PESTICIDES

Key Takeaways

Monitoring groundwater for pesticides contamination is very important for human and environmental health. A DATCP review of data from samples it collected statewide from 2008 through 2016 revealed an increased occurrence of detections of neonicotinoid insecticides in samples collected from monitoring wells, irrigation wells, private wells and surface water samples. In 2023, DATCP conducted a random sampling of approximately 400 wells across the state. The herbicide metabolites metolachlor ESA and alachlor ESA were identified as the most frequently detected pesticide compounds in groundwater. Imidacloprid, a neonicotinoid insecticide, was found in one well at a concentration exceeding the drinking water health advisory level of 0.2 parts per billion (ppb) set by the Wisconsin Department of Health Services (DHS).

GCC member agencies continue to work on multiple initiatives related to reducing pesticides in groundwater (see groundwater management sections – DNR, DATCP, UW). For actions to address pesticides contamination in groundwater, see the Recommendations Section.

Sections in this document

What are pesticides?

Pesticides are a broad class of substances designed to kill, repel or otherwise disrupt living things that are considered pests. They include insecticides, herbicides, fungicides and anti-microbials, among other types of biocides. Normal field applications, spills, misuse or improper storage and disposal can all lead to pesticide contamination in groundwater. As pesticides break down in soil and groundwater or are absorbed and metabolized by the target pest, some are converted into related compounds called metabolites, which may also be harmful to the pest or other living things.

Pesticide application sign. Photo: DATCP.

What are the human health concerns?

The health effects of exposure to pesticides or pesticide metabolites vary by substance. About 30 pesticides (and some pesticide

metabolites) currently have ch. NR 140 groundwater quality standards (WI NR 140.10), and a smaller number have an established maximum contaminant level (MCL), applicable at public drinking water systems (WI NR 809.20). However, there are approximately 500 unique agricultural pesticide active ingredients used in Wisconsin. Occasionally, pesticides and pesticide metabolites that do not have established NR 140 groundwater quality standards or a public drinking water MCL are detected in drinking water supplies, and information on the health effects of these pesticide compounds is often very limited or difficult to evaluate. In instances where NR 140 groundwater quality standards or a public drinking water MCL has not been established for detected pesticides, we rely on the DHS Drinking Water Health Advisory Levels to assess concerns. It is also difficult to predict the health effects of multiple pesticides in drinking water; several studies have indicated that pesticide mixtures can have different health effects than exposure to individual pesticides at the same concentrations[1,2].

Commonly detected pesticides and their metabolites which have established groundwater quality or drinking water standards in Wisconsin include atrazine, alachlor, metolachlor, and acetochlor, and their metabolites.

Atrazine is an herbicide commonly used on corn. The groundwater quality ES for atrazine and its three chlorinated metabolites (de-ethyl atrazine, deisopropyl atrazine and diamino atrazine) is 3 ppb, or micrograms per liter (µg/L). The drinking water MCL for atrazine (does not include metabolites) is 3 ppb. A number of epidemiological and animal studies have been conducted evaluating the potential health and environmental impacts from atrazine exposure[3-9] . People who drink water containing atrazine in excess of health-based standards over many years could experience problems with their cardiovascular system or reproductive difficulties.

Alachlor was used as an herbicide on corn and soybeans. Use of alachlor in Wisconsin has been replaced by other herbicides in the same family[10,11] (e.g., metolachlor, acetochlor), however, alachlor metabolites are still detected in groundwater. Both the groundwater quality enforcement standard (ES) and public drinking water MCL for alachlor are 2 ppb, and the groundwater quality ES for one of its metabolites, *alachlor ESA*, is 20 ppb. People who drink water containing alachlor in excess of health-based standards over many years could have problems with their eyes, liver, kidneys or spleen, may experience anemia, and may have an increased risk of getting cancer.

