THE MARCELLUS SHALE
AN ENERGY GAME CHANGER?

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McNees Wallace & Nurick LLC is a full-service law firm that employs more than 130 attorneys in Harrisburg, State College, Lancaster, and Hazleton, PA; Columbus, OH; and Washington, D.C.

The MWN website can be found at www.mwn.com.
Areas of Practice
Jim practices in the Energy, Communications, and Utility Law Practice Group and also is a member of MWN's PA Oil and Gas and Government Relations practice groups. He represents industrial users before state and federal regulatory commissions with respect to utility matters, including natural gas, electric, water, wastewater and communications. Jim devotes a significant part of his practice to representing industrial interests before state legislatures on energy and water matters. He also represents small utility companies and cable companies before state regulatory commissions regarding gas, electric, water, wastewater, telephone, radio common carrier and communication matters.

Jim's practice includes representation of large water and wastewater users regarding legislative and regulatory matters before local, state and federal agencies. While the majority of his practice is before the Pennsylvania Public Utility Commission and the appellate courts of Pennsylvania, he is also active in biofuel and alternative fuel development in the U.S. and Canada.

Licensed to practice
Pennsylvania, Ohio, DC, New York, U.S. Supreme Court, and U.S. District Court
WHAT IS MARCELLUS SHALE?

- Rock strata found between 4,000 and 8,500 feet below the surface, with typical thickness of the shale formation ranging from 50 to 200 ft
- Natural gas is trapped in the rock in the 390 million year old formation
- Formation is under parts of VA, WV, MD, OH, PA, and NY
- Formation measures 95,000 square miles or 60.8 million acres
MARCELLUS SHALE THROUGHOUT U.S.
MARCELLUS SHALE LOCATION IN PENNSYLVANIA

Marcellus Shale Formation
WHY IT MATTERS

- Marcellus Shale is the largest unconventional natural gas reserve in the world
  - Second largest natural gas field in the world
  - Rivals Russia's massive gas fields and the untapped resources on the coast of Iran and in the Caspian Sea
OTHER "BIG SHALES" IN U.S.

- **Barnett** in East Texas
- **Haynesville** in Louisiana
- **Fayetteville** in Arkansas
- **Woodford** in Oklahoma
WHY IT MATTERS

- Marcellus Shale formation contains >500 trillion cu.ft. of natural gas
- When/if fully developed expected to produce equivalent (in BTUs) of 87 billion barrels of oil
  - Or, 12 years of U.S. energy consumption,
  - Or,
  - 3 years of the world's energy consumption
ENERGY IMPACT

- Natural gas production in Pennsylvania is projected to produce 1 billion cubic feet per day of natural gas in 2010
- Pennsylvania projected to produce 13.5 billion cubic feet per day of natural gas per day by 2020
ENERGY IMPACT

- Strategic value is that this shale gas is close to NE US consumer markets
- An energy "GAME-CHANGER" because of low production cost and its "pipeline-ready" quality gas
Proposed Northeast Pipeline Projects: Focusing on Appalachian Connections

NORTHEAST PIPELINE

Prepared by NGA, 5-10, based on publicly available information. Project locations approximate.

National Fuel Gas, "West to East Project"

Tennessee, "Northeast Upgrade"

Tennessee, "300 Line Expansion"

Iroquois, "NYMarc"

Spectra/Algonquin, "East-to-West Project"

Spectra, "NJ/NY Expansion"

Williams, "Northeast Supply Project"

Spectra/Texas Eastern, "TEMAX and TIME III"

Williams, Columbia "Keystone Connector"

Natural Gas Update: Presentation to Northeast International Committee on Energy, June 9, 2010
ENERGY "GAME-CHANGER"

- Abundant "pipeline-ready" gas will flow from NE PA (and perhaps NY soon) to CT and New England
- Will substantially reduce the supply (or commodity) cost, which is the cost of the gas itself
- And, will substantially reduce the transportation and delivery component
  - Charges to get gas to home/facility (may range from 35-50% of total gas bill)
ENERGY "GAME-CHANGER"

