Communication of Methane Analysis Results and Mitigation Information to Private Well Owners in Ohio

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Issues

- Public concerns related to possible ground water quality impacts from shale gas development
- Lack of information by private well owners on their current ground water quality
- Lack of understanding by private well owners on what their pre-drilling sampling results mean and what actions they should take
- Local health districts/Cooperative Extension offices – often contacted for recommendations in counties with early drilling
Actions

- State agency workgroup identified the need for consistent recommendations for pre-drilling sampling of both private and public water systems – development of joint agency fact sheet
- Need for tools and information that well owners can use to understand their well water quality and implications for public health – Water Quality Interpretation Tool proposal
- Water quality issue of frequent presence of stray gas in private water wells – development of methane mitigation guidance, training and fact sheet
Pre-drilling Sampling Fact sheet information is for...

• Well owners that are concerned about impacts to their water wells from shale gas development
• Local health districts in areas of shale gas development
• Intended to apply to all types of oil and gas drilling
Sampling Prior to Drilling

- Oil/gas development companies may voluntarily collect water samples prior to drilling in rural areas.
- ODNR rules requirements for pre-drilling water sampling.
- Homeowners may voluntarily have their own well sampled or negotiate pre-sampling as part of a lease agreement.
Information to collect prior to sampling

- Well log record
  - Total depth of well
  - Type of aquifer
  - Historical static water level
  - Reported well yield
Conduct Research on Lab Services

• Sampling may be conducted by:
  – Ohio EPA certified labs
  – Local health districts
  – Home inspection services
  – Consultants and other water professionals

• Well owners should research the services offered by sample collectors and related costs!!
Water Sampling and Analysis Procedures

- **Proper sampling protocols are critical to ensure results are of value**
  - Collection of water sample prior to any treatment devices (water softener, disinfection) near the point of entry into the home
  - Collect a representative sample by flushing the system at least 5-10 minutes to ensure water collected is coming from the aquifer and not water stored in the well bore
  - Proper documentation of sample location, date/time, site ID information
  - Collection of water in proper containers for analysis method and use of preservatives
  - On-site measurements of pH and conductivity may be collected

- **Sampling protocol fact sheet/training development is in progress**

- Samples must be submitted to a certified laboratory and analyzed using standard methods
  - Ohio EPA certification
  - Ohio EPA voluntary certification
  - NELAP –National Environmental Laboratory Accreditation Program
Water Sampling Parameters

- Recommended parameter sets for water sampling are grouped in order of importance:
  - Tier 1 – lowest cost, most critical parameters
  - Tier 2 – moderate cost
  - Tier 3 – most comprehensive list
**Recommended Water Quality Sampling Parameters**

<table>
<thead>
<tr>
<th>Tier 1 Parameters</th>
<th>Tier 2 Parameters</th>
<th>Tier 3 Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barium</td>
<td>Tier 1 sample parameters + Calcium</td>
<td>Tier 1 and 2 sample parameters + BTEX (benzene, toluene, xylene, ethylbenzene)</td>
</tr>
<tr>
<td>Chloride</td>
<td>Hardness</td>
<td>Methane (dissolved)*</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Total Alkalinity</td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td>pH</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>Iron</td>
<td></td>
</tr>
<tr>
<td>Strontium</td>
<td>Manganese</td>
<td></td>
</tr>
<tr>
<td>Sulfate</td>
<td>Total suspended solids</td>
<td></td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td>Specific Conductivity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bromide</td>
<td></td>
</tr>
</tbody>
</table>

*Include with Tier 1 if laboratory can analyze for methane.

*Analysis for methane is recommended for all samples.*
Water Sampling Parameters

• Recommendations are also included to assess the overall health of a water well by analyzing for nitrate, arsenic and Escherichia coli (E. coli) bacteria as these are the most common contaminants of concern in ground water.
Water Sample Results

• Ideally, two or three samples should be collected in different calendar seasons to establish the normal variability in ground water quality over time due to rainfall and other factors.

• Ground water quality can vary over time and the seasons, and is influenced by the type of geologic materials the ground water is moving through, natural replenishment from rainfall and flooding (recharge), and chemicals used or applied on the ground that are transported by recharge moving to the ground water.

