Permian Basin Production and Looming Issues

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APRIL 19, 2018

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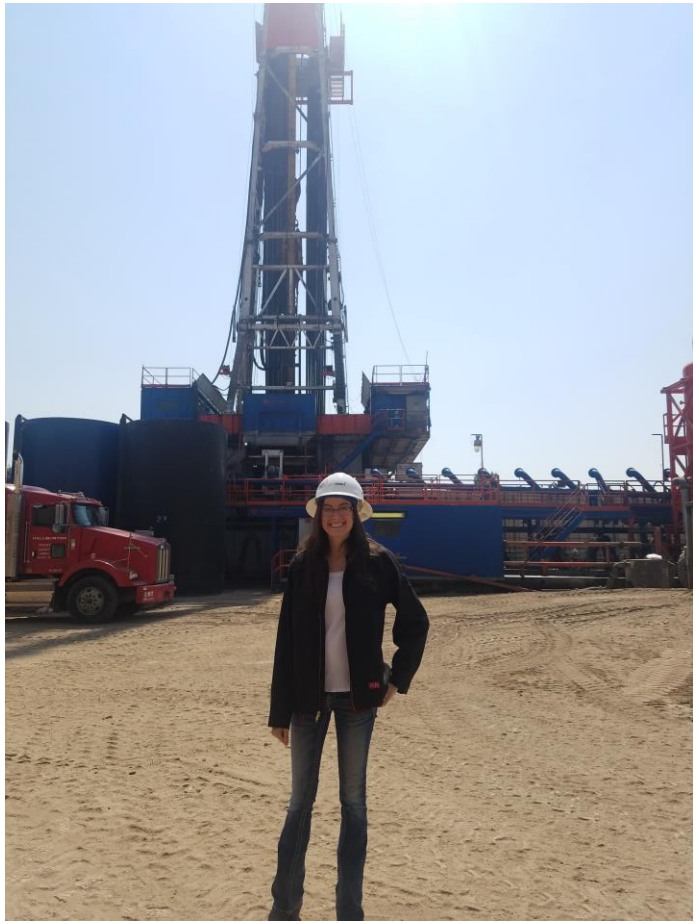

Source: Extraction rig, September 2017

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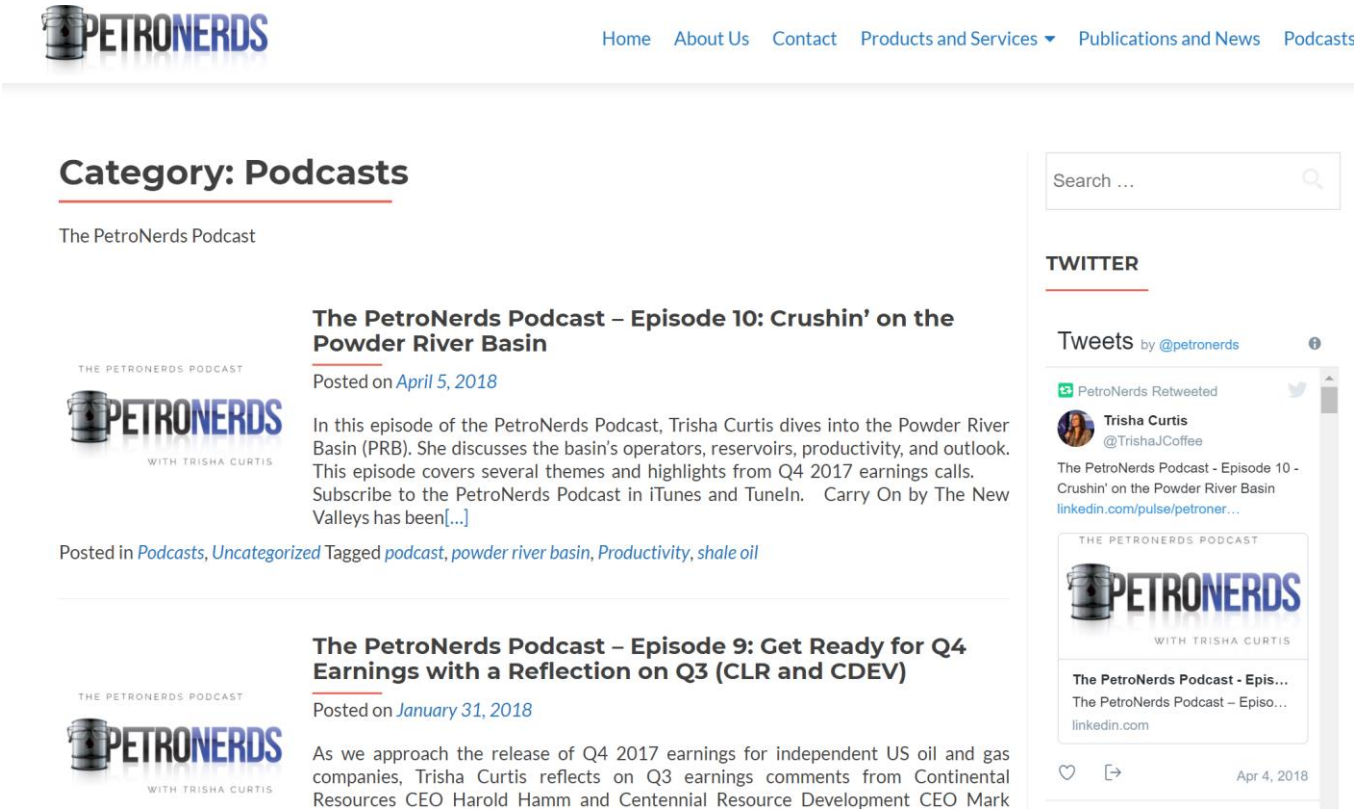

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The PetroNerds Podcast

The PetroNerds Podcast – Episode 10: Crushin' on the Powder River Basin

Posted on *April 5, 2018*

In this episode of the PetroNerds Podcast, Trisha Curtis dives into the Powder River Basin (PRB). She discusses the basin's operators, reservoirs, productivity, and outlook. This episode covers several themes and highlights from Q4 2017 earnings calls. Subscribe to the PetroNerds Podcast in iTunes and TuneIn. Carry On by The New Valleys has been[...]

Posted in *Podcasts*, *Uncategorized* Tagged *podcast*, *powder river basin*, *Productivity*, *shale oil*

The PetroNerds Podcast – Episode 9: Get Ready for Q4 Earnings with a Reflection on Q3 (CLR and CDEV)

Posted on *January 31, 2018*

As we approach the release of Q4 2017 earnings for independent US oil and gas companies, Trisha Curtis reflects on Q3 earnings comments from Continental Resources CEO Harold Hamm and Centennial Resource Development CEO Mark

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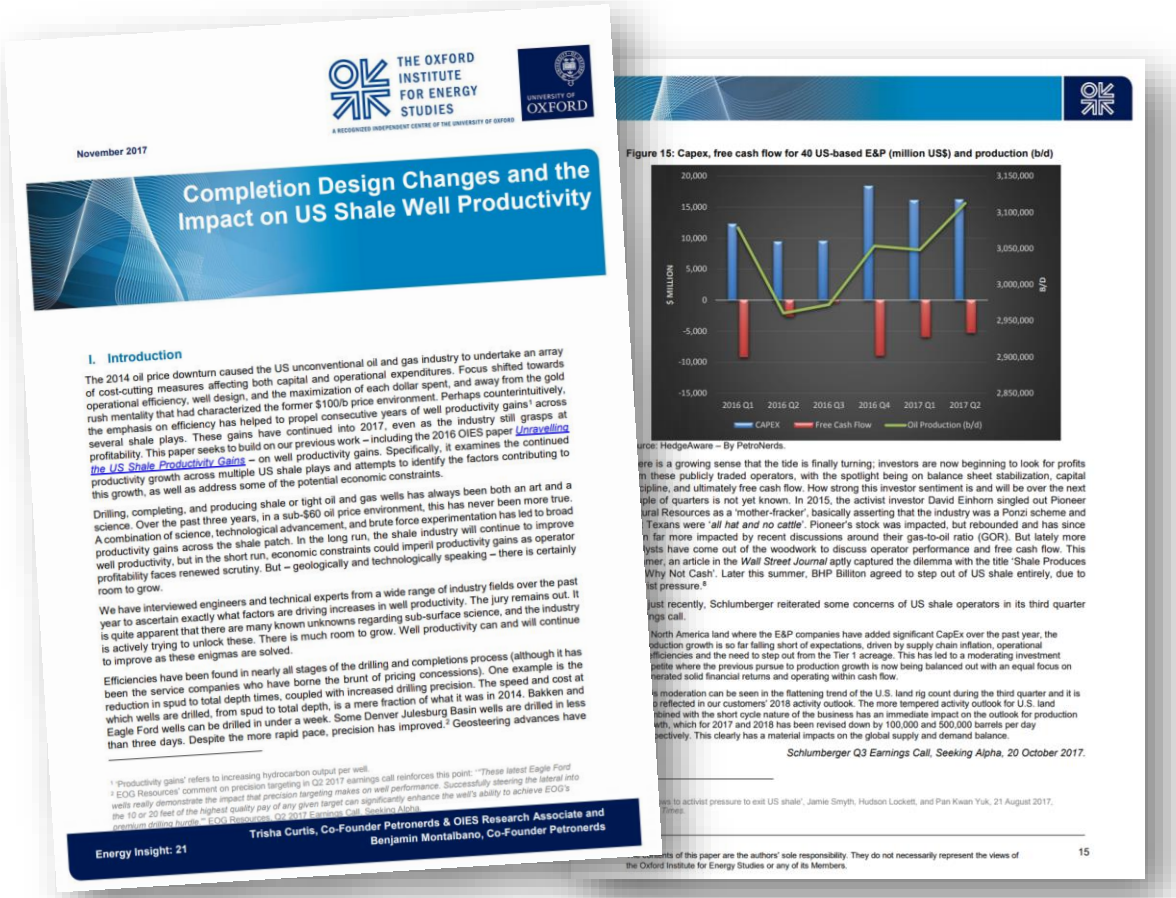
“Completion Design Changes and the Impact of US Shale Well Productivity”



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November 2017

Completion Design Changes and the Impact on US Shale Well Productivity

I. Introduction

The 2014 oil price downturn caused the US unconventional oil and gas industry to undertake an array of cost-cutting measures affecting both capital and operational expenditures. Focus shifted towards operational efficiency, well design, and the maximization of each dollar spent, and away from the gold rush mentality that had characterized the former $100/b price environment. Perhaps counterintuitively, the emphasis on efficiency has helped to propel consecutive years of well productivity gains[1] across several shale plays. These gains have continued into 2017, even as the industry still grasps at profitability. This paper seeks to build on our previous work – including the 2016 OIES paper *Unravelling the US Shale Productivity Gains* – on well productivity gains. Specifically, it examines the continued productivity growth across multiple US shale plays and attempts to identify the factors contributing to this growth, as well as address some of the potential economic constraints.

