

The background of the slide is a dense, repeating pattern of white line-art icons on a dark background. The icons represent various oilfield and industrial equipment, including pumpjacks, drilling rigs, valves, pipes, wrenches, hard hats, and safety glasses. A map of Texas is subtly visible in the center of the background pattern.

Produced Water Management Update for the STACK Play

GWPC Annual UIC Conference - February 26, 2019 - Fort Worth, TX

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Introduction

■ Timeline of resource developments

- Just now getting into “the top of the 4th inning”
- Moved from “can this work?” to “how to make this work better”

□ About 1,000 rigs currently drilling horizontal wells onshore USA

- ~ 600 in Permian; 500 in Texas and 100 in New Mexico
- ~ 150 rigs in Oklahoma; mostly SCOOP and STACK
- ~ 75% of the rigs are in just two plays

■ For the role of water in resource plays, some things are clear

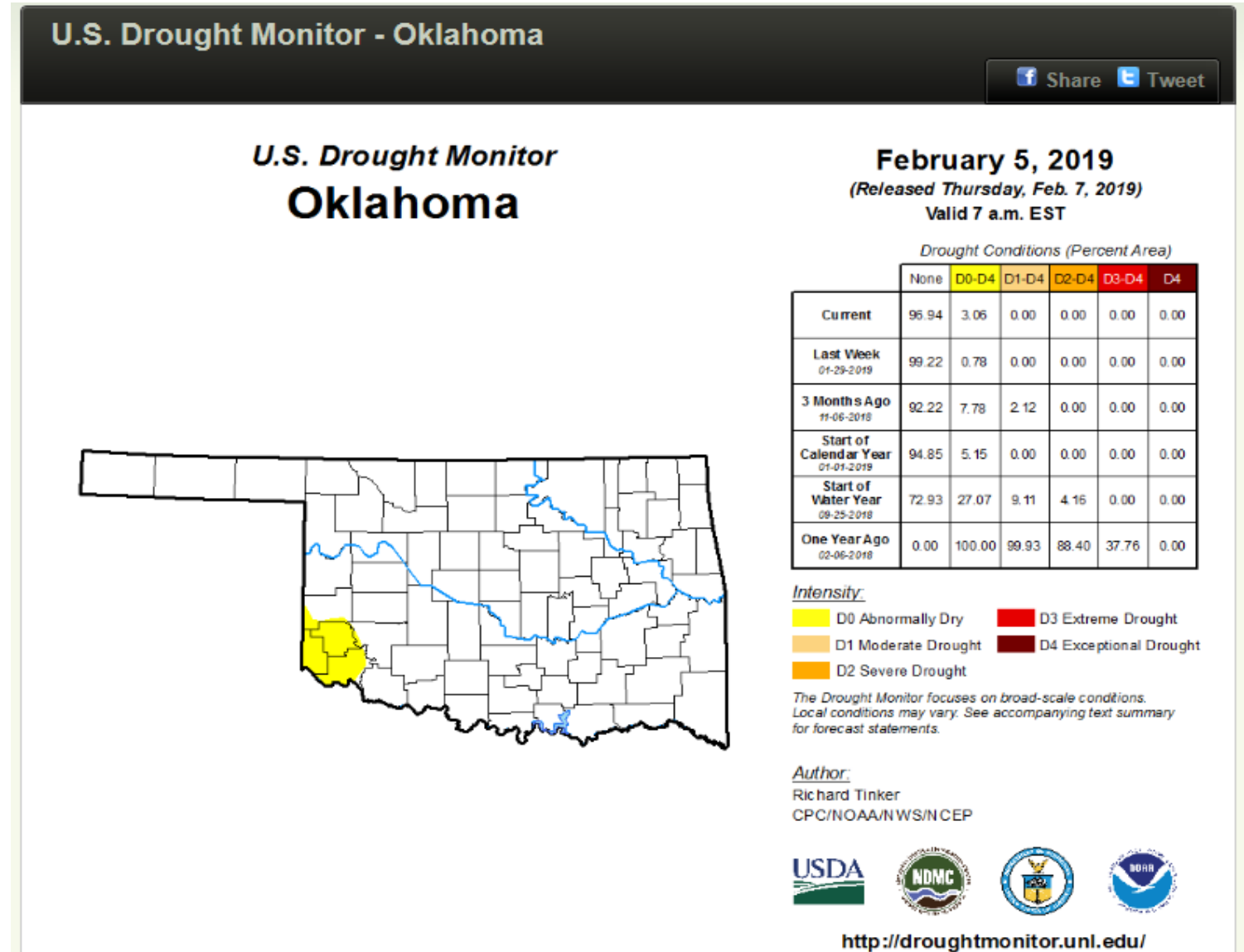
- Sustainable water management has to be commercially viable
- Wider range of water quality is being used and in increasing amounts
- Pressure pumping companies innovate chemistries at customers demand