• Water samples are a snapshot in time of the water quality in a well.
Health Based Standards

- Public water systems – Federal National Drinking Water Primary and Secondary Standards
- Private water systems – health based standards are the same as the federal primary and secondary drinking water standards
# Health Based Standards

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Primary Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barium</td>
<td>2 mg/l</td>
</tr>
<tr>
<td>Chloride</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td></td>
</tr>
<tr>
<td>Strontium</td>
<td></td>
</tr>
<tr>
<td>Sulfate</td>
<td>250 mg/l</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>500 mg/l</td>
</tr>
<tr>
<td>Iron</td>
<td>0.3 mg/l</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.05 mg/l</td>
</tr>
<tr>
<td>Bromide</td>
<td></td>
</tr>
<tr>
<td>Methane (dissolved)</td>
<td>10 mg/l*</td>
</tr>
<tr>
<td>Benzene</td>
<td>0.001 mg/l</td>
</tr>
<tr>
<td>Toluene</td>
<td>1 mg/l</td>
</tr>
<tr>
<td>Xylenes (total)</td>
<td>10 mg/l</td>
</tr>
</tbody>
</table>

* No Standard or state standard

For X: X indicates that there is no standard or state standard.
Interpretation of sampling results

• Homeowners typically do not understand their pre-drilling sampling results
• Are the water quality results normal, high or low?
• How will the water quality affect my health or the health of my family and our safety?
Water Quality Interpretation Tool

- Proposal submitted by the Ohio State University Cooperative Extension, Ohio Department of Health and Ohio EPA to develop an on-line water quality interpretation tool and companion guidance for well owners
- Modeled after the Pennsylvania on-line tool using Ohio standards
- Information on health effects
This webpage provides interpretation of water test results you have received from a water testing laboratory. Simply enter your results into the boxes below and click “Submit” at the bottom of the page to get an interpretation of your results. If you are visiting this site and have not had your water tested, you should arrange to have your water tested through a state certified water testing laboratory. A list of certified labs is available from your local Penn State Cooperative Extension office or online at http://water.epa.gov/grantd/grant_d.htm. For a list of recommended water tests and testing strategies, consult our water testing fact sheet. For more information on each of the contaminants listed here, consult the U.S. Environmental Protection Agency Safe Drinking Water web site.

- Enter numerical values - ONLY ENTER NUMBERS - DO NOT ENTER LETTERS.
  - If you do not have a value for a particular parameter, leave the space blank.
  - If you have a result larger than 999 do not enter commas.
  - If your water test results contain either ND (not detected) or BD (below detection) enter a zero in the form for that chemical parameter.
  - If your microbial test results are reported as either P (present) or A (absent), enter a zero for A and 10 for P. If you only received presence/absence bacteria results, you might want to consider asking the water testing laboratory to provide you with numerical results in the future. Numerical results provide important data on the severity and possible causes of bacterial contamination.

- NOTE: Results reported in ppm units are equal to mg/L units; Standards in mg/L can be converted to µg/L units by multiplying by 1,000.

### Enter Microbial Results (All are Primary Standards)
- Total Coliform Bacteria (bacteria per 100 ml)
- Fecal Coliform Bacteria (bacteria per 100 ml)
- E.Coli (bacteria per 100 ml)
- Giardia lamblia (oocysts)
- Cryptosporidium parvum (oocysts)

### Enter Volatile Organic Chemicals (All are Health-related Standards)
- Benzene (µg/L)
- Carbon Tetrachloride (µg/L)
- MTBE (Methyl Tert-Butyl Ether) (µg/L)
- Styrene (µg/L)
- Tetrachloroethylene (PCE) (µg/L)
- Toxline (µg/L)
- Trichloroethene (TCE) (µg/L)
- Total Trihalomethanes (µg/L)
- Vinyl Chloride (µg/L)
- Xylenes (Total) (µg/L)

### Enter Inorganic Chemicals with Health Standards
- Arsenic (µg/L)
- Barium (µg/L)
- Cadmium (µg/L)
The results of the values you entered are listed below. **(Perform new analysis)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Water test value entered</th>
<th>Does sample meet safe drinking water standards?</th>
<th>Drinking Water Standard</th>
<th>For more information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>20</td>
<td>NO, value exceeds standards</td>
<td>0.01 (mg/L)</td>
<td>Removal of Arsenic from Well in Pennsylvania</td>
</tr>
</tbody>
</table>

Arsenic occurs in groundwater from both natural sources and human activities. In drinking water, it is odorless and tasteless. In Pennsylvania, arsenic can originate naturally from certain types of rock, or it may be traced to deep-water brines produced from gas and oil well drilling or from industrial activity. Arsenic causes skin lesions, circulatory problems, nervous system disorders and cancer. Arsenic can be removed using reverse osmosis and certain types of ion exchange treatment units.
Methane Guidance and Training

