Multilateral Wells in Southeastern Ohio

Targeting the Marcellus and Utica from a Single Vertical Wellbore

Preview

- Multilateral well introduction
- Junctions: Drilling and construction procedures
- Case Study: Granite Wash Formation in the Anadarko Basin
- Economic analysis of Utica/Marcellus multilaterals
- Conclusions

Multilateral Introduction

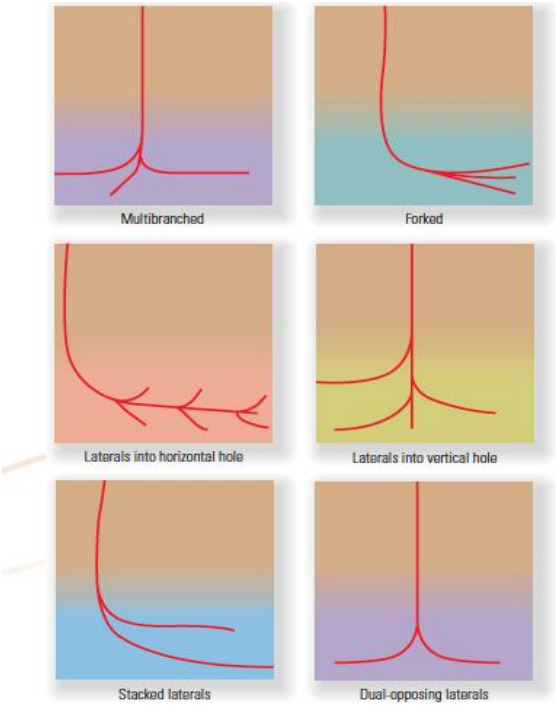
- Advantages of multilateral wells
  - Reduction in tangible/intangible costs
    - Reduced surface and intermediate drilling/casing
    - Less cementing
    - Fewer wellheads and gathering lines
    - Smaller pads
    - Less man-hours on location
    - Operational efficiencies

Multilateral Introduction

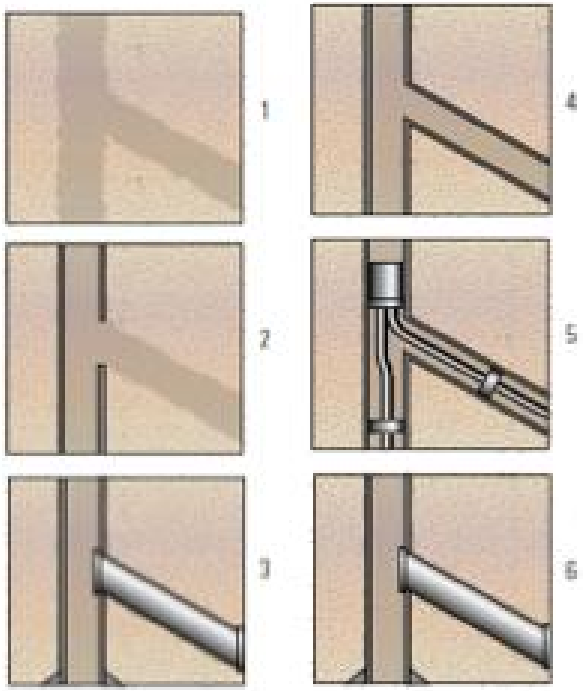
- Advantages of multilateral wells cont'd
  - Larger reservoir drainage volume
  - Quicker payout period
- Challenges of multilateral wells
  - Construction and installation of junction
  - Selective stimulation of individual laterals

