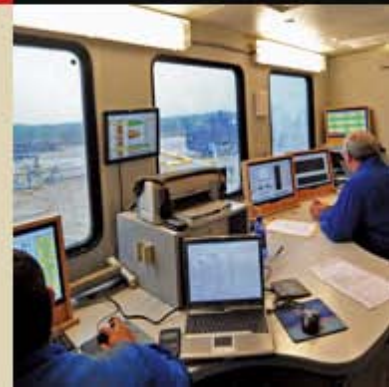


**CARBO** is the world's largest supplier of ceramic proppant, the provider of the industry's most popular fracture simulation software, and a provider of fracture design and consulting services. The Company also provides a broad range of technologies for spill prevention, containment and countermeasures.

Gary Kolstad  
Chief Executive Officer

**Triumphs & Tribulations of Tight Sands & Shales  
“Cracking the Code”  
2010 IPAA Annual Meeting**

**CARBO**



# Challenge: Permeability Keeps Getting Lower



“millidarcies”

1 md

“microdarcies”

.001 md

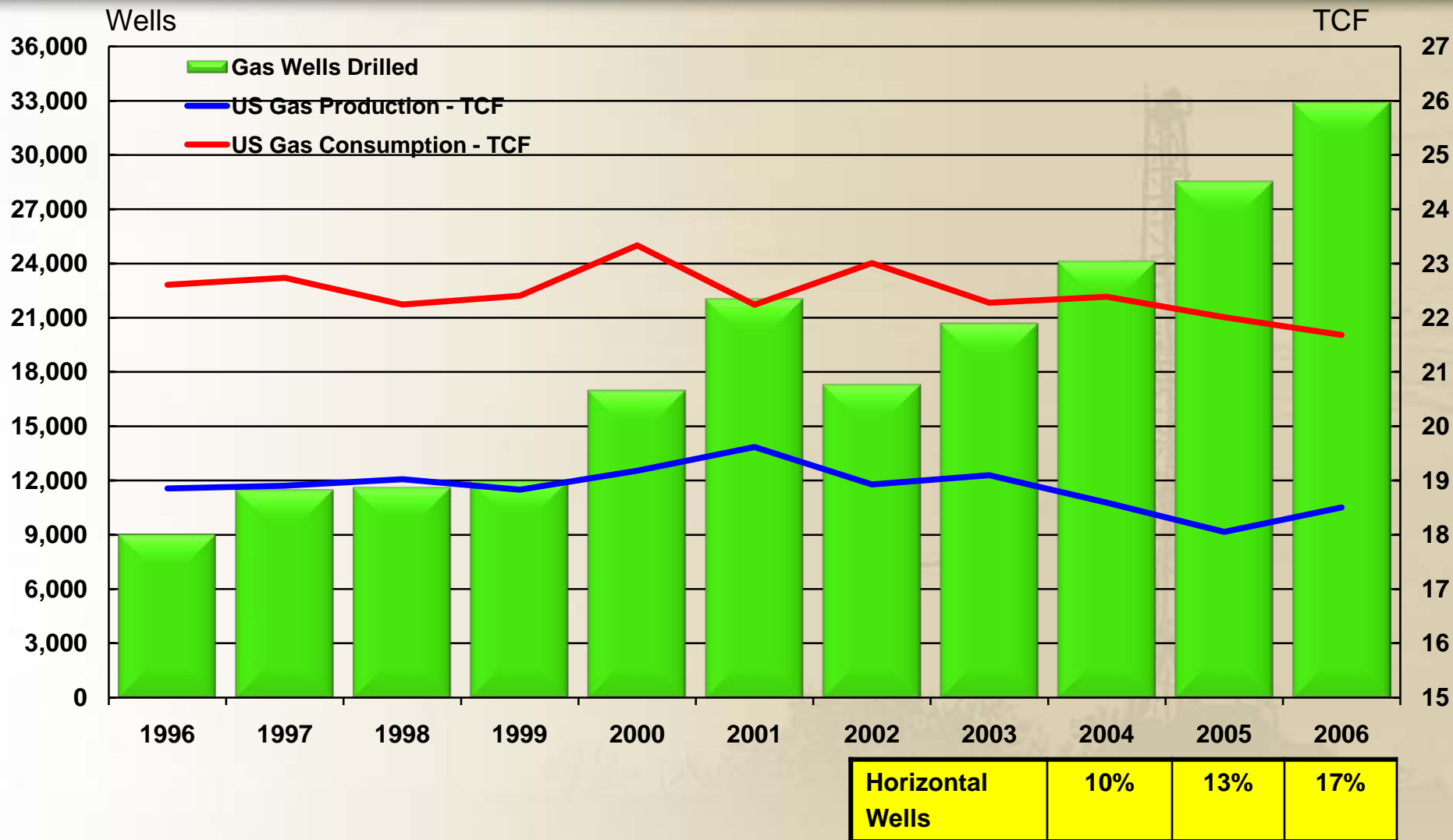
“nanodarcies”

.000001 md

# What Happened?

1996-2006 – We kept drilling more wells to offset declining production, but were not very successful. The downspacing of tight gas sands was a primary driver of drilling activity.

