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Part I: New Ways of Thinking About Oilfield Water in the Permian Basin

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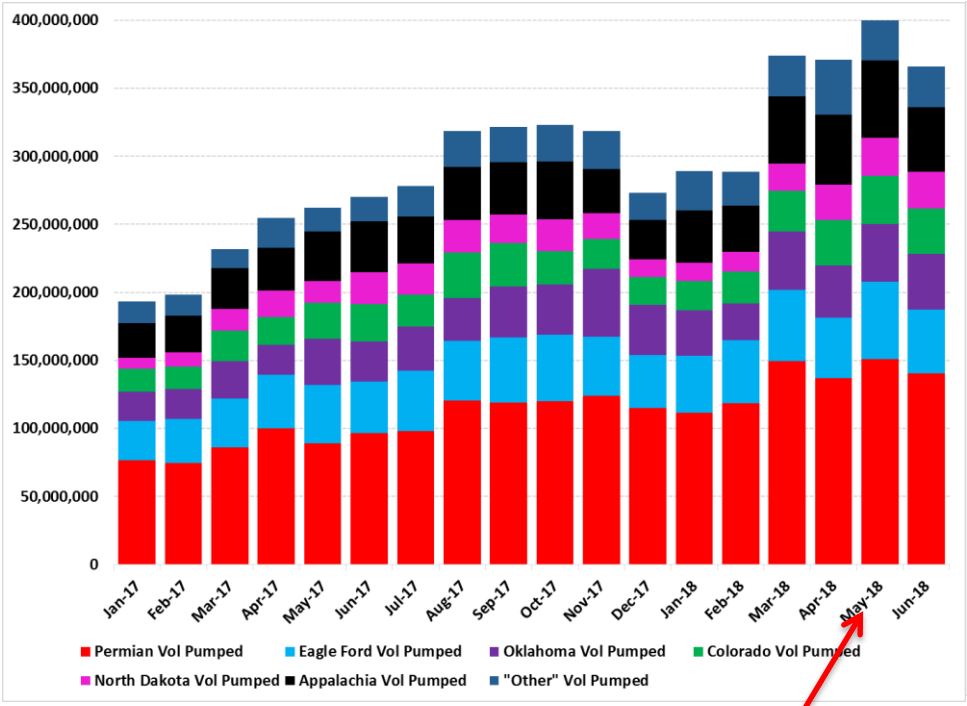
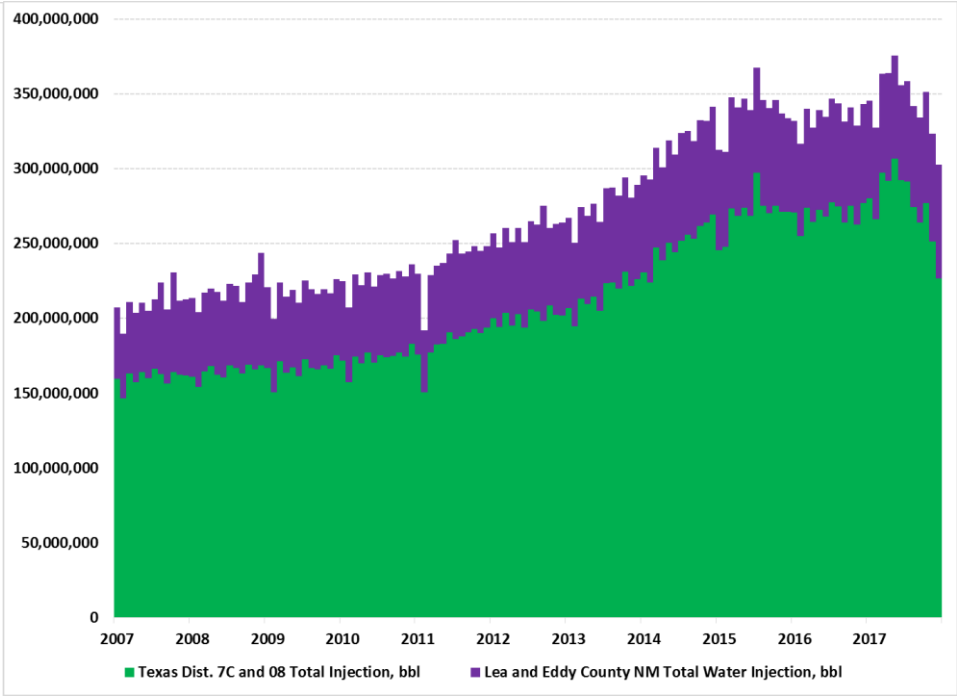
Permian Basin Oilfield Water: Supply & Demand

Frac Water Volumes Pumped (Permian in red)



Source: FracFocus

Water Injection—West Texas and SE New Mexico



Source: EIA, NM OCD, Texas RRC

Permian daily average equal to roughly what the City of San Antonio uses. Or, roughly 17 times the average daily water consumption of the City of Midland. New York City consumes approximately 700 million bbl of water per month—nearly 1.8 times the *national* monthly frac water usage.

https://data.cityofnewyork.us/Environment/Water-Consumption-In-The-New-York-City/ia2d-e54m

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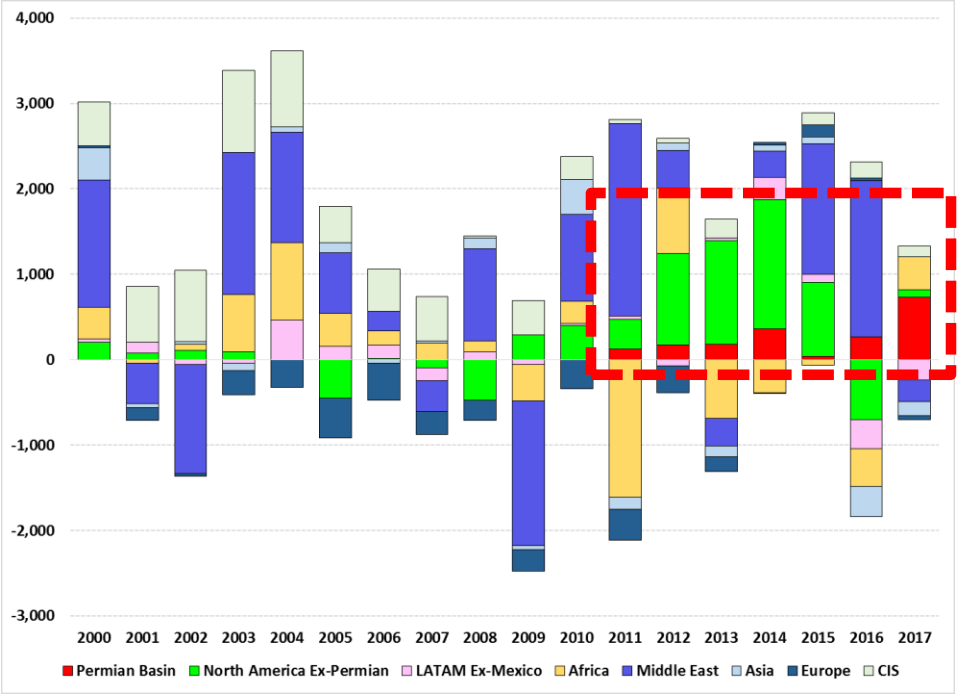
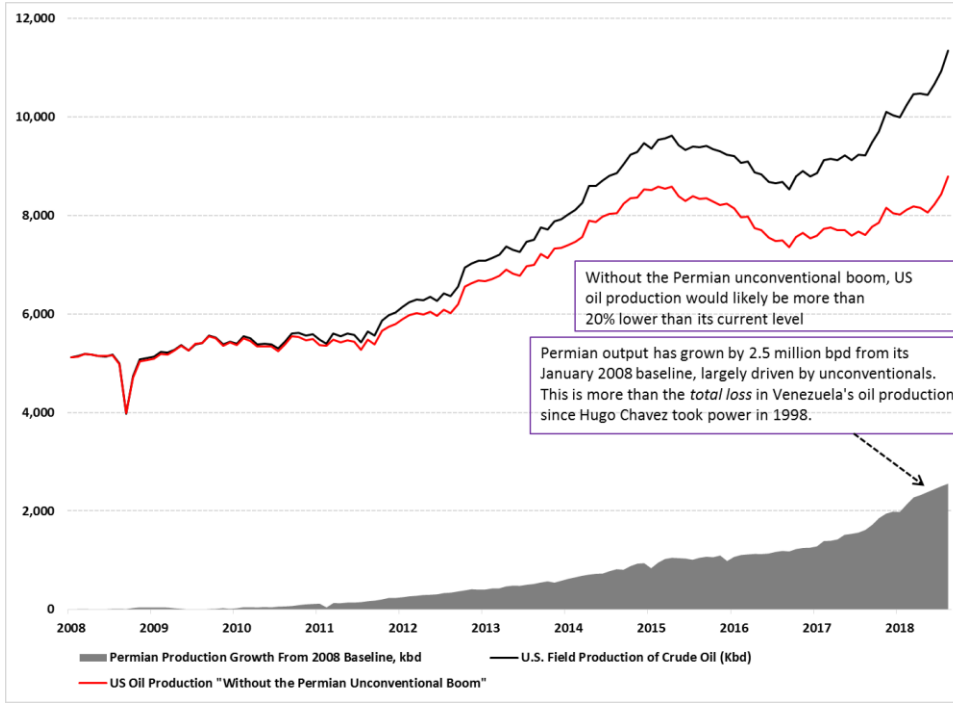
Permian Oil Production Growth Has Been a Major Global Shock Absorber