Junctions

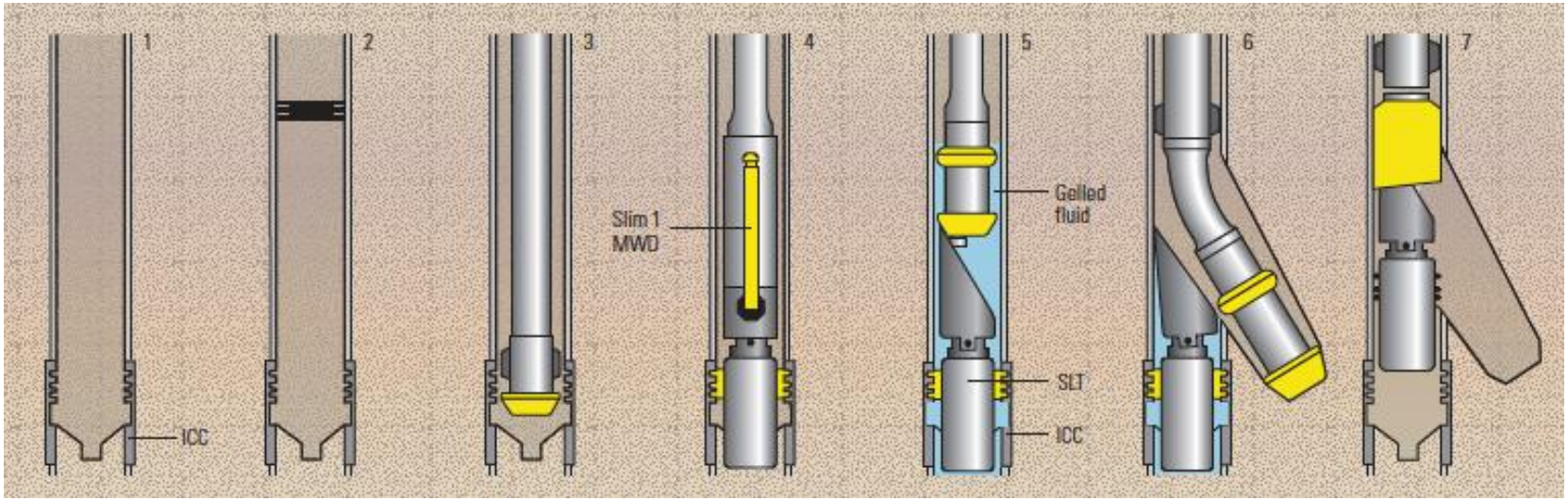
Wellbore Geometries



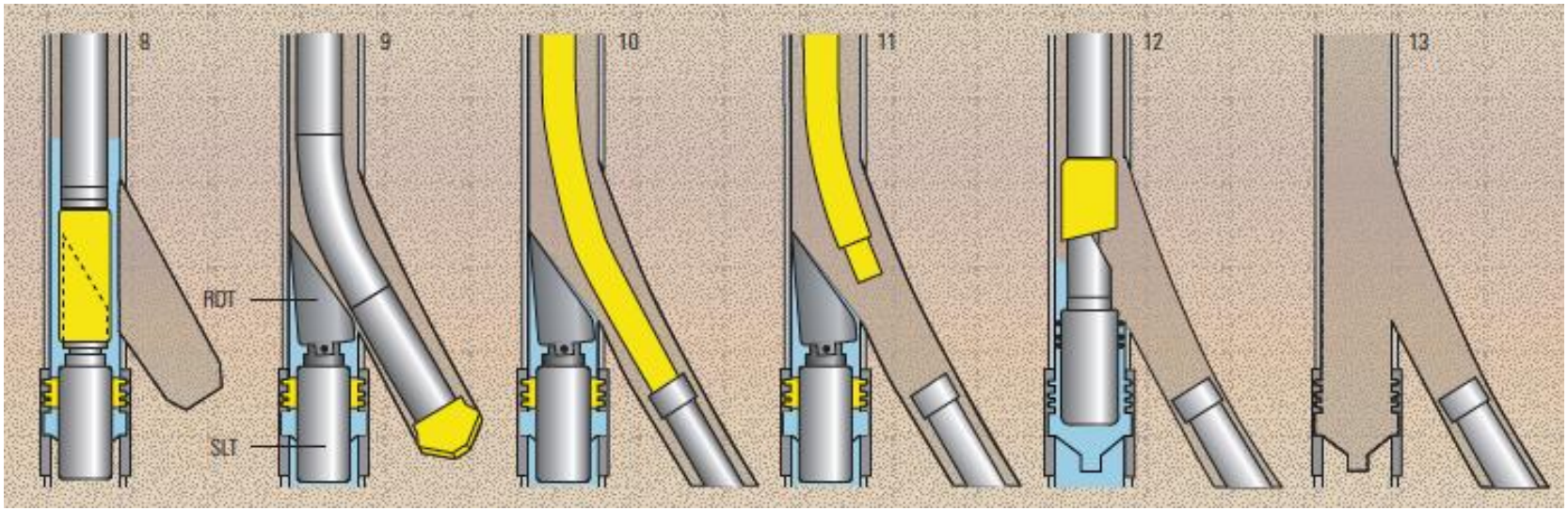
TAML Classifications



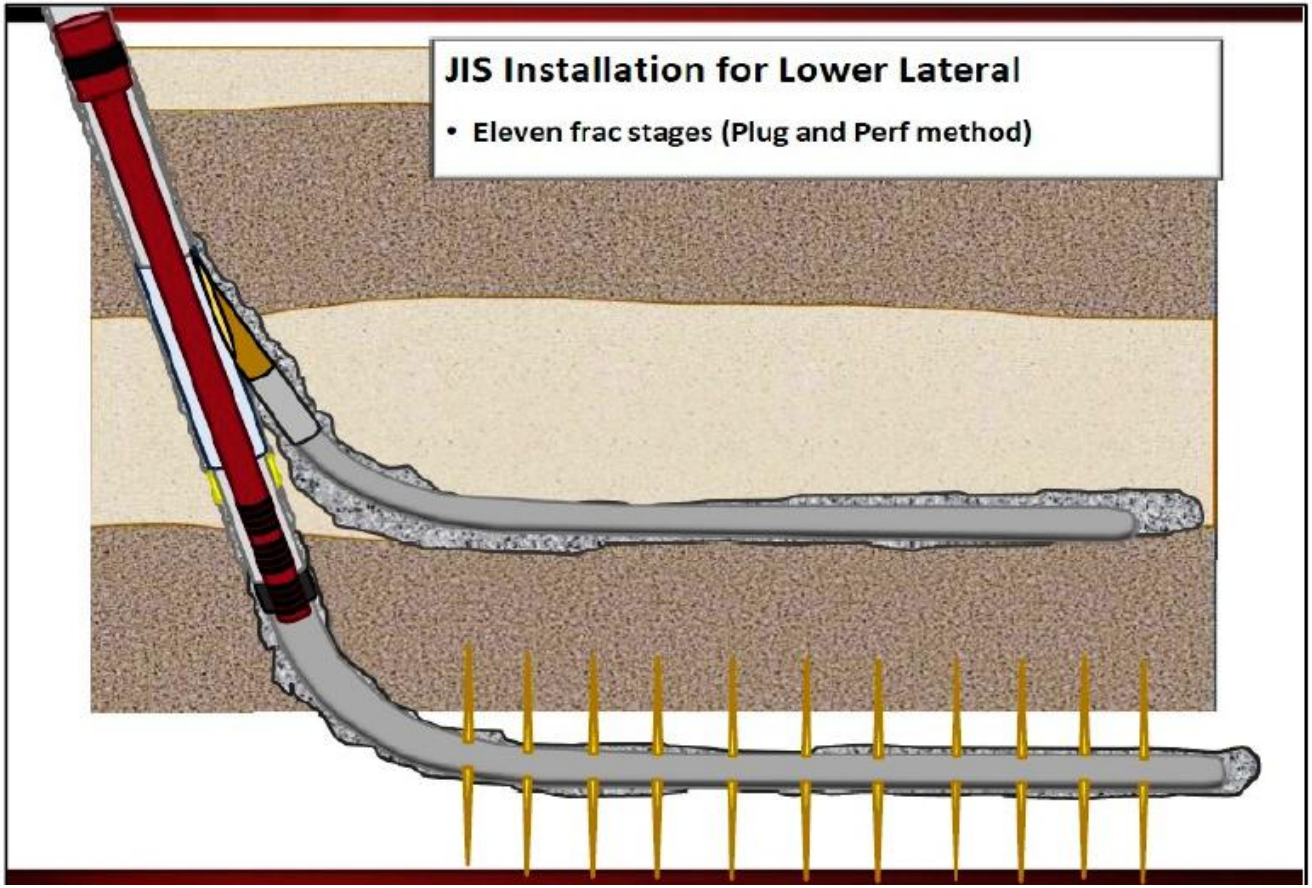
Junctions



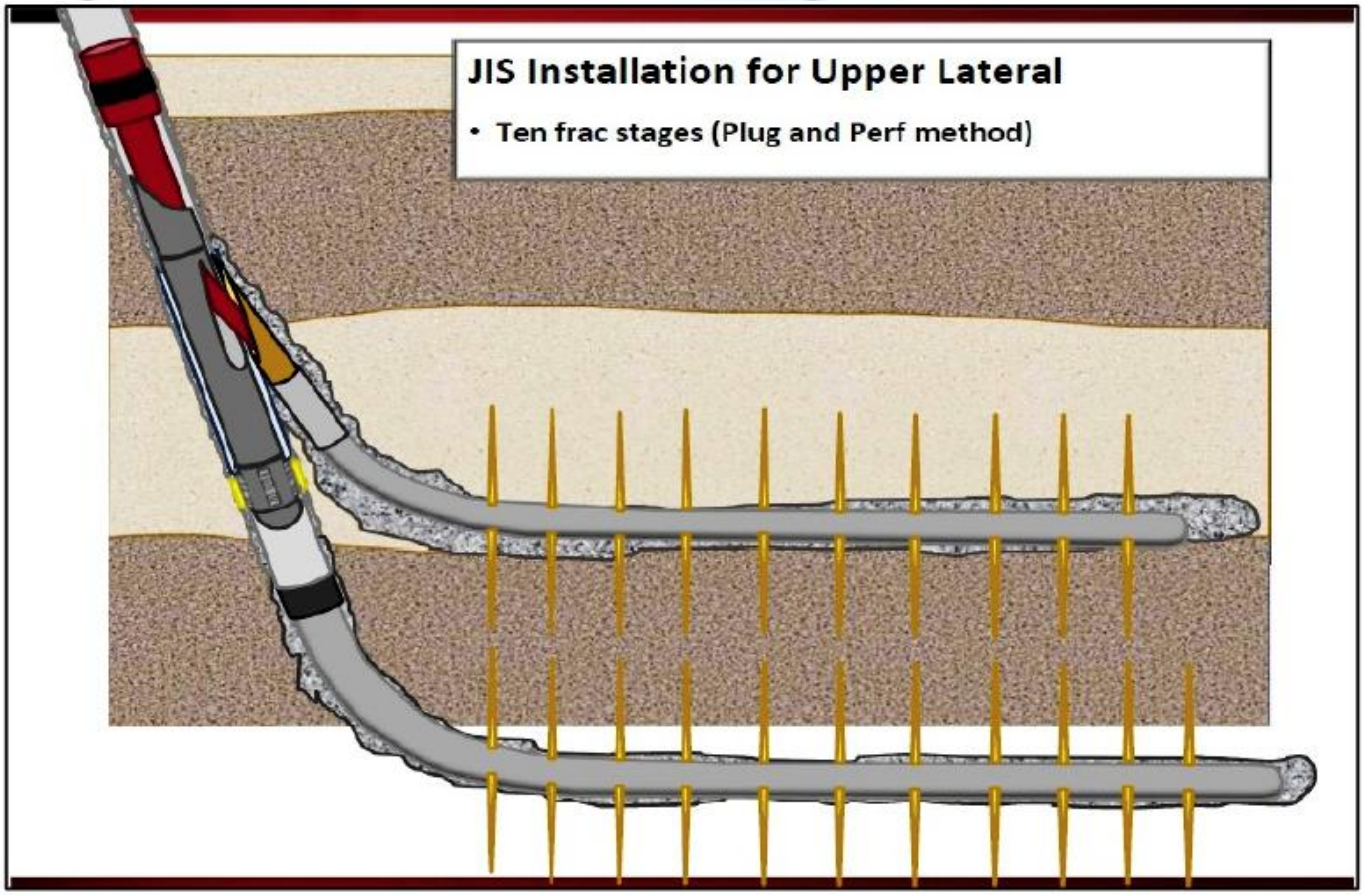
Junctions



Junctions


