K·STATE
Research and Extension

Water Quality Tests for Private Wells

An owner or user of a private water well is responsible for the well's water quality. Conversely, public water systems are managed by certified operators to ensure Environmental Protection Agency (EPA) drinking water standards are met. This publication contains information to understand test results from water-testing laboratories.

Important factors for safe water from private wells include:

- **well location** without pollutant pathways,
- **well construction** that meets current standards,
- **site management** to protect the well from contamination, and
- **annual well maintenance**.

Annual water quality tests are recommended as part of a maintenance program for private wells. No federal or state regulations require water testing to maintain water-quality standards for private water systems. EPA public water quality standards are normally used for private water systems and are reported in this publication. K-State Research and Extension publication, *Testing Private Water Systems* (MF3655), provides guidance on performing water tests.

Water quality tests include microbiological; inorganic and organic chemicals such as pesticides; synthetic organic chemicals (SOCs); volatile organic chemicals (VOCs); and radionuclides. Water tests also measure physical; chemical; and nuisance contaminants, such as water hardness, taste, and odor.

Drinking Water Standards

The EPA National Primary Drinking Water Regulations are available at: *www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations*.

MCL. Primary standards are established by maximum contaminant levels (MCL). The MCL is the maximum level of a contaminant allowed in a public water system. Customers must be notified when this level is exceeded.

MCLG. The maximum contaminant level goal (MCLG) is the level at which no known or anticipated health effects will occur and must include an adequate margin of safety. The MCLG is set at zero for known, probable, and possible human carcinogens.

SMCL. Secondary drinking water standards apply to contaminants that have aesthetic effects on water and may affect people. The secondary standard is reported as secondary maximum contaminant level (SMCL) and is not enforceable.

TT. The term TT specifies a mandatory minimum technique to treat public water.

Microorganisms

Microorganisms include organisms in water capable of reproducing or growing either in water or in an infected host. The contaminants include bacteria, protozoa (often in cyst form), viruses, fungi, and worms. Microbiological contaminants have been responsible for most illness, disease, and death associated with polluted drinking water.

Microorganisms and associated diseases in water can enter the human body by drinking water, through breaks in the skin, and through other passageways, such as inhalation. Contaminated food or objects, such as fingers, put in the human mouth, are avenues of exposure. Improper well construction and lack of well maintenance are contributors to microorganisms in water.

Bacteria, Total Coliform

(MCL: 0 for 95% of samples, MCLG: Zero)

The test for total coliform bacteria has been the standard test for microbiological safety for decades and is an excellent indicator of contamination in public water supplies. Coliform bacteria are widely distributed in the environment, in soil, on plants, on animals, and in the feces of warm-blooded animals.

Coliform bacteria are used to evaluate the safety of private water systems. A four-times-a-year test for total coliform is recommended. Coliform bacteria are not considered pathogens, although some strains are opportunistic pathogens, which means they may cause disease when a person's natural defense mechanism is impaired.

When a water test is positive for total coliform, conduct a separate test for fecal coliform or *E. coli*. Current EPA approved presence/absence tests identify the presence of both total and fecal coliform. A laboratory reporting the results of a bacteria test on water may use such terms as safe or not safe for human consumption; polluted or not polluted; coliform negative (no coliform found); or coliform positive (coliform present).

Any time a water bacteria test is positive for total coliform, fecal coliform, or other bacteria, check the well for possible entry points and make needed repairs. Shock chlorinate the well following the steps in the K-State Research and Extension publication *Shock Chlorination for Private Water Systems,* (MF911). K-State Research and Extension publication *Taking a Water Sample* (MF963), has additional information on coliform testing.

Well water that continues to test positive for coliform bacteria may have issues with harmful microbes, improper well construction, or water inflow through rock aquifers and limited soil filtration. In cases of persistent coliform bacteria, seek assistance from your local sanitarian, Kansas Department of Health and Environment (KDHE), or K-State Research and Extension. The well owner may consider construction of a new well, an alternative water source, or continuous disinfection equipment. For more information, see K-State Research and Extension publication *Private Well — Safe Location* (MF3667).

