

Understanding Your Water Test Report

This publication summarizes information to help you interpret a report from a water testing laboratory and to decide what action to take. It is intended primarily for homeowners with private water supplies (home wells), but environmental organizations, health departments, water testing laboratories and those on public water supplies may find this material of interest.

Regular water tests are recommended for all household water systems. Public water supplies are tested regularly in accordance with state and federal regulation. However, there is no law or regulation requiring testing or establishing water quality standards for private supplies. Owners and users of private water supplies are advised to test their water regularly and to interpret the results using the safe drinking water standards for public systems except as noted here.

Tests for household water include microbiological, inorganic chemicals, organic chemicals — such as pesticides, synthetic organic chemicals (SOCs), volatile organic chemicals (VOCs) — and radiological components. Tests also measure physical/chemical or nuisance contaminants such as water hardness and iron. This publication discusses the standards and health consequences for microbiological, inorganic chemicals and nuisance contaminants. Water testing is expensive so try to narrow down or identify what you need to test for. MU Extension publication EQ100 *Water Testing: What to Test For* provides more information.

Much scientific work has been and is being directed toward obtaining or setting sound criteria for water in domestic, industrial, agricultural and other uses. Where health is involved and where scientific data are sparse, professional judgments based on best available information have sometimes been established on an interim basis. Also, water quality standards change as scientific knowledge of contaminants and their effects on health increases.

Drinking water standards

Drinking water standards (Table 1) are established for contaminants that may have adverse effects on people's health and for contaminants that have aesthetic effects, such as taste, odor or staining. Standards for contaminants that could impact health are called primary drinking water standards and are enforceable by law for public water systems.

Table 1. Safe drinking water standards terminology.

ADI	Acceptable daily intake
MCL	Maximum contaminant level (primary standard, health effects)
MCLG	Maximum contaminant level goal
SMCL	Secondary maximum contaminant level (non-health effects)
SMCL	Secondary maximum contaminant level (non-health effects)
Milligrams per liter (mg per liter) = parts per million (ppm)	
Micrograms per liter (µg/L) = 0.001 µg/L or parts per billion (ppb)	

The Environmental Protection Agency (EPA) has responsibility for setting public drinking water standards through the Safe Drinking Water Act. These standards also can be used as a guide for monitoring levels in private well water.

Primary standards

Primary standards are usually established through maximum contaminant levels (MCL) but may be established through a mandatory treatment technique requirement.

Officials set standards using a figure calculated from animals studies called the acceptable daily intake (ADI) for chemicals that cause adverse health effects other than cancer. The ADI is the daily dose of a substance that a person can ingest over a lifetime without suffering any adverse health effects, and it includes a conservative safety margin.

The MCL is the maximum level of a contaminant allowed in a public water system, and customers must be notified when it is exceeded. The MCL must be set as close to the maximum contaminant level goal (MCLG) as application of best technology will allow. The 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 human carcinogens.

Secondary standards

Standards for aesthetic contaminants are called secondary maximum contaminant levels (SMCL). These secondary

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standards are not enforceable. Water meeting secondary standards should not have unpleasant taste, odor, appearance or side effects. In Missouri, the SMCL may be exceeded with little concern; for example, total dissolved solids (salts) may exceed twice the secondary standard.

The Safe Drinking Water Act amendments of 1986 require drinking water standards to undergo extensive review and revision. The present standards have been accepted by EPA as levels that should not pose negative health effects.

Microbiological contaminants

Microbiological contaminants include the living organisms in water that are capable of reproducing or growing either in water or in the host, once ingested. These contaminants include bacteria, protozoa (may be in cyst form), viruses and parasitic worms. Microbiological contaminants have been responsible for the majority of illness and disease associated with polluted water. Entry into the body is normally through drinking water, but breaks in the skin and other body openings may also be avenues of entry. Many diseases can be transmitted through water, and some are transmitted primarily by water. Food and objects (such as fingers) put in mouths are other possible means of exposure. Filtration and disinfection are the primary methods for control of microbiological contaminants.

Bacteria, coliform (MCL: 0 colonies per 100 milliliters)

EPA proposes an alternate presence/absence test for coliform bacteria.