The Permian Basin is Now the World's Premier Non-OPEC, Non-Middle East Source of Oil Supply Growth



Source: BP Statistical Review of World Energy 2018, EIA

Thought Exercise: What if the Permian Unconventional Space *Hadn't* Taken Off?



Source: EIA, OPEC Monthly Oil Market Report

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Putting Water's Logistical Impact Into Perspective

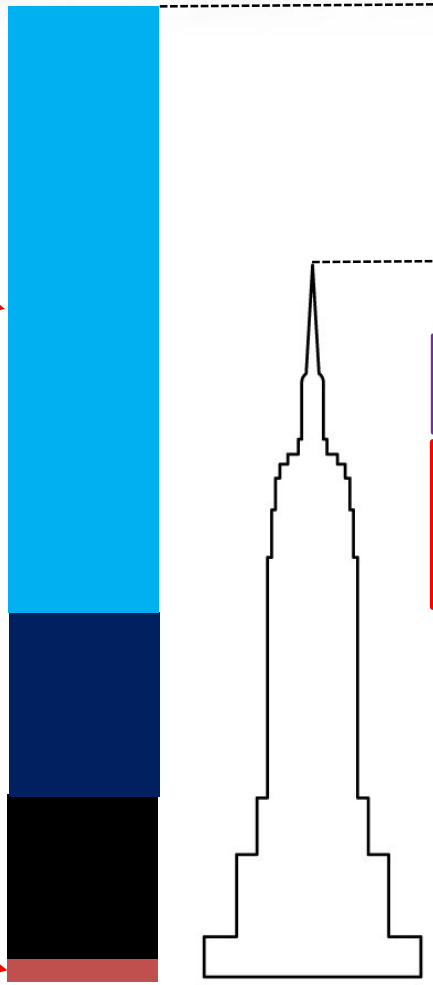
Per Well

Produced water:
Over 250,000 metric tons

Frac source water:
76,000 metric tons

Crude oil and liquids:
68,000 metric tons

Pipe, sand, misc. consumables:
Approx. 10,000 metric tons



Long-Lateral Permian Oil Well Inputs and Outputs Weigh ~405,000 metric tons

Empire State Building Weighs ~340,000 metric tons

~450 wells drilled per month

Water will likely account for approximately 80% of lifetime "mass moved" for many Permian Basin wells.

Source: CME Group, Empire State Realty Trust, FracFocus, TexasBrine.com

This analysis assumes 500,000 barrels of oil produced, with a water-to-oil ratio of 3:1. In many cases, wells will ultimately produce more oil and at a higher water cut.

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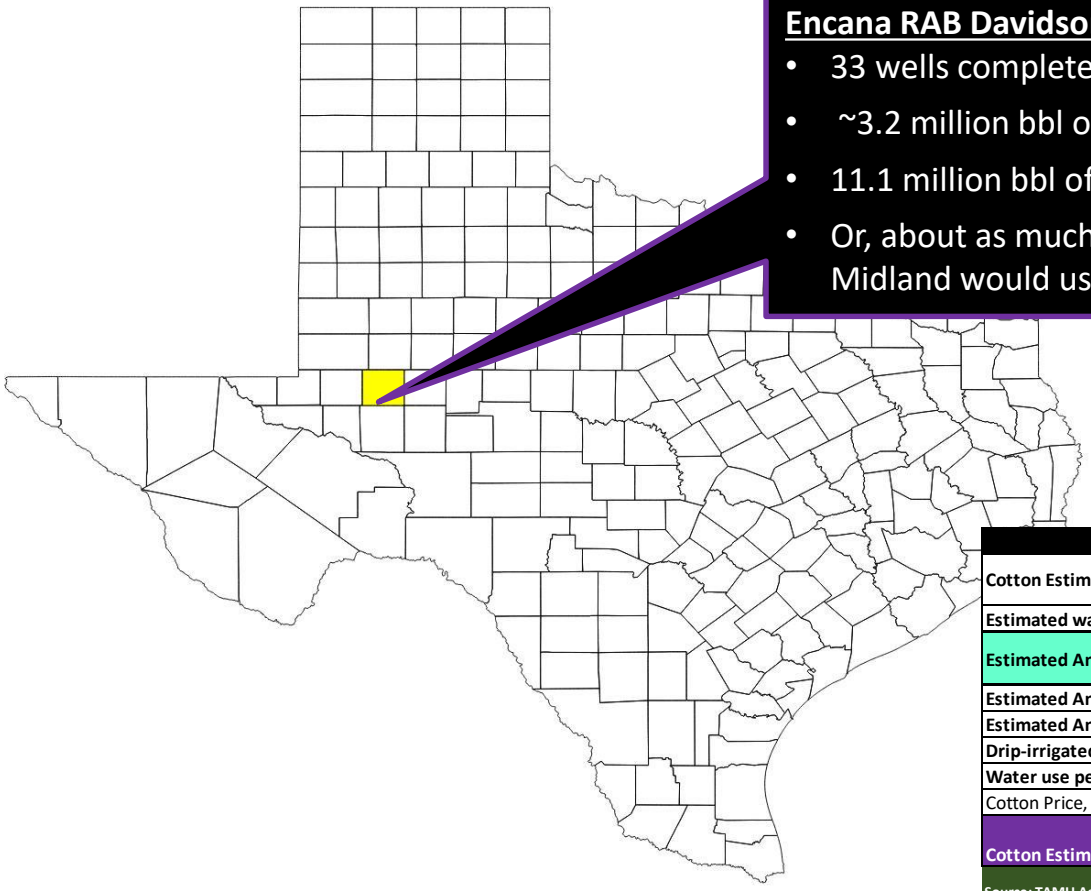
Putting Oilfield Water Flows in Perspective: Fracs & Farms



Encana RAB Davidson Pad:

- 33 wells completed between April 2016 and April 2017
- ~3.2 million bbl of oil and 13.3 bcf of gas produced thru Jul-18
- 11.1 million bbl of water pumped
- Or, about as much water as 1,000 acres of cotton grown near Midland would use in a single season

Source: FracFocus, TX DOT, TX RRC

Cotton Estimated Irrigation Need (District 2)	**18**	**ac-in**
Estimated water system efficiency	**95%**	
Estimated Annual Water Needs of 1,000 acres of cotton, AF	**1,579**	
Estimated Annual Water Needs of 1,000 acres of cotton, barrels	**12,249,474**	
Estimated Annual Water Needs of 1,000 acres of cotton, gal	**514,501,579**	
Drip-irrigated cotton lint yield per acre, annual	**1,500**	**lbs**
Water use per lb of cotton lint	**326**	**gallons**
Cotton Price, USDA West Texas (2017)	$0.74	per lb
Cotton Estimated Economic Output Per Gallon	**$0.002**	

