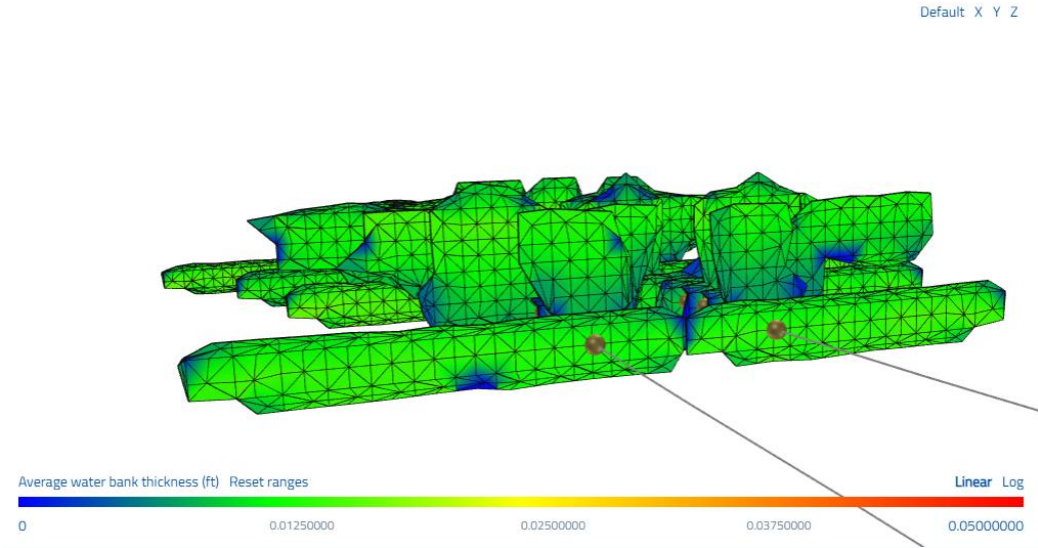


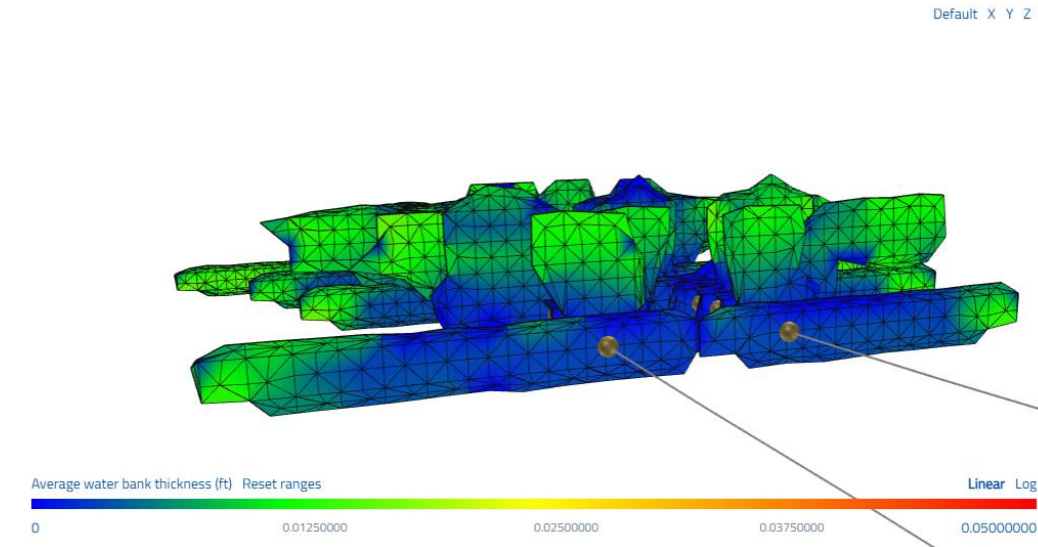
Water banking
Matching early time water flowback

Water Banking

Water banking addresses the issue of a temporary elevated water cut (or lack thereof) during initial flowback or after frac hits.



Water banking tracks the amount of water leaked off due to injections or frac hits and outputs an 'average water banking thickness' that you can observe in the UI.



As water is produced, the water banking thickness begins to decrease.