The test for coliform bacteria has been the standard test for microbiological safety for several decades. It is an excellent indicator of possible contamination in disinfected public water supplies. The test evaluates for coliform bacteria, which are widely distributed in the environment in soil, on plants, on animals and in very large numbers in the feces of mammals. When coliform are present, it means water has been exposed to one or more of these sources. In disinfected systems, this means the water has been recontaminated or disinfection is inadequate and the water may contain pathogens (disease-causing organisms).

Illness caused by pathogens commonly transmitted by water include typhoid, cholera, dysentery, hepatitis, giardiasis, polio, Legionnaires disease and several gastrointestinal and influenza-like illnesses. Coliform bacteria are not considered pathogens, though some strains are opportunistic pathogens, which means they may cause disease among people whose local or general natural defense mechanisms are impaired, such as the elderly, the very young and the ill (such as burns or immunosuppressive therapy).

Note: The presence of coliform also means the water may contain pathogens.

The coliform test has also been widely used to evaluate the microbiological safety of private water systems. Interpreting the health significance of the coliform test is quite difficult in this application. If the findings of no coliform is interpreted to mean the water supply is safe, a false sense of security can result. Especially a single sample may not be representative of water quality at other times or location.

Interpreting the finding of coliform in a water sample to mean the water is unsafe, or unfit to drink, may create a false sense of alarm. Although undesirable, the presence of some total coliform may be inevitable in some private water systems because the systems are not normally disinfected. Coliform bacteria are virtually everywhere in the environment. Their presence does not necessarily indicate contamination by human or animal waste or pathogens. However, all water systems should be free of all fecal coliform to be considered safe.

The difficulties in interpreting the meanings of coliform tests for private water supplies can be overcome by first ensuring the safety of the supply and distribution system against contamination, and then establishing a long record of test results. Quarterly sampling — four times a year — is recommended at least until a record of consistent results is obtained. Public systems are tested a minimum of once every two weeks (26 times per year). At this time, the EPA does not accept any coliform bacteria levels in public drinking water.

Coliform bacteria in a water supply means the water has been affected by the environment and disease-causing organisms may be present. Therefore, the presence of any coliform is cause for concern, and corrective action should be taken. Fluctuation in coliform count, such as increases after a rain, or seasonally, indicate direct contamination of the water source. Poor well construction is a common cause.

Steps to ensure safe water and correct bacteria problems

- Ensure safety of the water source. Is the well or spring located upslope and away from possible contamination sources? Is it safely constructed? Is it tightly sealed, clean and well-maintained?
- Verify integrity of the distribution system. (Is it free of cross connections with non-potable water? Do all outlets always have adequate air gaps or backflow preventers? Are in-line treatment devices clean and well-maintained?)
- Disinfect the water source and distribution system and re-test after a couple of weeks.

If following these steps does not remove bacteria, there is probably some overlooked cross connection or problem with the water source. A recent contamination of the supply by a large quantity of water that has carried bacteria into the aquifer — or continued contamination of the aquifer because of shallow soil cover, an abandoned well or other sources — are possibilities. In cases of persistent

coliform bacteria problems, seek further help from your local MU Extension center, local health departments or the Missouri Department of Health in evaluating the problem. In extreme cases, construction of a new well, continuous disinfection or connection to an alternate supply may be necessary.

A laboratory reporting the results of a bacteriological test on water may use such terms as satisfactory or unsatisfactory for human consumption.

Because the coliform test will detect bacteria strains not of fecal origin from air, soil and our hands, it is critical to sample correctly and from an acceptable location. Take care not to contaminate the sterile sample container or lid. Any locations following a water treatment device (cartridge or tank filter or softener) or open storage container, such as a cistern, have high probability of coliform contamination. Many coliform positive samples are traced to an unsatisfactory sampling location or poor care in sample collection. Other sample locations likely to produce meaningless results are single lever faucets, a frost-proof hydrant, hose bib, hose or any hot-water outlet.

Bacteria, other than coliform (no standard)

When bacteria other than coliform are present in large numbers, it means the water is of poor quality. Presence of any bacteria suggests that the water supply or the water system is or has been open to the environment. Fluctuations in the number of bacteria likely depend on how recently the contamination occurred. These bacteria do not indicate a high probability of pathogens (disease-causing organisms) as expected with coliform bacteria. However, like coliform bacteria, some of these bacteria are themselves opportunistic pathogens.

