Groundwater Testing in the Town of Charlotte

Jonathan Kim[1], Arthur Clark[2], and Taylor Smith[2]

[1] Vermont Geological Survey, 103 South Main St., Waterbury, VT 05671

[2] Dept. of Geology, Middlebury College, Middlebury, VT 05753

During the summer of 2009, the Vermont Geological Survey (VGS) worked with the Geology Department at Middlebury College to collect groundwater samples from 27 wells in the Town of Charlotte. These samples were analyzed for metals and non-metals at the Vermont Department of Environmental Conservation Laboratory in Waterbury. Groundwater sampling is usually part of VGS mapping projects.

Although the State of Vermont requires that public water supply wells are tested for many metals and compounds, private drinking water wells are not regulated. The Vermont Department of Health (VDH) has standards for many metals in drinking water although, for private wells, these are considered recommendations. In most cases, these VDH standards are based on those of the Environmental Protection Agency (EPA). EPA has two levels of drinking water standards that are designated primary for health and secondary ("nuisance") for taste, color, and odor (http://www.epa.gov/safewater/contaminants/index.html). Some VDH standards are stricter than those of the EPA (i.e. Uranium)

All of the wells sampled for this project were completed in bedrock. Figure 1 shows the locations of the 27 wells on the bedrock map. Water hardness is caused by dissolved calcium and magnesium compounds and directly reflects the composition of the bedrock (http://water.usgs.gov/owq/hardness-alkalinity.html). Charlotte has "very hard" water overall and this is a result of the abundant limestones and dolostones in the upper and lower plates of the Champlain Thrust. Since the Stony Point Shale is calcareous, wells completed within it tend to also have "hard" water (Figure 2). Hardness is responsible for rings that develop in bathtubs, sinks, and toilets.

Using the secondary standard for iron (300 parts per billion (ppb)), all except one of the wells with high iron are found in the lower plate of the Champlain Thrust (shales and carbonate rocks)(Figure 3). High iron levels cause rusty staining in bathtubs, sinks, and toilets. Elevated iron levels may be referred to as non-carbonate hardness. The source of the iron is likely sulfide minerals such as pyrite, which is particularly abundant in black shales.

All sampled wells are below the secondary standard for sulfate (SO_4)(Figure 4). A common source of sulfate is the weathering of pyrite. Elevated chloride levels (secondary standard) can result from the dissolution of road salt or contamination from septic systems; only one well tested in Charlotte had high chloride and it is next to a road.

Only two wells sampled in Charlotte exceed the secondary standard for Manganese (Figure 5).When excess Manganese is present, sooty black residues may form on surfaces exposed to groundwater. Manganese occurs naturally at some level in all rocks.

We tested groundwater for Fluoride (F), Arsenic (As), and Uranium (U). Although we did not find any elevated levels of Fluoride, the Vermont Dept. of Health (VDH) found that some wells in Charlotte and Ferrisburg had Fluoride levels exceeding primary and secondary standards (Figure 7). All of these wells were located in or near shales. Shales tend to have the highest levels of Fluoride of sedimentary rock types (e.g. Frencken, 1992). Long term consumption of water with Fluoride levels >2 can cause brown staining and pitting of teeth in children whereas levels > 4 ppm can result in bone disease (http://www.epa.gov/safewater/hfacts.html).

Only one well of the 27 tested above the Arsenic standard and another well exceeded the Uranium standard (Figures 8 and 9). Elevated Arsenic levels can be found in some sulfide minerals such as arsenopyrite, pyrite, galena, and sphalerite (e.g. Reiman and de Caritat, 1998); pyrite (and sometimes arsenopyrite) occurs in black shale. Uranium occurs naturally in trace minerals such as zircon, apatite, and monazite (Reiman and de Caritat, 1998) that are found in many types of rocks.

References:

EPA- Drinking Water Contaminants: http://www.epa.gov/safewater/contaminants/index.html

EPA-Fluoride: http://www.epa.gov/safewater/hfacts.html

Frencken, J.E.(editor), 1992, Endemic Fluorosis in developing countries, causes, effects and possible solutions, Publication number 91.082, NIPG-TNO, Leiden, The Netherlands.

Reimann, C. and de Caritat, P., 1998, Chemical Elements in the Environment, Springer-Verlag, New York, 398 p.