Source: TAMU Agricultural Extension (District 6 crop budgets), USDA

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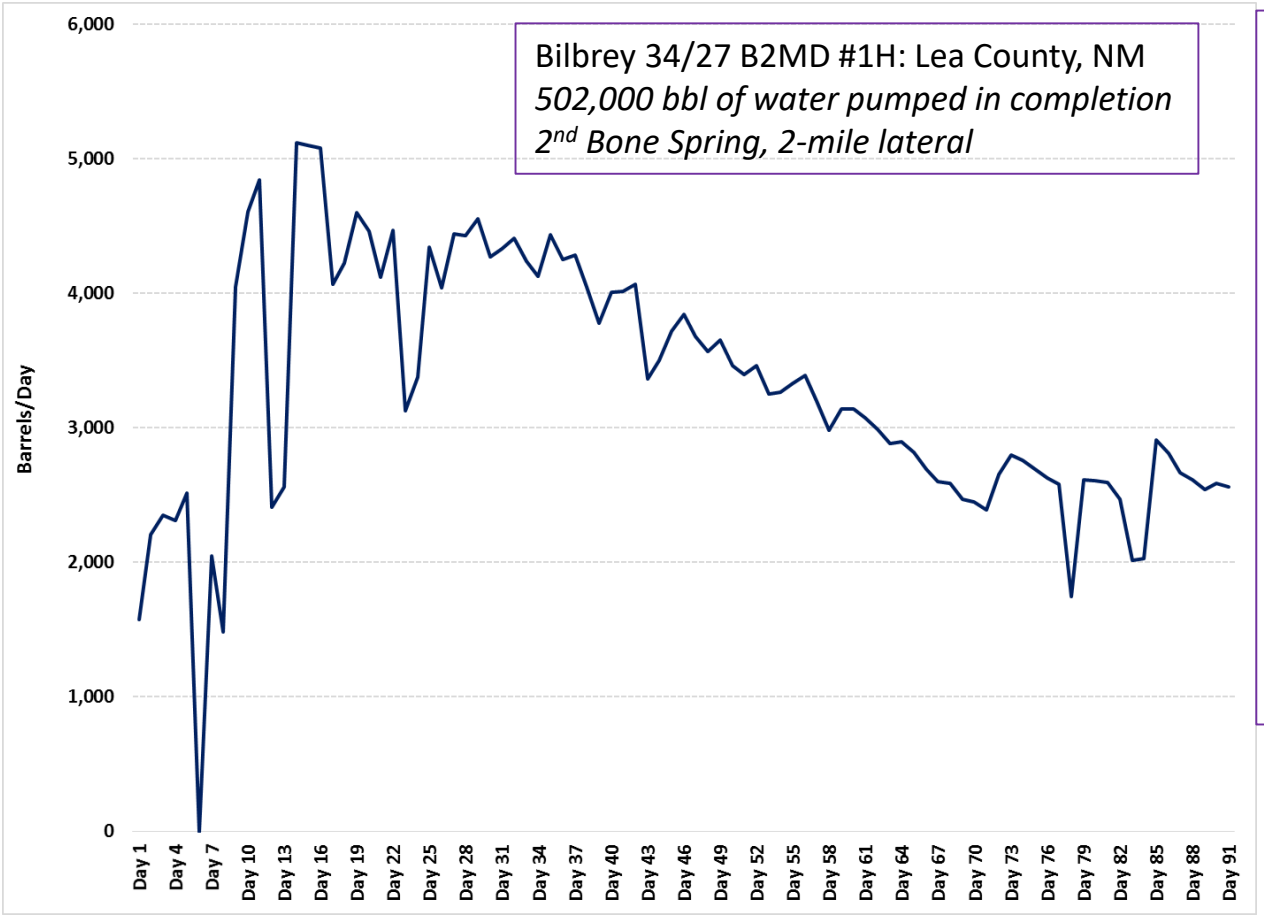
Putting Oilfield Water Flows in Perspective: Frac Flowback



Perspective:

- This well's cumulative 90 day flowback volume could fill about 19 Olympic-size swimming pools (660k gallon pool size)
- Now scale this out for a pad drill project with 5, 7, or even 30 wells, with many of them flowing back simultaneously post-completion.
- The resulting water management challenges—from both the perspective of managing peak flow and that of just managing the sheer volume—are substantial.

Source: Well Report Data

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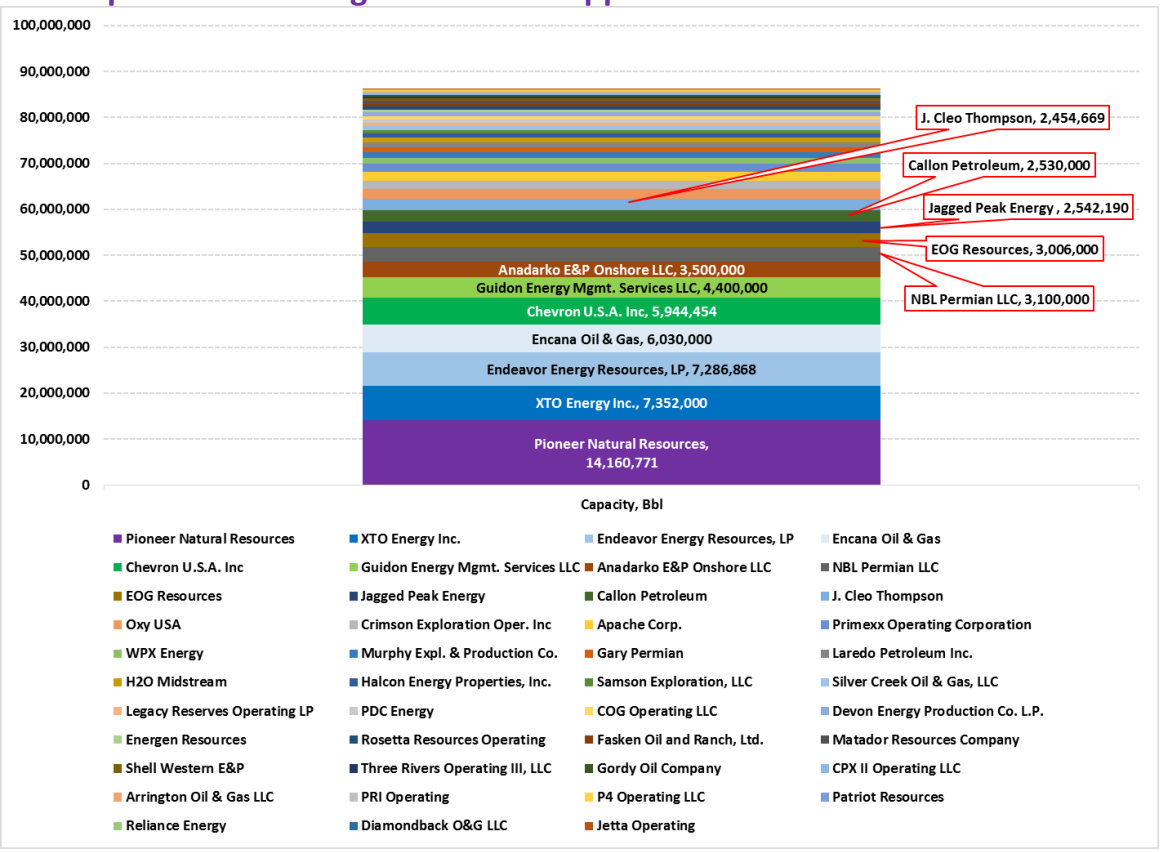
Companies Are Gearing Up to Recycle More Produced Water

Non-Commercial Fluid Recycling Pit Capacity Companies Have Sought Texas RRC Approval For



Source: Texas RRC

Company-level Permian Recycling Plans

- **Apache**—"…by year-end, we feel like we'll be able to utilize about 80% of recycled water for our fracs [*at Alpine High*]." (2Q2018 Earnings Call)
- **Devon—** "~80% of total water used in operations is recycled" [*NM Delaware Basin*] (EnergyPlex Presentation, 2018)
- **Encana**—"We expect average 40% recycled water use in the basin with some cubes as high as 80%..." (2Q2018 Earnings Call)
- **Guidon Energy**—"Once infrastructure was built, we began using 13/87 produced/fresh mix for all fracs." (May 2018 Presentation)
- **Noble**—"And by the end of the year [2018], I'd expect over 30% of the water used in our fracs to be recycled produced water." (2Q2018 Earnings Call)
- **Pioneer Natural Resources**—"Right now, we're increasing our reuse volumes of our produced water to the point where it's going to represent 15% to 20% of our water volumes in the fourth quarter this year." (2Q2018 Earnings Call)
- **Cimarex**—87% recycled PW in Culberson Wolfcamp completions, 46% recycled PW in Reeves Wolfcamp completions. (November 2018 Investor Presentation)

