

# Nuts and Bolts of Marcellus Shale Drilling and Fracking

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# True or False?

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

# Marcellus Shale

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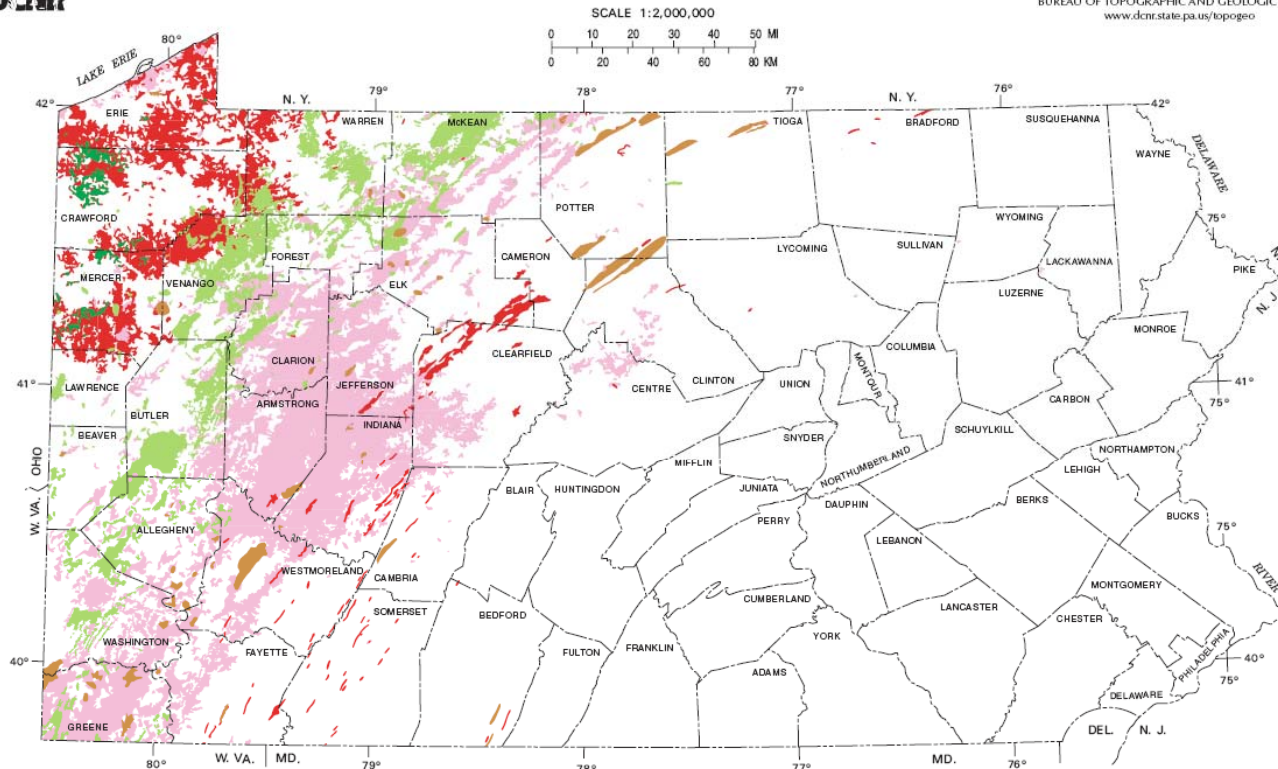
- Not the deepest
  - Over 11,000 wells in deeper formations
- Not the first to require horizontal drilling
  - Coalbed methane wells
- Not the first to use hydraulic fracturing
  - Standard operating procedure

# What's Different?

MAP 10  
DCNR

## OIL AND GAS FIELDS OF PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF  
CONSERVATION AND NATURAL RESOURCES  
BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY  
www.dcnr.state.pa.us/topogeo