Drilling, completing, and producing shale or tight oil and gas wells has always been both an art and a science. Over the past three years, in a sub-$60 oil price environment, this has never been more true. A combination of science, technological advancement, and brute force experimentation has led to broad productivity gains across the shale patch. In the long run, the shale industry will continue to improve well productivity, but in the short run, economic constraints could imperil productivity gains as operator profitability faces renewed scrutiny. But – geologically and technologically speaking – there is certainly room to grow.

We have interviewed engineers and technical experts from a wide range of industry fields over the past year to ascertain exactly what factors are driving increases in well productivity. The jury remains out. It is quite apparent that there are many known unknowns regarding sub-surface science, and the industry is actively trying to unlock these. There is much room to grow. Well productivity can and will continue to improve as these enigmas are solved.

Efficiencies have been found in nearly all stages of the drilling and completions process (although it has been the service companies who have borne the brunt of pricing concessions). One example is the reduction in spud to total depth times, coupled with increased drilling precision. The speed and cost at which wells are drilled, from spud to total depth, is a mere fraction of what it was in 2014. Bakken and Eagle Ford wells can be drilled in under a week. Some Denver Julesburg Basin wells are drilled in less than three days. Despite the more rapid pace, precision has improved.[2] Geosteering advances have

[1] 'Productivity gains' refers to increasing hydrocarbon output per well.
[2] EOG Resources' comment on precision targeting in Q2 2017 earnings call reinforces this point: "*These latest Eagle Ford wells really demonstrate the impact that precision targeting makes on well performance. Successfully steering the lateral into the 10 or 20 feet of the highest quality pay of any given target can significantly enhance the well's ability to achieve EOG's premium drilling hurdle.*" EOG Resources, Q2 2017 Earnings Call, Seeking Alpha.

Energy Insight: 21

Trisha Curtis, Co-Founder Petronerds & OIES Research Associate and Benjamin Montalbano, Co-Founder Petronerds

Figure 15: Capex, free cash flow for 40 US-based E&P (million US$) and production (b/d)

urce: HedgeAware – By PetroNerds.

ere is a growing sense that the tide is finally turning; investors are now beginning to look for profits n these publicly traded operators, with the spotlight being on balance sheet stabilization, capital scipline, and ultimately free cash flow. How strong this investor sentiment is and will be over the next ple of quarters is not yet known. In 2015, the activist investor David Einhorn singled out Pioneer ural Resources as a 'mother-fracker', basically asserting that the industry was a Ponzi scheme and Texans were '*all hat and no cattle*'. Pioneer's stock was impacted, but rebounded and has since n far more impacted by recent discussions around their gas-to-oil ratio (GOR). But lately more lysts have come out of the woodwork to discuss operator performance and free cash flow. This mer, an article in the *Wall Street Journal* aptly captured the dilemma with the title 'Shale Produces Why Not Cash'. Later this summer, BHP Billiton agreed to step out of US shale entirely, due to st pressure.[8]

ust recently, Schlumberger reiterated some concerns of US shale operators in its third quarter ngs call.

North America land where the E&P companies have added significant CapEx over the past year, the duction growth is so far falling short of expectations, driven by supply chain inflation, operational ficiencies and the need to step out from the Tier 1 acreage. This has led to a moderating investment petite where the previous pursue to production growth is now being balanced out with an equal focus on nerated solid financial returns and operating within cash flow.

s moderation can be seen in the flattening trend of the U.S. land rig count during the third quarter and it is reflected in our customers' 2018 activity outlook. The more tempered activity outlook for U.S. land mbined with the short cycle nature of the business has an immediate impact on the outlook for production with, which for 2017 and 2018 has been revised down by 100,000 and 500,000 barrels per day ectively. This clearly has a material impacts on the global supply and demand balance.

Schlumberger Q3 Earnings Call, Seeking Alpha, 20 October 2017.

ers to activist pressure to exit US shale', Jamie Smyth, Hudson Lockett, and Pan Kwan Yuk, 21 August 2017, Times.

nts of this paper are the authors' sole responsibility. They do not necessarily represent the views of the Oxford Institute for Energy Studies or any of its Members.

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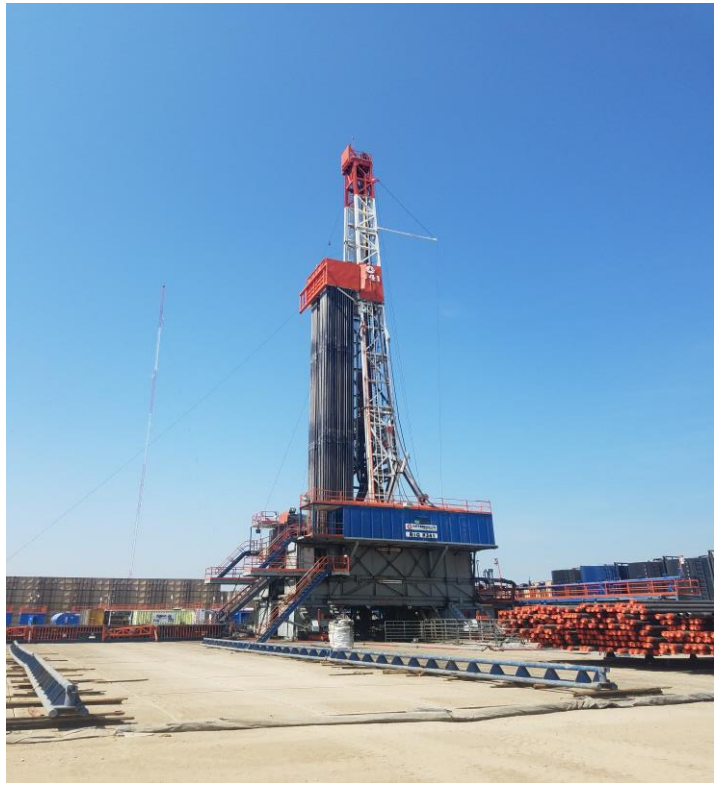
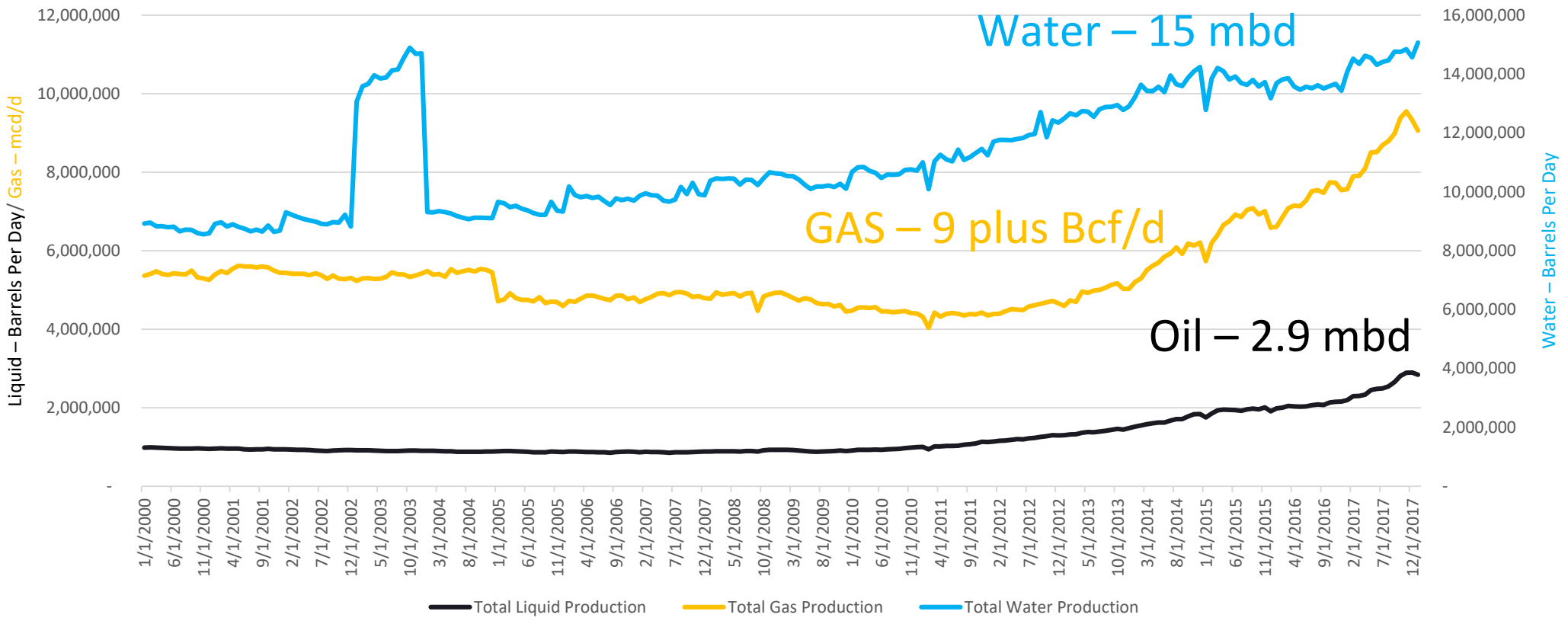
http://www.petronerds.com/wp-content/uploads/2017/11/OIES-PetroNerds-Completion-Design-and-Productivity-2017.pdf