U.S. Geological Survey, Hardness: http://water.usgs.gov/owq/hardness-alkalinity.html

Figure 1- Base Map for Wells Sampled for Groundwater Chemistry

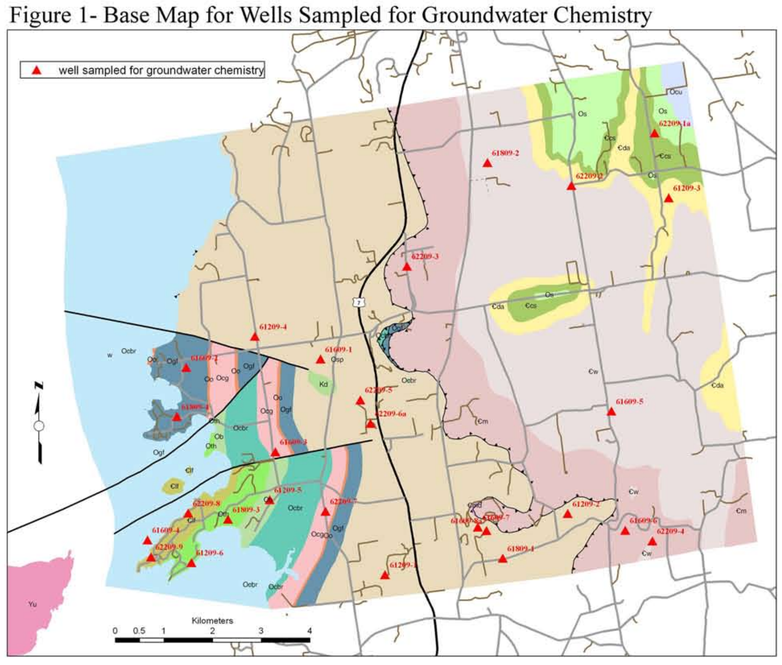


Figure 2- Scaled Levels of Carbonate Hardness in Charlotte Wells

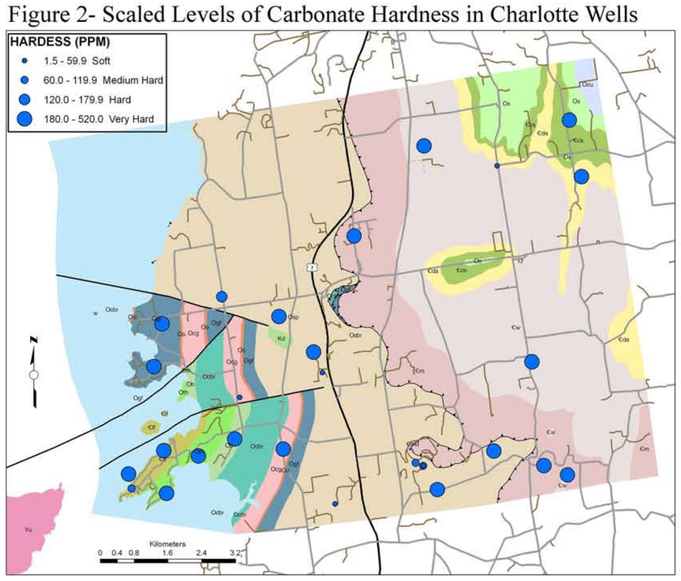
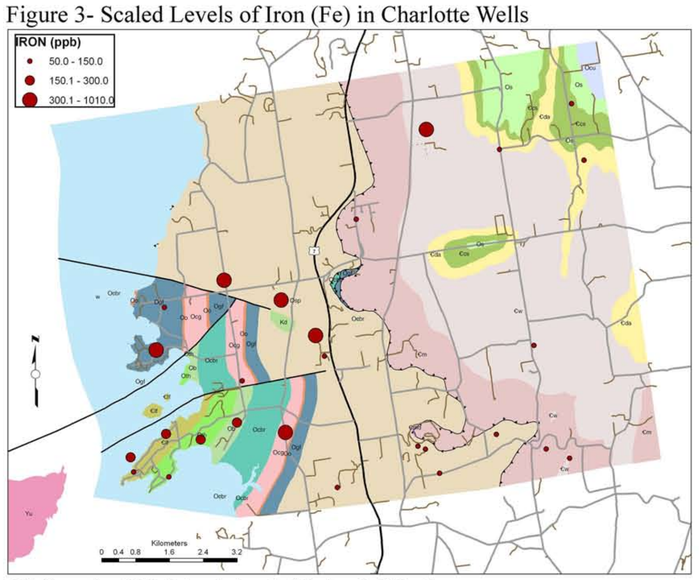
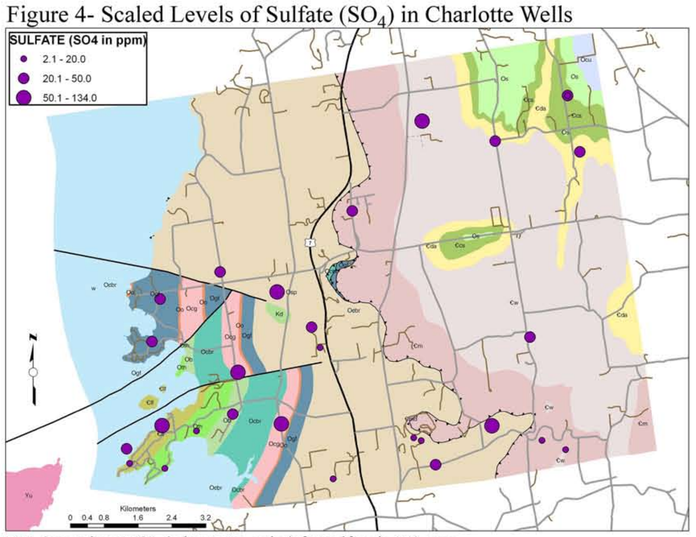


