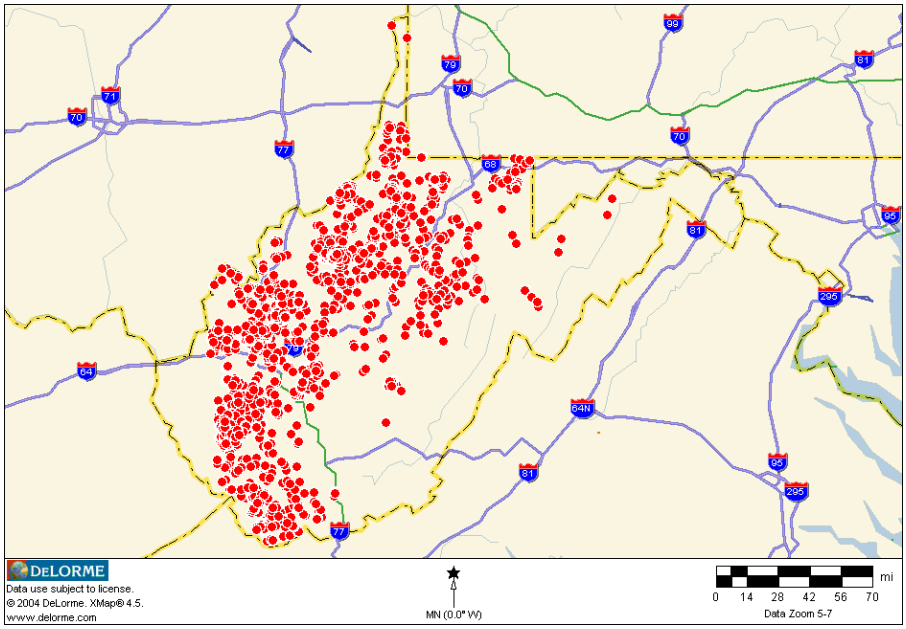
Source Water Protection and the Marcellus Shale

Lewis Baker, WVRWA Source Water Protection Specialist

The economy is booming, at least in regards to natural gas production. New methods of production have opened up vast new reserves, where gas is being extracted from shale rock by means of drilling thousands of feet down, and then *horizontally*, and then fracturing ("fracking") the productive horizons with millions of gallons of fluid. The biggest boom in natural gas in the USA has been occurring in the Marcellus Shale in Pennsylvania and New York, and it has begun in West Virginia.

The WV Geologic Survey has a database of over 2600 Marcellus wells permitted here, almost all of them since 2004. The top 10 counties with the most Marcellus well permits are Ritchie, Kanawha, Logan, Jackson, Putnam, Boone, Doddridge, Wetzel, Lincoln and Upshur. This is good news for local economies, tax bases, employment, etc.

According to the WVGS database, only about 3% of the 2600 Marcellus wells have been deviated horizontally so far, with the rest being more conventional vertical completions. The Marcellus wells with horizontal sections may use as much frack fluid as all the other 97% of the wells.



Marcellus wells permitted in WV. Nearly 2600 wells since 2004. WVG&ES Nov 3, 2009

Of course, every boom seems to have a downside. The large volumes of fracking fluids needed can mean small streams get sucked dry when used as sources of frack water, but worse is the potential for contamination of sources of drinking water. Fracking of the shales, generally thousands of feet underground, can on occasion lead to contamination of shallow fresh water zones of groundwater with the frack fluids or natural gas.

After the shale is fracked, millions of gallons of spent fluid may be brought back to the surface and held in large waste water ponds. Spills of this waste water can pollute surface streams, and show up at a public water intake before anyone can respond (as happened at West Union in Doddridge County, WV this summer).

So, what contaminants are contained in Marcellus Shale frack water that would be a problem when a spill happens? The fluids contain chemical additives, such as polysaccharides, that turn the fluid into a slimy gel. The actual mixture of additives, sometimes a long list of ingredients, are considered trade secrets, and were exempted from the federal Safe Drinking Water Act and the Clean Water Act during the Bush Administration. It is currently difficult to get this information unless a fracking company chooses to release it.

Besides the chemical additives, the millions of gallons of frack waste water at a drill site will include salt brine from the shale rock, sometimes making it even saltier than seawater. The brine will have high levels of chloride ions, as well as bromide and other ions. Bromides in source water will shift the mixture of disinfection by products (DBP) to the brominated forms in water supplies which use chlorine as a disinfectant, and lead to formation of bromate in water supplies which use ozone for disinfection.

Also, because a bromide ion is much heavier than a chloride ion, the amount of total trihalomethanes (TTHMs) created when disinfecting with chlorine will be increased significantly when bromides increase in the source water. The fact that bromide in source water is considered a DBP precursor has been reported in various research studies over the years, but is highlighted in recent research for water systems in the Pittsburgh area, posted on a PADEP website at http://www.depweb.state.pa.us/portal/server.pt/community/marcellus_shale_wastewater_partnership/18683.

The long title of the research report (Trihalomethane Speciation and the Relationship to Elevated Total Dissolved Solid Concentrations Affecting Drinking Water Quality at Systems Utilizing Monongahela River as a Primary Source During the 3rd and 4th Quarters of 2008) does not mention bromide, but TDS instead. Still, the report focused on bromides and is very interesting reading. It showed public water supplies in the Pittsburgh area had high TTHMs, mostly the brominated forms, in the fall of 2008.