Bacteria, Fecal Coliform
(*E. coli* should not be present)
When a test is positive for fecal coliform or *E. coli*, water should not be used for drinking, bathing, or in the kitchen until the defect in the well or other sources of contamination are corrected. Before a water system with a positive test is used, the water system should be shock chlorinated, and a follow-up water test shows no contamination.

Fecal coliform is the principal bacteria in the digestive tract of warm-blooded animals. *E. coli* are one of the principal types of fecal coliform. When water systems test positive for fecal coliform, there may be defects in the well or plumbing system that allow entry of fecal material. Not many strains of fecal coliform or *E. coli* are pathogens, but some strains are opportunistic pathogens, meaning they become active when a person's immune system is depressed.

Fecal coliform and *E. coli*, like all microorganisms, can enter directly into a well that has a defect in construction or well components, such as cracked or deteriorated casing or a missing sanitary seal. Bacteria can enter groundwater if the soil's natural filtering capacity is missing or is short-circuited. Examples include shallow soil cover, sink holes, rock bottom streams, abandoned wells, improperly plugged wells, and unplugged test holes.

When bacteria other than coliform are present in large numbers, they may crowd out or inhibit the growth of coliform bacteria. When this occurs, the result of the test is invalid, and the quality of the water supply is suspect.

Cryptosporidium (MCL: TT, MCLG: Zero)
Cryptosporidiosis is a disease caused by a one-celled microscopic protozoa, *Cryptosporidium parvum*, or "*Crypto*." The *Crypto* organism is found in human and animal fecal waste. *Crypto* is common in Kansas surface water and may exist in swimming pools, day care centers, and hot tubs. Drinking water containing the organism may cause the illness. It can pass from garden soil contaminated by animals to your hands or to vegetables that have contacted soil.

Unlike most bacteria, *Cryptosporidium* is not easily killed by chlorine. Heat provides the best method of disinfection. Boiling water for three minutes is considered adequate. Water also can be filtered to remove *Cryptosporidium*. Water filters labeled as cyst reduction, or one micron or smaller are reliable to remove *Cryptosporidium*.

Giardia Lamblia (MCL: TT, MCLG: Zero)
Giardia is a protozoan that causes giardiasis, an infection in the upper small intestine in humans. Incubation period is five to more than 25 days after exposure. If symptoms occur, they may include chronic diarrhea, abdominal cramps, bloating, fatigue, and weight loss.

Outbreaks of giardiasis occur from ingestion of microscopic *Giardia* cysts in fecally contaminated water. Water becomes contaminated by humans, or other wild or domestic animals. Localized outbreaks occur from ingestion of contaminated and improperly filtered surface water. Groundwater does not contain *Giardia* cysts unless it is contaminated by direct entry of water containing cysts. Outbreaks in areas supplied by groundwater usually involve person-to-person transfer of cysts via fecally contaminated objects.

A small percent of the human population will test positive for *Giardia*, and people may be carriers and have no obvious symptoms. A test for *Giardia* requires a gallon or more of water to filter out the cysts. A limited number of laboratories conduct this test.

Heterotrophic Plate Count (HPC) Bacteria
(MCL: TT, MCLG: N/A)
The surface water treatment rule sets a standard of 500 bacterial colonies per mL. Bacteria are common in surface-water systems and may occur in groundwater. These bacteria do not indicate probability of pathogens as expected with coliform bacteria. The heterotrophic plate count is a common method to evaluate the quantity of bacteria present. When bacteria other than coliform are present in large numbers, poor-quality water may exist.

Legionella (MCL: TT, MCLG: Zero)
Legionnaires' disease (Legionellosis) is a form of pneumonia caused by *Legionella* bacteria. The disease develops following inhalation of the bacteria after it has been vaporized from water coming from a shower, a humidifier, or air conditioning system. *Legionella* bacteria are found naturally in soil

and water. *Legionella* is an opportunistic pathogen that can infect people in poor health.

