



Arsenic in Minnesota's Well Water

Minnesota Department of Health

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Environmental Health Division

Many Minnesotans are surprised to learn that they may have arsenic in their well water. Despite its reputation as a poison, arsenic is like any toxic substance; its effects depend on how much and how long people are exposed to it. This publication tells about arsenic and its health effects, and what you can do if you have arsenic in your well water.

How does arsenic get into drinking water?

Arsenic is a part of the earth's crust and occurs naturally in soil and rock. Arsenic from soil and rock can dissolve into groundwater, the primary source of drinking water for much of Minnesota. When arsenic occurs in well water, the source is almost always a natural source.

Human activities can sometimes contribute to arsenic in groundwater, as well as in soil and air. While arsenic is not in common use today, it was once an ingredient in some pesticides, and residues remain from past use and improper disposal. Until January 2004, arsenic-based wood preservatives were used to treat some wooden foundations, decks, and children's play structures. Arsenic from these sources does not usually move very far in the environment.

Is arsenic common in Minnesota's well water?

Arsenic can occur in groundwater just about anywhere in Minnesota. Groundwater from the Twin Cities to the South Dakota border, and north along Minnesota's border with the Dakotas is more likely to contain elevated levels of arsenic. However, arsenic levels can vary from one well to the next, even within a very small area.

Most arsenic in Minnesota groundwater is thought to come from rock deposits that were eroded and re-deposited with clay by glaciers thousands of years ago. Arsenic is present in all soil and rock, but more arsenic dissolves into groundwater under certain conditions. In some areas, water from wells that are completed just below a layer of clay at least 10 feet thick can have higher levels of natural arsenic than water from wells completed deeper. Some groundwater in Minnesota has natural arsenic levels as high as 150 micrograms per liter. One "microgram per liter" is the same as 1 "part per billion." The federal drinking water standard for arsenic is 10.0 micrograms per liter (more on this later).

Studies of groundwater in Minnesota and some other states suggest that natural arsenic concentrations exceeding 10 micrograms per liter are more common than previously recognized. Based on existing monitoring data, it is now estimated that about 10 percent of all wells in Minnesota have natural arsenic levels of 10 micrograms per liter or more.

Are there other sources of exposure to arsenic?

In nature, pure arsenic is rare. It is usually combined with other elements to form chemical “compounds.” Arsenic in compounds that also contain carbon is called “organic arsenic.” Arsenic from plants and animals is usually organic. About two thirds of the small amount of arsenic that occurs in food is organic arsenic.

Arsenic in compounds that do not contain carbon, but contain other elements such as oxygen, chlorine, or sulfur, is called “inorganic arsenic.” Most arsenic in soil, rock, and groundwater is inorganic arsenic. Inorganic arsenic is generally more harmful than organic arsenic.

For most people, food and water are the primary sources of exposure to arsenic. Small amounts of arsenic naturally occur in some of the foods we eat, including fish and shellfish, rice, and other cereal products. Fish and shellfish contain mostly organic arsenic, which is the less harmful form. Rice, rice milk, and brown seaweed contain small amounts of inorganic arsenic, the more harmful form. Inorganic arsenic can also be found in some food supplements, such as chitin. It is estimated that most people consume about 50 micrograms of arsenic per day in food and water, with about 5 to 15 micrograms of that typically being inorganic arsenic.

Other ways that people can be exposed to arsenic include: breathing in sawdust or smoke when arsenic-treated wood is cut or burned; applying pesticides or soil supplements that contain arsenic; taking medications that contain arsenic; giving animals medications or treatments that contain arsenic; working in jobs like lead or copper smelting, or pesticide/fertilizer manufacture or application, and; swallowing small amounts of soil containing arsenic while playing or gardening.

How can arsenic affect health?

The health effects of arsenic depend on its chemical form, how much is consumed, and for how long.

A one-time oral dose of 70,000 to 180,000 micrograms of inorganic arsenic is fatal for most people. Although this amount is still quite small, about the weight of a few grains of rice, it is very large compared to the small amounts naturally present in water, soil, food, or air. These small amounts, however, may still cause harm if exposure to them occurs over many years.

