



Petroleum Engineers Club of Dallas

Don't Get Fooled on Type Curve Underwriting Again:
-- Permian Basin Type Well Selection in the Era of Cube Development

Presented by Rob Quigley

June 10, 2022



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3-D Development Type Well Selection

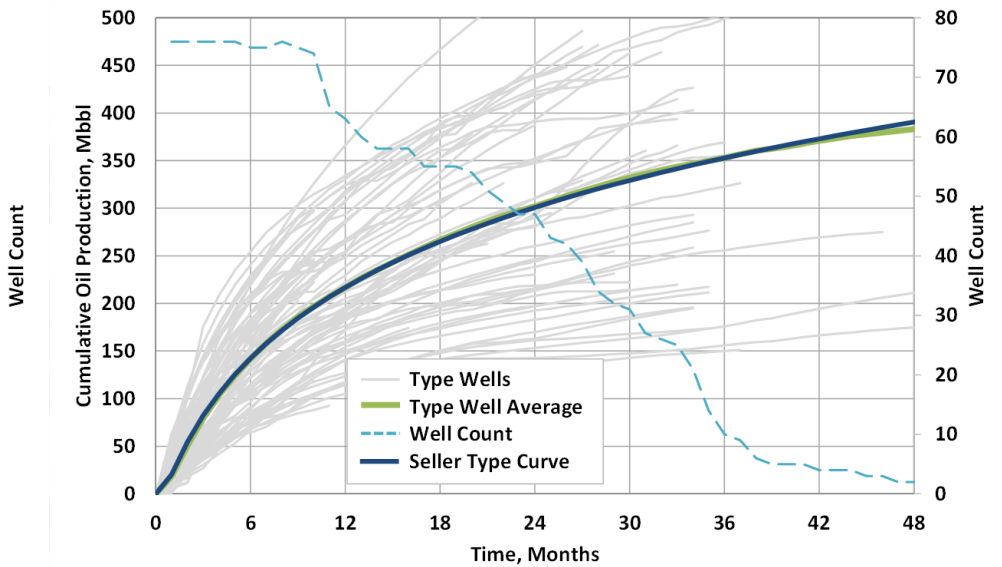
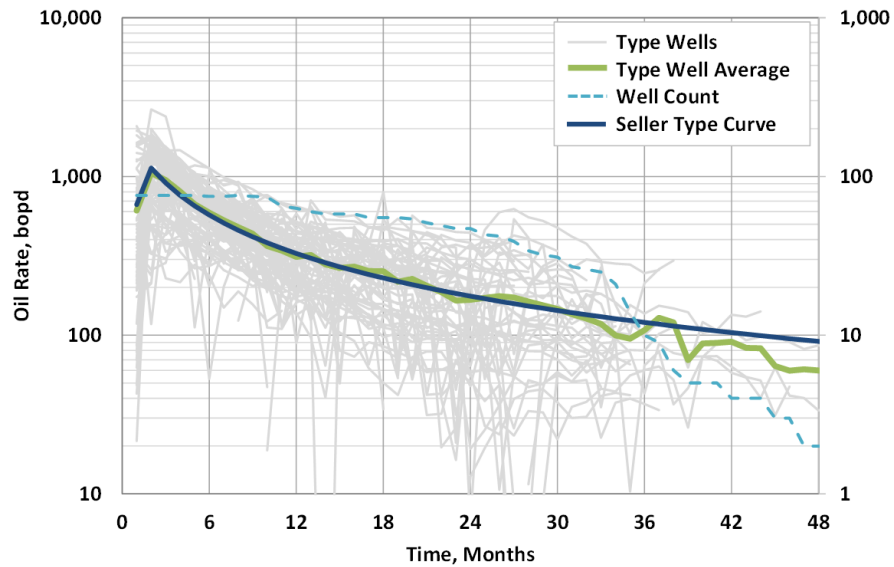
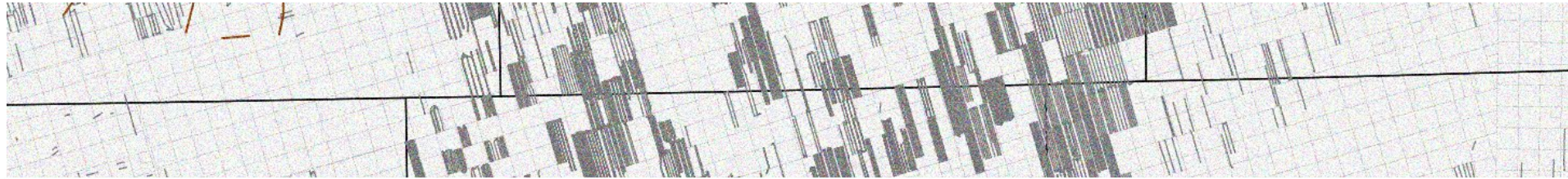
1. Introduction – Why is Picking Type Wells an Issue?
2. Classifying 3-D Well Spacing Configurations – A New Framework
3. 3-D Framework Examples With Well Performance
4. Midland Basin Trending to Cube Development
5. Proposed Type Curve Methodology – No 1st Order (Single-Bench) Type Wells
6. Impact on Inventory – Prospecting Tool
7. Summary

Introduction – Why is Picking Type Wells an Issue?

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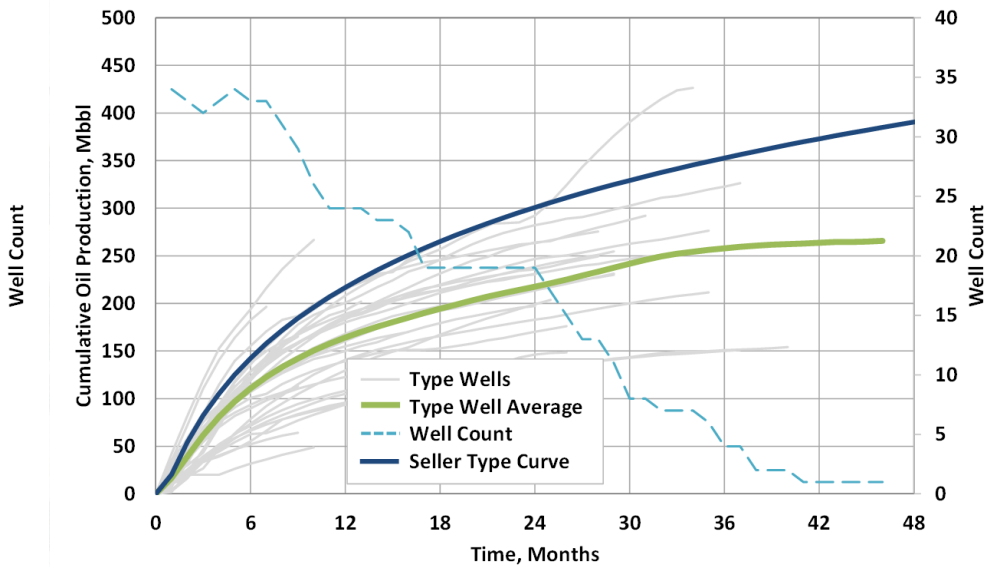
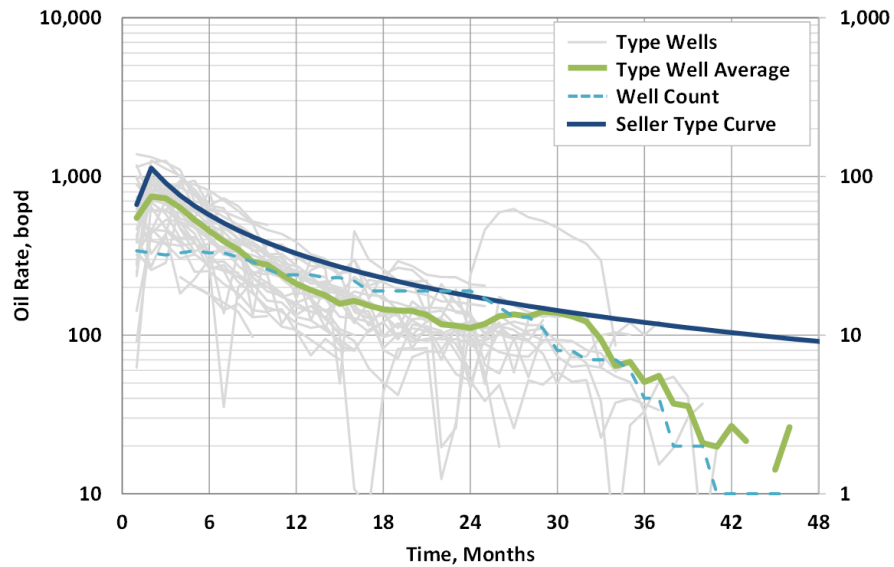
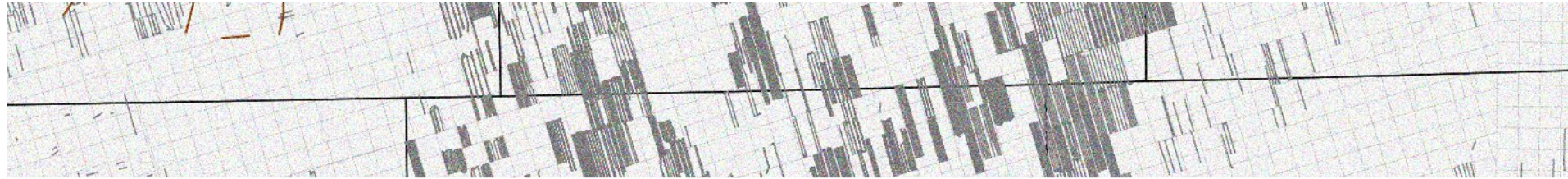


