RANGE RESOURCES®

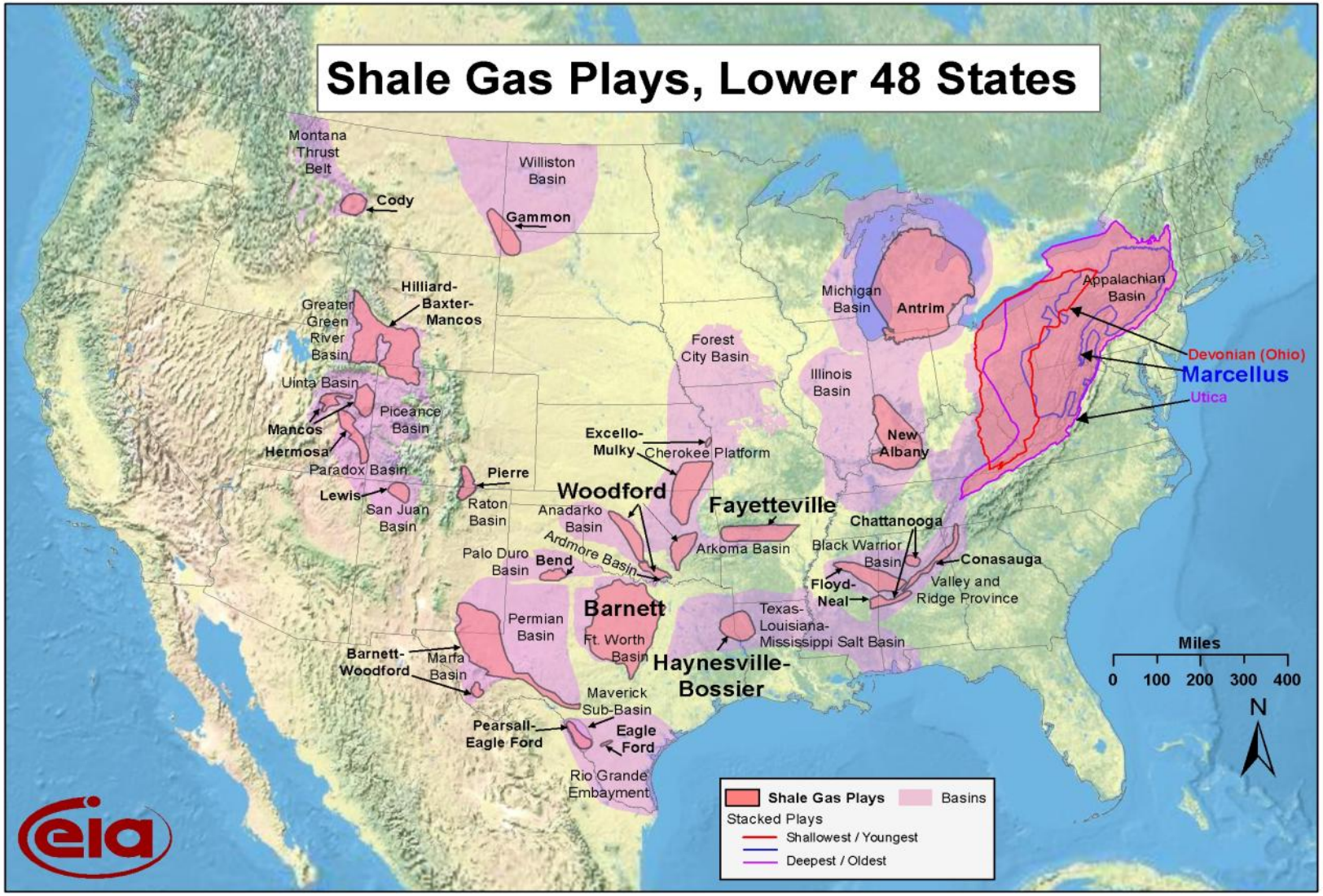
Marcellus Shale

2014

Range Resources

- Natural gas production company
- Included in S&P 500
- Regional Headquarters in Canonsburg, PA
- Pioneered Marcellus Shale, 2004
- More than $3 billion invested in Pennsylvania

North American Shale Plays



Source: Energy Information Administration based on data from various published studies.
Updated: March 10, 2010

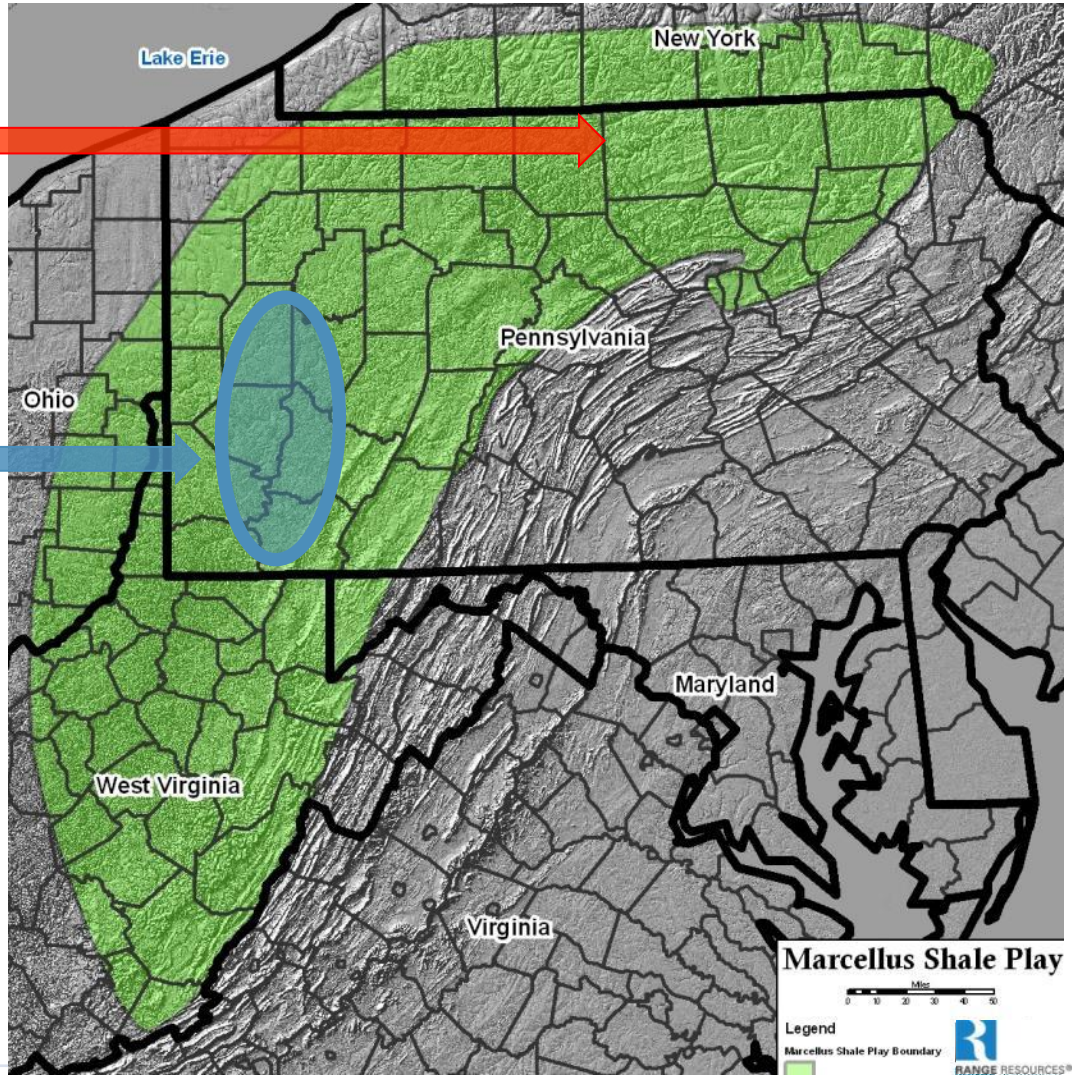
What is the Marcellus Shale?