JIS Installation for Lower Lateral
• Eleven frac stages (Plug and Perf method)

Junctions


JIS Installation for Upper Lateral
• Ten frac stages (Plug and Perf method)

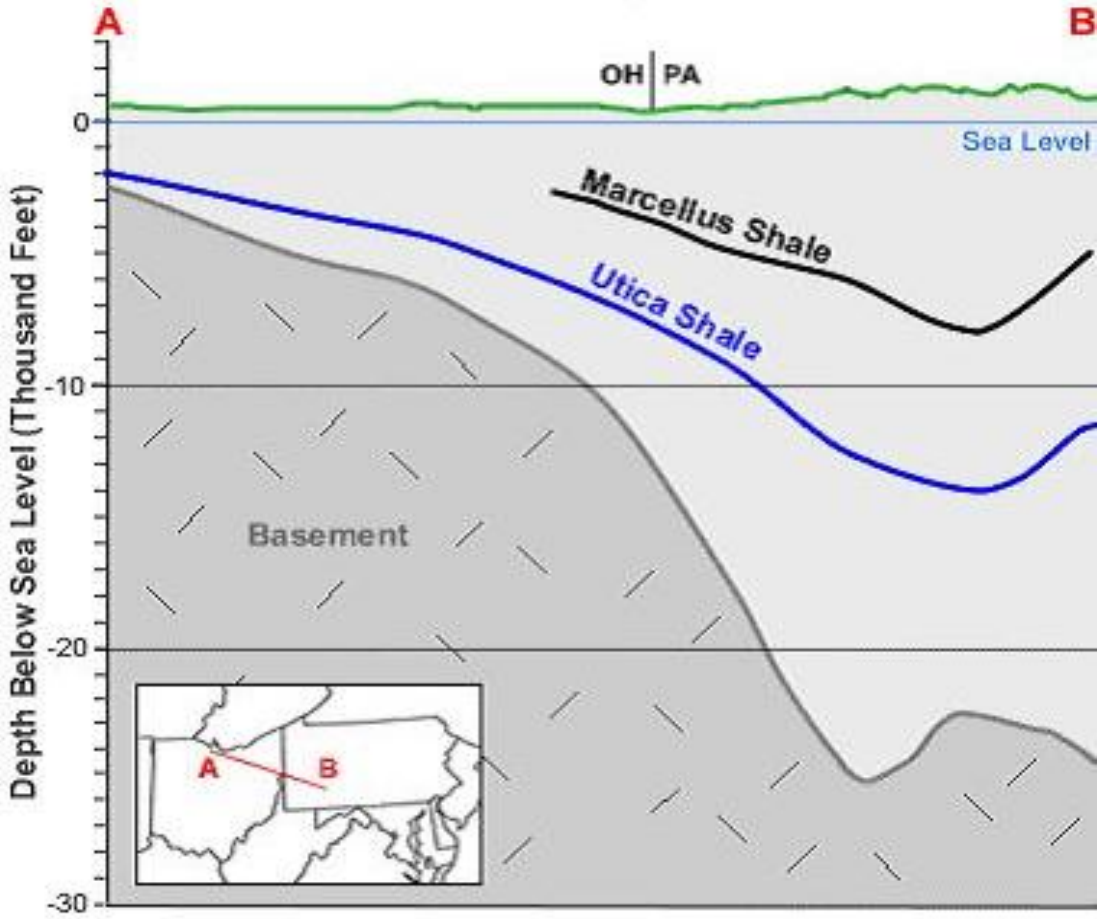
2013 Case Study

- Stacked multilateral in Anadarko Basin targeting Granite Wash
- Temporary TAML 5 junction installed at 12,500’
- Each lateral selectively fractured
- Results
  - Double the production of individual horizontal well
  - $2MM savings compared to 2 individual horizontal wells