# US Gas Wells Drilled vs Gas Supply & Demand 96-06



Source: EIA - Oct 10 MER/STEO est for production and consumption, Oct10 MER gas wells drilled, BHI

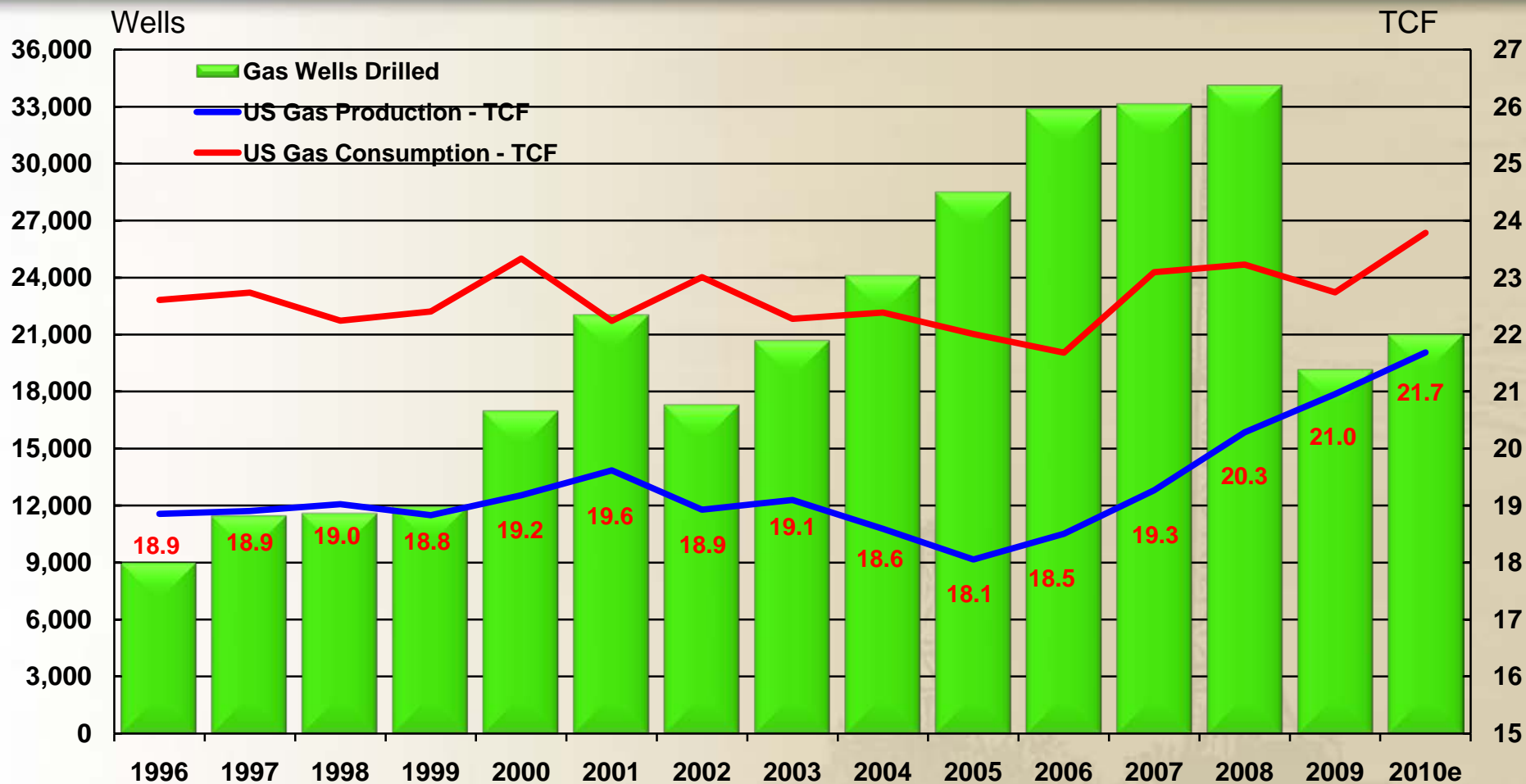
# What Happened?

1996-2006 – We kept drilling more wells to offset declining production, but were not very successful. The downspacing of tight gas sands was a primary driver of drilling activity.

