compliance assistance will be conducted with applicators. Targeted field inspection may be conducted if needed, depending on the effectiveness of the implemented activities in addressing the impairment. This may include inspecting cooperatives, dealers and/or applicators for compliance with label requirements.
Output	Inspection records
Timeline	2025 - 2028

Activity 5: Track and review the implemented activities and revise the response plan as needed

Collaborators	MPCA
Scope	The implementation status and progress of each activity will be tracked and reviewed annually. The response plan will be reviewed and revised as needed.
Output	Meeting notes
Timeline	2023 - 2028

Activity 6: Complete a response report summarizing the actions taken and any changes in Silver Creek acetochlor detections

Collaborators	MPCA
Scope	A short report detailing the progress of each activity will be prepared annually. A final report detailing the actions, findings, and outcomes of response plan will be written. Based on the outcome and evidence collected through water quality monitoring, the MDA will work with the MPCA to assess water quality data and discuss waterbody impairments.
Output	Annual progress report, final report
Timeline	2024-2028

Potential impacts of response plan

If water monitoring results indicate no additional acetochlor standard violations and the outcomes of the MDA’s response plan suggest current actions are adequate to prevent future violations through changes in acetochlor use or management, the Silver Creek may be considered for removal (delisting) from the 303(d) impaired waters list.

Recommendations for delisting water bodies from the 303(d) impaired waters list are made by the MPCA Assessment Consistency Technical Team (ACTT) every two years. The ACTT only makes recommendations for delisting water bodies from the 303(d) impaired waters list; final determinations are made by the United States Environmental Protection Agency (USEPA).

Recommendations for delisting are based on the weight of evidence with consideration given to quality and quantity of available data, weather and flow conditions, and documented changes in the watershed that could affect water quality. Particularly important for the delisting a waterbody impaired for acetochlor would be,

- new water quality data, collected during critical application periods, that indicates the water body is meeting water quality standards,
- changes in acetochlor use or management sufficient to provide reasonable assurance that future exceedances are unlikely even during critical spring run-off events; and
- no exceedances of either the chronic or acute water quality standard for acetochlor for several consecutive years.

References

¹ [United States Department of Agriculture National Agricultural Statistics Service \(2022\). Minnesota Ag News – Chemical Use \(Corn: fall 2021\).](#)

² [US Environmental Protection Agency \(2020\). Acetochlor: Draft Ecological Risk Assessment for Registration Review \(EPA-HQ-OPP-2016-0298\) P: 16-18](#)

³ [Acetochlor Herbicide: Le Sueur River and Little Beauford Ditch Acetochlor Impairment Response Report](#) .

⁴ MDA (2023 April). Acetochlor Herbicide Impairment in Silver Creek. Pesticide and Fertilizer Management Division (PFMD) Update. P9. & MDA (2023 September). Water Quality BMPs for Acetochlor Herbicide. Pesticide and Fertilizer Management Division (PFMD) Update. P6.