THE AMERICAN WELL OWNER

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

A Quarterly Publication for Well Owners - 2002 Number 4

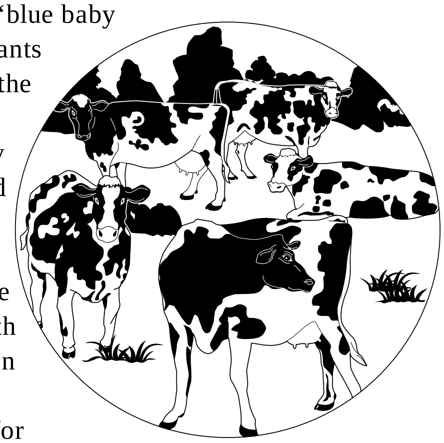
Solutions to Nitrate Problems

Nitrogen is important to all life. Nitrogen is most commonly found as a colorless, odorless and tasteless gas that makes up about 78 percent of the earth's atmosphere. Nitrogen also exists in the environment in many other forms and changes forms as it moves through the nitrogen cycle. It can be combined into living and non-living material, and then eventually returns back to the soil or air in a continuing cycle. Although nitrogen is an essential component of protein in our bodies, excessive concentrations of nitrate-nitrogen in drinking water can be hazardous to health for infants and pregnant women.

The main source of nitrogen in soils is from plant and animal residues. When changed into nitrate by bacteria in the soil, a nitrogen/oxygen ion (NO_3^-) becomes an important plant food. Farmers also add nitrate to the soil as fertilizer. However, nitrate is highly leachable and if there is excessive rainfall, over-irrigation or over application of fertilizers (as manure or chemical) nitrate will be leached below the plant-root zone and may reach groundwater.

The principal health concern occurs when bacteria in the digestive system transforms nitrate to nitrite. The nitrite oxidizes iron in the hemoglobin of red blood cells to form methemoglobin, which lacks the oxygen-carrying ability of hemoglobin. The transformation of nitrate to nitrite is more likely to occur when the pH level in the digestive tract is high (low acidity), allowing bacteria levels to rise.

This condition is known as methemoglobinemia, sometimes referred to as "blue baby syndrome" because in infants under six months of age, the digestive system has an underdeveloped capability to secrete gastric acid, and the bacteria count in the digestive system may rise. The condition may also be of concern for anyone with a gastrointestinal condition producing high pH or an impaired enzyme system for metabolizing methemoglobin back to hemoglobin.



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MESSAGE FROM THE PUBLISHER

Do You Have Information About Your Well?

Homeowners with wells should be concerned about protecting the area around their well to be sure that it is free from contamination risks. The usual items for attention include such things as fuel storage, applications of fertilizers and pesticides and nearby septic systems.

Concern by well owners is not just a health issue. A safe dependable water well and water system adds value to a home. New home buyers are likely to want specific information. Documentation of water tests, careful records of servicing and files on well construction (depth drilled, geology) and on well equipment (pump, pressure tank, conditioning equipment) can be of vital importance at the time of property transfer.

If you do not already have one, start a "well and water system" file and keep records of all aspects related to your private well system. Good records could mean the difference between "sale" or "no sale."

Andrew Stone

Andrew W. Stone
American Ground Water Trust

Solutions to Nitrate Problems . . . *continued from page 1*

The United States Environmental Protection agency has determined that levels of nitrate in drinking water should not exceed 10 parts per million (ppm or milligrams per liter). Treatment methods commonly available to homeowners to reduce nitrate levels in drinking water, including distillation, anion exchange and reverse osmosis.

Distillation

Distillation is one of the oldest methods of water treatment, though not commonly used today as a home treatment method. Distillation units or stills generally consist of a boiling chamber, where the water enters, is heated and vaporized; condensing coils or chamber, where the water is cooled and converted back to liquid water; and a storage tank for the distilled water.

Inorganic compounds such as nitrate, other large non-volatile organic molecules and compounds with boiling points greater than 100°C (212°F) do not evaporate with the water and are left behind. Compounds that have a boiling point temperature less than water will NOT be removed by a simple distillation treatment because they will vaporize before the water and then recondense in the collection tank along with the purified water.

The process is only capable of producing a small volume (5 to 15 gallons) of water per day from a typical residential installation. Because the units have low production volumes they are commonly installed as "point-of-use" (POU) treatments for drinking and cooking purposes only. This is frequently an acceptable and satisfactory remedy for solving a nitrate contamination problem because nitrate is not absorbed through the skin in a significant amount.