Metolachlor is an herbicide used widely on corn and soybeans, and on vegetable crops including peas, snap beans and potatoes. Both the parents, metolachlor and s-metolachlor, and metabolite forms, metolachlor-ESA and metolachlor-OXA, are routinely detected in groundwater. Health-based groundwater quality standards have been established for these compounds. The groundwater quality ES for metolachlor is 100 ppb, and the groundwater quality ES for metolachlor-ESA and OXA combined is 1,300 ppb. Although metolachlor and its metabolites are

commonly detected in groundwater, the concentrations detected are typically well below their respective ESs.

Acetochlor is an herbicide used for pre-emergent control of weeds in corn. The state groundwater quality ES for acetochlor is 7 ppb. A groundwater quality ES of 230 ppb has also been established for the combined acetochlor metabolites, acetochlor ESA and acetochlor OXA. No public water supply MCL has been established for acetochlor or its metabolites. Animal studies have shown that oral exposure to acetochlor can produce significant neurological effects[12]. Acetochlor has been classified by the EPA as a "suggestive human carcinogen".

How widespread are pesticides in Wisconsin?

In Wisconsin, the main source of pesticides in groundwater is agricultural herbicide and insecticide applications. For this reason, detection is more common in highly cultivated areas where agriculture is well established, notably in the south central, central and west-central parts of the state.

In 2023, DATCP conducted a statewide statistical survey of agricultural chemicals in groundwater by sampling 380 private potable wells across Wisconsin[13]. Water samples were analyzed for 106 pesticide compounds, including 56 herbicides, 16 herbicides metabolites, 26 insecticides, two insecticides metabolites, four fungicides and one pesticide safener. This study found that an estimated 43.1% of private wells in Wisconsin contained a pesticide or pesticide metabolite, up from 41.7% found in a similar survey conducted in 2016[14].

The primary metabolites of metolachlor and alachlor, metolachlor ESA and alachlor ESA, were the two most commonly detected pesticide products in those surveys. Metolachlor ESA and alachlor ESA 2023 estimated statewide detection rates were 36.1% and 19.6%, respectively. Atrazine and its metabolites, known collectively as the total chlorinated residues of atrazine (atrazine TCR), were also prevalent and occurred in about 20% of wells.

Neonicotinoids insecticides (clothianidin, imidacloprid, or thiamethoxam) were estimated to be found in 5.3% of the wells, with clothianidin being the most detected neonicotinoid compound in groundwater. In one sample, imidacloprid was found at a level exceeding the DHS Drinking Water Health Advisory of 0.2 ppb. No other pesticide compounds were found in exceedance of NR 140 groundwater quality ESs, public drinking water MCLs or DHS Drinking Water Health Advisories.

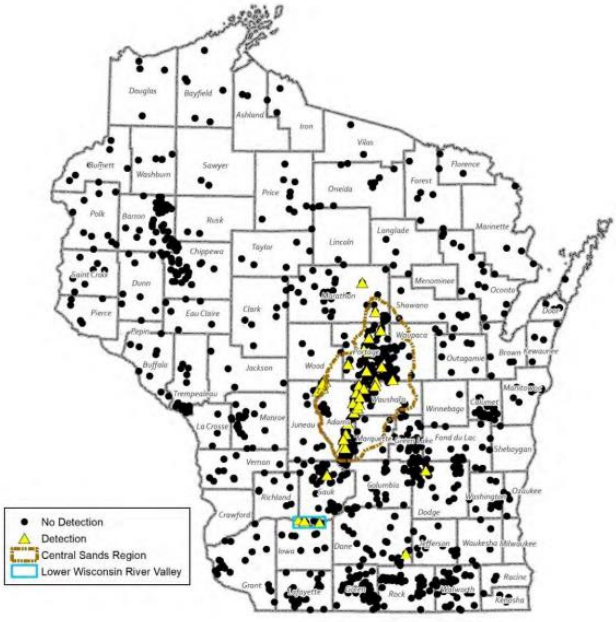
In addition to capturing the current picture of agricultural chemicals in groundwater, this study also relates these findings to land use and compares results of the 2023 survey to those of previous surveys. The final report of the results of the 2023 survey was published in early 2024[13]. Publications of DATCP agricultural chemical in groundwater surveys are available on the web at: datcp.wi.gov/Pages/Programs_Services/GroundwaterReports.aspx.

