Domestic Water Quality Criteria no. 0.513

by J.R. Self[1]

Quick Facts...

Two types of tests – bacteriological and chemical – are used to assess domestic water quality.

The Colorado State University Soil, Water and Plant Testing Laboratory is equipped to determine the chemical constituents of water.

Local county health departments or the Colorado Department of Health will perform bacteriological tests.

Chemical tests are needed to detect water contaminants such as nitrates, sodium, chlorides and the hardness capacity of water.

The appearance, taste or odor of water from a well or other source offers some information on obvious contamination, but chemical analysis is needed to detect most contamination in water. Obvious contaminates include silt (turbidity) and hydrogen sulfide, which can be detected by smell. As a rule, the senses will not detect impurities that cause hard water, corrode pipe and stain sinks. Two types of tests – bacteriological and chemical – are used to assess water quality. The two tests are separate and distinct and normally are not made in the same laboratory at the same time. The Colorado State University Soil, Water and Plant Testing Laboratory is equipped to analyze chemical tests. The analysis determines chemical constituents of water as they relate to drinking or irrigation purposes. Direct questions about testing water for bacterial or microbial contamination, including Giardia, to the local health department.

Bacteriological Tests

Bacteriological tests are used to determine if water is bacteriologically safe for human consumption. There are tests based on detection of coliform bacteria, a group of microorganisms that are recognized as indicators of pollution from human or animal wastes. Coliform bacteria are found in the intestinal tracts and fecal discharges of humans and all warm-blooded animals. Anyone who wants a bacteriological test performed on their drinking water should contact the local county health department to obtain the specially prepared bottles and instructions for taking a water sample. It is important to note that special techniques are required to collect samples because the samples can be contaminated if procedures are improper. If the county does not offer a bacteriological test for water, contact the Colorado Department of Public and Environmental Health, 4300 Cherry Creek Drive South, Denver, CO 80246-1530, (303) 692-2000.

Chemical Tests

Chemical tests identify impurities and other dissolved substances that affect water used for domestic purposes. Water begins to decrease in palatability when the amount of minerals, i.e., dissolved salts, exceeds 500 to 1,000 ppm, but this depends on the nature of the minerals. Note that sea water contains 30,000 ppm of dissolved salt. Beyond these limits, the water becomes increasingly unpalatable. Table 1 lists the constituents and parameters that are routinely determined on a water sample by the Colorado State Soil, Water and Plant Testing Laboratory. Table 2 lists additional constituents in water that can be determined on request by the Colorado State Soil, Water and Plant Testing Laboratory.

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Table 1: The parameters determined for the routine domestic water analysis test

Parameter	Recommended[a] limits-mg/l
Conductivity (Microsiemens/cm)	*
pH (pH units)	6.5-8.5
Calcium	*
Magnesium	*
Sodium	20
Potassium	*
Carbonate	*
Bicarbonate	*
Chloride	250
Sulfate	250
Nitrate	45[b]
Total Alkalinity as $CaCO_3$	400
Hardness as $CaCO_3$	*
Total Dissolved Solids	500
Boron	*

[a] Limits recommended for good quality domestic water. Limits suggested by U.S. Environmental Protection Agency; Drinking Water Regulations and Health Advisories, EPA 822-R-94-001, May 1994.

[b] Mandatory upper limit for nitrate (NO_3).

* Limits not established.

Table 2: Additional tests that can be determined in water on request

Constituent	MCL (mg/l)[a]
Arsenic	0.010
Selenium	0.05
Chromium (total)	0.10
Fluoride	4.0
Barium	2.0
Cadmium	0.005
Lead	0.015
Mercury	0.002
Copper	1.3
Nickel	0.1
Nitrate (as N)	10
Beryllium	0.004
SMCL (Mg/l)b	
Aluminum	0.05-0.2
Copper	1.0
Fluoride	2.0
Iron	0.3
Manganese	0.05
Silver	0.1
Zinc	5.0
Limits not established	
Ammonium	--
Phosphorus	--
Molybdenum	--

[a]Maximum contaminant level
[b]Secondary maximum contaminant level

Table 3. Hardness expressed as mg/l of $CaCO_3$.

mg/l or ppm[a]	Water hardness
0-75	Soft
75-150	Moderately hard
150-300	Hard
Over 300	Very Hard

[a]When expressed as grains of hardness, 1 grain = 17.1 mg/l (ppm).

Laboratory Reports – What Do The Numbers Mean?

Most testing laboratories report quantities of chemical substances by weight in volumetric units such as milligrams per liter (mg/l). For all practical purposes, 1 ppm = 1 mg/l. The factors reported on a water analysis report are discussed below and represent the parameters that are considered in the evaluation of domestic water quality.

The pH value is a measure of intensity of alkali or acid contained in the water. Absolutely pure water has a pH value of 7.0. In Colorado, the pH of well water normally is between 6.5 and 8.5. Water with pH lower than 5 may cause problems due to corrosion because many metals become more soluble in low-pH waters. A pH value higher than 8.5 indicates that a significant amount of sodium bicarbonate may be present in the water.