2007-2010 - We “Cracked the Code”

**1.) Accessing the Reservoir: Dramatically increased the reservoir contact area with Horizontal Drilling**

# US Gas Wells Drilled vs Gas Supply & Demand 96-10



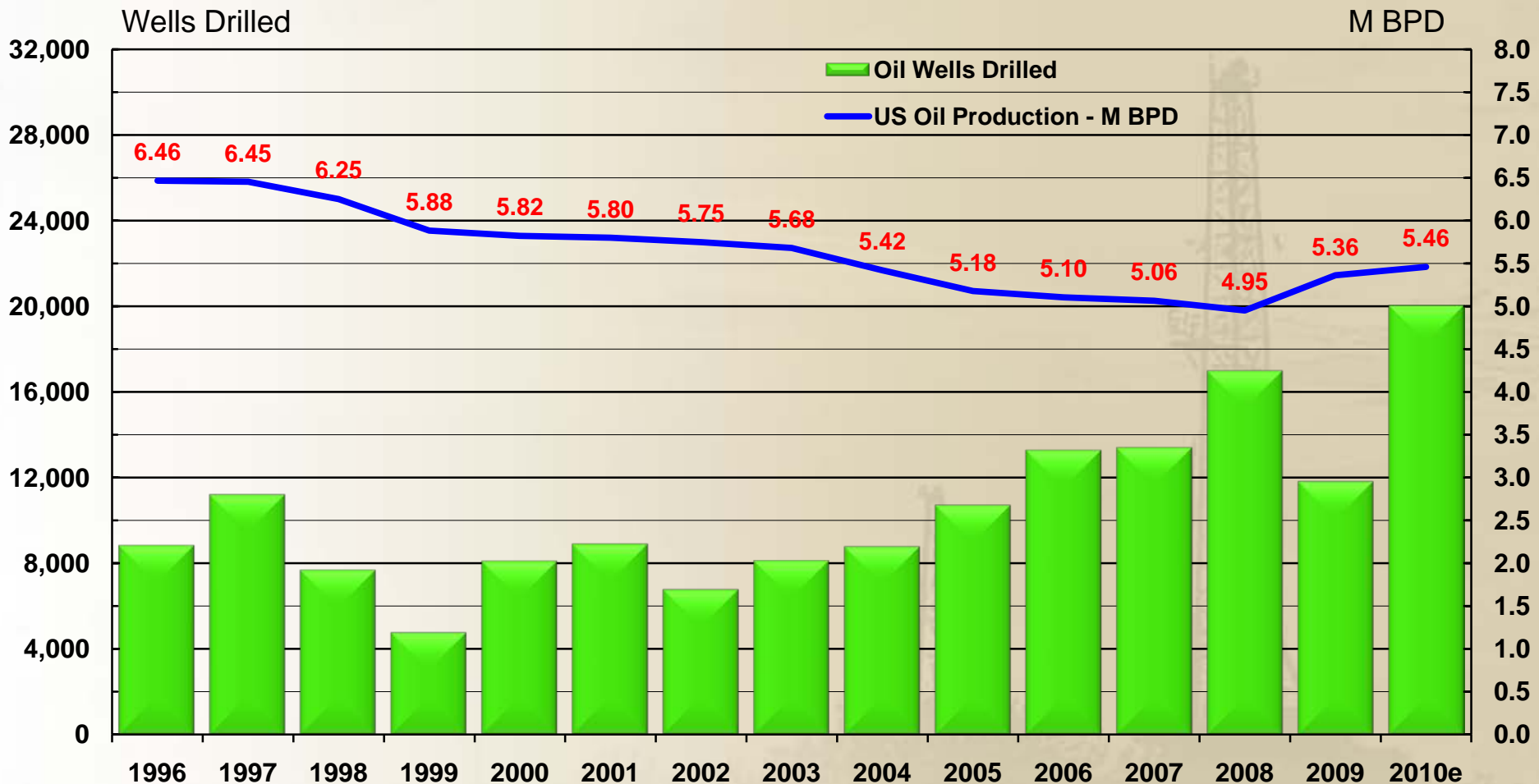
<b>Horizontal Wells</b>	<b>10%</b>	<b>13%</b>	<b>17%</b>	<b>22%</b>	<b>29%</b>	<b>42%</b>	<b>53%</b>
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Source: EIA - Oct 10 MER/STEO est for production and consumption, Oct10 MER gas wells drilled, BHI

# US Oil Wells Drilled vs Oil Production

96-10



Source: EIA - Oct 10 MER/STEO est for production, Oct10 MER oil wells drilled

# What Happened?

1996-2006 – We kept drilling more wells to offset declining production, but were not very successful. Downspacing tight gas sands was a primary driver of drilling activity.