- Development of guidance for local health district sanitarians, private water systems contractors and well owners to implement state water quality action standards
- Implementation of training through partnership with the Ohio Water Well Association
- Development of simple fact sheets for well owners
Methane Standards for Private Water Systems

- Ohio Administrative Code Chapter 3701-28-10 (O) requires that wells that produce methane greater than 10 mg/l shall be vented to the atmosphere to prevent explosive conditions and minimize human health exposures.
- Based on action levels recommended by Office of Surface Mining Reclamation and Enforcement (2001).
- No current standard for free gas detections.
Methane Standards for Private Water Systems

- Private water system must be vented using one of the following:
  - Vented cap extended to height to prevent combustion from normal household activities
  - Use of gas shroud sealed to the top of a submersible pump
  - Use of whole house aeration system
  - Wells located in basements or other similar structures must be vented to the outside with specifications for venting
Methane Guidance

• What is methane?
• Where does methane come from?
• Phases of methane in ground water – free gas or dissolved
• Symptoms of methane in water supply – spitting, fizzing, bubbling, cloudy water, increased turbidity
Methane Guidance

• Methane is a safety hazard – explosive limits in confined areas and asphyxiation

• Discussion of methane levels that create a safety hazard:
  • LEL – lower explosive limit – 51,000 mg/l or 5.1% volume by air up to 15%
  • Asphyxiant when it replaces oxygen in an enclosed area at a concentration of over 50% in air
Methane Guidance

Proposed action levels for detections of methane gas in homes:

<table>
<thead>
<tr>
<th>Action Level</th>
<th>Atmospheric</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Occupiable Space</td>
</tr>
<tr>
<td>Immediate Action – active venting/treatment</td>
<td>&gt;1%</td>
</tr>
<tr>
<td></td>
<td>Unoccupiable spaces</td>
</tr>
<tr>
<td></td>
<td>&gt;3%</td>
</tr>
<tr>
<td>Warning – investigate/vent</td>
<td>&gt;0.5% to &lt;1%</td>
</tr>
<tr>
<td></td>
<td>&gt;1% to &lt;3%</td>
</tr>
<tr>
<td>Monitor for trends</td>
<td>&gt;0.25% to &lt;0.5%</td>
</tr>
<tr>
<td>No immediate action</td>
<td>&lt;0.25%</td>
</tr>
<tr>
<td></td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

Based on OSMRE (2004)
Methane Guidance

• How is methane detected in homes?
  – by either collecting a sample of the water and analyzing for dissolved methane at a qualified laboratory,
  – or by using a gas detector to determine the percentage or mg/l (volume) of methane in the air within a confined structure when water is running, at the well vent, or the headspace of the well when the cap has been removed.
Methane Guidance

- What types of equipment are used to detect natural gas?
  - Mobile hand held detection meters
  - Wall mounted detections systems for homes
- What areas should be checked for natural gas?
  - Area around the well casing and cap – both prior to, during and after pumping
  - All rooms in the home and in the area housing the any water systems equipment
Methane Guidance

• Who can be contacted to have a water well checked for methane?
  • Fire departments that have gas detection meters
  • Private labs for collection of water samples
• Methods for water quality analysis for dissolved methane
  • Standard Method 6211
  • EPA 3810, RSK 175
Methane Guidance

• How are water samples reported?
  • As mg/l dissolved methane
  • Maximum concentration of methane dissolved in water at standard atmospheric pressure at 68 degrees F is 28 mg/l
  • Dissolved methane levels may be higher when water is pumped from deeper aquifers under higher pressure conditions (up to 130 mg/l)
Methane Guidance

• How are methane concentrations reported in air?
  • Percentage of air by volume or milligrams of methane per liter of air
  • Relationship between dissolved methane levels and percentages of methane in air
  • Explosive hazard will vary with the volume of space, the volume of water pumped and the ventilation of the space
Methane Mitigation – Key Issues

• Occurrence and concentration of methane will likely vary with time and seasonal changes in ground water levels
• More than one sample should be collected to determine the range in dissolved methane or free gas concentrations to adequately size venting or treatment
• At lower levels, simple venting methods may be tried with progression to more complex venting or treatment as necessary
Methane Mitigation

