



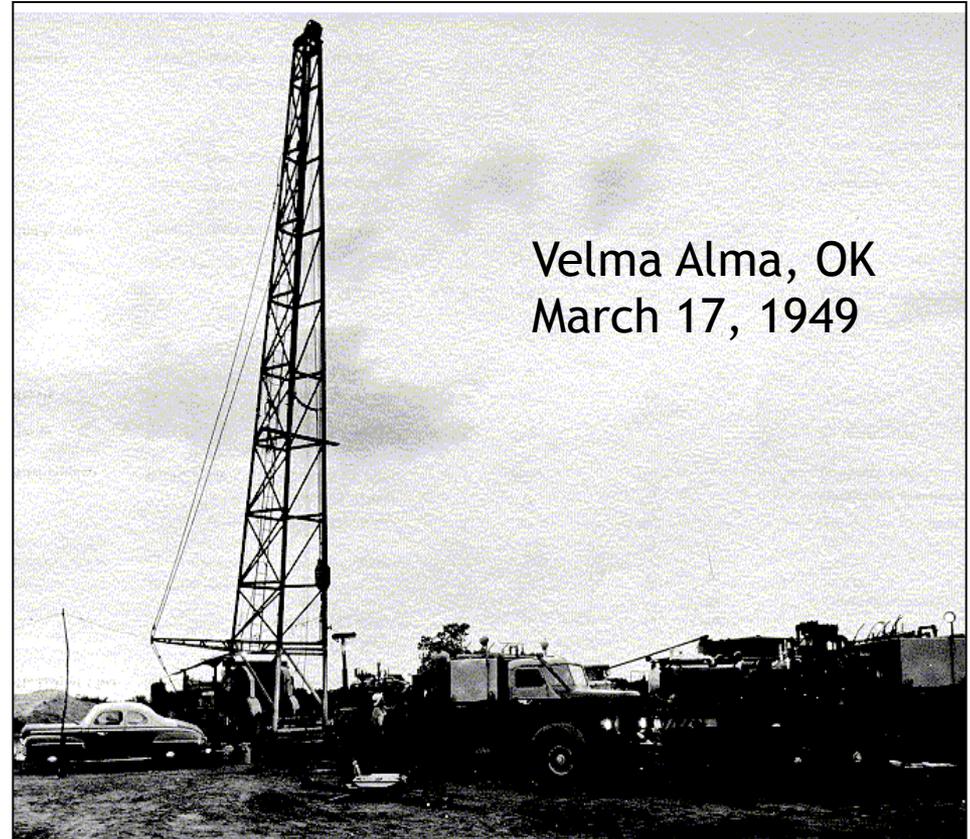
Energy Water Conservation & Recycling

33rd Annual Governor's Water Conference
November 13, 2012

Richard Luedecke
Vice president, Environmental, Health and Safety

The First Commercial Fracture Stimulation

- Fracture stimulation is a well-established technology with a strong environmental and safety record
- The technology has been used to complete more than 1 million wells over the past 60 years



Presentation Outline

Devon Overview

- Well Life Cycle Phases
 - Drilling
 - Completion
 - Production
- Regulation
- Hydraulic Fracturing: The Process
 - Technology Role
 - Water

Devon History

- Founded as a private company in 1971
- Became a public company in 1988
- Currently listed on the New York Stock Exchange under the ticker symbol DVN
- Has grown from 185 employees in 1981 to more than 5,000 employees today
- Established a portfolio to provide stable production and a solid platform for future growth



Devon Today

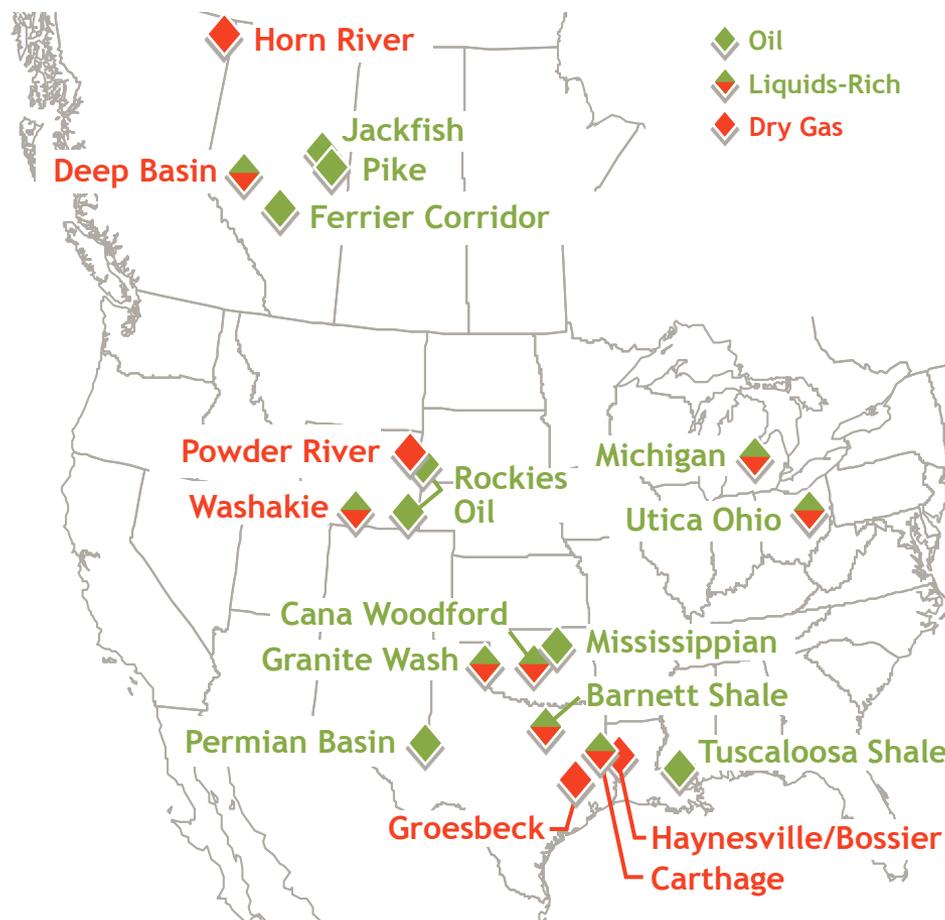
Proved reserves: \approx 3.0 billion BOE
(42% liquids)

