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Testing Private Water Systems

Public water supplies (city and rural) are routinely tested for contaminants including nitrate, bacteria, and minerals. Consumers rely on water utilities and regulators to ensure safe drinking water through notification of levels higher than accepted ranges. Many rural Kansas households depend on private water supplies, also known as private wells. The source of this water is groundwater found underground in the cracks and spaces in the soil, sand, and rock. To learn more about groundwater visit: *epa.gov/ground-water-and-drinking-water.*

People who use private water supplies are responsible for the quality and safety of their water. Lending institutions may require water tests and evaluation of the water system before approving a loan. Some county sanitary codes require water tests for private systems as well. This publication helps private water users understand important factors and make critical decisions about the frequency and kind of water tests necessary to provide safe water.

If a private well or spring is deficient in location, construction, protection, maintenance, or water quality testing, drinking water may not be safe. Water quality issues may affect the health of everyone in the household. Water testing is a reliable method to evaluate the safety of water. Color, turbidity, taste, and odor are discernible by human senses but offer few clues concerning impurities that may affect the health of water consumers. Water that appears problem free may not be safe or acceptable for all uses.

Water testing is necessary:

- to ensure water is safe to drink (meets Safe Drinking Water Standards);
- to evaluate need for water treatment and protection; and
- to record a baseline of water quality issues for later comparison.

The most important factors for safe private water sources are proper well location and construction. Also important are the management of activities near the well and conducting regular maintenance. If the well location, construction and/or maintenance are deficient, corrective actions should be taken before testing the water. These actions may include plugging the existing well, determining a new location for a safe water supply, and drilling a new well.

How Water Becomes Contaminated

Chemically pure water does not exist for long in nature. Water is an excellent solvent, dissolving some of almost everything it contacts.

Precipitation picks up gases, ions, and dust particles from the atmosphere. When rainwater contacts the earth, it flows over or through plant materials and surface layers of soil and rock, absorbing minerals. As rain falls onto parking lots, buildings, and equipment, the runoff water can absorb surface materials, including oil, sediment, fertilizers, and debris. This water then carries those contaminants into local water resources such as creeks or streams that can infiltrate into the soil profile.

Minerals like calcium, magnesium, carbonate, sodium, and chloride are of little concern in fresh water and even desirable because low levels contribute to good-tasting water; however, many undesirable chemicals also dissolve in water and can affect the quality of the private well. Thus, private water system testing is important.

Water test results generally indicate the natural groundwater is safe. When contamination is detected, the contamination may be a result of poor well or spring location, construction, protection, or maintenance. Human or natural activities can overload the soil's natural filtering, absorption, and removal capacity. When pollutants overload the soil's protection, they eventually reach the groundwater. Evidence of sewage, fuel, wastes, manures, pesticides, and fertilizer may be found in groundwater.

Ensuring Safe Drinking Water

Health effects from contaminated water can produce an acute or chronic toxicity. Acute toxicity is an immediate response within hours or days, while a chronic toxicity is a long-term response from low-level exposure over many years.

This publication focuses on acute toxicity because the risk is known, direct, and usually short-term. The highest priority is to ensure the water source is free of disease-causing organisms and pollutants that immediately affect body functions and health. Annual testing of private wells is important to establish a baseline of water quality

over several years for each private well. Collecting and documenting this information is important in making critical decisions about water quality and safety.

Where to Get Water Tested

Water test kits are available at most local K-State Research and Extension offices (*ksre.k-state.edu/about/statewide-locations*). Local health or environmental offices may have testing kits available. Water treatment dealers may offer water tests for nuisance problems.

When testing for issues affecting human or animal health, use a laboratory certified by Kansas Department of Health and Environment (KDHE). Using a certified laboratory is critical if results might be used as evidence of pollution or in litigation. A list of current certified laboratories is available through the KDHE Laboratory Improvement Program Office, *www.kdhe.ks.gov/1286/Environmental-Laboratory-Accreditation*.

How to Take a Water Sample

When collecting a water sample, follow the instructions from the certified laboratory. Use the provided container and follow directions to ensure a representative sample. If no directions are given, contact the laboratory directly. Samples should always be taken from cold, unsoftened, and untreated water. Select a faucet that is used regularly. Remove the aerator and allow the water to run for several minutes. For lead tests, sample the first flow after water has remained in the system overnight.

