

# Engineering World Class Wells in the Utica

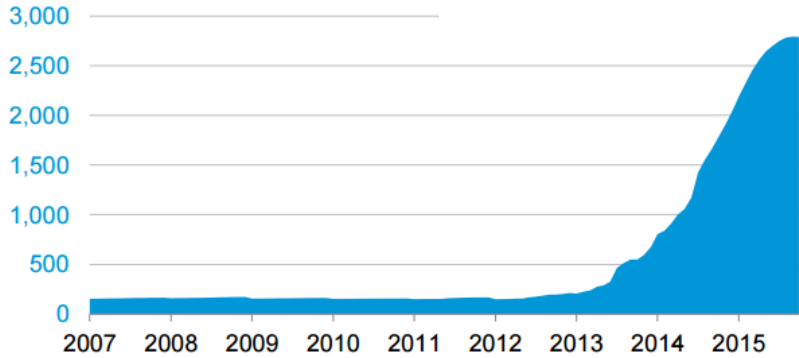
Brian Davidson

Technical Manager

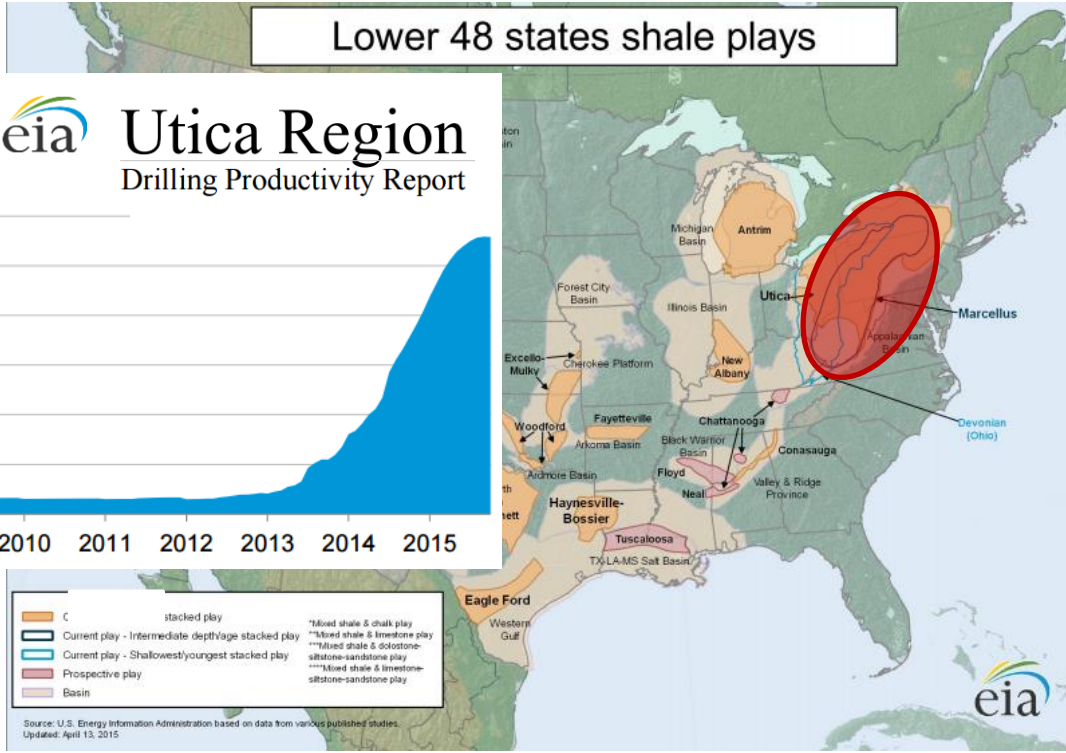
# Utica/Point Pleasant: OH, PA and WV



Utica Region  
Natural gas production  
million cubic feet/day



eia **Utica Region**  
Drilling Productivity Report



	C stacked play	*Mixed shale & chalk play
	Current play - Intermediate depth/large stacked play	**Mixed shale & limestone play
	Current play - Shallowest/youngest stacked play	***Mixed shale & dolomite-siltstone-sandstone play
	Prospective play	****Mixed shale & limestone-siltstone-sandstone play
	Basin	

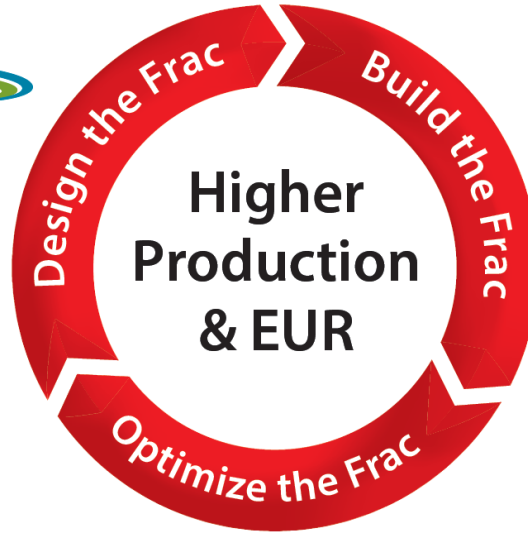
Source: U.S. Energy Information Administration based on data from various published studies. Updated: April 13, 2015

# Utica Outcrops in Utica New York





- Frac Design
- Economic Optimization
- Reservoir Performance
- Post Job Analysis



- Frac Conductivity & Durability
- Production Assurance
- Fracture Evaluation
- Flow Enhancement