Water Banking

$$k_{rw} = \lambda_{wb,w} + (1 - \lambda_{wb,w})k_{rw,orig}$$

$$\lambda_{wb,w} = \min\left(1.0, \frac{d_{wb}}{d_{wb,ref,w}}\right)$$

d_{wb} = thickness of the water bank (as seen in previous slide)

$d_{wb,ref,w}$ = is the “water bank ‘rel perm increase’ scaling thickness” which is specified by the user

$K_{rw,orig}$ = the original water rel perm

As water leaks off, the interpolation factor ($\lambda_{wb,w}$) eventually reaches 1, so the rel perm for water flowback is 1. As water is produced, the water banking thickness is decreased and $\lambda_{wb,w}$ eventually reaches zero and the water banking has no effect.

In order to make the effects of the water banking stronger, specify a lower value for $d_{wb,ref,w}$.

This only effects the water phase, but *optionally* you may want to reduce the production of the hydrocarbon as well by specifying the “water bank ‘rel perm decrease’ scaling thickness”. The procedure and equations are generally the same.

Water Banking Setup - Fracture Options

- Fluid Model Options
- Fracture Options**
- Proppants
- Water Solutes
- Well Controls

Water bank 'rel perm increase' scaling thickness [m] d_{wb} ?

Water bank 'rel perm decrease' scaling thickness [m] ?

Water bank immobile fraction ?



Advanced Options

Water bank option ?

- None
- Original
- Dec2020Update
- Jan2021Update
- March2021Update

The water banking thickness can be set 'globally' in the fracture options or alternatively 'by layer' in the curve sets. Note that the global setting is in meters - *even if you are using field units*.

The user specifies the "water bank 'rel perm increase' scaling thickness" (d_{wb}). Optionally, a value can be specified for the "water bank 'rel perm decrease' scaling thickness" if hydrocarbon output is to be reduced. And finally, you can specify the amount of water bank that remains trapped in the formation and is never flowed back.

In the advanced options, there are several different options of 'water banking' code available. They are somewhat similar but have evolved over time. The older versions are there for back compatibility. When starting a new history match it is recommended that the latest water bank option be employed.

Water Banking – Curve Sets

- ✓ Curve Sets
- Wells and Perforations
- Meshing Options
- Fluid Model Options
- Fracture Options
- Proppants

Water bank thickness to rel perm increase scaling thickness [ft] ?

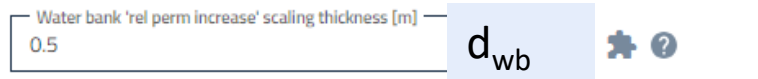
Water bank thickness to rel perm decrease scaling thickness [ft] ?

Water bank immobile fraction ?

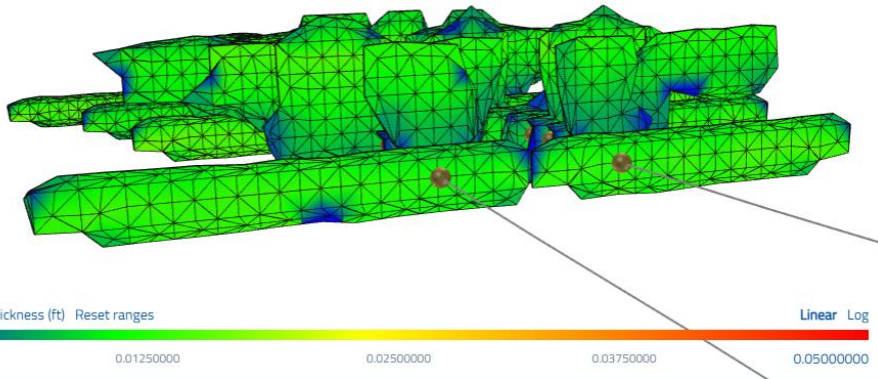
The water banking can also be set by individual curves sets, which are set ‘by layer’ in the static model.

Note that the by layer parameter does change to ft when using field units.

Water Banking – Setting the Water Banking Scaling Thickness



Default X Y Z



In this simulation, the water banking was set in the fracture options to 0.5 m (1.65 ft). By looking at the UI, the average water banking thickness right before production is approximately 0.0125 ft.

