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Virginia Household Water Quality Program: Bacteria and Other Microorganisms in Household Water

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Private water sources such as wells and springs are not regulated by the U.S. Environmental Protection Agency (EPA). Although private well construction regulations exist in Virginia, private water supply owners are responsible for providing maintenance for their water systems, monitoring water quality, and taking the appropriate steps to address problems, should they arise.

The EPA public drinking water standards are good guidelines for assessing your water quality. "Primary drinking water standards" apply to contaminants that can adversely affect health and are legally enforceable for public water systems. "Secondary drinking water standards" are nonregulatory guidelines for contaminants that may cause nuisance problems such as bad taste, foul odor, or staining.

Testing your water annually and routinely inspecting and maintaining your water supply system will help keep your water safe. For more information, visit the Virginia Household Water Quality Program website at *www.wellwater.bse.vt.edu.*

Introduction

The presence of potentially harmful, disease-causing (pathogenic) bacteria and other microorganisms is a concern when considering the safety of drinking water. Consuming water contaminated with pathogens can cause intestinal infections such as typhoid, dysentery, cholera, and hepatitis, among other diseases. Federal law requires public water utilities to provide biologically safe water. However, the safety of privately owned, individual water supplies such as wells, springs, and cisterns is the sole responsibility of the owner.

Sources of Bacterial Contamination

Bacterial contamination can come from a variety of sources, including sewage, animal waste, and decaying dead animals. Bacterial contamination often occurs when surface or other contaminated water (from streams, floodwaters, runoff, or a septic drain field) or vermin (insects or rodents) gain access to the water supply via a poorly located, constructed, or maintained water supply system.

Controlling bacterial contamination begins with a thorough inspection of your water supply system. The Virginia Household Water Quality Program recommends that you inspect your own system annually and have it inspected by a certified well water systems provider every 5 to 10 years. Most bacterial contamination issues are caused by improper water supply system construction or maintenance.

A properly constructed and maintained well has a casing that is free of cracks, holes, or corrosion and extends at least 12 inches above the ground surface. The ground next to the casing should slope away from the well to prevent water from collecting around the wellhead, and the top of the well casing should have a properly installed, sanitary well cap (figure 1a), or in the case of a bored well, a suitably sealed well cover (figure 1b). The well should also be properly sealed with a cement or bentonite (clay) grout material to prevent water from moving down into the ground around the outside of the well casing.

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Figure 1a. Properly constructed, drilled well with a sanitary well cap. Source: Bryan Swistock, Penn State University.

Figure 1b. A bored well with a tightly fitted concrete cap. Source: Bryan Swistock, Penn State University.

Figure 2. A properly sealed spring box will prevent surface water, insects and small animals from gaining access to the spring. Source: *http://aquariuspump.com/springbox.aspx.*

Springs are particularly susceptible to bacterial contamination because they are usually located in surface water drainage ways. A properly protected spring is developed underground and the water channeled into a sealed spring box (figure 2).

Another source of bacterial contamination could be leaking sewer pipes or a malfunctioning on-site wastewater treatment system (septic system). Good septic-system maintenance includes periodic inspections and having the septic tank pumped out every three to five years. If you are concerned about the proximity of your water supply to a septic system or other potential contamination source, contact the local Virginia Department of Health office, which can assess your setting and provide guidance.

Any time that work is performed on the water supply system or its components, particularly if the well is opened, the entire water system should be disinfected with chlorine. Simply pulling the pump out of the well, placing it on the ground to work on it, and returning it to the well is enough to contaminate the water supply with bacteria. If you are concerned that your water supply is contaminated with coliform bacteria, you should identify the possible source(s) and pathway(s) of contamination and take corrective action.

Testing for Bacterial Contamination

Bacterial contamination in water cannot be seen, tasted, or smelled, and health-related symptoms caused by bacterial contamination can occur some time after exposure has occured. The only way to reliably determine if your water is contaminated with bacteria is to have a sample analyzed by a certified laboratory. Because testing for specific disease-causing organisms can be expensive and difficult, water supplies are usually tested for the presence of an indicator organism – usually total coliform bacteria – which is relatively inexpensive and easy to detect.

