Marcellus Shale Development – Challenges and Opportunities

Presentation to the Marcellus Shale Advisory Commission

Radisav Vidic, PhD, PE
Professor and Chair, Department of Civil & Environmental Engineering

June 7, 2011
Safety and Environmental Protection

- Life Cycle Assessment
- Drilling/fracturing operations
- Water management
- Air quality issues
- Long-term well stability
Life Cycle Assessment
Life Cycle Assessment

• Energy return on energy invested
• Water use
• Global warming potential

Needs to be:
• Based on actual data
• Expressed per unit of energy produced
PRELIMINARY RESULTS

Based on: Jaramillo et al. (2007), Spath & Mann (2000), Spath et al. (1999)
Drilling/fracturing operations

- Identify hazards
- Risk assessment/management
  - Major hazards
  - Emergency response scenarios
- Best management practices
- Technology Transfer
- Spill prevention/containment
- Environmentally-friendly drilling fluids
Water Management

• Recycling/Reuse
• Water Bank Concept
• Water Treatment
• Acid Mine Drainage as a Resource
• Impoundment management
Recycling/Reuse

- Works for 12-15 yrs
- Eventually we are a net producer of water

- 4800 wells on 625 mi$^2$
- 3 refractures/well
- 33% water reuse
Water Bank Concept

• **Reuse difficult for smaller operators**
  – Insufficient well count
  – Insufficient capital

• **Develop rules for water banking**
  – Smaller operator dispose of their wastewater in regional impoundments
  – Larger operators get credit for water reuse and pollution elimination
Water Treatment

- New technologies
  - Mechanical vapor recompression
  - Membrane distillation
  - Gas hydrates
  - Crystallization

- Export knowledge and technology development

- Salt Management/Utilization Plan
Acid Mine Drainage as a Resource

Marcellus well sites

AMD sites
Acid Mine Drainage as a Resource

- **Policy Issues**
  - "You touch it, you own it"
  - Involvement and clarification from the Commonwealth is needed now

- **Technical issues**
  - Quantity
  - Access
  - Sulfate
Flowback/Produced water

Abandoned mine drainage (AMD)

Cleaner product
Quality sufficient for reuse

<table>
<thead>
<tr>
<th>Constituent</th>
<th>$K_{sp}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>BaSO$_4$</td>
<td>$1.08 \times 10^{-10}$</td>
</tr>
<tr>
<td>SrSO$_4$</td>
<td>$3.44 \times 10^{-7}$</td>
</tr>
</tbody>
</table>
Impoundment Management

- **Leak detection/prevention**
  - Optimal design
  - Containment guidelines

- **Biological control**
  - Aeration?
  - Disinfection?
  - Alternatives
Air Quality

- Emissions during drilling and fracturing
- Fugitive emissions (flaring)
- Emissions from impoundments
- Fugitive emissions during transport and processing
Long-Term Well Stability

• Monitoring
• Non-Destructive Evaluation (NDE)
• Casing/Construction Techniques
The Time to Act is Now

• What is needed
  – Data-driven, unbiased, peer-reviewed research on these problems
  – Universities can play role of *honest broker*

• Problem is larger than any one municipality – i.e. Impact Fee not designed to solve Commonwealth-wide problems
Center for Gas Resource Development

- Health, Safety & Environmental Protection at Drilling Sites
- Holistic Water Management
- Life Cycle Assessment
- Transportation Issues
- Workforce Development
- Public Outreach & Economic Development
ENERGY
Rising to the Challenge
Positioning Our Region for the Future