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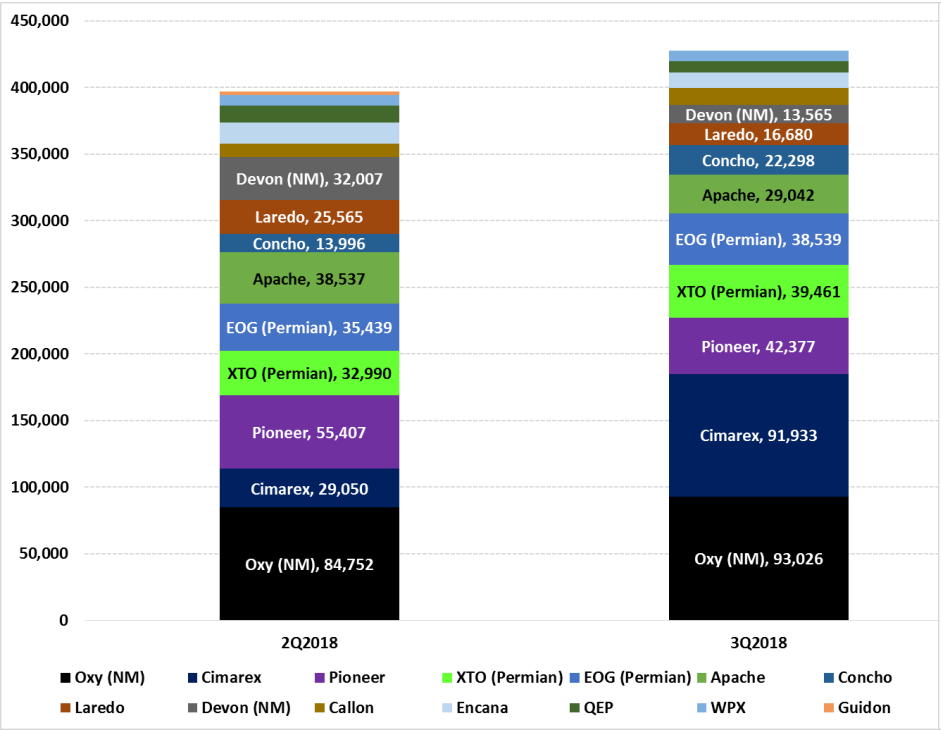
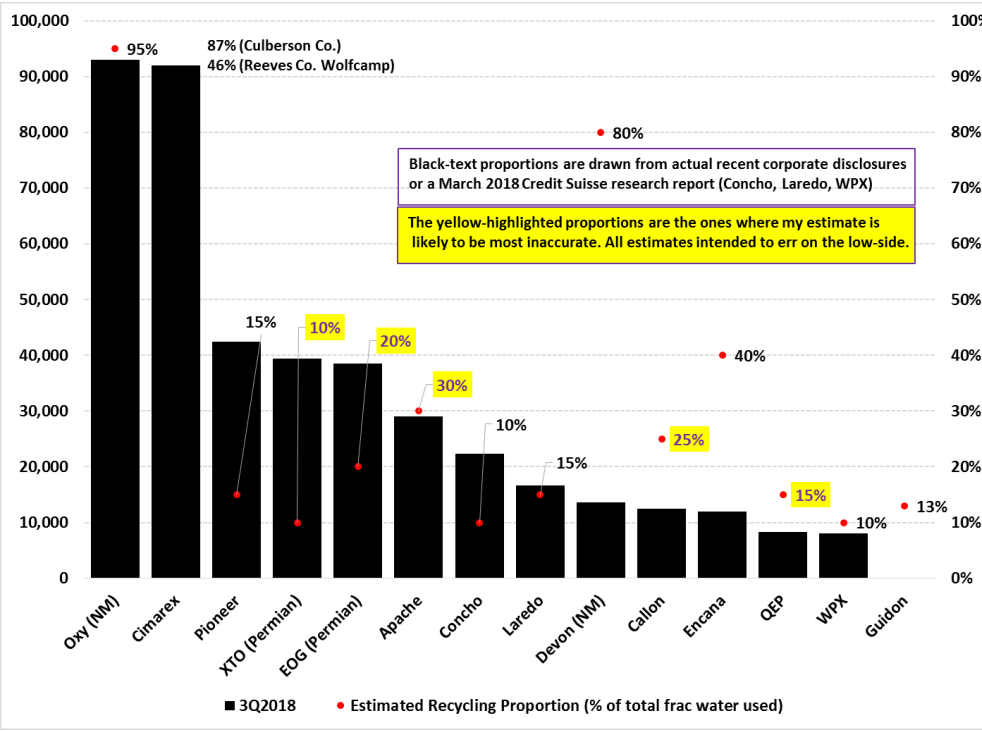
How Much Produced Water Are Permian Operators Actually Recycling?

Estimated Daily Average Recycled Water Volumes by Selected Permian Operators, Bpd



Estimated Proportion of Recycled Water as % of Total Frac Fluid Stream, 3Q2018



Source: Company Reports, Credit Suisse, Author's Estimates

- Methodology: Take management statements to investors, any other corporate communications I could locate detailing produced water re-use intentions or actual volumes/proportions, and a Credit Suisse research report on the same topic, apply these numbers to frac water usage data each operator reported to FracFocus and estimate recycling volumes for 2Q2018 and 3Q2018.

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Accommodating Future PW Volumes Might Require Unorthodox Solutions

Example: ***What might the economics of piping produced water down to the Gulf Coast and discharging treated PW into the ocean or disposing of it in depleted offshore fields look like?***

Initial model based on Vista Ridge water pipeline to San Antonio.

- 142 miles
- $930 million project cost
- 54-inch steel line
- Projected to move ~1 million bwpd.

Using Vista Ridge's economics as a baseline, installing 5 X 54-Inch, 650-mile long water pipelines between Orla and Corpus Christi would cost about $16 billion and financed at a 4.5% interest rate over 20-years, would yield an estimated CAPEX cost of $0.66/bbl and OPEX cost of $0.23/bbl, for a delivered cost to the Gulf Coast of $0.89/bbl.

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A Few Permian Oilfield Water Predictions

A. **Within 12 months from today (start date August 2018)**
   - A major Permian-focused water midstream firm goes public or has a similarly large liquidity event
   - At least 3 additional large private equity companies enter the space
   - At least 3 sizeable (80 kbd+ avg. actual volume handled) water midstream firms in the Permian will be acquired by a larger player

B. **Within the next 24 months**
   - There will have been a billion-dollar oilfield water transaction in the Permian
   - At least five Permian-focused entities other than Pioneer Water Management will be transporting and injecting 500 kbd or more of produced water

C. **Within the next 36 months (i.e. by August 2021)**
   - At least 4 million bpd of incremental produced water (relative to August 2018) must be handled

Source: Pinterest

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Part II: The Economics of Produced Water

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Produced Water Is Transitioning From a Liability Into an Asset

Source: http://grouches.wikia.com/wiki/File:Oscar_the_Grouch_old_banana_peels.jpg

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Significant Value At Stake

A Hypothetical "Billion Dollar Water Midstream" Company

Frac Source Water		Produced Water	
Average daily sales, thousand bbl	**100**	**Average daily volume gathered, thousand bbl**	**400**
Gross sales price, $/bbl	$0.40	Quoted charge per bbl of PW	$0.75
Water production cost (fresh or brackish from wells), $/bbl	$0.03	Gathering charge, $/bbl	$0.20
Water distribution cost, $/bbl	$0.15	Daily gathering revenue	$80,000
Impaired water acquisition and treatment cost, $/bbl	$0.25	Disposal Charge, $/bbl	$0.55
Net frac water revenue/bbl	$0.11	Daily disposal revenue	$220,000
Net daily sourcewater revenue	$11,000	Skim oil revenue, $/bbl	$0.20
Annual source water revenue (Million USD)	$4	Daily skim oil revenue	$80,000
		Injection disposal cost, $/bbl (opex + royalty)	$0.35
		Daily disposal cost	$70,000
		Net PW daily revenue	$310,000
		Net PW revenue per bbl of system intake	$0.78
		Annual produced water revenue (Million USD)	$113
Other operating expenses (salaries and misc.), Million USD		$11	
Annual Operating Income, Million USD		$106	
Depreciation & Amortization (est.), Million USD		$20	
EBITDA, Million USD		$126	
Enterprise Valuation Multiple (X of annual EBITDA)		8.0	
Implied Enterprise Value (Million USD)		**$1,008**	

Key Assumptions
Frac water transported an average distance of 15 miles, produced water 20 miles. Pipeline water movement assumed to cost $0.01/bbl/mile.
Disposal royalty of $0.15/bbl; Injection cost of $0.20/bbl; "Impaired water" means sourced from brackish aquifers, municipal effluent, or reused produced water. Impaired water assumed to constitute 1/2 of total frac water sales. Skim oil of 0.42% by volume of incoming produced water, WTI price of $60/bbl.
Sources: Bluefin Water Solutions (transfer cost), NGL (skim), Oasis Midstream Partners (D&A data), Author's Analysis

