Virginia Cooperative Extension

REPRINTED 2002

Housing

PUBLICATION 356-487

HOUSEHOLD WATER QUALITY

Bacteria and Other Microorganisms in Household Water

*Kathleen Parrott, Blake Ross, and Janice Woodard**

A common hazard of household water is contamination by potentially harmful bacteria and other microorganisms. Short term gastrointestinal disorders and illnesses such as gastro-enteritis, giardiasis, typhoid, dysentery, cholera, and hepatitis have been linked to water contaminated by microorganisms. The microorganisms which find their way into a water supply can come from a variety of sources including sewage, animal wastes, or dead and decaying animals.

Public water systems are required by state and federal governments to provide biologically safe water. However, the safety of a privately-owned, individual water supply, such as a backyard well, rests in the hands of its owner.

How can an individual tell if household water is contaminated with bacteria?

Bacteria in water cannot be seen, tasted, or smelled and many health-related symptoms are not immediate. Therefore, the only way to reliably determine if water is contaminated is by a laboratory test. Testing a water supply for a specific disease-causing organism can be expensive. Handling and culturing disease organisms requires special training and equipment. Instead, water supplies are usually tested for the presence of coliform bacteria. These bacteria are always present in the digestive systems of humans and animals, and can be found in their wastes. Coliform bacteria are also present in soil and in plant material. Most of these bacteria do not cause disease. They are simply an indicator that the water supply is contaminated and that disease-causing bacteria may be present.

The test for the presence of coliform bacteria is relatively inexpensive and easy to perform. The standard test is called *total coliform.* The Federal goal for total coliform in public drinking water is zero. Water samples that contain any coliform bacteria are generally reported as “total coliform positive.”

Federal regulations now require that public drinking water found to be “total coliform positive” must be analyzed with a *fecal coliform* or *E.coli* test. These fecal bacteria originate only in human and animal waste. It is unacceptable for fecal bacteria to be present in any concentration in a water supply.

What specific test(s) should be done?

Private water supply users interested in evaluating the bacteriological safety of the water should contact a Virginia-certified water testing laboratory. Upon submitting a water sample, request a *total coliform* test to be followed by a *fecal coliform* or *E.coli* test if the initial test of the sample is “total coliform positive.” Tests for specific bacteria or other microorganisms may be required if the water supply is suspected as the cause of a diagnosed illness among users.

When should a test be done?

The Virginia Department of Health recommends that private water supplies be analyzed for total coliform at least once a year. If you are considering buying property with a private water supply, always request a total coliform bacteria test. Testing is also recommended when any of the following conditions apply:

- there is an infant in the home;
- a new well is constructed;
- flooding occurs near the well or spring;
- any person or animal becomes sick from a suspected waterborne disease; or

* *Extension Specialist, Housing; Extension Specialist, Biological Systems Engineering; and Retired Extension Specialist, Home Management and Equipment, respectively; Virginia Tech*

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Virginia Cooperative Extension programs and employment are open to all, regardless of race, color, religion, sex, age, veteran status, national origin, disability, or political affiliation. An equal opportunity/affirmative action employer. Issued in furtherance of Cooperative Extension work, Virginia Polytechnic Institute and State University, Virginia State University, and the U.S. Department of Agriculture cooperating. J. David Barrett, Director, Virginia Cooperative Extension, Virginia Tech, Blacksburg; Lorenza W. Lyons, Administrator, 1890 Extension Program, Virginia State, Petersburg.
VT/133/0302/2.5M/223006/356487

VIRGINIA STATE UNIVERSITY

- the water supply system on a well or spring has been disassembled for repairs to components such as the well itself, pump, pressure tank, treatment devices or pipe lines.

What should I do if my water is contaminated with bacteria?

First, don't panic! You have probably been drinking this water for some time with no ill effects and could possibly continue to do so. While you and your family may have developed some immunity to harmful bacteria present in the water, there is no assurance that you won't suffer ill effects in the future as a result of continued exposure. Further, guests in your home who do not have this immunity may experience more immediate problems.