- Well Site Supervision
- Frac Diagnostics & Optimization
- Field Development Optimization
- Reservoir & Formation Analysis

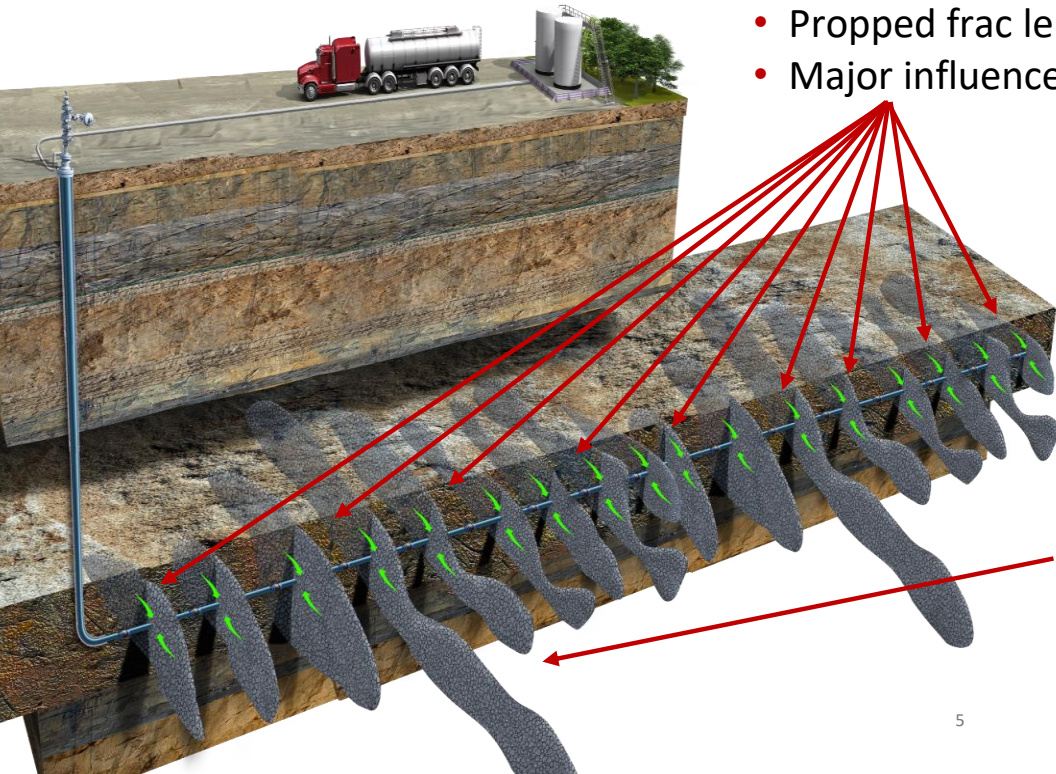


# Objective of a Hydraulic Fracture



## More.....Reservoir Contact Area

- Increase number of stages and perf clusters
- Increase pounds proppant per stage
- Propped frac length
- Major influence on short term production



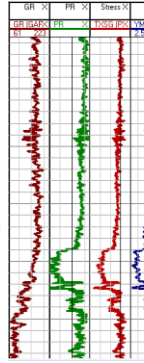
## More.....Frac Conductivity

- Increase proppant conductivity and durability
- Minimize damage caused by frac fluids (slickwater)
- Maintains effective frac length over long term
- Major influence on short & long term production

# Design The Frac (FRACPRO)

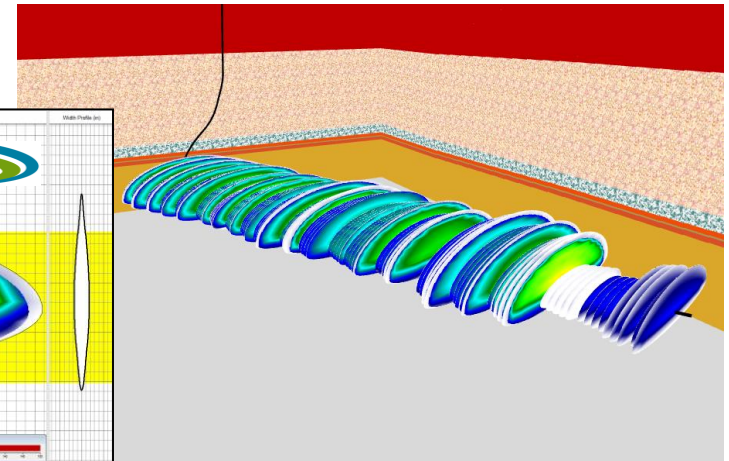
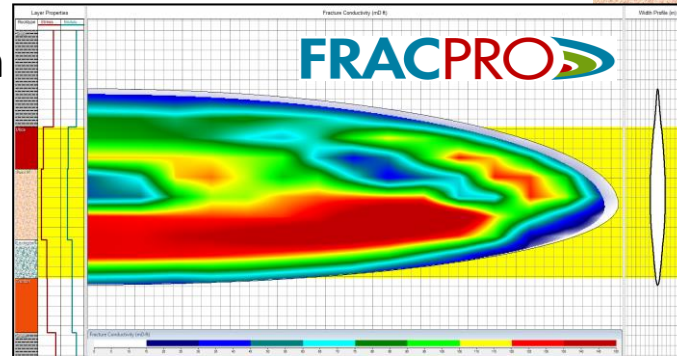


- Build FRACPRO model
  - Rock properties (mechanical properties)
  - Actual treatment volumes & materials
  - History match net pressure



