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# Marcellus Shale Development and Drinking Water - Potential Risks and Selecting a Water Testing Laboratory for Well and Spring Water

Water is a valuable resource. Many homeowners are concerned about natural gas development associated with the Marcellus shale formation and their private water supply. This informational sheet is designed to provide citizens with private water supplies an understanding of potential water quality impacts, pertinent water testing parameters, general water quantity and quality monitoring procedures, and laboratory resources related to natural gas development.

**Potential Water Quality Impacts from Drilling**

A single gas well can produce hundreds of thousands of gallons of waste fluids during drilling and during years of gas production. These waste fluids can be classified into several categories including:

• Top hole fluids are from the fresh water aquifers that are encountered usually within the first few hundred feet of the drilling process.

• Bottom hole fluids are very old salt water deposits encountered deep underground during drilling below the fresh water aquifers. These fluids are commonly referred to as “brines.”

• Stimulation fluids are used to improve gas recovery from shale and are returned to the ground surface during the “hydrofracturing” process. Large amounts of water, along with various other materials, such as sand, oils, gels, acids, alcohols and various man-made organic chemicals are used in stimulation fluids. Upon returning to the surface these fluids are called flow back fluids. About 15% of water injected into Marcellus wells is captured as flow back [c]. Although this is only a percentage of the fluids injected to fracture a well it represents a significant volume of water.

• Production fluids are produced along with the natural gas after the well is in production. Production fluids usually have a similar chemistry to the bottom hole fluids.

The volume of fluids produced during gas well drilling and operation can vary considerably

depending on the depth and location of the gas well. Drilling of deeper gas wells in the Marcellus formation relies more on hydrofracturing which requires several million gallons of freshwater. On average, about 15% of the water used for hydrofracturing Marcellus wells returns to the ground surface as a "flow back" waste fluid [d]. Flow back fluids are captured for reuse, treated and released, or sent to deep injection wells for disposal. Additional production fluid will continue to flow from the well, along with natural gas, during the wells' production life.

While top hole fluid is usually representative of groundwater used for local water wells and springs, the remaining water encountered during gas well drilling (bottom hole, stimulation and production fluids) will likely be contaminated with various man made and naturally occurring pollutants.

**Groundwater Pollutants from Gas Wells**

Groundwater contamination may occur from absent or corroded gas well casings (on older or abandoned gas wells) or it may originate from flooded or leaking waste fluid holding pits or spills at the drilling site.

Gas well waste fluids usually contain levels of some pollutants that are far above levels considered safe for drinking water supplies. As a result, even small amounts of pollution from waste fluids can result in significant impacts to nearby drinking water supplies. The broad categories of pollutants in gas drilling waste fluids include:

• **Salts**—most notably sodium and chloride. Gas well waste fluids can have over 100,000 mg/L of these compounds. This is highly saline as seawater contains only 35,000 mg/L salts. Other pollutants that can occur as various salts include magnesium, calcium and potassium. These salts cause a high level of "total dissolved solids" or TDS.

• **Metals**—including iron, manganese, barium, arsenic and trace amounts of other heavy metals.

• **Organics**—these include both natural and man-made materials that are used during the drilling process such surfactants, detergents, oil, grease, benzene and toluene. Dozens of other man-made organics may be used in small concentrations during hydrofracturing.

Another problem that can occur from gas well drilling is methane gas migration from gas wells into nearby water wells. The methane gas will rapidly escape from the groundwater and may pose an explosion hazard in confined spaces. Methane gas testing in water is difficult but it usually creates obvious symptoms in the home including effervescence and spurting faucets due to gas build-up.

**Homeowner Strategies to Protect Water Supplies**

**Establishing Water Quality**

In September of 2012 the United States Government Accountability Office issued a report based on research conducted, among others, by the Groundwater Protection Council, Duke University, and the Center for Rural Pennsylvania [d]. None of these reports indicate hydraulic fracturing fluids have contaminated groundwater from the hydrofracturing process. However, in 2009 and 2010 were two known cases of gas well casing degradation leading to methane migration in multiple drinking water wells in Pennsylvania [a].

Given issues with methane migration and the possibility hydraulic fracturing fluids could impact ground water, periodic maintenance and testing of private water supplies is a worthwhile endeavor. To differentiate water contamination levels between pre and post gas drilling, water testing needs to occur both before and after drilling. It may be

helpful to consider these three tiers of water quality testing:

• **Tier 1**— focus on parameters that are most likely to change if gas drilling affects groundwater to provide some legal protection at a minimal cost (typically $200 to $300). Tests might include total dissolved solids (TDS), pH, barium, chloride, iron, manganese, and methane/ethane.

• **Tier 2**— includes all of the tests in Tier 1 along with additional common pollutants to increase legal protection at a moderate cost (typically $400 to $600). Tests in addition to Tier 1 might include total suspended solids, hardness (calcium & magnesium), bromide, selenium, sodium, potassium, total organic carbon, strontium, oil & grease, surfactants (MBAS), lead, arsenic, alkalinity, coliform bacteria, sulfate and nitrate.

• **Tier 3**– includes all of the tests in Tiers 1 and 2 along with some more costly parameters to maximize legal protection (likely $800 or more) including various volatile organic compounds called VOC's (especially benzene, toluene, ethylbenzene and xylene), total petroleum hydrocarbons (TPH), uranium, radium, gross alpha, gross beta and radon.