Recommended Tests and Frequency

KDHE and K-State Research and Extension recommend annual water tests for coliform bacteria and nitrate. Common impurities and nuisance contaminants typically change slowly, so water testing for these is recommended every one to three years. The exception, which could require additional testing, would be in the case of chemical spills or flooding. Over time, the tests form a basis for comparison to detect possible water source contamination and quality issues.

Total Coliform Bacteria

An annual water test for total coliform bacteria is essential for safe drinking water. Coliform bacteria are common, and most strains are not pathogens (disease causing); however, the presence of coliform is an indicator that the well may be contaminated. Coliform bacteria are found in the feces of warm-blooded animals, in soil, and the environment. These bacteria indicate the water source has been comprimised and may be contaminated with sewage or animal wastes. Other bacteria, viruses, and cysts may also be present and could cause human illness.

Environmental factors that suggest a need for special or more frequent bacteria tests include:

- water flooding near a well or surface water supply;
- locations of water supply near confined livestock pens or other high-bacteria sources;
- change in water color, turbidity, odor, or taste;
- recurring digestive illness in people or animals; or
- following repair of well or plumbing system.

Fecal Coliform or *E. coli* Bacteria

If total coliform bacteria are indicated in a test result, a followup test for fecal coliform or *E. coli* bacteria is recommended. Finding fecal or *E. coli* bacteria means there is contamination from a human or animal fecal source. Pathogens can exist in the drinking water and the water must not be used for drinking, cooking, or washing without disinfection.

Fecal coliform live in the intestines of warm-blooded animals and are included in the total coliform test. *E. coli*, short for *Escherichia coli*, are specific fecal coliform strains. Most fecal or *E. coli* bacteria are not disease agents, but their presence suggests a high possibility of pathogens and disease.

Nitrate

An annual test for nitrates is the second most important test for safe water. Nitrates are naturally found in the soil, air, and water. High levels of nitrates can cause water-quality and health concerns. In warm-blooded animals, including humans, nitrate may be reduced to nitrite, which readily enters blood. Nitrite attaches to the hemoglobin and restricts the blood's ability to carry oxygen. In extreme cases, nitrite causes methemoglobinemia (blue baby syndrome) in human and animal infants. If the problem is not solved or treated, death may result.

High nitrate levels may affect horses and ruminant animals. In livestock, high nitrate levels can cause reduced milk production, weight loss, abortion, poor body condition, and reproduction issues often before other symptoms are observed.

Nitrate tests are important when livestock facilities, fertilizer storage or handling, or a septic system have been located within 400 feet of the well or surface water source.

Pesticide and Other Organic Chemicals

A pesticide test is recommended when the nitrate test is above the Maximum Contaminant Level (MCL) and

pesticides have been stored, mixed, handled, or disposed within 400 feet of the well. If wells are located close to agricultural fields, the potential exists for contamination. Test when an incident, such as a large spill or accident occurs. Also test annually if the well is within a quarter mile, especially upslope, of a commercial storage, handling, and mixing site.

Lead and Copper

A test for lead, copper, or both is recommended when plumbing systems contain lead or copper pipe or fittings, or there is evidence of corrosion (bluish or greenish stains on fixtures), low pH, soft water, or a combination of these factors. Groundwater normally does not contain significant levels of lead or other toxic metals; however, water with low pH or soft water additives can cause corrosion and can result in higher levels.

Nuisance Contaminants, Need for Treatment

The most common water quality problems are nuisances that make water less desirable for household uses but do not directly affect health. Standards are designated "secondary" when there is no direct health concern. These include chloride, copper, iron, manganese, sulfate, total dissolved solids (TDS) and zinc. Testing laboratories may have a drinking water suitability test that includes the most common anions and cations and nuisance impurities. Testing every one to three years helps identify the problem, evaluates the need for treatment, and aids selection of treatment equipment. Equipment dealers usually test for nuisance impurities to select and size treatment equipment.