- Large, natural gas rich, marine shale formation
- Spans across tens of million of acres
- Natural gas and hydrocarbons are trapped inside the solid shale

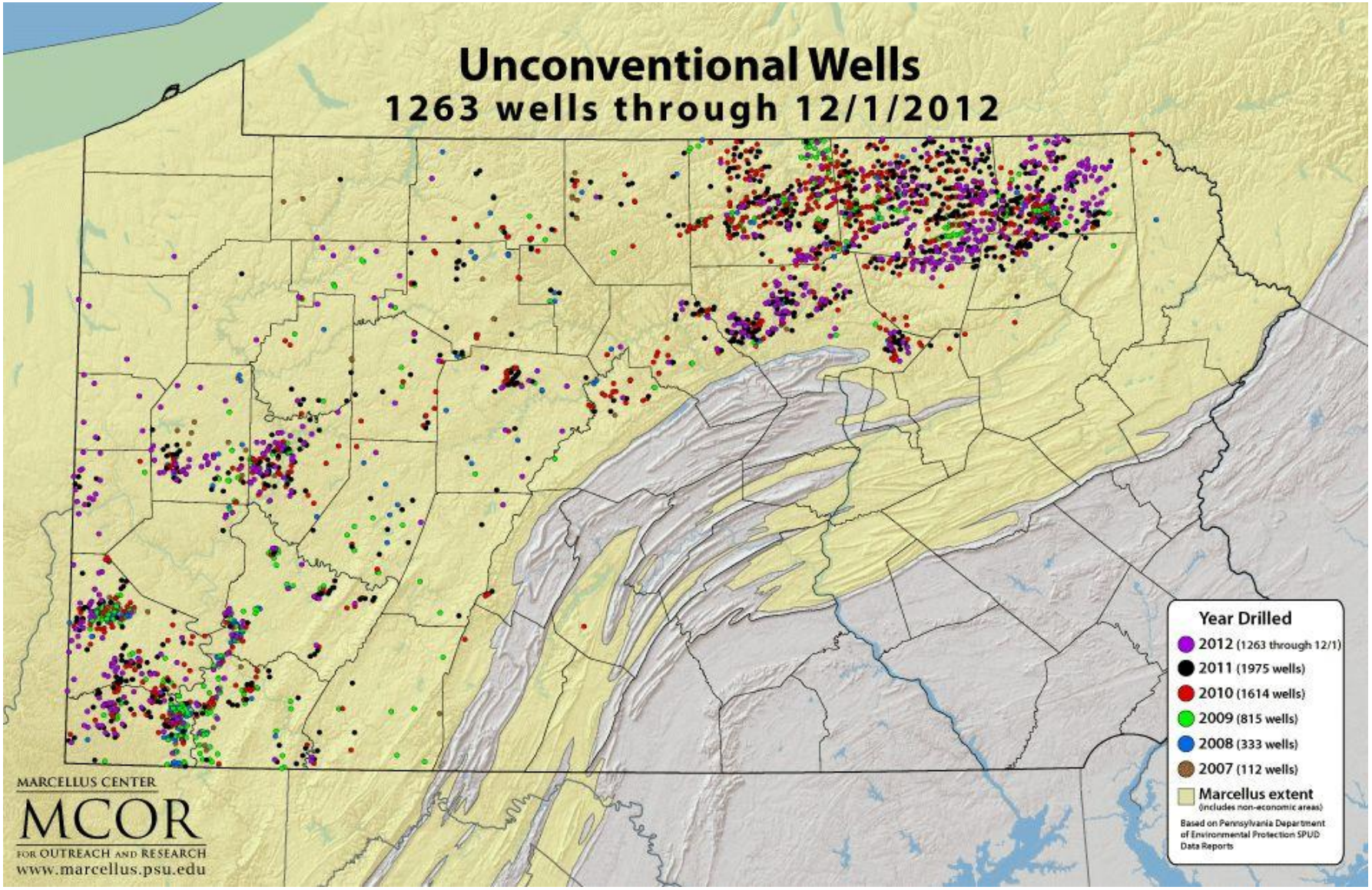
Marcellus Shale Play

Not all of the Marcellus will produce the same…

Size of the Barnett Shale, which provides 5% of US natural gas



Marcellus Wells Drilled



Marcellus Shale Development

State-of-the-art Technology - Proven Approach - Industry Expertise

Preparation → **Drilling** → **Completion** → **Production**

Preparation

Geoscientists determine drilling locations

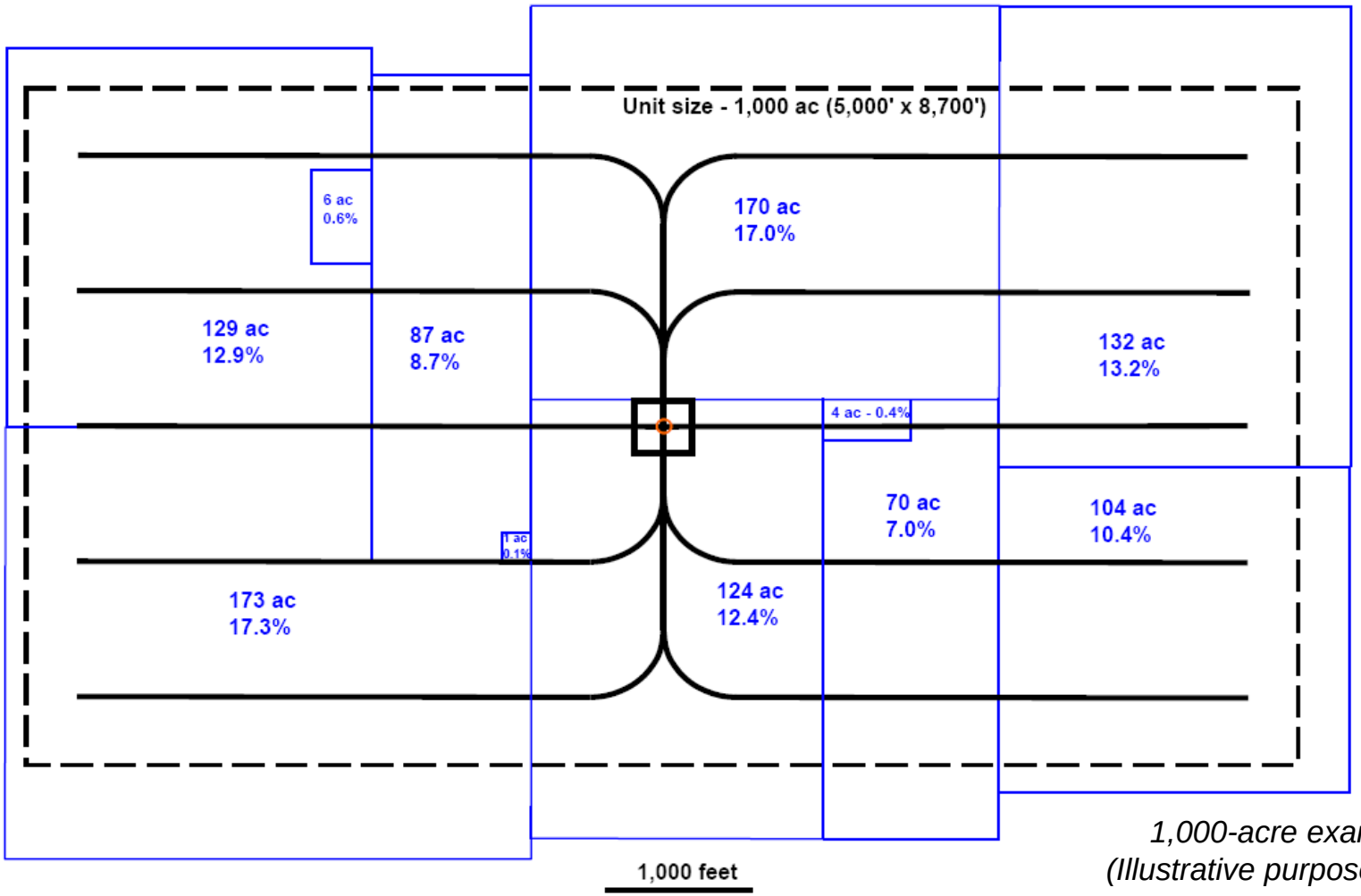
- 3-D seismic measurements
- Surface, sub-surface maps
- State-of-the-art Technology

Leases are Acquired

- Oil & gas owners (frequently the surface owner) are offered compensation for leasing rights to their property

- In addition to initial lease payment, oil & gas owners also receive royalties on natural gas sold from the wells in their unit

Unitization



1,000-acre example
(Illustrative purposes only)

Royalties are divided in proportion to the percentage of land that each land tract contributes to the total unit.

Pre-Drilling

Prior to receiving a permit…

- Required to do a full biological and endangered species evaluation of the area.

- Required to pre-test all waters sources within 1,500 feet of a new well site before construction. Range typically tests all water sources within 3,000 feet.