Figure 3- Scaled Levels of Iron (Fe) in Charlotte Wells



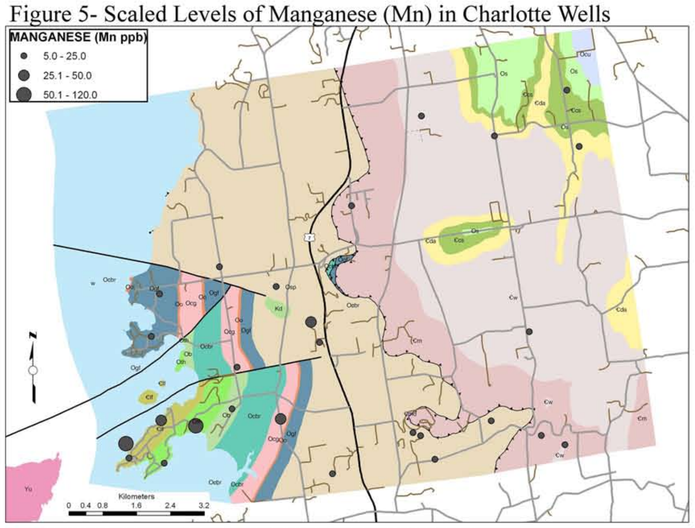
EPA Secondary MCL (odor, taste, color) for iron is 300 ppb.

Figure 4- Scaled Levels of Sulfate (SO_4) in Charlotte Wells



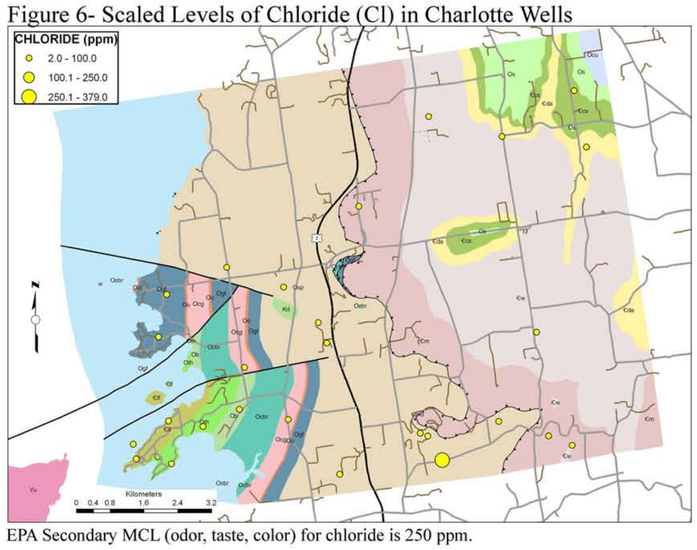
EPA Secondary MCL (odor, taste, color) for sulfate is 250 ppm.

