Minnesota Pollution Control Agency

Environmental Outcomes Division

Ground Water Monitoring & Assessment Program

Phosphorus in Minnesota's Ground Water

May 1999

What is phosphorus?

Phosphorus is a chemical commonly found in soil, rocks and plants. It is an essential nutrient for plant growth. Consequently, phosphorus is an important fertilizer in agricultural production, and it is used widely in urban settings.

Phosphorus is an important contaminant of surface water, since even low concentrations can lead to algal blooms, which diminish the recreational value of lakes and rivers. Phosphorus, particularly inorganic forms, is relatively immobile in soil.

What are sources of phosphorus in ground water?

Concentrations of phosphorus in rocks may be as much as 1,000 mg/kg (parts per million). Considerable amounts of phosphorus are tied up in vegetation. Humans have dramatically altered the phosphorus cycle. Phosphorus is an important fertilizer, but it is also present in human and animal wastes, in sludges and in detergents. Therefore, concentrations in many soils are therefore likely to be considerably higher than under native conditions.

Phosphorus is immobile, however, and it will not reach ground water in appreciable quantities except under certain conditions. These include low soil attenuation capacity (for example, soil with low concentrations of iron, aluminum and manganese) or preferential transport of phosphorus-containing wastes through the soil to ground water. An example of this preferential transport is a septic system completed below the depth of the seasonal high water table.

What is considered a safe level of phosphorus in ground water?

There are no drinking water standards for phosphorus. The primary concern with phosphorus is discharge to surface waters. Concentrations of total phosphorus exceeding 100 µg/L (parts per billion) may represent a threat to surface water. Although 347 samples taken in Minnesota exceeded 100 µg/L, only 18 exceeded 500 µg/L.

How is phosphorus distributed in Minnesota ground water?

The overall median concentration of total phosphorus was 70 µg/L in wells sampled from the Ground Water

Monitoring and Assessment Program (GWMAP) statewide baseline network of 954 wells. Inorganic phosphorus (phosphates) accounted for about 80 percent of the total phosphorus and organic phosphorus about 20 percent of the total phosphorus and organic phosphorus about 20 percent, assuming that 0.05 percent of organic matter is phosphorus. There was considerable variability between aquifers. The highest median concentrations occurred in the Cedar Valley (median = 203 µg/L), Cretaceous (140 µg/L) and buried Quaternary (124 µg/L) aquifers. Lowest concentrations occurred in the Jordan (25 µg/L), Prairie du Chien (34 µg/L) and Precambrian (35 µg/L) aquifers. The median concentration in the surficial Quaternary aquifer was 56 µg/L. Although the distribution of phosphorus is somewhat complicated, concentrations are highest in aquifers with large natural inputs. Concentrations increase as residence time increases, probably because of increased association with iron and manganese.

Which aquifers are most sensitive to contamination with phosphorus?

Contamination is difficult to define for phosphorus, since surface water is the primary concern. Aquifers that are most likely to impact surface water do not appear to be sensitive to contamination with phosphorus. Nevertheless, shallow ground water is likely to show some impacts from human activity. The baseline study does not provide good information for assessing phosphorus inputs to shallow ground water.

Why is it important to measure phosphorus concentrations in ground water?

Phosphorus should be sampled in aquifer systems that discharge to surface water and in which there are potentially large anthropogenic inputs. Along with sampling for phosphorus, sampling includes an assessment of the attenuation properties of the aquifer. This includes differentiation of phosphorus species, pH and concentrations of iron, manganese and aluminum.

What are some management strategies for reducing risks from phosphorus?

Despite the large anthropogenic inputs to soil, phosphorus will not be a contaminant of concern in most aquifers because of limited mobility. Excessive use of fertilizer and poor waste management, particularly on sandy soils with low organic matter content, are most likely to lead to high phosphorus concentrations in shallow ground water. Implementation of best management practices for agriculture and disposal of human and animal wastes represent the best mechanisms for limiting phosphorus inputs to ground and surface waters.

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