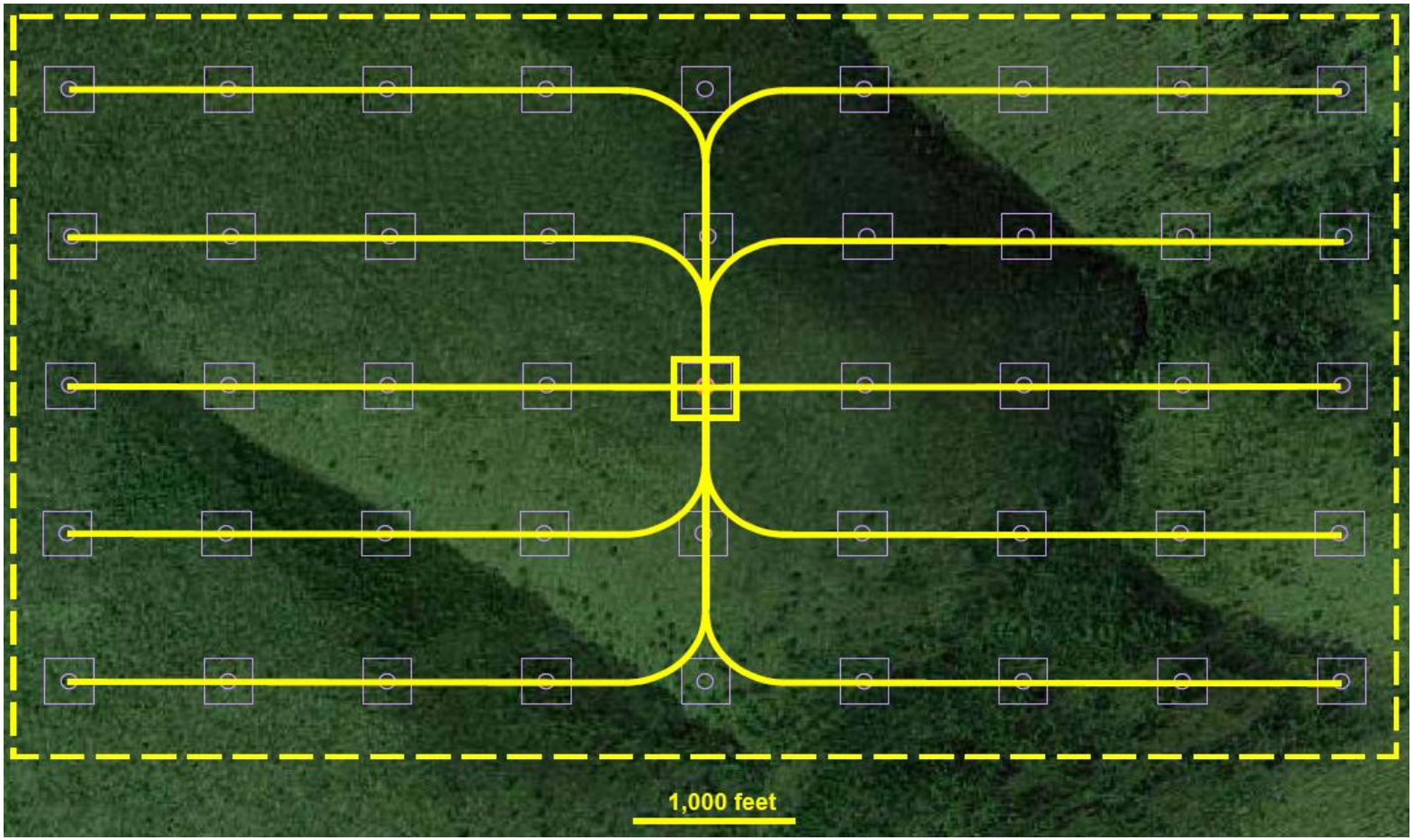
Site Preparation

Drilling

- State-of-the-art technology
- Multiple wells, single site
- Footprint is 4-6 acres
- Each well takes 3-4 weeks to drill on average

Utilize two rigs: Vertical and Horizontal

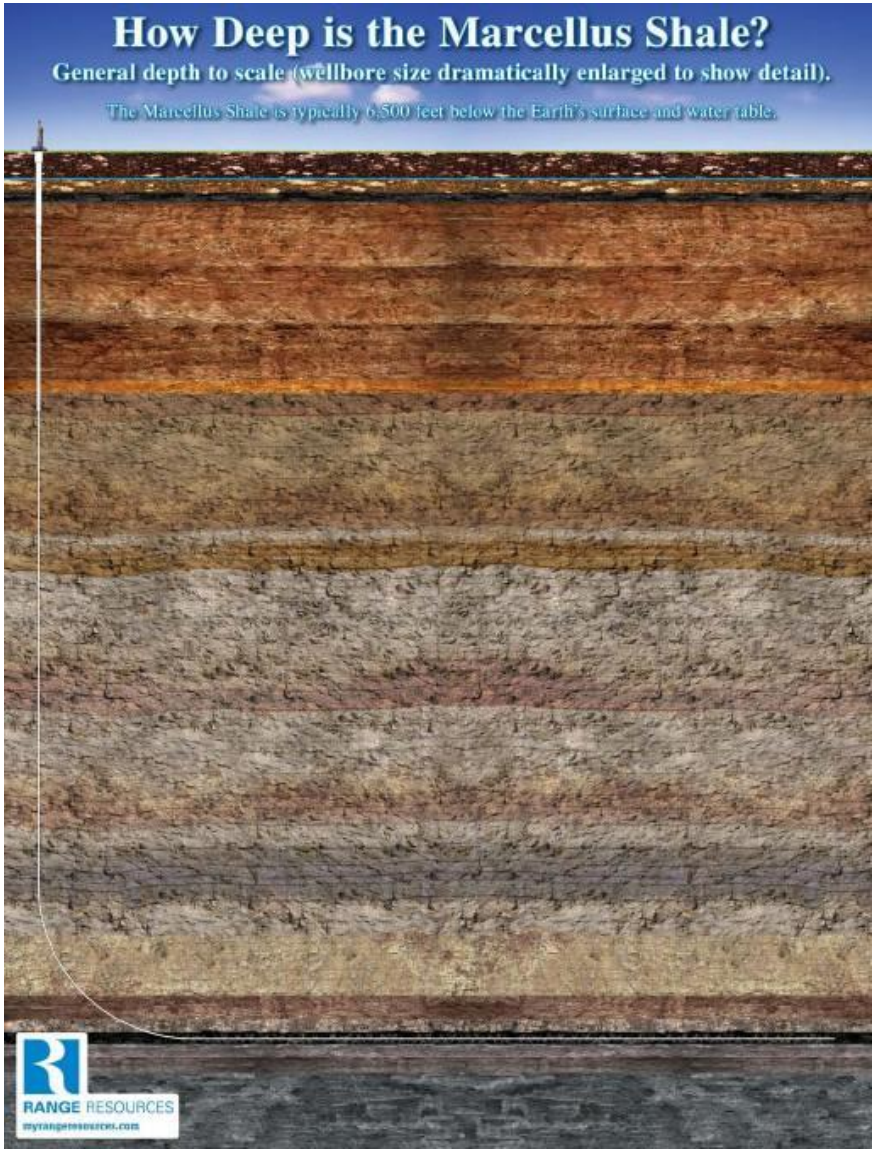
Horizontal Drilling



Total surface disturbance during drilling, including access road, drilling pad and required pipeline infrastructure:

- **Horizontal (yellow) develop 640 acres per pad with less than 1% surface disturbance**

Horizontal Technology



- Drill 5,000-8,000’ vertical up to 3,000’ horizontal
- Roughly 2 miles of drilling, spot-on accuracy
- Reduce surface disturbance, with less environmental impact

How Do You "Drill Horizontal"

Small bend in drilling motor assembly, roughly 1-2° , drills the curve over the course of 900', at a rate of 10° per 100' to achieve a 90° turn horizontally.

