URTeC-125

Production Effects from Frac-Driven Interactions in the SE Midland Basin, Reagan Co., TX

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Introduction

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- As operators transition from field delineation to field development, frac-driven interactions (AKA frac hits) are becoming more common and more severe in most unconventional shale plays
  - Miller et al. (2016), King et al. (2017), Pankaj (2018)

- DNR had observed FDIs company acreage but had not evaluated them systematically
  - Decided to quantify the effects within an area of active development

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What Are Frac-Driven Interactions?

- Frac-driven interactions (FDIs) formalized by Daneshy & King (2019)

- Variety of interactions:
  - Child-Parent pressure/fluid hits
  - Child-Child pressure/fluid hits

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Goals

1. Document FDIs in active area of development
2. Quantify FDI frequency, intensity
3. Create rules-of-thumb for shut-in procedures

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Methods

Workflow

1. Identify FDIs from offset frac jobs
2. Categorize parent-child spatial relationship
3. Measure inter-well distance
4. Plot FDI category vs. inter-well distance
    - Filter by different criteria

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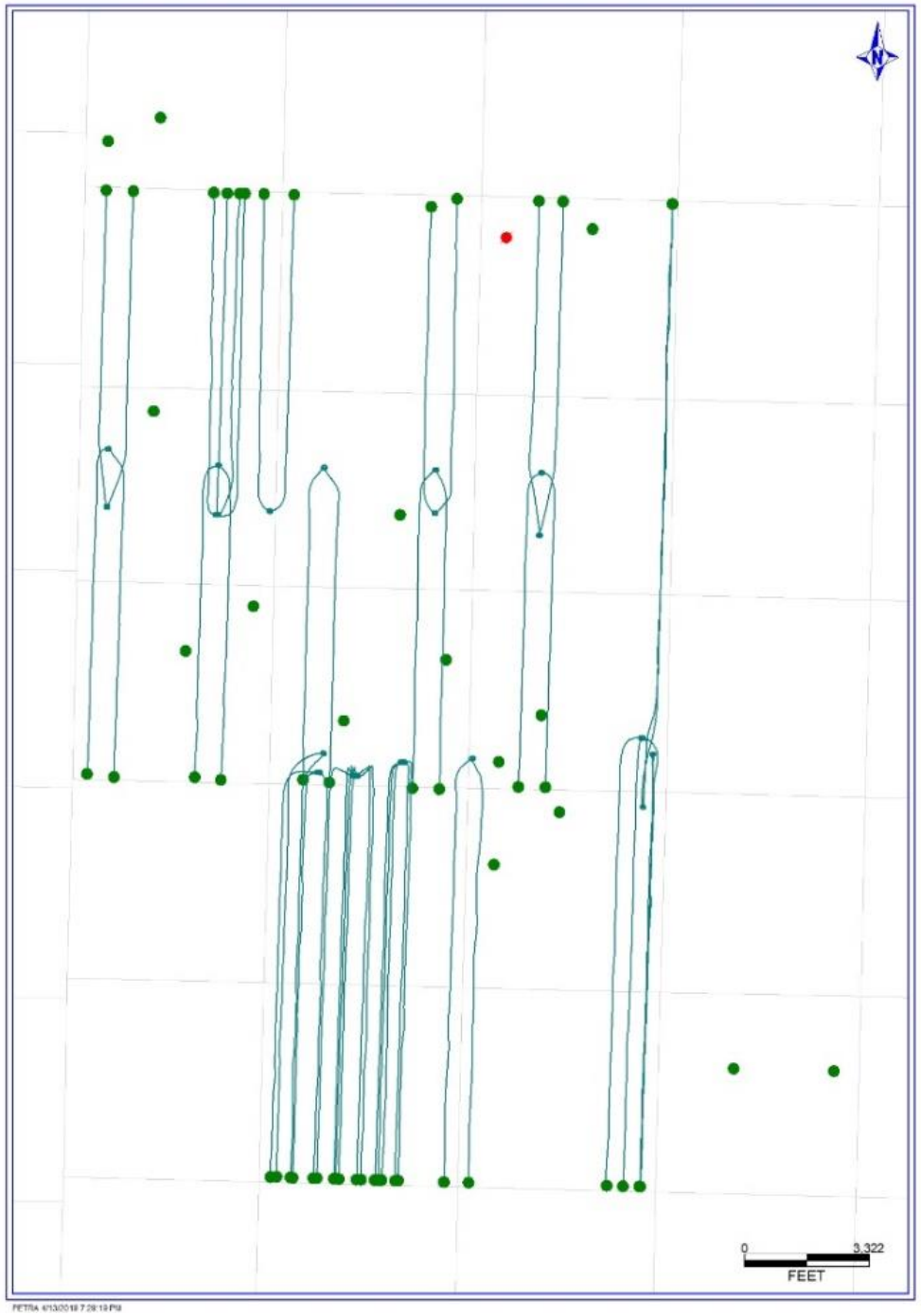
Study Area/Wells

- **Study area**
  - Midland basin, Reagan Co., TX
- **Study wells**
  - 47 horizontal wells
  - 16 vertical wells
  - 17 multi-well frac jobs



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FDI Interpretations

- Based on changes in oil rate, WOR, and GOR after an offset frac job
  - Must distinguish between flush production vs. FDIs

- Parent wells were reviewed if they were either…
  - Within one mile directly east or west of a frac job OR
  - Within a 500-ft radius of the heel or toe of a frac job

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FDI Interpretations

1. No FDI
2. Oil banking
3. Small water hit
4. Moderate water hit
5. Large water hit

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Parent-Child Spatial Relationships

Wellbore Geometry	Offset direction	Hz "buffer" well?	Configuration
Horizontal	Direct	False	A
		True	B
	Indirect	False	C
		True	D
	In–line	—	E
	Stacked	—	F
Vertical	Direct	False	G
		True	H
	Indirect	False	I
		True	J