The U. S. Environmental Protection Agency (EPA) has set a primary drinking water standard for total coliform bacteria of zero, or "absent." Water samples that contain any coliform bacteria are reported as positive for total coliform or "present," or results may be reported as an estimated number of bacteria per volume of water.

Most coliform bacteria do not cause disease, but their presence indicates that the water supply may be contaminated with other disease-causing organisms. While coliform bacteria are found throughout the environment, a specific subset of coliform bacteria called fecal coliform originates only in the intestines and waste of humans and animals.

Federal regulations require that public drinking water supplies found to have total coliform present must be tested for fecal coliform. Although not required, this is a good guideline for private water systems, also. Testing for the presence of fecal coliform bacteria typically focuses on *Escheria coli* (*E. coli*).

The Virginia Household Water Quality Program recommends that private water supplies be tested for total coliform at least once a year. Testing is also recommended when any of the following conditions apply:

- There is an infant or pregnant woman in the home.
- Prior to purchasing a new home that is reliant on a private water supply.
- A new well is constructed (required by Virginia law 12 VAC 5-630-370.D).
- Flooding occurs near the well, spring, or cistern.
- Any person or animal becomes sick from a suspected waterborne disease.
- The water supply system, including indoor plumbing, has been disassembled for service or repairs.

Private water supply users interested in testing their water for bacterial contamination should contact their local Virginia Cooperative Extension (VCE) office or a certified laboratory. The Virginia Household Water Quality Program maintains a list of certified laboratories on its "Resources" page at *www.wellwater.bse.vt.edu/resources.php.*

Be sure to follow all sample collection instructions carefully. Bacteriological samples must be analyzed within 24 to 28 hours of the time collected from the tap, so be aware that shipping the sample overnight or dropping it off at the laboratory may be required.

When submitting a bacteriological sample, request that if total coliform are present, the sample be tested for fecal coliform or *E. coli*, which will indicate whether your water supply is contaminated with human or animal waste. If this is the case, additional testing for specific bacteria or other microorganisms may be required.

My Water Is Contaminated. What Should I Do?

If you find that your water is contaminated with total coliform bacteria, don't panic. You and your family may have developed some immunity to organisms present in the water and may have suffered no ill effects. However, although you and your family have not yet been ill, there is no assurance that someone in the house might not become sick with continued consumption of the contaminated water. Guests in your home who are not accustomed to your water may also become ill.

As mentioned previously, if your water test shows the presence of total coliform bacteria, the testing labora-

The Virginia Household Water Quality Program, offered through Virginia Cooperative Extension (VCE), periodically conducts county-based household water sampling clinics where you can learn about the quality of your water supply, proper water supply system maintenance, and, if needed, possible water treatment options. Please contact your local Extension office or visit *www.wellwater.bse.vt.edu* for more information.

tory should perform an additional test for fecal coliform bacteria or *E. Coli.* The presence of fecal coliform or *E. coli* indicates that your water supply is contaminated with human or animal waste, which can be a significant threat to human health.

If your water does contain fecal coliform bacteria or *E. coli,* take immediate action. Boiling your water is an effective temporary means of disinfection until the source of the contamination can be eliminated or an effective treatment system installed. Boiling water vigorously for three minutes will kill fecal coliform bacteria. An alternative to boiling is to use bottled water or water from another source known to be safe for drinking and cooking.

In addition to pathogenic bacteria, a water supply could also be contaminated with nonpathogenic bacteria. Bacteria that feed on minerals in the water (iron, manganese, or sulfur) do not pose a health risk but can cause nuisance problems like the buildup of a bacterial slime (masses of bacteria that can clog plumbing systems), staining of porcelain fixtures, and/or odors. Strategies and treatment options for eliminating pathogenic bacteria are also effective for nuisance bacteria.

Treating Bacterial Contamination

Ensuring that your private water supply system is properly located, constructed, maintained, and protected is the first step toward ensuring protection from bacterial contamination. If bacteria continue to be a problem after taking steps to improve system protection and maintenance, there are several treatment options available for dealing with a contaminated water supply.