Viruses (MCL: TT, MCLG: Zero)
Viruses in drinking water are from the intestinal tract of humans and animals. Viruses from sewage enter the drinking water supply and produce a variety of diseases and health conditions and can live several days to months outside of live hosts.

Inorganic Chemicals

Inorganic chemicals are present in all drinking water and help give water its unique flavor. Levels of most inorganic chemicals are influenced by the soil, rock, minerals, and pollutants that have been in contact with the water. Lead and nitrogen as nitrate and/or nitrite are of greatest concern.

Nitrate (MCL and MCLG: 10 mg/L as nitrogen (N))
Nitrate test results are usually expressed as nitrate-nitrogen. Nitrate-nitrogen is the nitrogen portion of the nitrate ion. If the laboratory reports the amount of nitrate in a sample, convert to the correct scale by dividing nitrate by 4.5 to interpret your water test report. If your test report is unclear whether the number reported is nitrate or nitrate-nitrogen, check with the laboratory.

The nitrate standard is established to protect infants who consume water or formula mixed with water. Nitrate has caused methemoglobinemia (infant cyanosis or blue baby disease) in infants younger than 6 months old who have consumed high-nitrate water.

Pregnant women, those expecting to become pregnant, and nursing women, should also avoid high-nitrate water.

Total nitrate intake is the important factor. High nitrate levels are common to some foods such as leafy green vegetables and cured meats. Children older than 1 year of age and adults may be able to safely drink water with nitrate concentrations above the standard. Concentrations more than twice the standard (20 mg/L) are a health risk and should be corrected. Nitrate levels in groundwater in some areas have increased during the last decades, and there is growing concern for long-term health consequences. For more information about nitrate in well water, see *Nitrate in Groundwater* (MF857).

Nitrite (MCL and MCLG: 1 mg/L as nitrogen)
Nitrite is readily absorbed by blood in the digestive tract and attaches to the hemoglobin and interferes with the blood's capacity to carry oxygen to body cells. This standard is closely linked to the nitrate standard because the problem with nitrate occurs when it is chemically changed to nitrite in the digestive system. Since nitrite does not have to be chemically changed in the body to exhibit its effect, the reaction is similar in infants, children, and adults. High concentrations are rarely found in the environment.

Nitrite and nitrate levels should be combined to determine the effect on people. The health effect of nitrite is considered 10 times as important as that of nitrate. To estimate the combined effect of nitrite and nitrate, multiply the nitrite level by 10 and add it to the nitrate level. If the sum is 10 mg/L or above, the sample does not meet the drinking water standard.

Other Water Quality Parameters

This category includes alkalinity and other items, which are considered nuisance contaminants. These items do not affect health and are called secondary standards. Unlike many inorganic chemicals that cannot be detected by the senses, the contaminants usually are recognized directly or indirectly through the observed effects.

Alkalinity (recommended greater than 60 mg/L)
The alkalinity of water is a measure of its capacity to neutralize acids. Bicarbonates and carbonates are the major contributors to alkalinity; borate, silicate, hydroxide, and phosphate also contribute. A complex relationship of pH, hardness, alkalinity, dissolved oxygen, and total dissolved solids determines whether water will cause corrosion or deposits. Water with low alkalinity can be corrosive, which could cause deterioration of plumbing and an increased chance for lead from pipes, solder, or plumbing fixtures to enter drinking water.

Hardness (various measurements are used)
Water readily dissolves calcium and magnesium from soil and rocks. Hardness of 10 to 40 grains per gallon is common, and greater than 50 grains per gallon is not unusual. In addition to calcium and magnesium, iron and manganese also contribute to hardness.

Hardness minerals react with soaps and detergent, producing scum and deposits that make unsightly rings in the bathtub and wash basin and leaves deposits on clothes. Hardness also precipitates in appliances, water heaters, and water pipes, which reduces their capacity and eventually contributes to their early failure. The hardness minerals give water flavor and have no known adverse health effect.