2007-2010 - We “Cracked the Code”

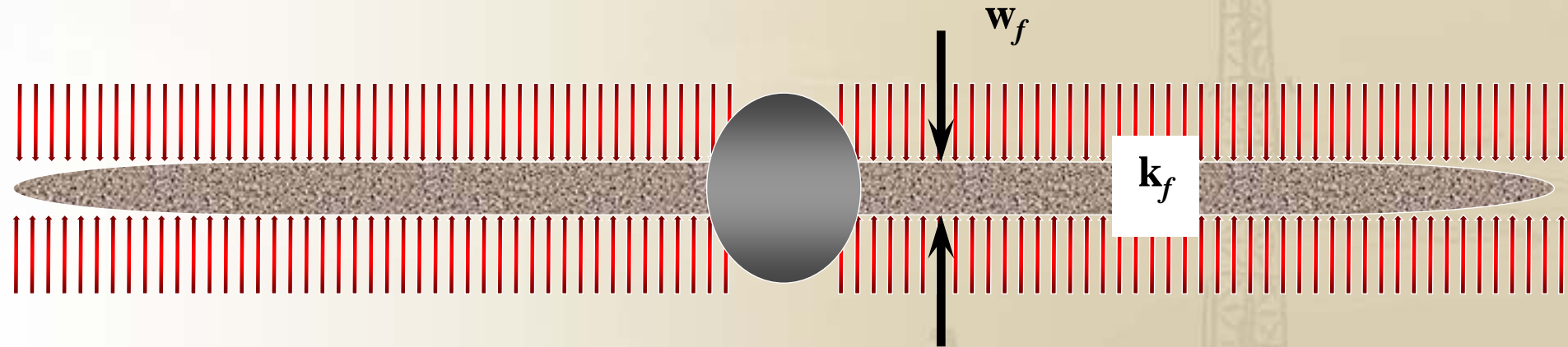
1.) Accessing the Reservoir: Dramatically increased the reservoir contact area with Horizontal Drilling

**2.) Producing the Reservoir: Increased the Conductivity of Fracs, which made low perm reservoirs economical**



# We Increased Fracture Conductivity

$$C_f = k_f * w_f$$



***How wide is the road and how good is the pavement?***

***Wider roads and better pavement costs money .....however, the benefit of increased conductivity is overwhelming in well productivity gains***