EXPLANATION



Shallow oil field



Deep oil field



Shallow gas field



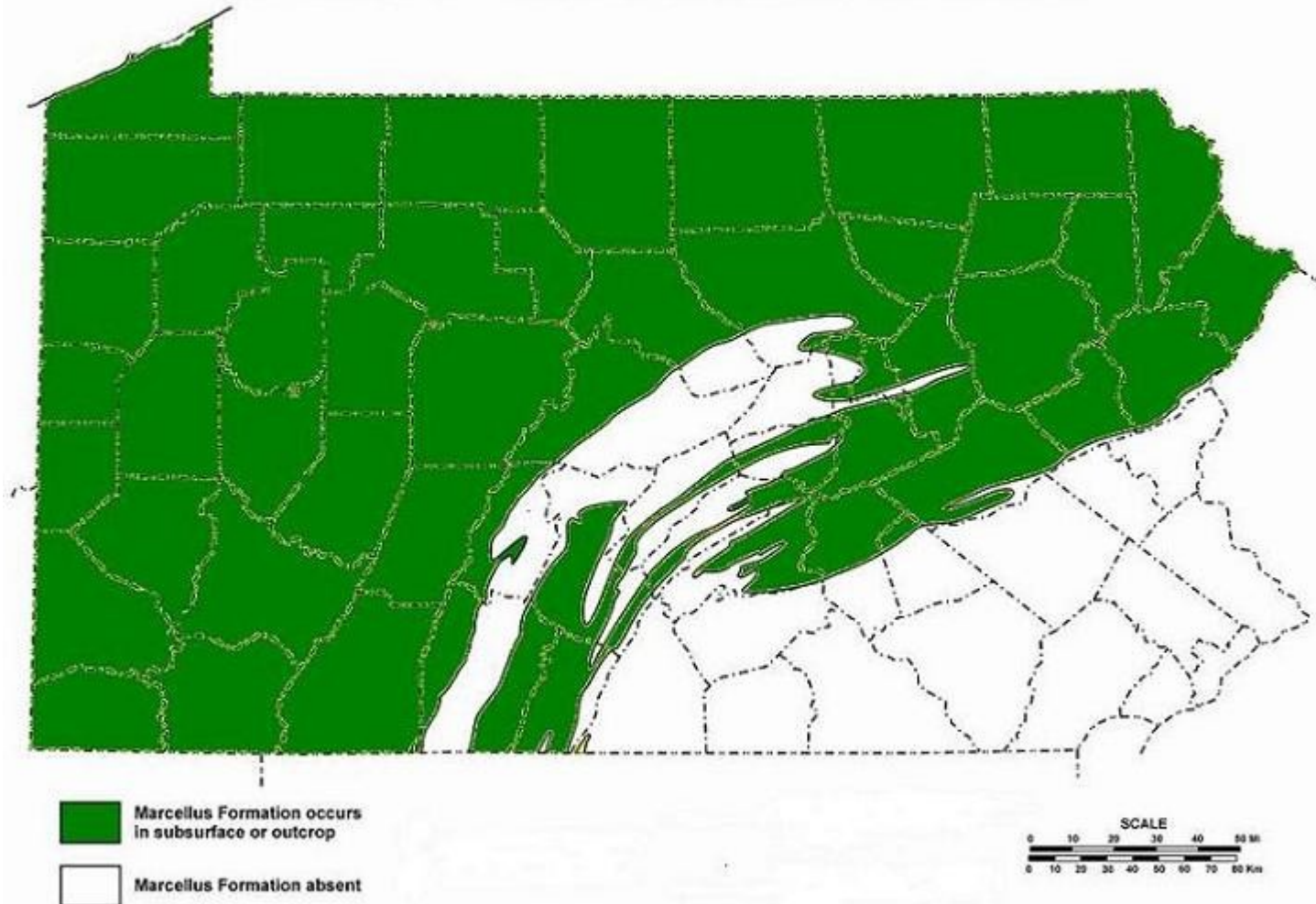
Deep gas field

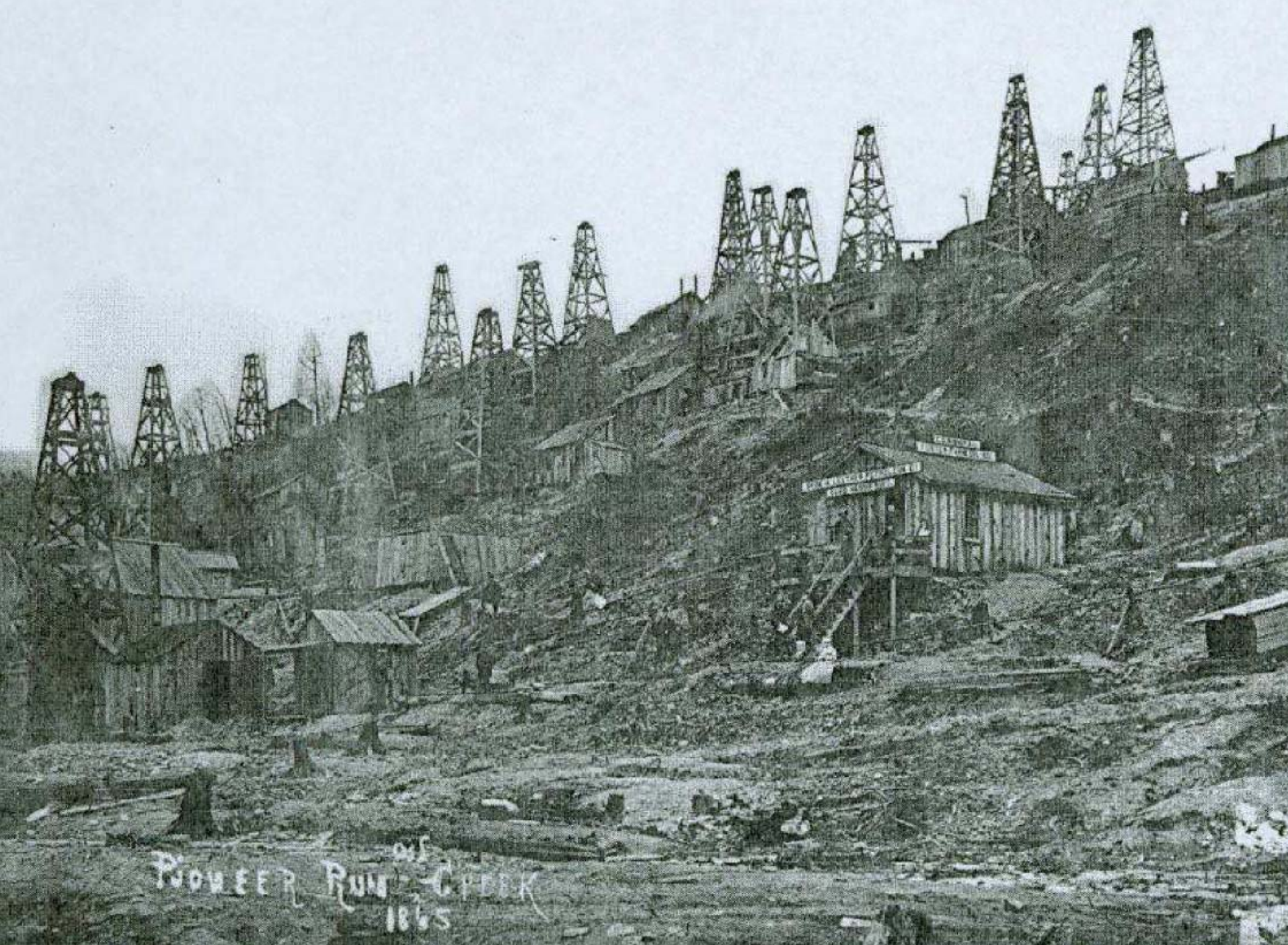


Gas storage area

# What's Different?

OCCURRENCE OF MARCELLUS SHALE IN PENNSYLVANIA





PIONEER RUN CREEK  
1865

# NATURAL GAS DRILLING



# How Large?

Figure 23. Deep gas production in Pennsylvania in 1990 by producing formation.

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

<sup>1</sup>Mcf, thousand cubic feet.

<sup>2</sup>Includes production from previous years reported in 1990.



**OIL AND GAS DEVELOPMENTS IN PENNSYLVANIA IN 1990 WITH TEN-YEAR REVIEW AND FORECAST**



John A. Harper  
Cheryl L. Cosart

William S. Lytle



# How Large?

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

# How Large?

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- 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?