Full Presentation Available At:

Gabriel Collins, "**What Does it Take to Create a Billion Dollar Oilfield Water Midstream Company?**," The Produced Water Society Permian Basin 2018 Symposium, 9 August 2018, Midland County Horseshoe Arena & Pavilion, https://www.bakerinstitute.org/media/files/files/6268339d/collins-oilfieldwatercompany.pdf

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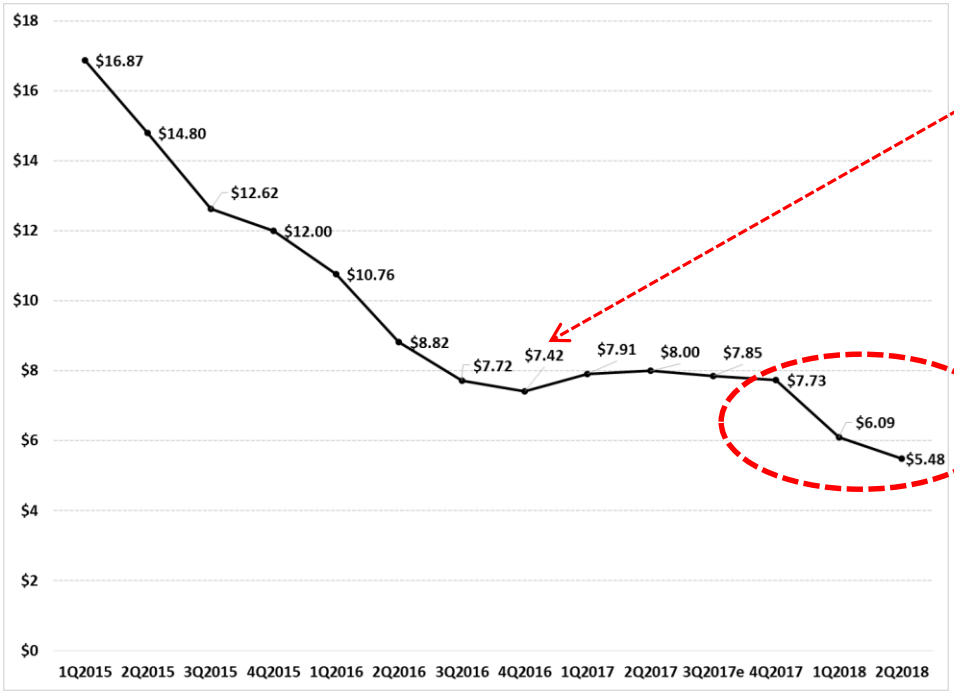
Permian Profitability Is an Infrastructure and Integration Game

- The molecular endowment of a given block of acreage is geologically fixed, but the other elements of the unconventional oil & gas development equation are highly dynamic. These include drilling and completion costs, materials sourcing, and midstream services to evacuate oil, gas, and produced water. All are subject to cost reduction via technological improvements--and most of all--solutions delivered through more deeply integrated infrastructure and when feasible, economies of scale.

Devon Energy Delaware Basin Lease Operating Expenses, $/BOE



Source: Company Reports, Author's Estimate

What Management Said Almost 2 Years Ago:
"*The majority of these cost savings are expected to be sustainable due to significant enhancements in the power and water-handling infrastructure over the past few years*."
—Devon Q4 2016 Operations Report,

What is Happening Now:
The company's investments in fixed infrastructure like power and pipelines, as well as sand, dedicated rigs, and frac crews appear to be delivering lower operating expenses even as activity heats back up and service cost inflation looms Basin-wide.

Cost savings ultimately accrue to the bottom line, as Devon reported $66 million in free cashflow on $322 million of revenue in 2Q2018 for its Delaware Basin assets.

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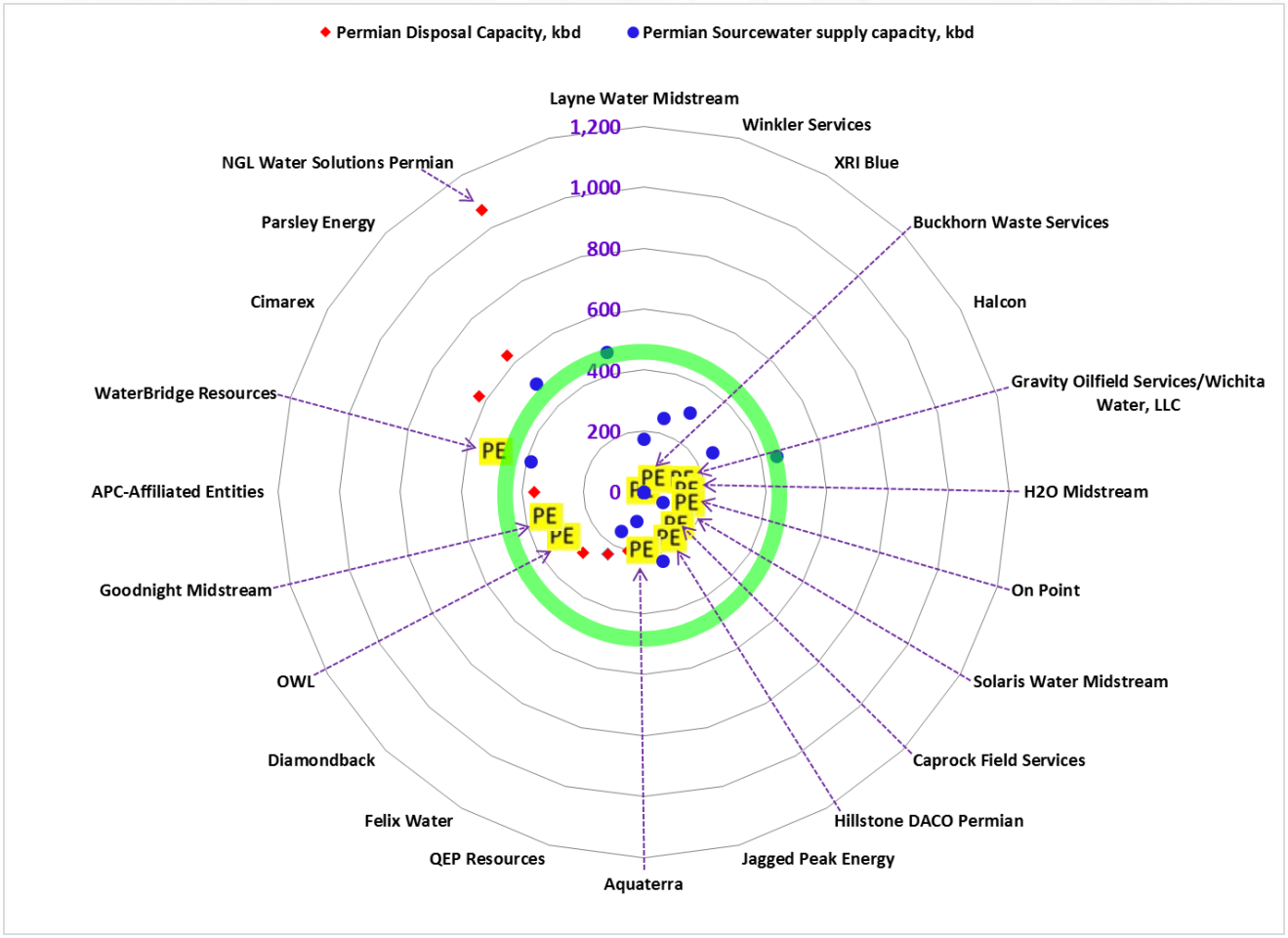
Permian Basin Oilfield Water Space Ripe for Consolidation and Organic Growth



"PE" = Private Equity-Backed

If sponsors and management teams were so inclined, the simple math is that combining 2-3 of the yellow highlighted PE-backed entities could create an entity that would have the nameplate capacity to handle enough water to potentially justify a billion dollar enterprise valuation.