What are the possible harmful effects of long-term exposure to arsenic?

Long-term exposure to arsenic can cause a number of harmful effects on the human body. There is increasing evidence that people who consume drinking water with arsenic levels over 100 micrograms per liter for many years can have health problems, including nervous system effects, diabetes, and several circulatory diseases. Arsenic sometimes causes corns (“hyperkeratosis”) to develop on the palms of the hands, the soles of the feet, and other places on the body.

Some studies have now shown that arsenic levels even below 100 micrograms per liter may cause some health problems, including nervous system problems, skin problems, high blood pressure, and reduced intelligence in children. Studies have also linked long term exposure to arsenic in drinking water to increased risk of cancer of the bladder, lungs, liver, and other organs.

It is difficult to pinpoint the exact concentration of arsenic in drinking water that can lead to a particular health problem. Individuals differ in their susceptibility to toxic effects. Most information about the toxic effects of arsenic comes from studying groups of people who consumed water containing naturally occurring arsenic over long periods of time. Most studies on arsenic in drinking water and cancer have been conducted in places where

the drinking water contained at least several hundred micrograms per liter of arsenic. But even this information is not precise; people drink from a variety of water sources, and the amount of water a person consumes varies over time. It is therefore difficult to know one person's exact exposure to arsenic in drinking water over time.

Harmful effects from exposure to arsenic in drinking water typically take years to develop. The time required for a condition to develop is related to the amount of arsenic consumed. For example, at high concentrations, darkening of the skin, called "hyperpigmentation," has been reported after just a few months of exposure, but at lower concentrations, it takes years to develop. Cancers related to arsenic in drinking water typically do not develop for decades. It is not yet clear if an exposure that occurs only for a few years early in life can still cause health effects in adulthood, or whether continuous exposure is necessary to result in health effects later.

Does arsenic have any beneficial effects?

Some limited recent research suggests that some arsenic in the diet, about 12 to 25 micrograms per day, may have a beneficial effect on some chemical processes in the body. This does not change the fact that larger amounts of arsenic can be harmful.

What is the standard for arsenic in drinking water?

The U.S. Environmental Protection Agency (EPA) sets standards, called "Maximum Contaminant Levels" (MCLs) for contaminants in public water systems. In October 2001, EPA established a new standard of 10.0 micrograms per liter for arsenic in drinking water. The previous MCL for arsenic had been 50 micrograms per liter. The MCL is mandatory for community public water systems and is recommended for private well water.

When estimating exposures, EPA uses a drinking water intake of 2 liters per day for adults. Therefore, at the MCL of 10.0 micrograms per liter in water, daily intake of inorganic arsenic from drinking water (about 20 micrograms per day) would typically be higher than daily intake of inorganic arsenic from food. If arsenic levels in drinking water are lower, food may be the greater source of exposure.

When EPA sets an MCL, it considers not only the health risks, but also the cost and technical difficulty of removing the contaminant down to that level. Many public water systems in the United States draw water from sources that have arsenic levels exceeding 10 micrograms per liter. The number of public water systems and the cost of removing arsenic make compliance with the new MCL very costly in some regions. EPA has to balance the scientific studies that show that the MCL is necessary to protect public health over a lifetime of exposure with the costs and technology required to remove arsenic from public water systems. While the MCL for arsenic is low, it is not low enough to completely eliminate all risk of cancer and other health effects. Nevertheless, many other factors, including cigarette smoking and excessive exposure to direct sunlight, also increase the risk of developing these diseases, so risk can be greatly reduced by a generally healthy lifestyle, including a healthy diet, exercise, and not smoking.

MCLs are mandatory for community public water systems. Private drinking water wells are not required to meet federal MCLs or any state drinking water standards. Rather, it is up to each well owner to decide whether he or she wants to take steps to reduce the levels of arsenic in the water. Based on the MCL for public water systems, the Minnesota Department of Health (MDH) recommends that water containing more than 10 micrograms per liter of arsenic not be consumed over the long term. Because arsenic is not easily absorbed through the skin and doesn't evaporate from water, exposure from other uses such as bathing and washing dishes and laundry is minimal.