Unevaporated residual liquids and solids must be removed from the evaporation area to ensure that the heating elements operate at the lowest demand level for heating energy.

Anion Exchange

The process is similar to common "water softening" ion-exchange except anions (negatively charged ions) are removed from the raw water rather than cations (positively charged ions) such as calcium or magnesium carbonate. Anion exchange uses chloride anions to remove various anion species including sulfate, sulfite, phosphate, nitrate, nitrite, bicarbonate, fluoride, arsenic and others. The anion exchange treatment process reduces the pH of the water. A water neutralizing system may be necessary following the exchange unit in order to correct the pH of the water.

Anion exchange systems can be regenerated with strong (brine) solutions of chloride anions. The chloride brines reattach to the resin beads and release the exchanged anions during a backwash process.

Reverse Osmosis

The reverse osmosis (RO) process involves filtering the raw water with semipermeable membranes that will allow water molecules to pass but not the molecules of dissolved solids such as nitrate. Pressure is applied to the raw water to accelerate its passage through the membrane. The residual raw water retaining the dissolved solids is released to drain and the RO filtered water is collected in a storage tank until needed for drinking or cooking. Household RO units usually have a pre-filter canister for sediment removal and an activated carbon post-filter for taste and odor removal. RO units are usually capable of producing between 10 to 20 gallons of good quality drinking water per day and are therefore best suited as point-of-use (POU) installations. The treated drinking water is quite corrosive because it is lacking dissolved solids. RO water will leach metals from metal pipes and should be stored in plastic tanks and plumbed with plastic piping (Be sure to upgrade the piping with plastic tubing on any ancillary water use devices in the kitchen such the ice maker).

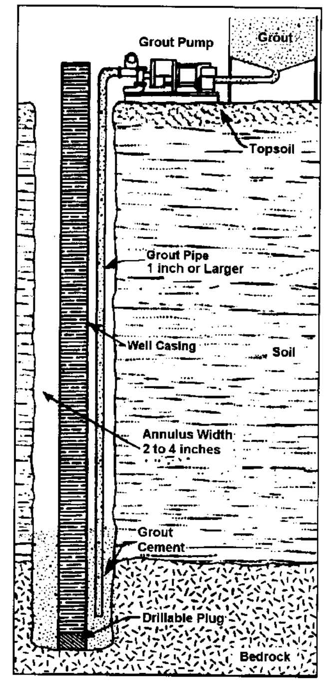
Nitrate-nitrogen occurs naturally in groundwater, usually at concentrations far below a level of concern for drinking water safety. Nitrate in water is undetectable without testing. The American Ground Water Trust recommends that new drinking water supplies be tested for nitrate to determine the baseline concentration, especially for households with infants, pregnant women, nursing mothers, or elderly people who are the most susceptible to nitrate. In addition, if the water supply has never been tested for nitrate, it should be tested. Keep a record of the nitrate levels in your well water to monitor the levels from year to year to assess if the concentration is changing up or down. It may take months or years for nitrate from nearby failed septic systems or agricultural uses to reach your well.

The Importance of Sealing a Well Casing

Water wells, if properly constructed, can provide a safe and reliable source of drinking water. An essential aspect of proper well construction is sealing the space between the well casing and the side of the drilled hole (called the well annulus). Well casing should also have a vermin-proof vented-cap and penetrate the ground at least 20 feet. If bedrock is present, the casing should be drilled into unweathered rock at least 5 feet. Because well construction regulations vary from state to state, homeowners should check with local authorities (e.g., State water well boards, health departments or state-level environmental protection agencies) to determine the specific regulations that apply to domestic drinking water wells.

If unsealed, the well annulus could provide a direct pathway from the surface to the ground water below at a significantly fast pace compared to infiltration through undisturbed soil. If the natural cleansing process incumbent during infiltration is short-circuited through the annular space, bacteria and other contaminants may be introduced to the ground water.

Properly sealing a well casing involves filling the annulus with a material that will stop water from flowing down the side of the casing. The process of filling the annulus is called grouting. Grouting typically involves pumping cement and/ or bentonite into the annular space starting at the bottom of the casing and filling back up to the surface. Starting the grouting process at the bottom of the hole reduces the possibility that air and water will be trapped in the space due to "bridging" and clogging conditions that commonly occur in the narrow portions of the annulus. To ensure that the annulus has enough space to accept grout without a high likelihood of clogging or having the casing touch the wall of the hole, the diameter of the drill hole should be 4 to 8 inches larger than the outside diameter of the well casing.