When bacteria other than coliform are present in large numbers (more than 100 per 100 milliliters) or are too numerous to count (TNTC), they may crowd out or inhibit the growth of coliform bacteria. When this situation occurs, the result of the test is invalid and the quality of the water supply is suspect. The same steps should be taken to ensure a safe water supply as previously identified for coliform bacteria and the water re-sampled after a couple of weeks.

Inorganic chemical contaminants

Inorganic chemicals regulated by drinking water standards are widespread in the environment. Concentrations of inorganic chemicals which exceed the MCLs may be due to human activities or natural conditions or both. Levels of most inorganic chemicals are greatly influenced by types of soil, rock, and minerals present.

Inorganic chemicals may enter the body through food, drinking water and the air we breathe. When the drinking water standard is exceeded, it may be necessary to treat a small amount of water for cooking and drinking. The treatment method can be identified by calling the local health department.

Aluminum (Proposed secondary maximum contaminant levels, or SMCL: 0.05 milligram per liter)

Aluminum is widespread in the environment. Intake occurs through food, water and air. Aluminum has been suspected of contributing to Alzheimer's disease, but inadequate scientific data exist to substantiate a cause-effect relationship.

Arsenic (Maximum contaminant levels, or MCL: 0.01 milligram per liter)

The high toxicity of arsenic and its widespread occurrence in the environment necessitates the limit on arsenic concentrations in drinking water. At one time, arsenic compounds were used extensively as pesticides and herbicides, but their use for these purposes has been dramatically reduced. Chronic health effects may include weight loss, depression, lack of energy and cancer.

Asbestos (Proposed MCL and MCLG: 7 million fibers per liter over 10 microns long)

Asbestos occurs naturally in the environment and has been used in asbestos-cement pipes in water distribution systems and in well casings. It has been introduced into drinking water through the corrosion of asbestos-reinforced cement pipes by water with a low pH. Water that has high pH and low corrosivity should prevent the deterioration of pipes that would introduce asbestos into water.

Barium (MCL: 2.0 milligram per liter)

Barium is fatal to humans in high doses (more than 550 milligrams). No study appears to have been made of the amounts of barium that can be tolerated in drinking water, but because of its toxic effects on the heart, blood vessels and nerves, a level with a large safety factor has been set. Barium can accumulate in the liver, lungs and spleen. It can cause nervous system disorders, heart disease and circulation impairment.

Cadmium (MCL: 0.01 milligram per liter)

EPA proposes to reduce the MCL to 0.005 milligram per liter and add an MCLG of 0.005 milligram per liter.

As far as is known, cadmium is biologically a nonessential, non-beneficial element of high toxic potential. Evidence for the serious toxic potential of cadmium is provided by:

- Poisoning from cadmium-contaminated food and beverages
- Epidemiological evidence that cadmium may be associated with renal arterial hypertension under certain conditions
- Epidemiological association of cadmium with "Itai-itai" disease in Japan
- Long-term oral toxicity studies in animals

The health effects of long-term exposure in the United States appear to be from diet, cigarette smoking and seepage into the groundwater from industrial plants,

especially wastewater. Cadmium is believed to be mutagenic but not carcinogenic.

Chloride (SMCL: 250 milligrams per liter)

The SMCL of 250 milligrams per liter for chloride is the level above which the taste of the water may become objectionable. In addition to adverse taste, high chloride concentrations in the water contribute to the deterioration of domestic plumbing and water heaters and municipal waterworks equipment. Chloride is suspected of being a contributor to high blood pressure. High chloride concentrations may also be associated with the presence of sodium in drinking water. See sodium discussion.

Chromium total (MCL: 0.1 milligram per liter)

Chromium is toxic to humans, produces lung tumors when inhaled and causes skin irritations. Long-term exposure may cause skin and nasal ulcers. Chromium accumulates in the spleen, bones, kidneys and liver. It occurs in some foods; in air, including in cigarette smoke; and in some water supplies. The level of chromium that can be tolerated over a lifetime without adverse health effects is still undetermined. Chromium is involved in use of blood sugar and is considered an essential nutrient.