■ How we operate today does not necessarily predict tomorrow

What Doesn't Concern Us (right now in Oklahoma) and Why

Freshwater supply for today's ops

http://climate.ok.gov/index.php/climate/map/u.s._drought_monitor_oklahoma/oklahoma_south-central_u.s



What Doesn't Interest Us (right now in Oklahoma) and Why

Third-party midstreams or industry consortiums for shared water infrastructure



What Matters Most, Everywhere—Understanding Your Rock



What Concerns Us Right Now—Consistent Water Quality

Parameter	Units	Fresh	Raw Produced	Treated
COD	mg/l	100	3,500	1,500
Calcium	mg/l	150	1,500	1,500
Barium	mg/l	30	0.8	0.8
Boron	mg/l	1.0	50	50
Iron, Total	mg/l	0.5	5.0	0
Chloride	mg/l	650	25,000	25,000
Bicarbonate	mg/l	125	800	400
Sulfate	mg/l	600	700	650
TDS	mg/l	2200	40,000	40,000
pH	standard units	8.2	7.0	7.2
Oil & Grease	mg/l	0	250	0

Not all listed

Average in

Average out

Target Specs*

***Translation:**

Within our treating facility capability,

For our current HF fluid designs,

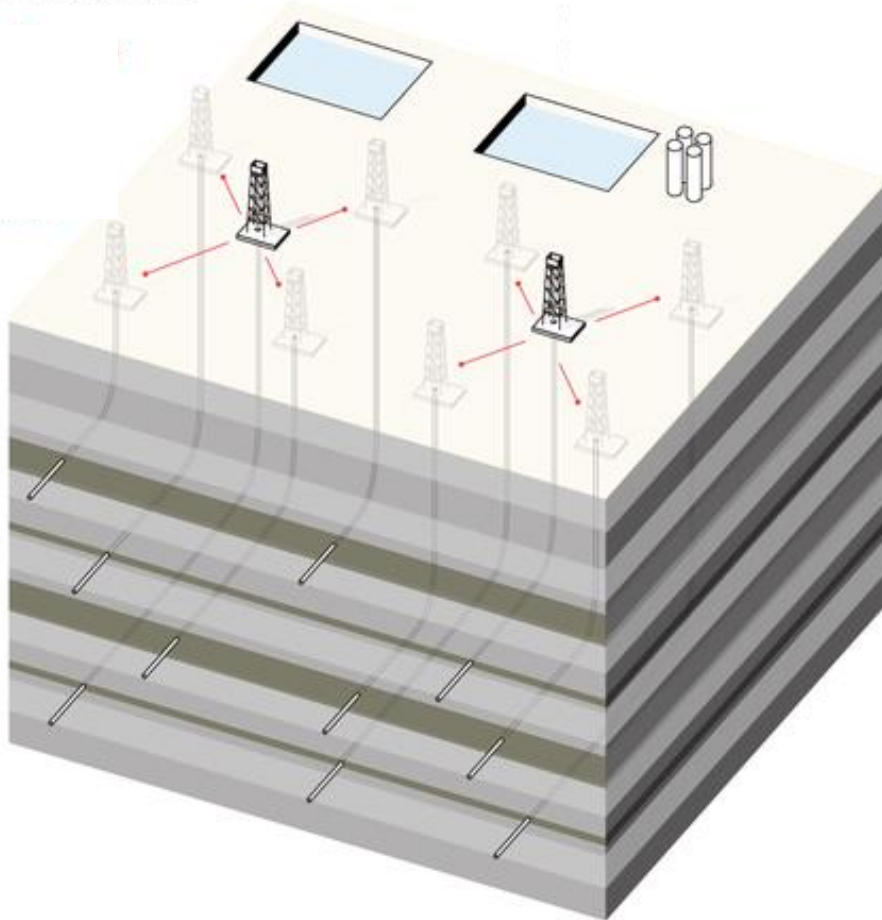
With our current HF service providers,

Within our current cost structure,

Until we change our minds!