Type Well Selection... Impactful



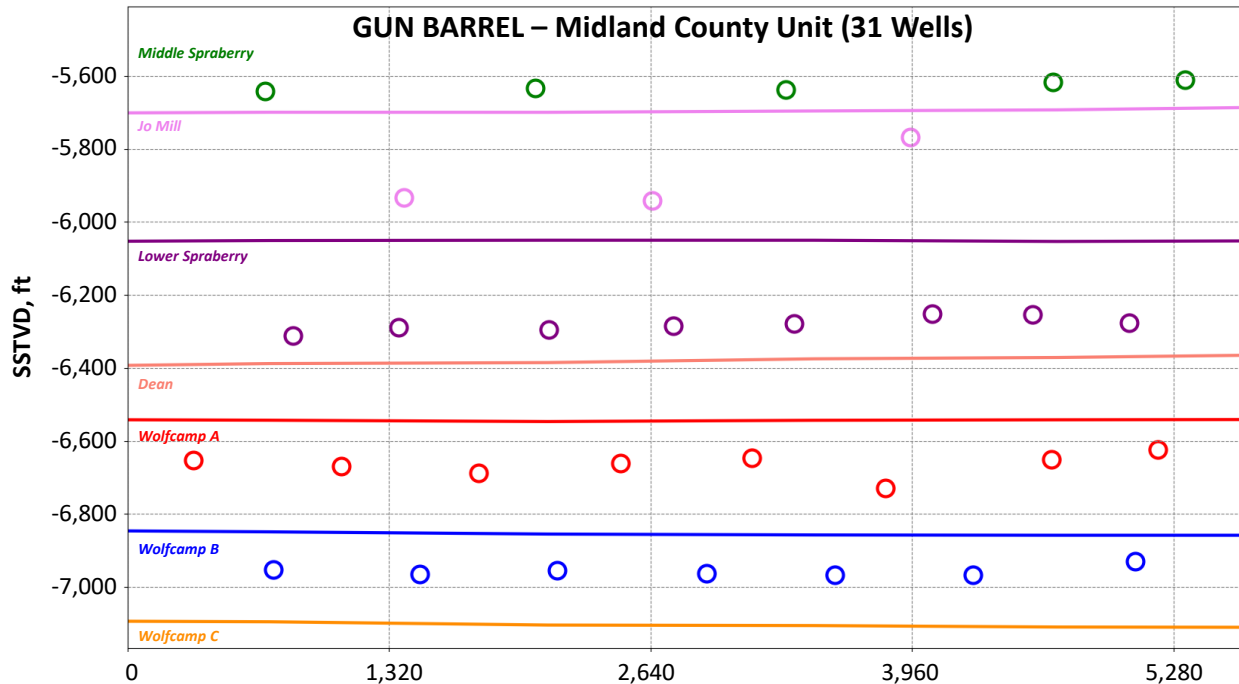
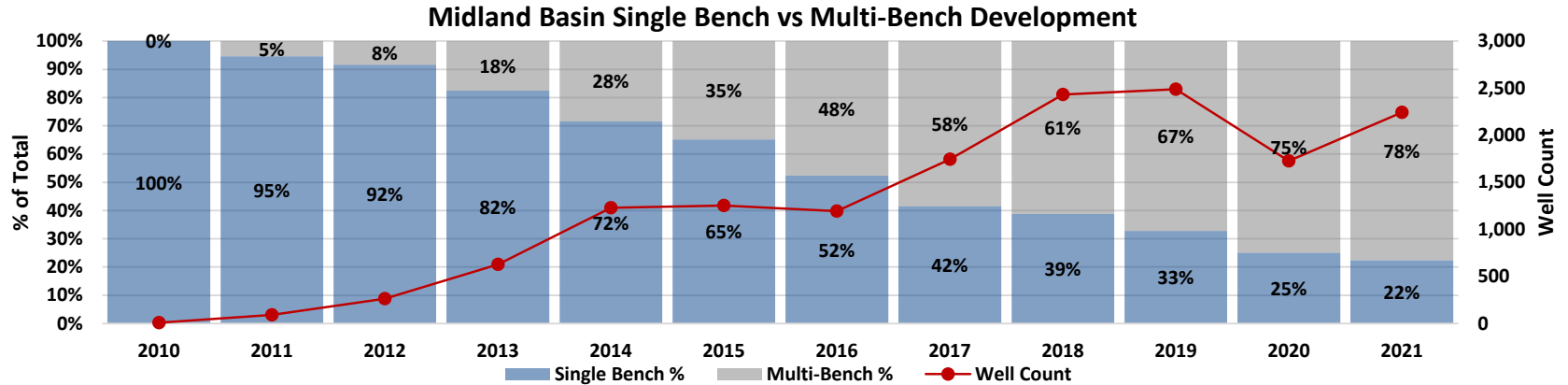
Looks like a good fit! Right?

Type Well Selection... Impactful



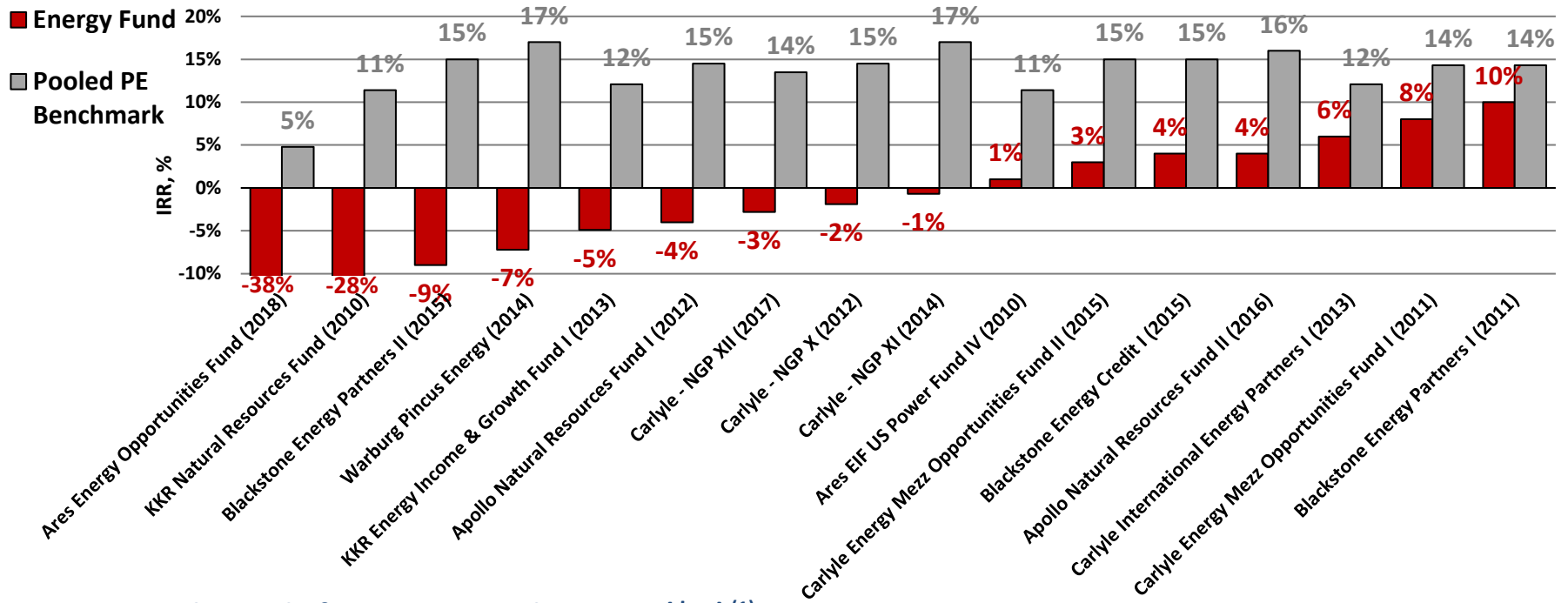
But what if this is the right type well selection?
Type Well Selection Matters

First a 2-D Problem... Now 3-D

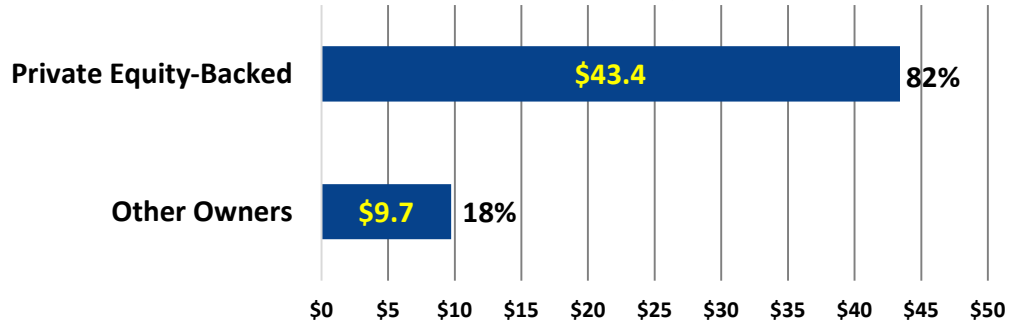


The Consequences of Underestimating Spacing Effects

Private Equity Energy Fund Returns (IRR) vs Benchmark⁽¹⁾



Debt Load of 2020 O&G Bankruptcies (\$ B)⁽¹⁾



“EUR estimates from many companies were grounded on two assumptions: that they could pack wells closer together, squeezing more value from the land they leased, and that they could replicate their best early wells. The results to date suggest those assumptions were often wrong.”
 –“Fracking’s Secret Problem – Oil Wells Aren’t Producing as Much as Forecast” (WSJ, January 2, 2019)⁽²⁾

(1) <https://pestakeholder.org/wp-content/uploads/2021/03/PE-Energy-Bets-Burn-Investors-PESP-March-2021.pdf>
 (2) <https://www.wsj.com/articles/frackings-secret-problem-oil-wells-arent-producing-as-much-as-forecast-1154645016>



Will We Get Underwriting Correct This Time Around?

Should Institutional Investors
Jump Back Into Oil & Gas Private
Equity? —Forbes March 2, 2022

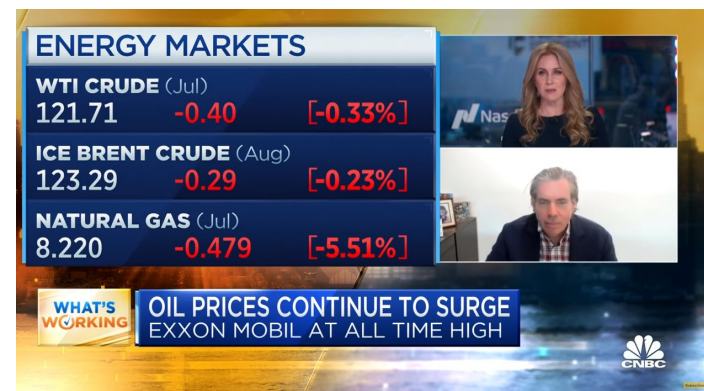
Higher Prices Spark Fresh
Investor Interest in Oil and Gas
—WSJ March 28, 2022

Big Investors Reconsider Oil and
Gas Upside as Supplies Remain
Tight —WSJ May 12, 2022

Big Banks Fund New Oil and Gas
Despite Net Zero Pledges
—BBC February 14, 2022

“What will it take to get capital to come back?
The answer is a three-year track record in the
space [of good returns] and we are about 18
months into that three years.”