Copper (MCL: 1.3 milligram per liter)

Copper in drinking water normally is not a concern, as the levels required to produce health effects in most people exceed the maximum possible concentrations. Experience indicates that copper at concentration levels exceeding 2 milligrams per liter causes blue-green staining of plumbing fixtures and an off taste. To many people, copper imparts a detectable taste at a concentration level of 1 milligram per liter. In instances where high copper concentration levels in the drinking water are observed, it is likely that other heavy metals are also present. Water containing 4 milligrams per liter copper was found to impart a green tint to dyed hair.

Fluoride (MCL: 4 milligrams per liter, MCLG: 4 milligrams per liter, SMCL: 2 milligrams per liter)

A fluoride concentration of approximately 1 milligram per liter helps prevent dental cavities and osteoporosis. At concentrations below 0.7 milligram per liter, fluoride would likely not be of benefit. This is most commonly a problem for children up to about 10 years old. Because this is the only effect, EPA recently increased the MCL for fluoride. Crippling bone changes may occur in some people if drinking water is above 8 milligrams per liter fluoride. There is no conclusive evidence that fluoridation causes cancer in humans.

Caution: At concentrations above 1.8 milligrams per liter, fluoride may cause staining of enamel of permanent teeth

Iron (SMCL: 0.3 milligram per liter)

Iron occurs naturally in many groundwater supplies throughout Missouri. It is essential in human and animal diets, but levels above the SMCL may impart an objectionable taste or odor to water and cause red staining of porcelain fixtures and laundry.

Animals may be sensitive to changes in iron concentrations in their drinking water. Dairy cows may not drink enough water to maintain optimum milk production if the water is high in iron. Dissolved iron in water used for washing and sanitizing milk-handling equipment may impart an oxidized or cardboard-like flavor to the milk.

Iron-contaminated water often causes reddish-brown stains to develop on bathtubs, sinks and toilet bowls. It can also stain laundry a pink or reddish color. These stains are very difficult to remove with ordinary cleaning compounds.

Frequently, water with dissolved iron also shows evidence of iron bacteria. These organisms use the iron as a source of energy and accumulate in masses that may plug well screens, pumps and pipelines. In time, a rust-colored, jelly-like mass will break loose and enter the plumbing system. Iron bacteria coat nearly everything, including toilet tank, pipes and storage tank. Decaying dead bacteria impart a bad taste to the water and leave stains that are very difficult to remove.

Lead (MCL: 0.15 milligram per liter)

Exposure to lead in water, either brief or prolonged, can seriously injure health. Prolonged exposure to relatively small quantities (more than 0.05 milligram per day) may affect health. Lead exposure occurs from air, food and water sources. All exposure is additive. Lead accumulates in the bones, resulting in elevated levels in the blood. Known effects range from subtle biochemical changes at low levels of exposure to severe neurological and toxic effects — even death — at much higher levels.

As with several other water contaminants, children, infants and fetuses are especially vulnerable to lead. Infants and children absorb a much greater portion of lead intake than adults. Their immature, developing bodies and central nervous systems are much more sensitive to its effects. A child's mental and physical development can be irreversibly stunted by over-exposure to lead. Health effects include reduced mental capacity (even intellectual developmental disorders), interference with kidney and neurological functions and hearing loss in children. The EPA-proposed MCL should be followed whenever pregnant women, infants or children are consuming water.

Water may be contaminated by lead from rocks and soil. However, most of Missouri has little lead in these sources, and most of the water's pH is above neutral, where lead is less soluble. There is little reason to expect lead in water supplies from these natural sources.

Lead pipe was used for service connections from water mains to homes or businesses as late as the 1960s. The use of solder containing lead has been made illegal for potable

Table 2. Guidelines for use of water with known nitrate content.