Learning that your water supply has been found to be contaminated with bacteria should encourage you to take action. So that you can prevent a potential problem from getting worse, you need to identify the possible source(s) of contamination and take corrective steps to purify the contaminated water.

What should be done to eliminate contamination in household water?

Household water from surface water supplies—streams, ponds, and cisterns—is especially susceptible to contamination and, in most cases, should be continuously disinfected, as described later in this publication. Additional treatment, such as sedimentation, coagulation, and filtration, may be needed to provide a suitable supply of water.

According to the U.S. Environmental Protection Agency, *septic systems* are a major source of contamination of an underground water supply (well or spring). Inappropriate siting of drainfields, and poor design, construction, and maintenance of septic systems, coupled with improper well or spring box construction, can lead to contamination of household water. At a minimum, having your septic tank pumped out every three to five years is recommended to reduce the probability of contamination.

Preventing the direct entry of surface water to a well or spring is an important option to consider to protect the supply from contamination with bacteria. It is important to remember that the groundwater supply itself may not necessarily be contaminated; rather the well or spring, if improperly constructed, may be funnelling contaminants from or near the land surface down into the groundwater.

A properly protected well is evidenced by the well casing extending 12 inches or more above the surface of the ground and the ground sloping away from the well to prevent surface water from collecting around the wellhead. The top of the casing should have a tight-fitting sanitary well cap. Additional protection from surface drainage should be provided by sealing the casing with cement grout to the depth necessary to protect the well from contamination.

Springs are particularly susceptible to bacterial contamination since they are generally located in surface water drainageways. A properly protected spring is developed underground and the water channeled to a sealed spring box. At no time should the water be open to the air at the surface.

Other measures to take are: 1) *keep all animals away from the well or spring area; 2) keep the plumbing system clean.* Any time work is performed on the plumbing or pump, the entire water system should be disinfected with chlorine, as described below. Simply pulling the pump out of the well, setting it on the grass to work on it, and returning it to the well is enough to contaminate the water supply with bacteria.

How can safe drinking water be made temporarily available while the source of contamination is being found and eliminated?

Boiling water is an extremely effective means of disinfection. Boiling your water continuously for 15 minutes will kill all bacteria. You could also purchase bottled water or use water from another source known to be safe for drinking and cooking.

Fresh liquid chlorine bleach containing 5.25 percent available chlorine (commonly found in grocery stores for laundry and other household purposes) can be added to a gallon of drinking water on an emergency basis. If the water is clear, add 8 drops of bleach; if the water is cloudy, add 16 drops. Mix bleach in water thoroughly and let stand for 30 minutes before drinking.

How can the water supply be made safe to drink after the source of contamination has been eliminated?

The Virginia Department of Health recommends cleaning and sanitizing a contaminated well or spring, and the entire plumbing system, by *shock chlorination*. See directions in the box on page 3.

Shock Chlorination Process

Wells

1. Pour the proper amount of liquid chlorine bleach or powdered chlorine mixed with several gallons of water directly into the well (See Tables 1a and 1b on page 4.)
2. Connect a garden hose to a nearby faucet and wash down the inside of the well for about 15 minutes.
3. Open each faucet inside and outside the house one at a time and let the water run. Close the faucet after a strong odor of chlorine is detected. If a strong odor of chlorine cannot be detected, add more chlorine to the well.
4. Let the water stand in the plumbing system for 12 to 24 hours. Do not run any water during this time.
5. Flush the system of remaining chlorine. Do this, one faucet at a time, starting with the outside faucet(s). This order will reduce the load on your septic system. Let each faucet run until chlorine odor is no longer noticeable.