What Really Concerns Us Right Now—Optimum Development

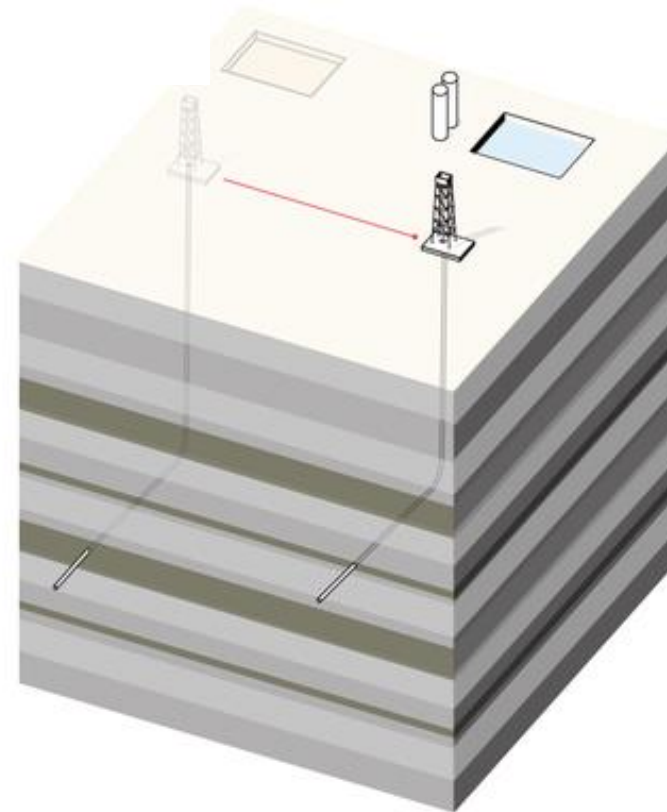
Cube development



Latest strategy is to drill development wells in a “block,” “cube” or “tank,” then completion operations follow

Sources: Encana, Bloomberg research

Traditional well pad



Traditional strategy starts with a leasehold or evaluation well (parent) with subsequent development wells (children) drilled a year or more later

Bloomberg

What This Development Strategy Looks Like Pre-Drilling



What This Development Strategy Looks Like While Drilling



Typical 10,000' Lateral Within a Drilling Unit or "DSU"