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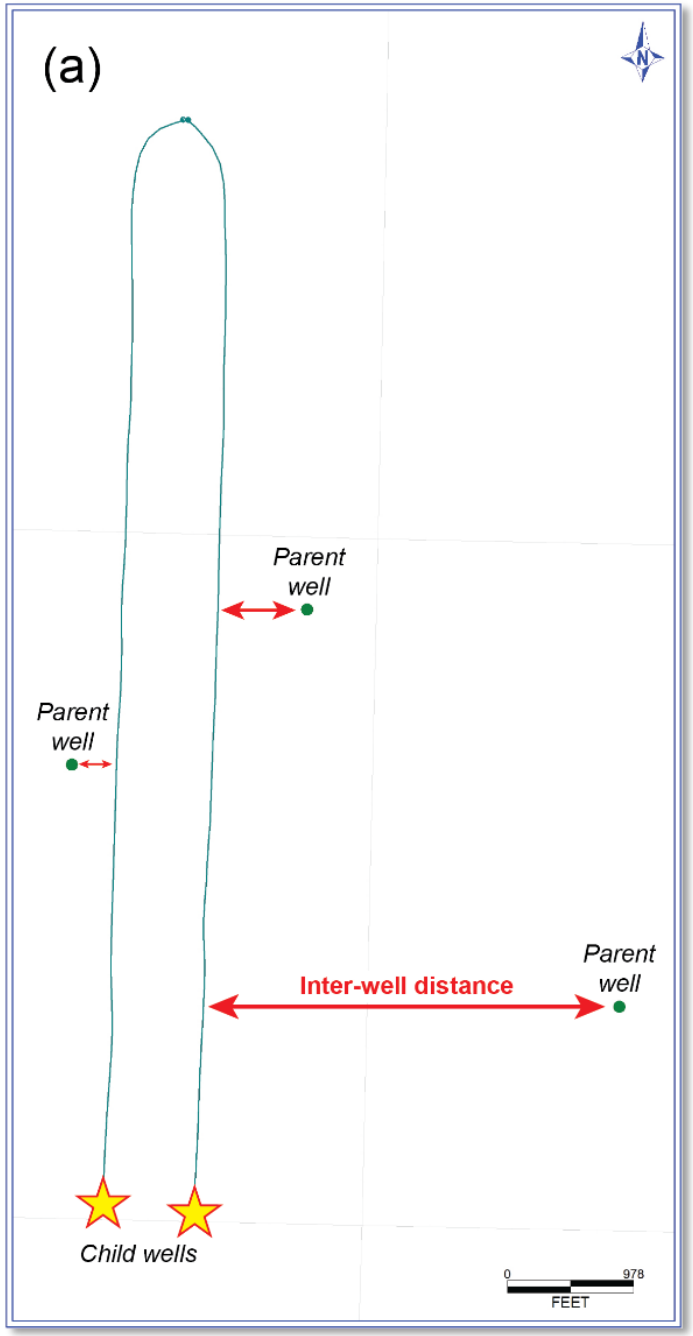
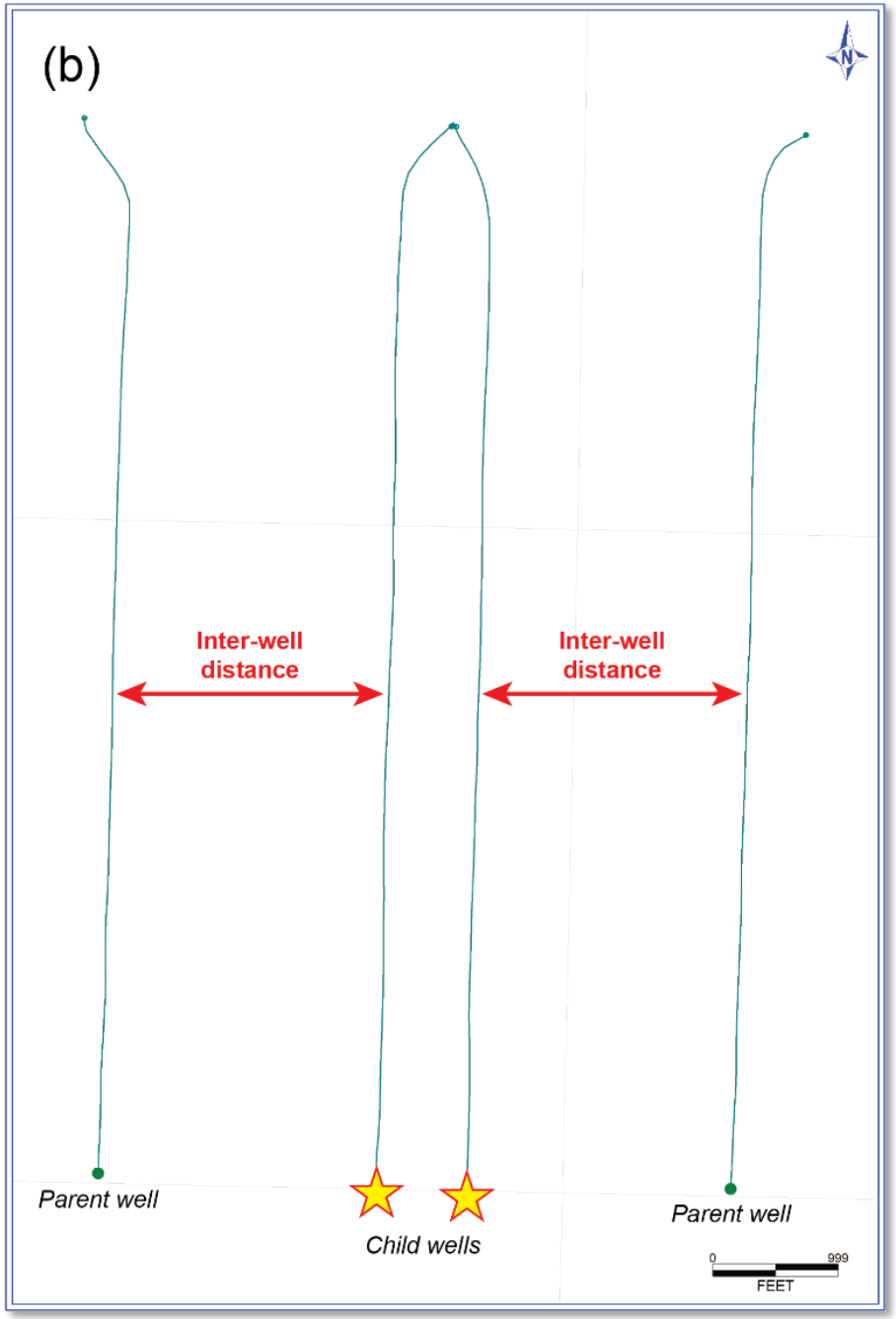
Direct Offsets (Vertical wells)





Direct Offsets (Horizontal wells)

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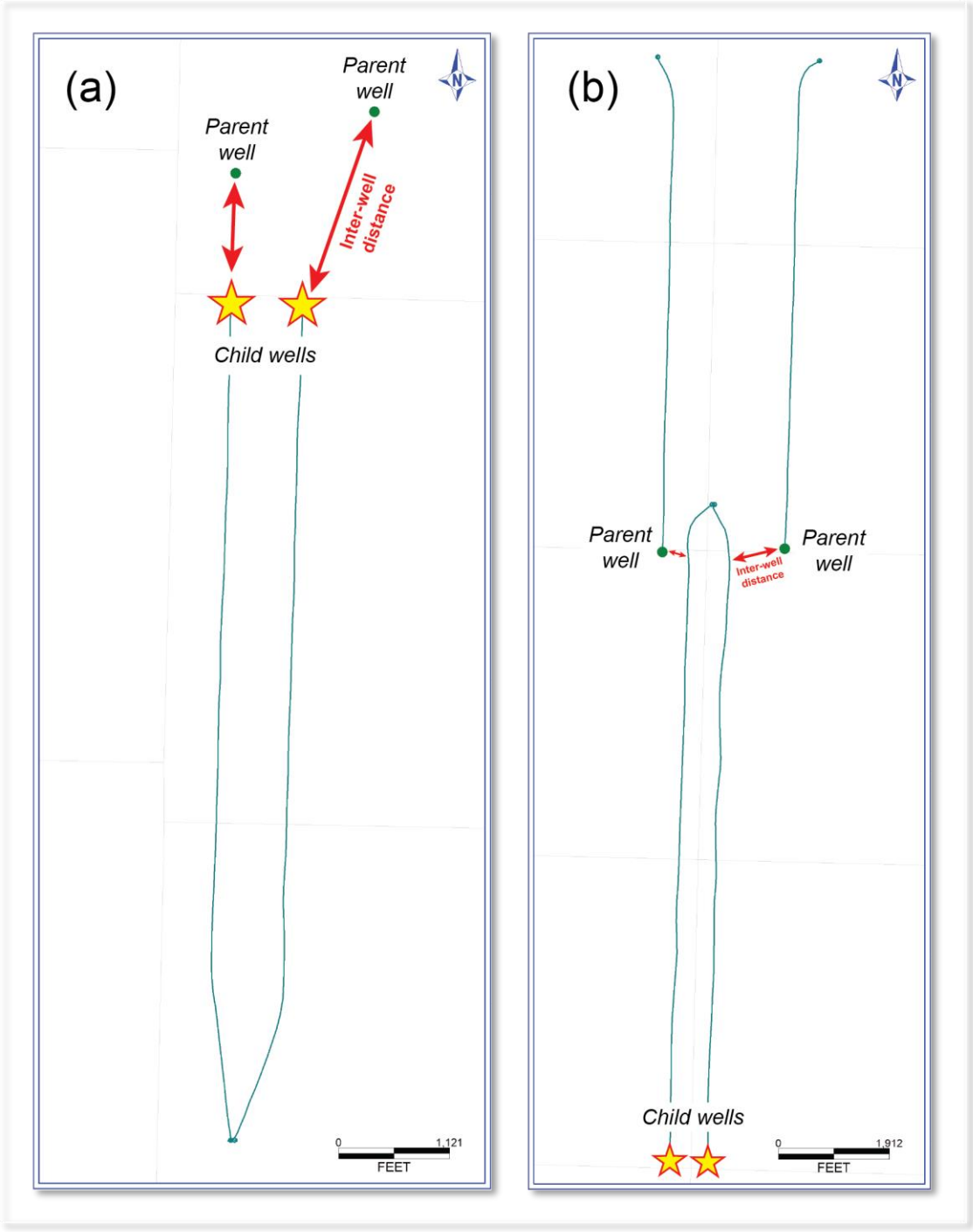
Indirect Offsets (Vertical wells)



Indirect Offsets (Horizontal wells)