In addition to THM precursors and unknown mixtures of additives, the frack wastes may contain some hydrocarbons from the shale, including benzene which has a drinking water MCL of only 5 parts per billion. Frack waste water has also been reported to contain radioactive elements, such as radium, thorium and uranium, in http://marcelluseffect.blogspot.com/2009/12/radioactivity-present-in-marcellus.html

Another good site online to read about the Marcellus Shale, with links to others can be found at: http://geology.com/usgs/marcellus-shale/. Here you will find a reprint of the USGS Factsheet 2009-3032, “Water Resources and Natural Gas Production from the Marcellus Shale”. The original factsheet contains the following picture of a Marcellus well location, showing the large number of frack tanks and other equipment hauled to the site.

Marcellus well location, with large number of frack tanks and other equipment hauled to the site.

New or revised laws, regulations and guidelines at the state and federal levels are being considered for natural gas production from the Marcellus and other shales in the US. They will be written to help prevent contamination of our water resources, but spills will still happen. For this reason, drilling of any new shale wells may be banned in certain watersheds. Chesapeake Energy, which owns the mineral rights to gas underneath the watersheds which are the source of New York City's drinking water supply, has decided to forgo any drilling there, before a threatened ban is imposed. Elsewhere, the drilling boom will proceed, subject to any new regulations.

Here in West Virginia, the WVDEP has just released a guidance document on permitting Marcellus wells. It mentions public water supplies only in regards to whether too much water may be withdrawn from a surface stream during low flow conditions. The guidance does not mention spills, spill prevention, notification of downstream water supplies before fracking starts or when a spill happens, or any potential water quality impacts to public supply source water. The guidance document is posted at http://www.dep.wv.gov/oil-and-gas/GI/Documents/Marcellus%20Guidance%201-8-10%20Final.pdf.

So, what are the best ways to detect Marcellus waste water spills that do happen, before they get to an intake? This question is being addressed by the Susquehanna River Basin Commission (SRBC), in Pennsylvania and New York. There, the SRBC has begun a program to install 30 monitoring stations throughout the Susquehanna watershed. Real time meters at each station will detect any increased conductivity in the source water, which would be a signature of a briny spill. The monitoring network will alert intakes downstream of any detected spills. The 30 monitoring stations are estimated to cost $750,000 to install and operate for the first year, and an oil and gas firm, East Resources, has offered to foot the bill. To find out more about the SRBC's proposed early warning system, go to http://www.srbc.net/programs/remotenetwork.htm.

There is also a more advanced early warning system already set up in southwestern Pennsylvania, which can monitor source water and detect many types of spills, including brine, and automatically alert intakes downstream. This regional source water protection early warning system, known as the River Alert Information Network (RAIN), has real time water quality data on its own website, at www.3rain.org. Data reported on this website comes from the public supply intakes serving the Pittsburgh region, as well as data from a number of in-stream monitoring stations.

The RAIN system operates in Pennsylvania's portions of the Monongahela, Allegheny, Youghiogheny, and Ohio Rivers' watersheds. Within the Monongahela basin in West Virginia, the US Geologic Survey has added 5 more real time monitoring stations.

Now that we have had a Marcellus brine spill that went unreported to the public water intake downstream (West Union), shouldn't we be looking for a way to fund a spill detection network for source water protection throughout West Virginia, modeled on the SRBC and RAIN projects?

One way to prioritize where to place conductivity meters in a WV early warning system would be to look at concentrations of Marcellus well permits by watersheds. By this method, the Guyandotte River Basin above Chapmanville would rate especially high. Another prioritization method would be to count how many Marcellus wells have been permitted within the "Zones of Critical Concern" (ZCC) delineated by the WV Bureau for Public Health. These ZCCs are the portion of a watershed above an intake within which a spill could reach the intake in five hours or less. By this count, the intakes which may be at the highest risk are on the upper Guyandotte: Chapmanville's ZCC contains 18 drill sites, Logan County PSD's ZCC has 21, and Gilbert's ZCC has 7 more.

In the central part of the state, the ZCC for West Union contains 2 Marcellus drill sites, including the one which had a spill in 2009. Statewide there are over 2 dozen public supply intakes which have Marcellus wells permitted within their ZCCs. There are more intakes which have Marcellus wells located within their watersheds, but above their ZCCs. The number of wells within a watershed, but above a ZCC can be fairly high. For example, West Union has 2 wells within the five hour ZCC, and 47 wells within the watershed, most of them within 12 hours travel time for a frack water spill to reach its intake.

I suggest our surface water systems get their own conductivity probes, if they haven't already done so, and as soon as possible set up a real time monitor in their raw water intake, with an alarm. The WV Bureau for Public Health is considering providing Source Water Protection grants to public supplies that install these monitors. We should also support efforts to obtain funding for an early warning system for spill detection in West Virginia's various watersheds, like on the Susquehanna River and in the RAIN watersheds in southwestern Pennsylvania.

Another suggestion for something water systems can start doing now, is to add routine sampling of the raw water for chloride and bromide, perhaps once a month. These would be fairly inexpensive, and help provide more detailed baseline data than just adding real-time conductivity. If bromide begins to exceed just 0.2 ppm in the raw water (probably when chloride is 20 to 40 ppm), then brominated forms of THMs may begin to increase. A brine spill, even after much dilution, can certainly have an impact because brines can contain over 30,000 ppm chlorides.