Spud to Total Depth in Less than Three Days



Extraction Oil and Gas, September 2017

Permian Basin Production



Permian Problems

With crude oil comes associated natural gas and produced water

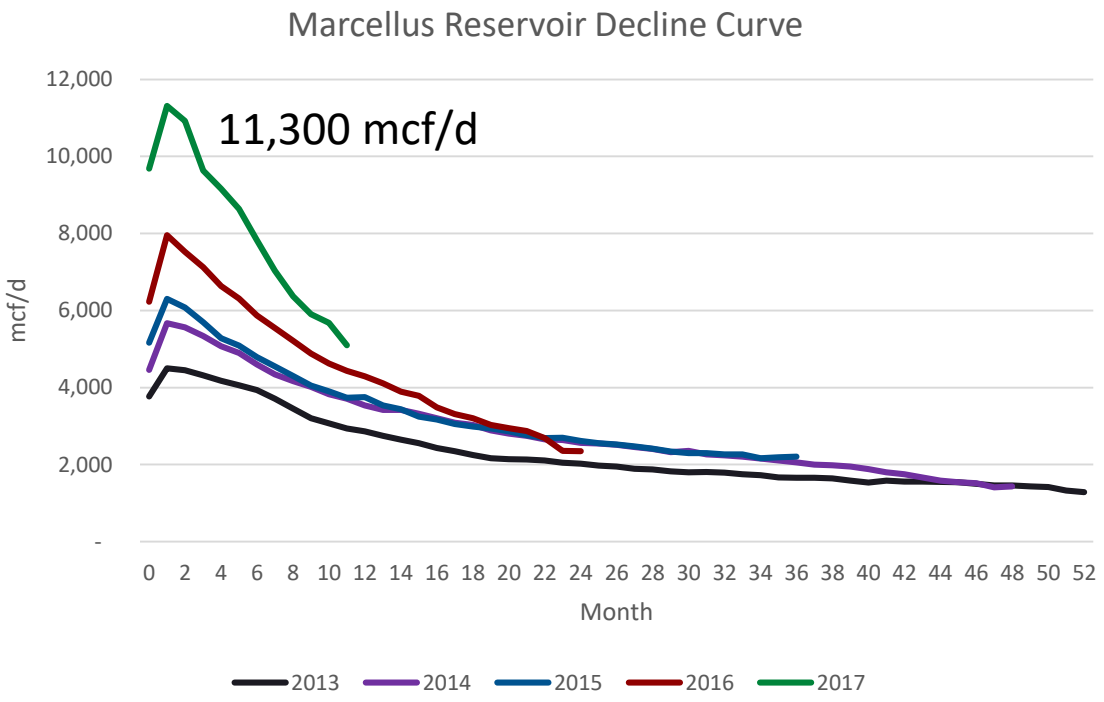
Gassy reservoirs can help drive oil production – at least in the Permian's case.

It isn't just the Permian that is the problem…..gas EVERYWHERE

- Ultra Petroleum – Pinedale, Wyoming

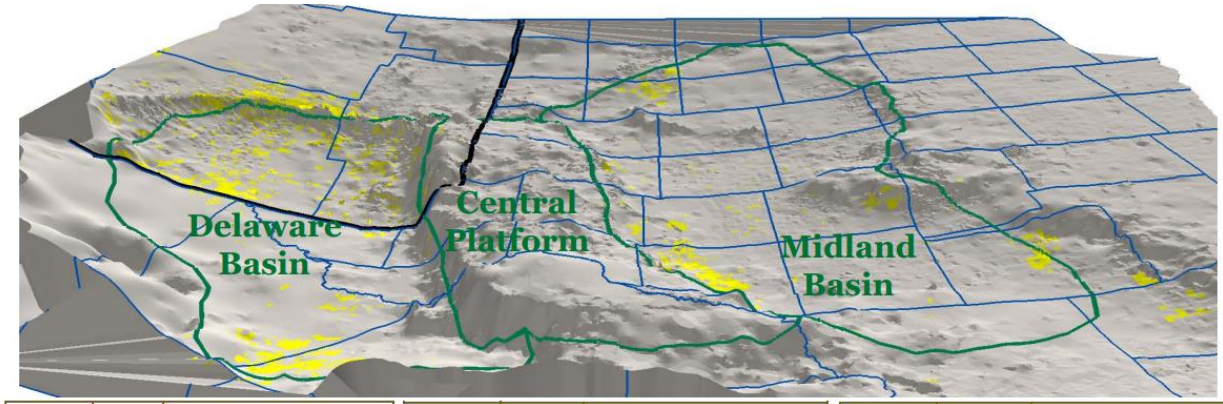
High intensity completions have done wonders for oil production and even more for gas production (IPs and well productivity)

- Marcellus



Source: PetroNerds, DrillingInfo data

Permian Basin Geology and Stratigraphy

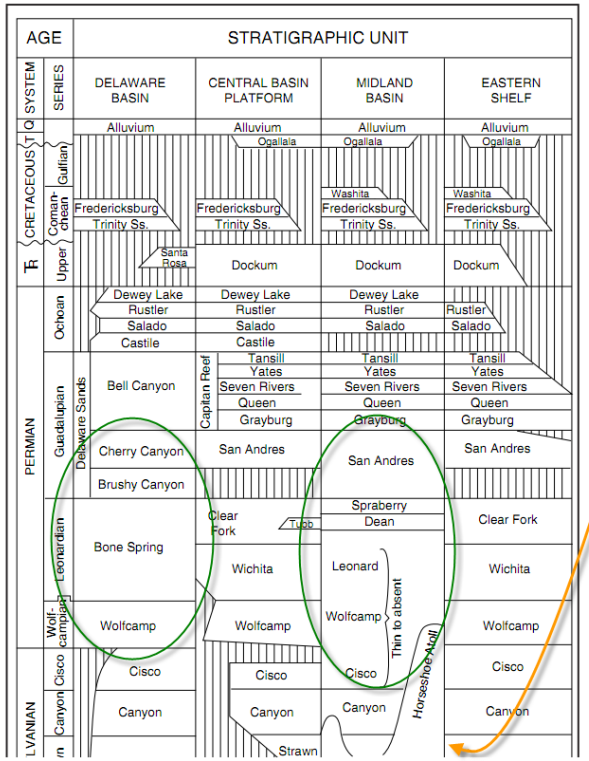


PERIOD	SERIES	DELAWARE BASIN FORMATION
GUADALAUPE	DELAWARE GROUP	LAMAR BELL CANYON
		CHERRY CANYON
		BRUSHY CANYON
LEONARD		UPPER AVALON SHALE
		LOWER AVALON SHALE
		1ST BONE SPRING
		2ND BONE SPRING
		3RD BONE SPRING
WOLFCAMP		WOLFCAMP
PENN		PENNSYLVANIAN

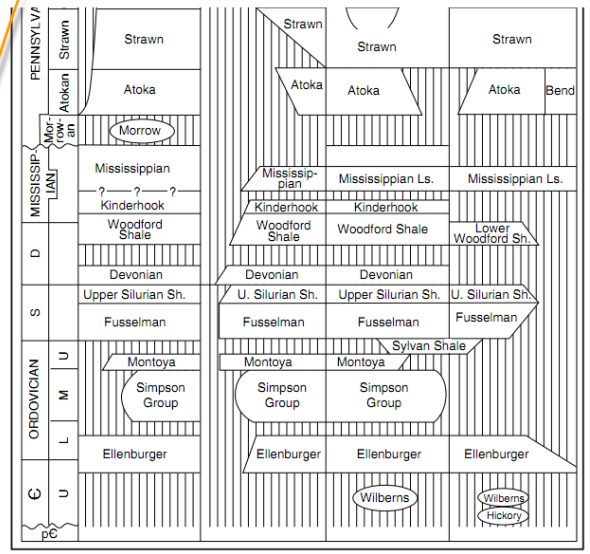
PERIOD	SERIES	CENTRAL PLATFORM FORMATION
GUADALAUPE	WHITE-HORSE	TANSILL
		YATES
		7 RIVERS
		QUEEN
		GRAYBURG
	WARD	SAN ANDRES
		GLORIETA
LEONARD	YESO	PADDOCK
		BLINEBRY
		TUBB
		DRINKARD
	ABO	
WOLFCAMP	WOLFCAMP	HUECO
		BURSUM
PENN	PENNSYLVANIAN	

PERIOD	SERIES	MIDLAND BASIN FORMATION
GUADALAUPE	WHITE-HORSE	TANSILL
		YATES
		7 RIVERS
		QUEEN
		GRAYBURG
	WARD	SAN ANDRES
		GLORIETA
LEONARD	CLEAR FORK	UPPER LEONARD
	UPPER SPRABERRY	
	LOWER SPRABERRY	
	DEAN	
WOLFCAMP	WOLFCAMP	
PENN	PENNSYLVANIAN	

Source: Concho Resources 2nd Quarter 2013 Investor Presentation



The Permian hosts a vast amount of stacked payzones that are actively being drilled and further delineated for the best spacing and completion plans.



Source: PERMIAN BASIN PROVINCE (044) By Mahlon M. Ball

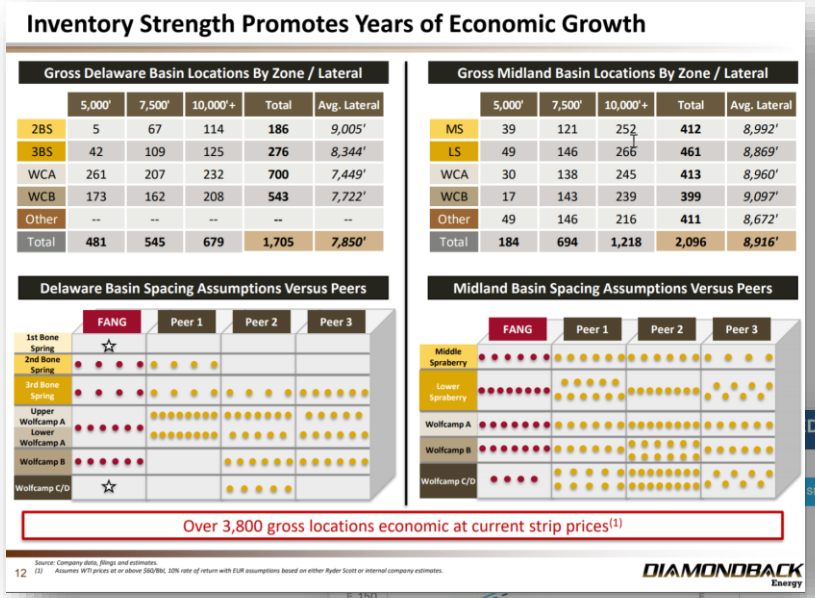
Still Early in the Game

This is a highly layered mix of conventional and unconventional reservoirs.