Public acceptance of hardness varies with location and water treatment, depending on the concentration to which a person is accustomed. Hardness is expressed as calcium carbonate, and over 300 mg/L is excessive for nearly everyone. Total hardness of 100 mg/L or less is generally considered acceptable for household and most other uses.

Hydrogen Sulfide

Hydrogen sulfide is found naturally in groundwater in parts of Kansas. Hydrogen sulfide is called the "rotten egg" gas because of its odor. The gas dissipates when water is exposed to the atmosphere. It is one of a few water contaminants that can be detected by smell at low concentrations. Hydrogen sulfide may be produced by decay of iron bacteria. Sulfate-reducing bacteria that use sulfate as an energy source are the primary producers of hydrogen sulfide.

Hydrogen sulfide is a problem in a water heater when sulfate-reducing bacteria colonize on the sacrificial anode. During periods of low use of hot water, hydrogen sulfide accumulates in the water. Corrective measures include increasing the water heater temperature to greater than 160 degrees Fahrenheit for several hours or changing the magnesium sacrificial anode to aluminum. If water heater temperature is raised, warn users of the hot water.

Additional Information

K-State Research and Extension offices — *www.ksre.k-state.edu/about/statewide-locations/*

Local health departments — *www.kdhe.ks.gov/2085/Directories-Maps*

Local environmental offices or county sanitarian — *www.kdhe.ks.gov/BusinessDirectoryII.aspx?lngBusinessCategoryID=49*

Nitrate and Groundwater (MF857) — *bookstore.ksre.ksu.edu/download/MF857*

Private Well Maintenance and Protection (MF3666) — *bookstore.ksre.ksu.edu/download/MF3666*

Private Wells — Safe Location — *bookstore.ksre.ksu.edu/download/MF3667*

Shock Chlorination of Private Water Well Systems (MF911) — *https://bookstore.ksre.ksu.edu/pubs/MF911.pdf*

Testing Private Water Systems (MF3655) — *https://bookstore.ksre.ksu.edu/pubs/MF3655.pdf*

Federal and State Resources

Free Private Well Training — *http://privatewellclass.org/*

Ground Water and the Rural Homeowner — *https://pubs.usgs.gov/gip/gw_ruralhomeowner/*

How Can You Help Protect Source Water? — *https://www.epa.gov/sourcewaterprotection/how-can-you-help-protect-source-water*

Kansas Department of Health and Environment – Geology and Well Technology Unit — *https://www.kdhe.ks.gov/274/Geology*

National Drinking Water Clearinghouse — *https://actat.wvu.edu/about-actat/national-drinking-water-clearinghouse*

National Primary Drinking Water Regulations — *https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations*

Private Well Info Sheets — *https://www.watersystemscouncil.org/water-wellhelp/wellcare-info-sheets/*

Protect Your Private Well — h*ttps://www.epa.gov/sites/default/files/2018-02/documents/epa-ogwdw-private-wells-v4.pdf*

Acknowledgments

Information in this publication was drawn from:

Bradshaw, M. H., & G. M. Powell (2004). *Understanding Your Water Test Report—Microbiological, Chemical and Nuisance Contaminants* (MF912). Kansas State University.

This project has received funding and support from K-State 105, Kansas State University's economic growth and advancement initiative for all 105 counties in Kansas. Learn more at *k-state.edu/105*.

Authors

Pat Murphy
Extension Engineer, Retired

Stacie Minson
Watershed Specialist

Joe Harner
Extension Engineer, Retired

Herschel George
Watershed Specialist, Retired

Dan Wells
Environmental Administrator
Kansas Department of Health and Environment

Melissa Harvey
Communications and Marketing Coordinator

K-STATE
Research and Extension

Kansas State University Agricultural Experiment Station and Cooperative Extension Service
K-State Research and Extension is an equal opportunity provider and employer. Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of K-State Research and Extension, Kansas State University, County Extension Councils, Extension Districts.

MF3679 December 2024