Q2 2012 production: 679 MBOED

Production mix: 22% oil
15% NGLs
63% natural gas

Significant midstream business
2012e operating profit: \approx \$385 million

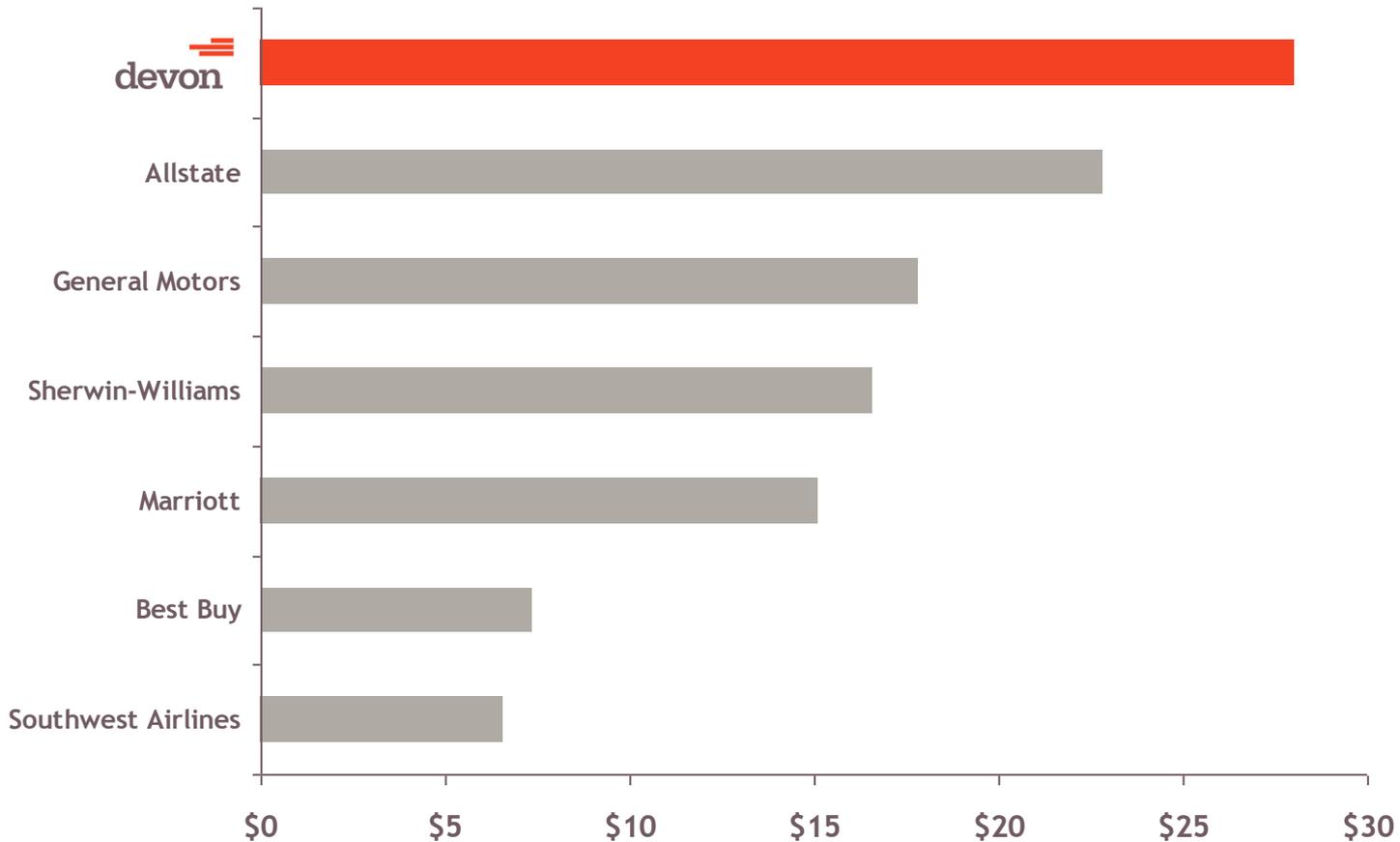
Enterprise value: \approx \$25 billion



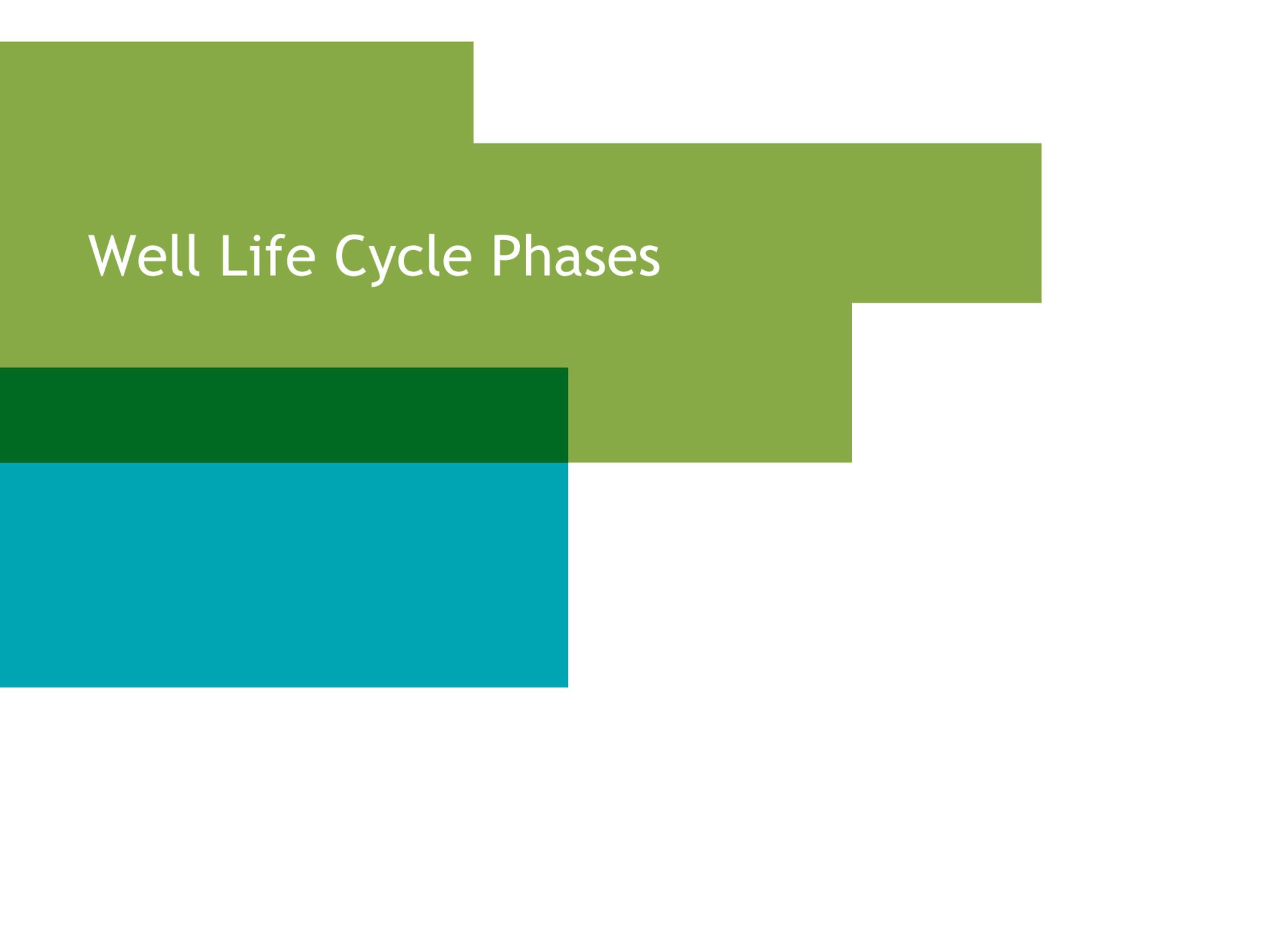
Larger than you might think...

Enterprise value

In billions of U.S. dollars



Source: Enterprise value as stated on Yahoo! Finance on Oct. 1, 2012.



Well Life Cycle Phases

Well Life Cycle Phases

- Drilling: creating the bore hole
 - Location construction
 - Well construction planning
 - Drilling – implementation of the construction plan
 - Installation of casing strings
- Completion: make ready for production
 - Perforate the casing
 - Fracture stimulate the reservoir
 - Install production tubing
 - Install surface production equipment
- Production: efficiently extract the hydrocarbons
 - Separate water, gas, liquid hydrocarbons
 - Manage operating costs
 - P&A