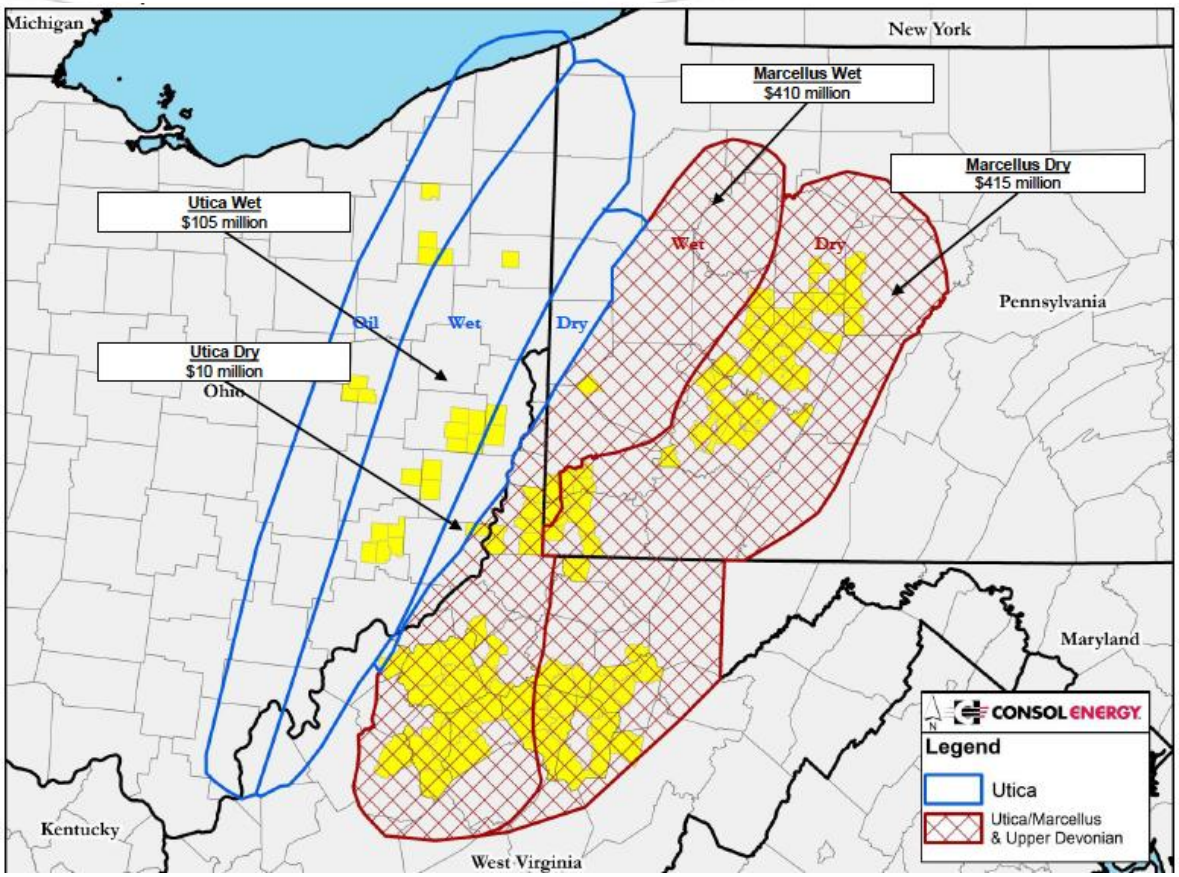
2013 Case Study

- In 2012 Apache Corporation spent $5MM to $7.5MM per well in the Granite wash
- On first attempt at multilateral, operator reduced D&C costs by ~15 to 20%.