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276,000% larger

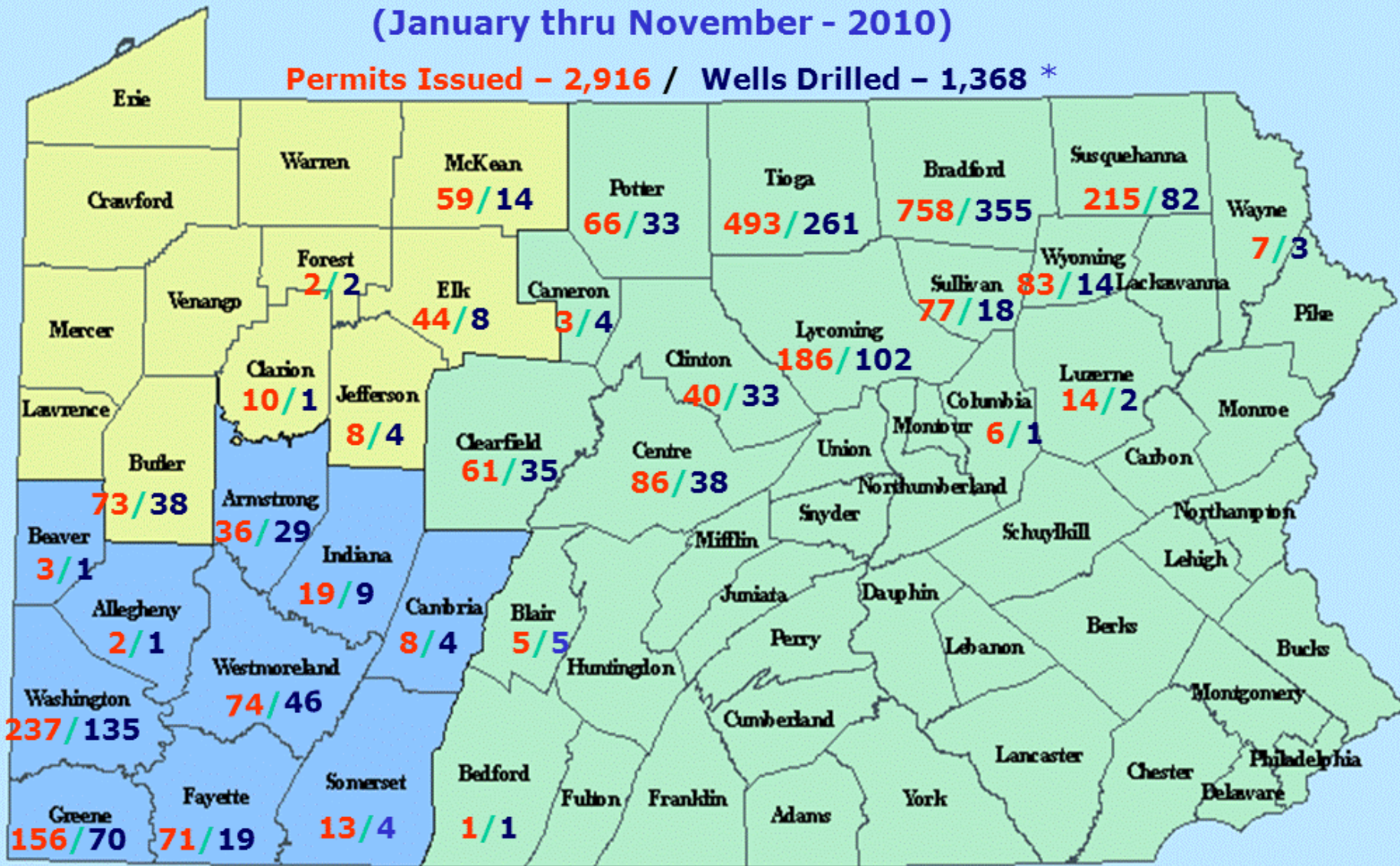
# How Large?