- More/cheaper gas for end-users
  - Gas-fired generation opportunities
- Clean energy
- New pipelines will result in new opportunity for end-users to direct connect
MARCELLUS MULTIPLIER

- "Marcellus Multiplier" – creating a surge in "wealth among the affected population" leading to more banking, real estate and "large purchase" activity

- Marcellus Shale projected to result in 88,588 PA jobs in 2010, an additional 111,413 in 2011, and approximately 211,909 by 2020
  - Good news for state with unemployment rate hovering just above 9%
ECONOMIC IMPACT

- From 2008 through April 2010, Chesapeake Energy paid $1.1B to Pennsylvania landowners in lease bonus payments and royalties.
- PSU estimates that over the life of the Marcellus play, >$250B in royalties will be paid to PA landowners.
## Summary of Actual, Planned, and Forecast Economic Impacts

<table>
<thead>
<tr>
<th>Year</th>
<th>Value Added</th>
<th>State &amp; Local Taxes</th>
<th>Employment</th>
<th>Wells Drilled</th>
<th>Output Bcfe/day*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>3,877</td>
<td>389</td>
<td>44,098</td>
<td>710</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Planned</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>8,039</td>
<td>785</td>
<td>88,588</td>
<td>1,743</td>
<td>1.0</td>
</tr>
<tr>
<td>2011</td>
<td>10,129</td>
<td>987</td>
<td>111,413</td>
<td>2,211</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Forecast</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>14,415</td>
<td>1,417</td>
<td>160,205</td>
<td>2,903</td>
<td>7.6</td>
</tr>
<tr>
<td>2020</td>
<td>18,853</td>
<td>1,872</td>
<td>211,909</td>
<td>3,587</td>
<td>13.5</td>
</tr>
</tbody>
</table>

Bcfe is billion cubic feet of natural gas equivalents per day.

HOW WE GET THE NATURAL GAS

- Marcellus Shale has been known to contain trapped methane for decades
- Technological advances in two well techniques made recovery of the gas economically viable
  - Hydraulic fracturing
  - Horizontal drilling
HYDRAULIC FRACTURING

- Large volumes of frac fluid pumped down the well bore under extreme pressure (up to 15,000 psi)
  - Approximately 1-6 M gallons of water per well is required
- Frac fluid is 99.5% water and sand
- Other substances include lubricants, biocides, scale inhibitors, oxygen scavengers, acids
Most of the frac water returns to the surface as "flowback"

Flowback has very high concentrations of Total Dissolved Solids (salt)
### MARCELLUS SHALE WATER ANALYSIS

#### PRODUCED WELL E – 3 DAYS AFTER

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.58</td>
</tr>
<tr>
<td>Calcium</td>
<td>18024.0</td>
</tr>
<tr>
<td>Magnesium</td>
<td>2379.56</td>
</tr>
<tr>
<td>Sodium</td>
<td>147447.00</td>
</tr>
<tr>
<td>Iron</td>
<td>166.47</td>
</tr>
<tr>
<td>Potassium</td>
<td>592.16</td>
</tr>
<tr>
<td>Barium</td>
<td>10134.10</td>
</tr>
<tr>
<td>Strontium</td>
<td>8220.09</td>
</tr>
<tr>
<td>Manganese</td>
<td>16.17</td>
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<tr>
<td>Sulfate</td>
<td>55.00</td>
</tr>
<tr>
<td>Chloride</td>
<td>241200.00</td>
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<tr>
<td>Bicarbonate</td>
<td>54.40</td>
</tr>
<tr>
<td>Carbonate</td>
<td>0</td>
</tr>
<tr>
<td>Hydroxide</td>
<td>0.00</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>NA</td>
</tr>
<tr>
<td>Hydrogen Sulfide</td>
<td>NA</td>
</tr>
<tr>
<td>TDS</td>
<td>428258.95</td>
</tr>
</tbody>
</table>