Nitrate-N (NO₃-N) mg per liter	Nitrate (NO₃) mg per liter	Risks and recommendations
Below 10	Below 45	Acceptable for all uses (below the standard). Recommend making a nitrate test each year until a consistent record of low nitrate is established.
10 to 20	45 to 90	Infants less than 1 year of age and pregnant women are at risk and should use an alternate water supply. Recommend regular nitrate tests at least yearly and alternate water supply low in nitrate for those at risk. Eliminate excess nitrate sources close to the well.
20 to 40	90 to 180	People and some livestock at risk, especially young or those in high-risk category. Recommend an alternate water supply or water treatment to reduce nitrate for drinking or cooking. Test nitrate in water for people and animals at least twice a year and check nitrate in livestock feed. This condition (two to four times the standard) indicates nitrate contaminants that should be corrected.
Over 40	Over 180	Hazardous to people and much livestock (over four times the standard). Proceed immediately to correct this hazard. Do not use this water for drinking or cooking without treatment. This condition indicates severe nitrate contaminants that should be corrected or water use discontinued immediately.

water plumbing systems. Industry standards now prevent the use of lead as an additive in solder used for plumbing.

Manganese (SMCL: 0.05 milligram per liter)

Excess manganese may produce a black or gray color in laundered goods and may impair the taste of tea, coffee and other beverages. Concentrations above the standard may also cause a dark stain on porcelain plumbing fixtures. As with iron, manganese may form a coating on distribution pipes which may slough off, causing dark stains on laundered clothing or black particles in the water. Manganese stains can be even more difficult to remove than iron stains.

Mercury (MCL: 0.002 milligram per liter)

EPA proposes to add an MCLG of 0.002 milligram per liter.

Mercury is distributed throughout the environment as a result of industrial and agricultural applications. Large increases in concentrations above natural levels in water, soils and air may occur in localized areas, though significant mercury problems are rare in Missouri. Outside of occupational exposure, food is typically the greatest contributor to total mercury intake, particularly fish. Poisoning is characterized by major changes in the brain, including loss of vision and hearing, intellectual deterioration and even death.

Nitrate (MCL: 10 milligrams per liter as nitrogen)

EPA proposes to add an MCLG of 10 milligrams per liter nitrate-nitrogen.

Nitrate has caused methemoglobinemia (infant cyanosis) or blue baby disease in infants less than 6 months old who have been given water or formula mixed with water high in nitrate. Approximately 200 cases have been reported since it was first discovered in 1945. Children under 1 year of age and pregnant women are at risk for adverse effects.

Nitrate test results are usually expressed as nitrate-nitrogen (Table 2). However, laboratories may report the amount of nitrate in a water sample. Nitrate-nitrogen is just the nitrogen portion of the nitrate ion. Because of the difference between the number expressed as nitrate-nitrogen or as nitrate, it is essential to use the correct scale 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.

Total nitrate intake is the important factor. Nitrate in food or feed is just as important as nitrate in water. High nitrate is common in some foods such as leafy green vegetables and cured meats. Drought-stressed livestock feeds and lush green growth from legumes or crops under high nitrogen fertility are common sources of high nitrates in livestock feeds.

The nitrate standard is established to protect infants less than 1 year old who consume water in formula or directly. There is little or no margin of safety for some infants. In rare cases, illness and even death have occurred with concentrations just above this level after only a day or two of exposure. Pregnant women should also avoid water above this standard. As with other environmental factors, there is a wide range in sensitivity between individuals, so not all would develop the same symptoms from exposure to high amounts of nitrate.

Children above 1 year of age and adults, who are not nitrate-sensitive, can safely drink water with nitrate concentrations above the standard, even much higher, for short periods. As nitrate levels in water have risen over several decades, there is growing concern about long-term health consequences. Unfortunately, there is not much definitive information on which to base recommendations.

It is believed that the higher the concentration, the greater the risk of adverse health consequences.

Livestock as a rule are less sensitive to poor water quality than are people. However, livestock are more likely to receive continued high nitrate from feed. For people, nitrate in food is seldom a concern because of a greater variety in their diet.

Nitrates less than twice the drinking water standard for humans should be of little concern for livestock health. Risk increases with concentration, as with most contaminants. Usually, the young and pregnant, ruminants, milking animals and horses are most at risk for adverse effects.