Should I test my private well for arsenic?

Yes! Arsenic in water has no taste or odor, and can occur just about anywhere in Minnesota, so the only way to know if your well water contains arsenic is to have it tested. While well owners are not required to test existing private wells for arsenic, MDH recommends that every well be tested for arsenic at least once. Well owners must arrange and pay for testing their well water for arsenic, which typically costs about \$30-\$40. Make sure that the laboratory you choose is **certified** by MDH to test drinking water for arsenic. For a list of all laboratories certified by MDH to test drinking water for arsenic go to: www.health.state.mn.us/labsearch and click on “Homeowners and the General Public: How to Search for Certified Laboratories.” If you do not have access to a computer, you can call a well specialist at one of the MDH district offices listed at the end of this publication, and they can help you find a laboratory.

State regulations now require licensed water well contractors (and anyone constructing a new well for his or her personal use) to have the water from each **new** drinking water well tested once for arsenic. The test result must be provided to the well owner before placing the well into service.

If no arsenic is detected in your well water, further testing is usually not necessary. If arsenic is detected at levels above 10 micrograms per liter in a well used for drinking and cooking, and if repeat sampling confirms the results, MDH recommends that you use an alternate source of drinking water or install a treatment system to reduce arsenic levels in the water.

What are the best methods for reducing arsenic in drinking water?

• Install a water treatment system.

There are several types of water treatment systems that can effectively reduce arsenic levels in drinking water. These include:

Specialty Media. Special removal medias have now been developed by many water treatment companies to specifically remove arsenic from water. They typically use “ferric (iron) hydroxide,” “ferric oxide,” or iron-enhanced ion exchange resins.

“Reverse Osmosis” systems with pre-oxidation. Reverse Osmosis (RO) is a water treatment process that removes most dissolved, inorganic contaminants from water by forcing the water through a cellophane-like plastic sheet known as a “semi-permeable membrane.” A pre-oxidation step is usually necessary to convert all arsenic in the water to a removable form. A small counter top RO unit will produce about 3 gallons per day. Slightly larger units that are usually installed under the counter will produce 5 to 20 gallons per day. RO units typically produce only 1 gallon of treated water from every 3 to 5 gallons of water treated. The remaining water goes to waste. The reverse osmosis unit should be checked regularly because the membrane can deteriorate over time.

Distillation systems. “Distillation” is a water treatment process that boils water, then cools the steam until it condenses into a separate container. The dissolved contaminants are left behind in the boiling pot. Distillation units require about four hours to produce 1 gallon of water, so this type of treatment uses a considerable amount of energy in its operation.

Remember that while some treatment systems can be useful for other purposes, systems such as conventional water softeners and activated carbon filters will not alone remove arsenic. And boiling the water will only concentrate the arsenic, due to evaporation of some of the water. MDH and the Minnesota Extension Service can provide additional information about selecting a water treatment system.

Before you buy a home water treatment system, make sure that it will meet your needs. Work with a reputable dealer in your area, and learn how the different systems work. Find out how much arsenic the systems will remove, the maintenance requirements, and the costs. MDH recommends that you choose a treatment system that is certified by an independent certifying organization, such as NSF International, Underwriter's Laboratory (UL), or the Water Quality Association, that tests water treatment systems to assure their effectiveness in living up to the manufacturer's claims. In Minnesota, water treatment systems must be installed by a licensed and bonded plumbing or water conditioning contractor, although homeowners may install equipment in homes they own and occupy. After the treatment system is installed, it is important to follow the manufacturer's recommendations for maintaining the system. Also, have the treated water tested periodically to make sure that the treatment system is working properly.

- **Construct a new well.**

In some areas, a new well constructed into a different water-bearing formation may produce water with less natural arsenic. Drilling a new well may be a good option if you already want to replace your existing well for other reasons. It can be less expensive in the long run than maintaining a treatment system. However, a new well may still contain natural arsenic even if the well is properly constructed, and in an appropriate location.