What This Development Strategy Looks Like While Completing

Sand

Water

Schedule

Oil

Gas

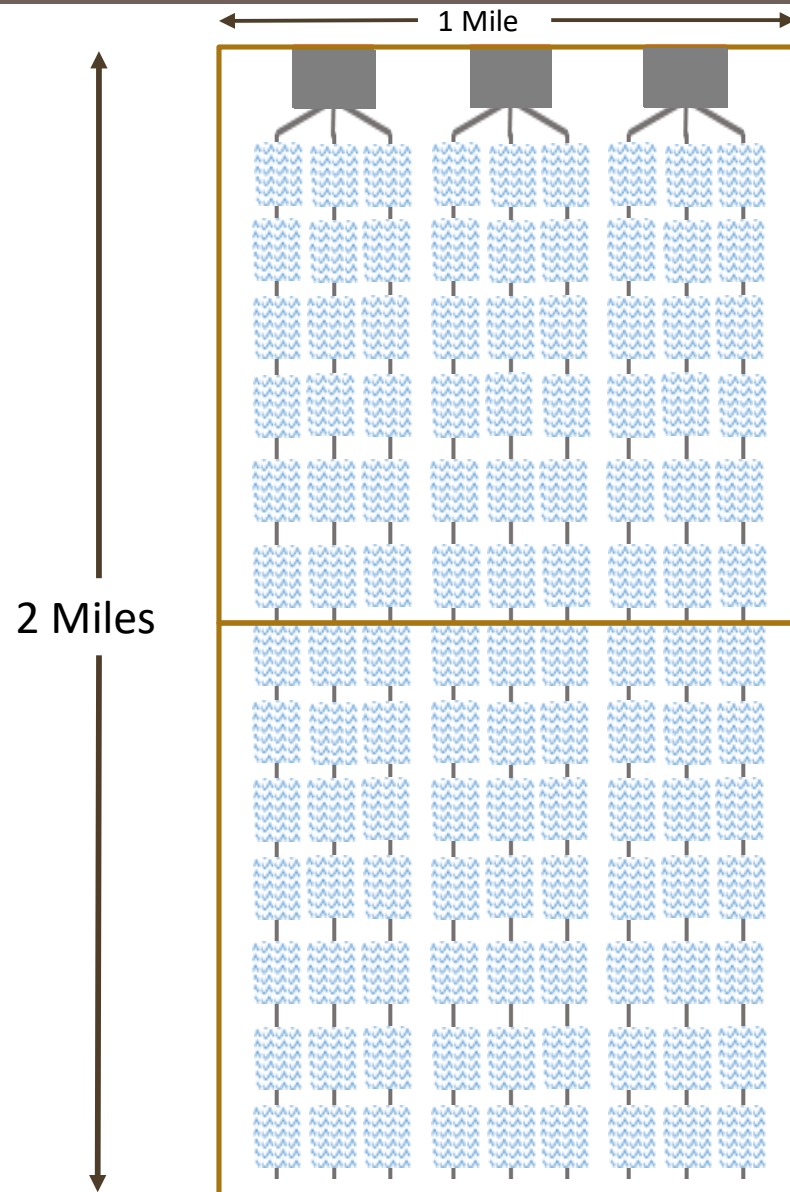
Water



Safely and Without Spills

Within Commercial Boundaries

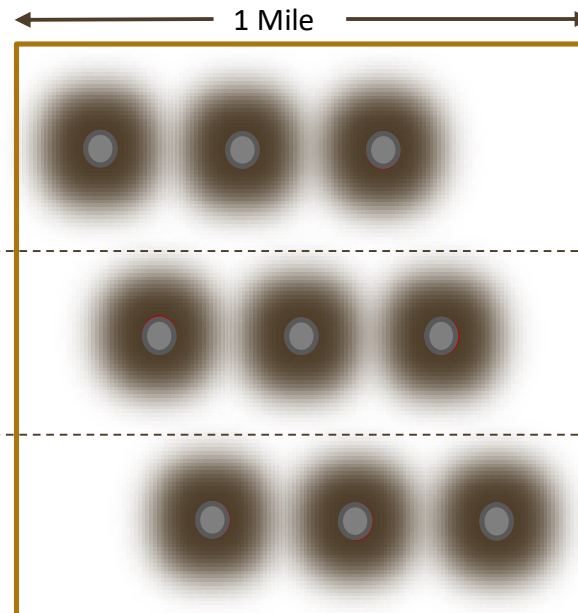
Water Delivery Tied to Development Strategy—One Pad at a Time



Water per 10,000' lateral		
given gal / ft	calc'ed bbl / ft	calc'ed bbls/10,000'
1,900	45.24	452,381

