Gas Development & the Environment

Conservation Law vs. Oil and Gas Act

Above Onondaga formation Rule of Capture applies to everything above the Onondaga layer Limestone including the <u>Marcellus</u>

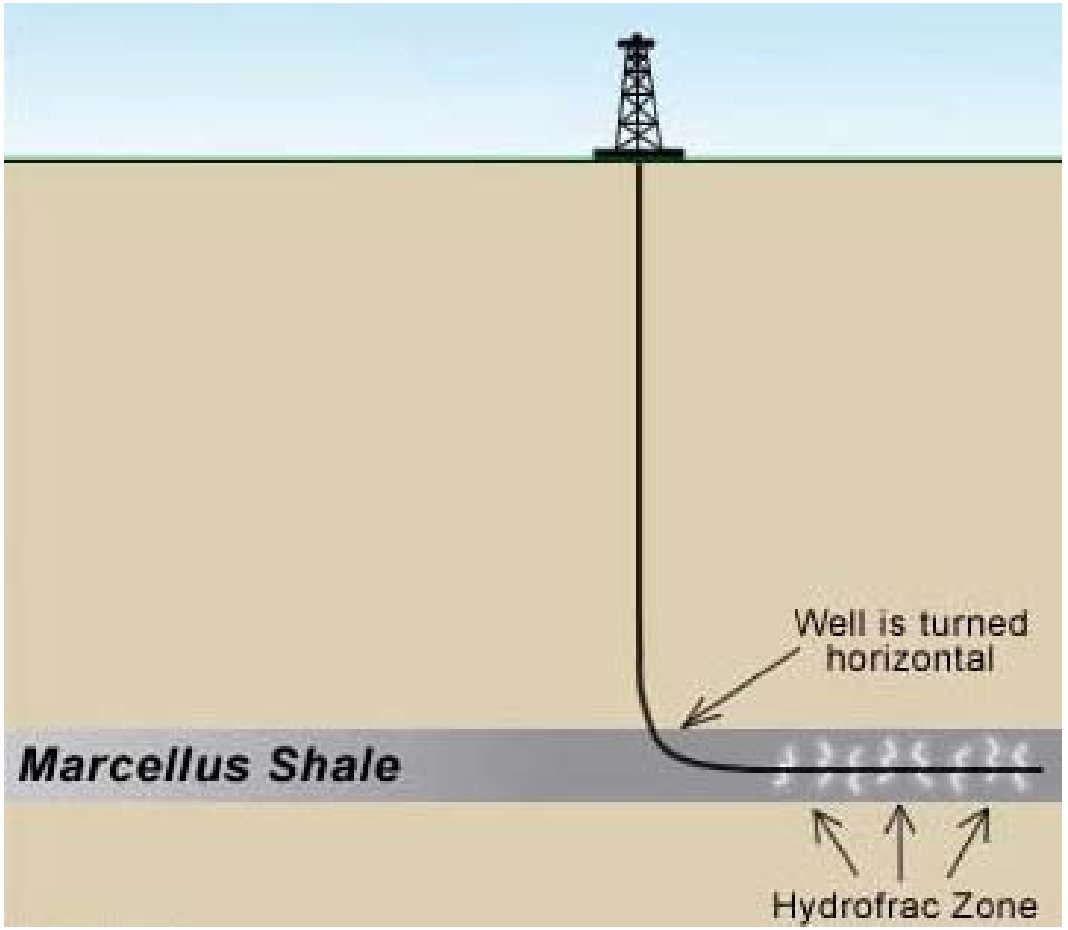
- If Coal then 1,000 foot well spacing
- If no Coal then no minimum spacing
- Can drill at the property line
- Do not have to compensate adjoining landowners
- Operators will want to pool to protect investment
- If you don't sign or protest you may not be compensated

Below Onondaga formation Oil and Gas Conservation Law applies to everything from the Onondaga Limestone and deeper so does not include the Marcellus

- If within a pooled area landowner must be integrated and compensated
- Must publicize the pooling order for successive weeks
- Must mail the order to those who have registered their address
- Well must be 330ft from boundary line
- Cement casing required
- DEP has well spacing authority