6000  
15 T

- Estimate fracture properties
  - Propped half-length
  - Conductivity

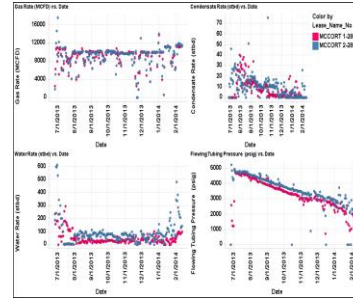


# Optimize the Frac (Calibrate Reservoir Model)

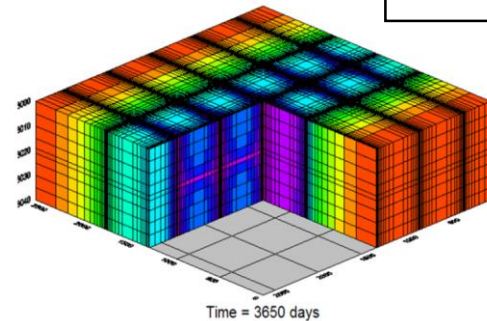
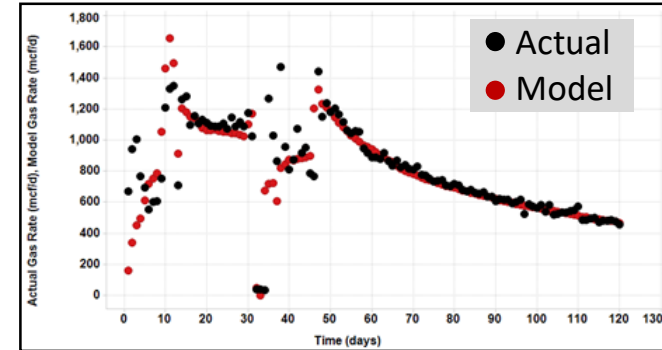


- Fracture geometry from FRACPRO
- History match actual production data using reservoir model
  - Formation properties
    - Permeability
    - Reservoir pressure
  - Fracture properties
    - **Effective** propped half-length
    - **Effective** fracture conductivity