**CARBO**

# Why do Tight Sands & Shales need Conductivity?



Very Low Permeability



Pressure & Temperature

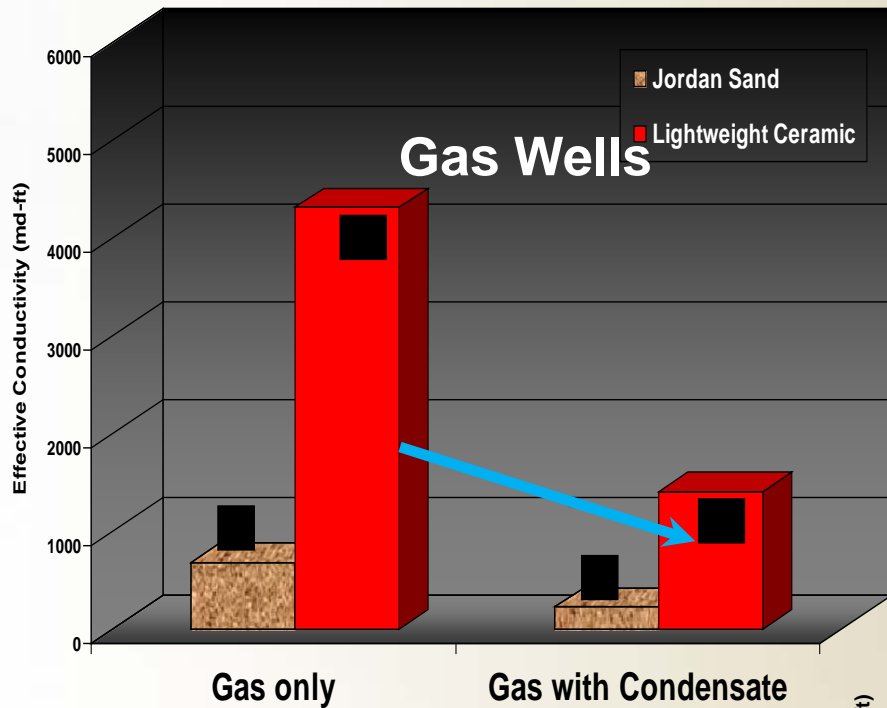


Multi-phase Flow

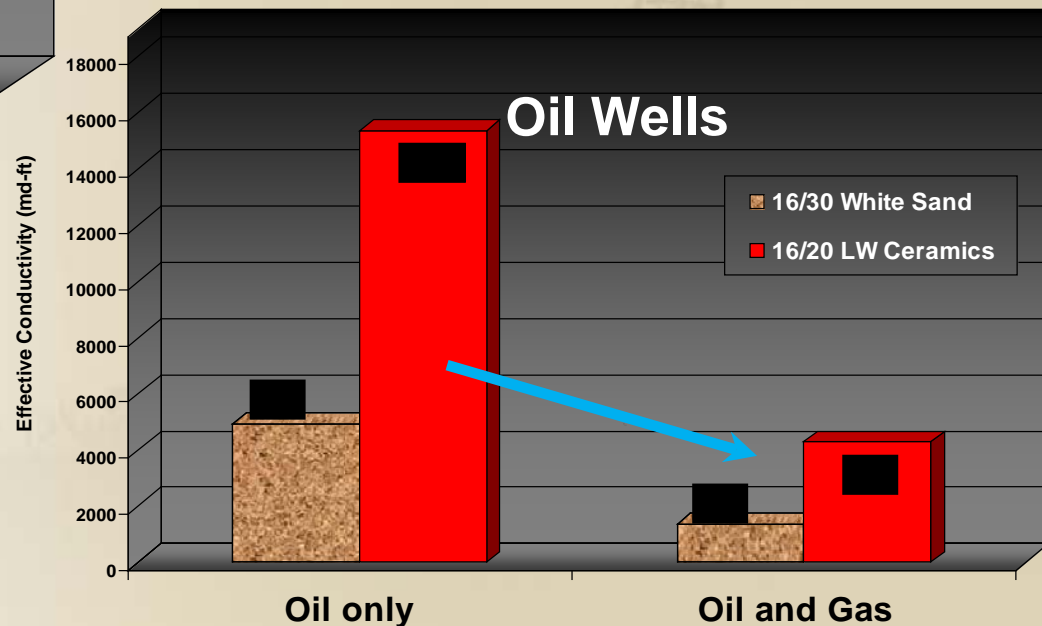


Transverse Fracs

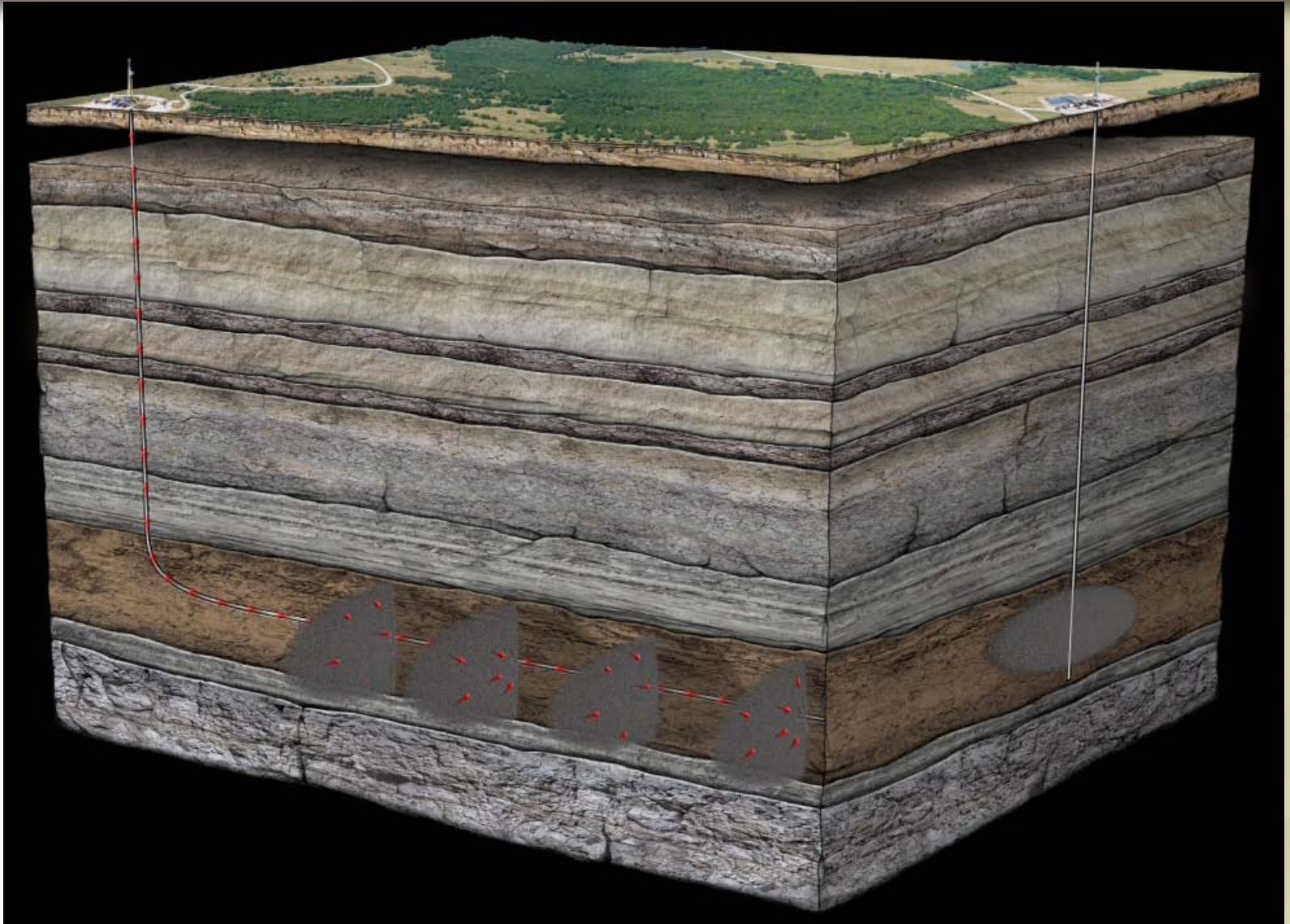
# Multiple Fluid Effects



*Multiple Fluids can reduce effective conductivity by over 70% in both oil and gas wells.*

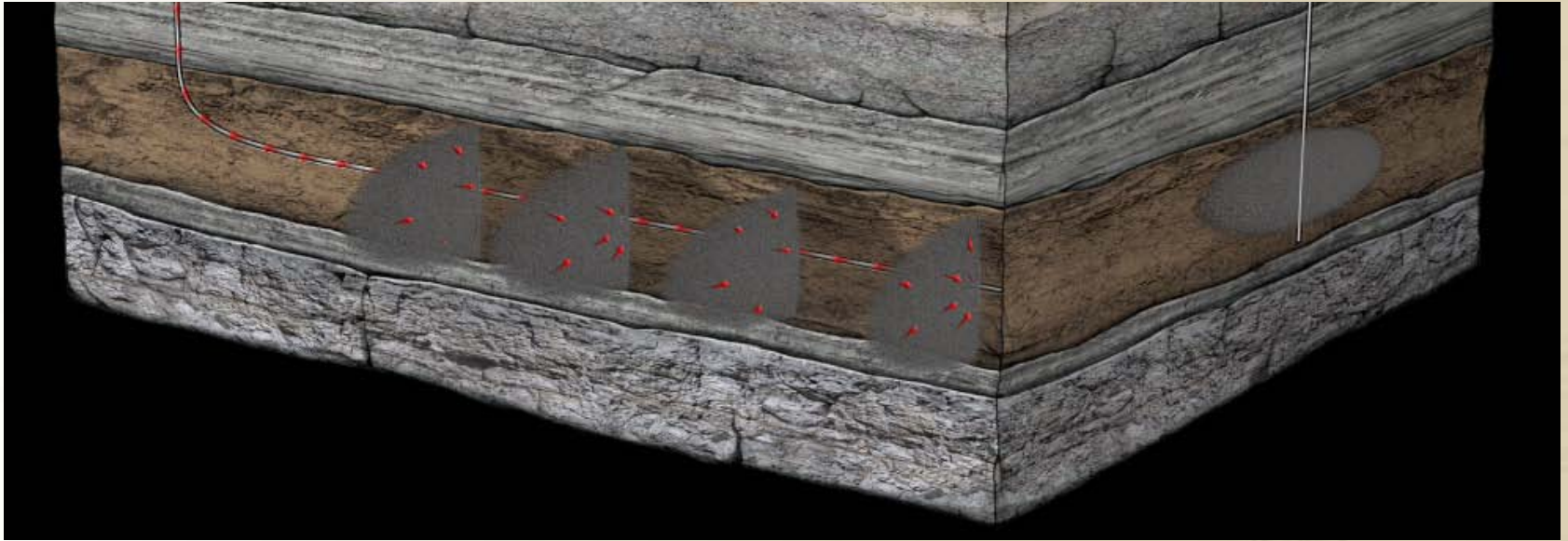


# Flow Convergence in Transverse Fracs





# Flow Convergence in Transverse Fracs



- A 100' tall vertical frac has over 100x the flow area at the wellbore than a 6" wellbore in a transverse frac.      (**200 Ft** of wellbore connection versus **1.6 Ft**)
- When fluids converge at the wellbore in a transverse frac, the pressure drop is 16,000 times higher than the vertical well at comparable rates.
- You will always benefit from more conductivity near-wellbore in transverse fracs