Drilling



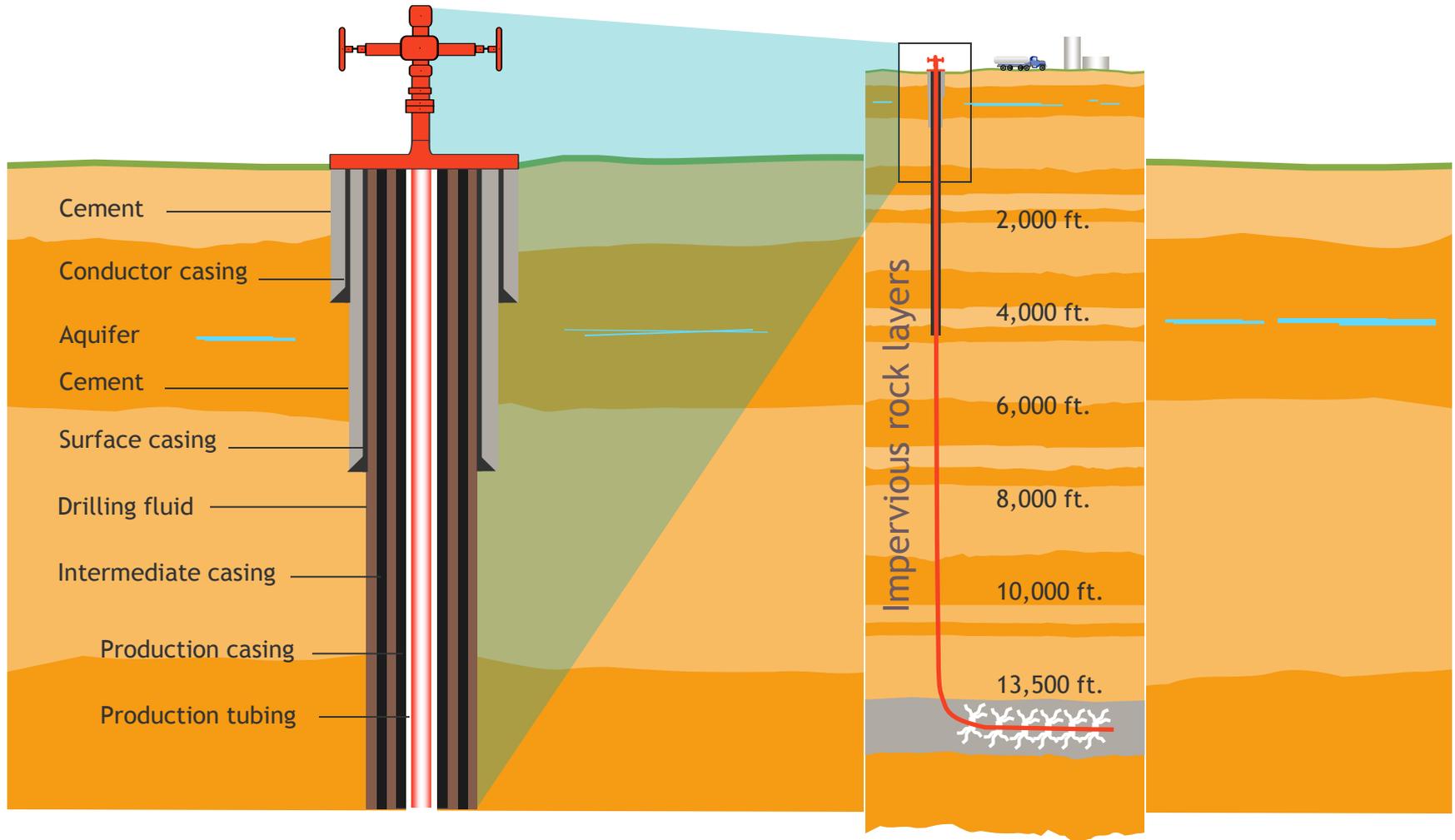
Regulation of Well Construction

State's Role

- States manage the oversight and enforce federal law and state rules
 - Have the on-the-ground personnel and expertise
- State-led enforcement allows fit-to-purpose solutions for localized issues
- Regulated activities:
 - Well design
 - Well location
 - Well spacing
 - Well operation
 - Water management and disposal
 - Waste management and disposal
 - Air emissions
 - Wildlife impacts
 - Surface disturbance
 - Worker health and safety

Groundwater protection Through proper well construction

In the Cana Field (Woodford Shale)



Hydraulic Fracturing



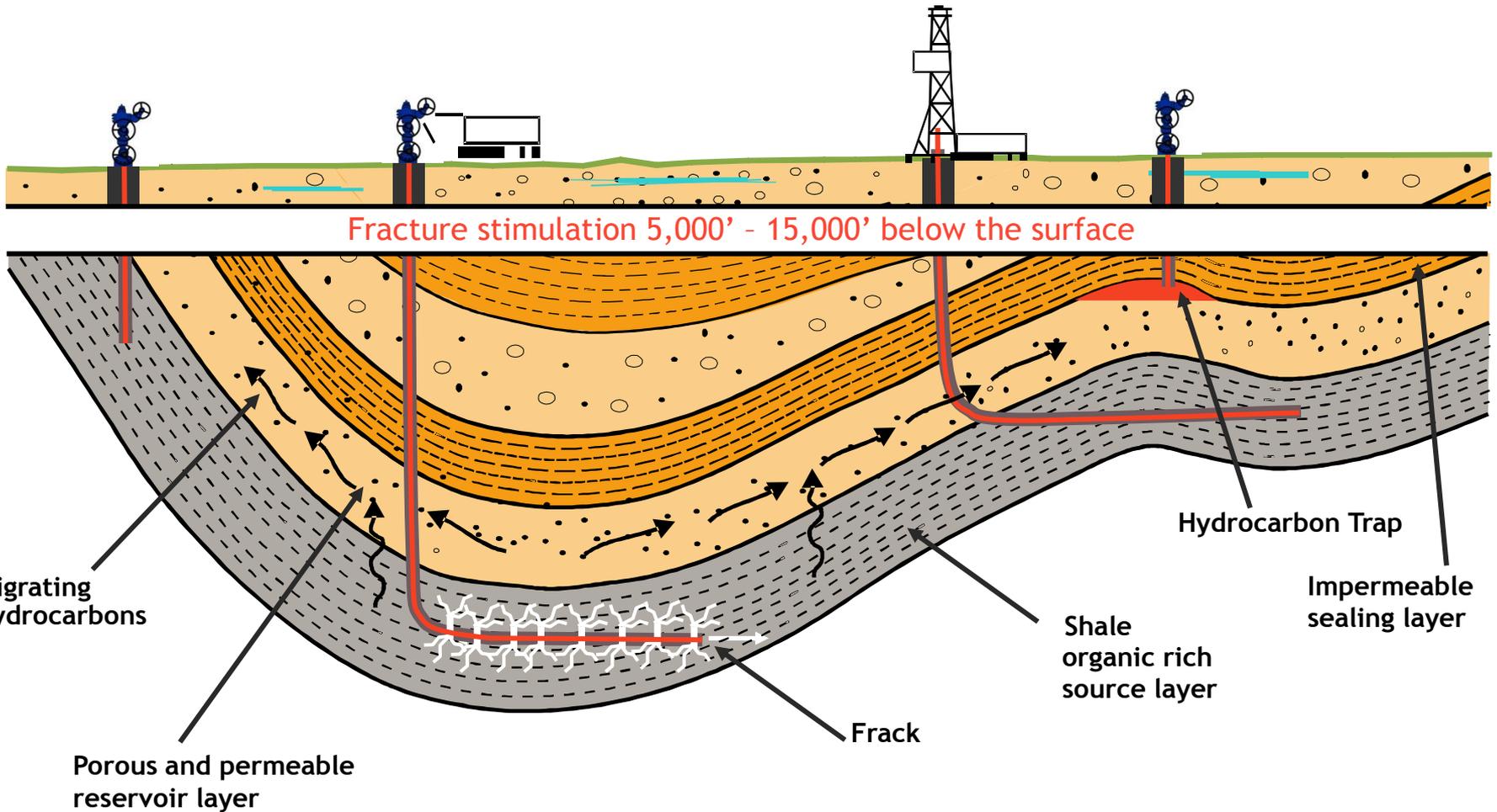
Technology's Role

- In the late 1970s, George Mitchell, then president and CEO of Mitchell Energy, became concerned about the longevity of his gas reserves.
- He challenged his engineers to think outside the box and identify additional reserves on their existing leases.
- Mitchell knew when drilling through the Barnett Shale that well logs would register “a kick in gas,” but common knowledge was that the shale wasn’t porous enough to give up whatever it held.
- Despite the cautioning of his engineers and investing nearly two decades of time and millions of dollars into fracture experiments on 30 wells, many of which were at a loss, Mitchell’s persistence paid off.
- Eventually, he found that “slick water,” a combination of a surfactant, water and sand, opened the shale.
- In 2002, following Devon’s acquisition of Mitchell Energy, we coupled the technique of horizontal drilling with hydraulic fracturing to revolutionize the industry.