Shock Chlorination

Shock chlorination involves disinfecting a contaminated well, spring, or cistern and the entire plumbing system using a concentrated chlorine solution. Although this method can be quite effective, disinfection will be temporary unless the source(s) of the bacterial contamination are eliminated. Liquid chlorine bleach (sodium hypochlorite) or soluble tablets or powder (calcium hypochlorite) may be used.

The solution is mixed based on the volume of water present in your water system, so you must know the depth, diameter, and water level of your well or the dimensions and depth of water in your spring box or cistern. The necessary chlorine solution is then circulated throughout the water supply system and left there for 12 to 24 hours to ensure enough contact time to destroy any bacteria present.

Shock chlorination should always be followed by a bacteria retest one to two weeks after the treatment. In Virginia, a certified water well systems provider can perform the shock chlorination for you. If you wish to shock chlorinate your system yourself, refer to *Shock Chlorination: Disinfecting Private Household Water Supplies*, VCE publication 442-663, and follow the instructions very carefully.

Continuous Disinfection

If attempts to control the contamination source do not eliminate bacteria from your water supply, a continuous disinfection system may be installed to treat the water. 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.

Continuous Chlorination

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

Chlorine also has limitations. Chlorine solutions are only moderately stable and organic matter, as well as iron and manganese that may be present in your water, can interfere with the effectiveness of chlorine. The low level of chlorine normally used to disinfect water is not an effective treatment for the parasites *Giardia* or *Cryptosporidia*.

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. Chlorinating systems, although simple to operate, require regular maintenance that involves handling chemicals.

Distillation

Distillation systems work by heating a volume of water until it boils, then collecting the water vapor or steam created and condensing it into a receptacle. The heat necessary for water distillation is very effective in killing pathogens. One of the benefits of distillation is that it uses no chemicals.

Distillation, however, takes longer to produce the processed water than other methods, units can be expensive to operate due to the energy consumption, and the length of time distilled water is stored can affect its quality. Distilled water has a very "flat" taste, because minerals naturally present in water are also removed by distillation.

Ultraviolet Light

Ultraviolet (UV) light is a very effective disinfectant that relies on water passing through a transparent sleeve, where it is exposed to an ultraviolet light bulb. UV light (radiation) disrupts the reproductive cycle of microorganisms. UV disinfection treats water without adding chemicals. As a result, it does not change the taste or odor of the water or remove beneficial minerals.

UV disinfection does have disadvantages. It is more effective against bacteria than against viruses and parasites, such as *Giardia and Cryptosporidia*. Ultraviolet light devices are most effective when water is clear, allowing good light penetration. Depending on the water supply, some type of filtration system could be required upstream of the UV system. UV bulbs must be replaced periodically to maintain the required UV output. Some UV systems contain detectors that activate audio and visual alarms in case of lamp failure to ensure that the system is working properly.

Ozonation

Ozonation uses ozone gas (O_3) — a more powerful disinfectant than chlorine — to destroy pathogens. Ozone produces no taste or odor in the water and requires a shorter contact time than chlorine. Ozonation systems can be very expensive to install and operate because they require significant initial investment and power to operate.

Summary

Bacterial contamination of water can pose health risks and nuisance effects. A water test is the only way to evaluate if pathogenic bacteria are present in a water supply. While federal law requires public water systems to provide biologically safe water, the safety of privately owned, individual water supplies, like wells, springs, and cisterns, is the sole responsibility of the owner. Effective measures to reduce the potential for bacterial contamination include the proper location, construction, and maintenance of individual water supply systems.

Properly maintaining septic systems is also crucial to reducing the risk of bacterial contamination. If bacterial contamination is found, take steps to identify and eliminate the source of contamination and the contamination pathway and disinfect the system. If continuous disinfection is needed, several treatment options are available. A reputable water treatment specialist can provide guidance in selecting an appropriate option.

For more information on bacteria and other microorganisms in household water, see the following websites:

- Virginia Household Water Quality Program: *www.wellwater.bse.vt.edu/resources.php.*
- Virginia Cooperative Extension: *http://pubs.ext.vt.edu/category/home-water-quality.html.*

For more general information, contact your local VCE office or Virginia Department of Health local district office, or visit *www.wellwater.bse.vt.edu.*

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