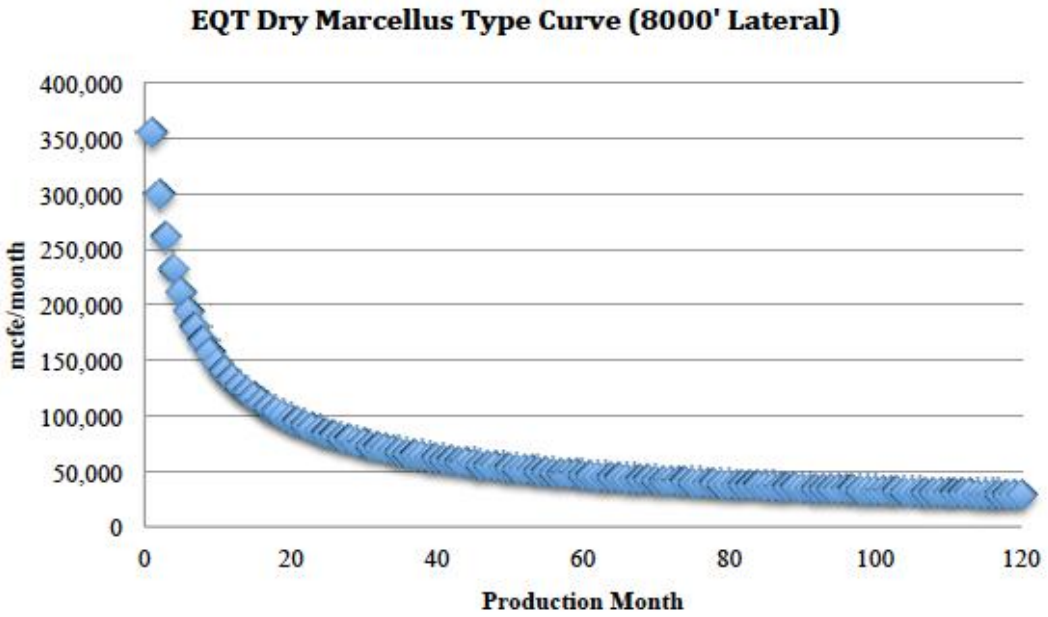
Utica/Marcellus Multilateral



Utica/Marcellus Multilateral

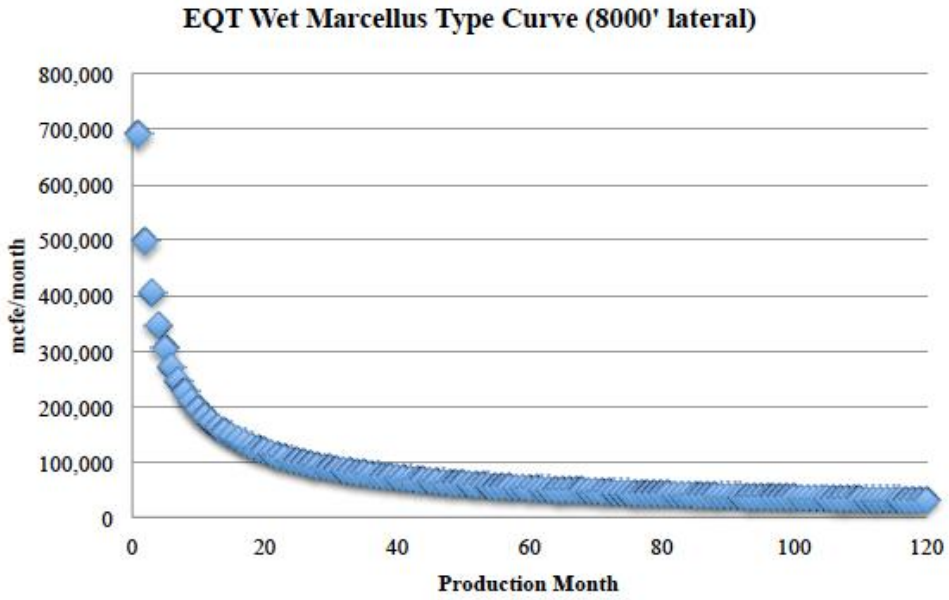


Utica/Marcellus Multilateral



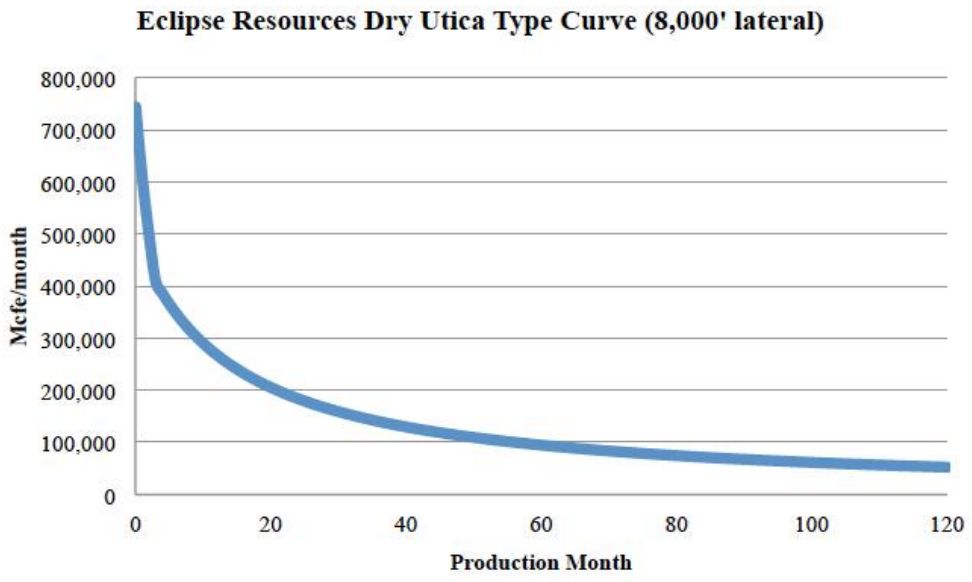
- EUR
  - 13.9 Bcfe
- 30-day IP
  - 11.7 MMcfe/d
- 50% volume reduction

Utica/Marcellus Multilateral



- EUR
  - 16.0 Bcfe
- 30 Day IP
  - 23.0 MMcfe/d
- 50% volume reduction

Utica/Marcellus Multilateral



- 3-month exponential decline
- Harmonic decline thereafter
- EUR
  - ~18.7 Bcfe
- 30-Day IP
  - ~24.5 MMcfe/d

Economic Analysis

Marcellus Well Costs				
Company	**Source**	**Formation**	**Development Cost**	**Well Cost/1000'**
Antero	2015 Co. presentation	Marcellus (Dry)	$10.6MM	$1,325
Rice Energy	2015 Co. presentation	Marcellus (Dry)	$10.0MM	$1,250
Eclipse Resources	2015 Co. presentation	Marcellus (Wet)	$8.45MM	$1,056
EQT Corp.	Co. website	Marcellus (Not Specified)	$9.60MM	$1,203
Southwestern Energy	2014 Co. presentation	Marcellus (Dry)	$9.92MM	$1,240
Southwestern Energy	2014 Co. presentation	Marcellus (Wet)	$9.92MM	$1,240
Consol Energy	2015 Co. presentation	Marcellus (Wet)	$8.75MM	$1,094
Consol Energy	2016 Co. presentation	Marcellus (Dry)	$9.29MM	$1,161