Source: Texas RRC, NM OCD, Company Reports, Author's Analysis

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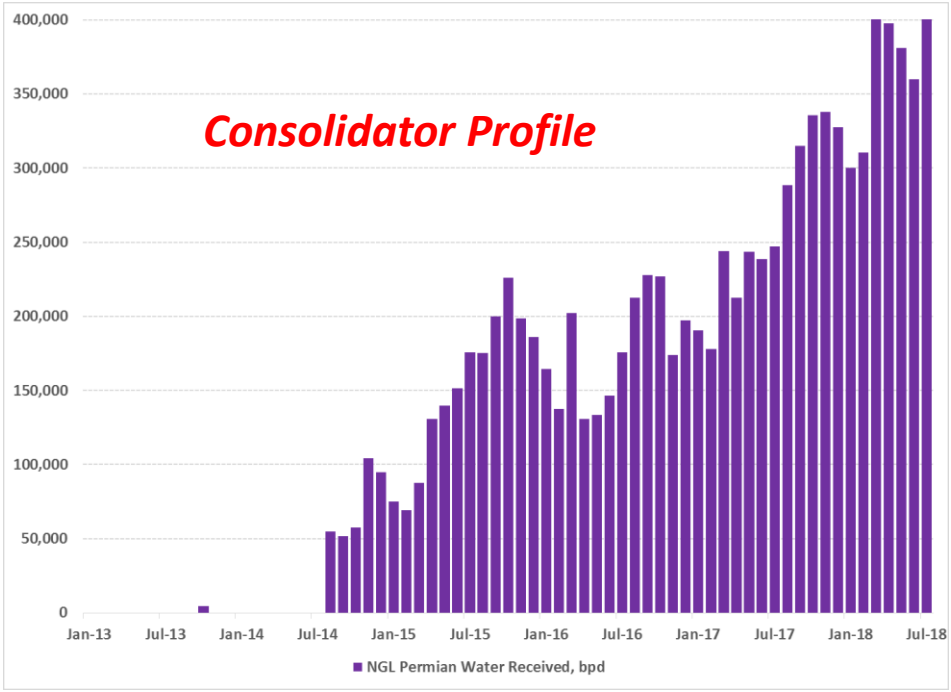
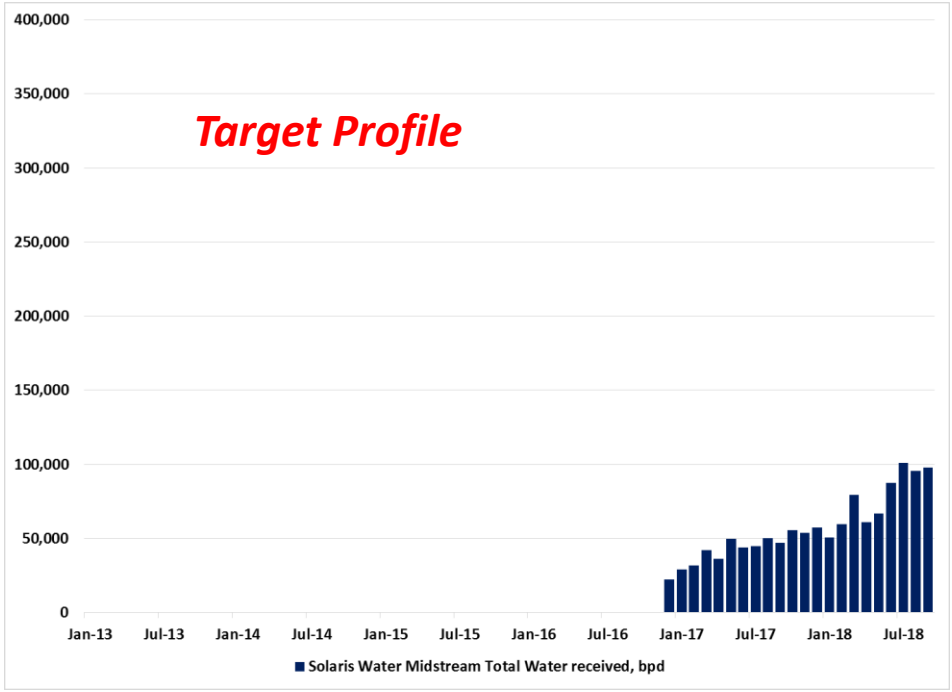
The Case for Water Midstream M&A

NGL Permian Water Received, Bpd



Solaris Water Midstream Water Received, Bpd



Source: New Mexico Oil Conservation Division, Texas RRC

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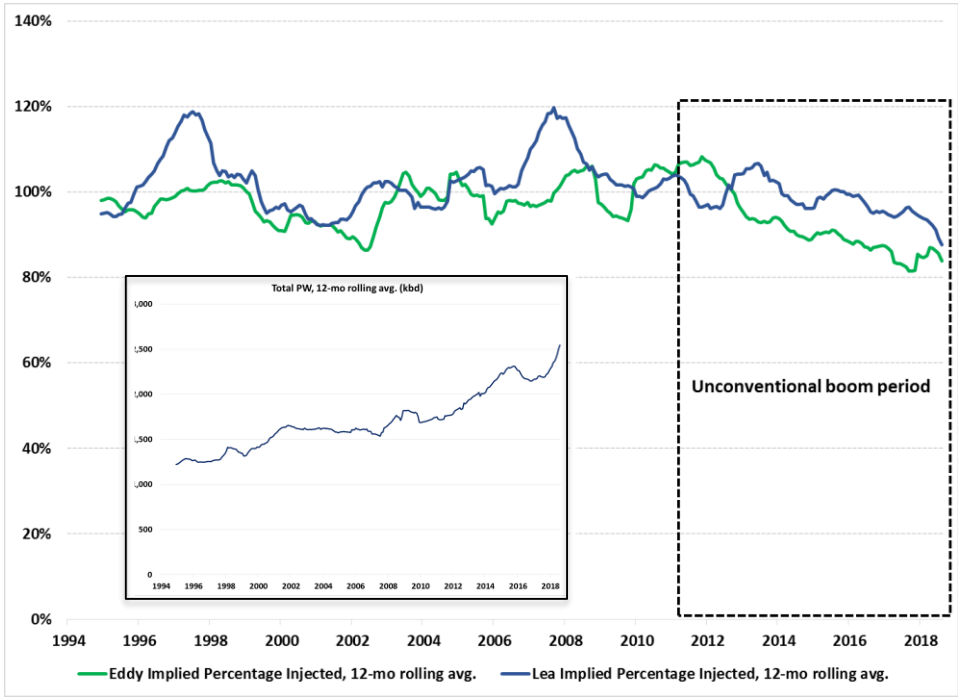
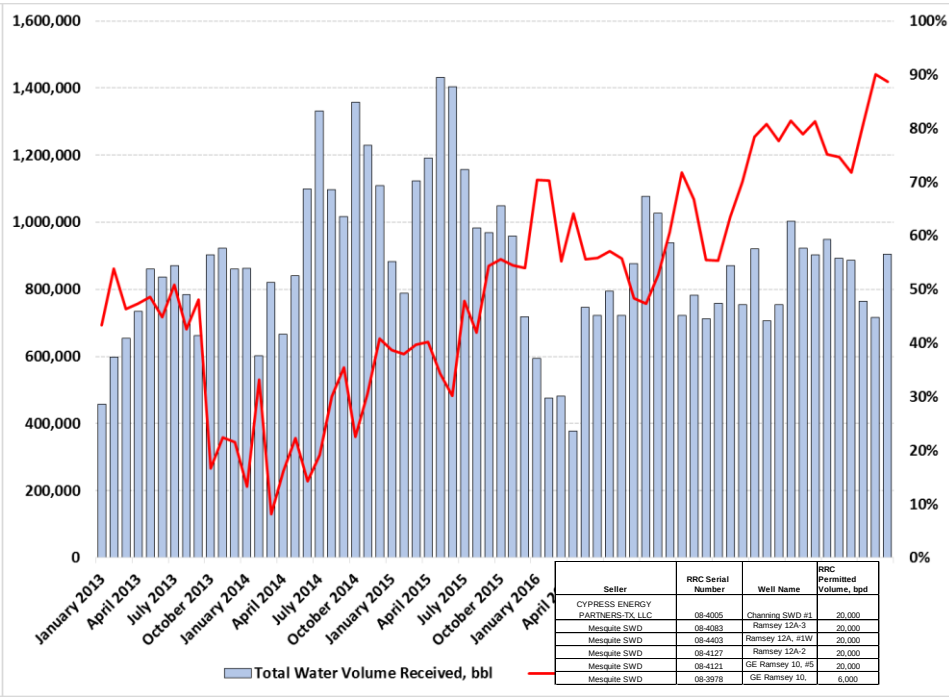
Is Texas Becoming New Mexico's Water Disposal Hinterland?

