Herbicides in Ground Water

Some background:

- I will use herbicides and pesticides interchangeably. Herbicides kill plants; pesticides include herbicides (plus chemicals that kill other things, like insects). We sampled for herbicides only.
- Herbicides, by their nature, are intended to have short half lives. Some can persist in soil from one growing season to the next, however.
- Most herbicides have moderate mobility in the environment (less than chlorinated solvents, more than most metals)
- Herbicides are applied in a variety of ways (incorporation, surface-applied; pre- or post-emergent; etc.)
- Some herbicides are highly volatile
- The primary herbicide groups include the triazines (atrazine, cyanazine, prometon, and metribuzin are the most important; widely used in agriculture, except prometon, which is nonselective and is used in right-of-ways), acetanilides (alachlor, metolochlor, acetochlor are the most important; widely used in agriculture), and the acid herbicides (2,4-D and dicamba are most important; widely used on urban lawns and some use in agriculture)

Agencies involved with pesticides

- MDA has authority to regulate herbicides (check out pesticide programs within MDA at http://www.mda.state.mn.us/appd/default.htm or open the attachment below called "Weeds").
- MDH is frequently involved in pesticide issues because pesticides occasionally show up in public drinking water and pesticides are a concern in many wellhead protection areas.
- The U of M does research.
- MPCA is involved with pesticides through some of its basin and watershed programs, including Clean Water Partnership and 319 funding.
- GWMAP became involved with sampling for herbicides because pesticides are potentially an important component of water quality characterization.

Additional info on pesticides

Pesticides impact drinking water through leaching to ground water and discharge to surface water. Surface water discharge includes overland transport of storm water runoff and contributions from tile drains.

Cleanup – The MDA is the lead agency for response to and cleanup of agricultural chemical contamination (pesticides and fertilizers) in Minnesota. This role was an outcome of the 1989 Minnesota Groundwater Protection Act which provided the MDA authority for agricultural chemical contamination under the Minnesota Environmental Response and Liability Act (MERLA – the Minnesota "Superfund") and created a reimbursement fund for the partial reimbursement of agricultural chemical cleanup costs (Agricultural Chemical Response and Reimbursement Account – ACRRA). The program operates under the primary authorities of Minnesota Chapters: 115B (MERLA); 18B (Pesticide Control Law); 18C (Fertilizer Law); 18D (Agricultural Chemical Liability, Incident, and Enforcement Law); and, 18E (ACRRA). The MDA agricultural chemical incident response program has four major program areas: 24 hour emergency response; comprehensive facility investigations; the Voluntary Cleanup and Technical Assistance Program (AgVIC); and, the ACRRA. The incident unit also is a contact point for agricultural chemical incident and facility database searches (http://www.mda.state.mn.us/incidentresponse/default.htm).

Control – Permits are required for commercial application of pesticides. Pesticide Response Plans include emergency response in cases of spills or leaks. MDA's Waste Pesticide Collection Program helps farmers, small businesses, households, and other pesticide users to properly dispose of unwanted and unusable pesticides (http://www.mda.state.mn.us/appd/wastepest/default.htm). The amount of pesticide collected through the Waste Collection Program has increased from 34100 pounds in 1991 to 236500 pounds in 1995 and 410718 pounds in 1999 (http://www.mda.state.mn.us/appd/wastepest/pounds.htm). The UMES provides pesticide

applicator training (http://www.extension.umn.edu/pesticides/pat/mnpat.html) and some other pesticide training (http://www.extension.umn.edu/pesticides/index.html).

Prevention : MDA operates a voluntary BMP program (http://www.mda.state.mn.us/appd/BMPs/BMPs.htm; http://www.pca.state.mn.us/water/nonpoint/nsmpp-ch10.pdf).