Nitrite (Proposed MCL and MCLG: 1 milligram per liter as nitrogen)

This standard is closely linked to the nitrate standard because the problem really occurs when nitrate is chemically changed to nitrite in the digestive system. Nitrite is readily absorbed by blood in the digestive tract. It attaches to the hemoglobin and interferes with the blood's capacity to carry oxygen to body cells. Because nitrite does not have to be chemically changed in the body to exhibit its effect, the reaction is direct and is similar in infants, children and adults. Fortunately, nitrite is not very stable, so high concentrations are rarely found in the environment.

Nitrate plus nitrite (Proposed MCL and MCLG: 10 milligrams per liter as nitrogen)

Nitrite and nitrate levels should be combined to determine the effect on people and animals. The health effect of nitrite is considered 10 times as important as 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 milligrams per liter or above, the sample does not meet the proposed drinking water standard.

Selenium (MCL: 0.05 milligram per liter)

There is considerable difficulty in determining the toxic levels of selenium intake in humans because the diet contains an unknown variety of selenium compounds in varying mixtures. Signs of toxicity have been seen at an estimated intake of 0.7 to 7 milligrams per day. Possible health effects include growth inhibition, skin discoloration, dental and digestive problems, liver damage and psychological disorders. Some studies have raised concern over the possible carcinogenic properties of this element, but at this time it is not believed to be carcinogenic.

Silver (MCL: 10 milligram per liter)

The need to set a water standard for silver arises from its intentional addition to waters as a disinfectant. Note that no public water system in Missouri uses silver as a disinfectant. The chief effect of silver on humans is a condition called argyria or argyrosis, an unsightly,

permanent blue-gray discoloration of the skin, eyes and mucous membranes. Because silver, once absorbed, is held indefinitely in the body tissue, a maximum level has been set. However, because skin discoloration is the only known health effect and because it is considered an aesthetic effect, EPA has proposed making it a secondary standard.

Sodium (Suggested MCL: 20 milligrams per liter)

Sodium is present in almost all surface water and groundwater. The amount varies widely, from less than 10 to several hundred milligrams per liter for public supplies across the state. Home water softeners — such as cation exchange type, using sodium chloride for recharge — add significantly to sodium in the water because they exchange sodium for the hardness minerals. Because of the increase in sodium and reduction in calcium and magnesium, unsoftened water is recommended for drinking purposes. The American Heart Association guidelines suggest no more than 2,300 milligrams per day of sodium intake to reduce the risk of hypertension for some individuals. For most persons, the sodium content of water is unimportant because the body eliminates the excess. The amount of sodium in the water may be important for those on a low-sodium diet because of heart, kidney and circulatory ailments. The usual low-sodium diets allow only about 20 milligrams per liter sodium in drinking water. When this limit is exceeded, the person should seek a health specialist's advice. Sodium is also a concern for irrigation water.

Sulfate (SMCL: 250 milligrams per liter)

Sulfate has no known health effects at concentrations up to about twice the standard, so it has a secondary standard. High concentrations of sulfate in drinking water have three effects:

- Water containing appreciable amounts of sulfate tends to form hard scales in boilers and heat exchangers
- Sulfate affects taste
- High sulfate can cause laxative effects for those not used to it

The laxative effect of sulfates is usually noted in transient users of a water supply because people who are accustomed to high sulfate levels in drinking water have no adverse response. Diarrhea can be induced at sulfate levels greater than 500 milligrams per liter but more typically near 750 milligrams per liter.

While sulfate imparts a slightly milder taste to drinking water than chloride, the taste threshold may be as low as 300 milligrams per liter.

Total dissolved solids or TDS (SMCL: 500 milligrams per liter)

Total dissolved solids (TDS) is a measure of all dissolved inorganic material in water. TDS higher than about 1,000 milligrams per liter is objectionable because of the mineral taste and possible health effects. Additionally, water with

TDS above a typical household level of 400 milligrams per liter has been found to decrease the average life of home hot water heaters approximately one year for each additional 200 milligrams per liter of TDS in the water. High TDS values may be an indication of the presence of excessive concentration of some specific substance, not addressed by other parameters in the Safe Drinking Water Act, which could make the water aesthetically objectionable to the user.