Technology's role

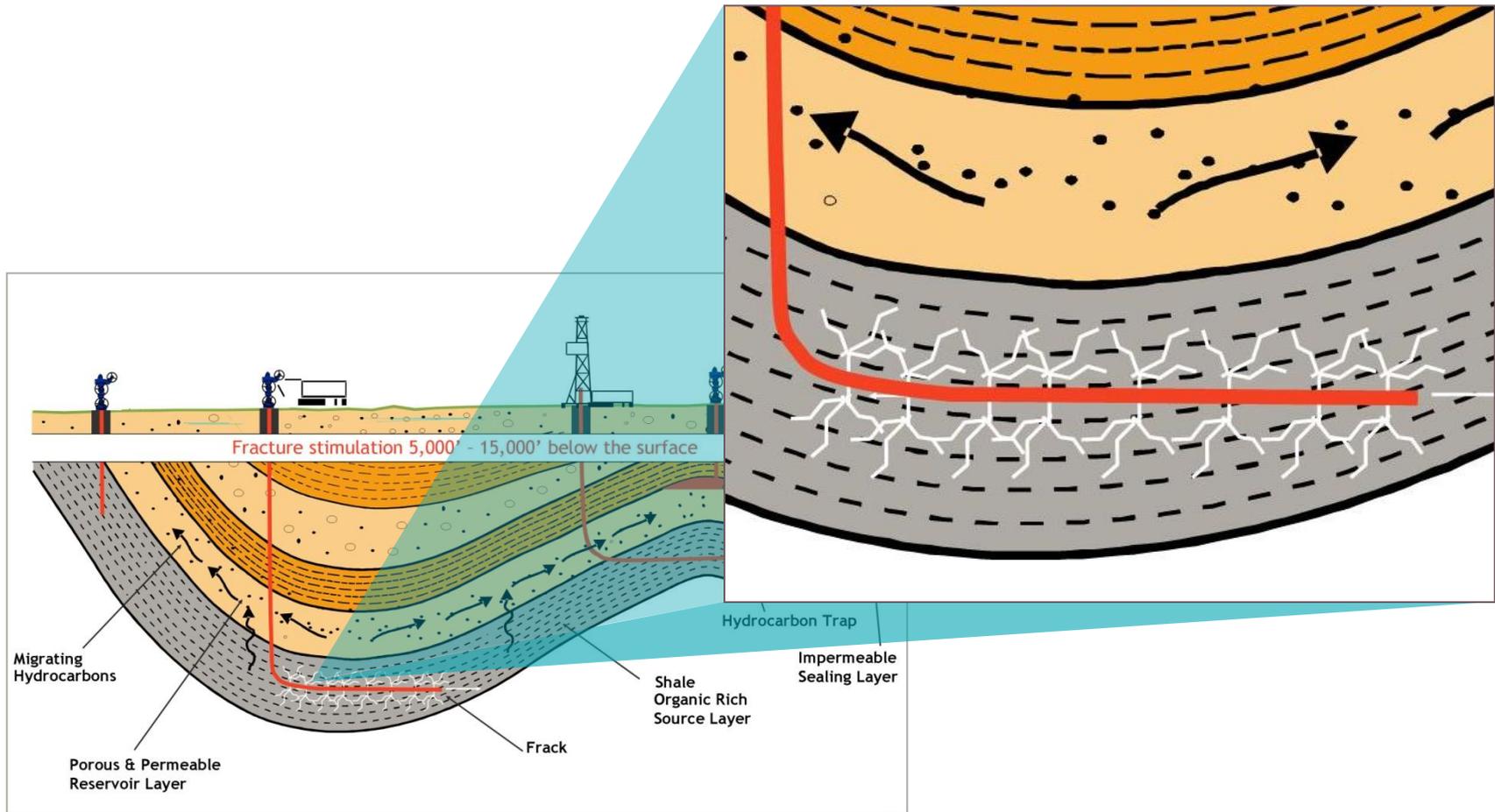
Why the revolution

Traps vs. shales

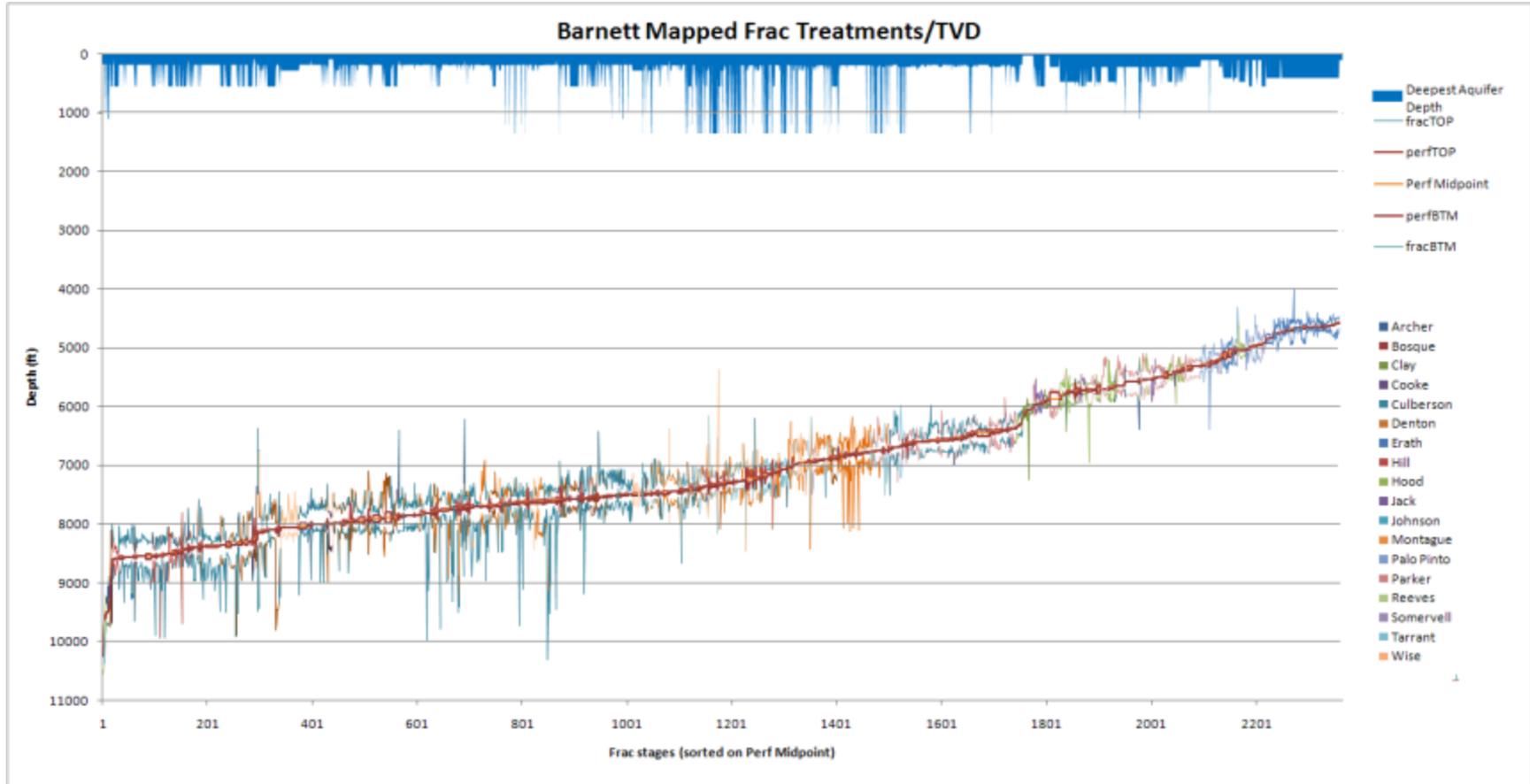


Hydraulic fracturing

Key to the revolution



Mapped Fracture Treatments Barnett Shale



Kevin Fisher, "Data Confirm Safety of Well Fracturing" *The American Oil & Gas Reporter* – July 2010

GWPC/IOGCC Chemical Registry

FracFocus



[HYDRAULIC FRACTURING](#)
HOW IT WORKS

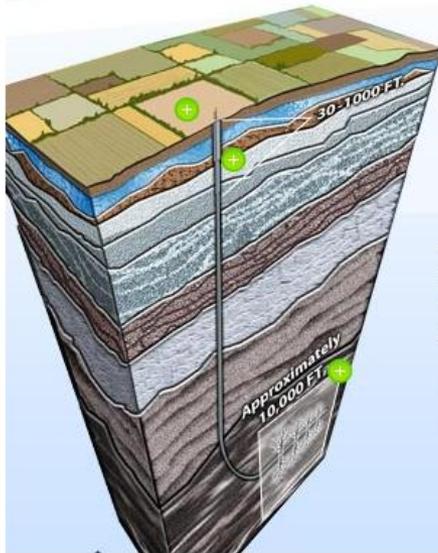
[GROUNDWATER](#)
PROTECTION

[FIND A WELL](#)
BY STATE

[REGULATIONS](#)
BY STATE

[CHEMICALS](#)
GLOSSARY

[FREQUENT](#)
QUESTIONS



Hydraulic Fracturing & HOW IT WORKS

This technique uses a specially blended liquid which is pumped into a well under extreme pressure causing cracks in rock formations underground. These cracks in the rock then allow oil and natural gas to flow, increasing resource production.