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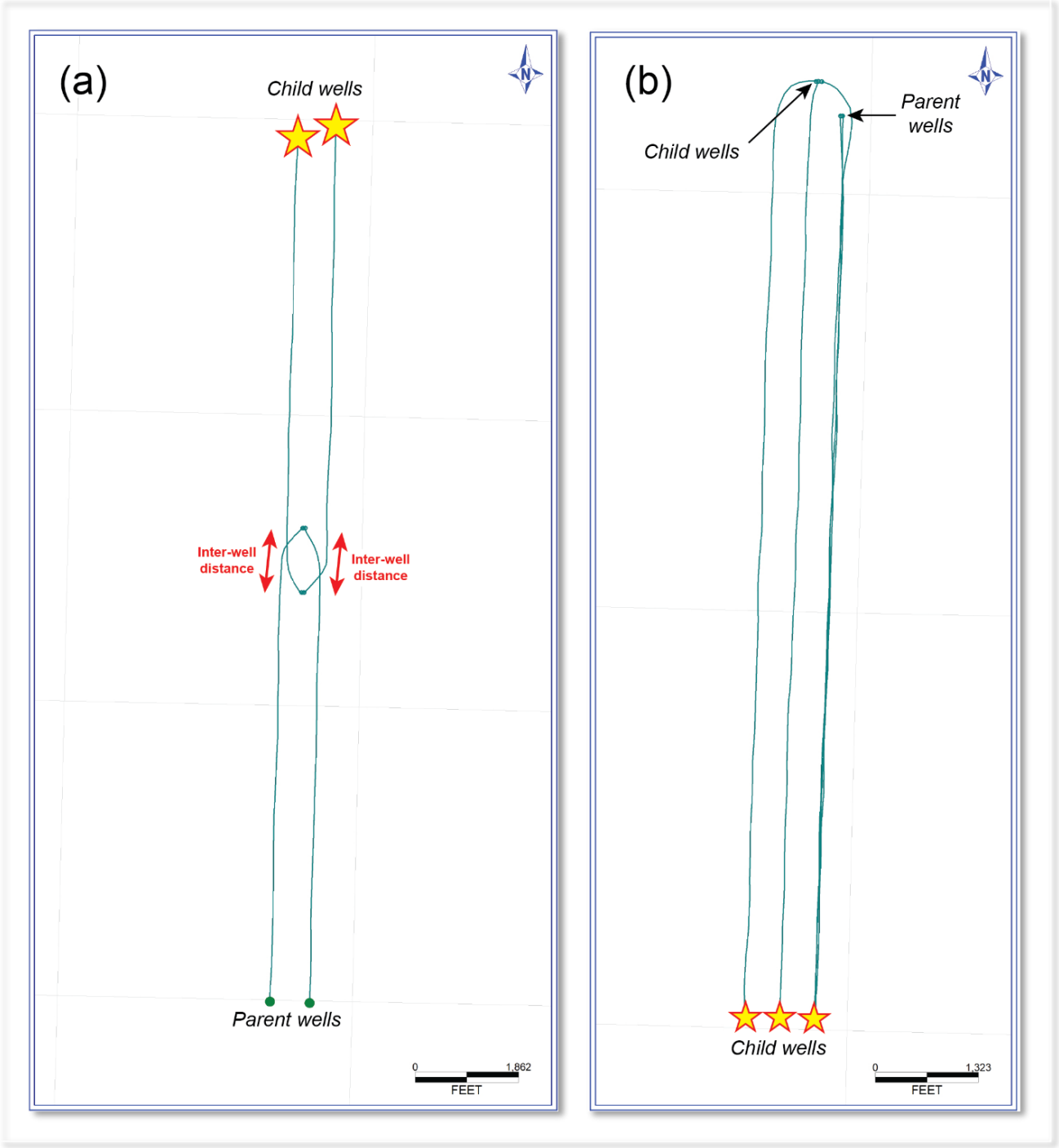
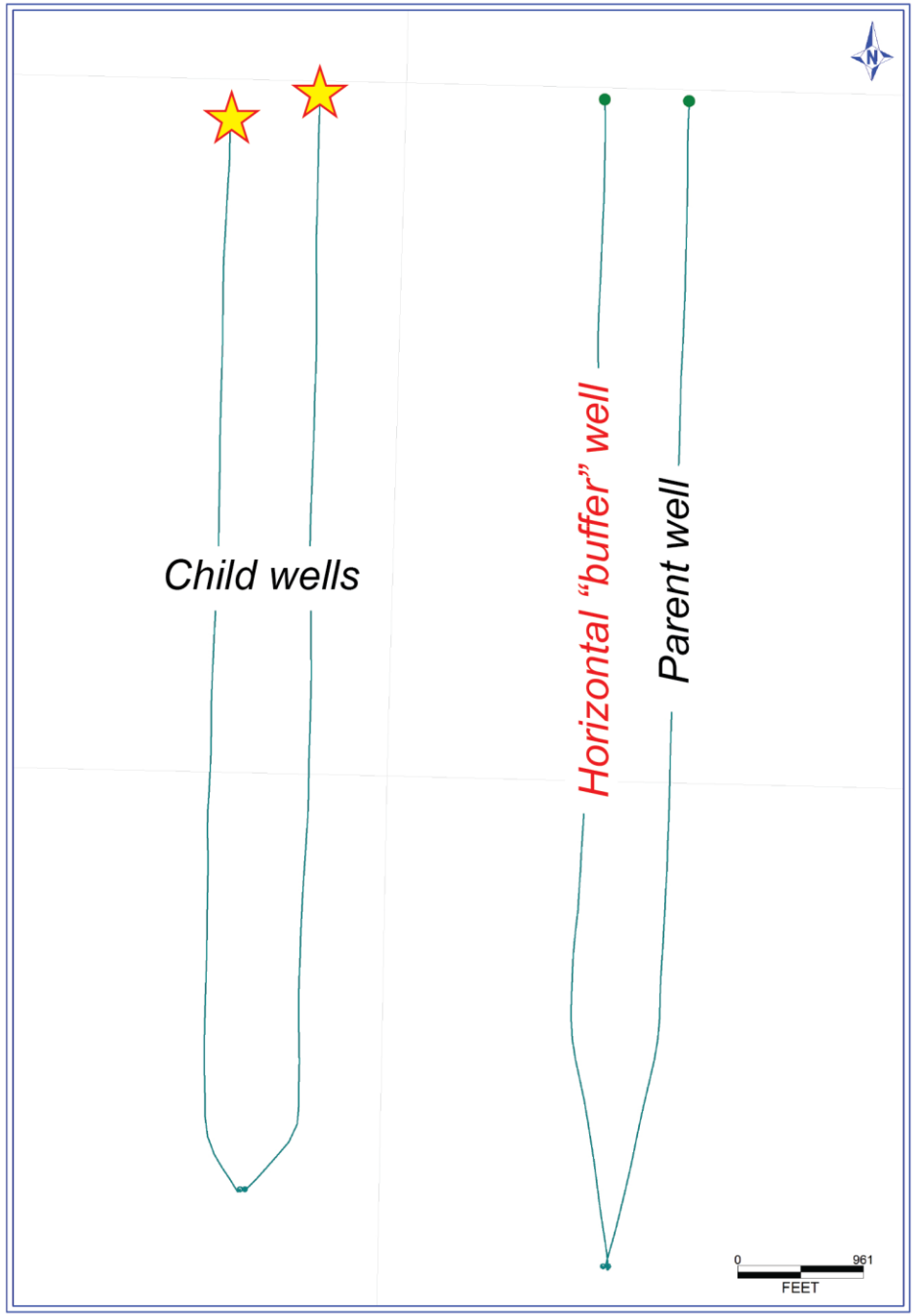
**Only applicable for horizontal wells