—Jeffrey Currie, Goldman Sachs Global Head of Commodities Research
(CNBC Interview, June 9, 2022)⁽¹⁾



(1) https://www.youtube.com/watch?v=EaFh9kG3_U

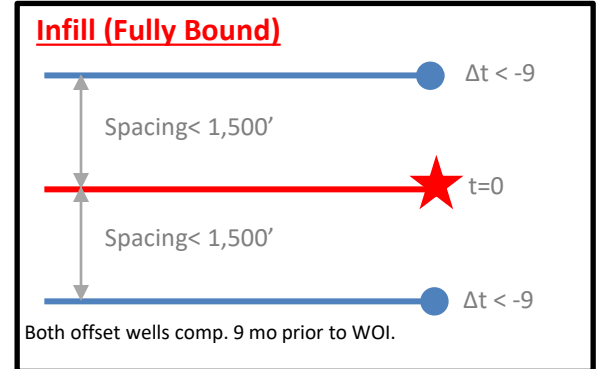
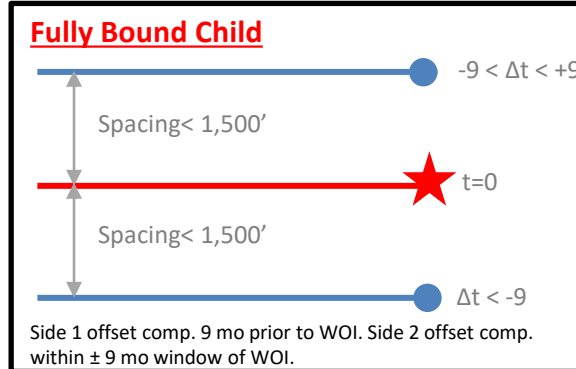
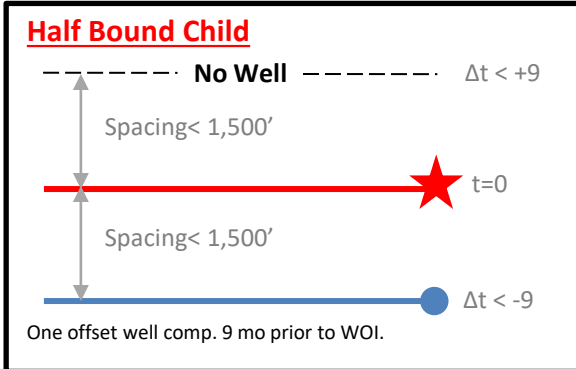
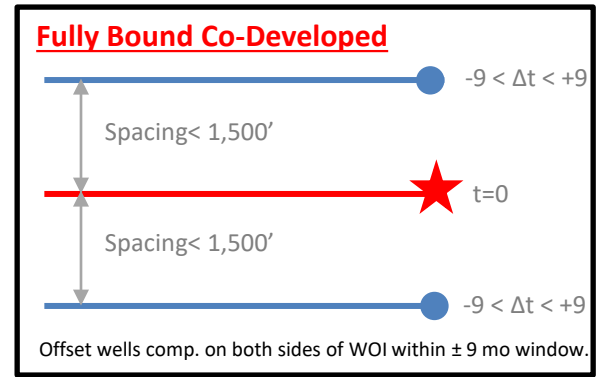
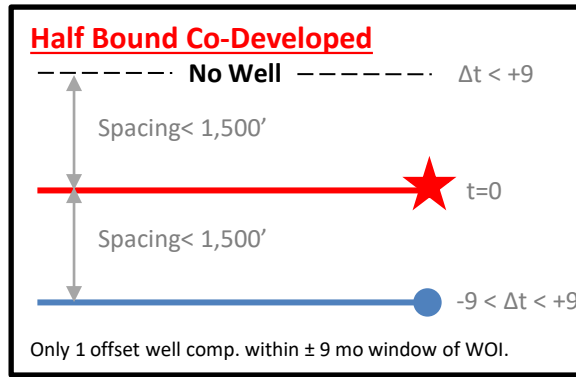
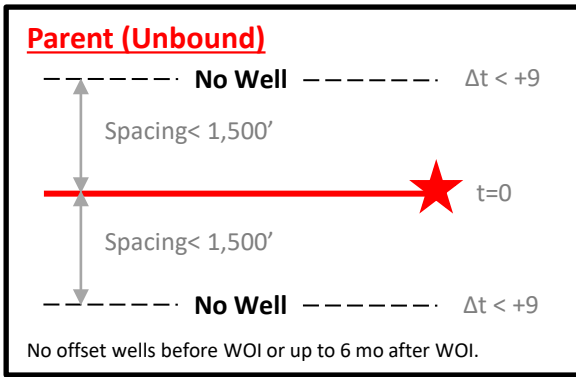
Classifying 3-D Well Spacing Configurations – A New Framework

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2-D Spacing Framework

In-Bench Spacing (URTEC-5058-MS)



Legend

★ = Well of Interest ("WOI")

● = Offset Well

Δt = Months between Comp. Date of WOI and Comp. Date of Offset Well

Bounding Terminology –

- ☐ **Fully Bound ("FB"):** Wells completed on both side of WOI before or up to 9 months after of the WOI's completion date.
 - Includes FB Co-Dev, FB Child, and Infill.
- ☐ **Half Bound ("HB"):** Side 1 of WOI has well completed before or up to 9 months after the WOI completion date. Side 2 of WOI has NO WELLS completed before or up to 9 months after the WOI completion date.
 - Includes HB Co-Dev and HB Child.
- ☐ **Unbound ("UB"):** WOI has NO WELLS completed on either side before or up to 9 months after of the WOI's completion date.
 - Only Parent wells.

Timing Designation Terminology –

- ☐ **Parent:** NO WELLS on either side of WOI.
 - Always considered UB.
- ☐ **Co-Developed ("Co-Dev"):** Completed at the same time (within a ± 9 month window) of offsetting well.
 - Can be either FB or HB.
- ☐ **Child:** WOI that is directly offset to a well that existed at least 6 months prior to the WOI.
 - Can be either FB or HB.
- ☐ **Infill:** Well that is drilled between two pre-existing wells (both offset wells completed more than 9 months before the WOI completion date).
 - Always considered FB.

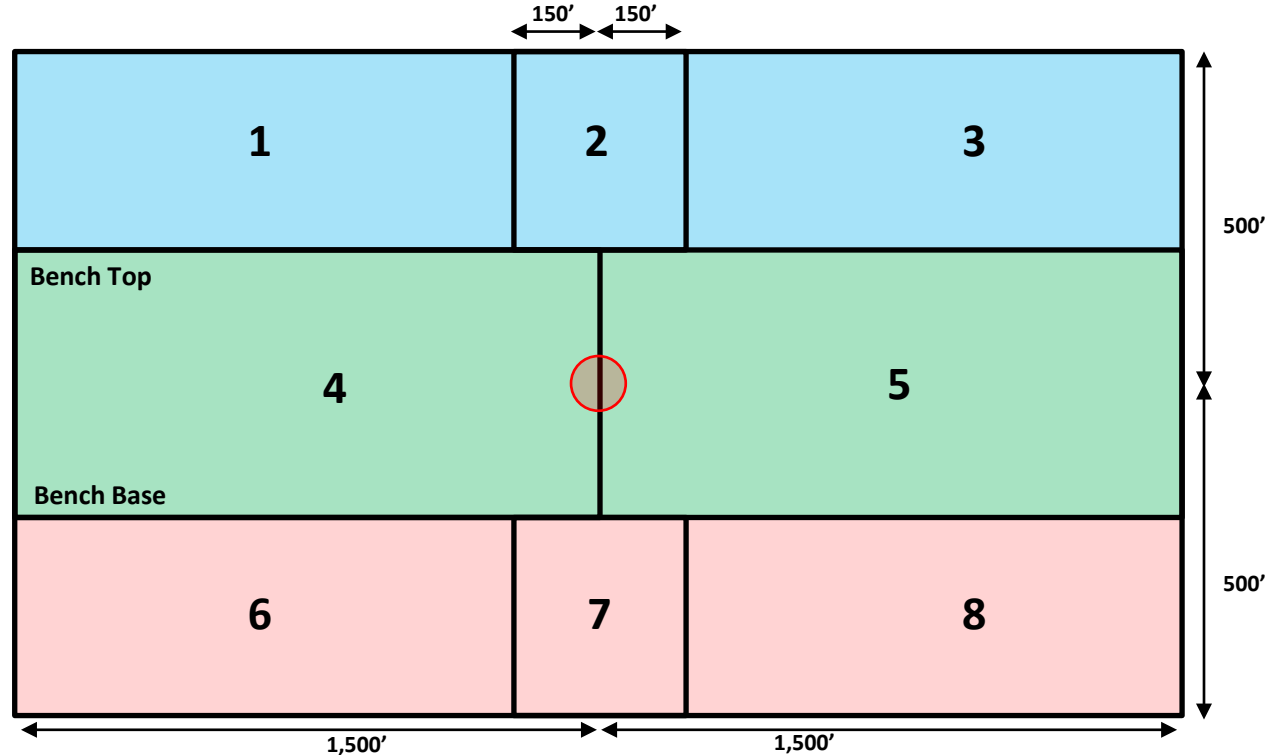
SPACING ID SUMMARY: VSO assigns 1 of 6 Spacing ID's to wells based on the methodology on this page. VSO only takes into account nearest offset wells within 1,500' of WOI. VSO assigns the Spacing ID based on the WOI's original status based on its completion date in comparison to offset well completion dates and a ± 9 month Δt cutoff.

SPACING ASSIGNMENT: VSO measures spacing on both sides of the WOI and assigns only the minimum spacing to half bound wells (HB Co-Dev and HB Child) and the average of both sides to parent and fully bound wells (Parent, FB Co-Dev, FB Child, and Infill).