[LEARN MORE ABOUT CASING >](#)

Hydraulic Fracturing Process

[History of Hydraulic Fracturing](#)

[Hydraulic Fracturing: The Process](#)

[Site Setup](#)

[Casing](#)

[Fracturing Fluid Management](#)

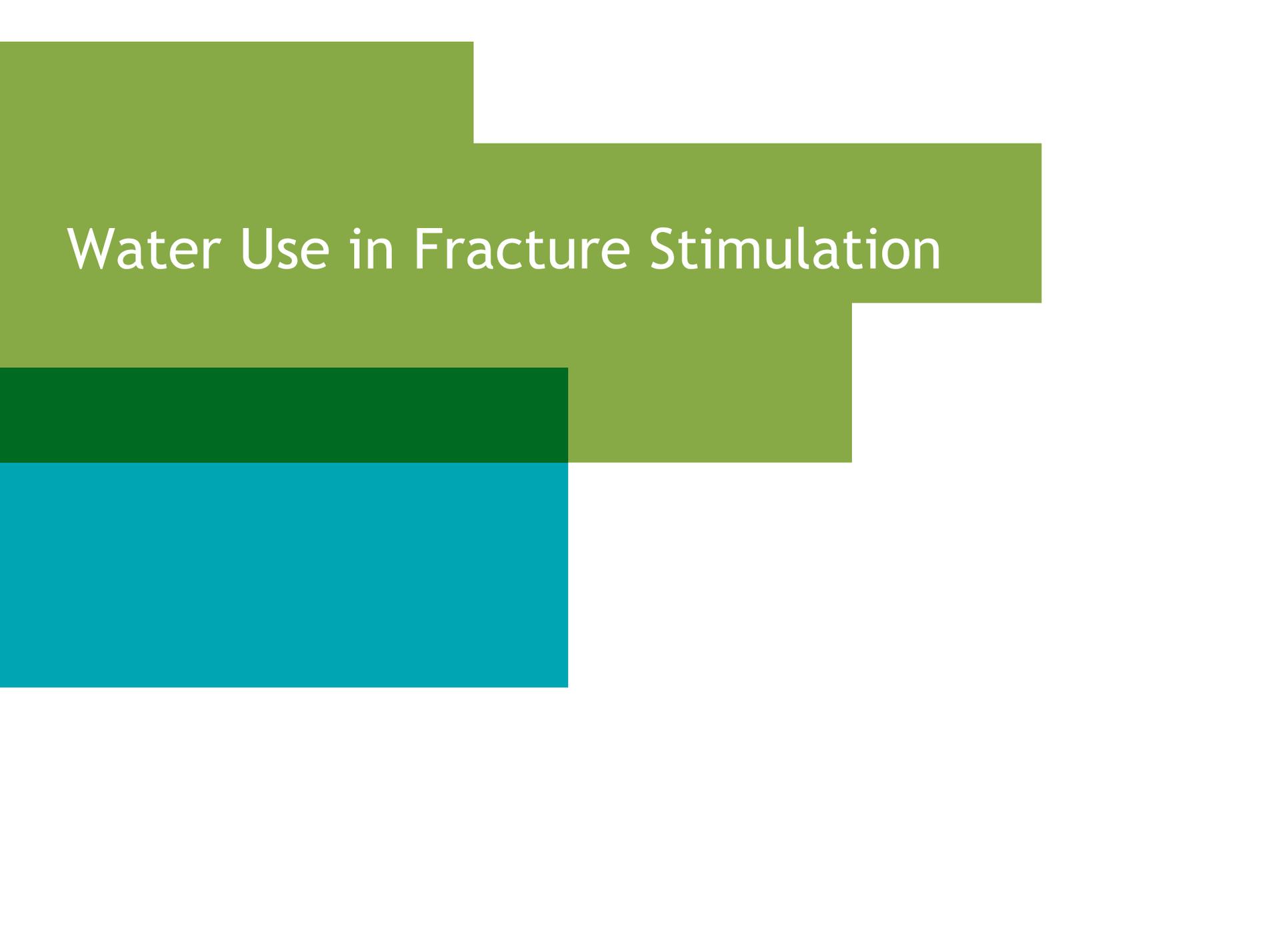
Looking for information about a well site near you?



Groundwater Protection

Where's the Problem?

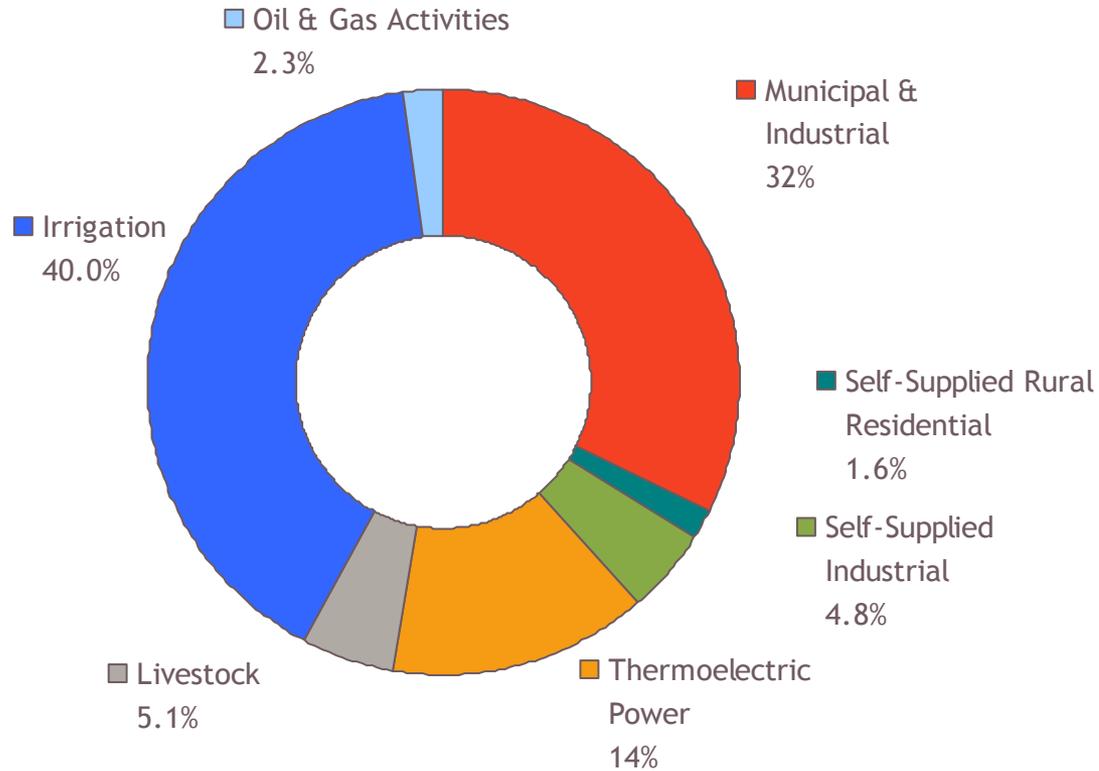
- **Lisa Jackson, EPA Administrator:**
 - Unaware “of any proven case where the fracking process itself affected water.” (U.S. Senate testimony, [05/11](#))
- **Taury Smith, NY State’s Top Geologist:**
 - “He said he has been examining the science of hydraulic fracturing the shale for three years and has found no cases in which the process has led to groundwater contamination.” (Albany Times Union, [3/14/11](#))
- **John Hanger, former PA DEP Secretary and Former PennFuture CEO:**
 - “It’s our experience in Pennsylvania that we have not had one case in which the fluids used to break off the gas from 5,000 to 8,000 feet underground have returned to contaminate ground water.” (Reuters, [10/4/10](#))
- **Colorado Oil and Gas Conservation Commission:**
 - “There has been no verified instance of harm to groundwater caused by hydraulic fracturing.” (Regulatory Statements on Hydraulic Fracturing, [6/09](#))
- **Louisiana Department of Natural Resources:**
 - We are “unaware of any instance of harm to groundwater in the State of Louisiana caused by the practice of hydraulic fracturing.” (Regulatory Statements on Hydraulic Fracturing, [6/09](#))
- **Texas Railroad Commission:**
 - “Though hydraulic fracturing has been used for over 60 years in Texas, our Railroad Commission records do not reflect a single documented surface or groundwater contamination case associated with hydraulic fracturing.” (Regulatory Statements on Hydraulic Fracturing, [6/09](#))



