Introducing the Center and Its Mission

Tom Murphy, Co-Director
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Marcellus Shale Wells Drilled 2010

Bureau of Oil and Gas Management

Wells Drilled

2010 January-July Wells Drilled - 1,717
Non Marcellus Shale - 895 Wells Drilled
Marcellus Shale - 822 Wells Drilled

As Reported by Operators

Updated 08/03/2010
Pennsylvania’s Oil and Gas

MAP 10

OIL AND GAS FIELDS OF PENNSYLVANIA

SCALE 1:2,000,000

EXPLANATION

- Shallow oil field
- Deep oil field
- Shallow gas field
- Deep gas field
- Gas storage area
The Marcellus is Overpressured

We know that the shale gas reservoir has “integrity” in the subsurface because it maintains a positive (excess) pressure relative to what is expected at depth, i.e., the reservoir is “sealed”
Marcellus Depth Map

Marcellus Shale exposed at surface ("outcrop")

Depth to top of Marcellus Shale in feet

<table>
<thead>
<tr>
<th>Depth of Marcellus Shale Base</th>
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<tbody>
<tr>
<td>Red</td>
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<tr>
<td>Orange</td>
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<td>Yellow</td>
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<td>Green</td>
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<tr>
<td>Blue</td>
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<tr>
<td>Light blue</td>
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<td>Purple</td>
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Depth of Marcellus Shale Base
- 2000 - 3000 ft
- 3000 - 4000 ft
- 4000 - 5000 ft
- 5000 - 6000 ft
- 6000 - 7000 ft
- 7000 - 8000 ft
- 8000 - 9000 ft
- > 9000 ft

Marcellus Shale Extent
(includes non-economic areas)

Marcellus location modified from USGS Marcellus Shale Assessment Unit. Onondaga depth after Wrightstone, 2005.
Marcellus Shale Total Thickness

Scale in feet

General thickening to the east and southeast
MCOR’s Mission

- MCOR explores the geology, technology, economics, environmental, business and social challenges posed by exploration and development.

- Leverage Penn State’s significant strengths in outreach and research to serve ALL stakeholders (including landowners, local and state government, natural resource organizations, natural gas industry, and concerned citizens of Pennsylvania).
• Funded by

College of Agricultural Sciences
College of Earth and Mineral Sciences
Penn State Outreach
Social Science Research Institute
Penn State Institutes of Energy and the Environment
Welcome to the Penn State Marcellus Center for Outreach and Research (M-COR)

Center Mission

The Penn State Marcellus Center for Outreach and Research (M-COR) will be the research, information and education leader for the Appalachian region by fostering, supporting and advancing research and research-based outreach on gas shale development. The Center will inform and serve the diverse group of stakeholders involved with or affected by the exploration and production of natural gas, including landowners, local government, business, natural resource organizations and the natural gas industry. By promoting collaborations and cooperative initiatives among disciplines and stakeholder groups, the Center will address the opportunities and challenges in gas shale development.
Energy needs
General balance of energy sources and anticipated needs
Heating and electricity generation—advantage of natural gas
Potential for natural gas vehicle transportation system

Geology
Appalachian Basin morphology/history—potential hot spots
3D view of Marcellus vs. shallow aquifers
Drilling through overlying strata/structure read through seismics

Technology/Engineering
What is horizontal drilling and why is it necessary?
Protection from blowouts and leakage
What is hydrofracing—impacts on water usage and water quality?
Pipeline and gas processing needs and technology
Water
Surface vs. groundwater and their potential interaction
Communication between deep and shallow horizons
Salt and other components
Monitoring systems and wells

Risk and Uncertainty
Evaluating risk and uncertainty—common risks and perceptions
What is the risk of a well failing?
Groundwater pollution potential

Landscape Alteration
Importance of forest ecosystems
Fragmentation impacts on wildlife and invasive species
Dirt and gravel road impacts
Assessing Landscape Change due to Marcellus Shale Drilling Operations and Devising Landscape Remediation Strategies to Minimize Site Impacts
   PIs: Margaret Brittingham (Forest Resources) and Patrick Drohan (Crop and Soil Sciences)

Environmental and Psychosocial Risk Regulators of Stress in Time and Context
   PIs: Brian Orland (Arts and Architecture) and Martin Sliwinski (Health and Human Development)

Implications of Marcellus Shale Development for the Well-Being of Resident Parents and Children: Community, Natural Environment, and Family Pathways
   PI: Diane McLaughlin (Rural Sociology)
The Impact of Marcellus Gas Development on the Rural Transportation Infrastructure
   PI: Barry Scheetz (Civil Engineering)

Fiscal and Community Impacts from Marcellus Shale Gas Development in Susquehanna and Washington Counties
   PI: Michael Jacobson (Forest Resources)

Assessing School Responses to Changing Workforce and Community Conditions in Pennsylvania in the Context of Marcellus Shale Development
   PI: Kai Schafft (Education)
AGENDA for LEGISLATIVE TALK & TOUR

1:30 – 2:00 p.m. Infrastructure Impacts
Barry Scheetz, Senior Scientist, Transportation and Infrastructure Director, Center for Dirt & Gravel Roads, Larson Transportation Institute

2:00 – 2:30 p.m. Economic Development Implications
Tim Kelsey, Professor of Agricultural Economics

2:30 – 3:00 p.m. Creamery Break

3:00 – 3:30 pm Public Policy Developments
Ross Pifer, J.D., Director of Penn State’s Agricultural Law Resource and Reference Center

3:30 – 4:00 p.m. Marcellus drilling process and preview of Friday’s field tour
Tom Murphy, Co-Director of Penn State Marcellus Center for Outreach and Research (MCOR)

4:00 – 4:30 p.m. Water Treatment Options
Dave Yoxtheimer, Extension Associate MCOR

4:30 – 5:00 p.m. Workforce Implications
Jim Ladlee, Senior County Extension Educator, Director of Marcellus Shale Education and Training Center

6:30 – 8:00 p.m. Dinner Writing Room #1, Nittany Lion Inn