Production Data



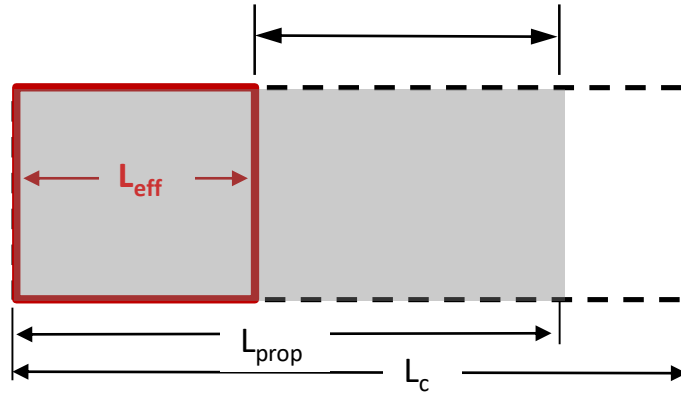
Production History Match



# Optimize The Frac (Efficient/Inefficient Fracture)



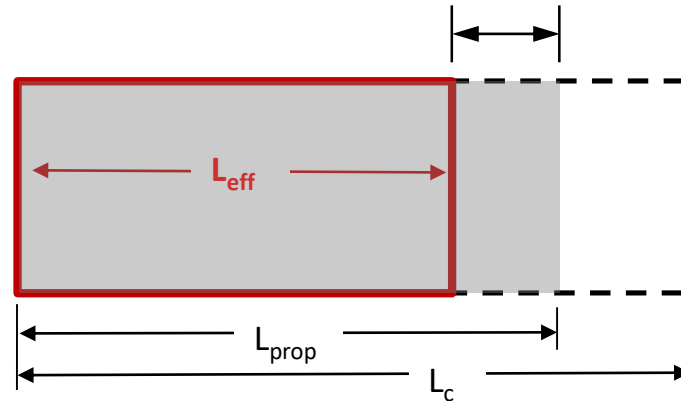
Inefficient Fracture



$$F_{CD} = \frac{k_f * W_f}{k * L}$$



Efficient Fracture



$$L_{eff} = \frac{k_f * W_f}{k * F_{CD}}$$

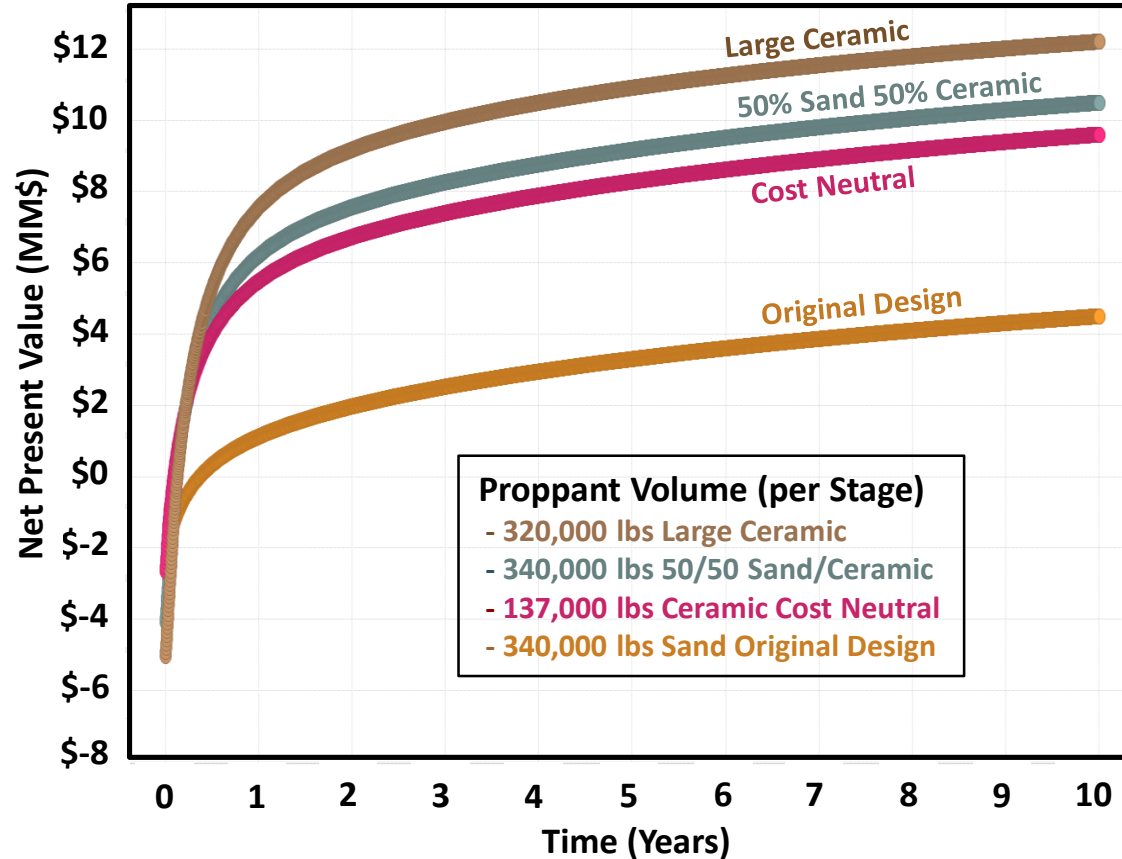
Same propped height



# Optimize The Frac (Forecast Production and NPV)



- Use calibrated models
  - FRACPRO
  - Reservoir model
- Estimate **Effective** propped fracture length
- Forecast production alternative designs
- Evaluate economics



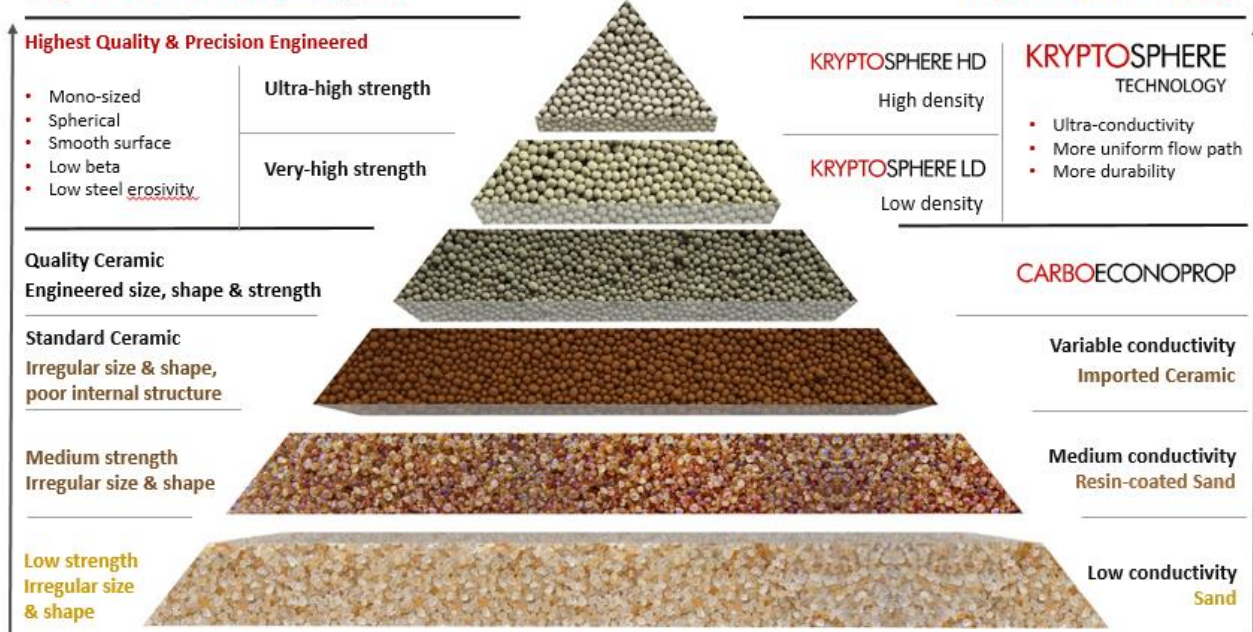
# Build the Frac

- Conductivity
  - Proppant Type
  - Proppant concentration
- Spacing between fractures
- Clusters per stage
- Contact area
  - Volume of treatment