Water Use in Fracture Stimulation

Water demand

State of Oklahoma — 2010



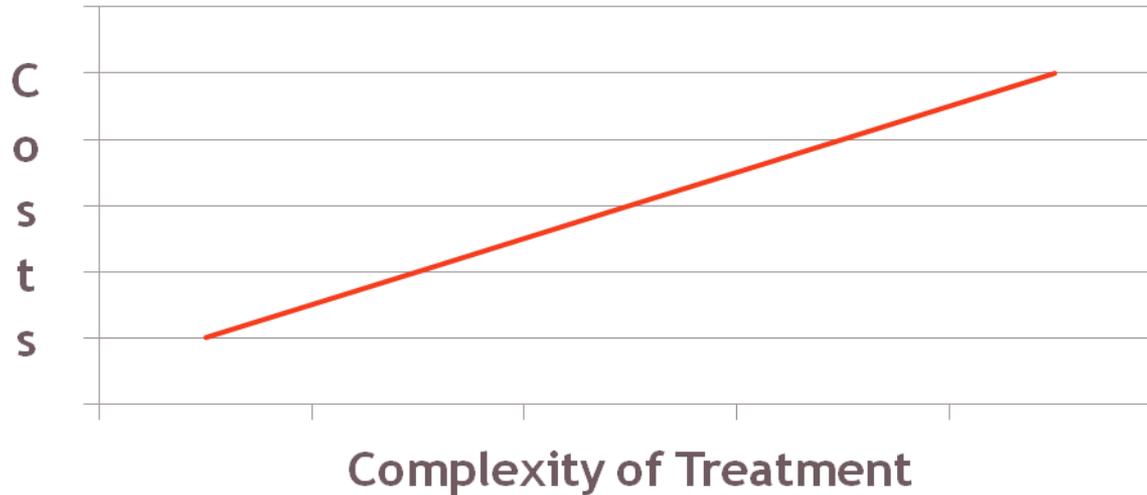
SOURCE: Oklahoma Water Resources Board

Water reuse process

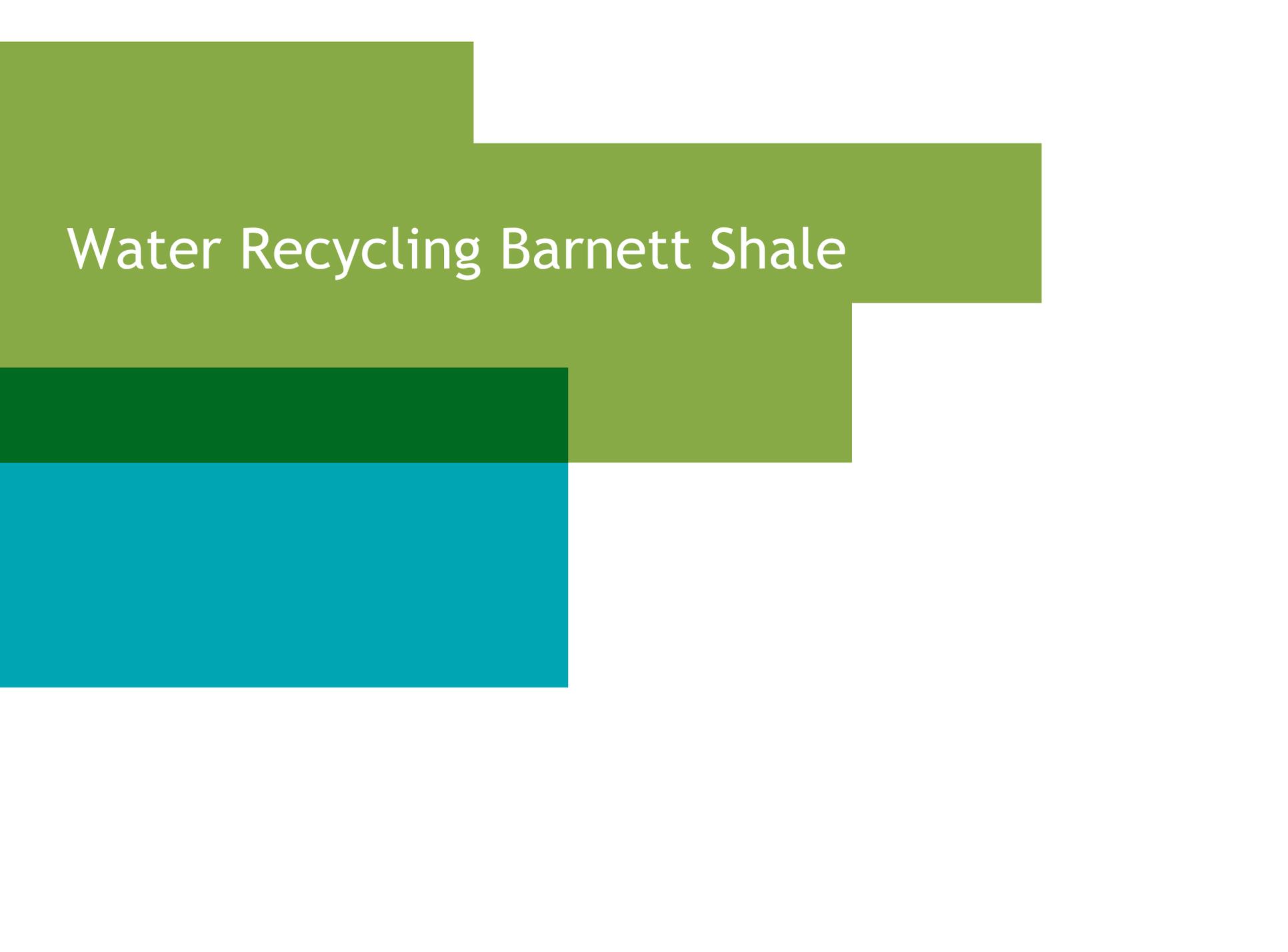


- Traditional and non-traditional water sources
 - Surface water, ground water, non-potable water, produced water, treated sewage effluent
- Plenty of treatment options (basic to advanced)
 - Blending, coagulation, electrocoagulation (EC), reverse osmosis (RO), distillation
- Reuse reduces freshwater footprint and gains competitive edge

Complexity continuum of treatment options



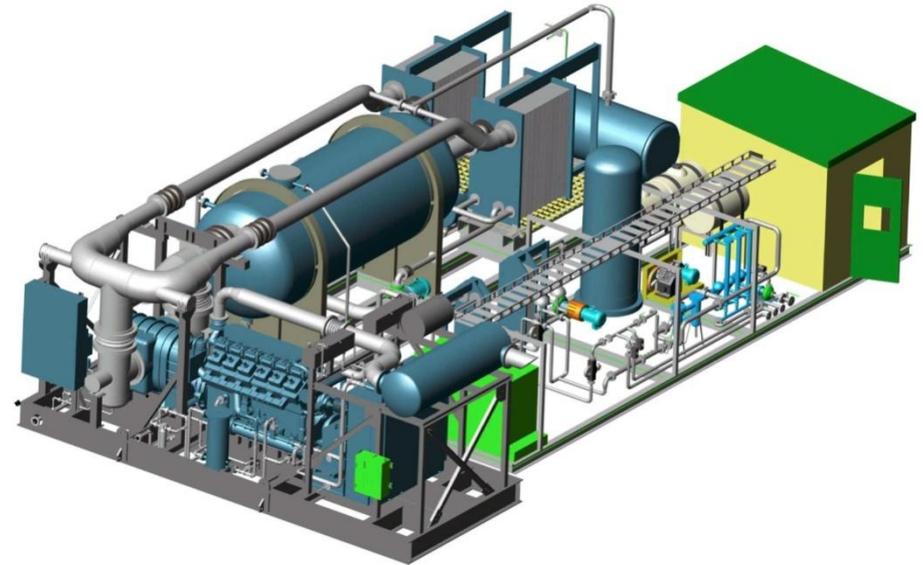
- Complexity of treatment a function of frac design and regulatory requirements
 - Frac designs can be widely variable including tolerance of salts
 - Regulatory requirements influence storage and conveyance options
 - Some amount of “make-up” water will be needed
 - Flowback water has highly variable characteristics



Water Recycling Barnett Shale

Water Recycling

- Approved by the Railroad Commission of Texas in 2005
- Implemented in 2005
- Vaporizes frac flow-back water and condenses it into clean, distilled water
- Remaining concentrated water removed for disposal or utilized for controlling pressures in another well completion as a “kill fluid”