Figure 5- Scaled Levels of Manganese (Mn) in Charlotte Wells



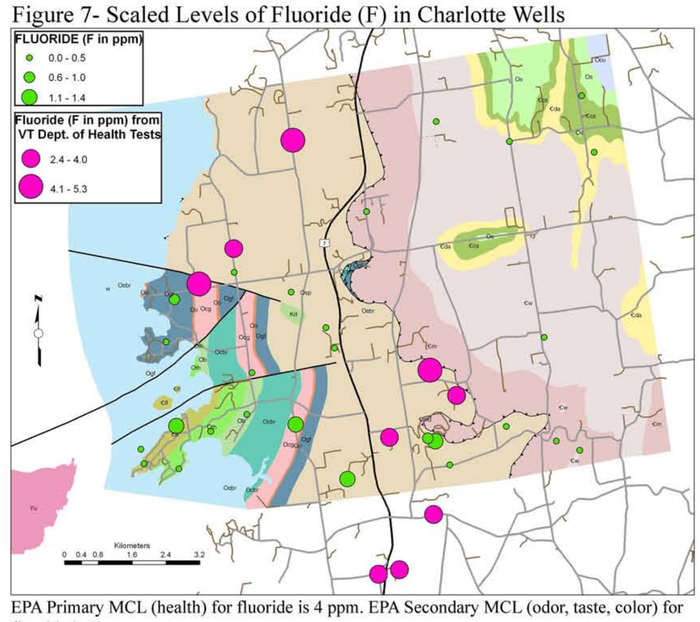
EPA Secondary MCL (odor, taste, color) for manganese is 50 ppb.

Figure 6- Scaled Levels of Chloride (Cl) in Charlotte Wells



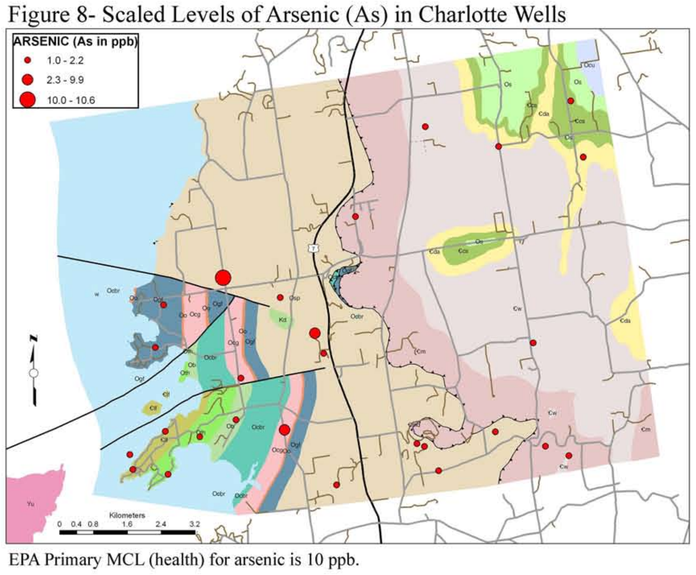
EPA Secondary MCL (odor, taste, color) for chloride is 250 ppm.

Figure 7- Scaled Levels of Fluoride (F) in Charlotte Wells



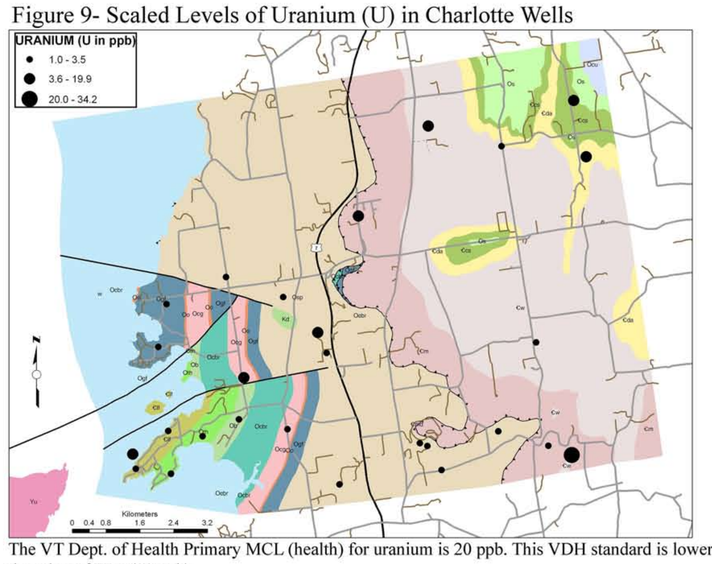
EPA Primary MCL (health) for fluoride is 4 ppm. EPA Secondary MCL (odor, taste, color) for fluoride is 2 ppm.

Figure 8- Scaled Levels of Arsenic (As) in Charlotte Wells



EPA Primary MCL (health) for arsenic is 10 ppb.

Figure 9- Scaled Levels of Uranium (U) in Charlotte Wells



The VT Dept. of Health Primary MCL (health) for uranium is 20 ppb. This VDH standard is lower than that of EPA (30 ppb).