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- Lease payments
  - Up to \$5,000+ / acre
  - 12% - 20% royalty
    - State minimum  $1/8^{\text{th}} = 12\%$
- 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 \***

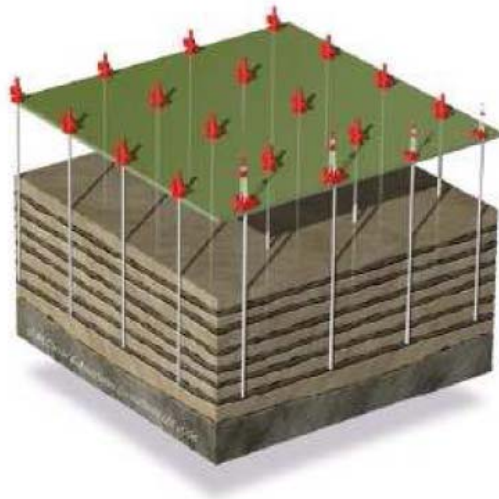


Updated 12/08/2010

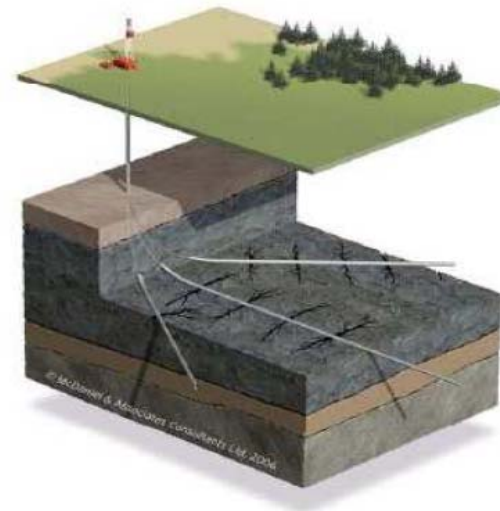
\* As reported by Operators

# Horizontal Drilling

## Horizontal Drilling



Traditional Wells



Horizontal Drilling

Source: America's Natural Gas Alliance

# Regulatory Structure

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- 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

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- 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

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- Regulates site development
- Erosion and Sediment Control Program
- Handling, treatment, and disposal of frac water and production fluids

# E&S Control Permit

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- Earth disturbance activity
- 5 acres or more
- Best management practices (“BMPs”)

# Dam Safety and Encroachments Act

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- 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

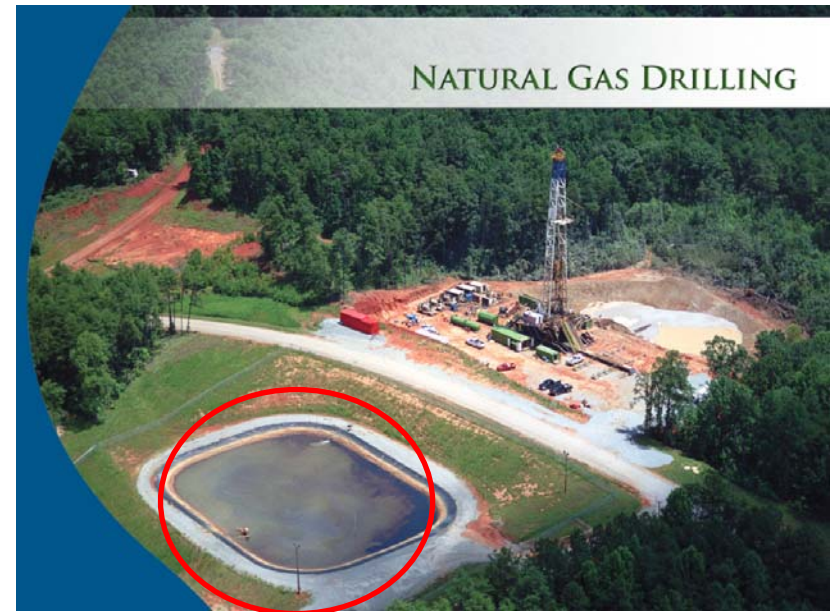
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- 58 P.S. §§ 451 – 459
- Regulates underground storage of gas in natural or man-made caverns
- Bonding requirements (\$100k / facility)
- 65 gas storage fields in 23 counties