How is pesticides contamination trending over time?

Many sampling programs initiated by DATCP, the DNR and other agencies in the mid-1980s to early 1990s are still ongoing today. The longest running sampling program for pesticides began in 1985 and is designed to evaluate the potential impact of agriculture on groundwater quality by sampling monitoring wells near selected agricultural fields in areas with high groundwater contamination potential. Testing in this program confirms that metolachlor ESA, alachlor ESA, and clothianidin are the most common pesticide related agricultural chemicals detected in groundwater at the monitoring well sites.

A DATCP review of data from samples it collected statewide from 2008 through 2016 revealed an increased occurrence of detections of neonicotinoid insecticides in samples collected from monitoring wells, irrigation wells, private wells, and surface water samples.

DATCP reported detections of the neonicotinoid insecticides clothianidin, imidacloprid and thiamethoxam in samples from monitoring wells, irrigation wells, and private wells tested, with most detections occurring in sandy irrigated vegetable growing areas in the Central Sands region and on terraces of the Wisconsin River Valley[15]. This review also reported that out of 34 streams sampled statewide, multiple detections of imidacloprid and thiamethoxam were reported year-round in two streams also located within the Central Sands region.



Locations of neonicotinoid detections in all potable wells sampled - 2008 through 2016.

Concentrations of total neonicotinoids detected in these streams pose significant concerns for aquatic invertebrates and other non-target aquatic species present in the streams. The report detailing the findings of DATCP's review was shared with U.S. EPA as they continue to evaluate the role that these compounds may have in declining pollinator populations nationwide.

Another study that has been repeated annually since 1995 focuses on re-sampling wells that once previously exceeded a pesticide standard. Over 160 wells have been sampled multiple times in this program, and over time, atrazine levels have been shown to decline in about 80% of the wells[16]. Many of these wells are located in what are now atrazine prohibition areas and the declines are likely the direct result of restrictions placed on the use of this pesticide in these areas.

DATCP has also conducted a statewide, statistically designed survey of agricultural chemicals in Wisconsin groundwater six times since the early 1990s (1994, 1996, 2001, 2007, 2016, and 2023). Recent analysis revealed that metolachlor ESA, and atrazine TCR estimated statewide detection rates increased since 2007 but remained stable since 2016. Alachlor ESA estimated statewide detection rates remained stable since 2001. Neonicotinoids (clothianidin, imidacloprid or thiamethoxam) estimated statewide detection rates increased since 2016.

DATCP began oversight of a Stipulated Agreement and Special Order between DATCP and Bayer CropScience (BCS) related to the limited use of the BCS pesticide isoxaflutole in Wisconsin. Isoxaflutole is a relatively new corn herbicide that has a high likelihood of leaching into groundwater. The Stipulated Agreement allows for its use on corn grown in just 12 counties (Columbia, Dane, Dodge, Fond du Lac, Grant, Green, Jefferson, Lafayette, Rock, Sauk, Walworth, and Waukesha) while BCS performs specific studies over eight years that are intended to evaluate the potential for surface or groundwater impacts. In 2019 Bayer completed isoxaflutole and isoxaflutole metabolites monitoring at the surface water tile drainage sampling sites in areas that received isoxaflutole applications. In October 2023, BCS concluded groundwater monitoring at eight sites over a multi-year study period.

Further Reading

- DHS resources for contaminants in drinking water
- DNR overview of pesticides in drinking water wells
- DATCP water quality reports
- DATCP Home Groundwater Standards for Pesticides

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