Zinc (SMCL: 5 milligrams per liter)

Zinc is found in some natural waters, most frequently in areas where it is mined. It is not considered detrimental to health unless it occurs in very high concentrations. However, it does give an undesirable taste and appearance to drinking water, which is the reason for the secondary standard classification.

Other water quality parameters

This category includes alkalinity and several other items, some of which are considered nuisance contaminants. Standards generally do not exist. Unlike many of the inorganic chemicals that cannot be detected by the senses, these contaminants are usually recognized directly or indirectly through the observed effects.

Alkalinity (recommended greater than 60 milligrams per liter)

The alkalinity of water is a measure of its capacity to neutralize acids. Bicarbonates and carbonates are the major contributors to alkalinity, but 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 is more likely to be corrosive, which could cause deterioration of plumbing and an increased chance for lead in water, if present in pipe, solder or plumbing fixtures.

Corrosivity (SMCL: non-corrosive; Goal: Langelier index at zero or slightly positive)

The Langelier index is commonly used as an indicator of corrosivity. Public systems usually monitor and adjust the water's physical/chemical properties if necessary to help minimize corrosion of the water distribution system. This helps ensure a long life and a minimum of problems for the plumbing system.

Foaming agents (SMCL: 0.5 milligram per liter)

Water contaminated by foaming agents is not usually a problem today because of the adoption of low-foaming detergents many years ago. At one time, foaming agents were a significant problem in water because of widespread use of non-degrading, high-foaming detergents.

Hardness (No standard but various measurement scales)

Water readily dissolves calcium and magnesium from the soil and rocks. This is a widespread problem in Missouri. Hardness of 15 to 40 grains per gallon (gpg) 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 detergents producing scums and deposits that make unsightly rings in the bathtub and wash basin and leave 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 may also precipitate in a glass of water. Hardness minerals give water flavor and have no known health effect; they may even contribute to better cardiovascular condition.

The following scales in Table 3 may help interpret water hardness. To convert grains per gallon to parts per million multiply hardness (gpg) by 17.1.

Table 3. Measures of water hardness.

Mg per liter	Grains per gallon	Description
0 to 60	0 to 3.5	Soft — no hardness problems
60 to 120	3.5 to 7	Moderately hard — increased hardness problems
120 to 180	7 to 10.5	Hard — selection of detergents helps solve cleaning problems
180 to 350	10.5 to 20.5	Very hard — select detergents and use some non-precipitating softening agent to cope with cleaning problems
More than 350	More than 20.5	Extremely hard — select detergents, use non-precipitating softening agent and consider ion-exchange softening to cope with hard water problems

Hydrogen sulfide

Hydrogen sulfide, a gas, is called the rotten egg gas because of its odor. It is one of a few water contaminants that can be detected at low concentration by the senses. In fact, our ability to smell this gas as it is released to the atmosphere is more sensitive than equipment to measure it. The gas readily dissipates when the water is exposed to the atmosphere.

Hydrogen sulfide may be produced during the decay of iron bacteria. However, bacteria that use sulfate as an energy source are the primary way that large quantities of hydrogen sulfide are generated.

Table 4. Recommended solutions to water quality problems.