# Water and Wastewater Storage

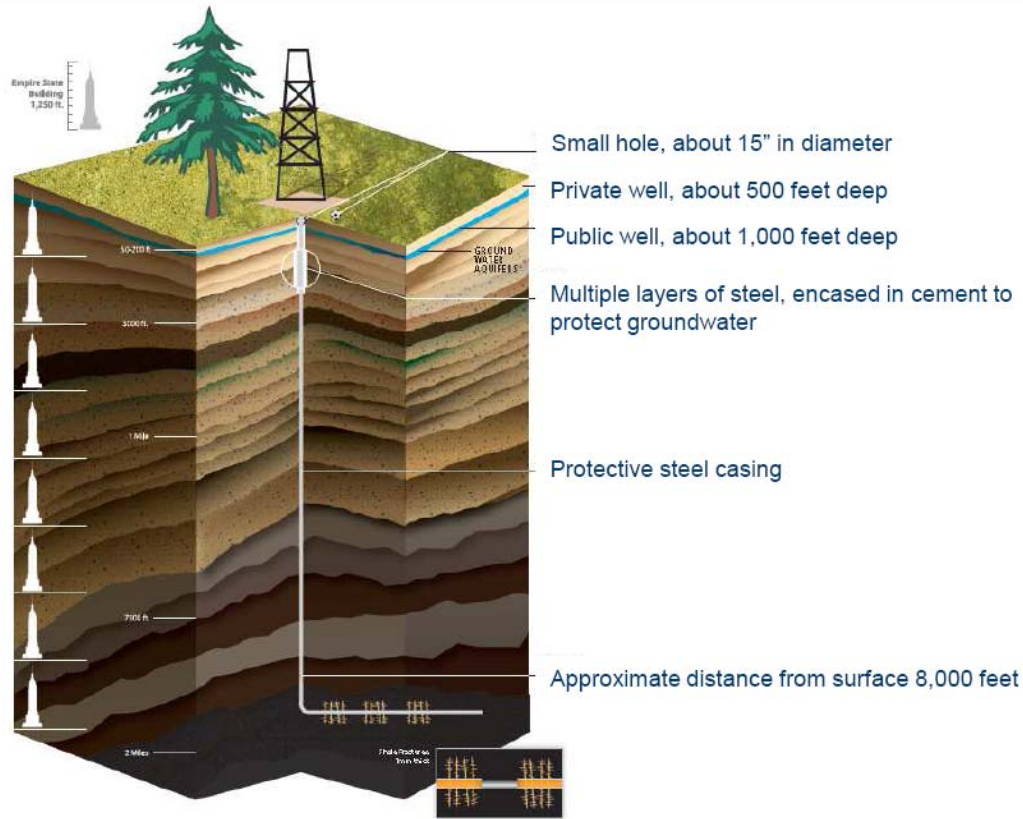
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- Centralized Impoundments
  - Service multiple wells
    - Fresh Water
    - Flowback



# Hydraulic Fracturing

## Hydraulic Fracturing



Source: America's Natural Gas Alliance

# Wastewater Management

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- 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

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- NORM and TENORM
  - Naturally occurring radioactive material
  - Technologically enhanced naturally occurring radioactive material