In-line Offsets



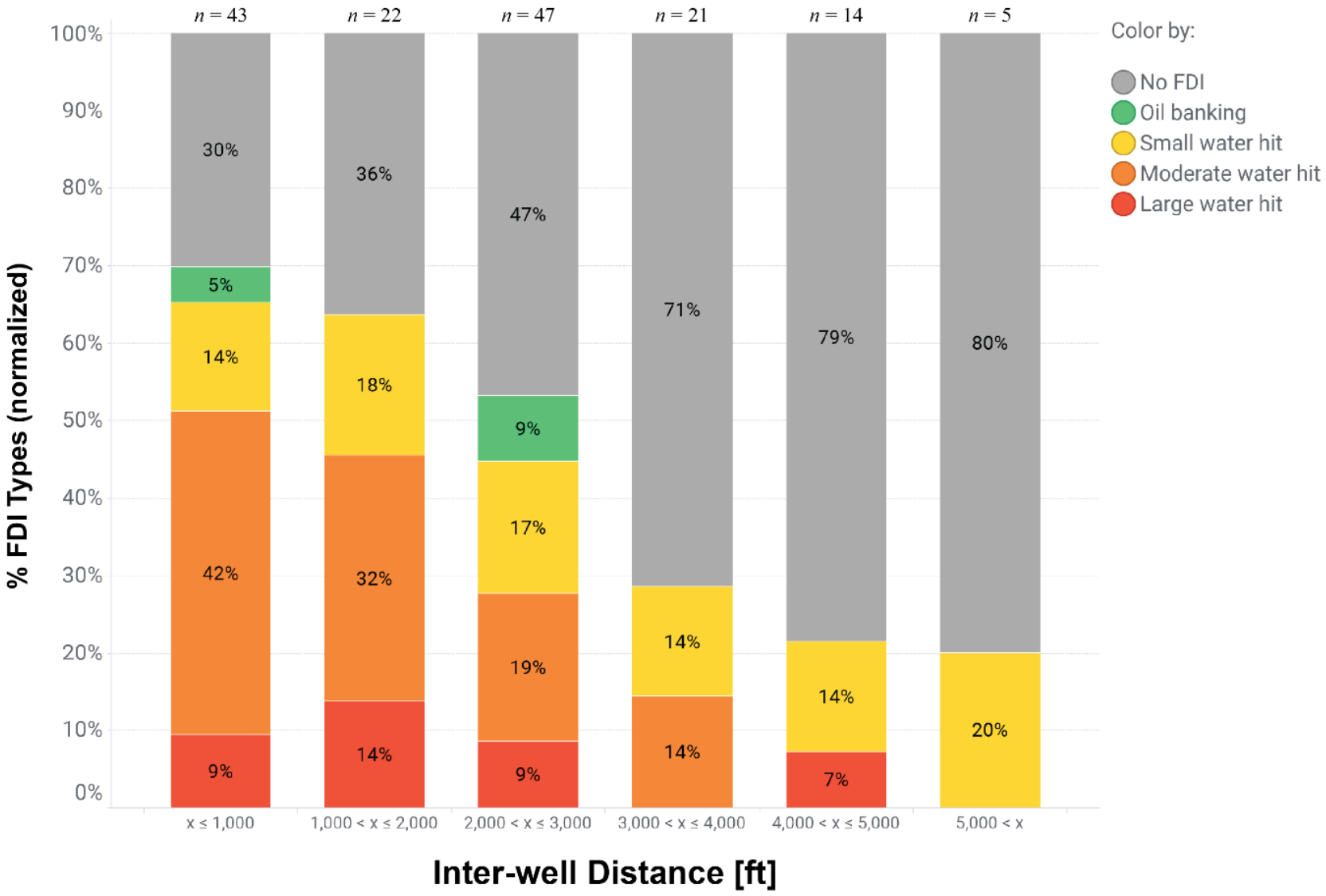
Stacked Offsets



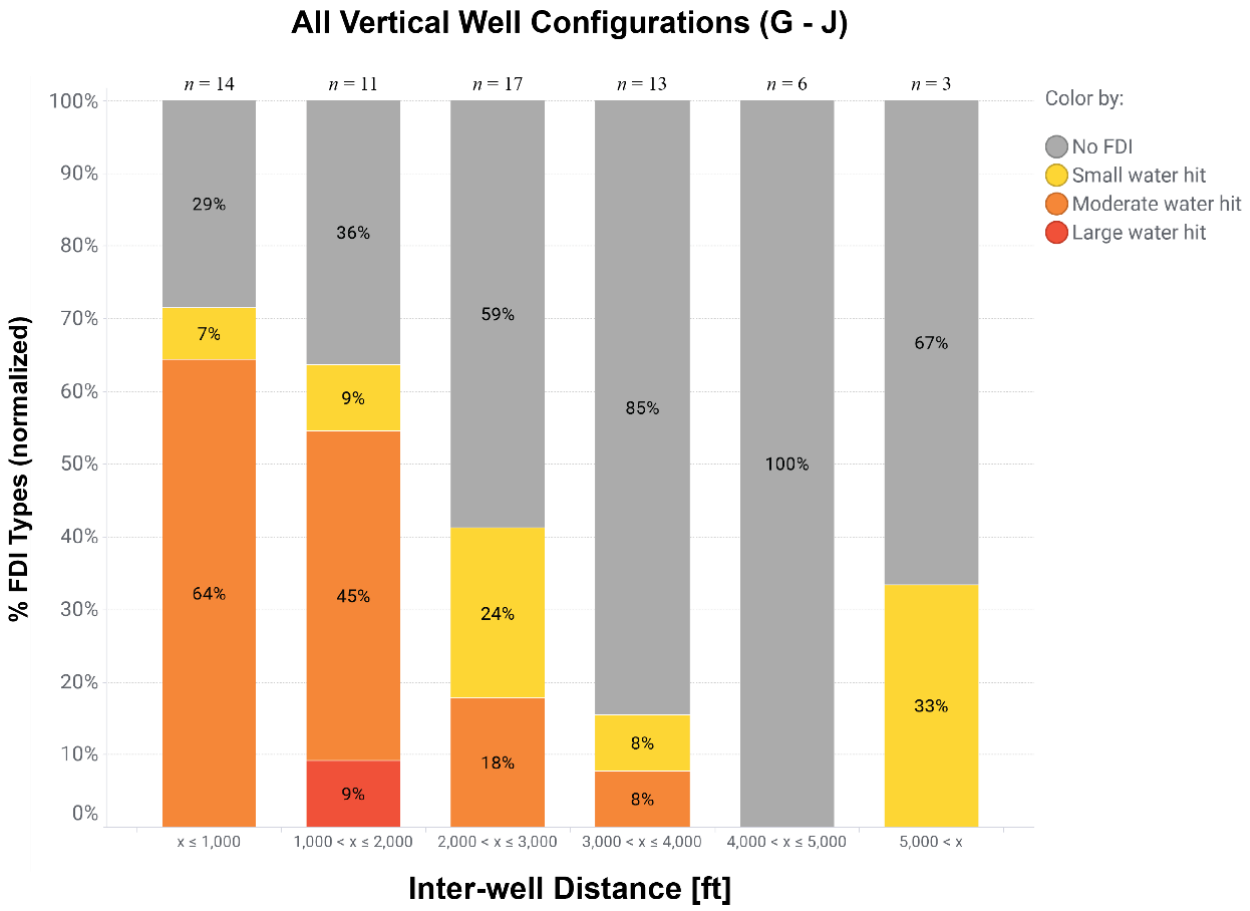
Horizontal "Buffer" Well