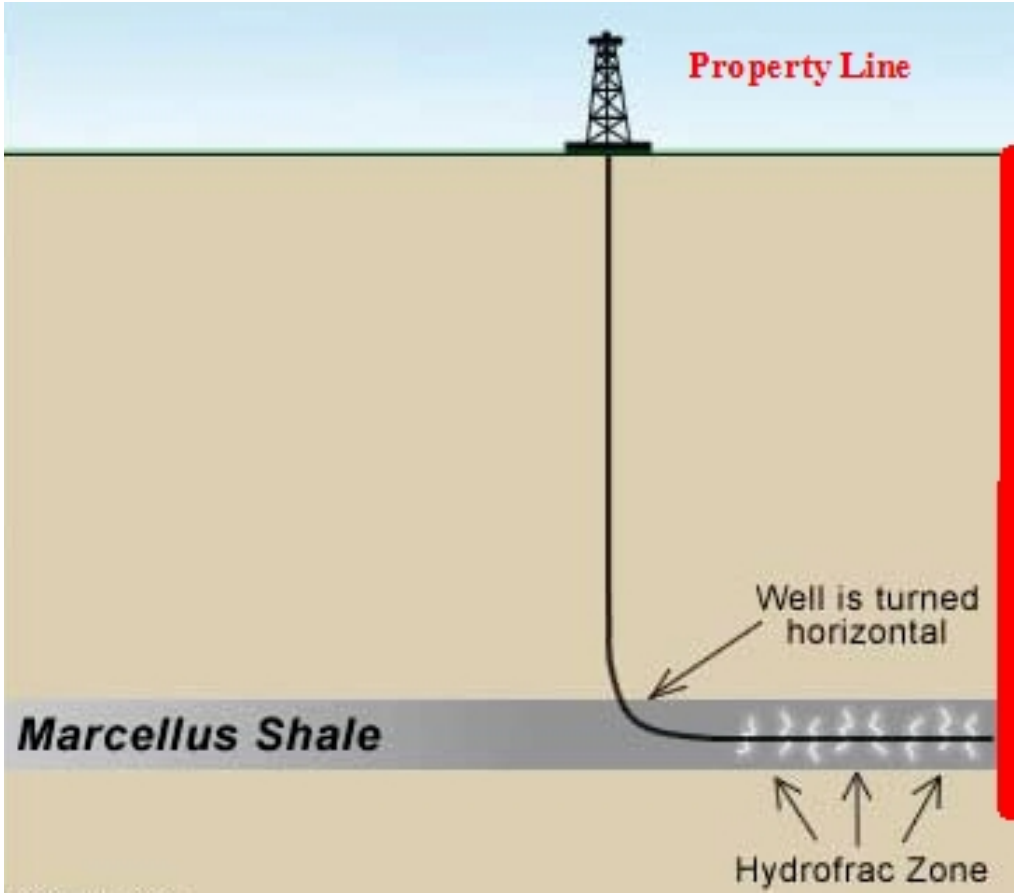
Property Rights

- For Horizontal & Vertical Wells



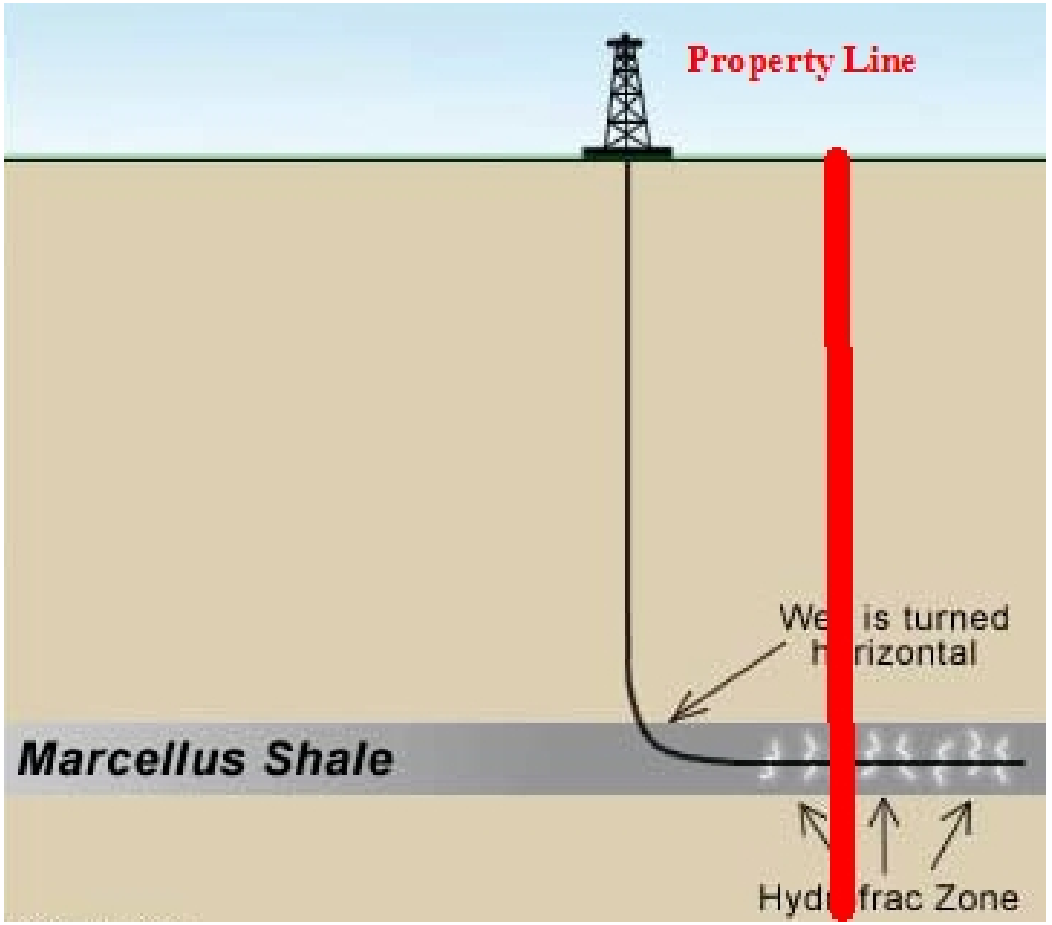
Property Rights

- Legal



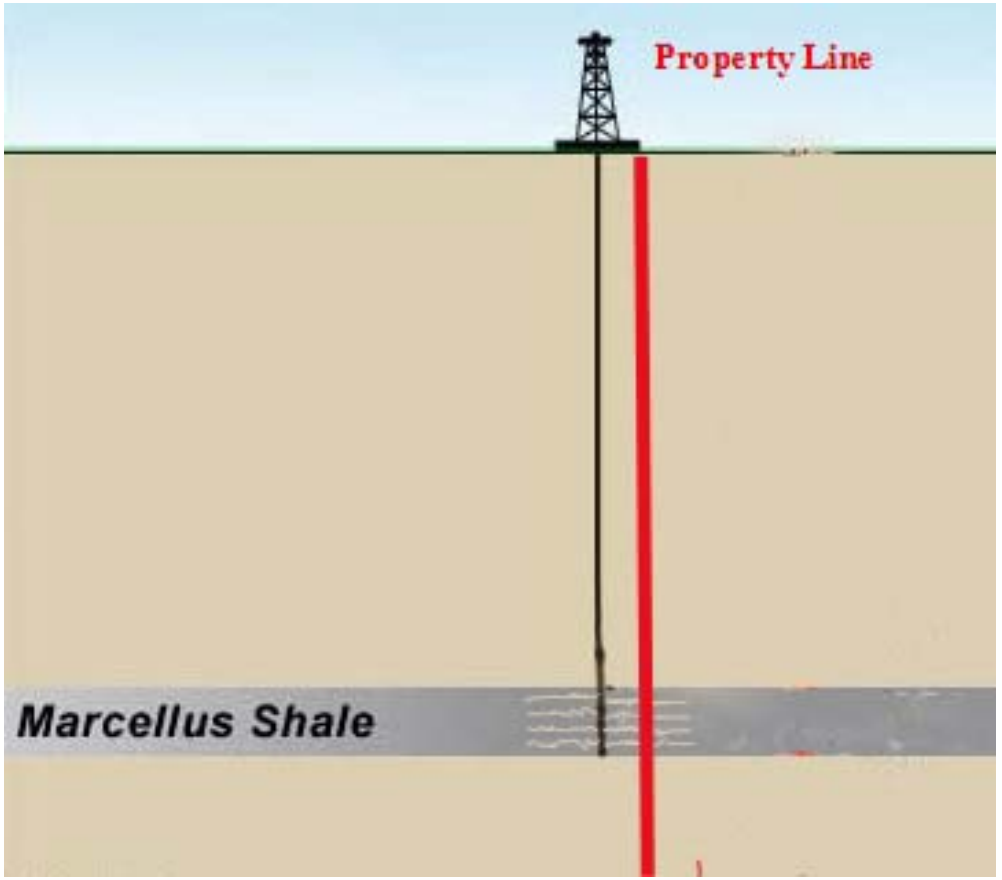
Property Rights

- Trespass



Property Rights

- Legal



The Environment

- Air
- Land
- Water

Air Emissions

- During the production of natural gas, condensates are also produced. The condensates consist of extremely toxic volatile organic chemicals such as benzene (known human cancer causing agent), toluene, ethyl benzene, xylene (BTEX) and other probable and possible cancer causing agents and sulfur based compounds (sour gas). These chemicals are released into the air from the separation process and tank storage of condensates.

- Emissions into the air from produced water tanks on the production site release methane, toxic volatile organic chemicals and sulfur compounds into the air.

- Natural gas is frequently vented to the air when a well is completed.

- Compressors and motors on the drilling and production sites release combustion products into the air. These combustion products combine with the volatile organic chemicals in the presence of heat and sunlight to produce ground level ozone.
  Elevated ozone levels result in increased respiratory impacts for community members in the area.
- The air emissions could have the potential to cause health impacts to workers and community members living in close proximity to drilling and production sites.

- The released methane gas contributes to global warming.