- Intense layering
- Interbedded shales, sandstones, and carbonates

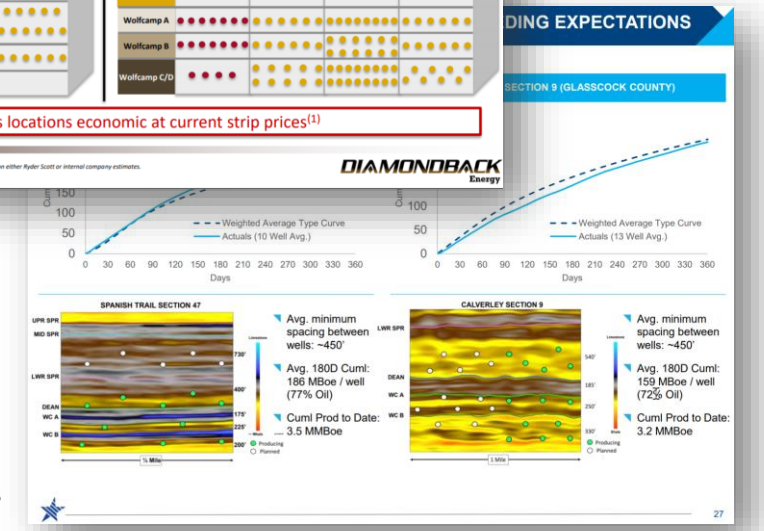
The Permian Basin has a tremendous amount of potential in terms of stacked pay, but successfully developing these stacked payzones will take a lot of work and a lot of capital.

- Stringent leasing requirements in the Permian Basin often prevent optimal asset delineation
- Land rush, Wall Street push, and high acreage costs
  - Now operators are trying to delineate, develop, and maintain leasing requirements all at the same time
  - Cost inflation also causing problems with soo much activity in the Permian
  - Local sand etc.
- Optimal spacing and completion design (frac) is key
  - Still early in this ball game
  - Inventory
  - Well density, parent child problems, all coming into focus



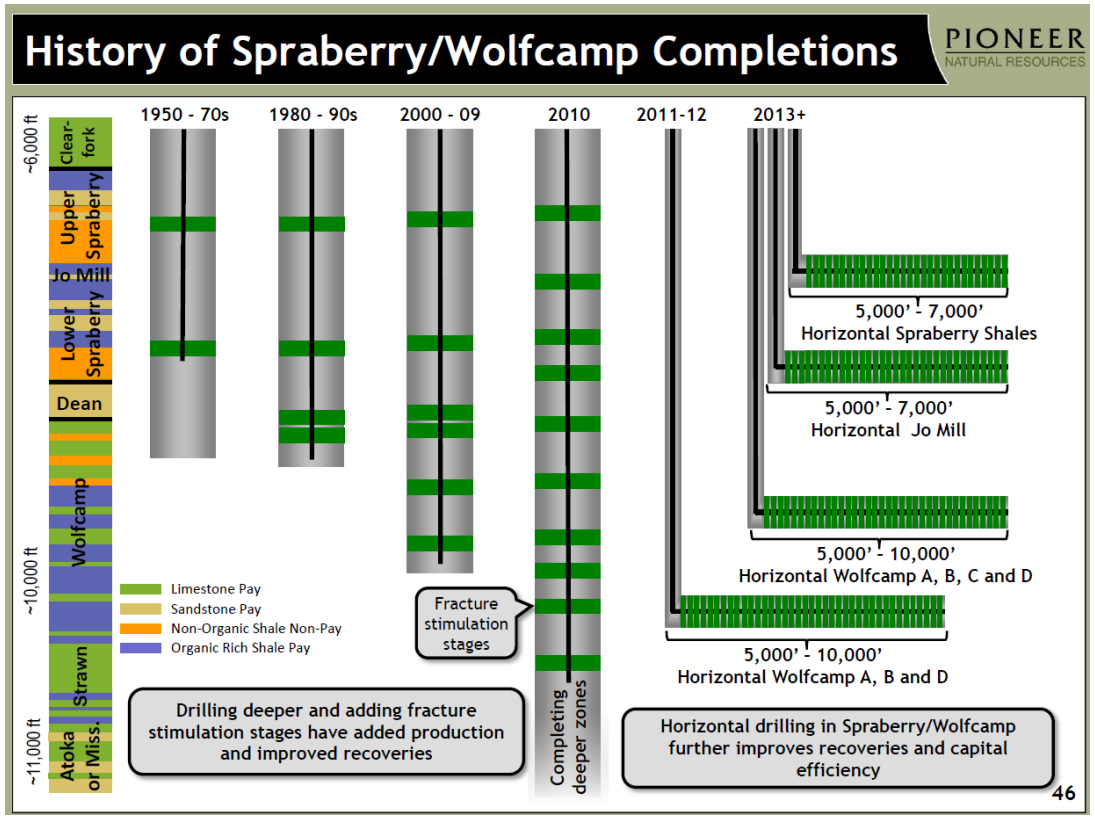
	5,000'	7,500'	10,000'+	Total	Avg. Lateral
2BS	5	67	114	**186**	*9,005'*
3BS	42	109	125	**276**	*8,344'*
WCA	261	207	232	**700**	*7,449'*
WCB	173	162	208	**543**	*7,722'*
Other	--	--	--	--	--
Total	**481**	**545**	**679**	**1,705**	***7,850'***

	5,000'	7,500'	10,000'+	Total	Avg. Lateral
MS	39	121	252	**412**	*8,992'*
LS	49	146	266	**461**	*8,869'*
WCA	30	138	245	**413**	*8,960'*
WCB	17	143	239	**399**	*9,097'*
Other	49	146	216	**411**	*8,672'*
Total	**184**	**694**	**1,218**	**2,096**	***8,916'***