New 3-D Spacing Framework

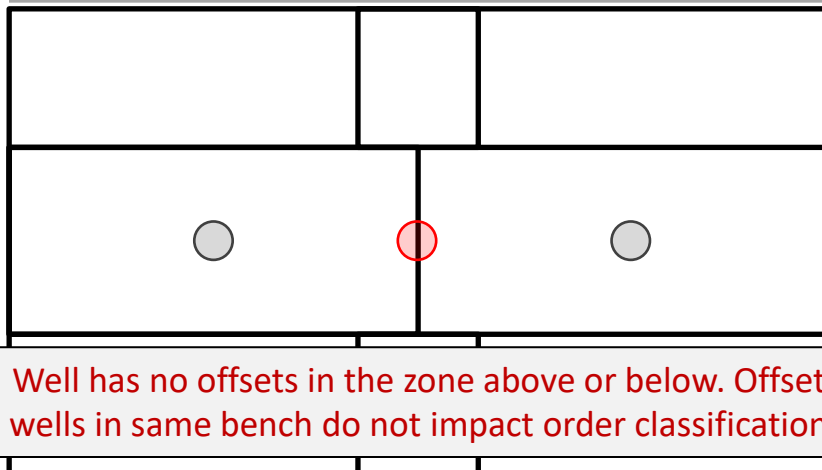
3D (In-Bench) Methodology



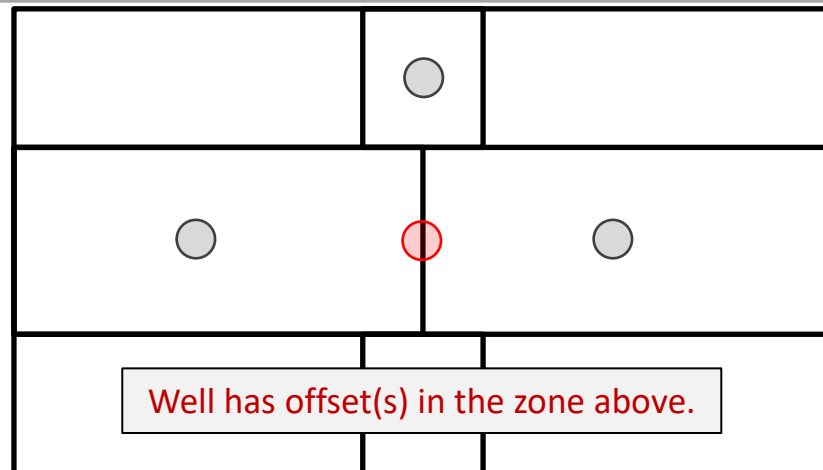
- ❑ **In-Bench Zone (Sectors 4 & 5):**
 - ❑ The In-Bench Zone is the zone most are already familiar with, made up of 2 sectors on either side of the well, extending horizontally by 1,500' and occupying the whole Bench.
- ❑ **Above Zone (Sectors 1, 2, & 3):**
 - ❑ This is the region above the Bench-of-Interest, but within 500' vertical distance of the WOI (“Well-of-Interest”).
 - ❑ The Above Bench Zone is split up into 3 sectors, with one being the narrow region directly above the WOI. This zone directly overhead is a hot-spot for offset wells.
- ❑ **Below Zone (Sectors 6, 7, & 8):**
 - ❑ This is the region below the Bench-of-Interest, but within 500' vertical distance of the WOI. Also 3 sectors.