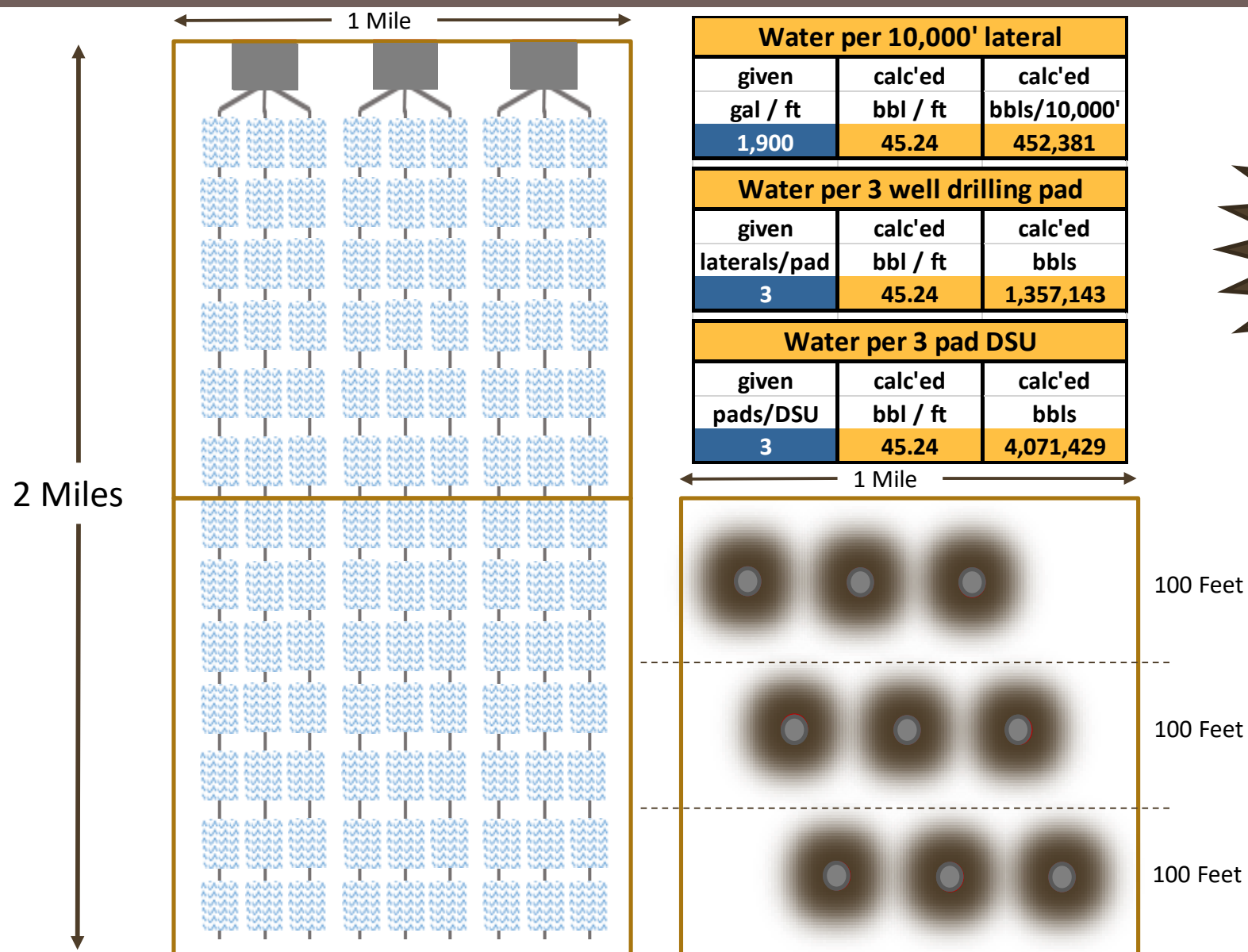
Water per 3 well drilling pad		
given laterals/pad	calc'ed bbl / ft	calc'ed bbls
3	45.24	1,357,143

Water per 3 pad DSU		
given pads/DSU	calc'ed bbl / ft	calc'ed bbls
3	45.24	4,071,429