- Average Marcellus drilling and completion costs
  - $9.57 MM

Economic Analysis

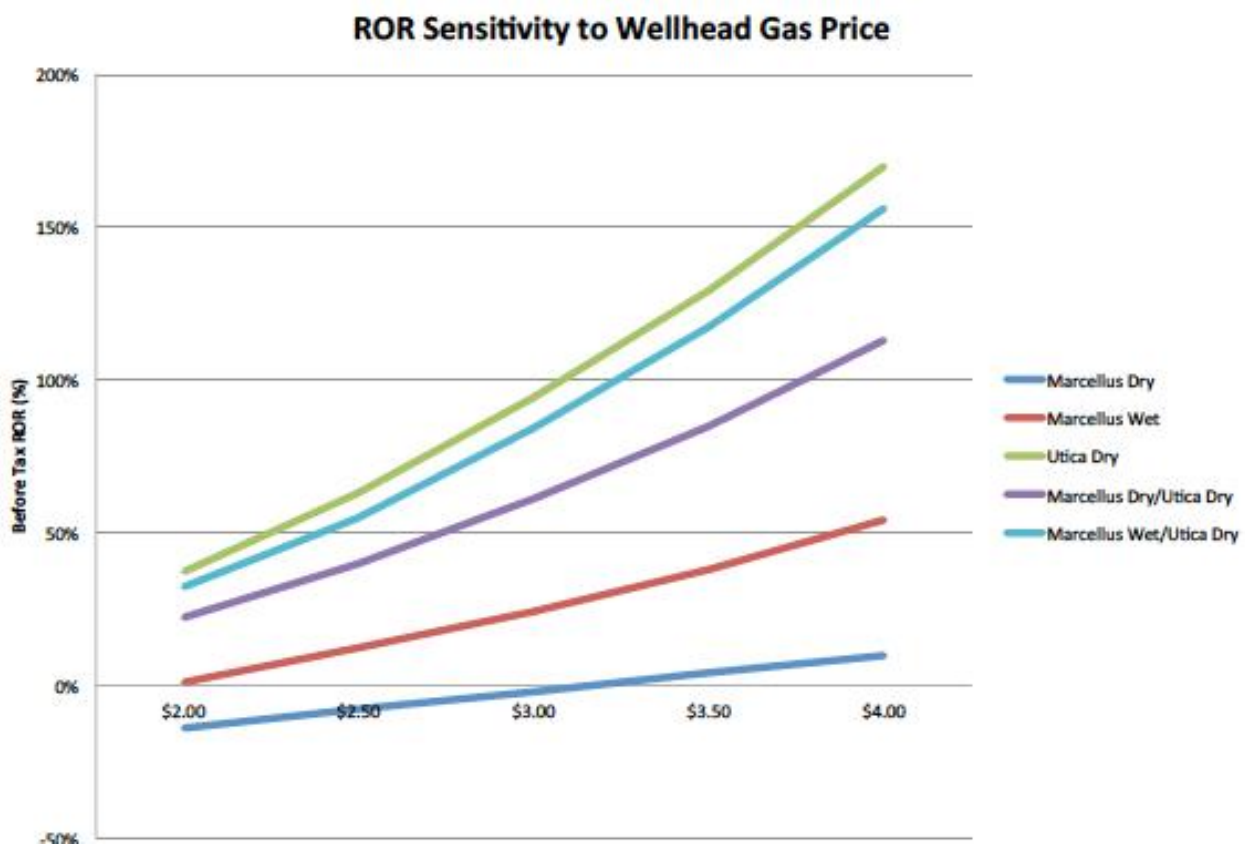
Utica Well Costs				
Company	**Source**	**Formation**	**Development Cost**	**Well Cost/1000'**
Antero	2015 Co. presentation	Utica (Dry)	$12.1MM	$1,513
Rice Energy	2015 Co. presentation	Utica (Dry)	$12.0MM	$1,500
Eclipse Resources	2015 Co. presentation	Utica (Dry)	$12.9MM	$1,613
Chesapeake Energy	2014 Co. presentation	Utica (Not specified)	$8.25MM	$1,031
Southwestern Energy	2014 Co. presentation	Utica (Dry)	$11.5MM	$1,440
Consol Energy	2014 Co. presentation	Utica (Dry)	$11.0MM	$1,371