New 3-D Spacing Methodology

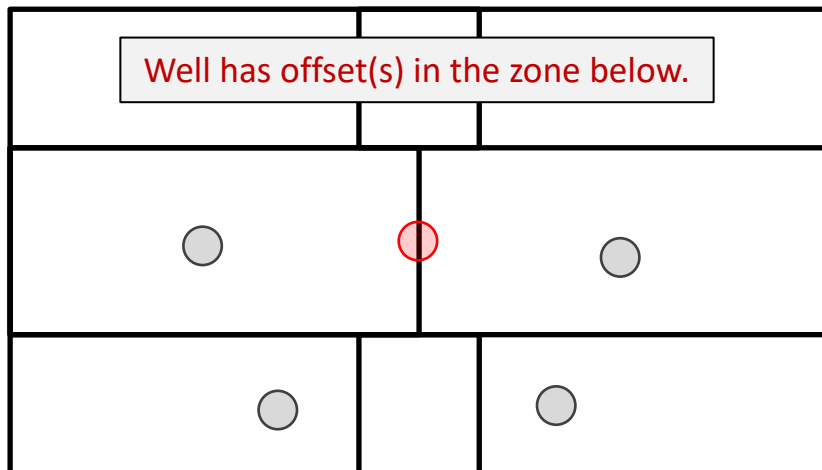
1st, 2nd, & 3rd Order



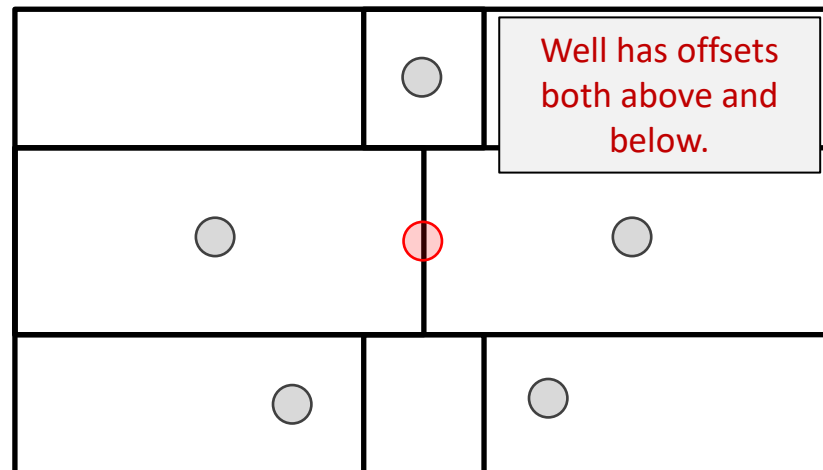
1st Order



2nd Order Lower

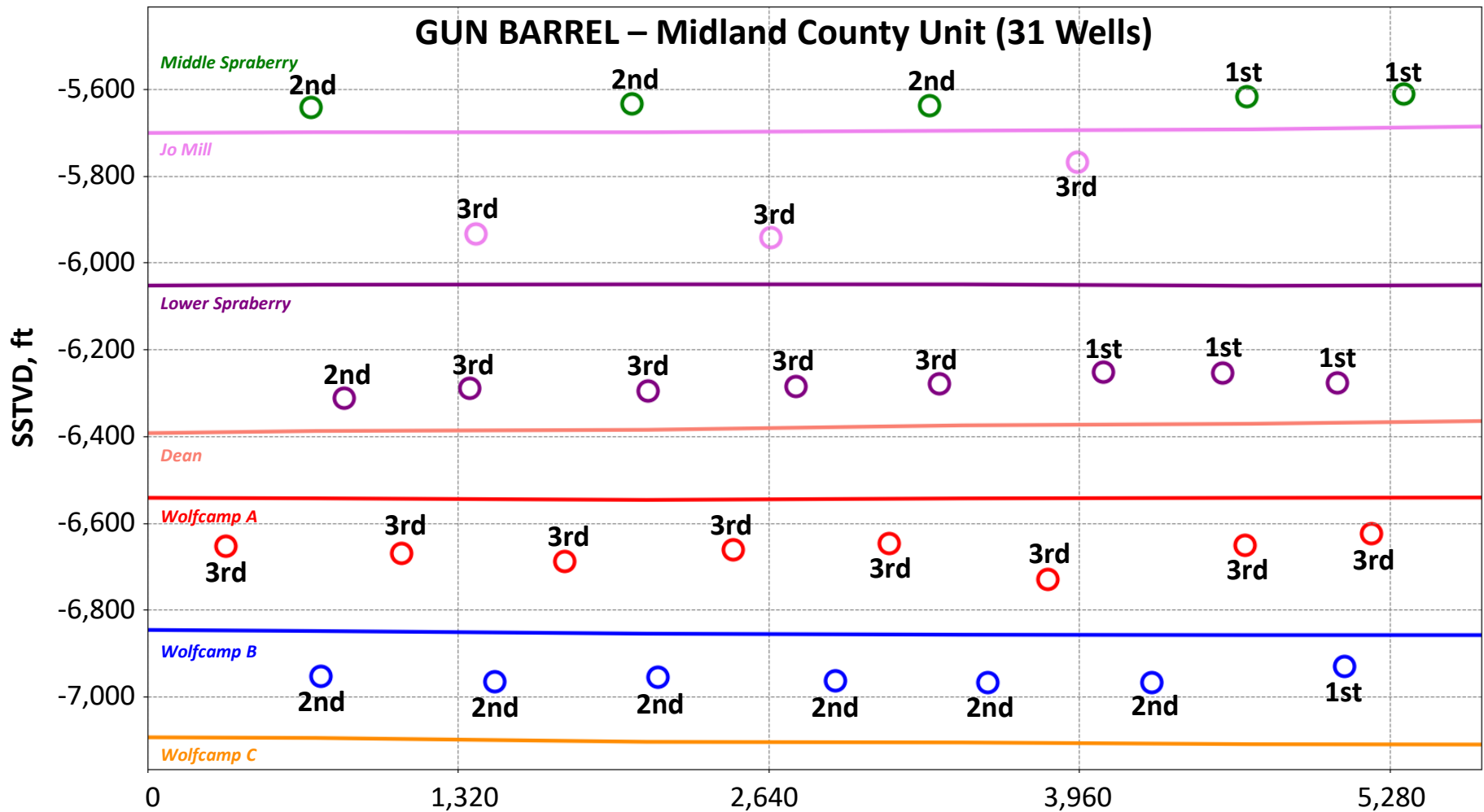


2nd Order Upper



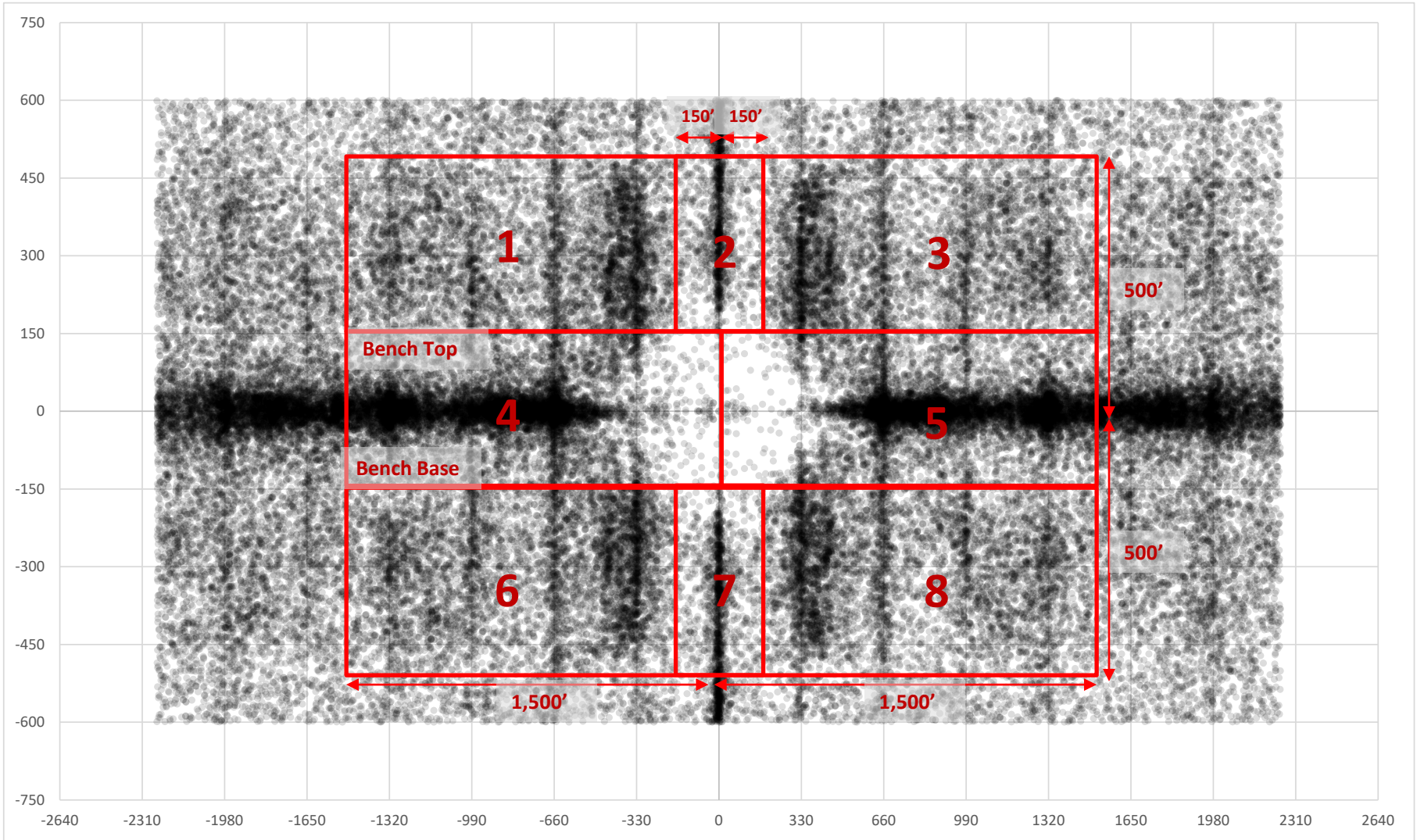
3rd Order

Midland Basin – Example Order Classification



Composite Gun Barrel Diagram

Midland Basin – All Benches



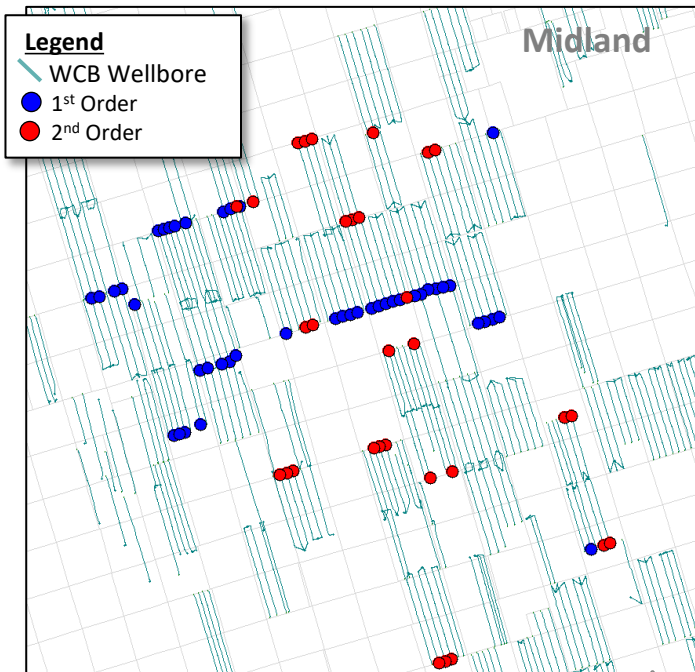
3-D Framework Examples with Well Performance

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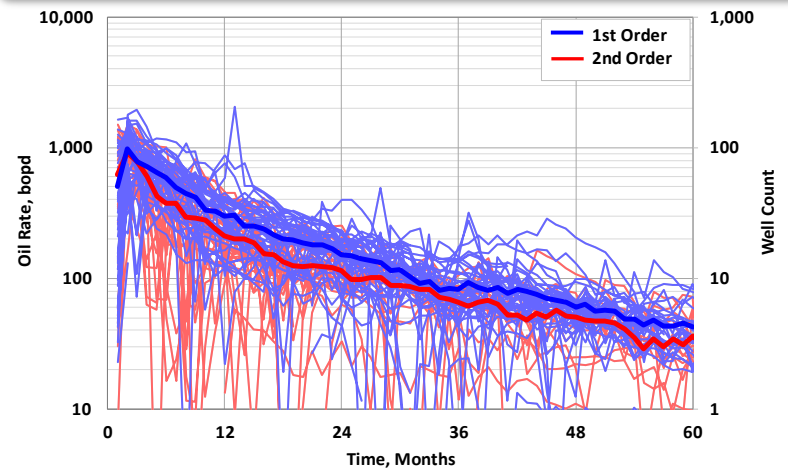
Illustrative Midland Basin Spacing Study

1st vs 2nd Order (Midland – Wolfcamp B) | 10,000' Norm. CLL

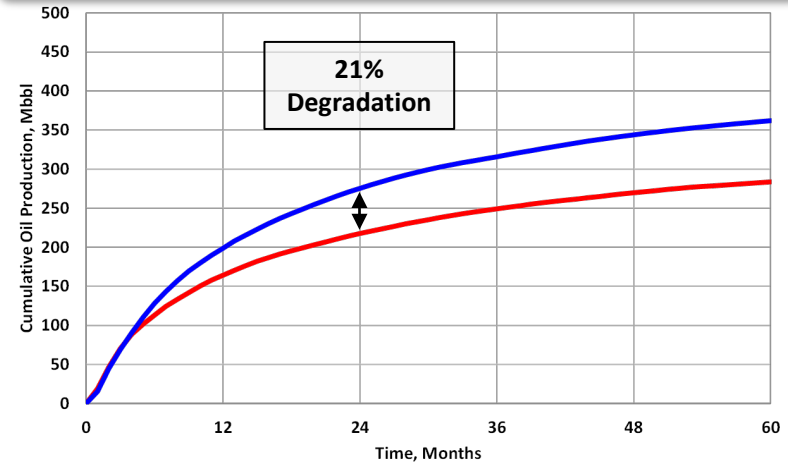


Well Statistics	1st Order	2nd Order
Min. Completion Date	6/20/2015	4/12/2015
Avg. CLL, Ft	9,005	8,685
Avg. Proppant, Lbs/Ft	1,680	1,703
Avg. Fluid, Gal/Ft	1,982	2,020
Hz. Spacing, Ft	841	805
Order Hz. Spacing, Ft	-	501
Order Vt. Spacing, Ft	-	316
Well Count	47	33
24-Mth Cum. Oil Deg., %	-	-21%

Oil Rate – Time

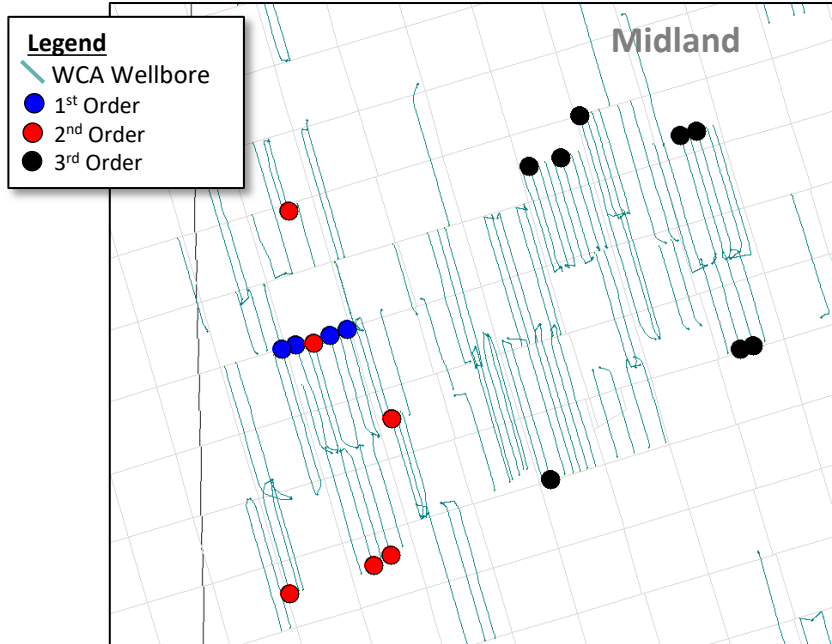


Oil Cum. – Time



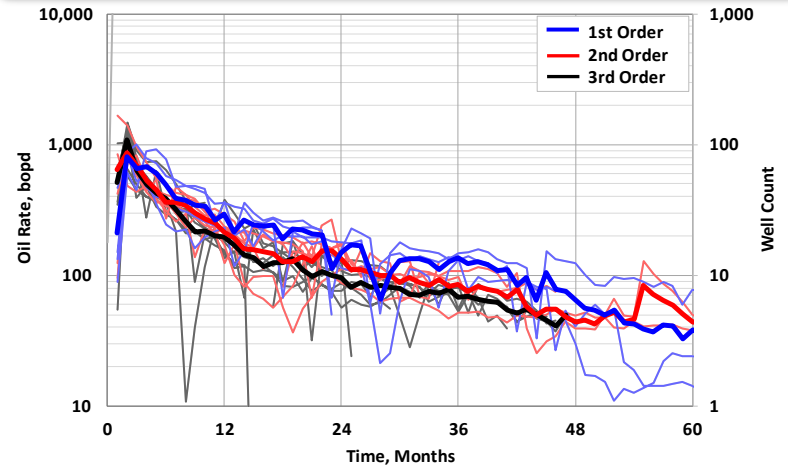
Illustrative Midland Basin Spacing Study