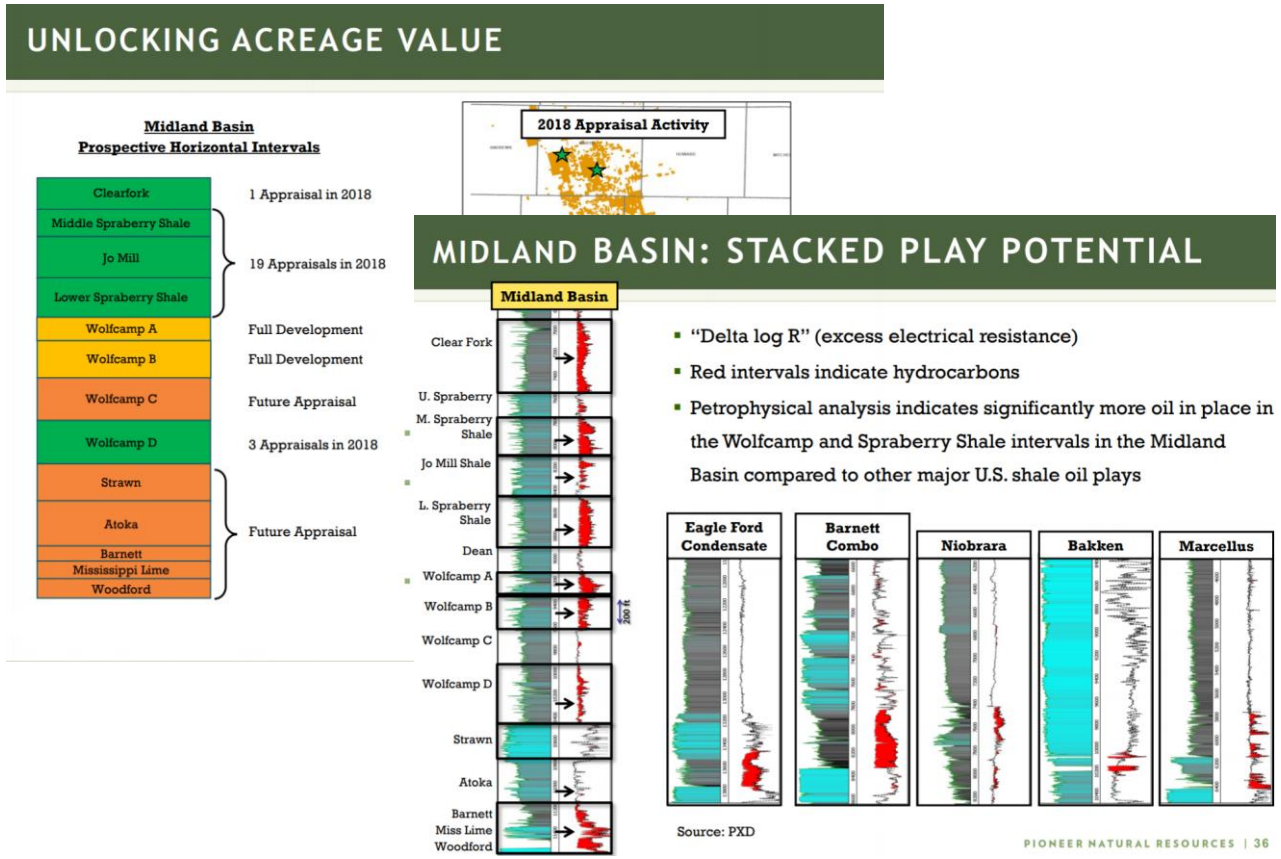


Source: Diamondback and Cimarex April 2018 Investor Presentations

Pioneer – Then and Now

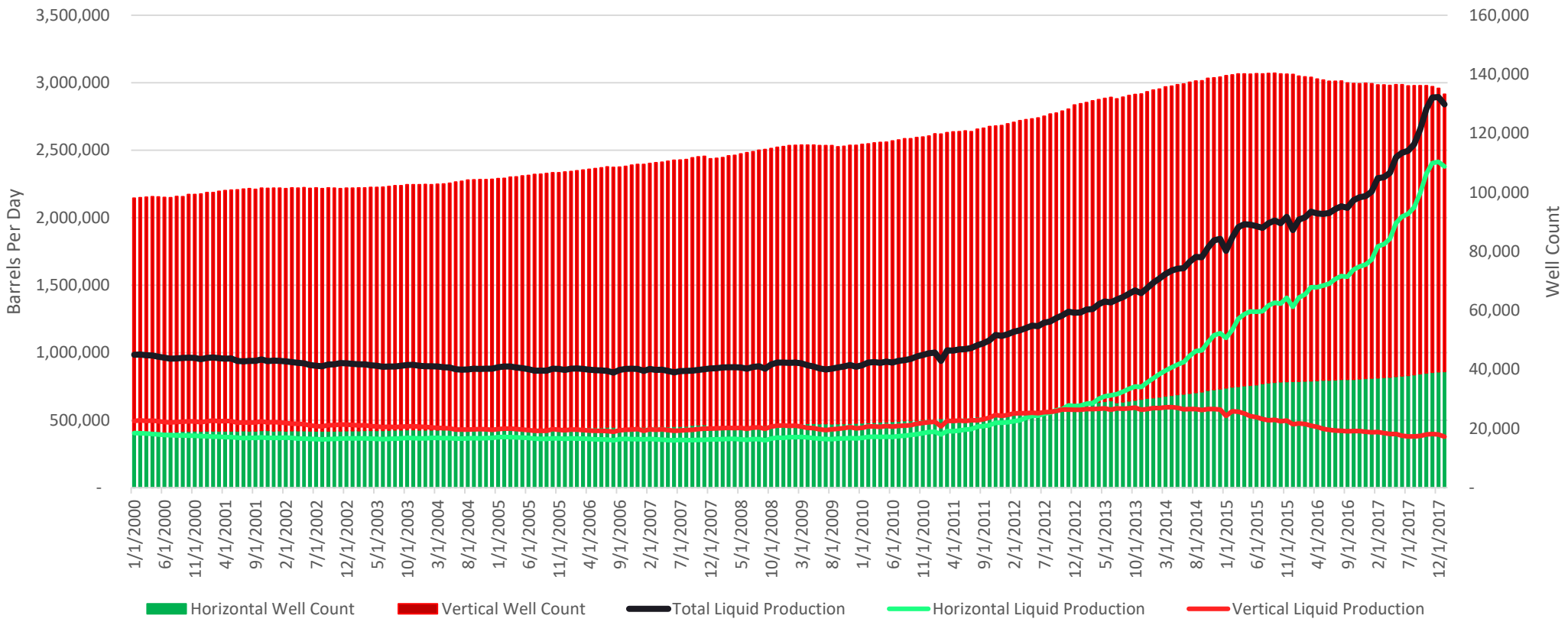


Source: Pioneer Natural Resources Oct 2013 Investor Presentation



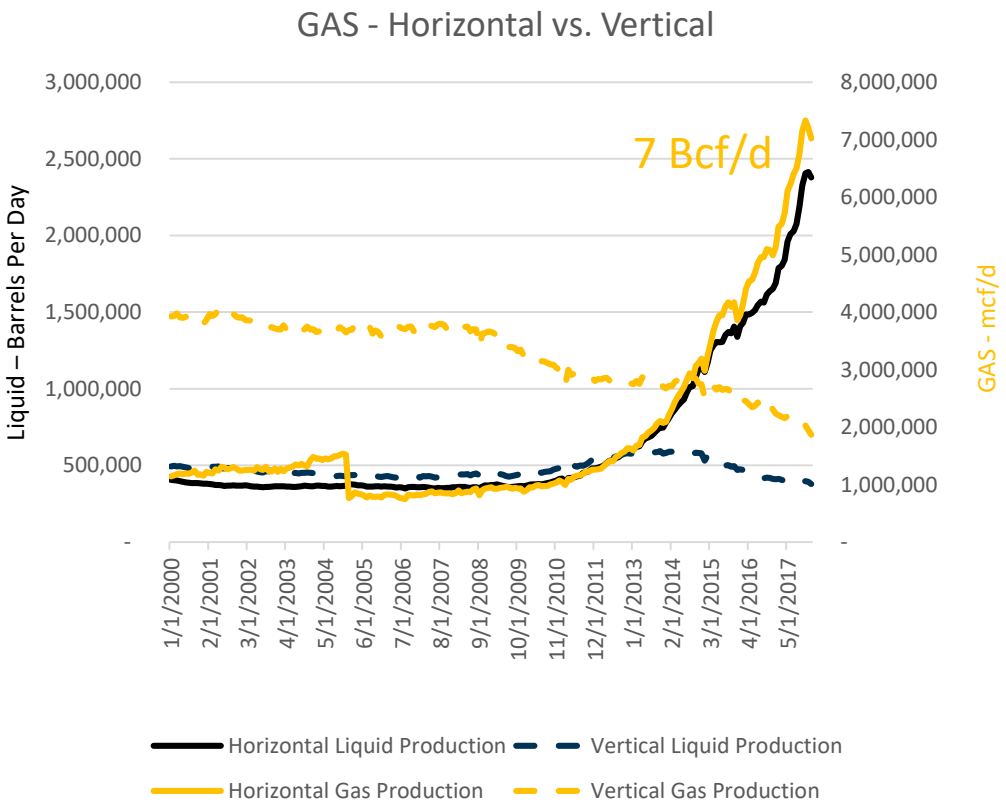
Source: Pioneer Natural Resources April 2018 Investor Presentation