Calcium and magnesium cause water hardness and result from limestone-type materials in underground soil layers. Separate values are of minor concern but they are combined for calculating hardness.

Hardness is the soap-consuming capacity of water; that is, the more soap required to produce lather, the harder the water. Hard water also causes greasy rings on bathtubs, film on dishes or hair after washing, and poor laundry results. Problems caused by hard water in bathing or washing can be overcome by the use of synthetic detergents or packaged softening compounds. The hardness of water may be removed by a water softening unit containing exchange resins. This will result in the exchange of calcium and magnesium (Ca and Mg) by sodium so it may be a concern to people on a low-sodium diet for medical reasons. Do not use softened water for gardens, lawns or plants. Hardness is reported as calcium carbonate in milligrams per liter (mg/l). A commonly used classification for hardness is given in Table 3.

Sodium may be of health significance to people on a low-sodium diet. Sodium can be reduced or removed by expensive treatment systems, but when Ca and Mg are removed from water by passing through a water softener, sodium replaces it.

Potassium is an essential nutritional element, but its concentration in most drinking water is trivial and quantities seldom reach 10 mg/l.

Carbonates and bicarbonates are the major contributors to the “total alkalinity” that may be determined in a routine water test. The alkalinity of a water sample is a measure of its ability to neutralize acids. Naturally occurring levels of total alkalinity up to 400 mg/l as $CaCO_3$ are not a health hazard. Low alkalinity is associated with low pH values and may indicate potential for problems due to corrosion of metal in plumbing systems.

Chloride concentrations in drinking water may be important to people on low-salt diets. Most people will detect a salty taste in water containing more than 250 mg/l of chloride. Expensive treatment methods are needed to remove chloride from water.

Sulfate content in excess of 250 to 500 ppm (mg/l) may give water a bitter taste and have a laxative effect on people not adapted to the water. Expensive treatment methods are necessary to remove or reduce sulfate in a private water system.

Nitrate in excess of 45 mg/l (or in excess of 10 mg/l if reported as nitrate-nitrogen) is of health significance to pregnant women and infants under 6 months. Do not use high nitrate-water in infant formulas or other infant foods. Considerably higher nitrate content apparently is tolerated by most adults. Nitrate can be removed from private water supplies, but the equipment is expensive and not commonly used.

Total dissolved solids, also called “total mineral content” or “total residue,” is the total amount of material remaining after evaporation of the water. Values of less than 500 ppm (mg/l) are satisfactory and up to 1,000 ppm (mg/l) can be tolerated with little effect.

Fluoride is important in the development of teeth in infants and youth. The optimum fluoride content to assist in the control of tooth decay is 0.9 to 1.5 ppm (mg/l). Excessive amounts are rarely found in Colorado waters, but a concentration over 3.0 ppm (mg/l) may cause darkening of the tooth enamel and other undesirable effects.

Iron and manganese are nuisance chemicals that cause troublesome stains and deposits on light-colored clothes and plumbing fixtures. Iron causes yellow, red or reddish-brown stains and deposits, while manganese stains and deposits are gray or black. Excessive amounts also may cause dark discoloration in some food and beverages and cause an unpleasant taste. Iron and manganese can be removed or reduced in a softener equipped with special resins or by small treatment systems involving aeration, filtration and chlorination.

Copper and zinc will cause an undesirable taste if concentrations are above the recommended limits. A water softening system should significantly lower the levels of these elements.

Arsenic, selenium, barium, cadmium, lead and mercury are potentially toxic elements. Fortunately, these elements rarely exceed the mandatory limits in most Colorado well water. If high concentrations are found, it is necessary to remove these elements using expensive treatment methods, such as distillation or reverse-osmosis. Lead contamination in drinking water can come from lead pipes and lead-based solder pipe joints.

Aluminum, ammonium, phosphorus, nickel and molybdenum are additional constituents that can be determined by the laboratory. Although no limits are established for these parameters, pollution of some sort is indicated if significant concentrations are detected in a water sample.

Taste and odor problems are difficult to solve. Some inorganic compounds may impart detectable tastes without odor. Hydrogen sulfide (rotten egg smell), when present, will impart an undesirable odor and taste. Generally, undesirable tastes may be caused by any of numerous organic compounds. These may be present naturally in the water or due to sewage or other surface contamination sources. They can impart disagreeable taste and odor in minute concentrations (a few parts per billion or a few milligrams per kiloliter) and specialized chemical tests are needed to detect such small levels. Turbidity in drinking water is caused by suspended sediments from erosion and runoff discharges. The maximum contaminant level in drinking is 1 to 5 turbidity units.

Water Treatment Systems

Some water constituents can be removed or reduced by ion-exchange resins, distillation, reverse osmosis or a combination of these methods. Other treatment processes might involve aeration or chemical oxidation followed by filtration. Organics can be removed by filtration through charcoal, but this may not be an effective method for removing inorganic contaminants. Treatment methods are specific to the type of chemical problems and generally are quite costly. For additional information on water quality or treatment systems, refer to the fact sheets listed below or call the EPA Safe Drinking Water Hotline, (800) 426-4791.

References

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