Nuts and Bolts of Marcellus Shale Drilling and Fracking

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True or False?

- Nothing being done to produce the Marcellus is new to Pennsylvania.
Marcellus Shale

• Not the deepest
  – Over 11,000 wells in deeper formations

• Not the first to require horizontal drilling
  – Coalbed methane wells

• Not the first to use hydraulic fracing
  – Standard operating procedure
What’s Different?
What’s Different?
Natural Gas Drilling
**Figure 23.** Deep gas production in Pennsylvania in 1990 by producing formation.

<table>
<thead>
<tr>
<th>Producing formation</th>
<th>Production in 1990 (Mcf)$^1$</th>
<th>Cumulative production at end of 1990 (Mcf)$^{1,2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tully Limestone</td>
<td>824</td>
<td>2,283</td>
</tr>
<tr>
<td>Marcellus Formation (deep black shale)</td>
<td>0</td>
<td>75,930</td>
</tr>
<tr>
<td>Onondaga Limestone</td>
<td>673,465</td>
<td>4,696,630</td>
</tr>
<tr>
<td>Oriskany Sandstone, Huntersville Chert, and Ridgeley Sandstone</td>
<td>1,947,057</td>
<td>1,322,597,942</td>
</tr>
<tr>
<td>Bass Islands Dolomite and Helderberg Group</td>
<td>35,379</td>
<td>1,461,855</td>
</tr>
<tr>
<td>Salina Group</td>
<td>991</td>
<td>45,512</td>
</tr>
<tr>
<td>Lockport Dolomite</td>
<td>49,642</td>
<td>5,903,585</td>
</tr>
<tr>
<td>Medina Group</td>
<td>35,813,233</td>
<td>313,541,031</td>
</tr>
<tr>
<td>Tuscarora Sandstone</td>
<td>0</td>
<td>3,886,966</td>
</tr>
<tr>
<td>Bald Eagle Formation</td>
<td>1,087,696</td>
<td>6,608,449</td>
</tr>
<tr>
<td>Beekmantown Formation</td>
<td>1,864</td>
<td>4,659</td>
</tr>
<tr>
<td>Gatesburg Formation and Little Falls Dolomite</td>
<td>0</td>
<td>207,200</td>
</tr>
<tr>
<td>TOTAL</td>
<td>39,610,151</td>
<td>1,659,032,042</td>
</tr>
</tbody>
</table>

$^1$Mcf, thousand cubic feet.

$^2$Includes production from previous years reported in 1990.
How Large?

- Marcellus Permits Issued
  - 2005: 4
  - 2006: 23
  - 2007: 71
  - 2008: 476
  - 2009: 1,984
  - 2010: 3,314
How Large?

- **Natural Gas Production in Pennsylvania**
  - 2005: 181,429,238 mcf
    - mcf = thousand cubic foot

- **Marcellus Shale**
  - 500 trillion cubic foot
  - 100+ year supply
  - Total U.S. Consumption ~ 2 years
How Large?

276,000% larger
How Large?

• Lease payments
  – Up to $5,000+ / acre
  – 12% - 20% royalty
    • State minimum 1/8th = 12%

• Water usage
  – Approximately 5 million gallons / well
Department of Environmental Protection
Bureau of Oil and Gas Management
Marcellus Shale Permits Issued & Wells Drilled
(January thru November - 2010)

Permits Issued – 2,916 / Wells Drilled – 1,368 *

Updated 12/08/2010

* As reported by Operators
Horizontal Drilling

Source: America’s Natural Gas Alliance
Regulatory Structure

- DEP
- Pa. Fish & Boat Commission
- River Basin Commissions
  - DRBC, SRBC
- EPA
  - Regulation of fracturing?
    - i.e., fracing or “fracking”
      - Underground injection of flow back
Oil and Gas Act

• Primary law
  – 58 P.S. §§ 601.101 – 601.605

• Regulates oil and gas and environmental aspects

• Requires reporting on activities and production

• Bonding of wells
The Clean Streams Law

• Regulates site development

• Erosion and Sediment Control Program

• Handling, treatment, and disposal of frac water and production fluids
E&S Control Permit

- Earth disturbance activity
- 5 acres or more
- Best management practices ("BMPs")
Dam Safety and Encroachments Act

- 32 P.S. §§ 693.1 – 693.27

- Encroachment permit
  - Covering well site / facility
  - Within FEMA designated floodway
  - Or within 50 feet of stream

- Impoundments
Underground Storage Act

• 58 P.S. §§ 451 – 459

• Regulates underground storage of gas in natural or man-made caverns

• Bonding requirements ($100k / facility)

• 65 gas storage fields in 23 counties
Water and Wastewater Storage

- Centralized Impoundments
  - Service multiple wells
    - Fresh Water
    - Flowback
Hydraulic Fracturing

Small hole, about 15” in diameter
Private well, about 500 feet deep
Public well, about 1,000 feet deep
Multiple layers of steel, encased in cement to protect groundwater
Protective steel casing
Approximate distance from surface 8,000 feet

Source: America’s Natural Gas Alliance
Wastewater Management

• Flowback and “produced water”
  – ~20% returned to surface
  – ~60% of flowback is reused
    • Some report 100% reuse
    • Disposal volumes ~ 4% of withdrawals

• Total Dissolved Solids (TDS)
  – DEP TDS Strategy
  – Increased salinity
Issues

• NORM and TENORM
  – Naturally occurring radioactive material
  – Technologically enhanced naturally occurring radioactive material
**Issues**

- **Gas migration**
  - Dimock, Pennsylvania
    - Methane
    - Public water hookup
      - 12 miles
      - $12 million
    - $4.1 million settlement with DEP in lieu of water hookup (December 16, 2010)
    - Multi-million dollar personal injury lawsuit continues
Water Withdrawals

- Need permit
  - SRBC, DRBC, DEP
Maryland, NY and Beyond

[Map showing Marcellus Isopach (feet) with different color codes for varying depths and extent of Devonian Shale and Marcellus Shale]
New York State

• December 13, 2010, Governor Patterson vetoed S.8129-B/A.11443-B.
  - December 13, 2010
  - Would have suspended the issuance of new oil and gas drilling permits through May 15, 2011
  - included all conventional, low-volume, vertical oil and gas wells
New York State

- **Executive Order**
  - December 13, 2010
  - Prohibits high volume hydraulic fracturing of horizontal wells through July 2011
  - NY DEC drafting regulations
Maryland

- Allegany and Garrett Counties in Western Maryland
- Several permit applications under review
- Proposals for a moratorium
  - Maryland Shale Safe Drilling Act of 2011
    - Would create moratorium until 2013
    - Overwhelming passed in House; Did not pass in Senate
  - Possible Executive Order
Questions?

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