

Health Benefits and Toxicity of Common Metals and Minerals in Wisconsin Drinking Water Supplies

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May 2001 (revised April 2006)

Almost 80% of the elements found on earth are classified as *metals*. Some elements, such as copper, iron, or lead, we easily identify as metals. But the metals group also includes such common elements as sodium and calcium. This brochure provides information to help you interpret the results of the Homeowner Metals Package testing for drinking water offered through the Water and Environmental Analysis Lab at UW-Stevens Point.

Some metals are essential to humans; others have no health benefits or are toxic. Other metals are essential to health in small amounts but toxic at higher concentrations. The discussion below indicates the maximum and minimum recommended daily amounts of these metals. The maximum recommended amounts are taken from the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Levels (MCLs) for public drinking water supplies. The minimum recommended amounts are taken from the National Academy of Sciences Dietary Reference Intakes for adults. The metals and minerals included in the Homeowner Metals Package can be divided into three categories:

Beneficial to health, not normally found in drinking water in toxic amounts:

calcium, magnesium, iron, potassium

Essential to health in small amounts, may be toxic at higher concentrations:

copper, manganese, sodium, sulfate, zinc

Toxic, no known benefit:

arsenic, lead

When measuring concentrations of minerals or contaminants in water:
one milligram per liter (mg/L) is equal to one part per million (ppm)
one microgram per liter (ug/L) is equal to one part per billion (ppb)

Analysis	Maximum recommended in drinking water (US EPA MCL; Drinking Water Standard)	Toxic Effect	Major Benefit	Minimum recommended in daily adult diet (Dietary Reference Intake)	Other Information
Arsenic (As)	0.010 mg/L (equivalent to 10 ppb)	cancer of skin, liver, kidney, bladder	no known benefit for humans although it may be an essential trace nutrient for some animals	none recommended	Occurs above health standard in parts of Wisconsin, especially Outagamie and Winnebago Counties, but has been detected in every county in the State of Wisconsin. Can be partially removed by reverse osmosis, anion exchange, or distillation treatment systems, but <u>not</u> by water softeners.
Calcium (Ca)	none	none known at drinking water concentrations	essential to bone and tooth development, blood clotting, muscle contraction, nerve transmission may reduce heart disease	1000-1200 mg/day	Naturally occurs in Wisconsin groundwater where soils or underground rock formations contain limestone or dolomite. Although drinking water normally supplies less than 20% of the RDA it still may provide a health benefit. Only 60% of women achieve the RDA of calcium in their diet. Needs to be combined with magnesium in the diet at a ratio of 2:1. Along with magnesium, causes hard water and may be removed by softening.
Copper (Cu)	1.3 mg/L for humans 0.5 mg/L for livestock	can cause digestive disturbances (nausea, vomiting) and liver and kidney damage at higher amounts	aids in iron utilization in the body	0.9 mg/day	Not naturally found in significant amounts in Wisconsin groundwater, but can be found in toxic amounts when naturally corrosive or acid water or artificially softened water is distributed in the home through copper pipes. Also toxic to fish. To minimize exposure to copper and lead (see Lead below), run your faucet for two minutes first thing in the morning and after being gone more than six hours to flush out water that has been standing in pipes. Never use water from the hot water tap to make food, infant formula or beverages.

Analysis	Maximum recommended in drinking water (US EPA MCL; Drinking Water Standard)	Toxic Effect	Major Benefit	Minimum recommended in daily adult diet (Dietary Reference Intake)	Other Information
Iron (Fe)	Aesthetic limit: 0.3 mg/L	none known at drinking water concentrations	important component of blood hemoglobin	8-18 mg/day	Naturally occurring trace mineral which causes taste problems and discoloration of water and clothing washed in it, when over 0.3 mg/L. High values associated with acid water or water lacking oxygen. Removing excess iron from drinking water without removing desirable calcium and magnesium is done through aeration or permanganate water treatment systems. Taste and odor problems associated with iron and sulfur can be magnified by nuisance iron bacteria.
Lead (Pb)	0.015 mg/L (equivalent to 15 ppb)	brain and nerve damage, kidney damage	no benefit	none recommended	Not naturally occurring in Wisconsin groundwater at levels of health concern. Found in water systems with brass fixtures, lead pipes or lead solder, especially when water is soft or corrosive. Amounts are usually lower after water has been run for several minutes (see Copper).
Magnesium (Mg)	none	none known at drinking water concentrations	neuromuscular activity of heart, energy metabolism, protein synthesis	310-420 mg/day	Naturally occurs in Wisconsin groundwater. Protects against heart disease; maintains normal heart rhythm; necessary for proper calcium and vitamin C metabolism. Along with calcium, causes hard water and may be removed by water softening.
Manganese (Mn)	Aesthetic limit: 0.05 mg/L	neurological disorders	antioxidant and catalyst for vitamins	1.8-2.3 mg/day	Causes aesthetic problems from black precipitates (specks). High concentrations of both manganese and iron can occur where water is low in oxygen, such as areas of wet or organic soils (near lakes and marshy areas). One study associated levels of manganese in water of 1.6-2.3 mg/L with behavioral changes (irritability). Iron treatment systems can also be used to remove manganese, but it is more difficult to remove than iron.
Potassium (K)	none	none	normal heart rhythm, helps regulate high blood pressure	2000 mg/day	Normally less than 5 mg/L in Wisconsin groundwater. Levels greater than 10 mg/l may indicate contamination from animal waste, unless potassium chloride is being used as a water softener salt. Some research suggests that high potassium diets reduce the rise in blood pressure related to high sodium intake. Potassium chloride is more expensive but is generally considered a healthier water softener salt than sodium chloride if you will be drinking softened water.
Sodium (Na)	30 mg/L (health advisory level)	blood pressure	help body maintain electrolytes	500 mg/day	Natural levels are less than 5 mg/L in Wisconsin groundwater except in some areas of eastern Wisconsin where groundwater is drawn from deep sandstone layers. Often found at elevated levels in groundwater from road salt or septic system effluent. Associated with increased blood pressure in susceptible individuals. Sodium is also part of the salt commonly added to a water softener. The sodium level in your water after softening will be approximately half the total hardness level (e.g. removing 200 mg/L total hardness with a water softener adds approximately 100 mg/L sodium to the water).
Sulfate (SO ₄)	250 mg/L	laxative effect	sulfur is a component of vitamins and amino acids	no information available	Naturally occurring in groundwater in some parts of Wisconsin. Concentrations over 250 mg/L may cause diarrhea in people not accustomed to consuming the water. Concentrations over 300 mg/L give water an off taste. Sulfate levels over 500 mg/L lower milk production and butterfat production in dairy cows. Sulfate is not the same as hydrogen sulfide (rotten egg gas) although both contain the element sulfur.
Zinc (Zn)	Aesthetic limit: 5 mg/L	interferes with use of copper in body	antioxidant, aids in protein formation	8-11 mg/day	Normally less than 5 mg/L in Wisconsin groundwater. Toxic to fish. Concentrations greater than 1 mg/L usually occur only when corrosive water is distributed through galvanized pipes, or in zinc mining areas in southwestern Wisconsin. Most diets are slightly deficient in zinc, with male diets typically achieving 95% of the RDA and females achieving 75%.