In-County Injection Proportion of PW Generally Declining in Eddy & Lea Counties Despite 2X Increase in PW Volumes



Source: NM OCD

Anecdotal Well Data Suggests Rising Proportion of NM-Origin Water Headed Across the Border to Texas Disposal Wells



Seller	RRC Serial Number	Well Name	RRC Permitted Volume, bpd
CYPRESS ENERGY PARTNERS-TX, LLC	08-4005	Channing SWD #1	20,000
Mesquite SWD	08-4083	Ramsey 12A-3	20,000
Mesquite SWD	08-4403	Ramsey 12A, #1W	20,000
Mesquite SWD	08-4127	Ramsey 12A-2	20,000
Mesquite SWD	08-4121	GE Ramsey 10, #5	20,000
Mesquite SWD	08-3978	GE Ramsey 10,	6,000

Source: TX RRC

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X-Factor: Will E&Ps Decide to Run Their Own Water Systems?

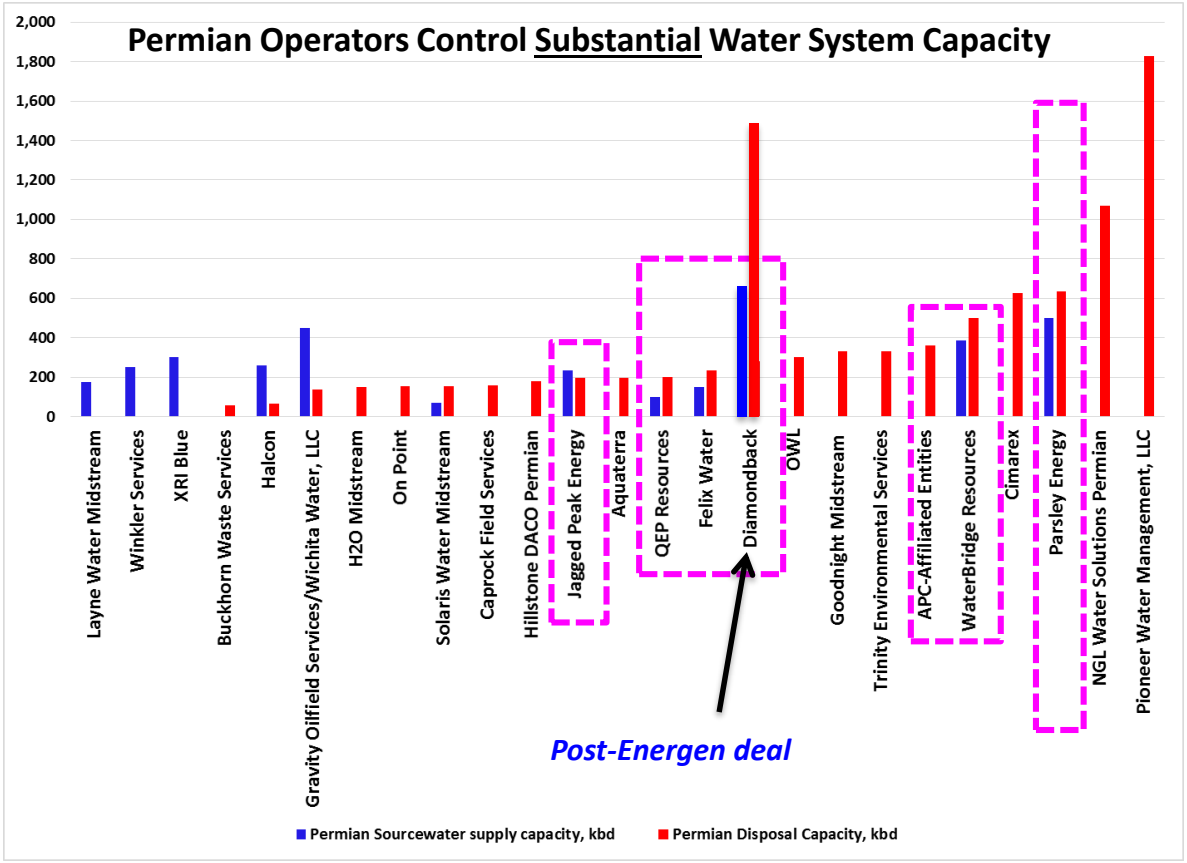
Midstream parties acknowledge the risk…

OMP, 2017 10-K, P.29

Potential third-party customers could decide to process and dispose of their produced and flowback water internally or develop their own midstream infrastructure systems for produced water and flowback water gathering and freshwater distribution…"

Source: https://diginomica.com/2014/08/12/rackspace/

But do they <u>really</u> think it will happen?



Source: Texas RRC, NM OCD, Company Reports, Author's Analysis

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Possible Adverse Economic Situations

- *What do water midstream economics look like in a de-rated injection environment?*

Sample System Cost Rough Estimate for a 200 Kbd Network

System Size						De-Rated Case
Trunk Lines ("2 pipes, 1 ditch")						
Material	Outside Diameter (in)	Installed Cost, $/ft	Installed Cost, $/mile	Gathering Mileage	Water Distribution Mileage	
HDPE	26	$172	$910,000	20	20	
Subtotal Cost, Million USD	$36					
Branches						
Material	Outside Diameter (in)	Installed Cost, $/ft	Installed Cost, $/mile	Gathering Mileage	Water Distribution Mileage	
HDPE	10	$66	$350,000	80	80	
Subtotal Cost, Million USD	$56					
Gathering Capillary Lines						
Material	Outside Diameter (in)	Installed Cost (on surface), $/ft	Installed Cost, $/mile	Gathering Mileage		
HDPE	4	$25	$132,000	80		
Subtotal Cost, Million USD	$11					
SWDs						
Capacity per well, bpd	**Interval**	**Cost per well (including facilities)**	**Number of Wells**			**Number of Wells**
20,000	Delaware	$6,500,000	3			6
30,000	Ellenburger/Devonian	$12,000,000	5			10
Subtotal Cost, Million USD	$80					$159
Ponds						
Size, bbl	**Built Cost/bbl of Capacity**	**Number**				
500,000	$1.50	3				
Subtotal Cost, Million USD	$2					
Miscellaneous Costs						
Assume 10% of other total costs						
Million USD	**$18**					$26
Total System Investment Cost, Million USD			**$203**			**$291**

News from the Oklahoma Corporation Commission

Matt Skinner, Public Information
Phone: (405) 521-4180
m.skinner@occemail.com

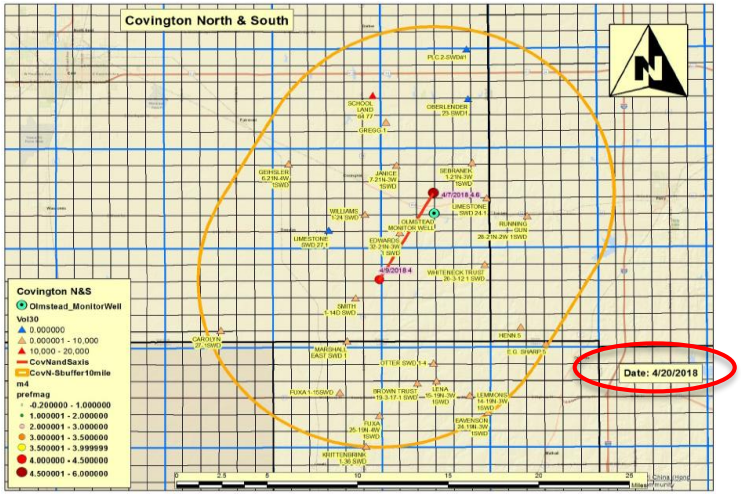
May 8, 2018

Media Advisory

Directive issued for further disposal well volume reductions in Covington/Douglas area

Because of recent earthquake activity in the Covington/Douglas area of Garfield County, the Oklahoma Corporation Commission's Oil and Gas Conservation Division (OGCD) has issued a directive for further reductions in oil and gas wastewater disposal well volumes.

Under the directive, all average daily volumes of Arbuckle disposal wells within 10 miles of the earthquake activity will be reduced another 20 percent.



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Can Greater Recycling Help Optimize the Oilfield Water Investment Cycle?