Here are some of the most common nuisance issues:

- **Acidic (low) or basic (high) pH** may cause corrosion that contributes to health concerns and staining of plumbing fixtures when some metals are corroded. pH adjustment can occur with proper treatment.
- **Hardness** is the most common nuisance problem in Kansas groundwater. Hardness causes difficulty with cleaning and laundry, deposits in water heaters, and shortens the useful life of water-using appliances. Equipment to remove hardness of water is readily available.
- **Hydrogen sulfide** gives water a disagreeable "rotten egg" or sulfur odor. A sensitive nose is a highly effective test. Routine disinfection of the well is a highly effective treatment.
- **Iron and manganese** are called "the stainers" because they contribute to permanent black or red stains of water fixtures and laundry. Special iron filters are effective.
- **Total dissolved solids/salts** are the sum of all impurities dissolved in water. At low levels, they are a benefit because they give water its taste.

Showing Contamination

The activities of businesses and people may damage the quality of wells and groundwater. Water tests before pollution and in the early stages of pollution are helpful to show damage to the supply. Some activities that may affect groundwater quality and resulting water tests that may show a cause are shown in Table 1.

Proving damage for litigation requires careful planning. The strongest evidence is provided when an unbiased third party, such as licensed engineer or health department sanitarian, collects and delivers the sample to the laboratory using a chain-of-custody record. This record shows who handled the samples and the time, so accountability is available for testimony.

Interpreting a Laboratory Test Report

A water test report may look confusing. It often has unfamiliar terms and abbreviations. Assistance in understanding and evaluating the test report may be available from the testing laboratory, the local county health or environmental office, the KDHE, or K-State Research and Extension.

Sources

Groundwater Foundation — *groundwater.org/what-is-groundwater*

Environmental Protection Agency — *www.epa.gov/privatewells*

Well Owner Resources — *wellowner.org*

K-State Research and Extension Bookstore — *www.bookstore.ksre.ksu.edu*

Acknowledgments

Information in this publication was drawn from the following sources.

Recommended Water Tests for Private Wells (2020). and *Testing to Ensure Safe Drinking Water (*2020). Originally published by the K-State Pollution Prevention Institute and reused with permission.

Powell, G. M., M. Bradshaw, & B. Dallemand (1999). *Recommended Water Tests for Private Wells* (MF871). Kansas State University.

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Table 1. Industry/Facility, Source of Contamination, and Parameters to Test

Industry/Facility	Source of Contamination	Parameters to Test
Agricultural related bulk storage: grain, silage, fuel, pesticides, fertilizer, oil, etc.	Leaks, spills, improper disposal of material, uncontrolled discharges, stormwater runoff	Past or present stored material(s), site runoff and discharges
Mining: salt, coal, lead, zinc, and other metals/minerals (surface and sub-soil removal)	Mine drainage, leaks, spills, storage areas, mined lands, tailings, and waste piles	Total dissolved solids (TDS), chloride, sodium, pH, heavy metals, corrosion index, sulfate
Oil and gas: test holes, old wells, abandoned wells, storage, brine disposal, etc.	Leaks, failed casings, improper plugging, unplugged test holes, abandoned wells, or spills	TDS, sodium, chloride, hydrocarbons, volatile organic chemical (VOC) scan, petroleum components
Landfills and solid/liquid waste disposal sites	Percolation from site, spills and rainwater runoff, pollutant plume develops in soil or groundwater	Chemical oxygen demand (COD), total organic carbon (TOC), ammonia, dissolved oxygen (DO), VOC scan, heavy metal scan, synthetic organic chemicals (SOC).
Home or business wastewater: lagoons, septic systems, sludge, and septic disposal	Leaks, spills, system overloading, poor maintenance or site selection	Total and fecal coliform bacteria, fecal streptococcus, nitrate, ammonia, TDS, TOC, chlorides, sodium
Agricultural operations: including crop and livestock production	Plant and animal production management of soil properties, rainwater infiltration and runoff, pesticide and fertilizer application, irrigation	Total and fecal coliform bacteria, sediment or total dissolved solids (TDS), soil chemicals, biochemical oxygen demand (BOD), ammonia, nitrate, phosphorus, TOC, COD
Industrial sites	Leaks, disposal, failures, poor construction, maintenance or management, spills control of stormwater runoff	VOC and SOC of chemicals used, produced or stored on the site; process chemicals
Water wells and surface sources for domestic or livestock uses	Wells with improper location, construction, maintenance or management	Total and fecal coliform bacteria, nitrates

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*.

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MF3655 March 2024