Evaluation of Household Water Quality in Montgomery County, Virginia

MARCH 2010

VIRGINIA HOUSEHOLD WATER QUALITY PROGRAM

Background

More than 1.7 million Virginia households 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 of Virginians reliant on private water supplies. Since then drinking water clinics have been conducted in 86 counties across Virginia and samples have been analyzed from more than 14,500 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 1 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 public drinking water standards are good 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.

Geology

The northwestern side of Montgomery County lies within the ***Valley and Ridge*** physiographic province of Virginia. Consolidated sedimentary rocks deposited beneath ancient seas underlie the Valley and Ridge province to the west of the Blue Ridge. In the lowlands, such as the Shenandoah Valley, limestone and dolomite occur beneath the surface forming the most productive aquifers in Virginia's consolidated rock formations. In contrast, sandstone and shale are the rock types often present in the ridges and upland areas, which yield only enough water for rural and domestic supplies. (GWPSC, 2008)

The connection between groundwater and surface water plays a major role in ground water recharge in the Valley and Ridge, where streams often cross fault zones and recharge aquifers. Wells in the fault zones have the greatest yields. Recharge also occurs through surface run-off into limestone sinkholes, bypassing filtration through the soil. This process can cause serious water quality problems since polluted surface water may be introduced directly into the groundwater system. Groundwater quality can also be adversely affected by private trash dumps located in sinkholes that receive surface run-off. In addition, carbonate formations contribute to the "hardness" of the groundwater (GWPSC, 2008)

The southeastern side of Montgomery County lies within the ***Blue Ridge*** physiographic province of Virginia. The Blue Ridge province is a relatively narrow zone to the west of the Piedmont province with some of the highest elevations in the state. Beneath a thin layer of soil and weathered rock lies the bedrock, a relatively impervious zone containing water primarily in joints, fractures, and faults. On the eastern side of the Blue Ridge, igneous and metamorphic rocks are most common; sedimentary rocks are more common on the western side. Steep terrain and thin soil covering result in rapid surface run-off and low groundwater recharge. The lower slopes of the mountains are the most favorable areas for groundwater accumulation. Springs are common and are often used for private water supplies. Because the rocks in the Blue Ridge are relatively insoluble, the ground water is not severely mineralized, but iron content is high in some locations (GWPSC, 2008).

Overview

In March 2010, 20 residents from Montgomery County participated in a drinking water clinic sponsored by the local Virginia Cooperative Extension (VCE) offices 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. The most common household water quality issues identified as a result of the analyses for the participants were high levels of hardness and sodium and the presence of total coliform bacteria. *Figure 1*, found at the end of this report, shows these common water quality issues along with basic information on standards, causes, and treatment options.

Drinking Water Clinic Process

Any Montgomery County resident relying on a well, spring, or cistern was welcome to participate in the clinic. Advertising began 8 weeks prior to the first meeting and utilized local media outlets, announcements at other VCE meetings, and word of mouth. Pre-registration was encouraged.

Kickoff meeting: Participants were given 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 was designed to collect information about characteristics of the water supply (e.g. age, depth, and location), the home (e.g. age, plumbing materials, existing water treatment), and any existing, perceived water quality issues. The purpose of the clinic is to build awareness among private water supply users about protection, maintenance and routine testing of their water supply.

Participants were instructed to drop their samples and completed questionnaires off 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, chloride, fluoride, sulfate, pH, total dissolved solids (TDS), hardness, sodium, copper, total coliform bacteria, and *E. Coli*. General water chemistry and bacteriological analyses were performed by the Department of Biological Systems Engineering Water Quality Laboratory at Virginia Tech. The Virginia Tech Soils Testing Laboratory performed the elemental constituent analyses. All water quality analyses were performed using standard analytical procedures.

The Environmental Protection Agency (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 out of range of these guidelines were identified on each test report. Test reports were prepared and sealed in envelopes for confidential distribution to clinic participants.

Interpretation meeting: At this 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 Supplies

The questionnaire responses, provided by all 20 participants at the clinic, helped to characterize the tested water supplies. One hundred percent of participants in the clinic indicated their water supply was a well (90% were drilled).

Participants were asked to classify their housing location as one of four categories. The choices, ranging from low to high density development, are: (1) on a farm, (2) on a remote, rural lot, (3) in a rural community, and (4) in a housing subdivision.

For the Montgomery clinic, rural community was the most common household setting (35%), followed by rural lot and subdivision (both at 25%).

Major sources of potential contamination near the home (within 100 feet of the well) were identified as septic systems (15%) and oil tanks (5%). Larger, more significant potential pollutant sources were also proximate (within one-half mile) to water supplies, according to participants. Forty percent of respondents indicated that their water supply was located within one-half mile of a farm animal operation while others indicated being within a half mile of either a manufacturing plant, field crops, or an old quarry (10% each).

