

THE AMERICAN WELL OWNER

★ INFORMATION AND ADVICE ABOUT GROUND WATER, WELLS AND WATER SYSTEMS ★

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Coliform and E. coli Bacteria

“Testing for bacteria” is the most common quality check for well water. “No bacteria” is the preferred result. There are many different types of bacteria that might occur in your well water. This article gives some background information about these minute single-cell organisms. (Just one, is a bacterium, but they are usually referred to in the plural, bacteria). Most are harmless to

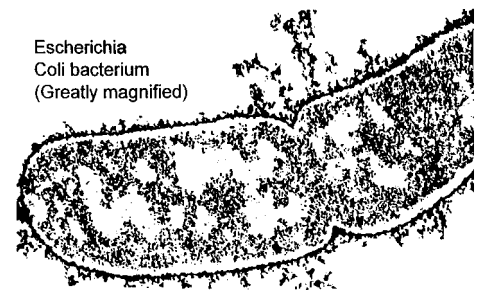
humans and many are actually beneficial for our existence. Microfossils in ancient rocks show bacteria were around 3.2 billion years ago. Bacteria were probably responsible for creating the first oxygen that appeared on Earth, about 2 billion years ago.

Some bacteria grow and multiply by using energy (food) obtained from minerals in ground water such as sulfur (“sulfur bacteria”) or iron (“iron bacteria”). Some bacteria thrive in oxygen rich environments (aerobic) and others in oxygen deficient (anaerobic) conditions. They have three fundamental shapes: spherical (coccus), rod-like (bacillus) and curved (vibrio, spirillum, spirochete). Most bacteria are very small (about 1 micron long). If they were lined up side by side, 25,000 bacteria would take up about an inch. Most bacteria reproduce by splitting into two. If

conditions are suitable, bacteria can reproduce very quickly, completing one division every 20 to 30 minutes.

Bacteria are very resilient, remaining dormant when conditions are not ideal. Dried, but living bacteria can even be carried in the air. Bacteria can excrete toxins or carry them inside their cell wall until they die and disintegrate. Some bacteria may invade a specific organ of the body, for example the brain, throat or bone. Bacteria may also produce enzymes, some of which are responsible for illness.

Coliform bacteria are the bacteria most commonly associated with well water. The United States Environmental Protection Agency (EPA) standard for drinking water is a total coliform count of zero. Coliform bacteria are a large group of various rod-shaped species



Escherichia
Coli bacterium
(Greatly magnified)

MESSAGE FROM THE PUBLISHER

DROUGHT AND CONSERVATION

A difference of only a few gallons can tip the balance between having enough water, and experiencing a water crisis! There is an ever-increasing awareness of drought throughout the US and summer watering restrictions are now a semi-permanent feature for many communities with utility supply. Well owners can also benefit from water conservation. For many wells, the rocks in the immediate area of the well store water. Using less water can help ensure that there are still supplies available in times of drought. Less water use means less energy to heat water and less use of electricity for water pumps. Reducing in-home water use also puts less stress on septic systems.

Because ground water is always on the move (usually very slowly) water you “save” early in the year may not necessarily be there to use later in the year. In the short term however, well water you don’t use this week is likely to be available next week. Conservation is a key ingredient of sustainability. By 2050 there will be an additional 100 million people in the US. So drought or no drought, there are good reasons to be careful with our use of water resources.

The Trust’s *WATER CONSERVATION PAMPHLET* for homeowners is available for purchase for bulk distribution to homes and communities. Call (603) 228-5444 for details.

A handwritten signature in black ink, reading "Andrew W. Stone". The signature is written in a cursive, flowing style.

Andrew W. Stone
American Ground Water Trust

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COLIFORM AND E. COLI BACTERIA . . . continued from page 1

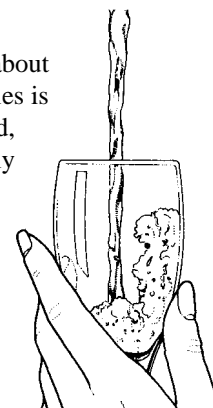
and strains of bacteria. The group includes bacteria that occur naturally in the intestines of warm-blooded animals (fecal coliform) and non-fecal coliform. Non-fecal coliform bacteria are very common and are found virtually everywhere on soil particles, insects, plants, animals, walls and furniture in homes and on your skin and clothes.

Fecal coliform can include disease causing (pathogen species) and non-disease causing species. Over 200 types of non-disease causing bacteria have been found in human digestive tracts. Most arrive on the food and drink we consume. Many yogurt cultures include coliform bacteria. *Lactobacillus acidophilus* is the most common bacteria strain used in commercial yogurts and some studies show it creates an acidic environment that inhibits harmful bacteria in the digestive tract.