**428,258 mg/l TDS**

- Water Chemistry Varies
- High TDS After Initial Flowback
- Flowback Volume is High
- Production Water is High

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OPPORTUNITY EXISTS BUT CONTROVERSY CONTINUES

- Environmental concerns
  - Water availability (for fracking)
  - Produced/frac water water disposal
  - Gas migration into water wells and aquifers
  - As a result, gas drilling is largely on hold in the Delaware River Basin

- Gas safety and reliability
- Transportation issues
- Crumbling infrastructure
- NORM
BALANCING OF MULTIPLE PRIORITIES IS REQUIRED IF THE MARCELLUS WILL BE AN ENERGY GAME-CHANGER

<table>
<thead>
<tr>
<th>Energy Development</th>
<th>Economic Development</th>
<th>Environment/Infrastructure</th>
<th>Working with Producers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Develop the considerable natural gas resources</td>
<td>• Promote economic activities that generate tax revenue</td>
<td>• Protect surface water supplies – river systems</td>
<td>• Protect sizable investment in mineral rights</td>
</tr>
<tr>
<td>• Provide effective solutions for challenges facing energy producers</td>
<td>• Create permanent job growth</td>
<td>• Protect ground water resources – minimize contamination</td>
<td>• Develop access to sustainable water supply</td>
</tr>
<tr>
<td>• Promote utilization of clean fuel sources</td>
<td>• Attract maximum infrastructure investment to promote economic growth</td>
<td>• Reduce heavy vehicle emissions and noise</td>
<td>• Discharge waste streams safely and economically</td>
</tr>
<tr>
<td></td>
<td>• Maximize the use of our water supplies to support economic growth</td>
<td>• Reduce wear and tear on existing roadways</td>
<td>• Reduce community disruption from heavy vehicle transportation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Create favorable PR opportunities</td>
</tr>
</tbody>
</table>
APPENDIX 1
MARCELLUS SHALE DEFINITIONS

• **Dry gas** - doesn't contain the condensate that must be extracted before entering the pipeline, and is typically referred to as "pipeline ready"
• **Flowback** – fluids that flow back after the fracture
• **Fracturing** – hydraulic cracking open the zone, trapping proppant in the zone
• **Gelled System** – crosslinked polymer, Thixotropic, Hi proppant, costly
• **Permeability** – ease of a fluid or gas flows in the formation
• **Play** – used in the industry to refer to a geographic area targeted for exploration and development. An area comes into "play" upon recognition of an economic quantity of gas to be found
• **Production** – water, gas and oil from the well
• **Proppant** – sand or other solid utilized to hold the zone open after release of the pressure; must have excellent permeability
• **Shales** – tight, non-conventional gas plays thought uneconomical
• **Slick Water System** – low cost, high water volume, low proppant fracture system that can be pumped at very high rates
APPENDIX 1
MARCELLUS SHALE DEFINITIONS

- **Total Dissolved Solids (TDS)** – the dry weight of dissolved material, organic and inorganic, contained in water and usually expressed in ppm or mg/l. US EPA secondary standard for TDS is 500 mg/l.

- **Unconventional Gas** – gas that is more difficult or uneconomical to extract, usually because the technology to reach it has not been developed fully, or is too expensive. However, the Natural Gas Policy Act provided incentives for extracting unconventional natural gas, and spurred investment into deep exploration and development drilling, making much deep gas conventionally extractable.

- **Wet Gas** – Wet gas doesn't mean "wet" with water, but refers to a mix of hydrocarbons that contain considerable condensate or liquid compounds, like propane and butane. Gas processing companies earn extra revenues from the compounds extracted from wet gas, which is typically found on the western edges of the Marcellus Shale formation.