Barnett Shale recycling facility

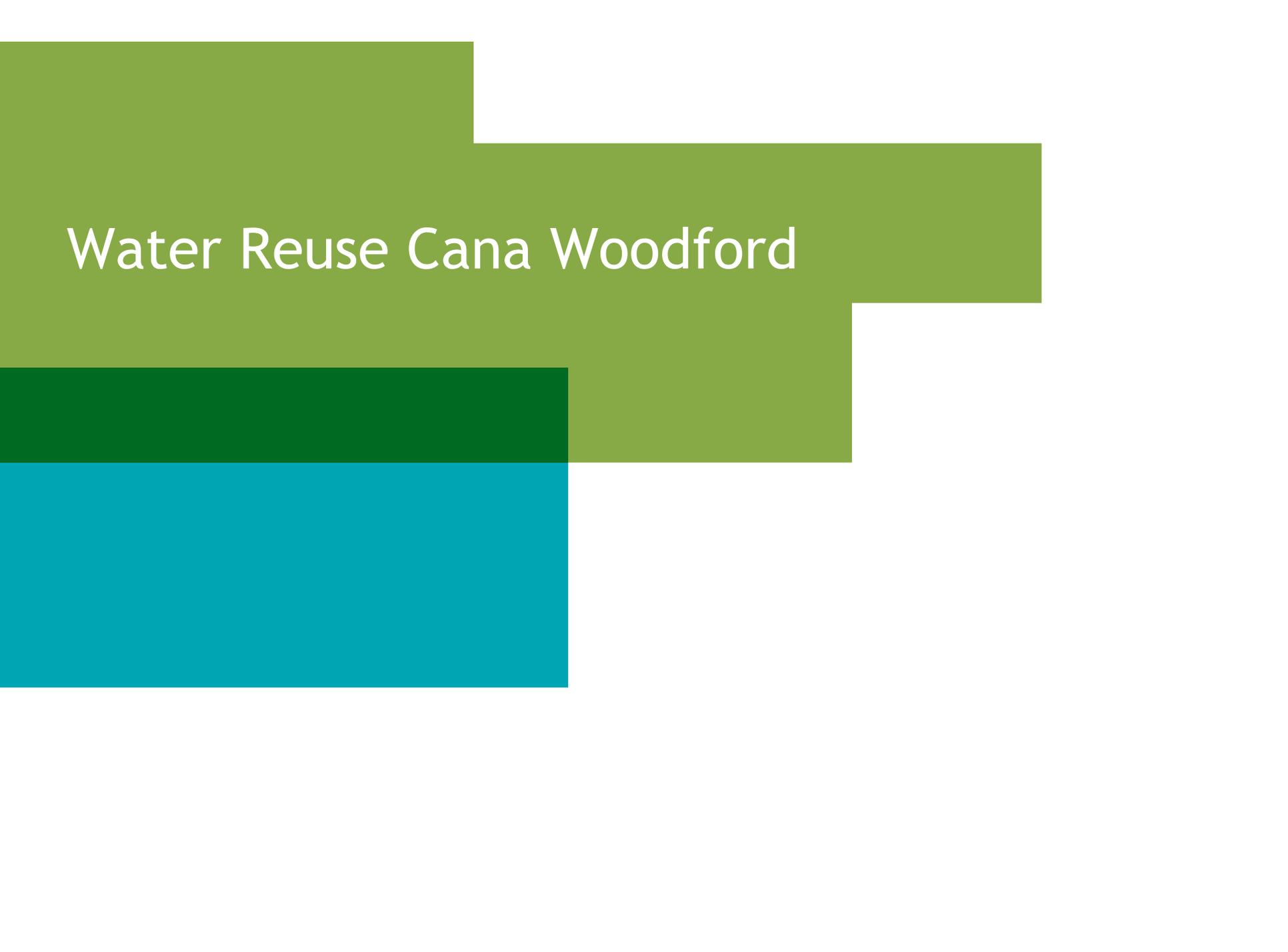
Freshwater storage and completion activity



Water Recycling Fountain Quail

- 22,500 bbls/day at peak
- 14+ million barrels processed (588+ million gallons)
- 11+ million barrels of distilled water generated (462+ million gallons)
- 110 wells fracked with recycled water



The background features a series of overlapping rectangular blocks in shades of green and blue. A light green block is at the top, followed by a darker green block, and a teal block at the bottom. The text is centered within the light green block.

Water Reuse Cana Woodford

Opportunities for water reuse

Cananda Woodford Shale

- Exceptional produced water quality in the Cananda Woodford Shale
 - Very low total dissolved solids (TDS)
 - Early stages of produced water quality about 12,000 TDS
 - Later stages of produced water quality about 20,000 TDS
 - Potential exists to reuse these fluids, thus reducing the demand for fresh water
- Current quantities available for re-use:
 - 26,000 barrels (1.1 million gallons) per day of produced fluid from 196 wells

Developing a new pit rule for produced water

- With the development of the Cana-Woodford Shale, Oklahoma regulators and Devon recognized the use of larger pits to store produced waters from the flowback process
- Earlier regulations allowed only for temporary storage
- New revised regulations include enhanced construction and design requirements and permitting options

Oklahoma
Hydraulic Fracturing
State Review

January, 2011



Water reuse facility

Settling pond, Cana-Woodford

- SWD well/injection pumps disposal capacity of 30,000 bpd @ 1500 psi
- Truck unloading station with above-ground settling tank capacity of 6,000 barrels (bbls)
- Fully automated with level alarms, meters for allocation, and chloride level
- Currently taking 20,000 bpd from infill well produced water
- Plan to recycle 4MM bbls in 2012



Cana-Woodford Water Re-Use Facility - Storage Pond

- 575' x 575' 7.5 Acres Depth 12'
- 502,000 BBL Capacity plus 2' Freeboard
- 60 Mil High Density Polyethylene Liner
- Leak Detection System
- Automated:
 - Level Indication
 - Chloride Level



Water reuse pipeline

Cana-Woodford

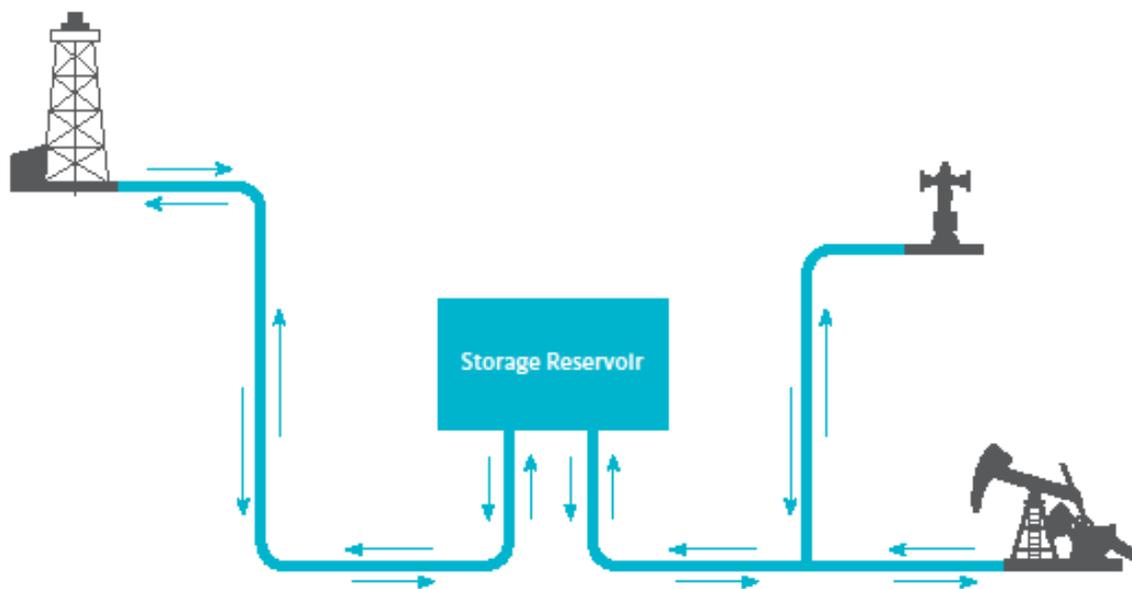
- 12", 10", and 8" Star fiberglass pipe, rating 450 psi @ 200 degrees (infill Flowback temp 175 deg F)
- Will handle 30,000 bpd flowback rate for all 30 sections
- Can deliver 70+BPM to 10 infill sections for stimulation
- Capable of delivering 30-70 BPM to remaining 20 infill sections for Stimulation
- Flowed 150,000 BBLS in last 2 weeks from Brooks wells