Escherichia coli (E. coli), often listed in water quality analyses, is one species of fecal coliform bacteria. A single E. coli is 2 microns long and about 0.5 microns in diameter. There are hundreds strains of E. coli bacteria that differ only in the type of toxin or enzyme that they produce. Despite the fact that they originate in the digestive system of a warm-blooded creature, most E. coli strains are not harmful to humans.

E. coli can be easily cultured in a laboratory and therefore, they are a good indicator species for bacterial contamination in water tests. Its presence in a water sample indicates that sewage material may be present and that if sewage is present, more harmful disease-causing organisms may also be present, for example *Vibrio cholerae* that causes cholera.

Over 150 million Americans use ground water for drinking every day. Most is from public utility wells but about 40 million people obtain ground water from 15 million private wells. The source water for many utility supplies is from lakes and rivers and because of the billions of organisms in surface water; utility supply water is treated, usually with chlorine or ozone, before entering the supply pipelines. Most private well water from properly constructed wells does not require treatment because there is much less chance of contamination. However, homeowners should check their source water quality. Common causes of bacteria in wells are that the well is receiving water from close to the surface, or that the well cap is not properly sealed. Very often “shock chlorination” can kill off all bacteria in a well. Home treatment devices are available to ensure that any bacteria that do enter the well are removed before the water gets to the kitchen tap. It is the responsibility of homeowners to keep self-supplied well water free from health risk. The Trust’s web site www.privatewell.com has information about well bacteria and water treatment for homeowners.



Solutions to Sulfur Problems (Rotten egg smell) continued from page 4

remove iron and manganese from household drinking water. However, hydrogen sulfide oxidation processes need more oxidant to be effective. Treatment systems for hydrogen sulfide will require a longer contact time (perhaps 20 minutes) with chlorination systems, more frequent regeneration cycles (greensand resin backwashed with potassium permanganate) or the generation of more ozone with ozonation systems.

Because the oxidation process creates solid particles, the backwash cycles must be powerful enough to push the precipitated materials out of the filter. (Activated carbon filters cannot be regenerated in this way and must be replaced periodically). To increase the efficiency of hydrogen sulfide removal when concentrations are high, it is sometimes necessary to combine two or more of these methods.

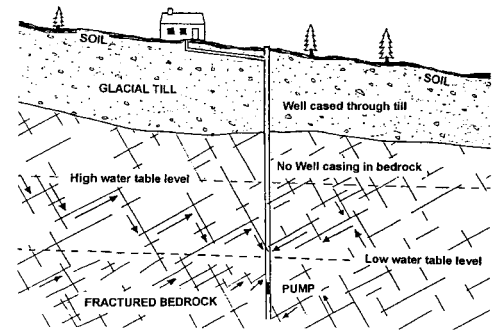
Sometimes the rotten egg odor is created by sulfur bacteria that use the dissolved sulfate as an energy (food) source. The bacteria chemically change the sulfate to hydrogen sulfide gas. The bacteria prefer the hot water side of the household plumbing system but may be found in the cold water pipes too. Before installing treatment equipment, it is advisable to try to kill the sulfur bacteria with chlorine disinfection (The chlorine disinfection method is described on the Trust website www.agwt.org/bacteria.htm and should include treating the hot water tank). If this shock treatment does not work then a continuous chlorination system may be required.

Sulfur bacteria are not detected by basic bacteria tests used by commercial and local health department laboratories to find coliform bacteria. Specific tests to identify sulfur bacteria are relatively expensive and time consuming. It may be more effective to simply disinfect the water system and observe the result rather than test for the sulfur bacteria.

Finally, a third situation may create a “rotten egg” type odor. Some older hot water tanks use magnesium anode rods to prevent corrosion. These rods sometimes react with the water to produce an odor that resembles hydrogen sulfide. If the odor you detect is only from the hot water and disinfection has not worked, call the manufacturer of your hot water tank to inquire about the type of anode rod in your heater and how the rod can be replaced with a less reactive rod.

HOW DEEP SHOULD MY WELL BE?

"How deep will the well be?" is a common question before drilling a well. If the driller has drilled several wells in the nearby area, he may be able to estimate the approximate depth where water will be encountered. Most of the time, however, the depth needed to find the required well yield cannot be determined accurately prior to drilling. A well is an engineered hole in the ground via which ground water can be brought to the surface. Drilling machines can drill to great depths. Deeper wells usually cost more than shallow wells to construct in the short-run. However, not drilling deep enough can result in later problems that will be much more expensive to fix. Listed below are some of the factors that may influence decisions about the depth of a water well.



Seasonal Rise And Fall Of The Water Table

During the year, the water table will fluctuate up and down in the well in response to seasonal precipitation in the area and local ground water use. The well must therefore be drilled deeper than the lowest expected elevation of the water table. Water level fluctuations may occur over several years if there have been drought conditions. Knowing the lower limit of the range of water levels over several years therefore can be helpful.

