# Marcellus Shale Environmental Issues

Ken Bird, C.I.H.
Cummings/Riter Consultants, Inc.

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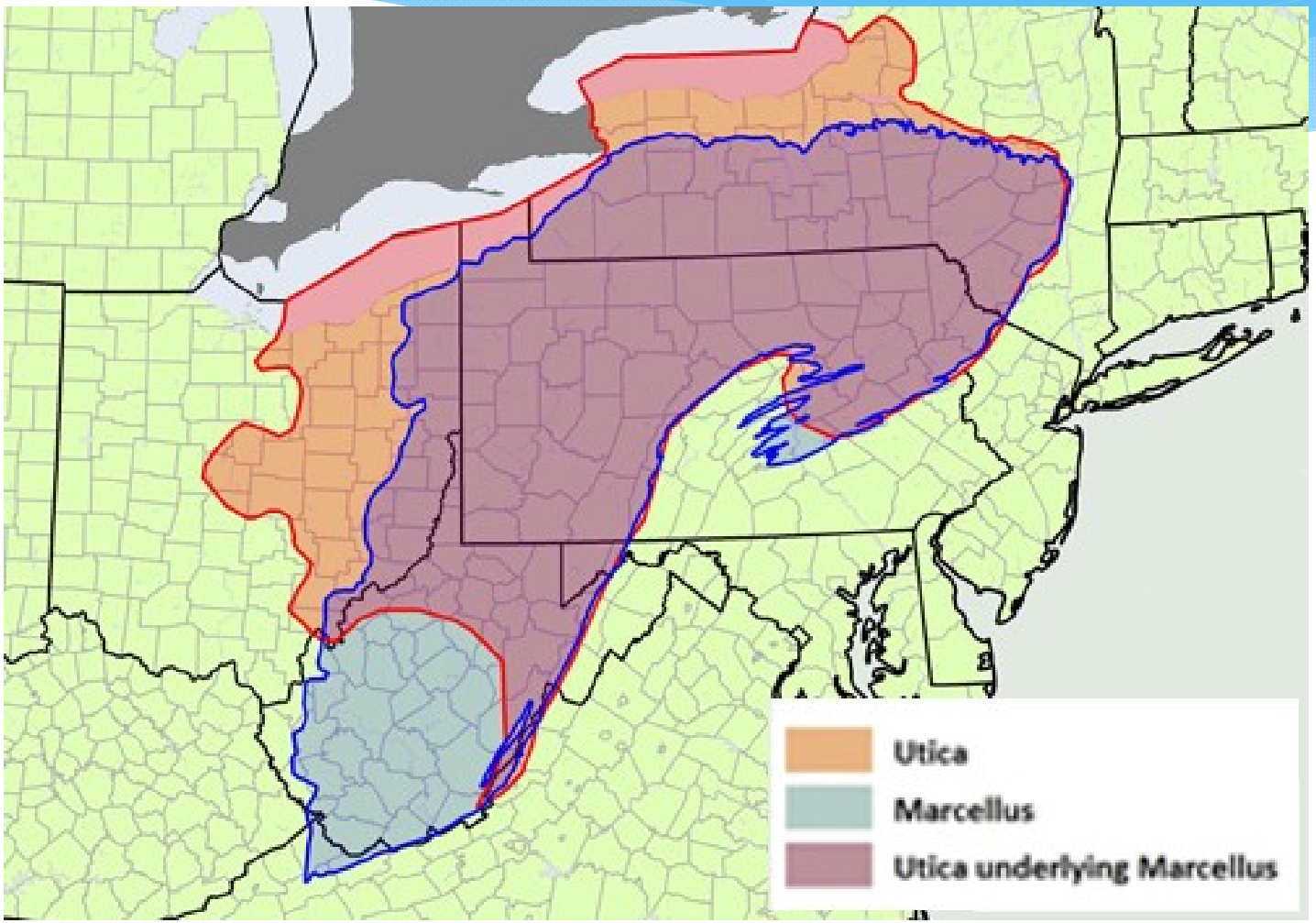
# Marcellus Shale Environmental Issues Overview