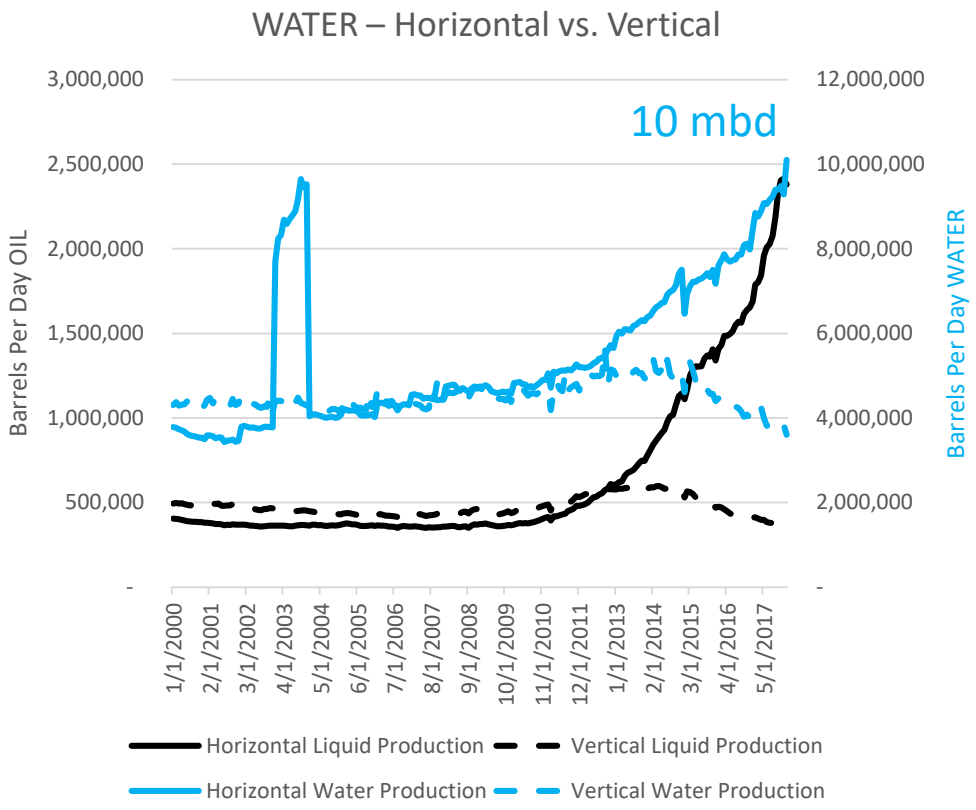
Horizontal Liquid Production



Source: PetroNerds, DrillingInfo data

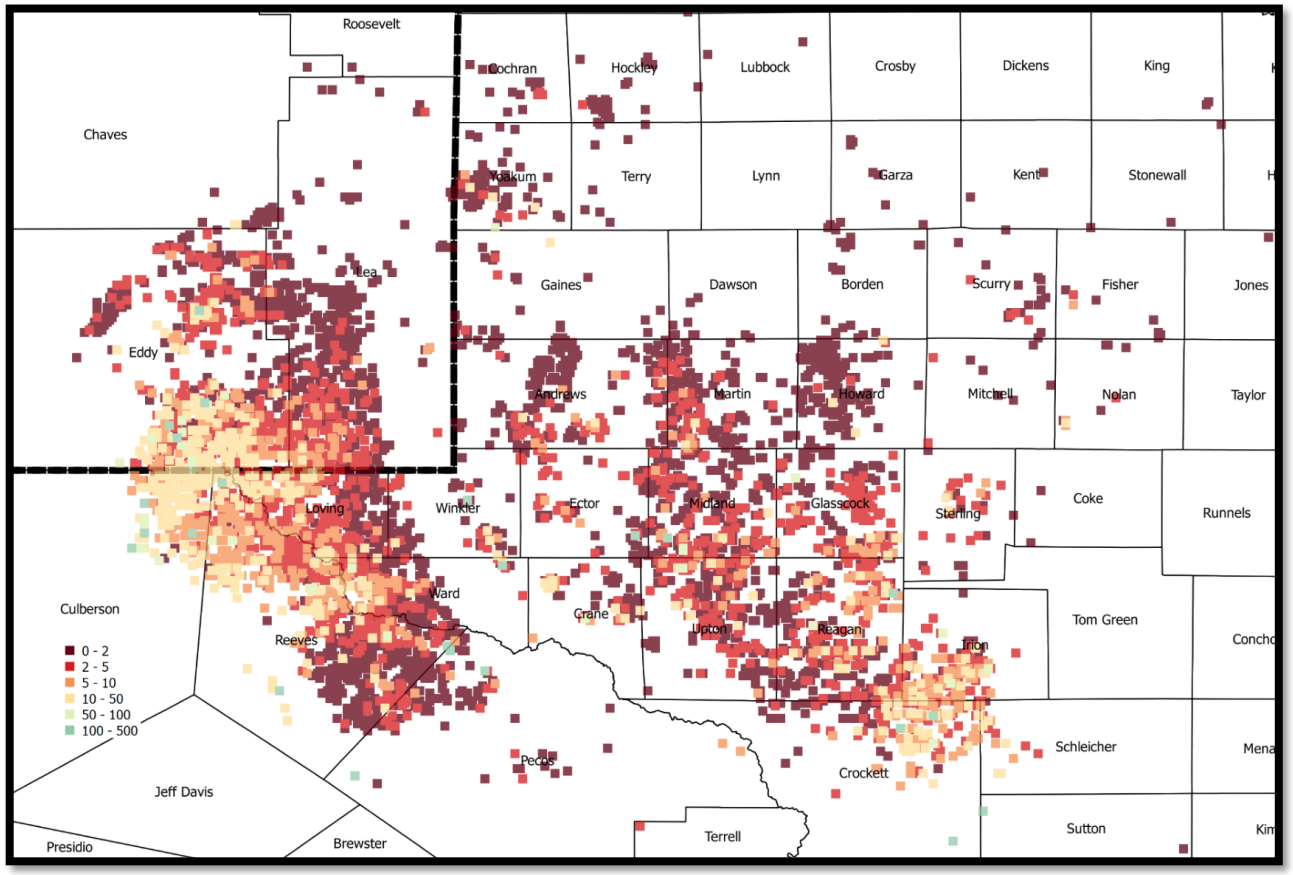
Associated Gas and Produced Water





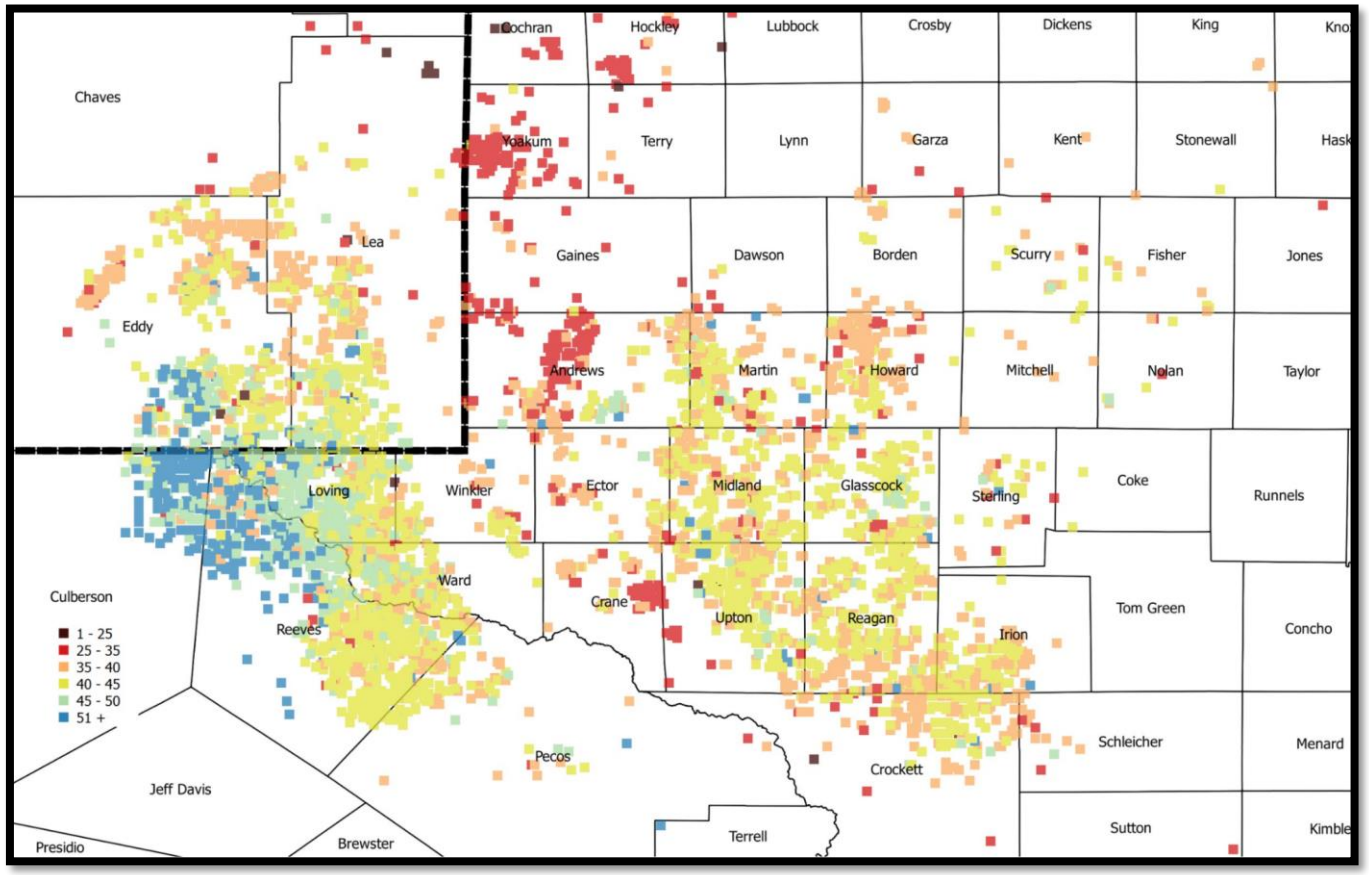
Source: PetroNerds, DrillingInfo data

Gas to Oil Ratio in the Permian Basin



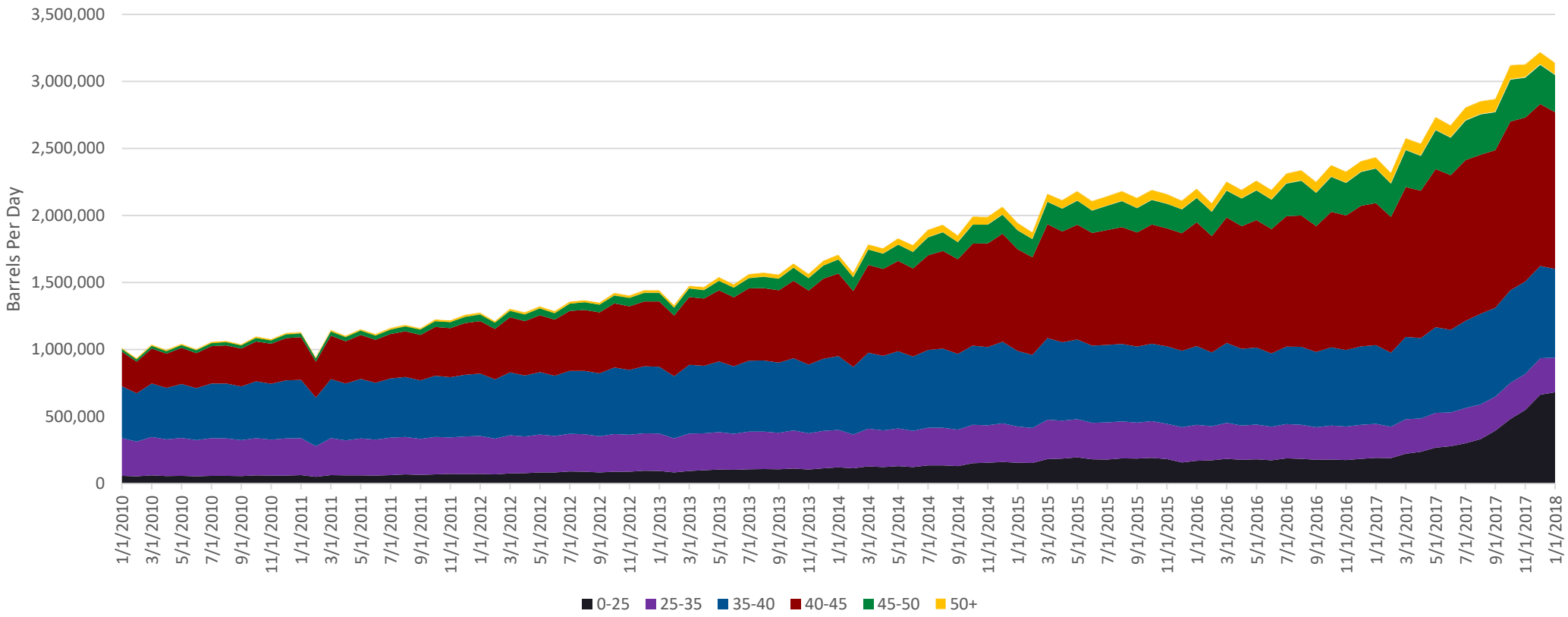
Source: PetroNerds, DrillingInfo data

API Gravity in the Permian Basin



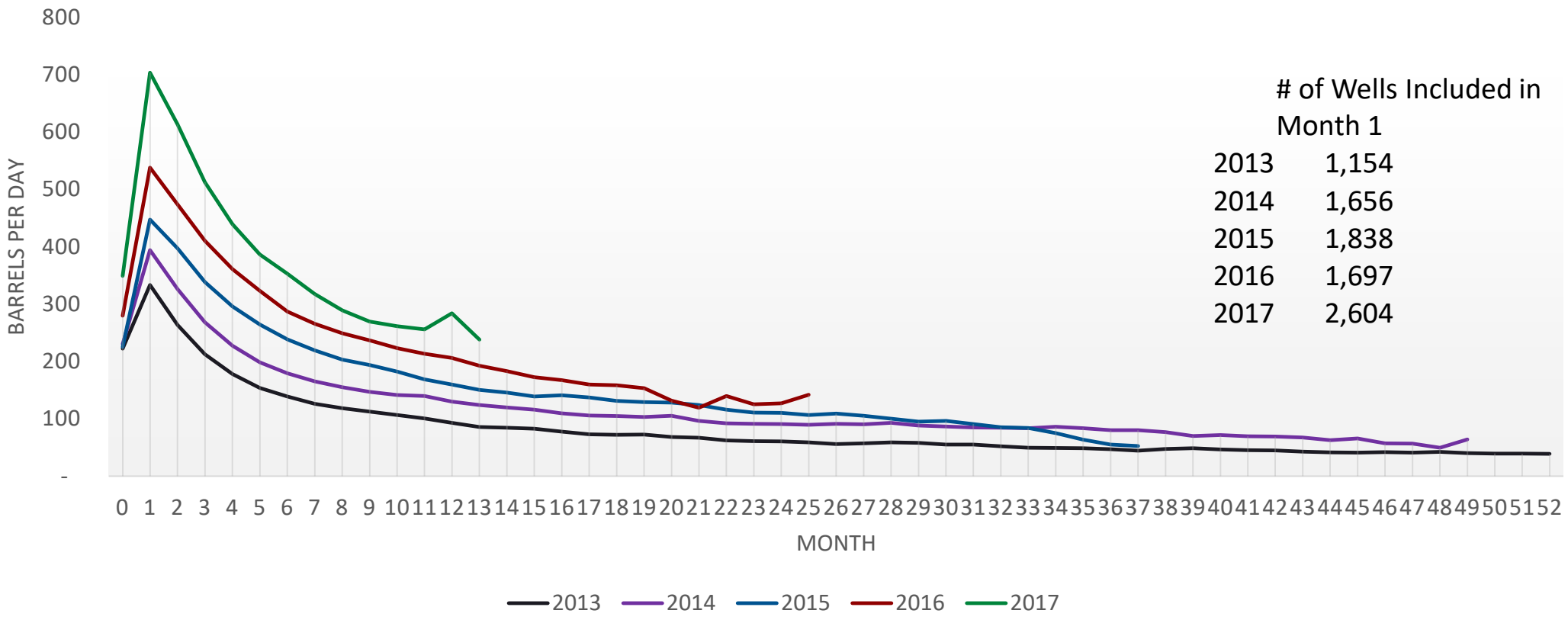
Source: PetroNerds, DrillingInfo data

Production by API Gravity



Source: PetroNerds, DrillingInfo data

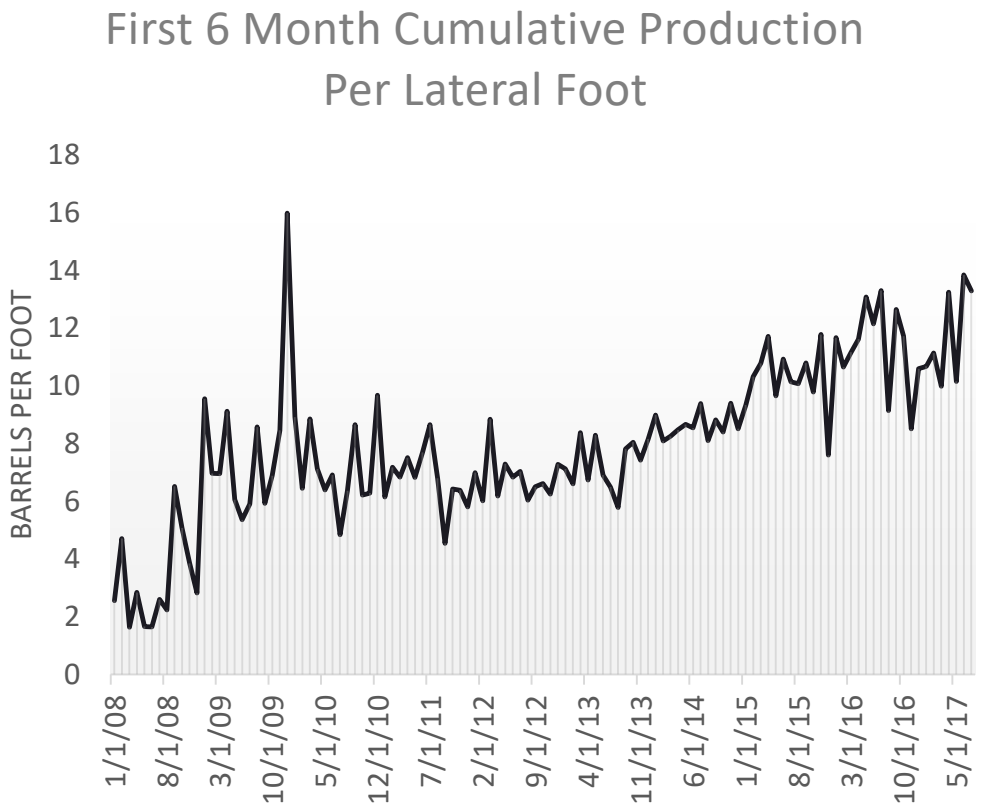
Permian Basin Decline Curve

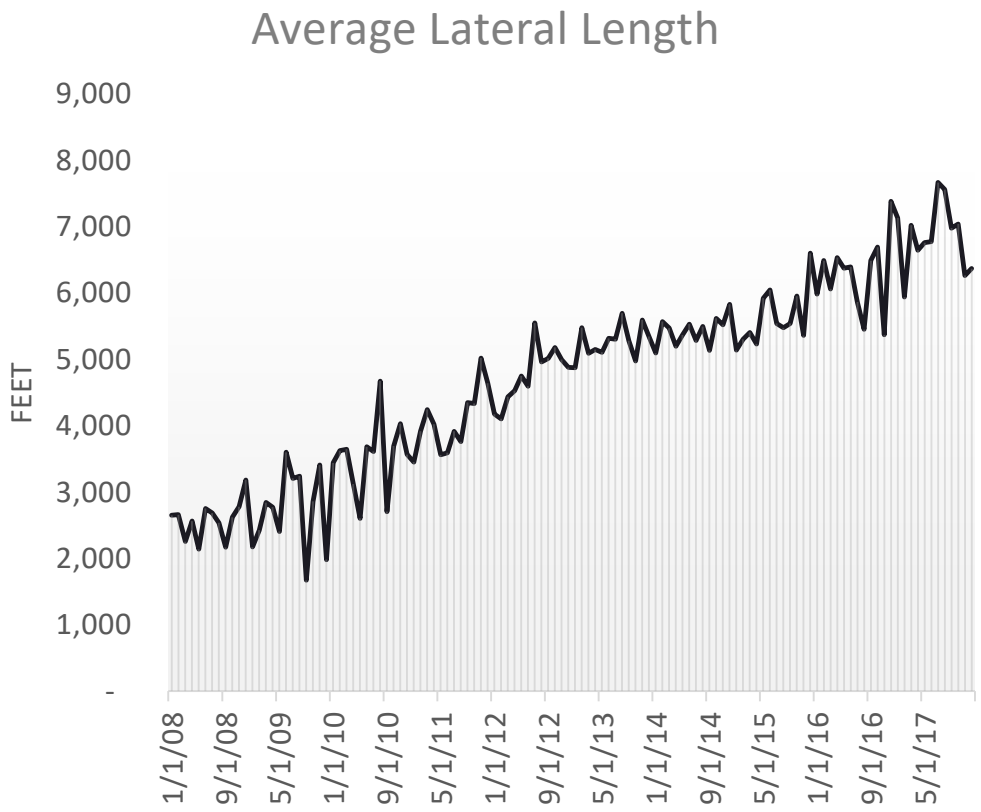


# of Wells Included in Month 1	
2013	1,154
2014	1,656
2015	1,838
2016	1,697
2017	2,604

Source: PetroNerds, DrillingInfo data

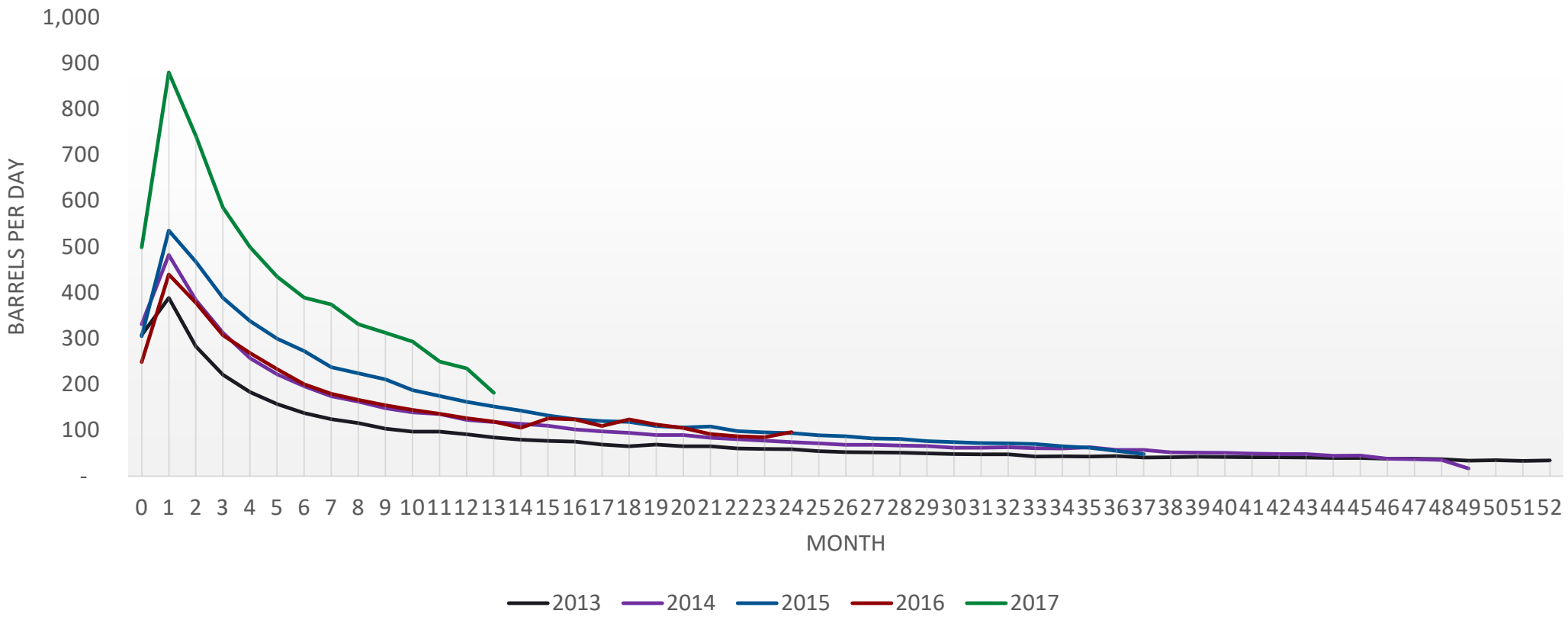