Surface Contamination Risks

Deeper wells that are properly constructed (including grout, casing, well cap, and pitless adaptor [in freezing climates]) usually provide good protection from bacterial contamination sources originating at the surface. Increasing the well depth and the length of well casing will result in a longer flow path of water from recharge at the surface to pumping from the well. The longer the length of time water is in the subsurface, the more opportunity there is for bacteria to die-off or be trapped by soil and rock.

Poor Quality Water Zones

In some areas of the country with multiple aquifers, there may be zones of poor water that should be avoided or "cased off" so this lower quality water does not adversely impact the well. Information about the expected rock formations, likely local changes in water table depth and the water quality for a general region can be obtained from the driller, local offices of the United States Geological Survey, state geological surveys or geology departments at local universities and colleges.

Low Yielding Rock Formations

In low yielding rock formations the well may have to be drilled deep enough to serve as a storage cavity for ground water. Once a well is drilled, the total depth, depth to the top of the ground water table (static level) and diameter of the well determine how much water will be stored within the well cavity. The larger the well diameter the more water will be stored for a given well depth and water table elevation. To find the "thickness" of the water stored in the well subtract the depth to the static water level from the drilled depth of the well. To determine the volume of water stored in a well find the well diameter in the table below and multiple the "thickness" value by the gallons per foot factor.

Well diameter in inches	4	6	8	12	24	36
Approximate Gallons per foot of well depth factor	0.65	1.5	2.6	5.9	23.5	52.9

Regulations And Building Code Requirements

Well regulations vary according to the state in which you live. Before drilling a new well or purchasing a home with a well, check with your local and state health departments for the specific rules in your area. Most states require a minimum of 20 feet of casing and often require the casing reach bedrock. Proper grouting (sealing) around the outside of the well casing in combination with a vermin-proof well cap, prevents surface water and bacteria from using the well hole itself as a pathway directly to the water table.

Well depth plays a role in pump placement. Pumps should never be set directly at the bottom of a well. It is usually best to place the pump 10 to 20 feet up from the bottom of the well. In low-yield wells that recharge slowly, placing the pump below the recharge zone may create cascading water situations that lead to additional sediment build up in the well cavity. An automatic shut-off switch can be wired into the pump power line so that the pump will shut-off when the water level falls close to the pump.

For more information about ground water and wells go to TRUST, NGWA or WSC websites: www.agwt.org, www.ngwa.org, www.watersystemscouncil.org.



AMERICAN GROUND WATER TRUST

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TOPICS IN UPCOMING ISSUES

- Solutions to Nitrate Problems
- Do I Need a Backflow Device?
- Water from Space?

Solutions to Sulfur Problems (Rotten egg smell)

Dissolved sulfate is a normal constituent of most ground water. Its presence may go unnoticed if the water remains oxygenated and if sulfur bacteria are not present. In some cases, however, high sulfate concentrations may have a laxative effect, especially if a person changes from their usual water source to another with a higher sulfate content, such as may occur during a vacation.

Sulfur occurs in some ground water as a dissolved sulfate (SO_4^{2-}) or hydrogen sulfide gas (H_2S). Concentrations of these constituents range widely from aquifer to aquifer depending on the rock types, the possible presence of contaminants, the presence of bacteria species that may interact with the water, and the length of time that the water has been underground. Concentrations generally tend to increase with greater contact time.

Most water well issues related to sulfur revolve around the presence of dissolved hydrogen sulfide. Hydrogen sulfide is a flammable, colorless gas that is soluble in water. Although hydrogen sulfide gas can be lethal when concentrated in the breathing zone, the levels found in ground water are typically too low to create any risk right out of the tap. However, if the gas is able to collect in a low area, such as a well pit, it can build up to dangerous levels by displacing the less dense oxygen in that area.

The United States Environmental Protection Agency (EPA) does not consider consuming hydrogen sulfide gas dissolved in ground water as a risk to human health. However, hydrogen sulfide can be a nuisance because its presence creates a "rotten egg" odor and if used for cooking can change the taste of foods. It also is corrosive and may deteriorate plumbing and discolor fixtures with a black residue.

Treatment methods for hydrogen sulfide will vary according to its concentration. When the concentration is less than one ppm (milligram per liter [mg/L]), activated carbon filtration will adsorb the hydrogen sulfide from the water and reduce the unpleasant taste. For concentrations up to two ppm, adding air to the water (aeration treatment) will reduce the dissolved hydrogen sulfide concentration by releasing it to the surrounding air. This process must be vented to a remote location (perhaps above the roof line) so household living areas are not affected by the odor. It may be necessary to "polish" the aerated water by using an activated carbon filter to further remove any remaining hydrogen sulfide taste or odor.

When concentrations exceed two ppm, it is commonly necessary to condition the water with oxidation treatments such as chlorination, potassium permanganate or ozone. The systems are similar to those used to

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