Minnesota Pollution Control Agency

Environmental Outcomes Division

Ground Water Monitoring & Assessment Program

Cadmium, Lead and Mercury in Minnesota's Ground Water

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What are cadmium, lead and mercury?

Cadmium, lead and mercury are metals that are found at relatively low concentrations in the environment. Their behavior differs widely. Lead is nearly immobile in soil, cadmium is somewhat mobile, and mercury can be very mobile in certain forms. Mercury is highly volatile, while cadmium and lead are not. Despite these differences, cadmium, lead and mercury are very toxic to humans and other organisms. They are important chemicals of concern in the environment, and their effects can be long-lasting. Consequently, they are discussed together.

What are sources of cadmium, lead and mercury in ground water?

Concentrations of cadmium, lead and mercury in rocks are approximately 1.0, 5.0 and 0.5 mg/kg (parts per million). These chemicals are not very soluble and natural concentrations in ground water will be less than 0.5 µg/L (parts per billion).

Cadmium, lead and mercury have many anthropogenic sources. Cadmium is widely used in industrial applications, including the manufacture of batteries. It is also found in industrial wastes, sewage sludge, mining wastes, and fossil fuel combustion products. Lead was once commonly used in automobile fuels, paint and plumbing. Although these uses have decreased, lead is still used in batteries and alloys, and it is found in sewage wastes and in fossil fuel combustion products. The primary anthropogenic sources of mercury are fossil fuel combustion, disposal of human waste and smelting activities. Mercury has been used also in paints and pharmaceuticals.

What are considered safe levels of cadmium, lead and mercury in ground water?

The Minnesota Department of Health (MDH) established a health risk limit (HRL) of 4 µg/L (parts per billion) for cadmium. A HRL is the concentration of a contaminant in ground water that is safe to ingest daily over a lifetime. The HRL was based on kidney effects in animal studies. Health-based drinking water criteria have not been established for mercury and lead. The maximum contaminant level (MCL) for mercury is 2 µg/L. No level of lead is considered safe in drinking water, although an action level of 15 µg/L at the tap can be used to identify highly impacted water. An additional concern with these

chemicals, particularly mercury and lead, is that they accumulate in the environment. Consequently, there are food chain concerns for these chemicals.

How are cadmium, lead, and mercury distributed in Minnesota ground water?

The HRL for cadmium was exceeded in five wells sampled from the Ground Water Monitoring and Assessment Program (GWMAP) statewide baseline network of 954 wells. The action level for lead was exceeded in nine wells. The MCL for mercury was not exceeded in any wells. Median concentrations of cadmium, lead and mercury in all samples were 0.030, 0.22 and less than 0.10 µg/L. Therefore, concentrations in ground water are very low. The highest concentration of mercury was 0.38 µg/L, and mercury does not represent a health concern in ground water. There was, however, considerable variability in the distribution of cadmium and lead. Median cadmium concentrations in the Cedar Valley and Galena aquifers were 1.4 and 0.63 µg/L, respectively. Median concentrations in all remaining aquifers were less than 0.10 µg/L. Elevated cadmium concentrations in these two aquifers appear to be a function of geology. Lead concentrations were highest in the St. Lawrence (median = 2.7 µg/L), Ironton-Galesville (0.99 µg/L) and Prairie du Chien (0.50 µg/L) aquifers. The distribution of lead is related to several factors. Lead concentrations in the Jordan and Prairie du Chien aquifers increased as oxygen concentrations increased, indicating there are anthropogenic sources of lead in these aquifers. A similar observation, though not as strong, occurred for the surficial Quaternary aquifers. In Precambrian aquifers, lead concentrations increased with depth, suggesting low inputs from anthropogenic sources and increasing lead concentrations as residence time increases. In other aquifers, there were no relationships between lead concentrations and other sampled parameters.

Which aquifers are most sensitive to contamination with cadmium, lead and mercury?

The Upper Carbonate aquifers have high naturally occurring concentrations of cadmium. They are sensitive to additional inputs from anthropogenic sources. Surficial aquifers have been impacted by anthropogenic sources of lead. Lead is persistent in the environment and these impacts will probably continue for some time. It is unclear whether these anthropogenic inputs represent a health concern to humans. Mercury is not a chemical of concern in ground water, except possibly at heavily contaminated locations.

Why is it important to measure cadmium, lead and mercury concentrations in ground water?

Cadmium, lead and mercury are very toxic to humans and other organisms. Their distribution in the environment is often used as an indicator of overall human impacts to the environment. It is important to sample for these chemicals in aquifers where they may occur at high concentrations, since their drinking standards are very low and there are a variety of anthropogenic sources.

What are some management strategies for reducing risks from cadmium, lead, and mercury?

Few aquifers with naturally occurring concentrations of lead, mercury or cadmium pose a potential health concern. Use of lead and mercury has decreased significantly in the past decade. These reductions will gradually lead to decreases in the environmental impacts from these chemicals.

Additional information, including reports and distribution maps, can be found on the Minnesota Pollution Control Agency's Web site at ***http://www.pca.state.mn.us/water/groundwater/gwmap/index.html***.