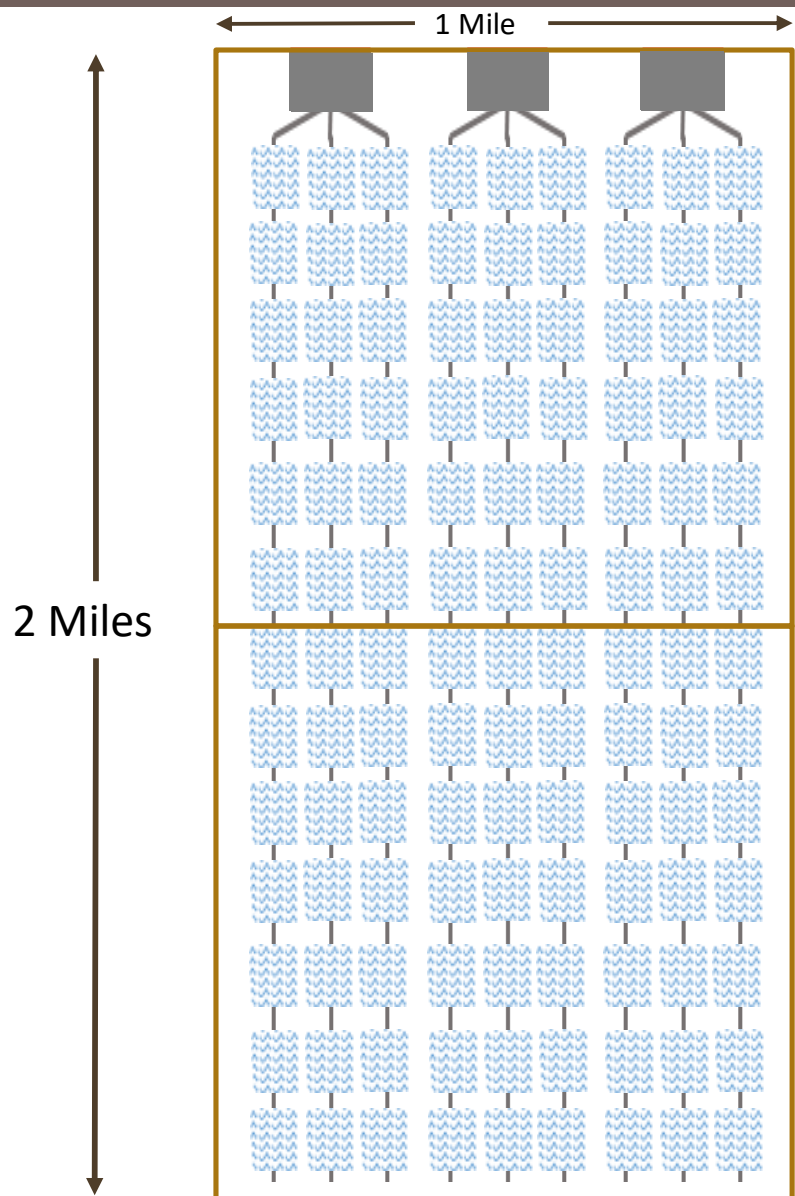
4 mm bbls
needed over
an ~ 9-week
period

Water Delivery Tied to Development Strategy: Outside—Inside



4 mm bbls
needed over
an ~ 6 week
period

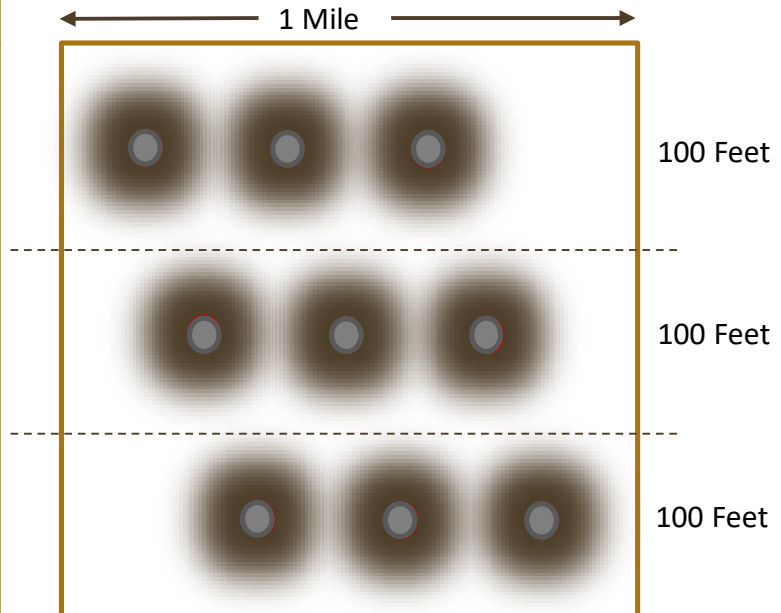
Water Delivery Tied to Development Strategy: All Pads at Once



Water per 10,000' lateral		
given gal / ft	calc'ed bbl / ft	calc'ed bbls/10,000'
1,900	45.24	452,381