Measuring Productivity





Source: PetroNerds, DrillingInfo data

Bone Spring Reservoir Decline Curve



Source: PetroNerds, DrillingInfo data

Top Permian Basin Operators by Production

	Operator	Daily Liquids b/d	Daily Gas mcf/d
1	OCCIDENTAL ENERGY COMPANYINC.	276,024	556,347
2	PIONEER NATURAL RESOURCES COMPANY	210,694	461,204
3	CONCHO RESOURCES INC.	197,709	659,170
4	EOG RESOURCES INCORPORATED	131,031	407,233
5	APACHE CORPORATION	102,584	477,368
6	EXXON MOBIL CORPORATION	91,408	285,160
7	ANADARKO E&P ONSHORE LLC	88,790	295,583
8	DIAMONDBACK E&P LLC	83,932	123,888
9	CHEVRON U.S.A. INC.	82,071	397,068
10	ENCANA CORPORATION	72,643	157,580
11	PARSLEY ENERGY OPERATIONS LLC	71,987	184,253
12	ENERGEN CORPORATION	68,566	234,231
13	CIMAREX ENERGY COMPANY	64,035	477,567
14	KINDER MORGAN INCORPORATED	51,368	158,186
15	RSP PERMIAN LLC	49,326	104,704
16	MEWBOURNE HOLDINGS INC	48,960	202,757
