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Household Water Quality in Clarke County, Virginia

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VIRGINIA HOUSEHOLD WATER QUALITY PROGRAM

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Clarke Program Overview

In June 2013, residents from Clarke County participated in a drinking water testing clinic sponsored by the local Virginia Cooperative Extension (VCE) office and the Virginia Household Water Quality Program. Clinic participants received a confidential water sample analysis and attended educational meetings where they learned how to interpret their water test results and address potential issues. According to survey data collected, 51 samples were tested, serving 120 individuals. The most common household water quality issues identified were hardness, sodium, and lead as well as the presence of E. coli and total coliform bacteria. The figure found at the end of this report shows these common water quality issues along with basic information on standards, causes, and treatment options.

Background

More than 1.7 million Virginians use private water supplies such as wells, springs, and cisterns. The Virginia Household Water Quality Program (VAHWQP) began in 1989 with the purpose of improving the water quality and health of Virginians who are reliant on private water supplies. Since then drinking water clinics have been conducted in 90 counties across Virginia and samples analyzed from more than 16,000 households. In 2007, the Virginia Master Well Owner Network (VAMWON) was formed to support the VAHWQP. Virginia Cooperative Extension agents and volunteers participate in a one-day VAMWON training workshop that covers private water system maintenance and protection, routine water testing, and water treatment basics. They are then able to educate others about their private water supplies. More information about these programs may be found at our website: www.wellwater.bse.vt.edu.

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 maintaining their water systems, for monitoring water quality, and for taking appropriate steps to address problems should they arise. The EPA Safe Drinking Water Standards are beneficial guidelines for assessing 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 non-regulatory guidelines for contaminants that may cause nuisance problems such as bad taste, foul odor, or staining. Testing water annually, and routinely inspecting and maintaining a water supply system will help keep water safe.

Understanding Household Water Quality

Water quality refers to the chemical, physical, and biological characteristics of water, usually related to a specific use for the water. It is assumed that household water is used for common household purposes like drinking, cooking, washing, and showering. Household water quality is affected by four primary factors: geology, land use, well construction and location, and plumbing components and water treatment. Water is a great solvent, dissolving much of what it comes in contact with. Because water is a great solvent, quality of groundwater is influenced by the type of rocks and sediment it is exposed to as it travels from the surface (where it falls as rain) to the water table. For example, water that comes from areas with limestone is often high in minerals like calcium and magnesium. Activities on the land surface can affect groundwater quality as well. For example, use of fertilizer on lawns or agricultural fields can contribute nutrients such as nitrogen to groundwater. The location of a well or spring is also important; it should be located away from possible sources of contamination. Wells should be constructed properly with a sealed cap, intact casing, and grout material around the casing to prevent surface water from entering the well. Finally, plumbing materials used in homes, as well as water treatment devices, affect household water quality. Some household water contains lead or copper, which can be leached from solder in pipes or plumbing components. Water treatment devices can also affect water quality by removing certain contaminants or adding others. For example, a water softener works by removing hardness (calcium and magnesium) and replacing it with sodium via ion exchange. Consideration of all of the factors that affect water quality is important when understanding water test results and ways to address problems with water quality.

Drinking Water Clinic Process

Kickoff meeting: Any resident relying on a well, spring, or cistern was welcome to participate in the clinic.

Participants were shown a brief presentation that addressed common water quality issues in the area, an introduction to parameters included in the analysis, and instructions for collecting their sample. Sample kits with sampling instructions and a short questionnaire were distributed. The questionnaire included questions about characteristics of the water supply (e.g. age, depth, and location, plumbing materials, existing water treatment), and any perceived water quality issues. Basic demographic information about the household was asked, including household income, age and education level of residents, and whether or not household members drink the water from the private water supply being tested.

Participants dropped off their samples and completed questionnaires at a predetermined location on a specific date and time.

Sample collection: Following collection at a central location, all samples were iced in coolers and promptly transported to Virginia Tech for analysis.

Analysis: Samples were analyzed for the following water quality parameters: iron, manganese, nitrate, fluoride, sulfate, pH, total dissolved solids (TDS), hardness, sodium, copper, lead, arsenic, total coliform bacteria, and *E. coli*. General water chemistry and bacteriological analyses were performed by the Department of Biological Systems Engineering Water Quality Laboratory and Civil and Environmental Engineering Department at Virginia Tech. All water quality analyses were performed using standard analytical procedures.

The EPA Safe Drinking Water Standards, which are enforced for public water systems in the U.S., were used as guidelines for this program. Water quality parameters not within range of these guidelines were identified on each water sample report. Reports were prepared and sealed in envelopes for confidential distribution to clinic participants.

Interpretation meeting: Participants received their confidential water test reports, and VCE personnel made a presentation providing a general explanation of what the numbers on the reports indicated. In addition, general tips for maintenance and care of private water supply systems, routine water quality testing recommendations, and possible options for correcting water problems were discussed. Participants were encouraged to ask questions and discuss findings either with the rest of the group or one-on-one with VCE personnel after the meeting.