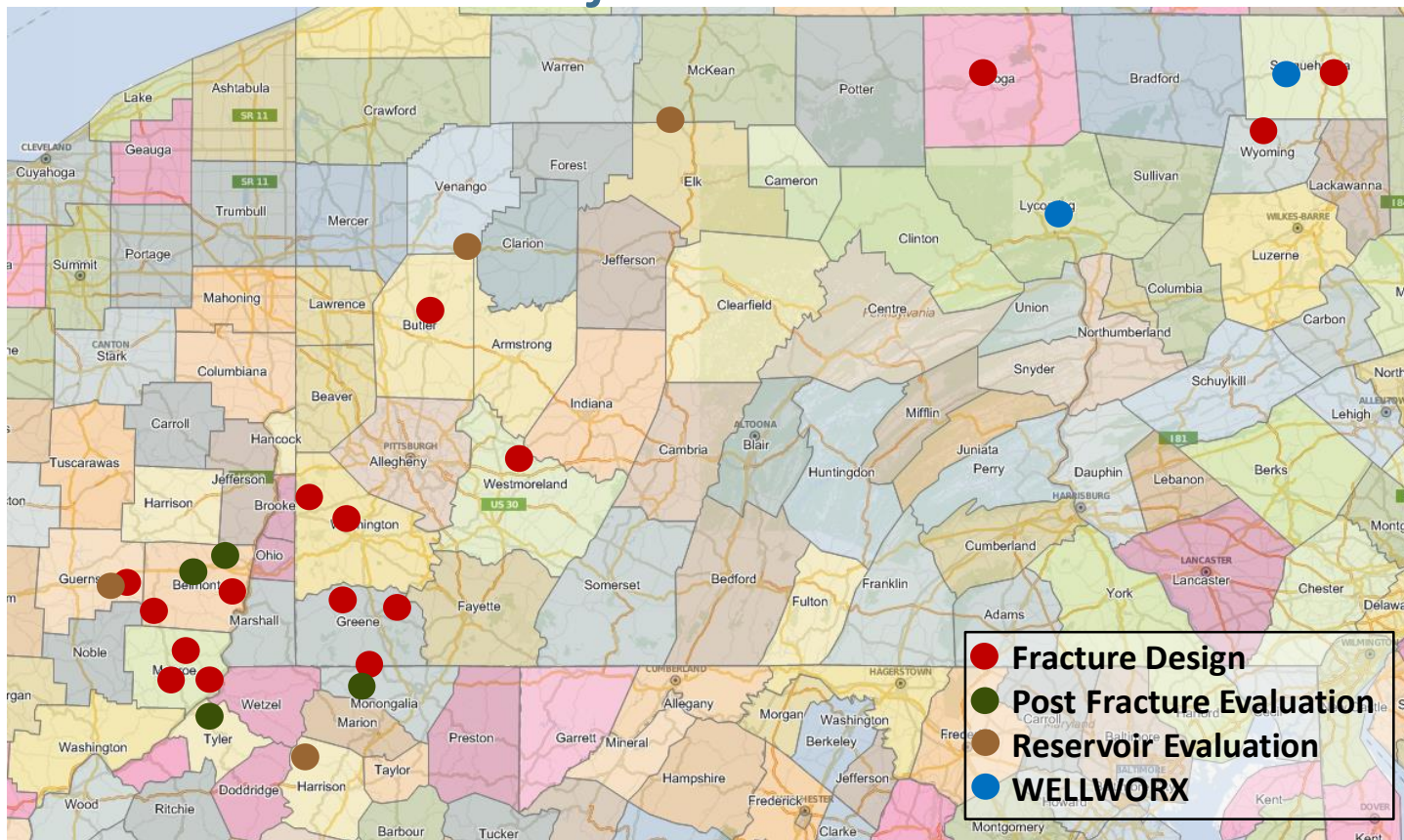
## Highest Production, EUR, ROI

## Highest Conductivity



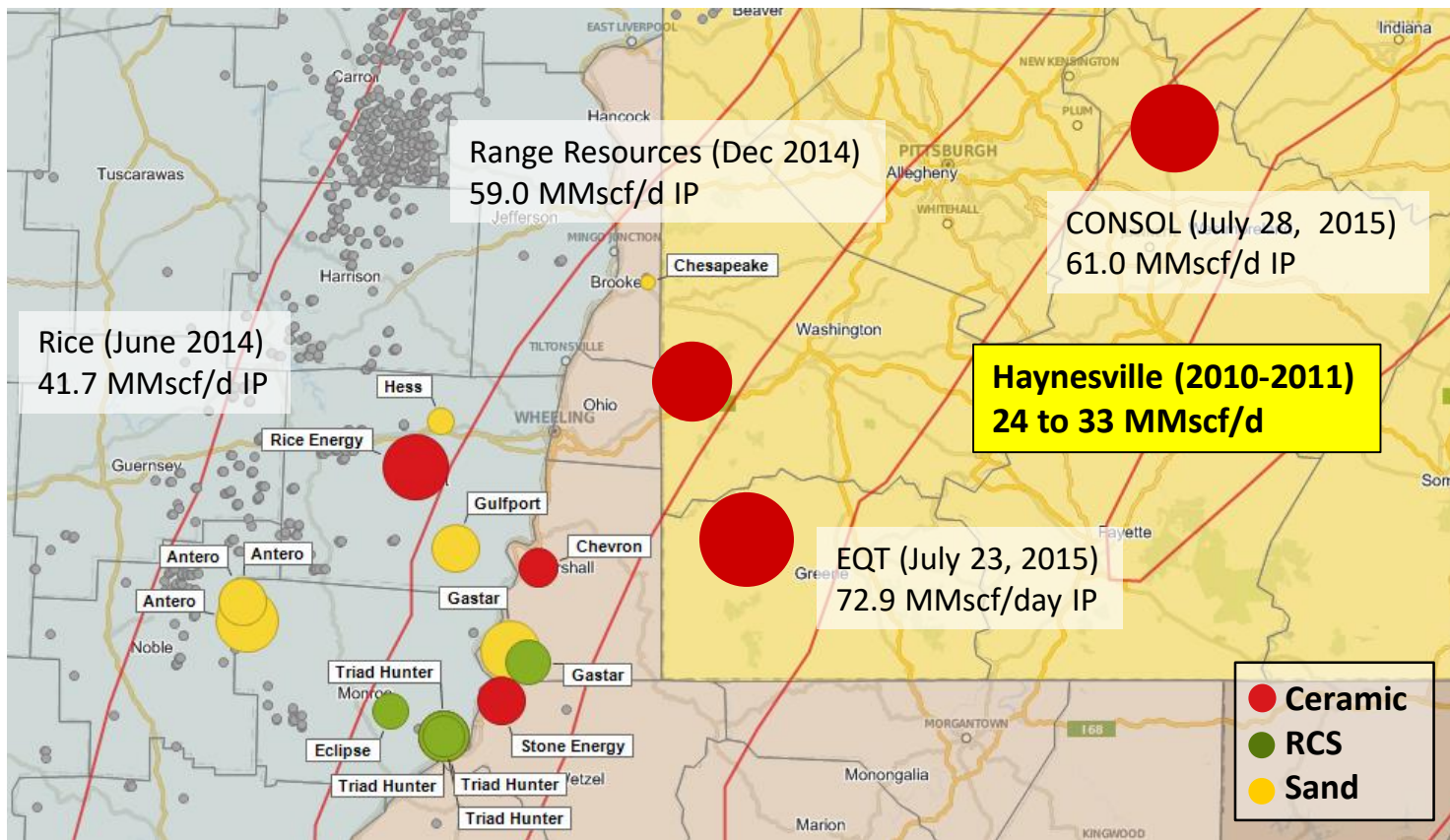
$$\text{Conductivity} = \text{Permeability of the frac} \times \text{width of the frac} = K_{\text{frac}} \times W_{\text{frac}}$$

