



# Water Quality

Focus Area  
Drinking  
Water



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## Understanding Your Water Test Report

Reviewed and adapted for Missouri  
by Wanda Eubank, Jerry Carpenter, Bev Maltsberger, University of Missouri-Columbia,  
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

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. See WQ 100, *Water Testing: What to Test For*, for further information.

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, iron, etc. This publication discusses the standards and health consequences for microbiological, inorganic chemicals and nuisance contaminants.

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 estab-

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

#### Understanding the Safe Drinking Water Standard

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)
Milligrams per liter (mg/l) = parts per million (ppm)	
Micrograms per liter ( $\mu\text{g/L}$ ) = 0.001 $\mu\text{g/L}$ or parts per billion (ppb)	

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 0 for known human carcinogens.

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

Drinking water standards are undergoing extensive review and revision as required by the Safe Drinking Water Act amendments of 1986. The following discussion includes current and proposed standards. The final standards adopted as a result of the present review may not be the same as those presently proposed. The discussion of potential health effects, however, is unlikely to be significantly changed.

## Microbiological contaminants

Microbiological contaminants include the living organisms in water which 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 in the past. 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/100 ml) 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 con-

tamination 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. This is most likely among the elderly, the very young and the ill (such as burns or immunosuppressive therapy). **Remember: 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 (especially in a single sample) is interpreted to mean the water supply is safe, a false sense of security can result. The 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 they 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 (four times per year) sampling 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). EPA's proposed presence/absence test that identifies the presence of both total and fecal (those strains only found in feces of humans and warm-blooded animals) coliform may soon be widely available. This would aid the interpretation of coliform tests on private water systems.

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 are:

1. 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?)
2. 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?)
3. Disinfect the water source and distribution system (see WQ 102, *Bacteria in Drinking Water*) and retest 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 University Extension, 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. Care must be taken not to contaminate the sterile sample container or lid. Any location 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 are likely depending 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 (over 100) 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 resampled 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, University Extension and/or a testing laboratory.

### Aluminum (Proposed SMCL: 0.05 mg/l)

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 (MCL: 0.05 mg/l)

#### EPA proposes to reduce the MCL to 0.03 mg/l and add an MCLG of 0.0 mg/l.

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 and lack of energy and cancer.

### **Asbestos (Proposed MCL and MCLG: 7 million fibers/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 which has high pH and low corrosivity should prevent the deterioration of pipes that would introduce asbestos into water.

### **Barium (MCL: 1.0 mg/l) EPA proposes to increase the MCL to 5 mg/l and add an MCLG of 5 mg/l.**

Barium is fatal to humans in high doses (over 550 mg). 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 mg/l) EPA proposes to reduce the MCL to 0.005 mg/l and add an MCLG of 0.005 mg/l.**

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: a) poisoning from cadmium-contaminated food and beverages; b) epidemiologic evidence that cadmium may be associated with renal arterial hypertension under certain conditions; c) epidemiologic association of cadmium with "Itai-itai" disease in Japan; and d) long-term oral toxicity studies in animals. The health effects of long-term exposure in the U.S. 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 mg/l)**

The SMCL of 250 mg/l 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 hypertension (high blood pressure). High chloride concentrations may also be associated with the presence of sodium in drinking water. See sodium discussion.

### **Chromium total (MCL: 0.05 mg/l) EPA proposes to increase the MCL to 0.1 mg/l and add an MCLG of 0.1 mg/l.**

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, kidney and liver. It occurs in some foods, in air (including 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 (SMCL: 1 mg/l) EPA proposes to add an MCL of 1.3 mg/l and MCLG of 1.3 mg/l.**

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 mg/l 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 mg/l. 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 mg/l copper was found to impart a green tint to dyed hair.

### **Fluoride (MCL: 4 mg/l, MCLG: 4 mg/l, SMCL: 2 mg/l)**

A fluoride concentration of approximately 1 mg/l helps prevent dental cavities and osteoporosis. At concentrations below 0.7 mg/l, fluoride would likely not be of benefit. **Caution: At concentrations above 1.8 mg/l, fluoride may cause staining of enamel of permanent teeth.** 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 mg/l fluoride. There is no conclusive evidence that fluoride or fluoridation causes cancer in humans.

### **Iron (SMCL: 0.3 mg/l)**

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 bath tubs, 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: 0.05 mg/l)**

**EPA proposes to reduce the MCL to 0.005 mg/l at the source and an average of 0.01 mg/l at the household tap, and add an MCLG of 0.**

Exposure to lead in water, either brief or prolonged, can seriously injure health. Prolonged exposure to relatively small quantities (more than 0.05 mg/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 and 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 and 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 mental retardation), 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.

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

### **Manganese (SMCL: 0.05 mg/l)**

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 mg/l)**

**EPA proposes to add an MCLG of 0.002 mg/l.**

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 (particularly fish) is typically the greatest contributor to total mercury intake. Poisoning is characterized by major changes in the brain, including loss of vision and hearing, intellectual deterioration and even death.

### **Nitrate (MCL: 10 mg/l as nitrogen)**

**EPA proposes to add an MCLG of 10 mg/l 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 one year of age and pregnant women are at risk for adverse effects.

Nitrate test results are usually expressed as nitrate-nitrogen (see column 1 in the chart on page 6). However, laboratories may report the amount of nitrate in a water sample (column 2 in the chart on page 6). 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.

The nitrate standard is established to protect infants less than a 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 nitrate.