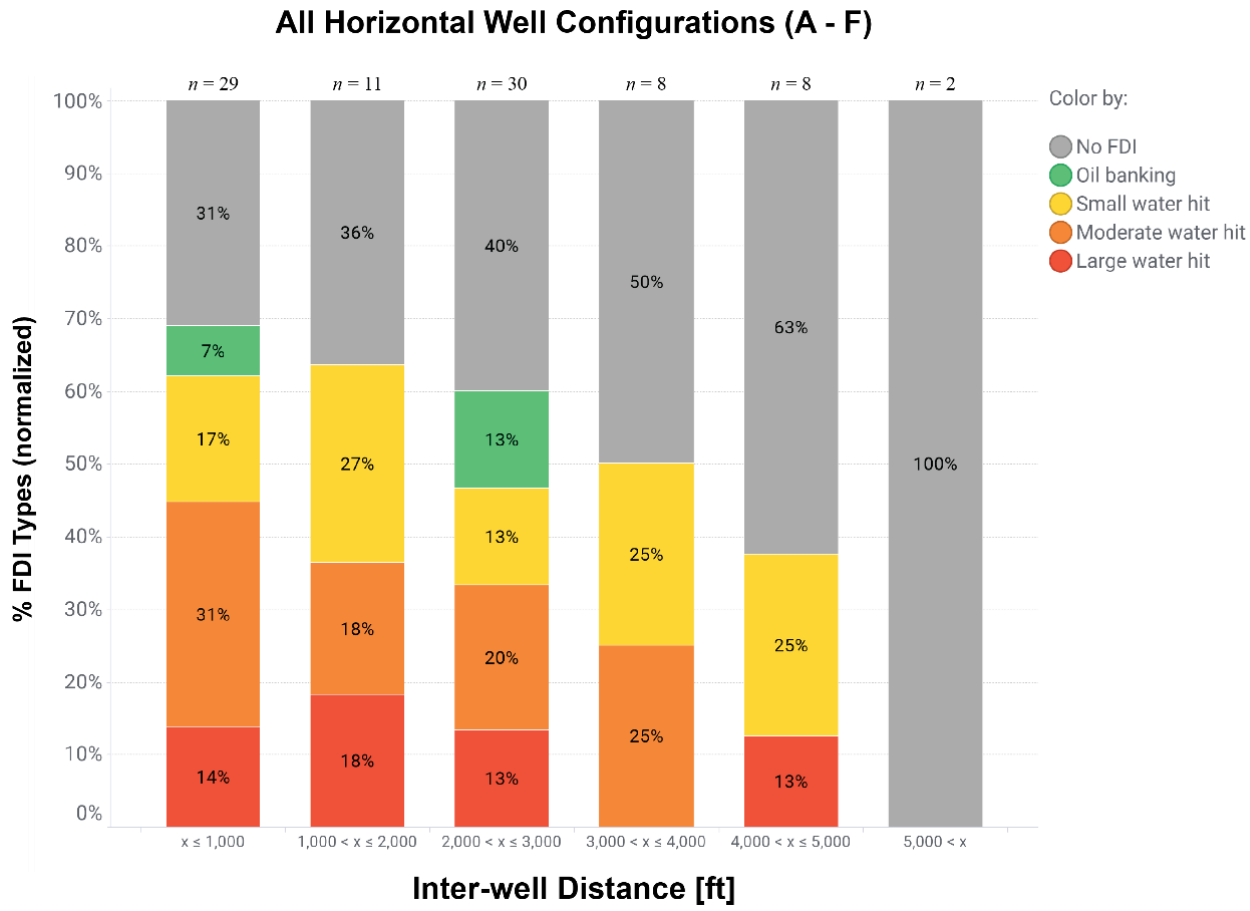
Results

All Configurations



Vertical vs. Horizontal Parent Wells





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