# Recent STRATAGEN Projects





# Highest Gas Production from a Shale Formation



Source: Company Press Release/Investor Presentation

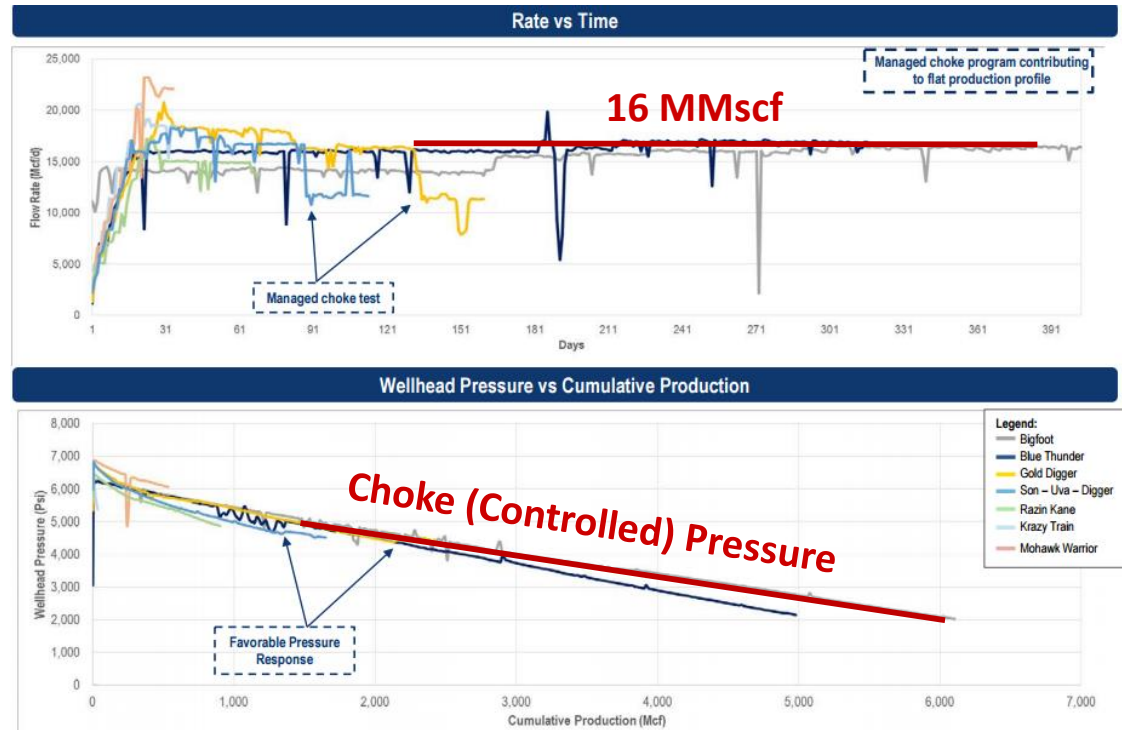




# 6.2 Bcf in 390 Days (Maintaining 16 MMscf/d)



- High EUR
- Slow pressure decline
- IP reported first well
- No IP reported on next 7 wells
- Prevent damage to proppant pack and formation