17	RD SHELL	47,638	117,148
18	DEVON ENERGY CORPORATION	45,105	177,719
19	SURGE OPERATING LLC	44,011	42,721
20	SM ENERGY COMPANY	40,563	73,676
21	LAREDO PETROLEUM INC.	37,173	214,359
22	CENTENNIAL RESOURCE PRODUCTION LLC	35,086	81,964
23	RKI EXPLORATION & PRODUCTION LLC	35,030	185,845
24	JAGGED PEAK ENERGY LLC	30,546	50,148
25	ENDEAVOR ENERGY RESOURCES LP	30,464	63,261

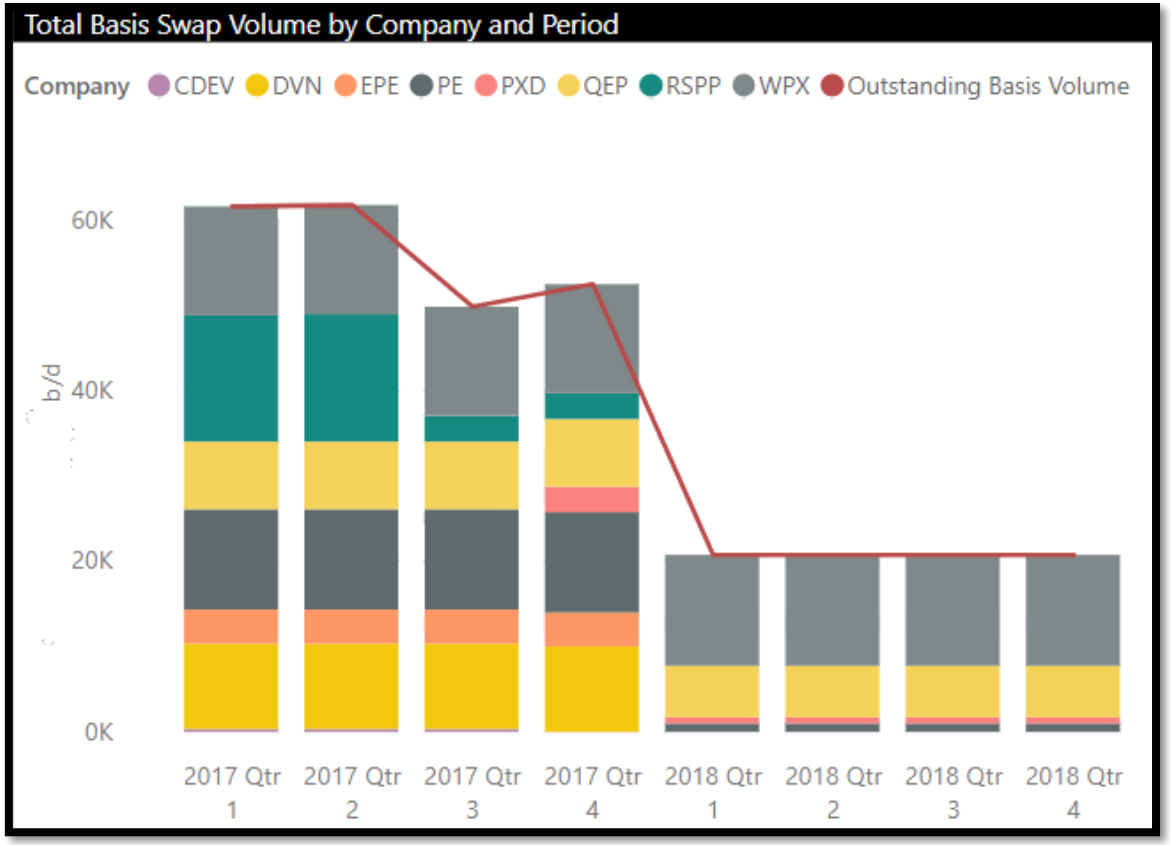
Source: PetroNerds, DrillingInfo data

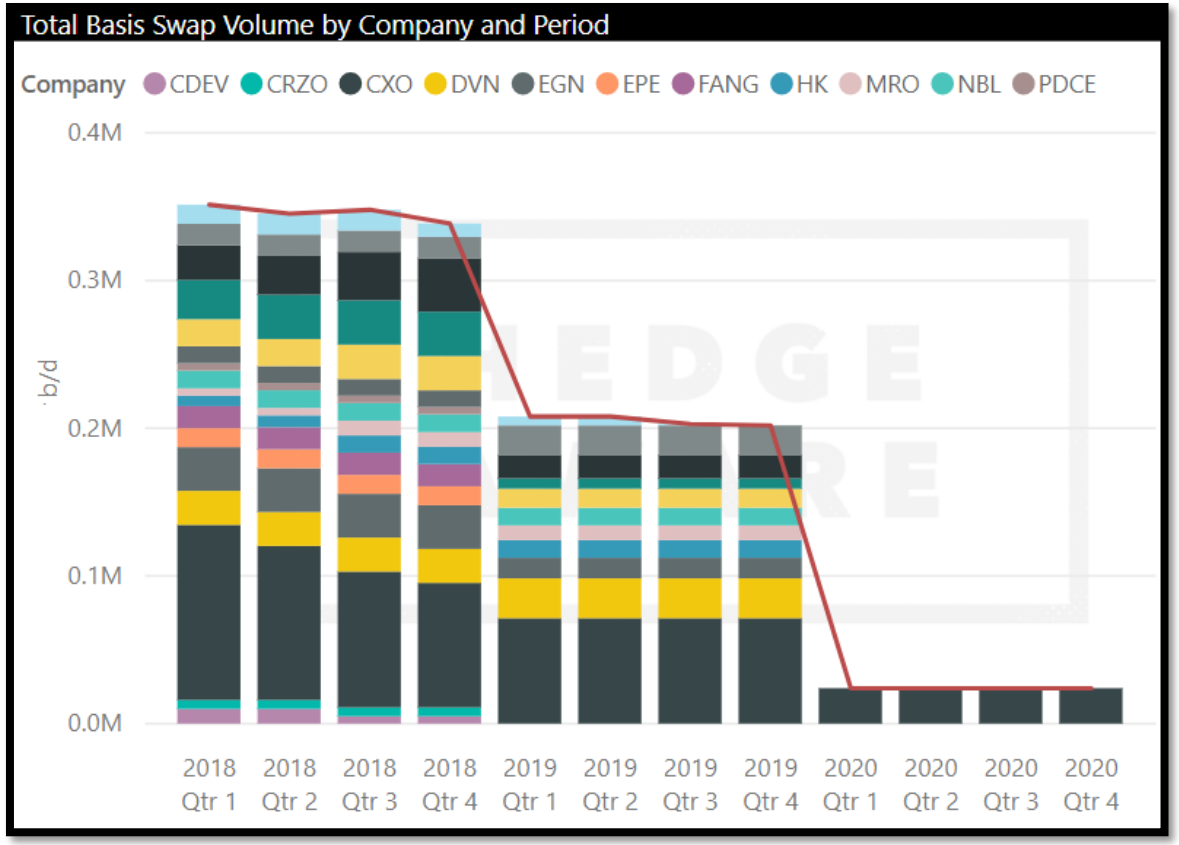
Why Everyone Now Cares about "Basis Swaps"

Operators can protect themselves against capacity constraints for both oil and gas through outright derivative hedges as well as basis swaps.

Flurry of investor concerns about capacity constraints.

Midland Basis Swaps: Q4 2016 vs Q4 2017





Source: PetroNerds, HedgeAware. Survey of 41 publicly traded E&Ps.