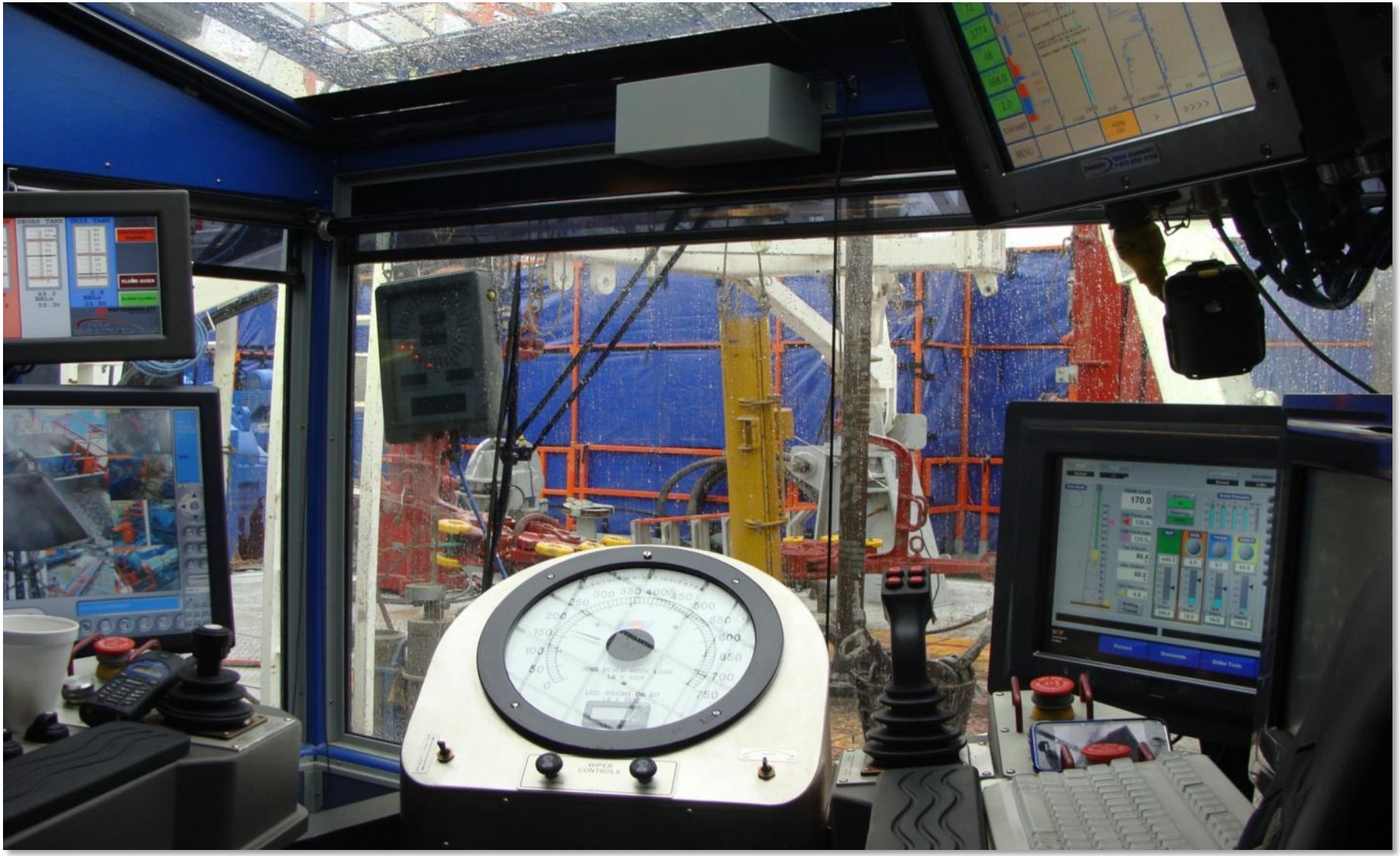
It's not abrupt, rather a gradual sweeping motion.

Drill Bits

- Used for specific types of drilling
- Can vary depending on rock formation

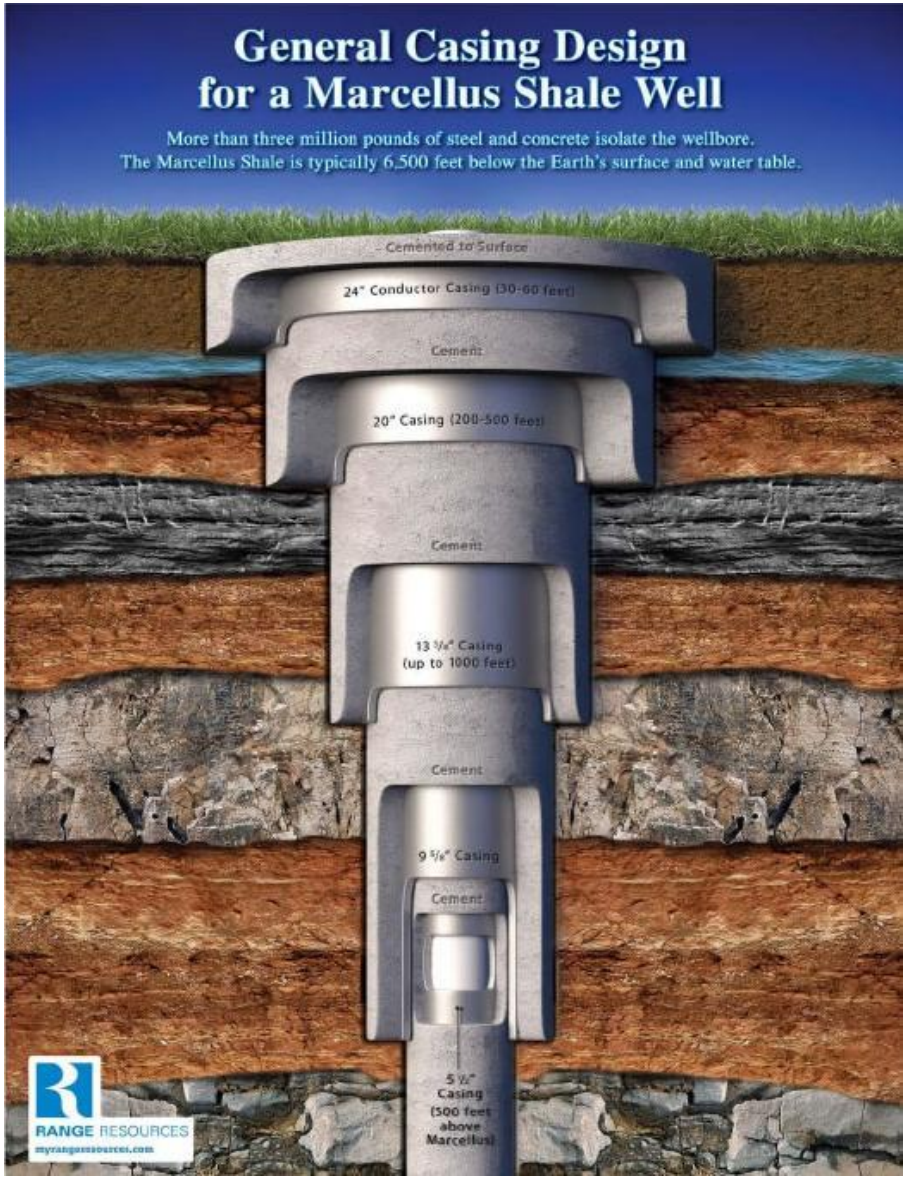
Closed-Loop System

Doghouse



Drilling Pad

Well Casing



- A well is comprised of 5 strings of casing that gradually get smaller, like a telescope.
- Each string is fully cemented to the surface and allowed to set for at least 8 hours.
- Over 3 million pounds of U.S. steel and cement go into each well.