Findings and Results

Profile of Household Water

Ninety-eight percent of participants in the Clarke County clinic indicated their water supply was a well. Ninety-two percent of these were drilled. Participants also described the type of material used for water distribution in each home. The two most common pipe materials in Clarke County were copper (80.4%) and plastic (54.9%). Many homes were reported as having more than one type of plumbing material, which is quite common.

To properly evaluate the quality of water supplies in relation to the sampling point, participants were asked if their water systems had water treatment devices, and if so, the type of device. Sixty-seven percent of Clarke participants reported at least one treatment device installed. The most commonly reported treatment device was a softener (52.9%) followed by a sediment filter, installed by 29.4% of participants.

Participants' Perceptions of Household Water Quality

Participants were asked whether they perceived their water supply to have any of the following characteristics: (1) corrosive to pipes or plumbing fixtures; (2) unpleasant taste; (3) objectionable odor; (4) unnatural color or appearance; (5) floating, suspended, or settled particles in the water; and (6) staining of plumbing fixtures, cooking appliances/utensils, or laundry.

Staining problems were reported by 39.2% of clinic participants in Clarke County. The most commonly reported description was "white/chalky" (31.4%), followed by "rusty" (9.8%). Sixteen percent of participants reported objectionable odors in their water, most describing a "rotten egg" smell (11.8%). Sixteen percent reported particles in their water, most describing "white flakes" (13.7%).

Bacteriological Analysis

Private water supply systems can become contaminated with potentially harmful bacteria and other microorganisms, which can cause short-term gastrointestinal disorders, such as cramps and diarrhea. Other diseases that may be contracted from drinking contaminated water include viral hepatitis A, salmonella, dysentery, typhoid fever, and cholera.

Microbiological contamination of a water supply is typically detected with a test for total coliform bacteria. Coliform bacteria are present in the digestive systems of humans and animals and can be found in the soil and in decaying vegetation. While coliform bacteria do not cause disease, they are indicators of the possible presence of disease causing bacteria, so detecting them in drinking water warrants additional testing.

Positive total coliform bacteria tests are often confirmed with a retest. If coliform bacteria are present in a water supply, possible pathways or sources include: (1) improper well location or inadequate construction or maintenance (e.g. well too close to septic, well not fitted with sanitary cap); (2) contamination of the household plumbing system (e.g. contaminated faucet or water heater); and (3) contamination of the groundwater itself (perhaps due to surface water entering groundwater).

Finding total coliform bacteria in a water sample triggers testing for the presence of *E. coli* bacteria. If *E. coli* are present, it indicates that human or animal waste is entering the water supply.

Of the 51 samples collected in Clarke County, 74.5% tested positive (present) for total coliform bacteria. Subsequent *E. coli* analyses for all of these samples showed that 27.5% of the samples tested positive for *E. coli* bacteria.

Program participants whose water tested positive (present) for total coliform bacteria were encouraged to retest their water to rule out possible cross contamination, and were given information regarding emergency disinfection, well improvements, and septic system maintenance. Any participant with a sample that tested positive for *E. coli*, was encouraged to take more immediate action, such as boiling water or using another source of water known to be safe until the source of contamination could be addressed and the water supply system disinfected. After taking corrective action, participants were advised to have their water retested for total coliform, followed by testing for *E. coli* if needed. In addition, participants were provided with resources that discussed continuous disinfection treatment options.

The table found at the end of this report shows the general water chemistry and bacteriological analysis contaminant levels for the Clarke County drinking water testing clinic participants.

Chemical Analysis

As mentioned previously, all samples were tested for the following parameters: iron, manganese, nitrate, fluoride, sulfate, pH, total dissolved solids (TDS), hardness, sodium, lead, arsenic, and copper. Selected parameters of interest for the Clarke drinking water testing clinic samples are discussed below.

Lead

Lead is not commonly found in groundwater, but may enter household water as it travels through plumbing materials. Lead can cause irreversible damage to the brain, kidneys, nervous system, and blood cells, and is a cumulative poison, meaning that it can accumulate in the body until it reaches toxic levels. Young children are most susceptible, and mental and physical development can be irreversibly stunted by lead poisoning. Lead may be found in household water from homes built prior to 1930 with lead pipes, prior to 1986 with lead solder, or in newer homes with "lead-free" brass components, which may legally contain up to 8% lead. The EPA limit for lead in public drinking water is 0 mg/L, and the health action limit is 0.015 mg/L. In these drinking water clinics, participants collect two samples from their taps: 1) a first draw sample, which is drawn first thing in the morning after the water hasn't been used in at least 6 hours, and therefore has a substantial contact time with the plumbing and 2) a flushed sample, taken after water has been run for 5 minutes, and therefore has not had significant contact with pipes. If lead is present above 0.015 mg/L in the first draw sample, but is not detected in the flushed sample, simply running the water for a few minutes prior to collecting water for drinking may address the problem. Alternatively, addressing the corrosiveness (acidity) of your water by installing an acid neutralizing filter may solve the problem. Reverse osmosis systems or activated carbon filters (labeled to remove lead) can remove it from your water. In the Clarke group, 11.8% of first draw samples exceeded 0.015 mg/L lead. None of the flushed samples exceeded 0.015 mg/L.