- Shale Layer - 4,000 to 9,000 Feet Below Ground Surface
- 50 to 250 Feet Thick
- Primary States - Ohio, Pennsylvania, New York, and West Virginia

# Utica - Marcellus Shale Basins



# Marcellus Shale Environmental Issues

- Air
- Solid Waste
- Water
- Roads and Traffic

# Marcellus Shale Environmental Issues
# Air

- Gas Processing
- Compressors
- Fugitive Emissions
  - Road
  - Compressor stations
- Temporary Sources - Flares

# Marcellus Shale Environmental Issues Solid Wastes

- Drill Cuttings
- Drill Mud

# Marcellus Shale Environmental Issues Water

- Frac Water
- Quantity - Up to Three Million Gallons per Well

# Water Resources Comparison

| | Gallons per million BTU | |
|---|---|---|
| | Range | Midpoint |
| Deep shale natural gas | 0.60 – 5.80 | 3 |
| Nuclear | 8 – 14 | 11 |
| Conventional oil | 8 – 20 | 14 |
| Coal | 13 – 32 | 23 |
| Fuel ethanol from corn | 2,510 – 29,100 | 15,800 |
| Biodiesel from soy | 14,000 – 75,000 | 44,500 |

**Source: Ground Water Protection Council, U.S. Department of Energy*

# Marcellus Shale Environmental Issues Water

Frac Water - What is it?

- 99.5% Water and Sand
- 0.5% Additives

# Frac Water Additives

| Compound | Purpose |
|---|---|
| Acids – 0.123% | Helps dissolve minerals and initiate fissure in rock (pre-fracture) |
| Glutaraldehyde – 0.001% | Eliminates bacteria in the water |
| Sodium chloride – 0.01% | Allows a delayed break down of the gel polymer chains |
| N, n-Dimethyl formamide – 0.002% | Prevents the corrosion of the pipe |
| Borate salts – 0.007% | Maintains fluid viscosity as temperature increases |
| Petroleum distillates – 0.088% | "Slicks" the water to minimize friction |
| Guar gum – 0.056% | Thickens the water to suspend the sand |
| Citric acid – 0.004% | Prevents precipitation of metal oxides |
| Potassium chloride – 0.06% | Creates a brine carrier fluid |
| Sodium or potassium carbonate – 0.011% | Maintains the effectiveness of other components, such as crosslinkers |
| Ethylene glycol – 0.043% | Prevents scale deposits in the pipe |
| Isopropanol – 0.085% | Used to increase the viscosity of the fracture fluid |

**Source: DOE, GWPC: Modern Gas Shale Development in the United States: A Primer (2009)*

# Marcellus Shale Environmental Issues Water

- After Fracing
- Flowback Water - 20% to 25% Return, Salts/Solids
  - Reuse
  - Recycle
- Production – Brine
  - Reuse
  - Off-site disposal

# Marcellus Shale Environmental Issues Groundwater

- > 1.2 Million Private Wells in Pennsylvania
- Impacts??

# Marcellus Shale Environmental Issues Groundwater

- Pre-existing Water Quality
- Historical Gas Extraction
- Naturally Occurring

# Marcellus Shale Environmental Issues Groundwater

- Stray Gas - Appears to be More of an Issue in Northern Counties
- Frac Water????  Lots of Interest!!!!

# Marcellus Shale Environmental Issues Groundwater

- Pre-drill Water Quality Samples - Vicinity of Well
- Extensive Statewide Pre-drill Water Quality - Industry Led
- Whose Gas is in the Well?

# Marcellus Shale Environmental Issues Groundwater

- Portable Water Protection Practices
  - Casing off fresh water zone
  - Minimum set back distances
  - Water well testing
  - Sentry wells
  - Improved casing cement
  - More extensive well location evaluation
    - Surface
    - Subsurface
  - Different fracing techniques