Completions

Hydraulic fracture stimulation or fracing is: the injection of fresh water and sand at high pressure, into the formation fracturing the rock and safely releasing the gas.

Each well is completed in stages starting at the toe of the wellbore and working out towards the heel.

A typical Marcellus frac job requires 4-5 million gallons of water per well.

Completions

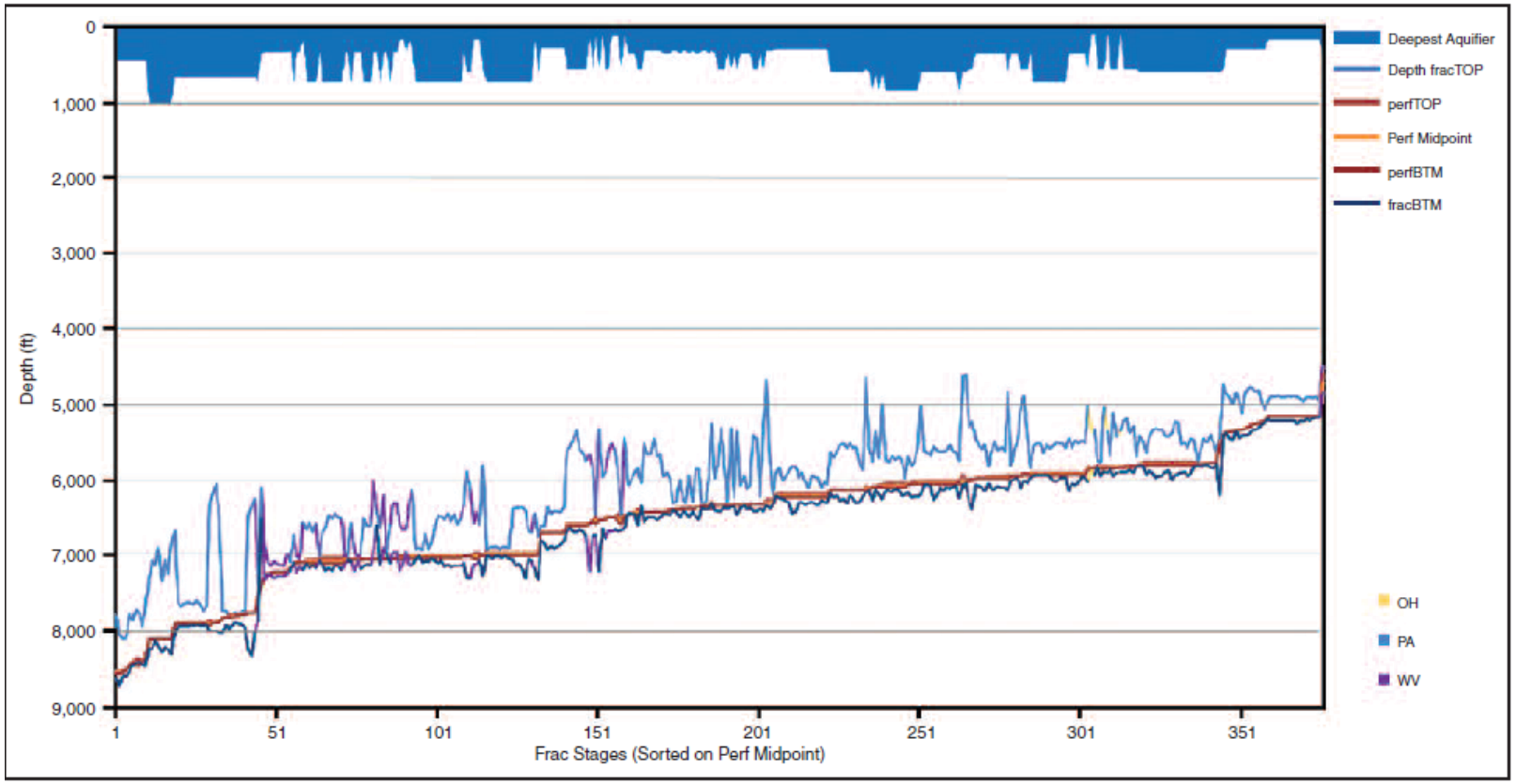