1st, 2nd, & 3rd Order (Midland – Wolfcamp A) | 10,000' Norm. CLL

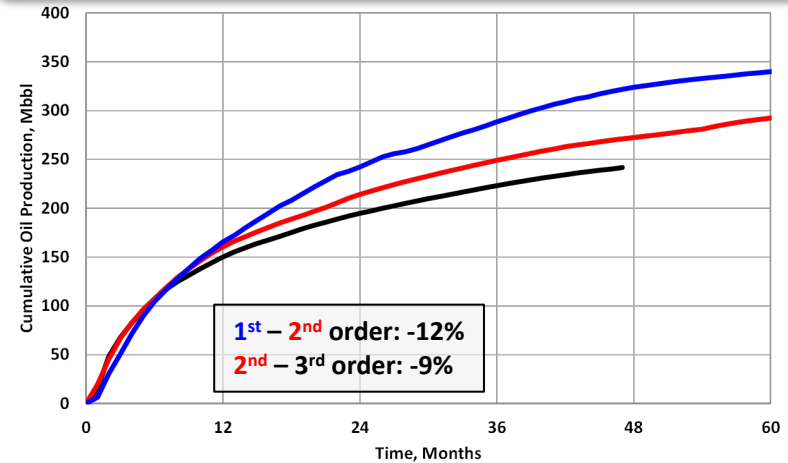


Well Statistics	1st Order	2nd Order	3rd Order
Min. Completion Date	11/22/2015	9/17/2015	1/12/2018
Avg. CLL, Ft	8,725	7,521	8,316
Avg. Proppant, Lbs/Ft	1,688	1,983	1,873
Avg. Fluid, Gal/Ft	2,127	2,368	1,947
Hz. Spacing, Ft	762	757	792
Order Hz. Spacing, Ft	-	779	407
Order Vt. Spacing, Ft	-	276	304
Well Count	4	6	8
24-Mth Cum. Oil Deg., %	-	-12%	-9%

Oil Rate – Time



Oil Cum. – Time

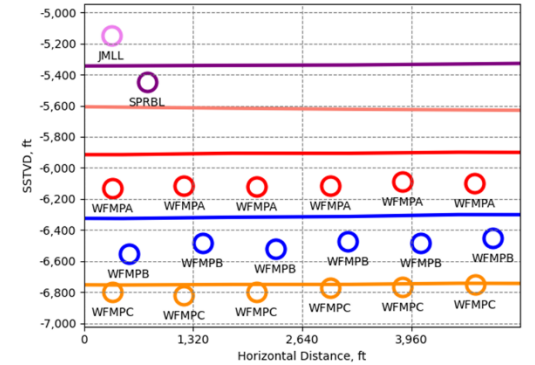
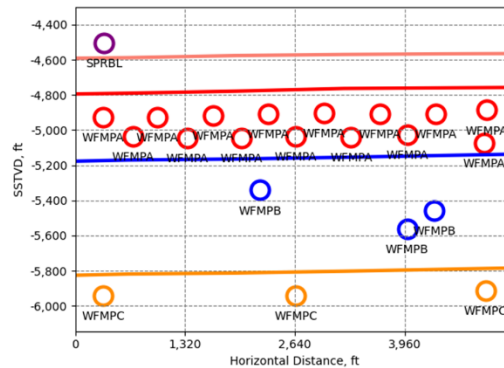
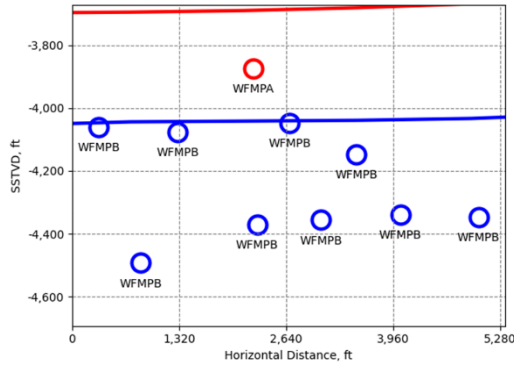
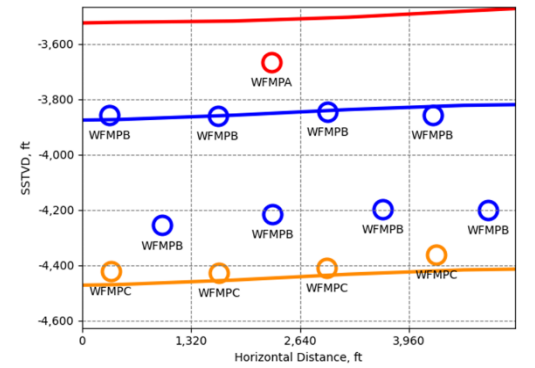
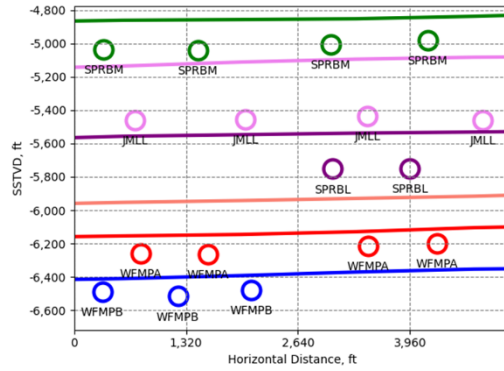
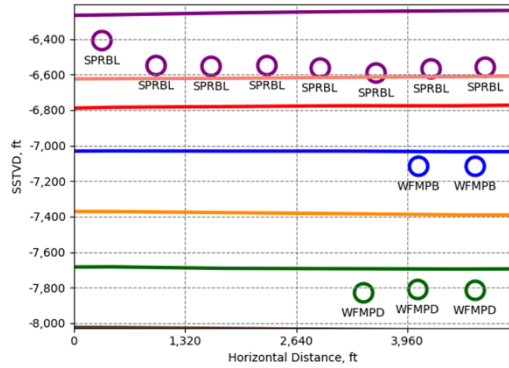
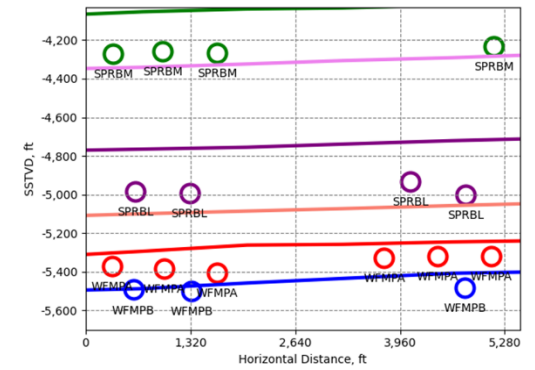
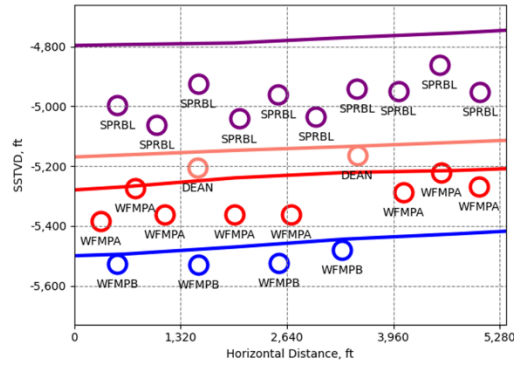
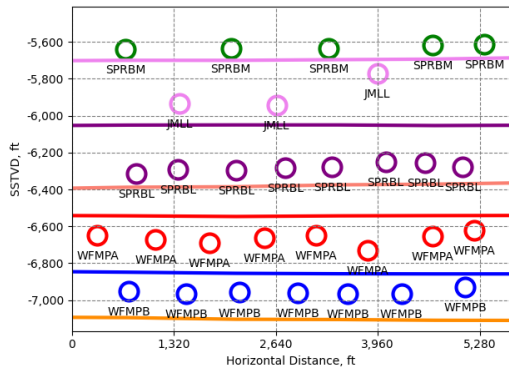