Water per 3 well drilling pad		
given laterals/pad	calc'ed bbl / ft	calc'ed bbls
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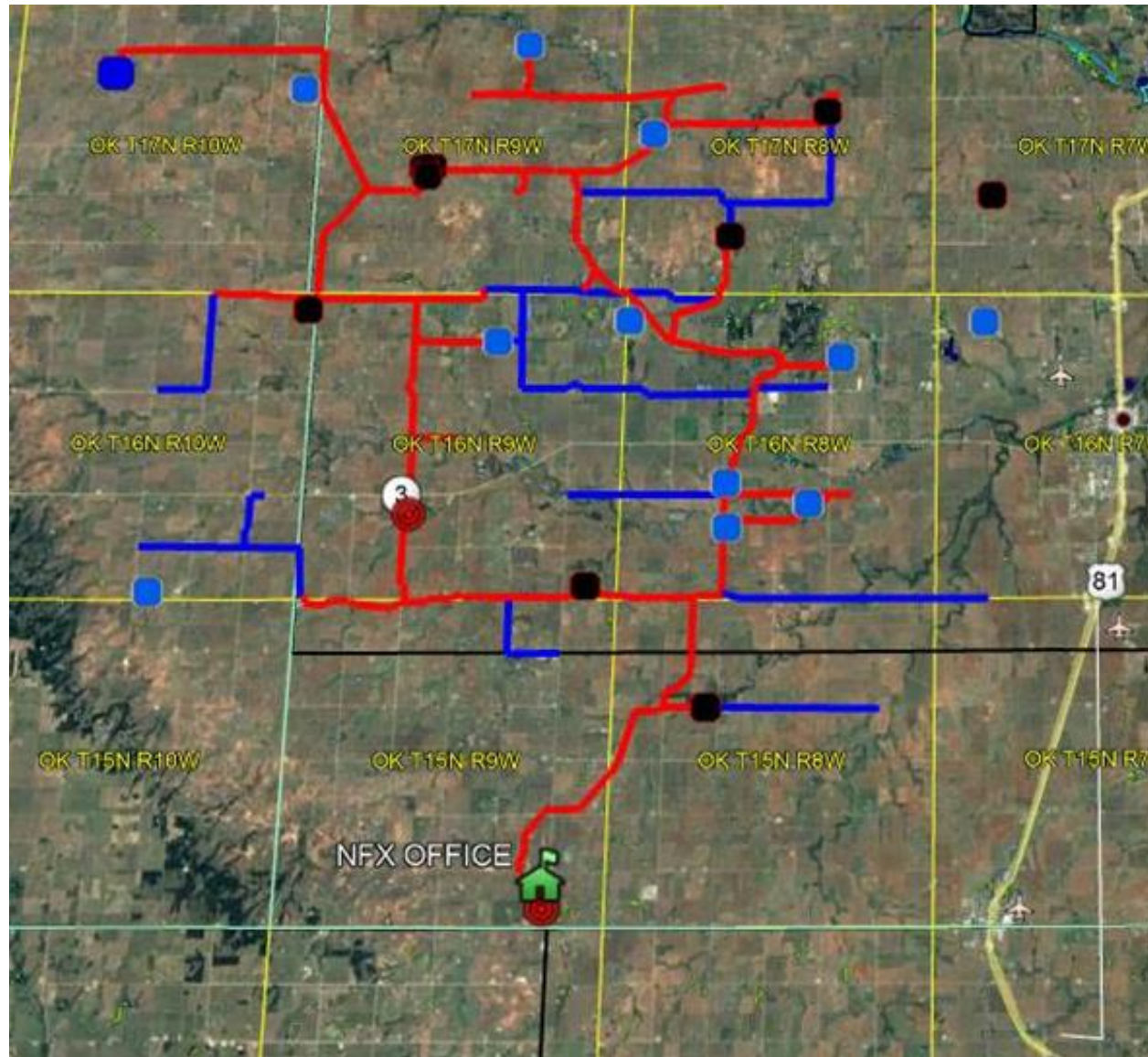


4 mm bbls
needed over
an ~ 3-week
period

Source Water Management—Storage and Handling



Source and Produced Water Management—Connected is Good



- Over 150 miles of 12" HDPE
- Planning for another 140 miles
- 10 mm bbls freshwater storage
- 5 mm bbls prod water storage
- One Company SWD well
- One 3rd party SWD well
- One 30 mbpd Recycling Facility

Produced Water Treatment and Reuse aka Recycling



Optionality is Crucial—SWDs are still Necessary



Comprehensive Water Management—Part of our Social License



Conclusions, Predictions, Discussion

■ Conclusion

- Water quantity requirements for HF operations are driven by well performance
- Water quality tolerances are driven by pressure pumping company innovation

■ Near term predictions for water

- Volumes, delivery locations and schedules will remain variable
- The drought cycle will encourage more recycling, plus alternative sourcing
- SWD disposal remains integral to ops

■ Longer term predictions

- NPDES discharge and beneficial use options for produced water outside oil and gas operations