Springs

1. Scrub the walls of the spring box with a solution of 1/2 cup of liquid chlorine bleach (1 tablespoon calcium hypochlorite) and as much water as needed to clean the area
2. For each 100 gallons of water to be disinfected, mix 1 1/2 quarts of liquid chlorine bleach (3 ounces calcium hypochlorite) with several gallons of water. (A spring box holds 7 1/2 gallons of water for each 1 cubic foot of storage space.)
3. Follow step 3 in directions given for shock chlorinating wells.
4. Let the water stand in the plumbing system for at least 12 hours. If the spring flow is low enough, it may be possible to keep the disinfectant in the spring box for the required time. Otherwise, you will have to add disinfectant continuously throughout the period.
5. Follow step 5 in directions given for shock chlorinating wells.

This treatment introduces high levels of chlorine in the water. Chlorine compounds are usually added to the water in solution form. The chlorine added may be fresh liquid chlorine bleach (sodium hypochlorite), containing 5.25 percent available chlorine, or soluble tablets or powder used for disinfecting swimming pools (calcium hypochlorite), containing about 70 percent available chlorine.

If you have water treatment equipment, such as a water softener, iron filter or sand filter, check the manufacturer's literature before shock chlorinating to prevent damage from strong chlorine solutions. Disconnect or by-pass carbon or charcoal filters during shock chlorination because the process will use up the capacity of these filters.

Be careful when handling concentrated chlorine solutions. Wear rubber gloves, goggles, and a protective apron when handling chlorine solutions. If it accidentally gets on your skin, flush immediately with water.

Never mix chlorine solutions with other cleaning agents or ammonia because toxic gases may be produced.

Do not use "fresh scent" or other chlorine bleach containing perfumes, "all fabric" bleaches or fabric softeners. Plain chlorine laundry bleach should be used for disinfecting water. Chlorine solutions lose strength while standing or when exposed to air or sunlight. Make fresh solutions frequently to maintain effectiveness.

Wait one to two weeks and retest your water for bacteria. Before retesting, check to be sure there is no chlorine left in the well or spring system using an inexpensive chlorine test kit (usually available at pool supply stores). If shock chlorination and measures to prevent contamination do not eliminate the bacteriological problem, continuous disinfection may be necessary.

How can water be continuously disinfected?

Most household water can be disinfected continuously by chlorination, distillation, ultraviolet light, or ozonation. *There is no ideal disinfection method;* each has its advantages and limitations.

Chlorination is widely used to disinfect water because it destroys bacteria within a reasonable contact time and provides long term protection. Chlorine, readily available at a low cost, is easy to handle and is also effective in controlling algae.

Chlorine also has its limitations. Its solutions are only moderately stable, and organic matter as well as iron and manganese can interfere with the action of chlorine. Low levels of chlorine normally used to disinfect water are not an effective treatment for the parasite *Giardia. A* relatively high chlorine level must be maintained for at least 30 minutes to kill *Giardia.* High chlorine concentrations can have objectionable tastes and odors, and even low chlorine concentrations react with some organic compounds to produce strong, unpleasant tastes and odors. Chlorinators, although simple to operate, require regular refilling with chemicals.

Table 1a. Quantities' of liquid chlorine bleach (5.25% chlorine) required for water well disinfection.

Depth of water In well (ft.)	Well Diameter (in)															
	2	3	4	5	6	8	10	12	16	20	24	28	32	36	42	48
5	1C	1C	1C	1C	1C	1C	1C	1C	2 C	4C	1Q	2Q	3Q	3Q	4Q	5Q
10	1C	1C	1C	1C	1C	1C	2C	2C	1Q	2Q	3Q	4Q	4Q	6Q	8Q	2.5G
15	1C	1C	1C	1C	1C	2C	3C	4C	2Q	2.5Q	4Q	5Q	6Q	2G	3G	4G
20	1C	1C	1C	1C	1C	2C	4C	1Q	2.5Q	3.5Q						
30	1C	1C	1C	1C	2C	4C	1.5Q	2Q	4Q	5Q						
40	1C	1C	1C	2C	2C	1Q	2Q	2.5Q	4.5Q	7Q						
60	1C	1C	2C	3C	4C	2Q	3Q	4Q								
80	1C	1C	2C	4C	1Q	2Q	3.5Q	5Q								
100	1C	2C	3C	1Q	1.5Q	2.5Q	4O	6Q								
150	2C	2C	4C	2C	2.5Q	4Q	6Q	2.5G								

Table 1 b. Quantities[1] of calcium hypochlorite (70% chlorine) required for water well disinfection.