Land

- Drainage Plan
  - Well spacing
- Habitat fragmentation
- Infrastructure Damage
- Noise
  - Compressor stations
- Long Term- How well do the gas companies steward the land

Water Sources

- **Surface water** is a primary source of water for drilling and hydraulic fracturing fluids. Most is obtained via <10% Q710
- **Groundwater** is a potential source if surface water is not available. Groundwater availability is limited in some play areas such as the Marcellus where it typically consists of shallow alluvial aquifers less than 200 feet in depth.
- **Municipal water** suppliers can also be a source where available.
- **Waste water** from municipal and industrial treatment facilities can be used depending on quality of the effluent and availability.
- **Produced water** can be treated and reused depending on the quality of the water; primarily the TDS and chloride concentrations. Typically, the effectiveness of a treatment system is less for water with a TDS above 20,000 ppm.

Produced Water Treatment Options

- Most treatment plants do not remove TDS- they dilute & discharge
- At present, economically viable options for the treatment of produced water consist primarily of Distillation/ Evaporation or Reverse Osmosis systems.
- All have limitations as to the quality and quantity of water that can be treated. Both produce a high concentration solute that requires disposal.
- Typically, as the TDS of the produced water increases, the quantity of useable water treated decreases. If the TDS of the produced water is 150,000 ppm, then only about 50% of the water treated would be useable…the remaining 50% would require disposal.

Water Contaminants

- Shale fracturing requires
  - 1.2 million gallons of water for each vertical well
  - 3.5 million gallons of water for each horizontal well

- A horizontal well would use 140,000 pounds of chemicals.

- 20 to 40% of hydraulic fracturing flow back water remains underground. The flow back water contains large quantities of the chemicals used in the fracturing process.

  Fracturing fluids consist of :
  - surfactants
  - friction reducing chemicals
  - biocides
  - scale inhibitors
  - propping agents

  The biocides consist of polynuclear aromatic and polycyclic organics that are possible and probable human carcinogens.

  The flowback water is also contaminated with the fracturing fluids and could be potentially contaminated with radioactive NORM which consist of the human carcinogen, Radium 226.

Distillation/Evaporation

- Devon Energy is currently using a Distillation/Evaporation System in the Ft. Worth Barnett Shale Area.
  - 2,500 BBL/day throughput with 2,000 BBL/day of Fresh Water produced.
  - Requires approximately 100 MCF/day of Natural Gas to process the fluid

- Chesapeake has plans to install four Water Evaporation Units at the Brentwood SWD Facility in Fort Worth.
  - Employs natural process of evaporation to turn water into water vapor.
  - Uses “Waste Heat” from compressor; no need to consume fuel.

Reverse Osmosis

- Currently being Employed by EnCana in the Ft. Worth Barnett Shale Area.
- Uses a Reverse Osmosis Membrane System to remove salt from flow back water.
- 10,000 BBL/day Throughput with a Limit of 20,000 ppm Chlorides.
- Requires approximately 100 MCF/day of Natural Gas to process the fluid

Produced Water Disposal Options

- Primary means for management of produced water from Shale Gas is disposal in a Class II UIC well.
- Since Shale Gas development is occurring in areas that have not had oil and gas development in the past, Class II UIC wells may not be available.
- Other areas, such as the Marcellus Shale development area, are geologically challenged with regard to available injection zones. Currently there are only 6 disposal wells in NY and 8 in PA. Permitting a Class II well in NY may take a year or more.
- Other options include treatment at industrial or municipal treatment systems.
- Long Term: The build up of chemicals in the ecosystem is the issue

Sustainable Development

- Sustainable Shale Gas Development will require a toolbox approach to both water supply and management issues.
- Multiple sources of water, including treatment and reuse of produced water and use of waste water, will need to be employed by industry to avoid conflicts with competing users…at least in some areas. Overall, the quantity of water needed for shale gas development is small as well as temporary compared to other long term uses such as power supply.
- Management and disposal of produced water may dictate the pace of shale gas development in some areas where options, such as available Class II UIC wells, are limited.

Important Legislative Action

- In 2005 the Energy Policy Act exempted Hydraulic Fracturing from the Safe Drinking Water Act
  - June 9, 2009, Two Bills knows as the FRAC Act were introduced in the US House and Senate to regulate Hydraulic Fracturing
  - House Bill - Introduced by Representatives from New York and Colorado
  - Senate Bill - Introduced by Senators from Pennsylvania and New York
- Repeal the Hydraulic Fracturing exemption currently contained in the Safe Drinking Water Act, Underground Injection Control Program
- Give EPA the authority to regulate Hydraulic Fracturing under the UIC Program within the Safe Drinking Water Act
- Modify the definition of Underground Injection specifically to include Hydraulic Fracturing
- Obligate oil and gas operators to disclose fracturing fluid constituents to regulatory agencies which in turn must provide the information to the public.