Source: Rice Investor Presentation September 9, 2015

# 1.35 Bcf First 46 Days (30 MMscf/d)

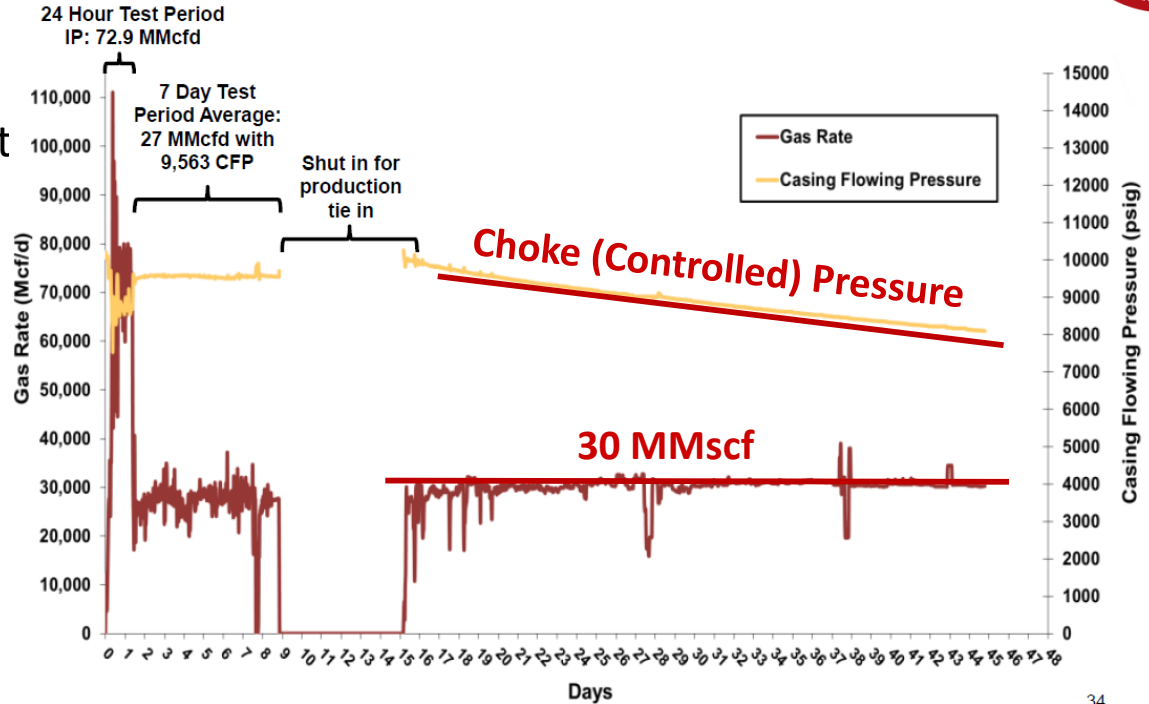


- First Well

- 72.9 MMscf/d IP
- 30.0 MMscf/d constant
- Slow pressure decline
- High EUR

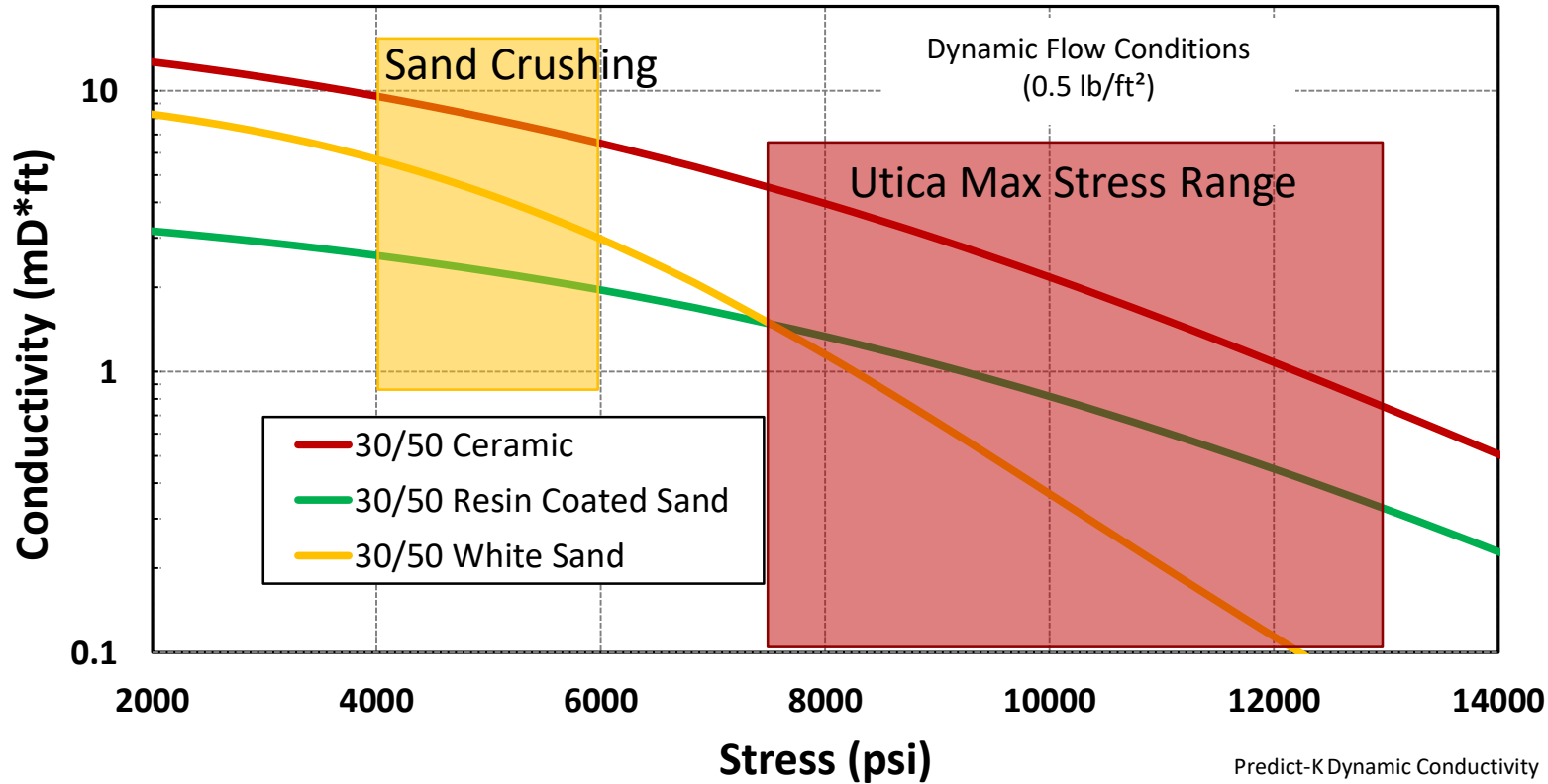
- Second Well

- No IP reported
- Prevent damage to proppant pack and formation



Source: EQT Investor Presentation September 4, 2015

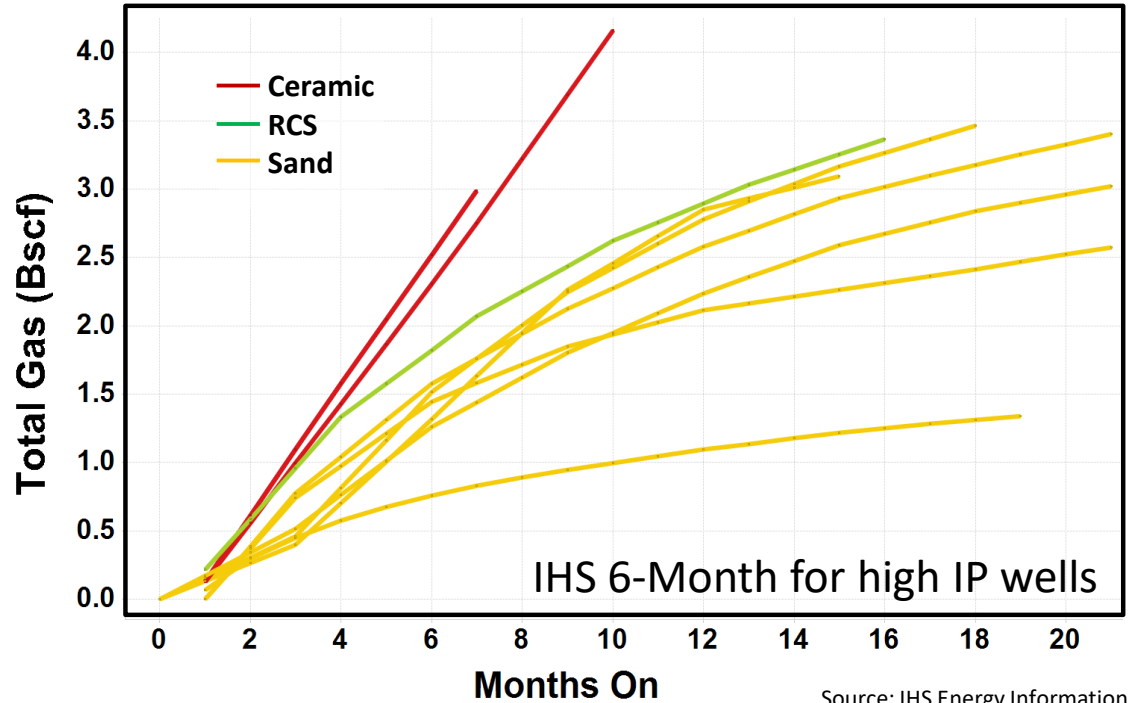
# Proppant Conductivity Decreases at Higher Stress



# IP for Show - Decline for Dough



- Ceramic wells constant rate; increasing EUR
- High rate wells managed pressure production