1 = First choice or best treatment option 2 = Second choice	3 = Third choice 4 = Fourth choice
Contaminant or problem: Bacteria	
1. Locate and remove source of contaminants 2. Alternate water supply	3. Chemical feeder (Continuous disinfection: chlorination) 3. Distillation
Contaminant or problem: Acidity/alkalinity/pH	
1. Chemical feeder	1. Neutralizing filter
Contaminant or problem: Sediment/asbestos	
1. Sediment filter	2. Reverse osmosis 2. Distillation
Contaminant or problem: Common inorganic chemicals	
1. Reverse osmosis	1. Distillation
Contaminant or problem: Heavy metals such as cadmium, chromium, lead, mercury, silver, etc.	
1. Reverse osmosis 1. Distillation 2. Chemical contaminant filter (Removes small amounts of some contaminants.)	2. Activated carbon, or a taste and odor, filter is an ideal medium for bacteria growth. Use only on water supplies that are continuously disinfected or known to be free of bacteria. Iron removal capacity of softening depends on amounts of iron, filter capacity and type of exchange media, usually a two-stage carbon filter. Higher concentrations require use of special iron treatment equipment, i.e., iron filter. Removes small amounts of some contaminants.
Contaminant or problem: Nitrate/nitrite	
1. Locate and remove source of contaminants 2. Alternate water supply 3. Distillation	3. Reverse osmosis (Requires a semi-permeable membrane, pressure over 60 psi and regular monitoring of salts to ensure effective removal. Reverse osmosis reduces but does not remove all nitrates.)
Contaminant or problem: Sodium	
1. Alternate water supply	2. Reverse osmosis 2. Distillation
Contaminant or problem: Total dissolved solids (salts)	
1. Reverse osmosis	1. Distillation
Contaminant or problem: Iron and manganese	
1. Zeolite-ion exchange softening (Iron removal capacity of softening depends on amounts of iron, filter capacity, and type of exchange media. Higher concentrations require use of special iron treatment equipment, i.e., iron filter)	2. Resin-ion exchange softening (Iron removal capacity of softening depends on amounts of iron, filter capacity, and type of exchange media. Higher concentrations require use of special iron treatment equipment, i.e., iron filter)
Contaminant or problem: Hardness	
1. Resin-ion exchange softening	2. Zeolite-ion exchange softening
Contaminant or problem: Odor/taste	
1. Activated carbon filter, also called a taste and odor filter, is an ideal medium for bacteria growth and should be used only on water supplies that are continuously disinfected or known to be free of bacteria. Iron removal capacity of softening depends on amounts of iron, filter capacity, and type of exchange media. Usually a two-stage carbon filter. Higher concentrations require use of special iron treatment equipment, i.e., iron filter)	1. Chemical contaminant filter (Iron removal capacity of softening depends on amounts of iron, filter capacity, and type of exchange media. Higher concentrations require use of special iron treatment equipment, i.e., iron filter.)
Contaminant or problem: Pesticides/VOCs	
1. Alternate water supply 2. Chemical contaminant filter 3. Reverse osmosis 3. Distillation (A vented distiller is necessary for this process.)	4. Activated carbon filter (A carbon filter — also called a taste and odor filter — is an ideal medium for bacteria growth and should be used only on water supplies that are continuously disinfected or known to be free of bacteria. Usually a two-stage carbon filter.)
Contaminant or problem: Turbidity	
1. Sediment filter 2. Activated carbon filter (A carbon filter — also called a taste and odor filter — is an ideal medium for bacteria growth and should be used only on water supplies that are continuously disinfected or known to be free of bacteria. Usually a two-stage carbon filter.)	3. Alternate water supply

Odor (SMCL: 3 threshold odor number)

Odor is caused by gaseous or volatile materials that are released from the water. Odors tend to increase with warmer water. Most people readily detect odor, so there is little reason to monitor this parameter.

pH (SMCL: 6.5 to 8.5)

The term pH indicates whether water is acidic or basic. The scale is 0 to 14 with 7 being neutral. Acids (less than 7) include acids, soda pop, vinegar and many fruits and fruit juices such as citrus, tomatoes, grapes and apples. Bases (greater than 7) include antacids, bicarbonate of soda and many laundry detergents. Lower pH tends to make many substances, such as metals and hardness minerals, more soluble.

High concentrations of lead in water are usually the result of low pH which dissolves lead from soil or rock or from the plumbing system if present.

Turbidity

Turbidity is a measure of light transmission and indicates the presence of suspended material such as clay, silt, finely divided organic material, plankton and other inorganic material. Turbidities in excess of 5 are usually

objectionable for aesthetic reasons. If turbidity is high, be aware of possible bacterial contamination.

Treatment options

Treatment choices for water that contains contaminants above the safe drinking water standard, or for other water quality problems, are varied and must be carefully selected only after water tests. Table 4 identifies the most common problems and recommended treatment methods.

This MU publication — previously named WQ101 *Understanding Your Water Test Report* — was reviewed and adapted for Missouri by Wanda Eubank, Jerry D. Carpenter and Beverly A. Maltzberger, MU, and Nix Anderson, Missouri Department of Health, from “Understanding Your Water Test Report” by Michael H. Bradshaw, Health and Safety Extension Specialist and G. Morgan Powell, Natural Resource Engineer, Kansas State University

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