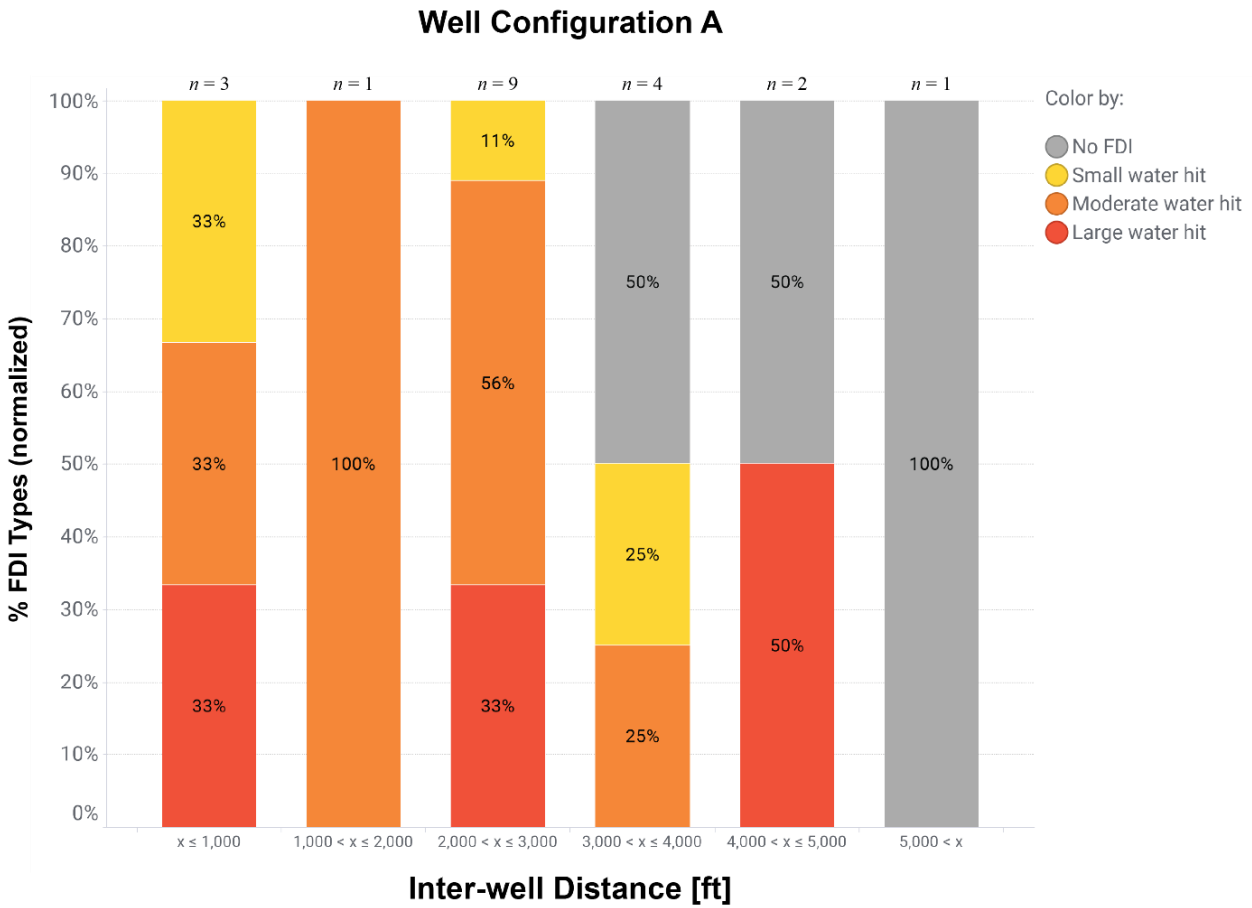
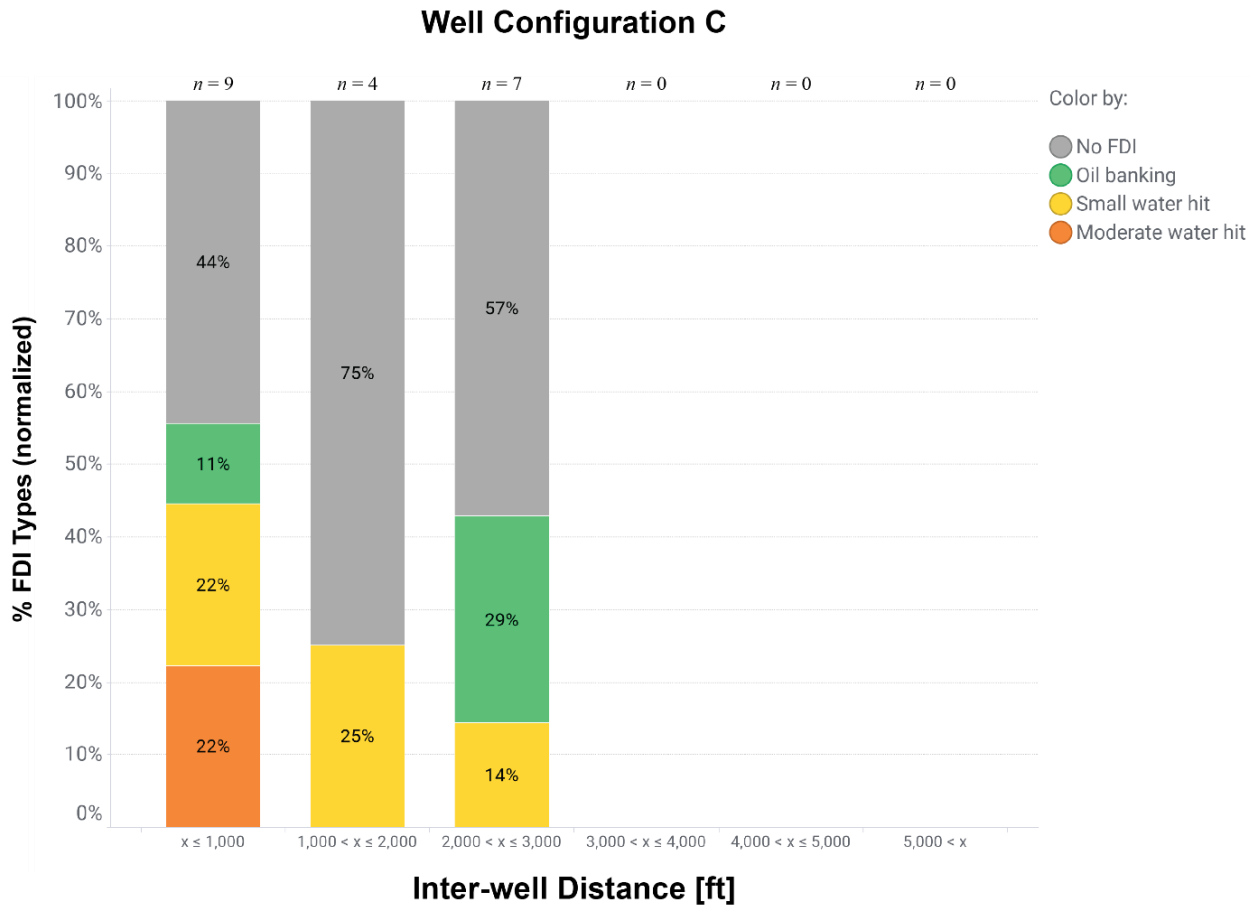
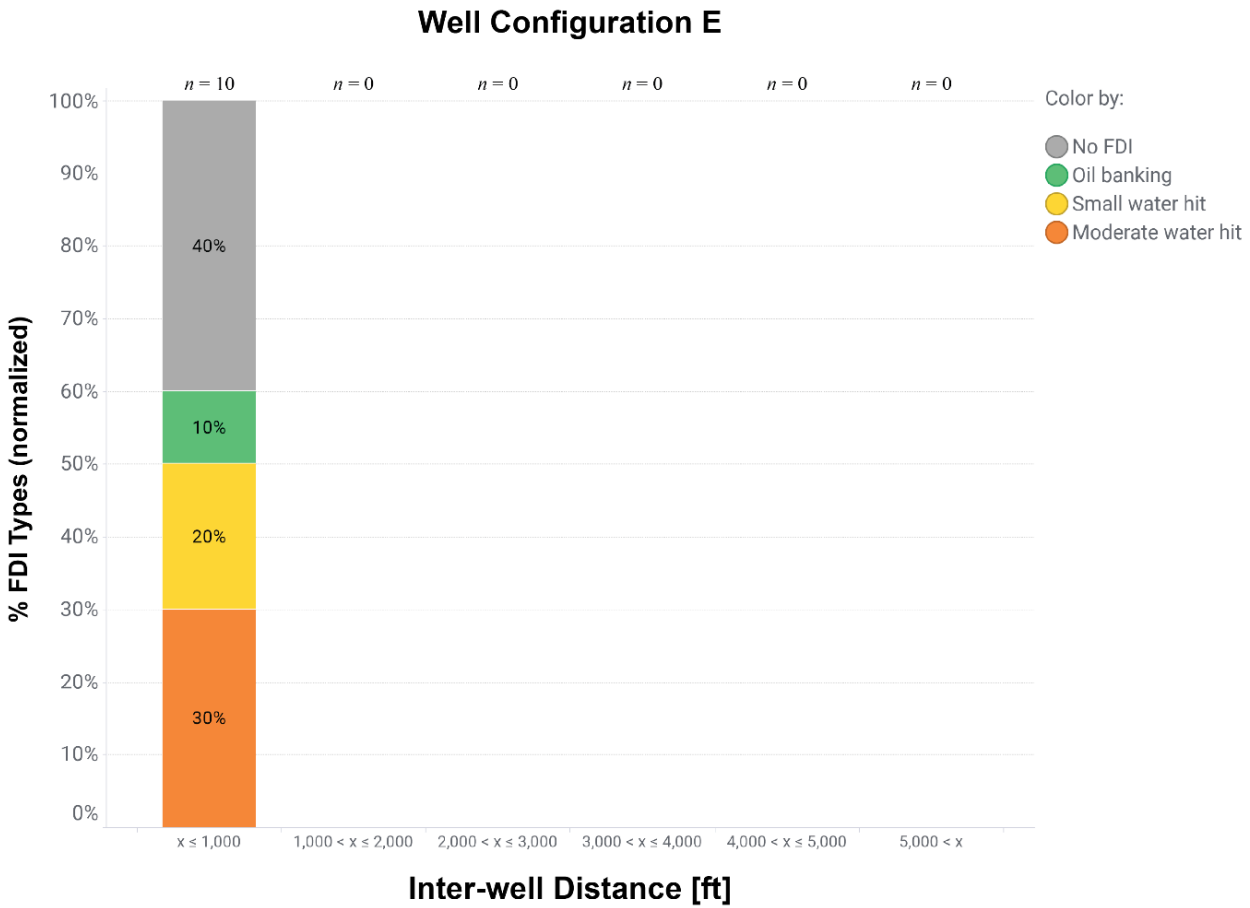
Direct vs. Indirect Offsets