Midland Basin Trending to Cube Development

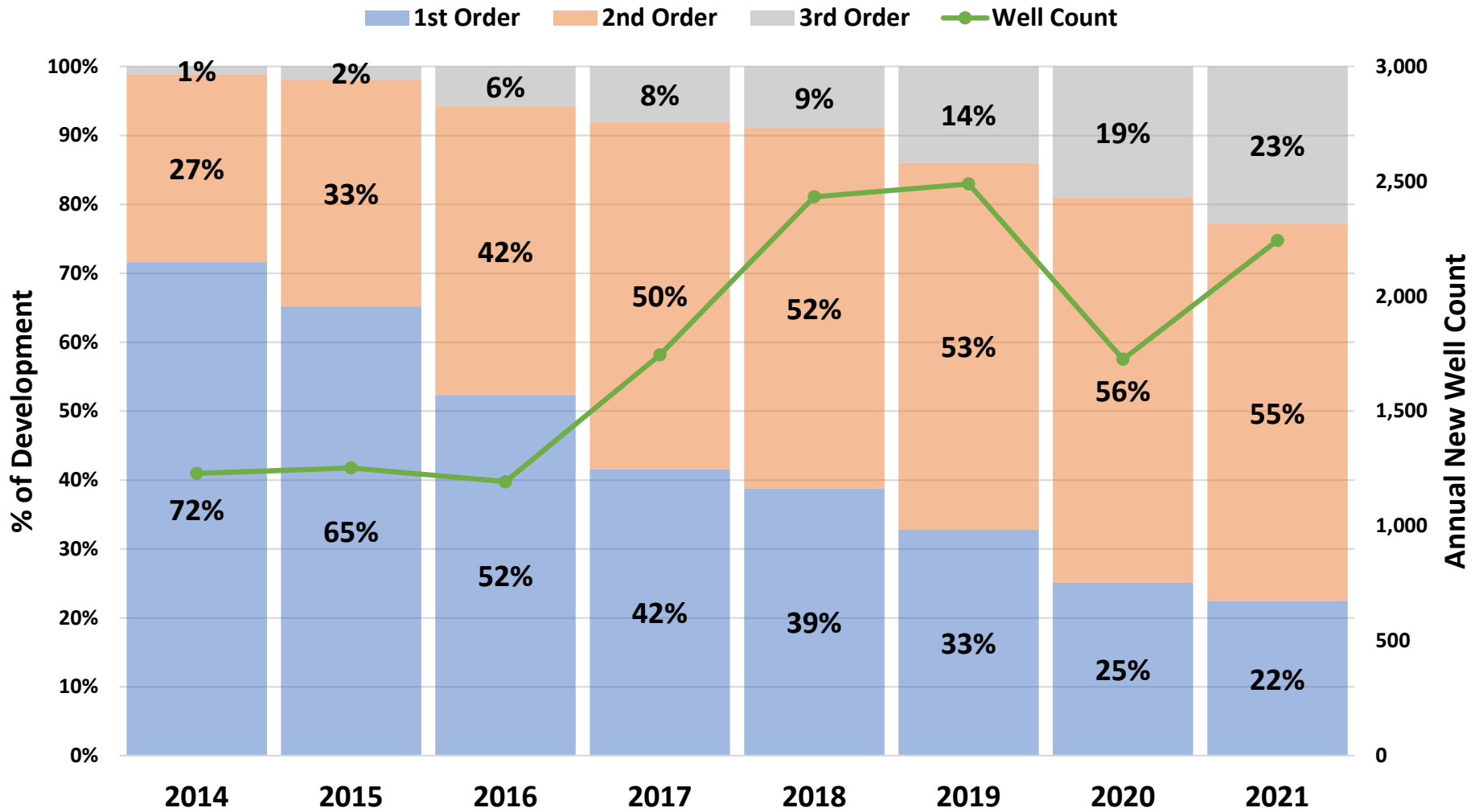
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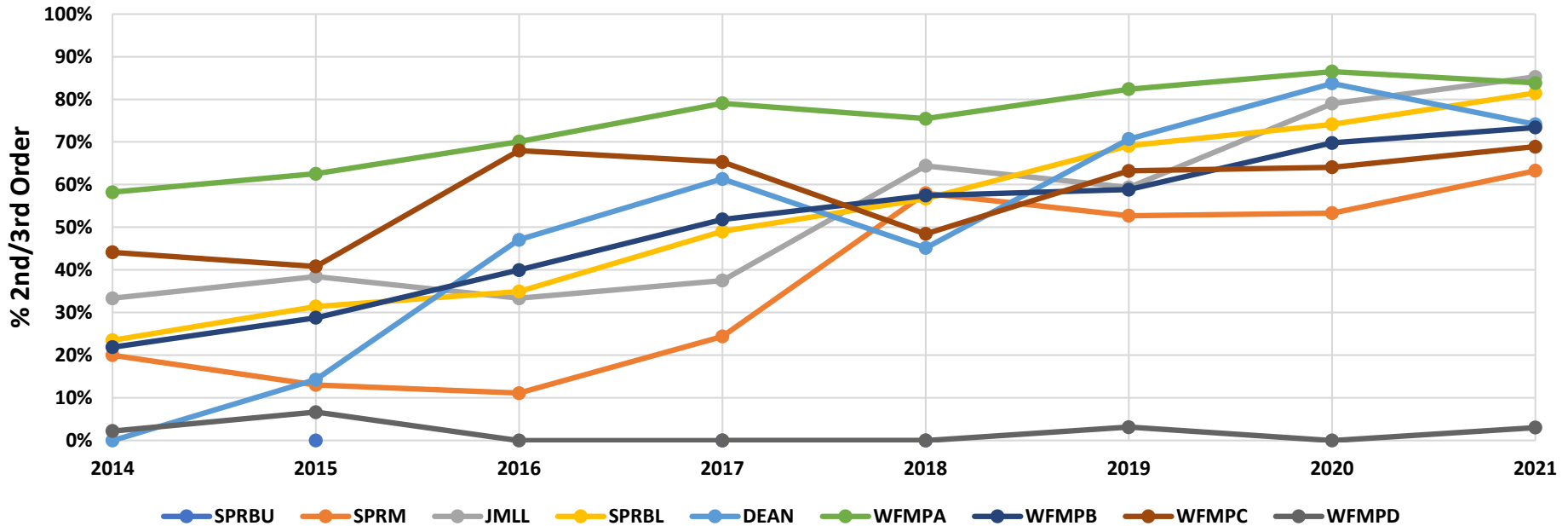
Midland Basin – 3D Problem Now, Not 2D



Midland Basin Trending Toward Multi-Bench Development



Midland Basin By-Bench Cube Trends



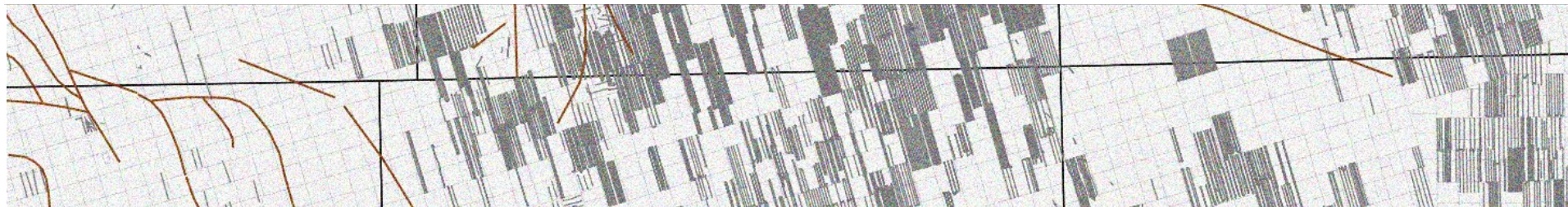
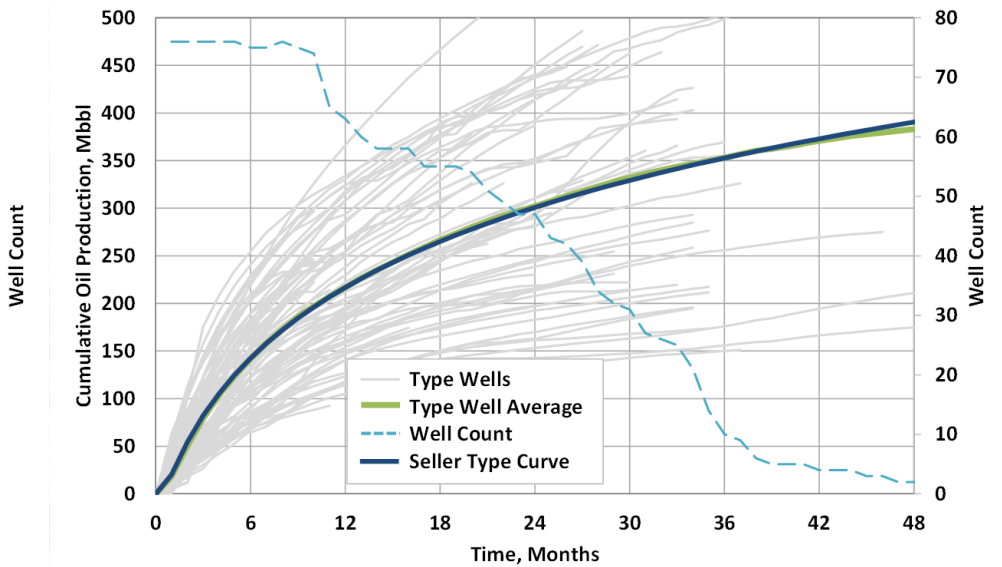
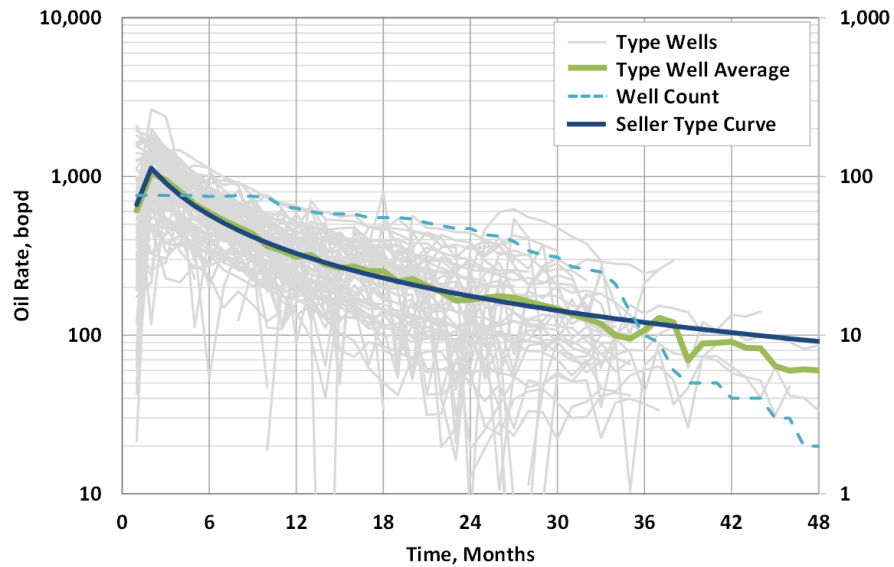
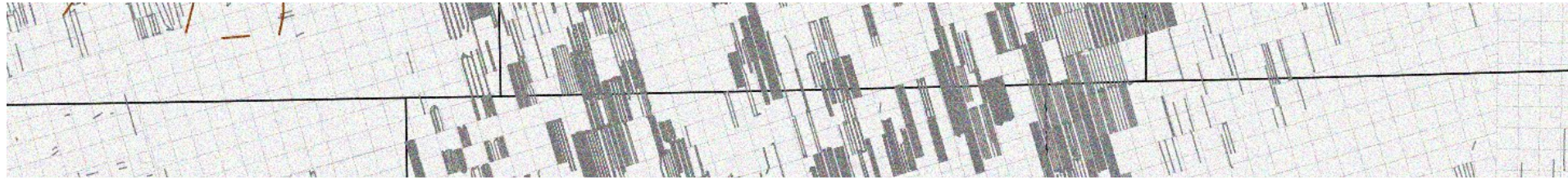
Bench	1st Order	2nd Order	3rd Order	Grand Total
SPRBU	94%	6%	0%	16
SPRM	52%	48%	0%	369
JMLL	31%	43%	26%	572
SPRBL	37%	52%	10%	2,491
DEAN	37%	56%	7%	669
WFMPA	23%	49%	28%	3,848
WFMPB	55%	42%	3%	6,704
WFMPD	46%	53%	1%	767
WFMPD	97%	3%	0%	303
Grand Total	43%	46%	11%	15,739