CAPEX to Dispose of 50 kbd of Produced Water

Option 1: Delaware Sands SWD

2 wells @ 25 kbd per well
X
$5 million-to-$6.5 million per well
$10 million-to-$13 million

Option 2: Devonian/Ellenburger SWD

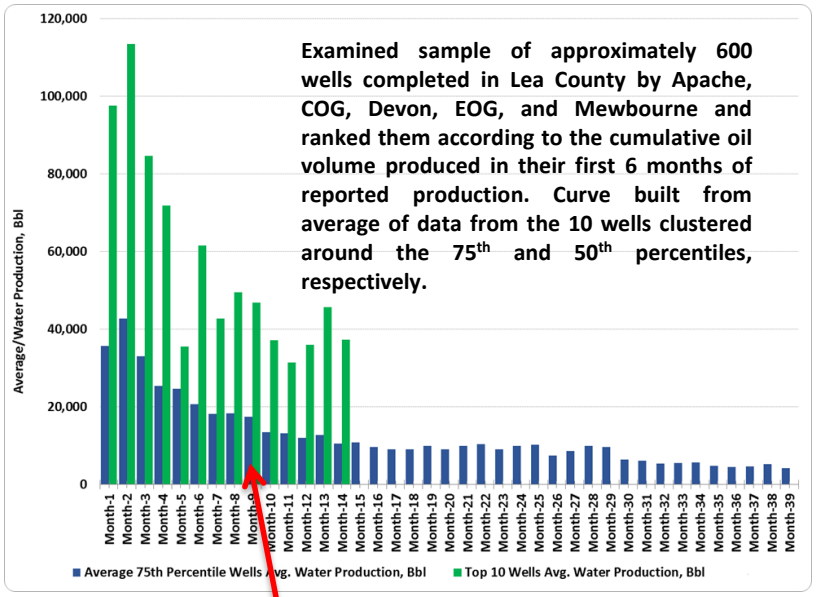
2 wells @ 25 kbd per well
X
$8 million-to-$12 million per well
$16 million-to-$24 million

Option 3: Recycling

1000 kb pond capacity @ $1.25/bbl of built storage
+
$1,000k for process units
$2.25 million

These impacts would become especially strong in an injection-constrained environment.

Water Production Profile of Top-Tier Wells in Lea County, NM



Source: NM OCD, Author's Analysis

Peaky, front-loaded flows.

- **CAPEX differences favor recycling. OPEX parameters will vary depending on scale and quality of incoming water, as well as E&P customer needs.**
- **The core question is: do recycling investments early in a play's development when frac'ing is most intense and the demand for feedstock water is highest help defer SWD investments that can then be made later when PW flows are more predictable and capital and capacity optimization are easier to do?**

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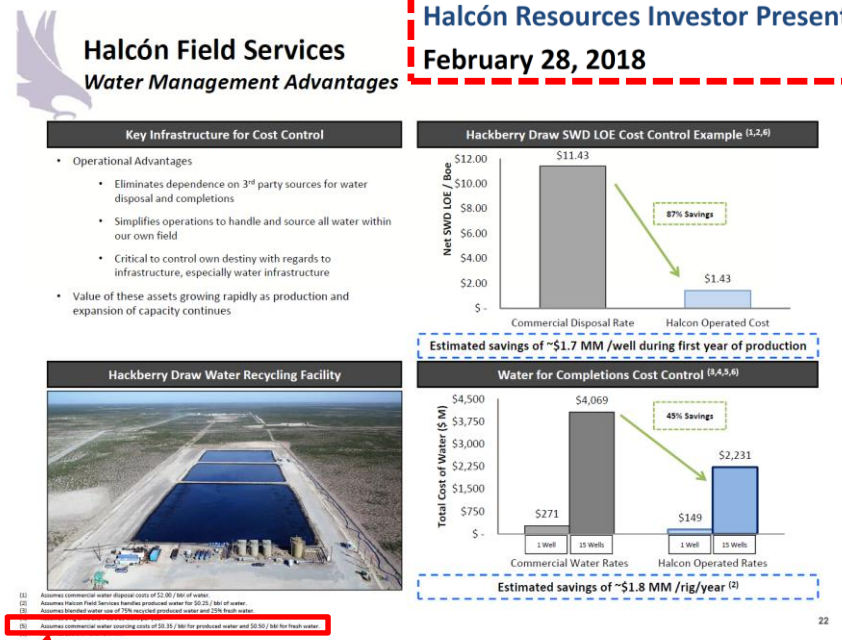
Tradable Produced Water: The New "WTS?"

Food For Thought

- "WTS" is current parlance is the abbreviation for West Texas Sour, a crude oil with an API gravity of 30.2 and sulfur content of between 1.5% and 2.8% by weight.
- In the Permian oilfield water world, there is a case to be made for what we can somewhat facetiously call the new WTS—as in "West Texas Salty" for the highly saline produced waters that flow up from wells in the region.
- Instead of API gravity and sulfur content, perhaps the quality specs for this hypothetical benchmark for recyclable produced water would be XX ppm total suspended solids, XX ppm of iron and other precipitate-forming ions, and levels of XX * 10^{x} per barrel or less of bacteria.

At least one Texas-focused operator has already contemplated a world in which produced water carries a commercial price tag.

Halcón Resources Investor Presentation
February 28, 2018



(5) Assumes commercial water sourcing costs of $0.35 / bbl for produced water and $0.50 / bbl for fresh water.

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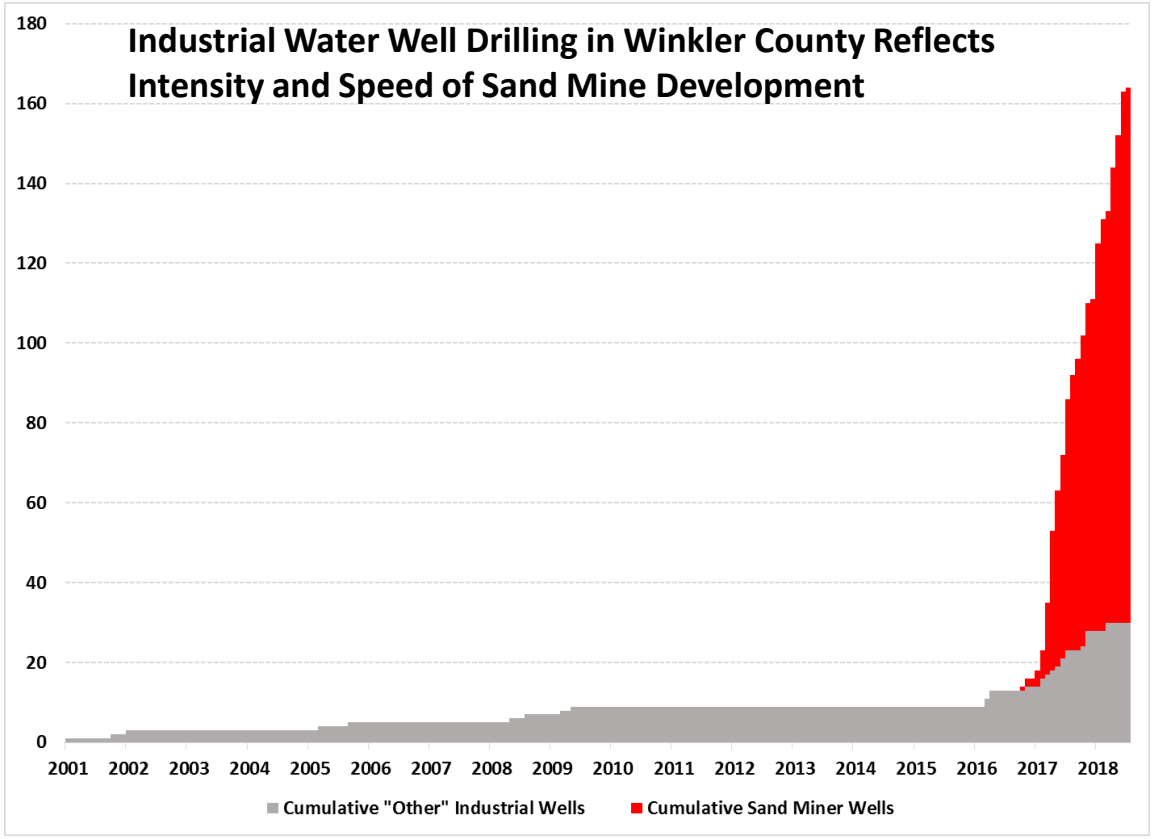
Oilfield Input Transitions Can Happen Fast

- **Consider the velocity at which E&Ps are adopting In-Basin frac sand.**
- **It took a while for the transition to reach a tipping point, but now sand suppliers are scaling up at warp speed to meet demand.**

The Dunes at Kermit: March 2015

The Dunes at Kermit: September 2017

Source: YouTube, Midland Reporter Telegram



Source: TWDB, Author's Analysis

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Cutting-Edge Texas Groundwater and Oilfield Water Research

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