Depth of water In well (ft.)	Well Diameter (in)															
	2	3	4	5	6	8	10	12	16	20	24	28	32	36	42	48
5	1T	1T	1T	1T	1T	1T	2T	3T	5T	6T	3 oz	4 oz	5 oz	7 oz	9 oz	12 oz
10	1T	1T	1T	1T	1T	2T	3T	5T	8T	4 oz	6 oz	8 oz	10 oz	13 oz	1.5 lb	1.5 lb
15	1T	1T	1T	1T	2T	3T	5T	8T	4 oz	6 oz	9 oz	12 oz	1 lb	1.5 lb	1.5 lb	2 lb
20	1T	1T	1T	2T	3T	4T	6T	3 oz	5 oz	8 oz						
30	1T	1T	2T	3T	4T	6T	3 oz	4 oz	8 oz	12 oz						
40	1T	1T	2T	4T	6T	8T	4 oz	6 oz	10 oz	1 lb						
60	1T	2T	3T	5T	8T	4 oz	6 oz	9 oz								
80	1T	3T	4T	7T	9T	5 oz	8 oz	12 oz								
100	2T	3T	5T	8T	4 oz	7 oz	10 oz	1 lb								
150	3T	5T	8T	4 oz	6 oz	10 oz	1 lb	1.5 lb								

[1]Quantities are indicated as: C = Cups; q = Quarts: G = Gallons; T = tablespoons; oz. = ounces (by weight); lb = pounds

Source: Manual of Individual and Non Public Water Supply Systems published by the U.S. EPA office of Groundwater and Drinking Water, EPA - 570/9-91-004, Washington DC, May 1991.

The heat necessary for water *distillation is* very effective in killing disease-causing microorganisms. One of the benefits of distillation is that it uses no chemicals. Distillation, however, takes longer to produce the processed water than some other methods, units can be expensive to operate, and the length of time distilled water is stored can affect its quality. Distilled water has a very "flat" taste.

Ultraviolet light is a very effective disinfectant. This method disinfects water without adding chemicals. Therefore, ultraviolet light disinfection units do not create any new chemical complexes, do not change the taste or odor of the water, and do not remove beneficial minerals from the water.

Ultraviolet light disinfection also has its disadvantages. This disinfection technique is more effective against bacteria than against viruses and parasites such as *Giardia*. There is no simple test to determine whether or not the system is providing proper disinfection. Ultraviolet light devices are most effective when water is clear and allows the light to easily pass through. Therefore, ultraviolet light devices are often combined with other treatment devices such as mechanical filters, activated carbon filters, water softeners, and reverse osmosis systems to provide complete water quality solutions. Safety features, such as detectors that activate audio and visual lamp alarms in case of lamp failure, are available to ensure that adequate disinfection conditions are maintained.

Ozonation uses ozone which is a more powerful disinfectant than chlorine. Ozone produces no tastes or odors in the water. However, as a gas, ozone is unstable and has a very short life so it must be generated at the point of use.

Even if tests confirm that you have a bacteriological problem, before investing in expensive equipment, have your household water supply inspected by a County Health Department official.

More Information

For more information about providing biologically safe household water, contact your local Cooperative Extension or Health Department Office.

Acknowledgments

The authors wish to thank the following individuals who reviewed this publication:

Allen Hammer and Robert Hicks, Virginia Department of Health, Richmond

Robert Custard, Regional Sanitarian, Virginia Department of Health, Manassas

Helen Smith, Extension Agent, Rappahannock County