Protecting Groundwater from Nonpoint Source Contamination

What's the issue?

Any time rainfall or snowmelt runs across the land surface, this water picks up some amount of soil, nutrients, and other pollutants. Just as this runoff can cause water quality problems in streams and other surface water bodies, it can also carry contaminants to groundwater when it seeps into the soil. On agricultural landscapes, runoff may pick up bacteria, nutrients, or pesticides through contact with soil, manure, or crops. In urban areas, road salt and organic compounds from impervious surfaces are typical nonpoint contaminants.

Flooded fields after manure spreading can quickly carry nitrogen and other nonpoint source pollution to the groundwater. *Photo: Marty Nessman, DNR.*

Protecting groundwater from nonpoint source contamination is a complex management challenge. In contrast to "point source pollution," which comes from an easily identifiable source like a pipe, it is very difficult to sort out relative contributions from sources scattered across the landscape. Even when the contributing areas are well known, the effectiveness of alternative management strategies can be highly dependent on landscape characteristics like soils and slopes that vary considerably from site to site. In addition, many nutrients and other pollutants build up in groundwater and respond very slowly to changes in inputs. Although groundwater sometimes responds within months or a few years, it is not unusual for it to take decades to see environmental results from a change in management strategy.

Because of this high variability and long timescales, long-term monitoring and scientific research that evaluates management practices for nonpoint contaminants are routinely identified as priorities by the Groundwater Coordinating Council (GCC). Approximately 25% of all research projects funded by the Wisconsin Groundwater Research and Monitoring Program since 1984 have been related to nonpoint contaminants. Agricultural contaminants are of particular concern, since nitrate is one of the top drinking water contaminants in the state and pesticides and their metabolites are estimated to exist in one third of all Wisconsin wells (DATCP, 2008).

GCC in Action: *The Atrazine Rule*

The development of the Atrazine Rule (ATCP 30, Wis. Adm. Code) illustrates how the benefits of long term state-funded research and monitoring can build on one another over time to effectively protect public health and the environment while upholding a strong economy.

The herbicide atrazine was first detected in monitoring wells and private drinking water wells in the mid-1980s. This prompted a statewide well sampling program in 1988, which revealed that atrazine was present in 12% of the Grade A dairy farm wells (LeMasters and Doyle, 1989). Follow-up research supported by the GCC notably demonstrated that normal agricultural applications of atrazine, rather


Atrazine is an herbicide popularly used on corn in Wisconsin and across the US. *Photo: DATCP*

than only point spills and mishandling, could lead to groundwater contamination (Cowell and LeMasters, 1992). Armed with the understanding that this was a nonpoint source pollution problem, the Department of Agriculture, Trade and Consumer Protection (DATCP) first evaluated a modeling approach to try to simulate contaminant transport and identify vulnerable areas. However, early results indicated that the behavior of atrazine in the environment was too complex to be reliably predicted by modeling (Muldoon et al., 1994). A more empirical approach, relying on actual well test results and analyses of soils, geology, production intensity, and application practices more successfully identified areas with the highest susceptibility to atrazine contamination (Daniel et al., 1990; Bradbury and McGrath, 1991; Hanson et al., 1996). Critically, these studies showed that areas with highly permeable sandy soils were not uniformly susceptible to contamination and areas with medium textured loamy soils were not uniformly safe – nuanced differences in soil type and regional production intensity had substantial effects on groundwater susceptibility. Ultimately, this allowed DATCP to develop and refine an atrazine rule that limits statewide use of atrazine and prohibits it only in certain highly vulnerable areas where atrazine in wells has exceeded the groundwater enforcement standard. In the atrazine prohibition areas, atrazine levels generally drop below the MCL in 2 to 7 years (DATCP, 2010).

The intensive monitoring and research efforts supported by the GCC allowed for a more tailored rule to be developed. This resulted in a rule that benefited both the agricultural economy by allowing continued uses of an inexpensive herbicide in most areas of the state, while also protecting groundwater and public health in environmentally sensitive areas of the state by prohibitions on use where data showed a need.

Other Projects in Other Places

DATCP Statewide Survey of Agricultural Chemicals

An integral element of nonpoint monitoring in Wisconsin is the statewide statistical survey of agriculture chemicals that is periodically performed by DATCP. As agricultural practices have evolved and laboratory methods have improved, the number of pesticide compounds analyzed in this study has grown from one compound (atrazine) in 1994 to 31 compounds in 2007 and will include close to 80 compounds in 2016. According to the last survey conducted in 2007, an estimated 9% of wells exceed the nitrate standard (10 mg/L) and 33% of wells contain a detectable level of at least one pesticide or pesticide metabolite (DATCP, 2008). As demonstrated by the development of the Atrazine rule, regular assessment of the extent of nonpoint source contaminants is critical to prioritizing issues and making fair and effective management decisions.

Reducing Nitrate Inputs to Groundwater

Nitrate is Wisconsin's most widespread contaminant. Agriculture accounts for about 90% of the nitrate in Wisconsin groundwater (Chern et al., 1999), so efforts to address this problem overwhelmingly focus on management of manure and fertilizer application. Nutrient management plans specify the amount and timing of all nutrient sources applied to a field as well as other best practices that both optimize economic input and reduce groundwater quality impacts. Not all farms have a nutrient management plan, but DATCP provides free resources and training for farmers to encourage total coverage across the state.

While there is still significant potential to reduce statewide nitrogen inputs with increased adoption of NMPs, improvement in nitrate levels in groundwater has remained frustratingly elusive after years of efforts. In light of this, the Department of Natural Resources (DNR) began a new program to work with communities on a nitrate demonstration project. This is a long-term program targeted at reducing nitrate levels in groundwater by making the most efficient use of nitrogen in agricultural production. At agricultural fields in selected demonstration communities, activities include measuring all current nitrogen inputs and baseline groundwater nitrate levels, calculating agricultural input and production costs, determining and implementing best nitrogen management practices that optimize groundwater conditions and agricultural production efficiency, and measuring whether predicted results are achieved. After several years of monitoring and modeling, costs of nitrogen management will be compared to water treatment costs for nearby wells to identify optimal nitrogen management systems.

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