As our information about the occurrence of arsenic grows, we will learn more about which water-bearing formations in an area have higher or lower levels of arsenic. While there will still be no guarantees, the chances of constructing new wells with lower arsenic levels should improve in some areas. For more information about new well construction, contact a licensed water well contractor, or a well specialist at your nearest MDH district office.

- **Connect to a community public water system.**

In some cases, connection to a community public water supply system may be possible. All community public water systems are regularly tested for arsenic and other contaminants and must comply with all EPA standards. Most community public water systems already comply with the new MCL, and all are expected to comply by 2010. Testing results are available from each community public water system.

- **Buy bottled water.**

You may be able to reduce arsenic levels in your drinking water by using bottled water. It is important to note that while all public drinking water systems must meet applicable federal MCLs, no single set of standards applies to all bottled water. Instead, bottled water is subject to a variety of standards, depending on the type of bottled water and where it is bottled. These standards may be more or less stringent than those for public water systems. If you are considering switching to bottled water, be sure that levels of arsenic and other contaminants in the bottled water you choose are lower than levels in water from your current water supply. The bottling company should be able to provide testing results for their water.

Should I test my well water for anything else?

Bacteria. Private wells should be tested at least once a year for "coliform" bacteria. Spring is usually a good time to test. It's also a good idea to test for coliform bacteria any time water changes in taste, odor, or appearance.

Nitrate. Well water should also be tested every year or two for nitrate, more frequently if nitrate has been found previously. Always test the water before you start giving it to an infant. Infants under six months of age must not be given water that exceeds the state Health Risk Limit for nitrate (10 milligrams per liter as nitrogen). Boiling the water will not remove nitrate; it will actually increase the concentration of nitrate in the water.

Lead. When water stands idle in the plumbing pipes for more than a few hours, it can absorb lead if the plumbing has old lead pipes, lead-soldered copper pipes, or older brass plumbing components. MDH recommends either: (1) routinely flushing standing water until it feels colder (usually 30-60 seconds) to reduce any lead present, or (2) testing your water for lead after it has been standing in the pipes at least six hours, to see if regular flushing is needed. Also, never use water from hot water faucets for drinking or cooking.

Other Contaminants. Other contaminants sometimes occur in private water systems, but much less frequently than bacteria, nitrate, arsenic, or lead. If the well is located close to fuel tanks or to a commercial or industrial area, a test for “volatile organic chemicals,” which are components of fuels, solvents, and cleaners, is a good idea. Agricultural chemicals are sometimes found in wells located near cropped fields or handling areas for agricultural chemicals. Wells that are shallow or in areas of geologic sensitivity (such as fractured limestone) are more vulnerable to contamination by agricultural chemicals than are deep wells. If your well is located in an agricultural area, and especially if it is a shallow well, testing for several of the chemicals most commonly used in the area may be warranted.

Fluoride. If children or adolescents are drinking the water, a test for natural levels of fluoride will give your dentist useful information when considering fluoride supplements. A small number of wells in Minnesota (primarily northeastern Minnesota) do exceed the health standard for fluoride, which can cause discoloration of tooth enamel.

Where can I get more information or help?

If you have any questions about your well or well water quality, or would like more information, contact a well specialist at your local MDH district office.

MDH District Offices

625 North Robert Street
P.O. Box 64975
St. Paul, Minnesota 55164-0975
651-201-4600 or 800-383-9808

705 Fifth Street Northwest
Bemidji, Minnesota 56601
218-308-2100

320 West Second Street
Duluth, Minnesota 55802
218-723-4642

1505 Pebble Lake Road
Fergus Falls, Minnesota 56537
218-332-5150

3333 West Division Street
St. Cloud, Minnesota 56301
320-223-7300

1400 East Lyon Street
Marshall, Minnesota 56258
507-537-7151

18 Wood Lake Drive Southeast
Rochester, Minnesota 55904
507-206-2700

Visit the MDH Well Management Section Web site at: www.health.state.mn.us/divs/eh/wells.

To request this document in another format, call 651-201-4600. Deaf and hard-of-hearing: TTY 651-201-5797.

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