Participants also described the type of material used for water distribution in each home on the questionnaire. The two most common pipe materials were copper (60%) and plastic (40%).

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 currently installed, and if so, the type of device. Sixty percent of participants reported at least one treatment device installed. The most commonly reported treatment device was a water softener (45%) followed by a sediment filter (25%).

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 50% of clinic participants. Rusty (35%) and white/chalky (15%) stains were the most commonly reported.

An objectionable odor of a rotten egg was reported by 5% of participants, and 5% reported a musty smell. Five percent reported having black specks their water, while 5% reported red slime.

Five percent reported unpleasant tastes. Finally, 10% reported an unnatural appearance in their water, observed as muddy or yellow.

Bacteriological Analysis

Private water supply systems can become contaminated with potentially harmful bacteria and other microorganisms. Microbiological contamination of drinking water can cause short-term gastrointestinal disorders, such as cramps and diarrhea that may be mild to very severe. Other diseases that may be contracted from drinking contaminated water include viral hepatitis A, salmonella infections, 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 their presence in drinking water warrants additional testing.

Since total coliform bacteria are found throughout the environment, water samples can become accidentally contaminated during sample collection. 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 (well too close to septic, well not fitted with sanitary cap), (2) contamination of the household plumbing system (e.g. contaminated faucet, water heater) and (3) contamination of the groundwater itself (perhaps due to surface water/groundwater interaction)

The presence of 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 20 samples collected, 25% tested positive (present) for total coliform bacteria. Subsequent *E. coli* analyses for all of these samples showed that 10% 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 whose samples 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 initial corrective measures, participants were advised to have their water retested for total coliform, followed by testing for *E. coli*, if warranted. In addition participants were provided with resources that discussed continuous disinfection treatment options.

Table 1, found at the end of this report, shows the general water chemistry and bacteriological analysis contaminant levels for the Montgomery drinking water clinic participants.

Chemical Analysis

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

Sodium

The EPA limit for sodium in drinking water (20 mg/L) is targeted for the most at-risk segment of the population, 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 20 clinic samples, 40% exceeded the EPA standard 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. Forty-five percent of the clinic participants reported using 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.

Thirty-five percent of the clinic samples were considered to be “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. Hard water is very common in the Valley and Ridge physiographic province because of the prevalence of carbonate (limestone) formations in the region. Ion exchange water softeners are typically used to remove water hardness.

Conclusions

Participants were asked to complete a program evaluation survey following the interpretation meeting. Of those that completed the survey, 93% indicated they would test their water either annually or at least every few years. Seventy-nine percent indicated that they would discuss what they learned through their participation in the clinic with others. Finally, 29% of respondents plan on grading the area around the well or performing maintenance on the well and 21% plan on seeking additional testing.

References

U.S. Environmental Protection Agency. Drinking Water Contaminants. http://www.epa.gov/safewater/contaminants/index.html. Accessed online 4/2011.

Virginia Cooperative Extension. Virginia PowerPoint Map. http://www.intra.ext.vt.edu/marketing/maps/powerpoint.html Accessed online 4/2011.

Virginia Department of Environmental Protection Groundwater Protection Steering Committee. Virginia’s Five Physiographic Provinces. http://www.deq.virginia.gov/gwpsc/geol.html Accessed online 4/2011.

Additional Resources

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

Acknowledgements

Many thanks to the residents of Montgomery County who participated in the Drinking Water Clinic.

The Water Quality Laboratory of the Department of Biological Systems Engineering and Soils Testing Laboratory of the Department of Crop and Soil Environmental Sciences at Virginia Tech were responsible for water quality analyses, as well as data management.

This document was prepared by Brian L. Benham, Associate Professor and Extension Specialist at Virginia Tech; Erin James Ling, Extension Water Quality Program Coordinator; Jen Pollard Scott, Research Assistant; Jessica Lutz, Environmental Research Specialist; and Barry Robinson, VCE Montgomery Office.