- Average Utica drilling and completion costs
  - $11.3 MM

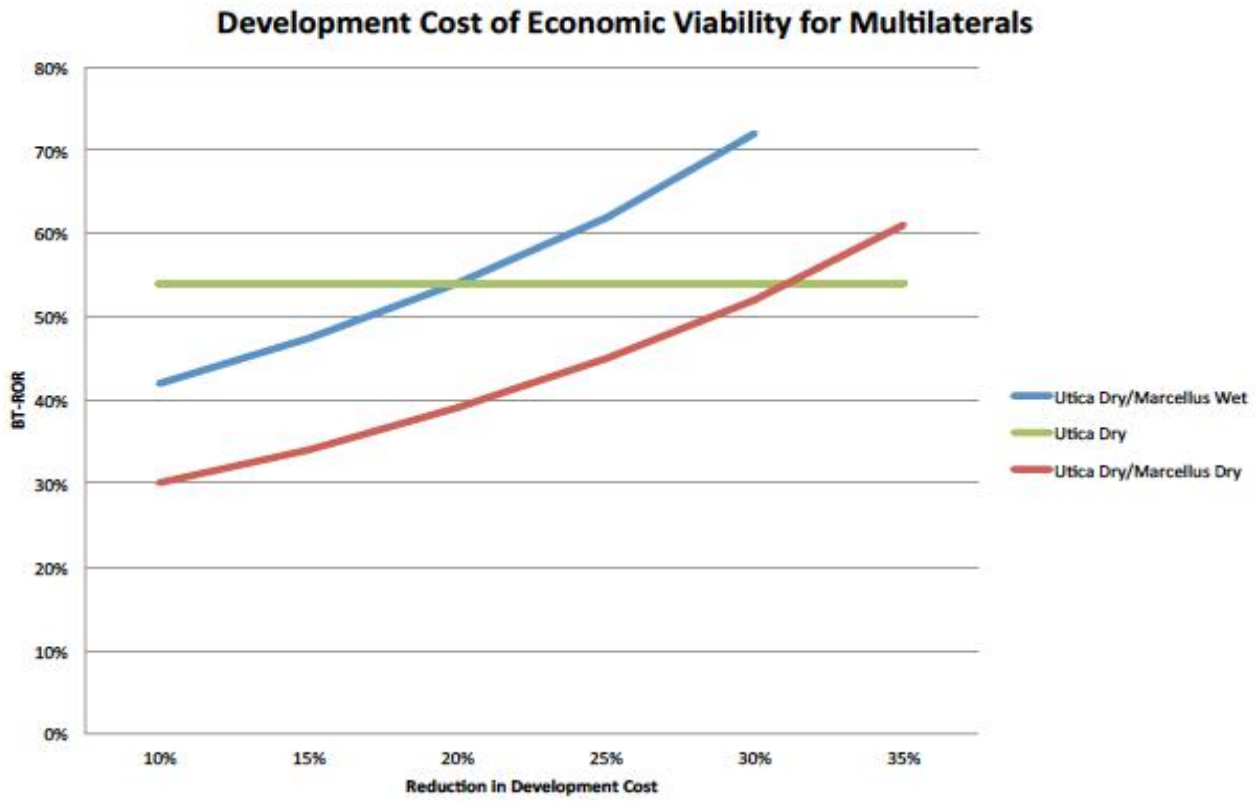
Economic Analysis

- Assumptions
  - Operating costs
    - Fixed: $60,000/year
    - Variable: $0.23/mcfe
  - Wellhead gas price based on 3-year NYMEX strip and 3-year transportation basis strip
  - NGL separation neglected; Gas price adjusted for BTU content
  - Cost reduction of 15% for multilateral wells

Economic Analysis



Economic Analysis



Conclusions

- Multilateral wells in southeastern Ohio require a 22% reduction in D&C costs for wet Marcellus areas and a 32% reduction for dry Marcellus areas
- Multilaterals in PA and WV stand a better chance of being economically viable because the Marcellus is thicker
- Economics of 2 laterals into the Utica should be analyzed

Sources

- Antero Resources Inc. Investor Presentation: 2014. www.anteroresources.com. Accessed
- February 2015
- Bosworth, S et. al. Key Issues in Multilateral Technology. Oilfield Review, Winter 1998.
- Chesapeake Energy Corporation. Investor Presentation: May 2014. www.chk.com.
- Accessed February 2015
- Consol Energy Inc. Analyst Day: June 2014. www.consolenergy.com. Accessed February 2015

Sources

- Durst, D. G. & Vento, M. Unconventional Shale Play Selective Fracturing Using Multilateral
- Technology. Paper SPE 163959 presented at the SPE Middle East Unconventional Gas
- Conference and Exhibition. Muscat, Oman. 28-30 January 2013
- Eclipse Resources Inc. Investor Presentation: January 2015. www.eclipseresources.com.Accessed January 2015
- Economides, M. J., et. al. Petroleum Production Systems: 2nd Edition. Prentice Hall. October 2012

Sources

- EQT Corporation. Marcellus and Upper Devonian Decline Curves Data: June 2014. EQT Investor Relations. www.eqt.com. Accessed February 2015.
- Greenburg, J. Today's Technologies Support Operator Goals. North American Unconventional Yearbook 2012. p 145-146. Accessed 20 December 2014. www.hartenergy.com
- Husain, T. M., et. al. Economic Comparison of Multi-Lateral Drilling Over Horizontal Drilling for Marcellus Shale Field Development. January 2011. Pennsylvania State University College of Earth and Mineral Sciences. www.ems.psu.edu. Accessed December 2014

Sources

- LoCricchio, Ed. Granite Wash Play Overview, Anadarko Basin: Stratigraphic Framework and Controls on Pennsylvanian Granite Wash Production, Anadarko Basin, Texas and Oklahoma. AAPG Data Pages. June 2012. www.searchanddiscovery.com. Accessed February 2015
- Ohio DNR Division of Oil and Gas Resources. Oil and Gas Well Locator. www.oilandgas.odnr.gov. Accessed December 2014.
- Rice Energy Inc. Investor Presentation: January 2015. www.riceenergy.com. Accessed January 2015

Sources

- Southwestern Energy Inc. Investor Presentation: 2014. www.swn.com Accessed February 2015
- Utica Shale: The Natural Gas Giant Below the Marcellus. Figure 5a. www.geology.com. Accessed January 2015.