Sodium

The EPA recommendation for sodium in drinking water (20 mg/L) is targeted for the most at-risk segment of the population, which are those with severe heart or high-blood pressure problems. The variation in sodium added to water by softeners is very large (ranging from around 50 mg/L to above 300 mg/L). Sodium in drinking water should be considered with respect to sodium intake in the diet. The average American adult consumes 2000 - 4000 mg of sodium per day. If concerned about sodium in water, intake should be discussed with a physician.

Of the 51 Clarke clinic samples, 47.1% exceeded the EPA recommendation of 20 mg/L. Some of this sodium could result from sodium naturally present in the geology (rocks, sediment) where well water originates, but the primary source of sodium is a water softener. There are several options for addressing sodium levels in softened water. Since only water used for washing needs to be softened, a water treatment specialist can bypass cold water lines around the softener, softening only the hot water and reducing the sodium in the cold drinking water. Another option is using potassium chloride instead of sodium chloride for the softener, although this option is more expensive.

Hardness

Hard water contains high levels of calcium and magnesium ions that dissolve into groundwater while the water is in contact with limestone and other minerals. Hard water is a nuisance and not a health risk.

In Clarke County, 43% of samples were considered "very hard" (exceeding 180mg/L of hardness). Hard water is indicated by scale build-up in pipes and on appliances, decreased cleaning action of soaps and detergents, and reduced efficiency and lifespan of water heaters. Ion exchange water softeners are typically used to remove water hardness.

Conclusion

Clinic participants received objective information about caring for and maintaining their private water supply systems, and specific advice about addressing any problems that were identified through the analysis of their water sample.

References

U.S. Environmental Protection Agency. Drinking Water Contaminants. http://www.epa.gov/safewater/contaminants/index.html. Accessed online 3/2014.

Virginia Cooperative Extension. Virginia PowerPoint Map. http://www.intra.ext.vt.edu/marketing/maps/powerpoint.html. Accessed online 3/2014.

Additional Resources

For more information about the water quality problems described in this document, please refer to our website. You will find resources for household water testing and interpretation, water quality problems, and solutions here: www.wellwater.bse.vt.edu/resources.php

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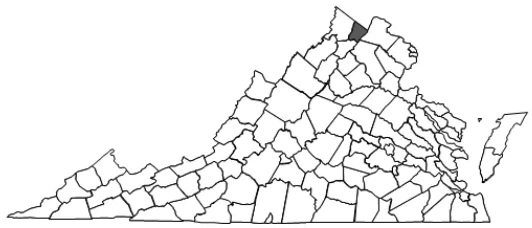
Figure 1. Common Household Water Quality Issues in Clarke County - 2013



Presence of total coliform bacteria
- Most coliform bacteria do not cause disease, but presence indicates more dangerous microorganisms may enter water supply
- EPA recommends that coliforms should be absent

Hardness
- Hardness is calculated from the magnesium and calcium mineral content of water; comes from limestone bedrock
- EPA recommends a level of 120 mg/L or less
- Nuisance contaminant; no health risk

Sodium
- EPA recommendation for sodium (20 mg/L) is targeted for those with severe heart or high-blood pressure problems
- May come from geology or water softener

Lead
- Can cause irreversible damage to the brain, kidneys, nervous system, and blood cells.
- Can leave grey stains on sinks, tubs, and laundry.
- The EPA standard goal for lead is 0 mg/L with a health action limit of 0.015 mg/L.

Table 1. Water Chemistry and Bacteriological Contaminant Levels for the Clarke Drinking Water Testing Clinic - 2013

2013 Clarke County VAHWQP Drinking Water Clinic Results N = 51 samples				
Test	**EPA Standard***	**Average**	**Maximum Value**	**% Exceeding Standard**
Iron (mg/L)	0.3	0.112	3.346	5.9
Manganese (mg/L)	0.05	0.019	0.798	3.9
Hardness (mg/L)	180	147.9	487.2	43.1
Sulfate (mg/L)	250	16.8	118	0.0
Fluoride (mg/L)	2.0/4.0	0.26	2.2	2.0
Total Dissolved Solids	500	397.0	795	21.6
pH	Min 6.5	7.1	5.4 (min)	7.8 (< 6.5)
	Max 8.5		7.8 (max)	0.0 (< 6.5)
Sodium (mg/L)	20	68.48	210.2	47.1
Nitrate - N (mg/L)	10	2.554	13.817	3.9
Copper-First Draw (mg/L)	1.0/1.3	0.447	4.742	7.8
Copper-Flushed (mg/L)	1.0/1.3	0.044	0.39	0.0
Lead-First Draw (mg/L)	0.015	0.006	0.094	11.8
Lead-Flushed (mg/L)	0.015	0	0.005	0.0
Arsenic-First Draw (mg/L)	0.010	0.001	0.001	0.0
Arsenic-Flushed (mg/L)	0.010	0.001	0.003	0.0
Total Coliform Bacteria	0.0	1,152.0	22,749	74.5
E. Coli Bacteria	0.0	3.0	57.0	27.5

*EPA primary and secondary standards of the Safe Drinking Water Act are used as guidelines for private water supplies.