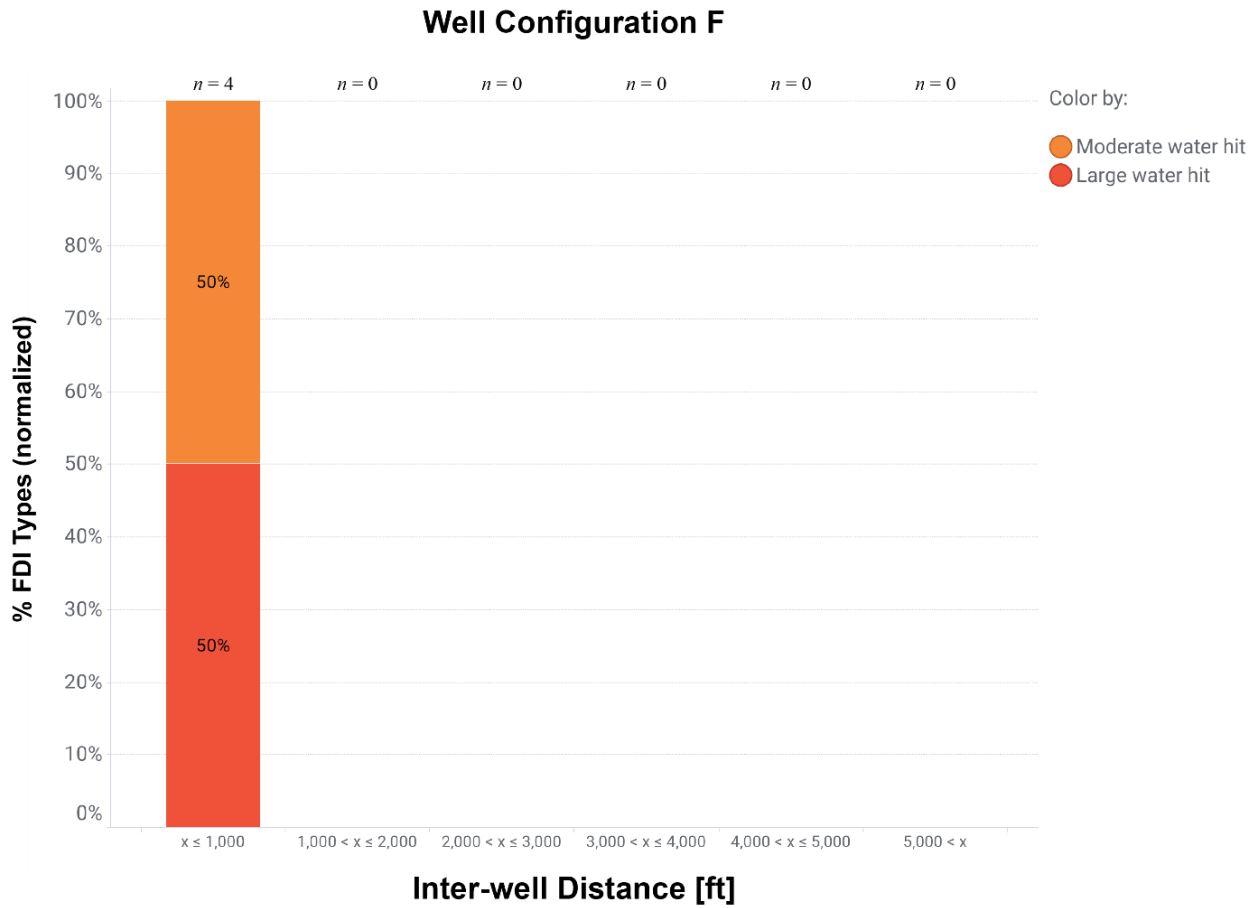




**Limited to parent wells with no "buffer" well

In-line vs. Stacked Offsets





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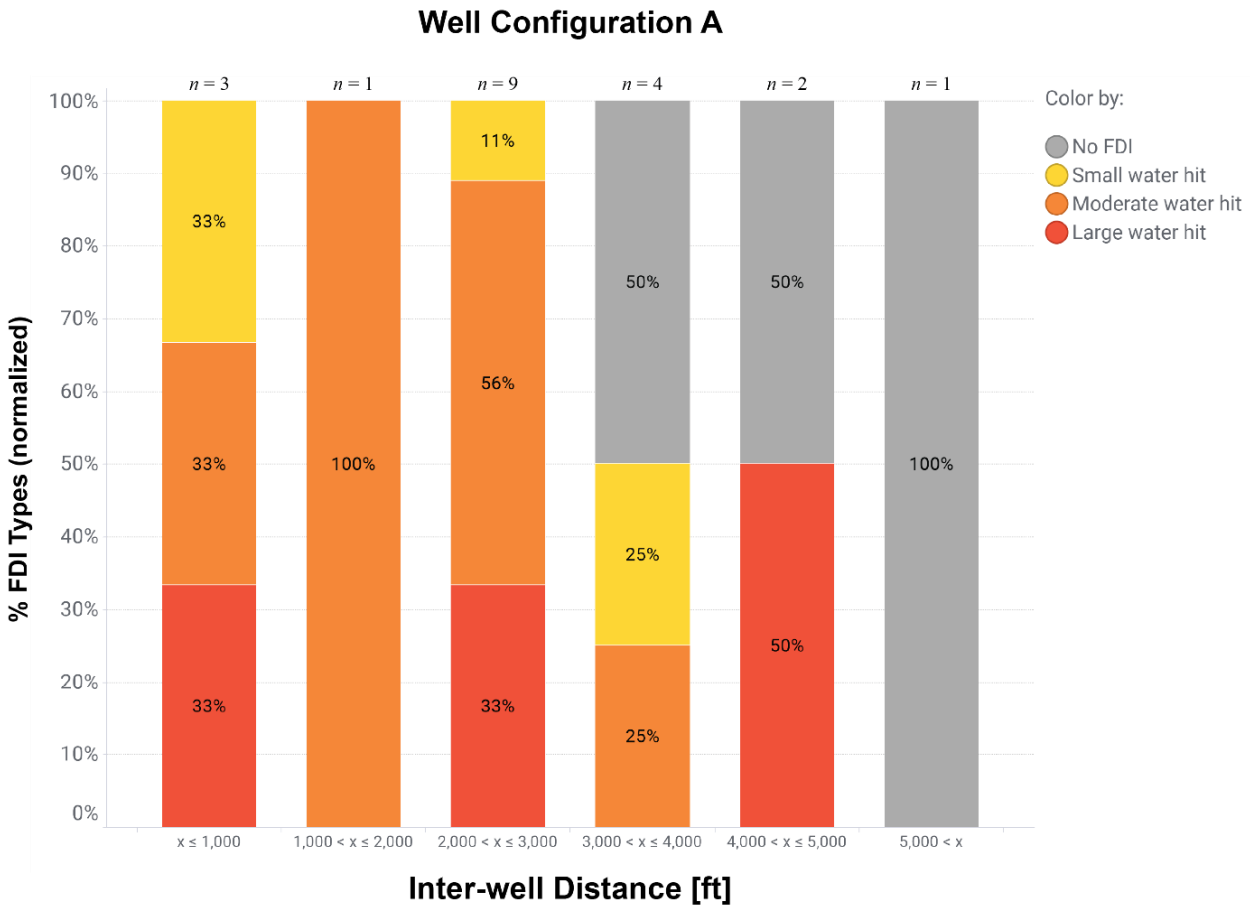
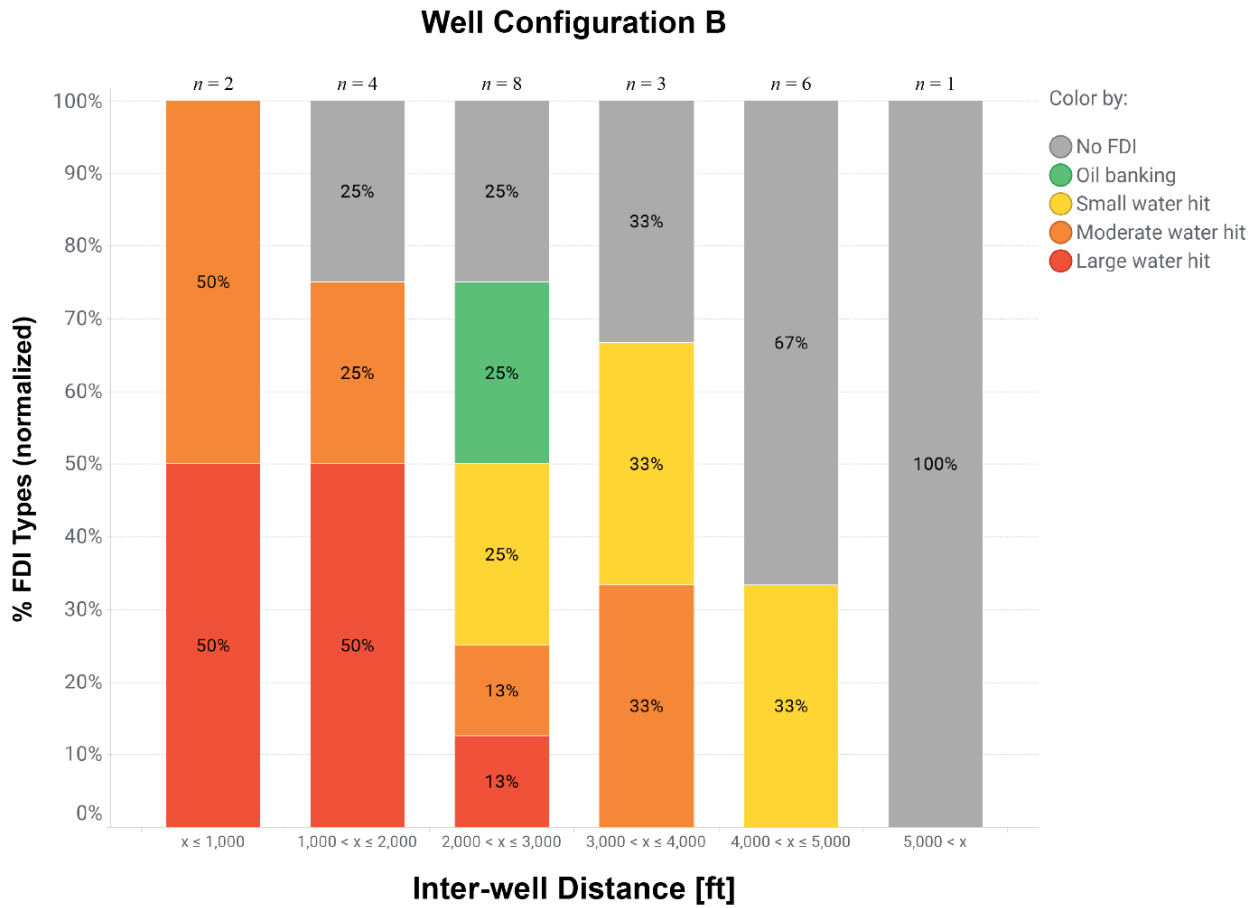
Direct Offsets Without vs. With "Buffer" Well