Education – FANMAP, a program administered through MDA, is designed to educate farmers in sensitive hydrologic environments about assessing nutrient and pesticide needs (http://mrbdc.mankato.msus.edu/inventory/state/sbmp.html; http://www.mda.state.mn.us/appd/1999acpp.pdf). Another example of a program that utilizes education is EQIP (http://www.extension.umn.edu/mnimpacts/impact.asp?projectID=1029).

Results

The following sections very briefly summarize our results. If you have interest and time, open the following attachments for greater detail.

- Pesticides in Cottage Grove Groundwater
- Pesticides in St. Cloud Groundwater

GWMAP data - shallow monitoring wells

In 1996, we began our land use study in St. Cloud. As with nearly any pesticide sampling, our parameter list was limited because of the expense and limited analytical capabilities. In 1997 we sampled urban and rural areas for MDA List I and List II herbicides. These included the major herbicides used in agriculture and in residential areas. In 1998 we began sending our samples for agricultural herbicides to the USGS lab in Kansas, because they analyzed for several degradates.

Considering just the data from the USGS lab, between 1998 and 2000, we had 238 detections of herbicides in shallow monitoring wells; 232 were from the seven wells completed in agricultural areas. Only 33 of the 238 detections were of the parent compound; the remainder were herbicide degradates. All agricultural wells had detectable levels of herbicides at some point during the study. 95 percent of the deteced herbicide mass was accounted for by degradates. In urban areas, dicamba (used on urban lawns) was detected in three wells in late summer and prometon (used in right-of-ways) was detected in three wells in spring. All these urban detections occurred in sewered areas.

In 2001, we conducted some sampling from shallow monitoring wells in other locations in central Minnesota. The data have not yet been entered into our data base. Visual examination of the data seem to show results similar to St. Cloud.

In SW MN, we have detected these herbicide degradates at a much lower frequency in agricultural areas, perhaps in about 20 percent of sampled wells (data not yet fully analyzed). One reason is these chemicals are not used as widely in this part of the state.

GWMAP data - domestic wells

We sampled domestic wells in St. Cloud on one occasion and detected herbicides in 9 of 20 wells. In these nine wells we detected 18 herbicides, 16 of which were degradates. All detections occurred in agricultural areas.

In Cottage Grove, we detected herbicides in 51 of 73 domestic wells. Only 30 of the 167 detected chemicals was a parent compound. 97 percent of the total herbicide mass detected was of degradates.

In 2001, we conducted some sampling from domestic wells in other locations in central Minnesota. The data have not yet been entered into our data base. Visual examination of the data seem to show results similar to St. Cloud.

GWMAP data - surface water

In surface water from our St. Cloud study, at least one herbicide was detected on 29 of 32 occasions. Degradates accounted for 61 of 78 detections and 93 percent of the total herbicide mass detected.

Health and Risk

Concentrations of parent compounds were below drinking water criteria. The degradates do not have health criteria. There is some feeling in the research community that the degradates of the acetanilide herbicides are not particularly toxic to humans, while the triazine herbicide degradates may retain their toxicity. If we use straight additivity, there were five exceedances of drinking criteria in Cottage Grove sampling and six in St. Cloud. All the exceedances were for alachlor and its degradates.

More information

For more information, open the two attachments above for references, or check out the following web sites.

http://wwwmn.cr.usgs.gov/umis/ (USGS NWQA for Upper Mississippi Basin)
http://wwwmn.cr.usgs.gov/redn/ (USGS NWQA for Red River Basin)
http://ks.water.usgs.gov/Kansas/pubs/fact-sheets/fs.076-98.html (Upper Midwest USGS study)
http://toxics.usgs.gov/bib/bib-msea-on-line.html (bibliography for MSEA investigations, including from the Princeton site in east-central Minnesota)

MDA is doing long-term monitoring of herbicides in shallow ground water in central Minnesota. See pages 3 through 6 at http://www.mda.state.mn.us/appd/1999acpp.pdf

USGS continues to do work in the Midwest, including expanding the list of degradates being analyzed.