- Sand wells slowing production rate; small incremental EUR
- Sand crushing at 6000 psi



Source: IHS Energy Information

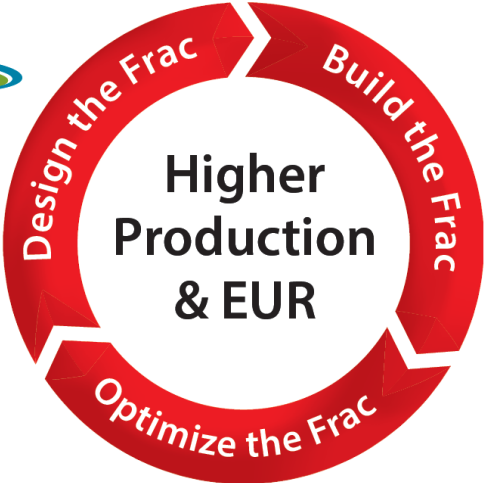
# High Utica Productivity (Good Reservoir & Good Completion)



- Reservoir
  - High reservoir permeability, not nano-Darcy or pico-Darcy
  - High reservoir pressure (0.80 to 0.95 psi/ft)
- Propped fracture (conductivity and contact area)
  - High strength proppant
    - High closure stress, 7,500 to 13,000 (Depth 9000 to 13,500 ft)
    - Sand crushes at 4000 to 6000 psi
  - High conductivity
    - Multiphase flow (gas, oil, and water)
    - High velocity (Non-Darcy) flow in fracture



# Thank You!



## Questions?