**Establishing Water Quantity**

Diminished or lost water supplies resulting from gas well drilling has occurred but is rare. When this does occur, it is usually an obvious, complete loss of water rather than a subtle decrease in water yield. Well and spring owners who wish to document water supply conditions before and after gas well activities would need to hire a professional water well contractor or hydrogeologist to independently measure and document these conditions. You can find a list of local water well contractors certified by the National Ground Water Association (NGWA) at http://wellowner.org (Click "Find a Contractor"). Cost for this service, at the base level, will be about $400. However, higher level tests can cost $1,000.

**Monitoring Your Own Water**

In addition to water samples analyzed by labs, some water supply owners are interested in methods to continuously monitor their water quality. Inexpensive total dissolved solids (TDS) or conductivity meters can be purchased from many online suppliers for $50 to $100. These meters allow the water supply owner to quickly and easily measure the total amount of dissolved contaminants in their water. Large increases in the TDS or conductivity in conjunction with nearby gas drilling activity would warrant follow-up testing by a state accredited water lab.

***Test results from water samples collected and/or tested by the homeowner are generally not recognized in legal proceedings because they are not independent and not professionally collected. As a result, samples collected and submitted by homeowners should be utilized only for educational monitoring purposes.***

**Laboratory Testing of Well Water**

*Photography Credit: P. Phung*

**Selecting a Private Water Testing Laboratory**

Drinking water laboratories are certified with the Maryland Department of the Environment. The entire list of certified laboratories is updated twice yearly and is available online at http://www.mde.state.md.us or at this direct link. At any given time there may be one hundred or more certified laboratories. However, many lack certification to test private drinking water supplies in parameters associated with natural gas development. The table below is designed to guide those interested in testing drinking water in parameters associated with natural gas development.

| Laboratory | Website | Phone Number | County/ State ** | Tests and Pricing Options *** |
|---|---|---|---|---|
| Geochemical Testing | http://www.geo-ces.com | (814) 443-1671 | PA | Tier 1: $152<br>Can include hardness (calcium & magnesium), aluminum, dissolved iron, and bacteria for $27.45.<br>Total Package: $180 |
| Microbac Inc. (Central PA Division) | http://www.microbac.com | (717) 763-0582 | PA | Tier 1: $215<br>Tier 2: $600<br>Tier 3: $1,120 |
| Mountain Research, LLC | http://www.mountainresearch.com | 814-949-2034 | PA | Tier 1: $180<br>Tier 2: $542<br>Tier 3: $1,238 |
| QC Laboratories | http://www.qclaboratories.com | (215) 355-3900 | PA | Tier 1: $141<br>Also performs most tier 2 and 3 tests, including most radiologicals |
| Reliance Laboratories Inc. | www.reliancelabs.net | (304) 596-2084 | WV | Tier 1: $184<br>Tier 2: $398<br>Tier 3: $793 |
| Trace Laboratories | http://tracelabs.com | (410)584-9099 | MD | Tier 1: $235<br>Tier 2: $715<br>Tier 3: $1,415 |

## Certified Drinking Water Quality

## Laboratories *

* Listing in this table is not an endorsement by the University of Maryland. Any additions or corrections to this document should be reported to the University of Maryland Extension. Certification dates are as of July 2012. For a current list of all certified drinking water laboratories visit http://www.mde.state.md.us or use this direct link

** Some laboratory companies operate out of several offices. Listed here are those most likely to deal with water testing associated with natural gas development.

*** Pricing and available testing may change. To find exact and current tests available please contact water testing laboratories. Costs listed do not include water collection fees. These fees range from approximately $40 - $75 per hour.

*This publication adapted material from the following publications:*

a Environmental Impacts Durring Marcellus Shale Gas Drilling: Causes, Impacts, and Remedies, Consodine, T., Watson, R., Consodine, N., Martin, J. Shale Resource and Society Institute, June 2012, all rights reserved

b Gas Well Drilling and Your Private Water Supply by Swistock, B., Rizzo D. Pennsylvania Cooperative Extension, Published July 2012, all rights reserved.

c Natural Gas Well Development in the Susquehenna River Basin, Susquehanna River Basin Commission Information Sheet, January 2010, all rights reserved.

d Oil and Gas: Information on Shale Resources, Development, and Environmental and Public Health Risks, Rusco, F.Kehr, C., Carroll L., Chaudhary, N. Cilbert, C., O'Niel, A., Revesz, W., Royer, D., Spaan, J., Theodoropoulos, K., Timmerman, B., United States Government Accountability Office, September 2012, all rights reserved

e The Impact of Marcellus Gas Driling on Rural Drinking Water Supplies, Elizabeth W. Boyer, Ph.D., Bryan R. Swistock, M.S., James Clark, M.A., Mark Madden, B.S., and Dana E. Rizzo, M.S. The Center for Rural Pennsylvania, Published March 2012, all rights reserved

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This publication, Marcellus Shale Development and Drinking - Potential Risks and Selecting a Water Testing Laboratory for Well and Spring Water (FS-949), is a series of publications of the University of Maryland Extension. The information presented has met UME peer review standards, including internal and external technical review. Please visit http://extension.umd.edu/ to find out more about Extension programs in Maryland.