• Ohio rules require a permit from the local health district to install water quality treatment equipment (for contaminants) or alter a private water system
• Installation must be performed by a registered private water systems contractor
• A follow up inspection and water sample will be collected by the local health district after installation of venting equipment
Methane Mitigation – Low Levels < 2 mg/l

1. Passive venting –
   - Passive venting through a vented well cap may work to reduce methane levels where no prior venting has been installed.
   - The vent diameter may be no less than one inch in diameter, and the vent opening must be screened and extend to a height to prevent combustion from normal activities around the home (lighting grills and cigarettes).
   - Wells with buried seals should be extended above grade, wells located in basements or basement offsets should be vented outside.
   - Wells located in well pits should be extended above grade or at least have vents extended above the well pit cover.
Methane Mitigation – Low Levels < 2 mg/l

2. Retention tank for warming the water –
   - Ground water in Ohio has an average temperature of 51-52 degrees Fahrenheit, and methane vents slowly from colder water.
   - A 120 gallon retention tank in a basement or other area that reaches normal room temperatures can be used to warm the water and improve the rate of ventilation of methane.
   - The retention tank must be vented to the outside air with a vent diameter of no less than one inch, and the vent opening must be screened and extend to a height to prevent combustion from normal activities around the home (lighting grills and cigarettes).
3. **Installation of a gas shroud** –

- A gas shroud installed over a submersible pump will primarily reduce pump locking issues - may also reduce or eliminate methane or other gas problems.
- Gas shrounds may not be reliable due to cold temperatures of ground water in Ohio.
- A PVC pipe or a piece of casing is installed from the top of the submersible pump motor, 10 or more feet above the pump.
- The shroud is sealed at the top of the submersible pump motor below the pump intake. The top of the shroud is open and set below the pumping water level.
- As methane rises through the water column in the well, some of the dissolved methane bypasses the pump intake, reducing the amount of methane in the water that is drawn into the home.
- This method works primarily on 6-inch or larger diameter wells with standard well pumps, and wells that pump relatively small quantities of water at one time.
Methane Mitigation – Moderate to High Levels > 2 mg/l

- A spray aeration system is the most reliable way to eliminate methane but it is also the most expensive option.
- A spray aeration system must be installed and maintained in a warmer environment at >45 degrees Fahrenheit.
- The water temperature must be above 58 degrees to gain complete dissolved methane removal using aeration methods.

Source: Alberta Agriculture and Rural Development, Dissolved Gases in Well Water
Methane Mitigation – Moderate to High Levels > 2 mg/l

- Spray aeration systems spray the water in a fine mist using a spray bar or nozzle inside an enclosed tank.
- The methane gas separates from the water during the spray process and is vented via a vent pipe with screen and flap valve to the atmosphere to an elevation above the roof of the house or building.
- The aeration system can be installed prior to the pressure tank or after the pressure tank and the system is repressurized by another pump to provide adequate water pressure in the home. A check valve is required after the pressure tank.
- The aeration process may also oxidize out some dissolved constituents such as iron or sulfur that will precipitate particles that may require filtration. In some cases, additional continuous disinfection may be needed since there can be additional bacteria growth due to atmospheric mixing of the water.
Other Possible Remediation Steps

- Use well log information or a down-hole camera survey (with pumping) to determine where methane is entering the well if possible
  - If the methane is from a lower geologic formation, seal the well back past the methane producing zone using neat cement or concrete
  - If methane is produced from a shallow geologic formation, install additional casing past the producing zone if possible and grout the casing using neat cement or concrete
Private Water Systems Contractor Training

• ODH is partnering with the Ohio Water Well Association to develop training for local health district sanitarians and well contractors
  – Guidance document information
  – Methane mitigation options
  – Installation procedures and follow up inspections/sampling
• Regional training scheduled for this fall with initial focus on eastern Ohio
Well Owner Fact Sheets

- Develop series of well owner fact sheets on:
  - Methane occurrence as a stray gas
  - Detection and sampling methods
  - Action levels and venting requirements
  - Mitigation methods and working with a private water systems contractor
Well Owner Outreach

- Use of web and social media
- Dissemination of information through local health districts and private water systems contractors
- Partner with OSU Cooperative Extension and develop well owner training and outreach
Contact Information

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Resources

- ODNR, Division of Oil and Gas Resources Urban Drilling well sampling requirements
- Recommended sampling parameters – Mahoning and Columbiana County
- Other state recommendations – Pennsylvania, New York, West Virginia
- Published literature
- US Geological Survey
- Industry voluntary sampling list