Proposed Type Curve Methodology – No 1st Order (Single Bench) Type Wells

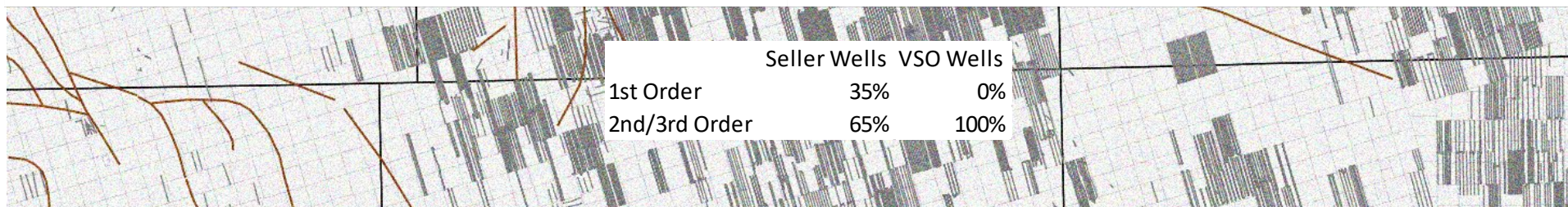
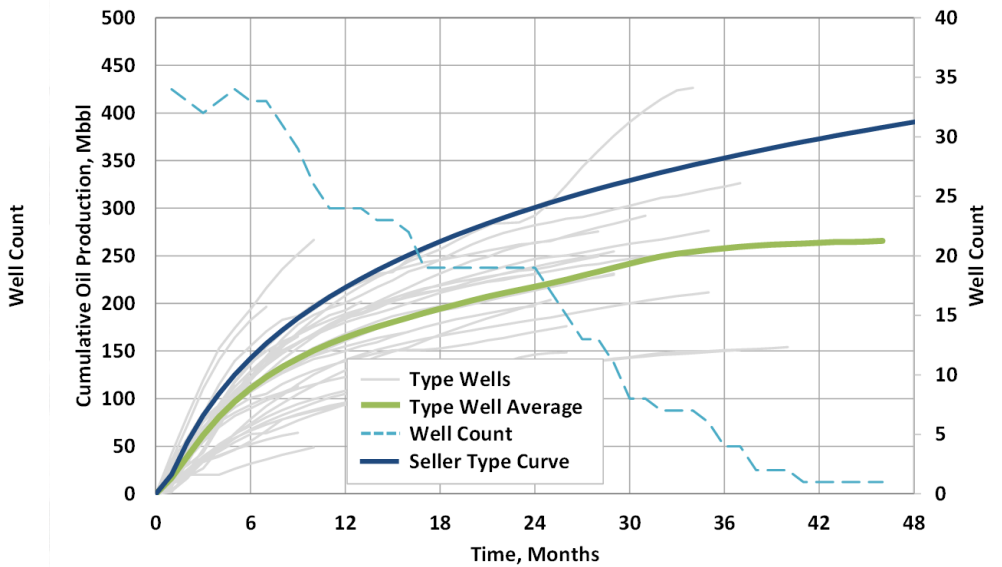
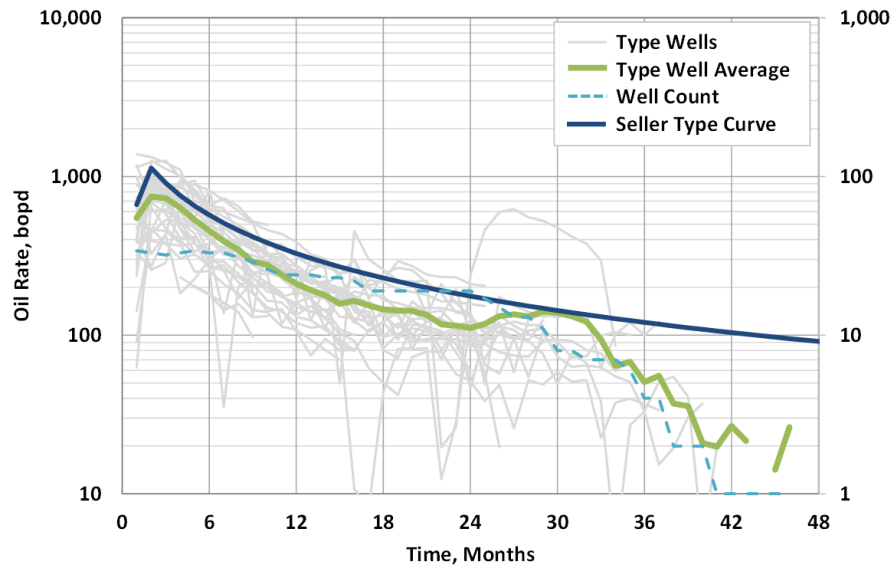
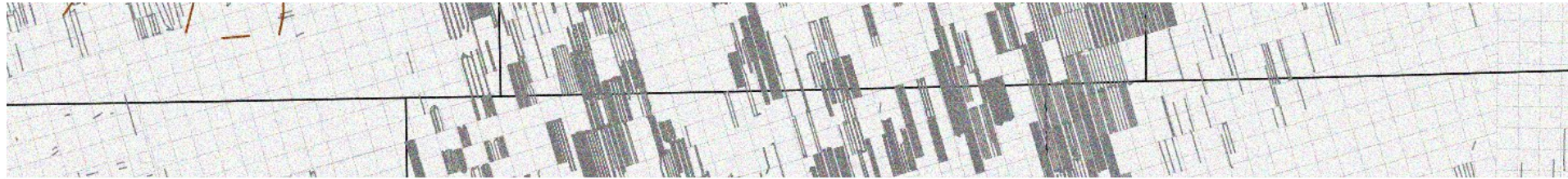
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Exclude First Order Wells from Type Well List



Exclude First Order Wells from Type Well List



Impact on Inventory – Prospecting Tool

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Applying Framework to Inventory

Midland Basin Wolfcamp A Prospecting Map

Remaining WPS

Legend

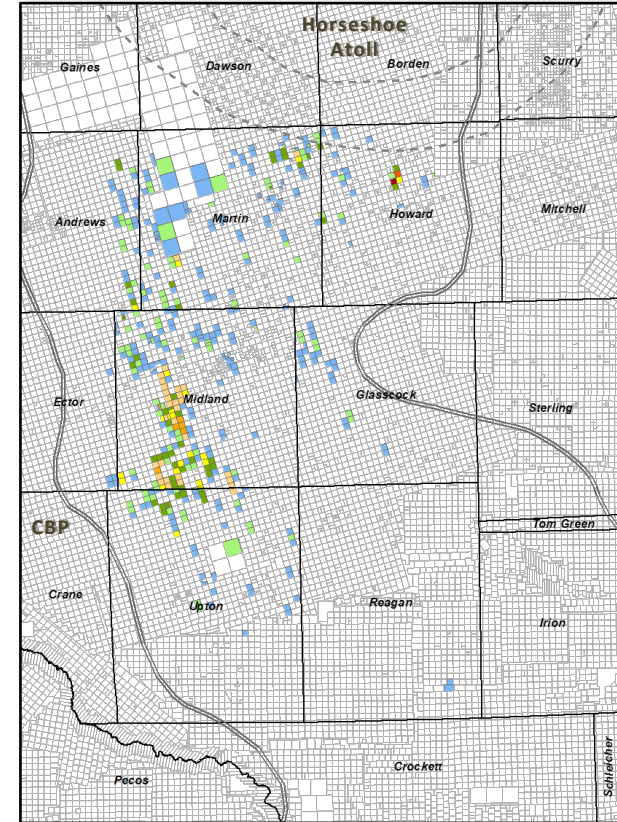
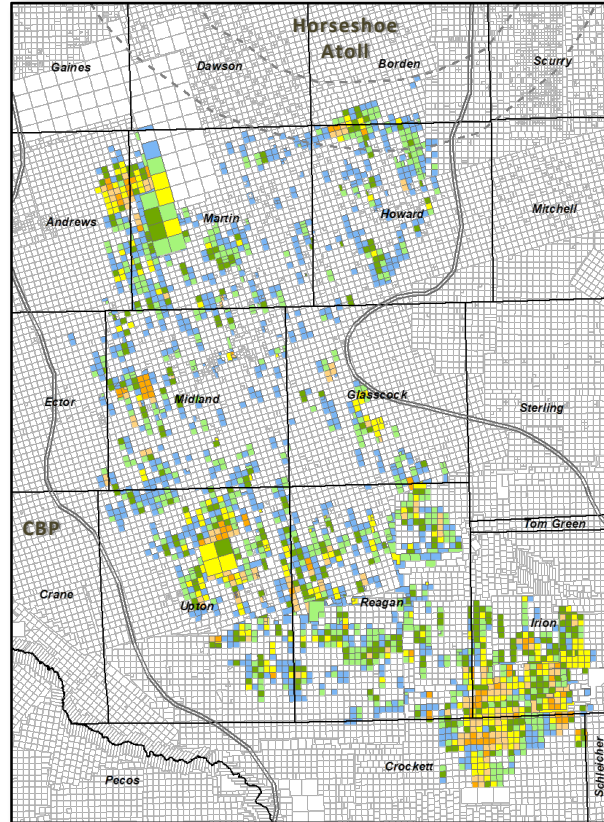
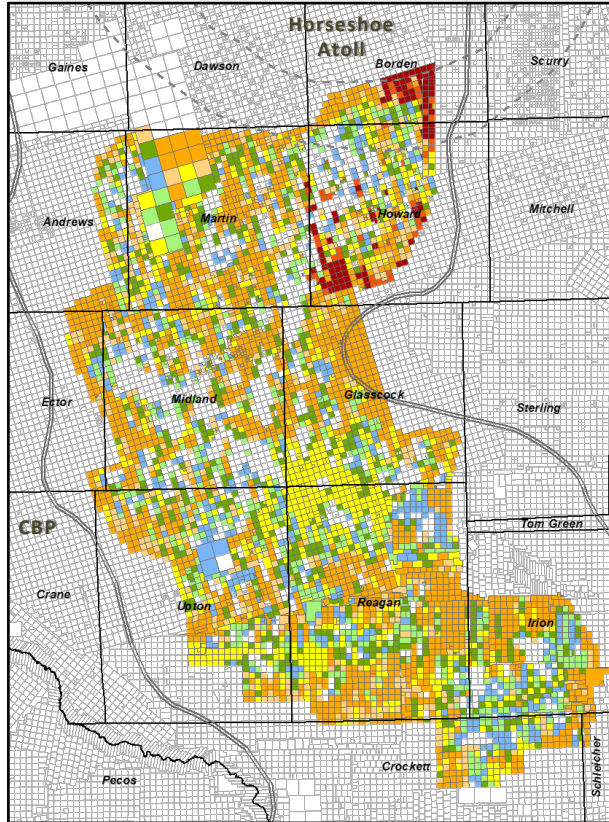
0 1 2 3 4 5 6 7 8+



1st Order/Open

2nd Order Child/Infill Remaining

3rd Order Child/Infill Remaining



3-D Development Type Well Selection

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