Command Center

Hydraulic Fracturing

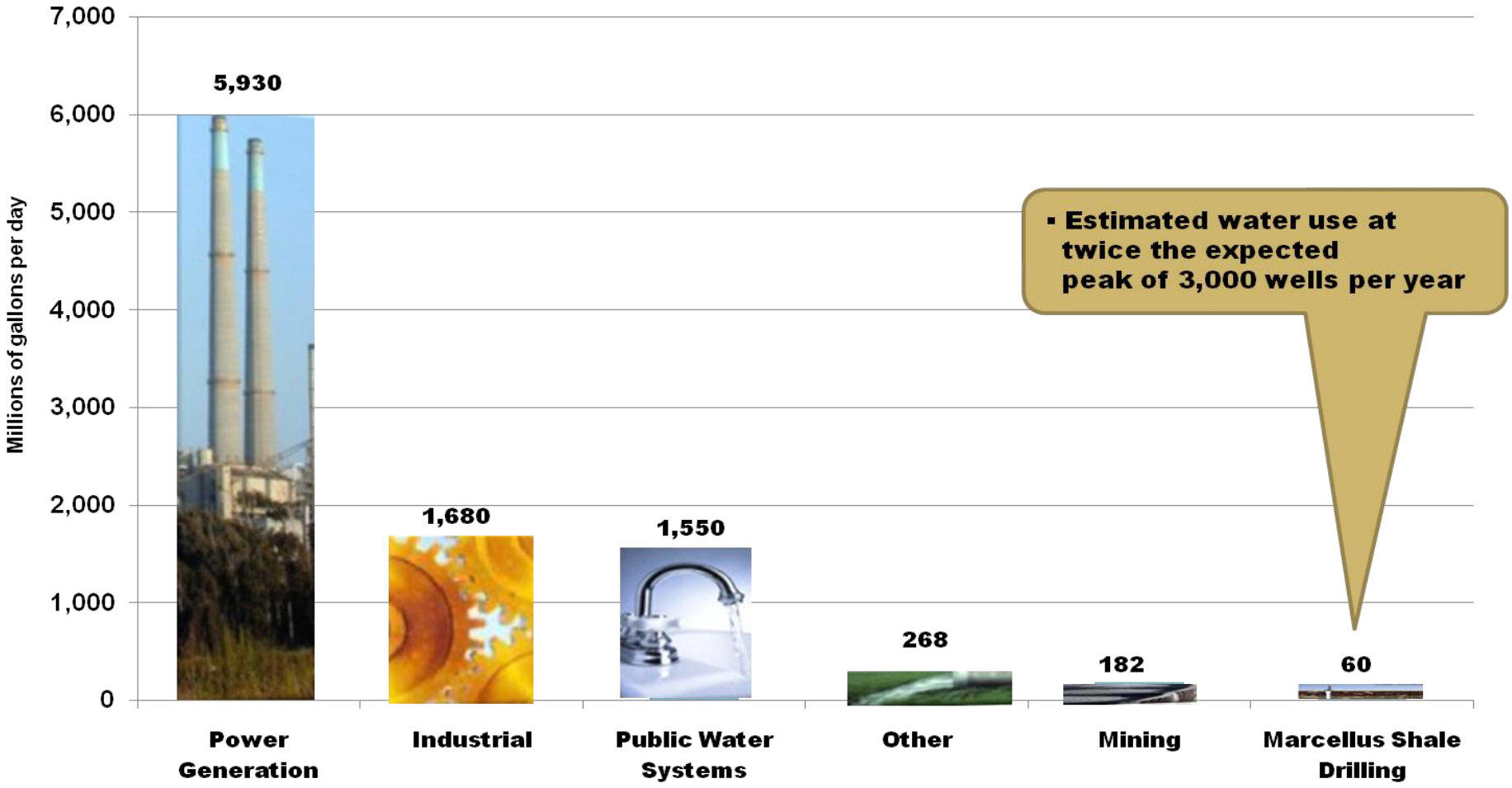
THE AMERICAN OIL & GAS REPORTER

The shallowest fracture tops are still ±4,500 feet, almost one mile below the surface and thousands of feet below the aquifers.

Marcellus Shale Mapped Fracture Treatments (TVD)



Water Usage Comparison



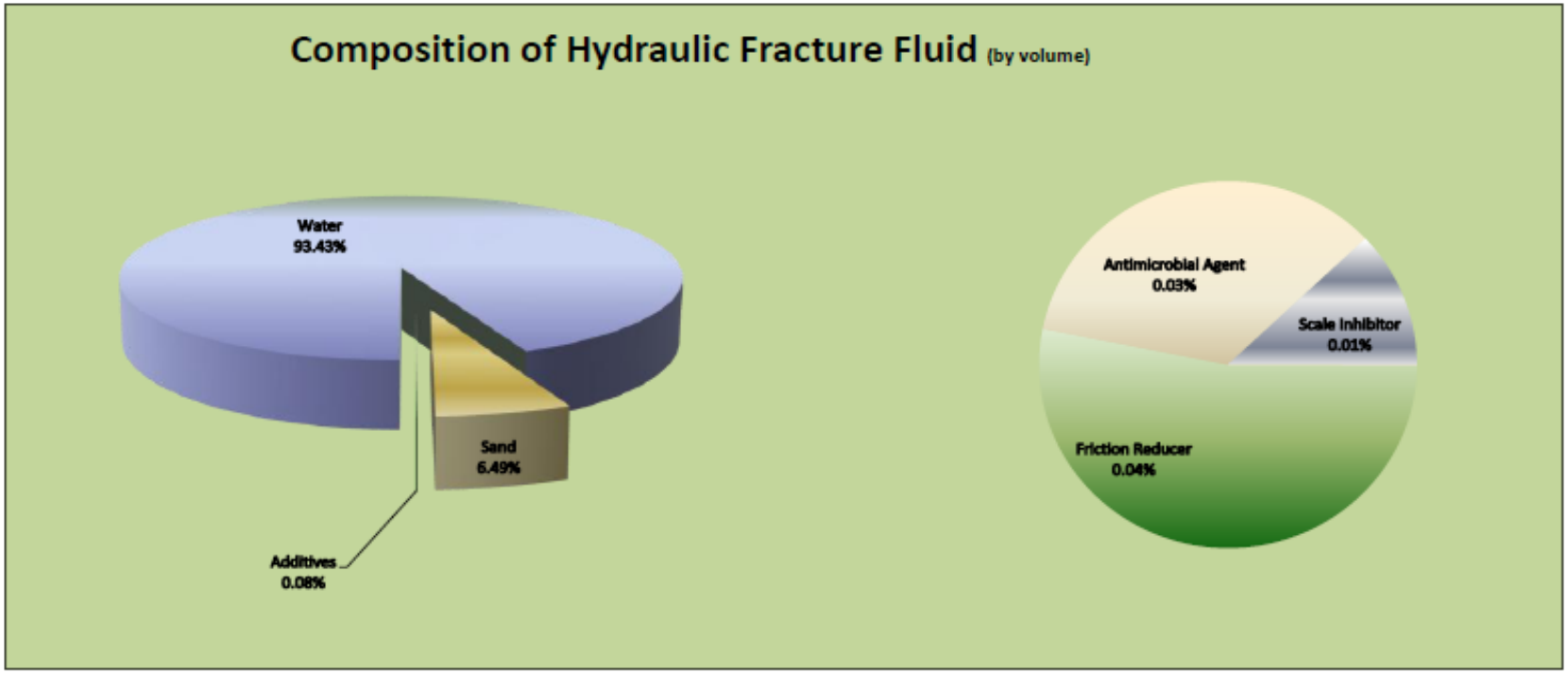
Source: USGS, Pennsylvania Water Consumption