# Economic Conductivity

## Proppant Types & Conductivity

Highest Production, EUR, IRR

Highest Conductivity

**High strength** (minimizes crush)  
**Uniform size and shape**  
(maximizes frac porosity and permeability)  
**Thermal resistant** (durable, minimizes degradation)

**Engineered, Manufactured Product**

**Tier 1 - High Conductivity**  
**Ceramic**

**Medium strength**  
**Irregular size and shape**

**Tier 2 - Medium Conductivity**  
**Resin Coated Sand**

**Low strength**  
**Irregular size and shape**

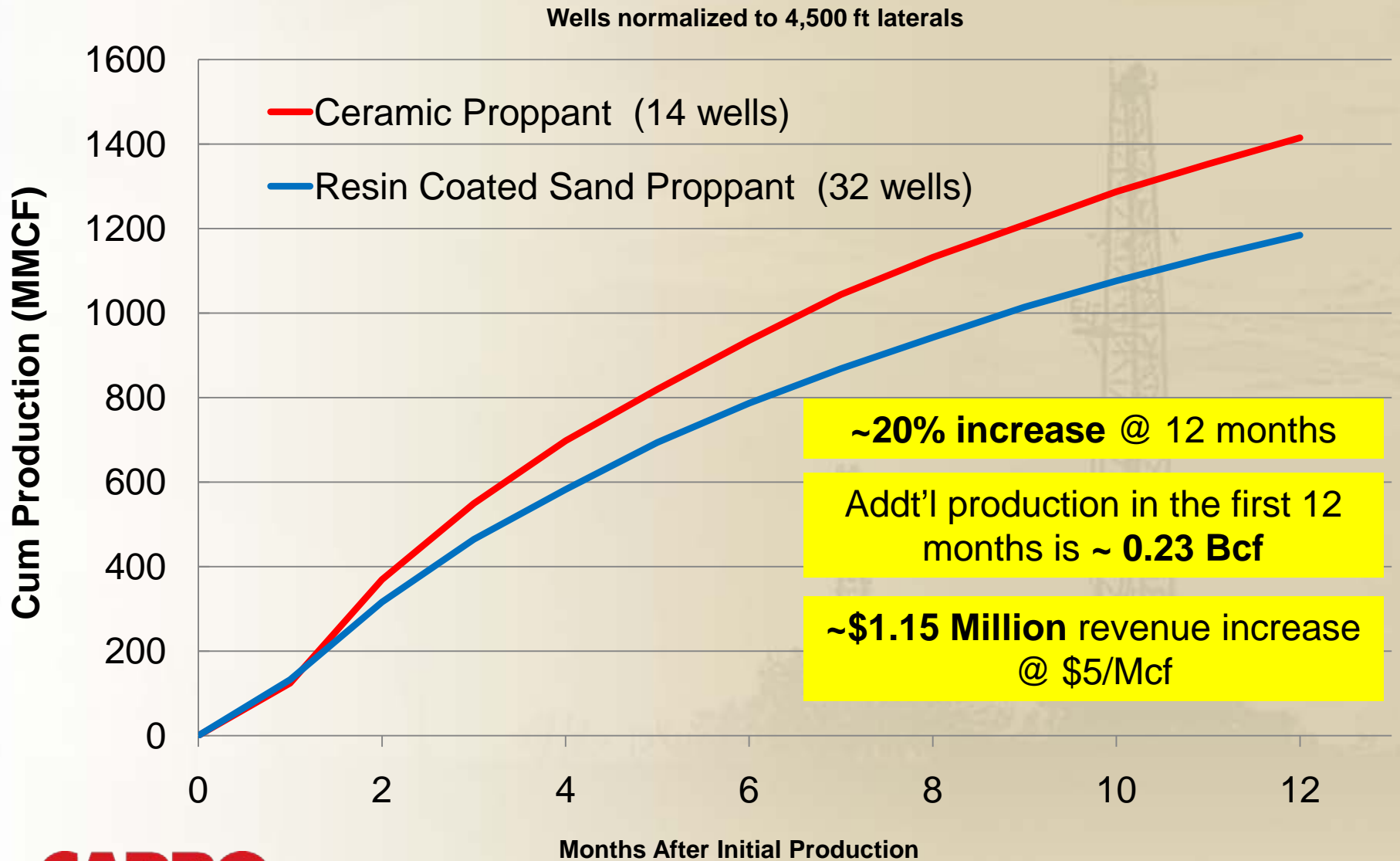
**Naturally Occurring Product**

**Tier 3 - Low Conductivity**  
**Sand**

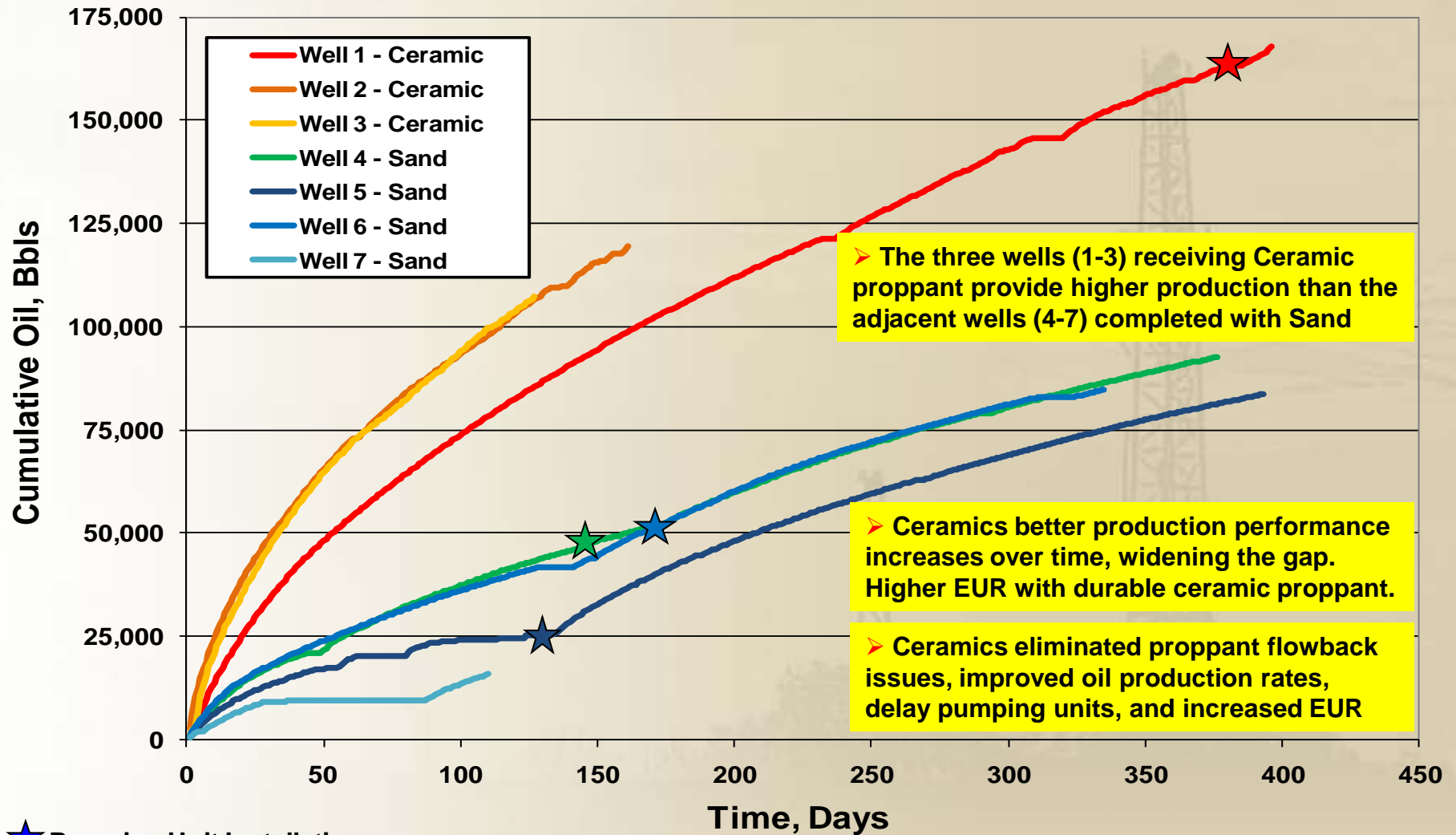
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$$\text{Conductivity} = \text{Permeability of the frac} \times \text{Width of the frac} = K_{\text{frac}} \times W_{\text{frac}}$$

# Haynesville Field Study Results



# Bakken Field Study Results



➤ The three wells (1-3) receiving Ceramic proppant provide higher production than the adjacent wells (4-7) completed with Sand

➤ Ceramics better production performance increases over time, widening the gap. Higher EUR with durable ceramic proppant.

➤ Ceramics eliminated proppant flowback issues, improved oil production rates, delay pumping units, and increased EUR

★ Pumping Unit Installation





# Summary

- E&P companies have done a tremendous job of growing Natural Gas reserves in the US, and arresting the decline in Oil production
- Technology has once again allowed us to make lower permeability reservoirs economical
  - Accessing the Reservoir: Rotary steerable, MWD, LWD
  - Producing the Reservoir: High Conductivity proppants, enhancing the economics of low perm reservoirs
- The industry success means the US can lower our dependency on foreign energy sources, improve the environment with lower emissions Natural Gas, and improve the US balance of payments