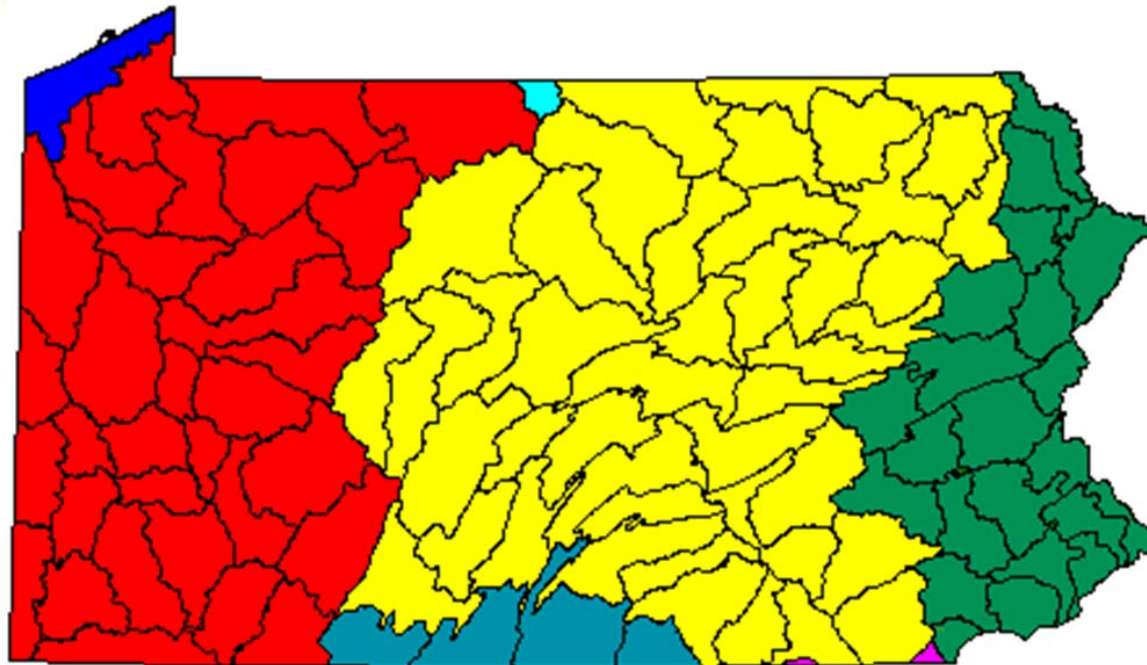
# Issues

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- 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

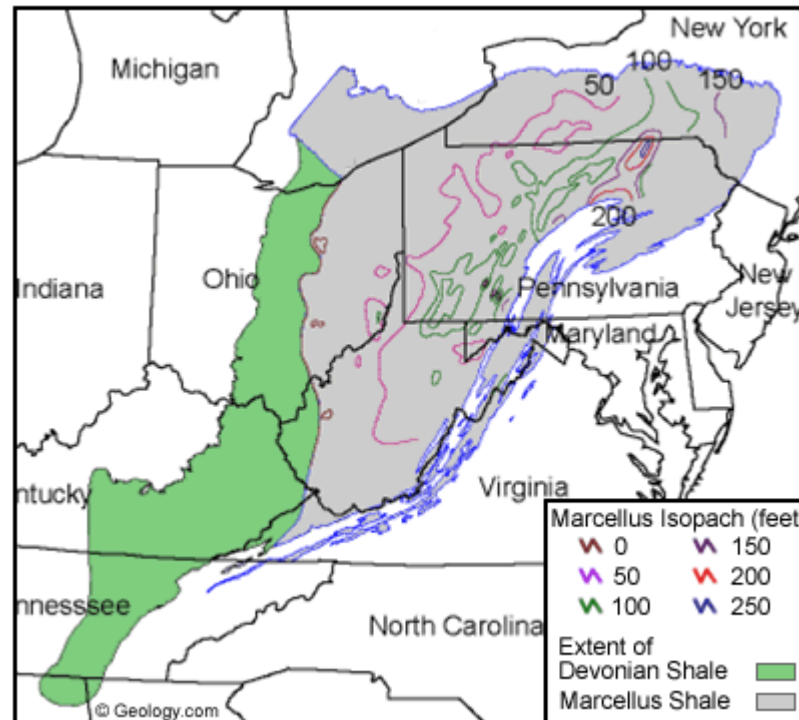
# Water Withdrawals

- Need permit
  - SRBC, DRBC, DEP



- |                                |                                     |
|--------------------------------|-------------------------------------|
| ■ Lake Erie                    | ■ Susquehanna River Basin           |
| ■ Ohio River Basin             | ■ Elk & Northeast/ Gunpowder Rivers |
| ■ Genesee River (Lake Ontario) | ■ Delaware River Basin              |
| ■ Potomac River Basin          |                                     |

# Maryland, NY and Beyond



# New York State

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- 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

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

# Maryland

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- 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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