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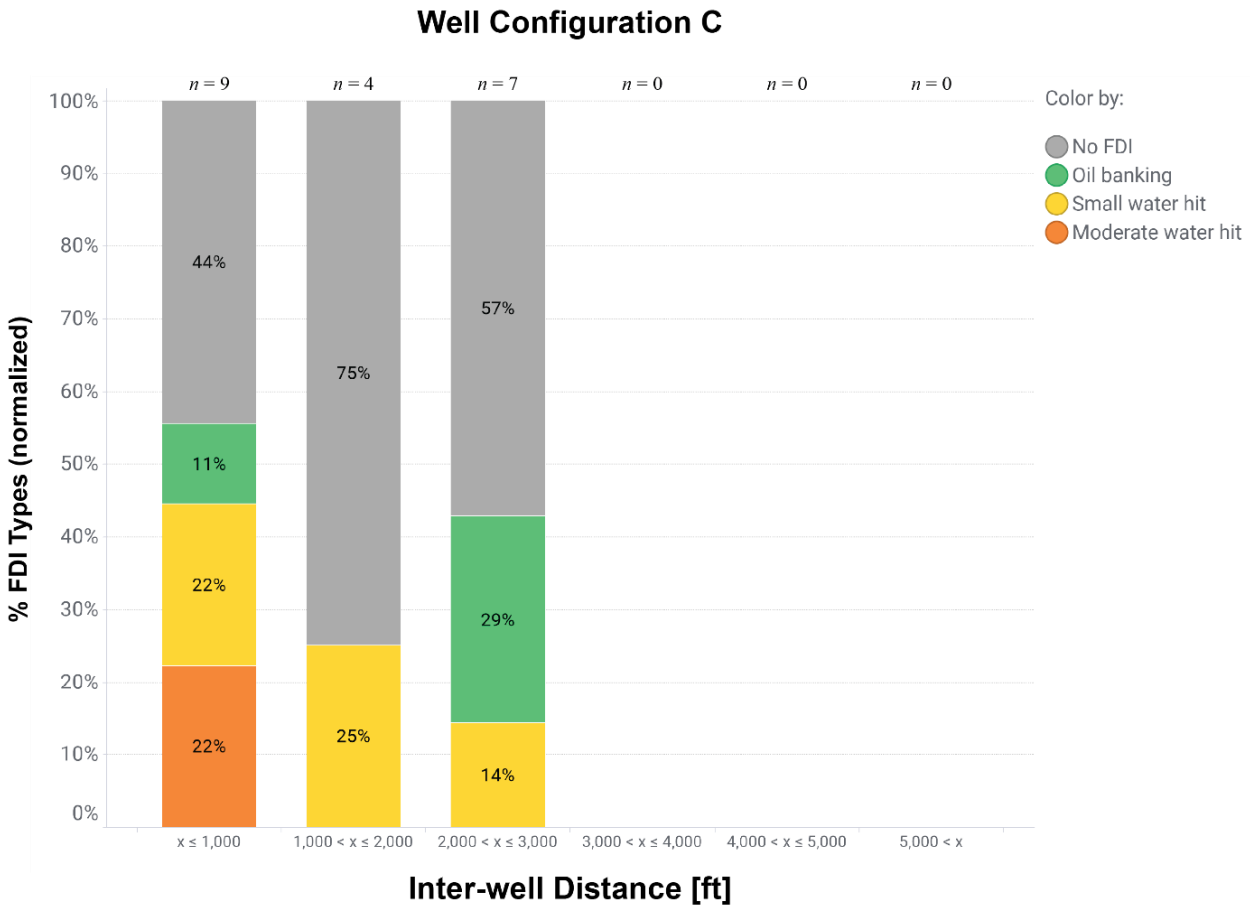
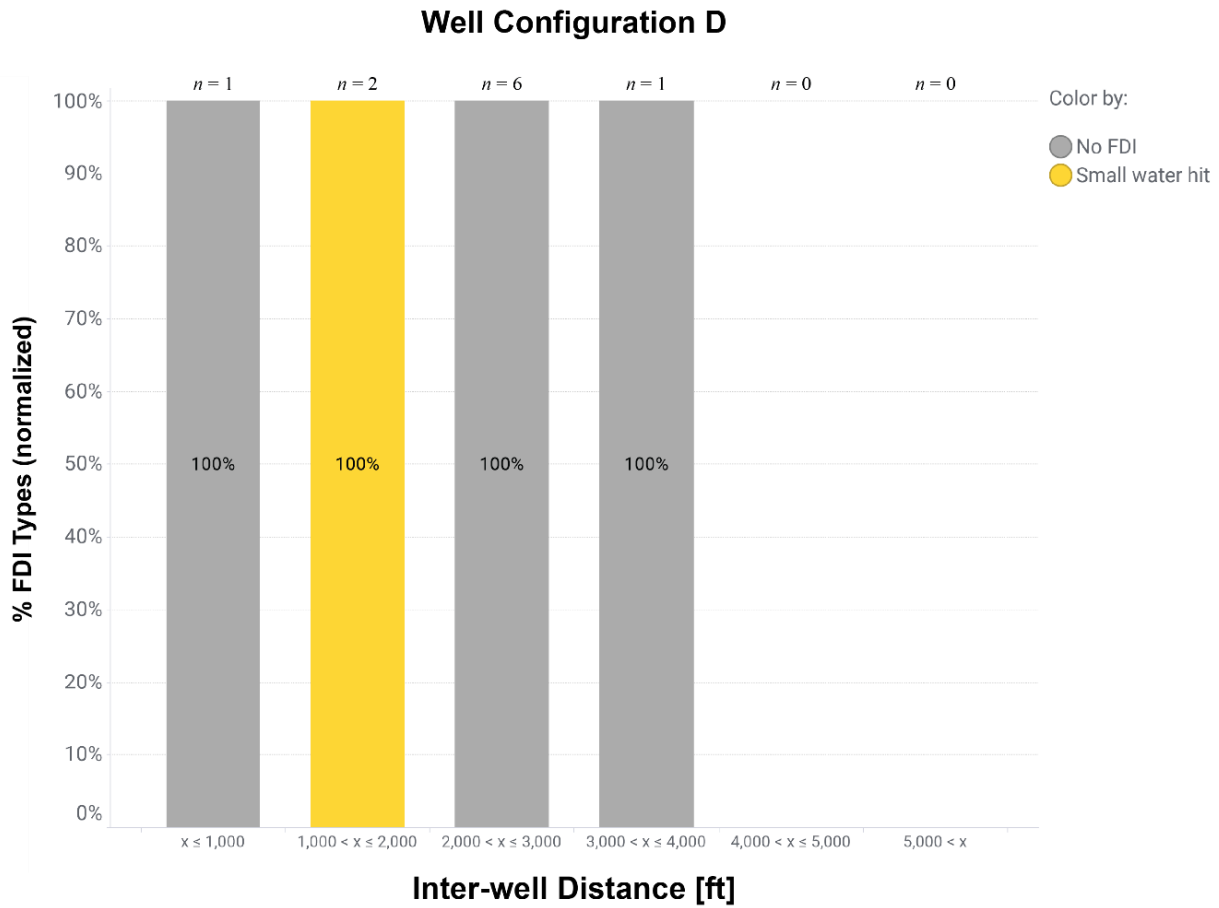
Indirect Offsets Without vs. With "Buffer" Well





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Major Takeaways (1/2)

- Horizontal wells receive FDIs more frequently, and with greater intensity, than vertical wells
- Stacked or direct offset parent wells receive FDIs more frequency and greater intensity
- FDI frequency and intensity is strongly correlated with inter-well distance
  - More strongly correlated for vertical wells

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Major Takeaways (2/2)

- “Buffer” wells significantly reduce FDI frequency and intensity
  - Albeit at the expense of the “buffer” well itself
- Oil banking is occasionally encountered in horizontal wells but not observed in vertical wells
  - EDIT: Oil banking has been observed in vertical wells in other areas
- Most parent wells received either (a) small/moderate water hits or (b) no FDI at all

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Discussion

Discussion (1/2)

- End-member results not surprising
  - Horizontal vs. vertical wells
  - Direct vs. Indirect vs. In-line vs. Stacked offsets
  - “Buffer” well present vs. absent

- However, the cumulative effect of each layer was more marked than anticipated

Discussion (2/2)

- The efficacy of “buffer” wells was not foreseen but aligns with field experience

- Positive FDIs were not recognized previously despite its occurrence in other unconventional plays
  - See Miller et al. (2016), Pankaj (2018)

- FDIs are a nuisance but do not appear to pose a major risk

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Conclusions

Conclusions (1/2)

- FDI frequency/intensity are a strong function of:
    1. Wellbore geometry
    2. Offset direction between the parent/child well
    3. Presence/absence of a “buffer” well
    4. Distance

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Conclusions (2/2)

- FDIs are not a significant risk to oil production in parent wells in SE Midland basin

- Production effects are:
  - Usually limited to increased water production and lower GORs
  - Usually temporary (weeks to months)

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Questions?

References

References

- Daneshy, A. and King, G. E. 2019. Frac-Driven Interaction (FDI) Between Horizontal Wells: Causes, Consequences and Mitigation Techniques. Hydraulic Fracturing Journal 5 (4): 4–30.
- King, G.E., Rainbolt, M.F., and Swanson, C. 2017. Frac hit induced production losses: Evaluating root causes, damage location, possible prevention methods and success of remedial treatments. Presented at the SPE Annual Technical Conference and Exhibition, San Antonio, Texas, USA, 9 – 11 October. SPE-187192-MS. https://doi.org/10.2118/187192-MS.
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- Pankaj, P. 2018. Decoding positives or negatives of fracture-hits: A geomechanical investigation of fracture-hits and its implications for well productivity and integrity. Presented at the SPE/AAPG/SEG Unconventional Resources Technology Conference, Houston, Texas, USA, 23 – 25 July. URTEC-2876100-MS. https://www.onepetro.org/conference-paper/URTEC-2876100-MS.