Hydraulic Fracturing Fluid

Yute Unit #4H
Well API: 37-003-21982

Completion Date: 11/29/10 - 12/7/10
Township: Frazier

% Composition of Hydraulic Fracture Fluid (by volume)						
Product Name	**Additive**	**Purpose**	**Use and Dillution**	**Volume**	**Overall %**	**Common Uses**
Water	Carrier Fluid	Creates fracture network in shale and carry proppant to the formation	Primary constituent	3,115,601 gal	93.427%	Water is the most abundant molecule on the Earth's surface
Sand	Sand	Allows fractures to remain open so gas can escape	Second most common constituent, making up almost 6% of the fluid	216,599 gal	6.495%	Drinking water filtration, play sand
FRW-200	Friction Reducer	Reduces friction between fluid and pipe	Diluted at one-half gallon per 1,000 gallons of water	1,377 gal	0.041%	Water treatment; soil conditioner; some children's toys
MC B-8650/Bioban	Antimicrobial Agent	Eliminates bacteria in the water that produce corrosive byproducts	Diluted at one-half gallon per 1,000 gallons of water	0,903 gal	0.027%	Water treatment, disinfectant; sterilize medical and dental equipment and surfaces
MX 588-2	Scale Inhibitor	Prevents scaling in pipe	Diluted at one-tenth gallon per 1,000 gallons of water	313 gal	0.009%	Water treatment, household cleaners, de-icing agent



Water Impoundment

Water Transfer

Water Lines Walked Daily

Production

- Following fracing, water is flowed back and to clean out the wellbore
- Small footprint – wellhead, separators, production tanks

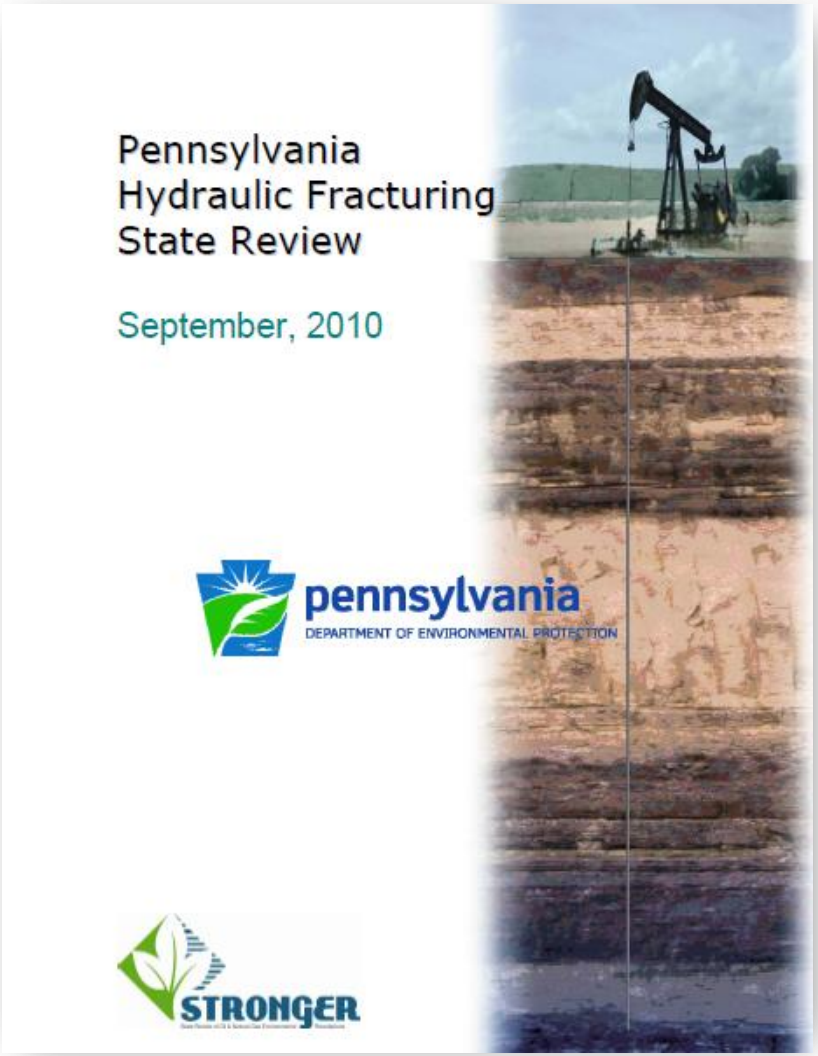
Production

Vapor Controls

Environmental Regulations & Protections

State Review of Oil & Natural Gas Environmental Regulations (STRONGER): state regulators, NGOs, EPA, DOE and others – "Pennsylvania regulations deserve 'special merit' and among best in nation."

U.S. Secretary of Energy Advisory Board, directed by President Obama & lead by former U.S. Central Intelligence Administration director and assistant Secretary of Defense John Deutch said that *many of their national recommendations were based on Pennsylvania standards*



Environmental and Safety Record - Water

Despite strong results and adequate regulation, we must continue to diligently monitor air and develop improved technologies

US Environmental Protection Agency Administrator, Lisa Jackson – *"I'm not aware of any proven case where the fracking process itself has affected water."*

Pa DEP Oil and Gas Secretary Scott Perry – *"There has never been a case of fracking fluid causing direct contamination of groundwater"*

- Countless state and federal studies have reached the same conclusions
- Potential for human or mechanical errors that may result in impacted water
- According to the DEP in a letter to the Groundwater Protection Council in 2009, approximately 0.25% of all oil and gas wells may impact groundwater, typically turbidity
- Company subjected to fines, payments & legally responsible for all repairs
- None of those cases had a negative impact on health or the environment

Confirmed by researchers at the Center for Rural Pennsylvania and Penn State

Environmental and Safety Record - Air

Despite strong results and adequate regulation, we must continue to diligently monitor air and develop improved technologies

Pennsylvania Department of Environmental Protection – conducted a series of five-week tests using the DEP's Laboratories Mobile Analytical Unit and stated:

- *"DEP finds no health threat from Marcellus air emissions."*

Texas Commission on Environmental Quality – conducted a similar, but longer term and more expansive and determined:

- *"Air Monitors Show No Levels of Concern in Barnett Shale Area."*

Texas Department of Health – conducted a series of blood and urine tests of residents and determined:

- *"No negative health impacts or clusters, including cancer and abnormal levels of carcinogens beyond the general population."*

City of Fort Worth – conducted a year-long air study and their report:

- *"Did not reveal any significant health threats"*

Activity

Inconveniences

- Dusty
- 24-hour operations
- Truck traffic
- Noise and lights
- Some road damages
- **Temporary**

Thank You

Additional Information:

www.rangeresources.com

www.marcelluscoalition.org