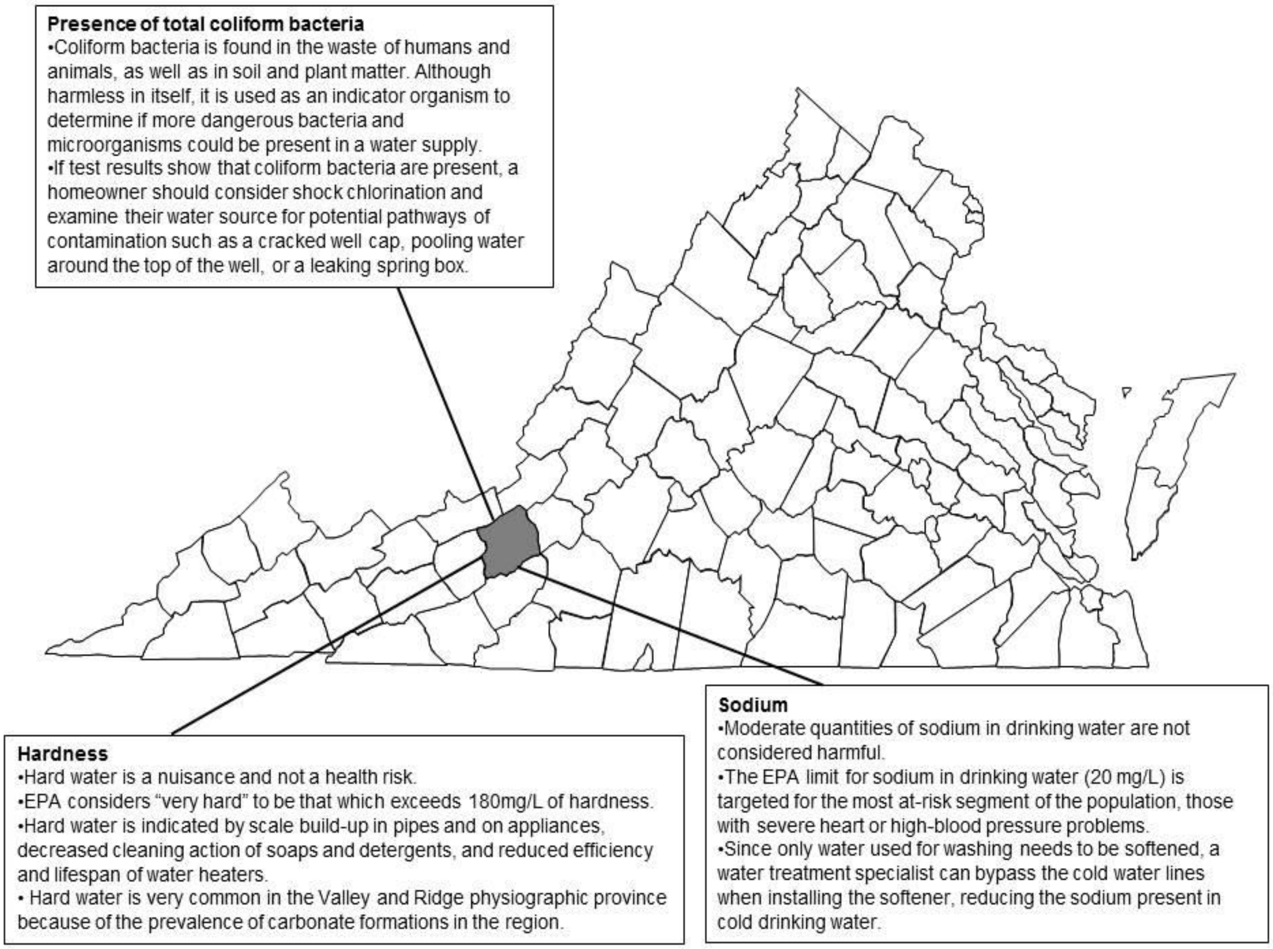

Figure 1. The most common household water quality issues found in the 20 Montgomery clinic participant samples were high levels of sodium and hardness, and the presence of total coliform bacteria.

2010 Montgomery County
VAHWQP Drinking Water Clinic Results
N = 20 samples

Test	EPA Standard	Average	Maximum Value	% Exceeding Standard
Iron (mg/L)	0.3	0.075	1.076	5
Manganese (mg/L)	0.05	0.020	0.342	5
Hardness (mg/L)	180	127.9	438.5	35
Sulfate (mg/L)	250	14.5	70.9	0
Chloride (mg/L)	250	3.0	14.0	0
Fluoride (mg/L)	2.0/4.0	0.14	0.31	0
Total Dissolved Solids	500	297	550	5
pH	6.5 to 8.5	7.09	7.72/6.16	5 (<6.5)
Copper (mg/L)	1.0/1.3	0.015	0.107	0
Sodium (mg/L)	20	48.08	155.82	40
Nitrate - N (mg/L)	10	0.826	4.265	0
Total Coliform Bacteria	ABSENT	--	--	25
E. coli Bacteria	ABSENT	--	--	10

Table 1. General water chemistry and bacteriological analysis contaminant levels for Montgomery County drinking water clinic participants (N=20). This program uses the EPA primary and secondary standards of the Safe Drinking Water Act, which are enforced for public systems, as guidelines for private water supplies.