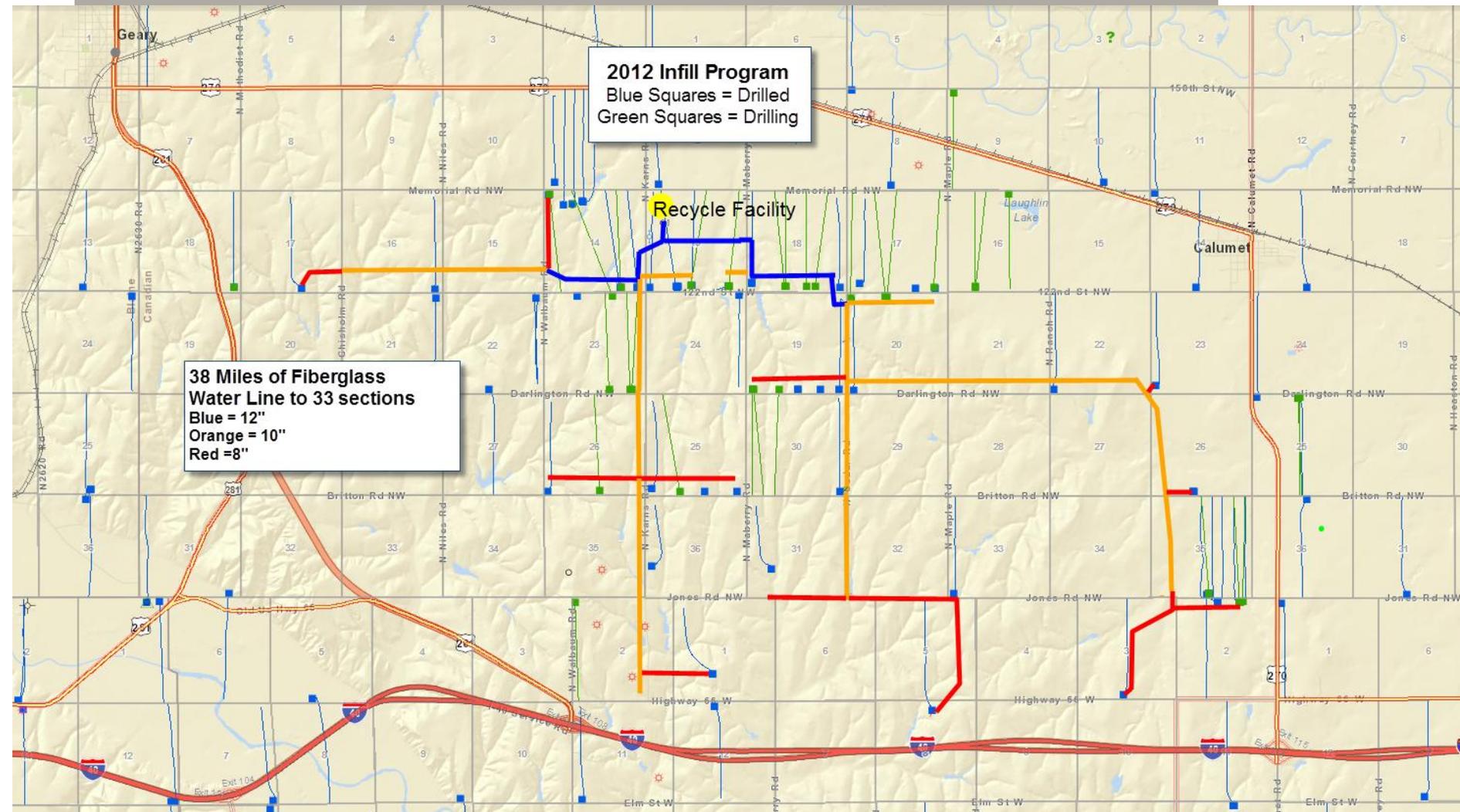
Cana-Woodford reuse facility

Summary

- A disposal well is located next to the re-use facility to handle excess water
- Pipelines to handle 30,000 bpd will soon connect to 33 sections.
- Result: reuse water will contribute to completion of 270 wells



Pipeline for recycling operations



Thank You.

The background features a series of overlapping rectangular blocks in shades of green and blue. A light green block is at the top, followed by a darker green block, and a teal block at the bottom. The word 'Seismicity' is written in white on the light green block.

Seismicity

Demystifying seismic events

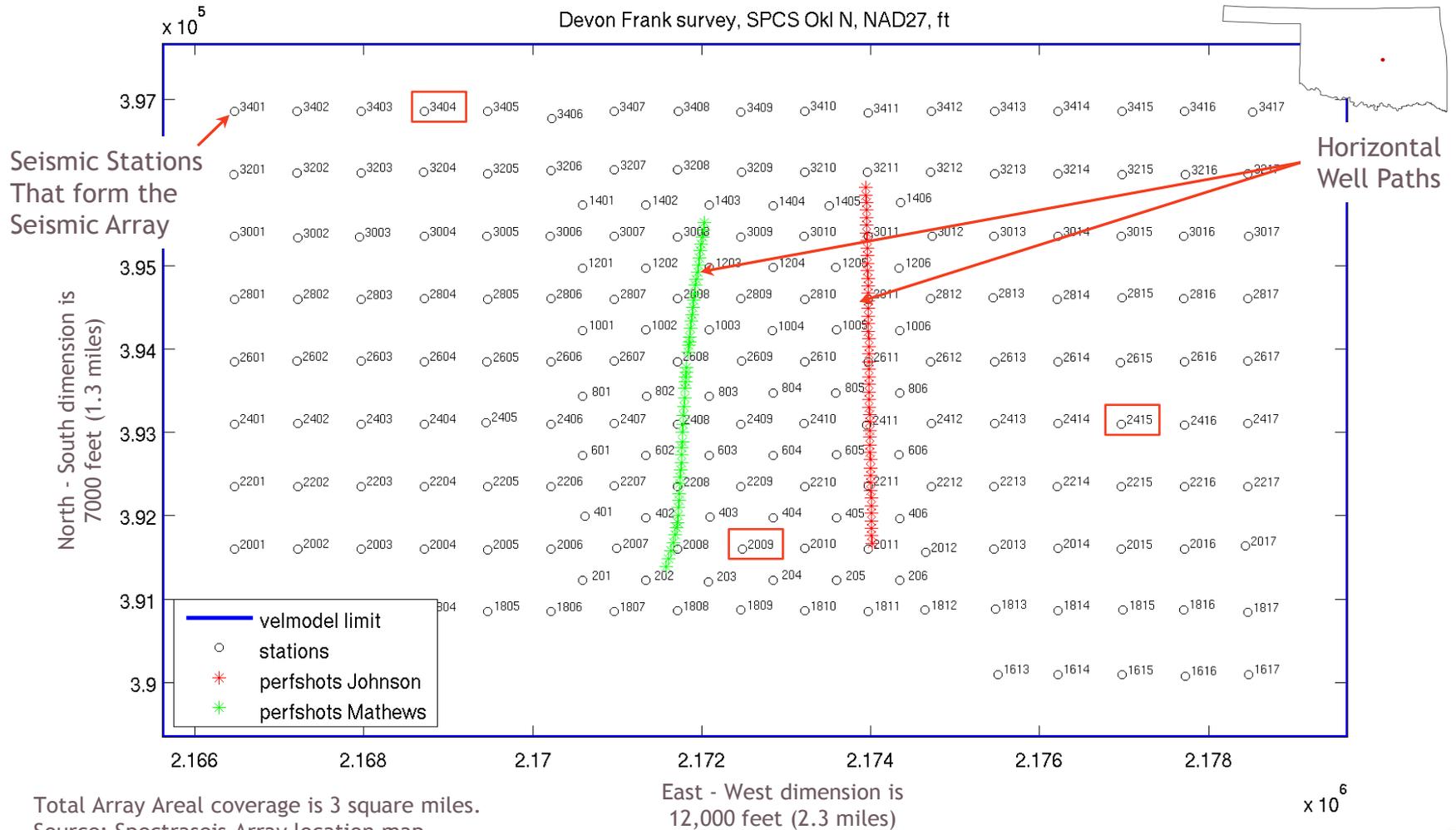
Purported connection to E&P activity

- Experts' consensus: Low risk managed through good practices
- “We don't see any connection between fracking and earthquakes of any concern to society.” – Bill Ellsworth, senior U.S. Geological Survey geophysicist, to *E&E News*, April 23, 2012.
- Fewer than 30 out of 150,000 U.S. disposal wells have had any alleged connection to seismic activity
- Generally no damage from those events
- Devon uses advanced seismic imaging technology and interpretation methods to identify and avoid faults.
- Industry expanding water recycling/reuse programs to reduce need for disposal wells

Seismic risk in context

Seismic array monitoring example

Frank 11 100 - Station layout



Seismic risk in context

Comparison of frack and trains

Relative Seismic Amplitudes