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

## Guidelines for use of water with known nitrate content

Nitrate-N N03-N <u>mg/l</u>	Nitrate N03 <u>mg/l</u>	
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.
10-20	45-90	Infants less than one 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.
20-40	90-180	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 (2 to 4 times standard) indicates nitrate contaminants which should be corrected.
Over 40	Over 180	Hazardous to people and much livestock (over 4 times standard). Proceed immediately to correct this hazard. Do not use this water for drinking or cooking without treatment. This condition indicates severe nitrate contaminants which should be corrected or water use discontinued immediately.

or crops under high nitrogen fertility are common sources of high nitrates in livestock feeds.

Children above one 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 mg/l 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. Since 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 mg/l 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 mg/l or above, the sample does not meet the proposed drinking water standard.

### **Selenium (MCL: 0.01 mg/l)**

#### **EPA has proposed raising the MCL to 0.05 mg/l and adding an MCLG of 0.05 mg/l.**

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

mg/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: 0.05 mg/l)**

#### **EPA has proposed eliminating the MCL and establishing an SMCL of 0.09 mg/l.**

The need to set a water standard for silver arises from its intentional addition to waters as a disinfectant. (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 (No standard now or proposed)**

Sodium is present in almost all surface water and groundwater. The amount varies widely, from less than 10 to several hundred mg/l for public supplies across the state. Home water softeners (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. Evidence suggests that prolonged excessive sodium intake (over 3,300 mg/day) increases 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 mg/l 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 mg/l)**

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: 1) water containing appreciable amounts of sulfate tends to form hard scales in boilers and heat exchangers; 2) sulfate affects taste; and 3) 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 mg/l but more typically near 750 mg/l.

While sulfate imparts a slightly milder taste to drinking water than chloride, the taste threshold may be as low as 300 mg/l.

#### **Total dissolved solids (SMCL: 500 mg/l)**

Total dissolved solids (TDS) is a measure of all dissolved inorganic material in water. TDS over about 1,000 mg/l is objectionable because of the mineral taste and possible health effects. Additionally, water with TDS above a typical household level of 400 mg/l has been found to decrease the average life of home hot water heaters approximately one year for each additional 200 mg/l 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 mg/l)**

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 mg/l)**

The alkalinity of water is a measure of its capaci-

### **Measures of Water Hardness**

<u>mg/l</u>	<u>Grains per gallon</u>	<u>Description</u>
0-60	0-3.5	Soft - no hardness problems
60-120	3.5-7	Moderately hard - increased hardness problems
120-180	7-10.5	Hard - selection of detergents helps solve cleaning problems
180-350	10.5-20.5	Very hard - select detergents and use some non-precipitating softening agent to cope with cleaning problems
Over 350	Over 20.5	Extremely hard - select detergents, use non-precipitating softening agent and consider ion-exchange softening to cope with hard water problems



ty 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 mg/l)**

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 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 which make unsightly rings in the bath tub and wash basin and leave deposits on clothes. Hardness also precipitates in appliances, water heaters and water pipes which reduce their capacity and eventually contribute 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 may help interpret water hardness. To convert grains per gallon to parts per million multiply hardness (gpg) by 17.1.

### **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.

### **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 7.0 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 which 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. The following table (on page 10) identifies the most common problems and recommended treatment methods.

1 = First choice or best treatment option; 2 = Second choice; 3 = Third choice

Contaminant or problem	Locate & remove source of contaminants	Alternate water supply	Chemical feeder	Neutralizing filter	Activated carbon <sup>a</sup> filter	Zeolite-ion exchange softening	Resin-ion exchange softening	Reverse osmosis	Distillation	Chemical contaminant filter	Sediment filter
Bacteria	1	2	3 <sup>b</sup>						3		
Acidity/alkalinity/pH			1	1							
Sediment/asbestos								2	2		1
Common inorganic chemicals								1	1		
Heavy metals such as cadmium, chromium, lead, mercury, silver, etc.					2 <sup>f</sup>			1	1	2 <sup>f</sup>	
Nitrate/nitrite	1	2						3 <sup>d</sup>	3		
Sodium		1						2	2		
Total dissolved solids (salts)								1	1		
Iron and manganese						1 <sup>c</sup>	2 <sup>c</sup>				
Hardness						2	1				
Odor/taste					1 <sup>c</sup>					1 <sup>c</sup>	
Pesticides/VOCs		1			4			3	3 <sup>g</sup>	2	
Turbidity		3			2						1

<sup>a</sup>Caution: A carbon filter (also called 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. The chemical contaminant filter is usually a two-stage carbon filter.

<sup>b</sup>Continuous disinfection (chlorination).

<sup>c</sup>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.

<sup>d</sup>Requires a semi-permeable membrane, pressure over 60 psi and regular monitoring of salts to insure effective removal by reverse osmosis. Reverse osmosis reduces but does not remove all nitrates.

<sup>e</sup>Activated carbon generally does a good job of removing odor and taste from chlorine, organic sources and certain gases (when tastes are from minerals, it will probably not improve taste).

<sup>f</sup>Removes small amounts of some contaminants.

<sup>g</sup>A vented distiller is necessary for this process.

## For more information

These MU publications provide more information about private water supplies:

WQ 100, *Water Testing: What to Test For*;

WQ 102, *Bacteria in Drinking Water*;

WQ 103, *Nitrate in Drinking Water*;

WQ 104, *Understanding Home Water Treatment Systems*.

To order these publications, contact Extension Publications, University of Missouri–Columbia, 2800 Maguire Blvd., Columbia, MO 65211.



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