Bentonite is a clay that expands when mixed with water. When wet its volume increases by about 13 times compared to its volume when dry. This quality allows it to tightly fill small and irregular spaces between the casing and the hole wall. When mixed with cement the bentonite-cement-slurry creates a seal that is somewhat plastic so that it can absorb slight movement of the casing without cracking. The slurry is also more resistant than plain bentonite to washouts if high water content zones must be sealed. Cement by itself has a tendency to shrink as it cures and may pull away from the sides of the annular space. Shrinkage is especially likely if the cement is "mixed thin" with too much water. Also cement heats up significantly when it cures and so cement grout is not recommended for plastic or PVC well casing.

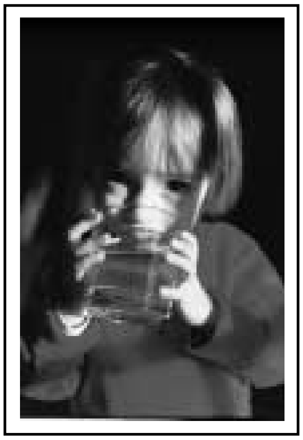
Drill cuttings (rock fragments released from the hole during drilling) are sometimes used as a backfill of the annular space. Although the drill cuttings as usually very small particles, they may not pack together well enough to provide the best seal for a well because of their composition, hard surfaces and shape. Grouting a drill hole may cost a little more initially, but it is a small price to pay compared to cleaning up a polluted well.

Taste of Ground Water *continued from page 4*

Common water tastes and their sources:

Rotten egg – Hydrogen sulfide gas
Metallic or Bitter – Dissolved metals (e.g., iron, manganese, copper, zinc, lead),
Salty – Chloride or in general high Total Dissolved Solids (TDS) levels
Septic, musty, earthy – Bacteria
Bleach-like – Chlorine
Bitter – Tannins

Treatments with granular activated carbon or reverse osmosis are two effective methods to remove objectionable tastes and odors from a drinking water supply. However, the next time you ask for a glass of water consider that the taste is the signature of the local aquifer. In most cases, it has a unique and pleasant "flavor." Enjoy!



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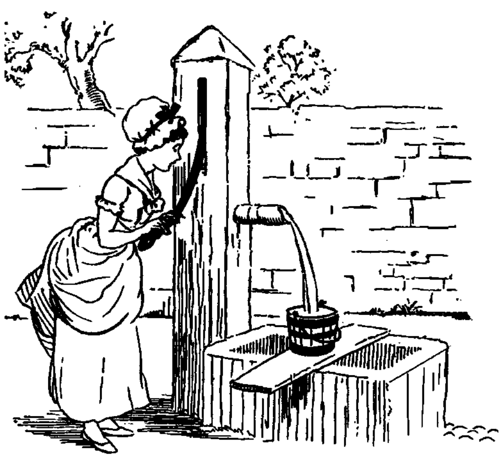
AMERICAN GROUND WATER TRUST

16 Centre Street, Concord, New Hampshire 03301

TOPICS IN UPCOMING ISSUES

- **Do I need a backflow device?**
- **What are Iron Bacteria?**
- **Solutions to Hardness Problems**

The Taste of Water



In the late 1800's through the early 1900's mineral water spas such Saratoga Springs, New York and Colorado Springs, Colorado were popular resort and health therapy destinations for the affluent of the United States. Part of the attraction for "taking the waters" was the taste of the mineral water and natural carbonation of many of the springs. Pure water – H_2O – does not have a "flavor." Water obtains tastes from the substances it comes in contact with during its travel through the Hydrologic Cycle. These substances can be rocks, minerals, organic (plant and animal) debris and residues, anthropogenic (human-made) materials and waste products, air-borne particles (for snow and rain) or other sources of water that may join and mix together in a particular aquifer zone.

Water is a natural and efficient solvent and will accept most compounds into solution. It takes time for water to dissolve a substance. Substances that dissolve and increase in concentration in a relatively short time are said to have a high solubility. Low solubility substances take a longer time to dissolve. The amount of time that is required to dissolve a certain amount of a material depends on many variables such as water temperature, pH, oxygen concentration of the water, physical structure of the substance (molecular structure), chemical composition of the substance and pressure.

The longer a water droplet remains in the ground water regime, the more "flavors" it is likely to contain and the stronger the taste may become. For this reason spring waters, which typically have short residence times beneath the ground, have lower concentrations of dissolved solids and consequently milder tastes in comparison to water from deeper aquifers.

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Individual Subscription Rates:
1 year (4 issues) $6
2 years (8 issues) $11
3 years (12 issues) $16
All rates subject to change.