Calculating the water rel perm increase:

$$k_{rw} = \lambda_{wb,w} + (1 - \lambda_{wb,w})k_{rw,orig}$$

$$\lambda_{wb,w} = \min(1.0, \frac{d_{wb}}{d_{wb,ref,w}})$$

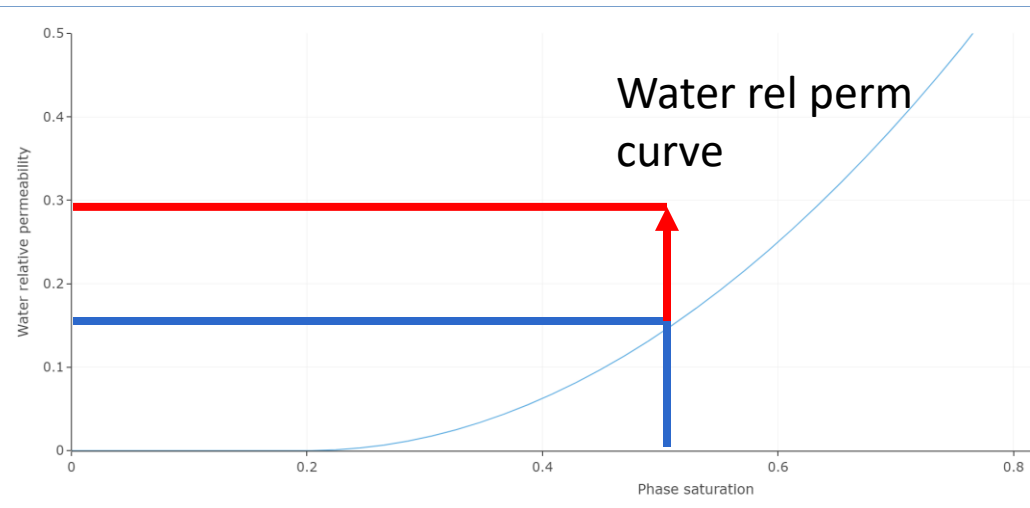
$$\lambda_{wb,w} = \min(1, 0.0125 / (0.5 * 3.3)) = \min(1, 0.0076) = 0.0076$$

$$k_{rw} = 0.0076 + (1 - 0.0076) * k_{rw,orig} = 1 * k_{rw,orig}$$

K has not changed so water banking has had no effect on this simulation! (that's why 0.5 m is the default 😊)

Water Banking – Setting the Water Banking Scaling Thickness

What is a reasonable value to increase the early time water production?



In this example, based on a S_w of approximately 50%, $K_{rw,orig}$ is 0.15.

We saw previously that the average water banking thickness was 0.0125'.

If we want to double $K_{rw,orig}$ to 0.3:

$$k_{rw} = \lambda_{wb,w} + (1 - \lambda_{wb,w}) * k_{rw,orig}$$

$$\lambda_{wb,w} = 0.1765$$

and therefore:

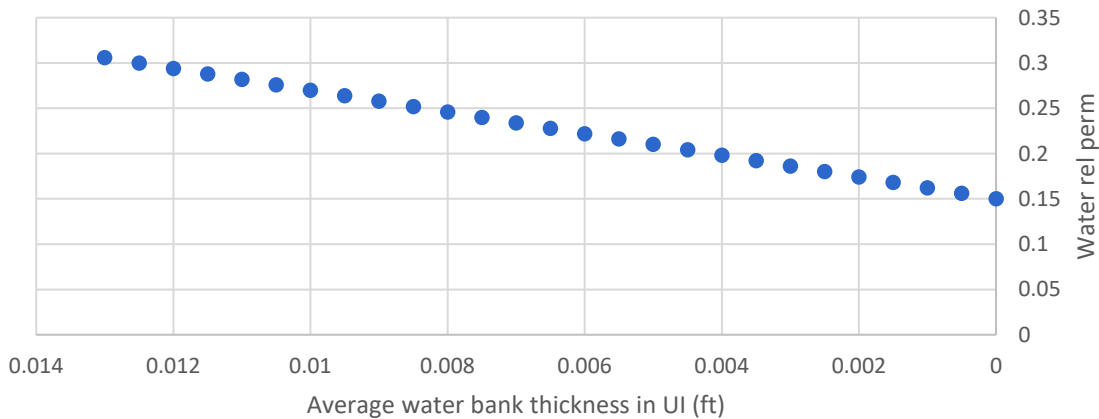
$$d_{wb,ref,w} = 0.0708 \text{ ft (0.02145 m)}$$

$$k_{rw} = \lambda_{wb,w} + (1 - \lambda_{wb,w})k_{rw,orig}$$

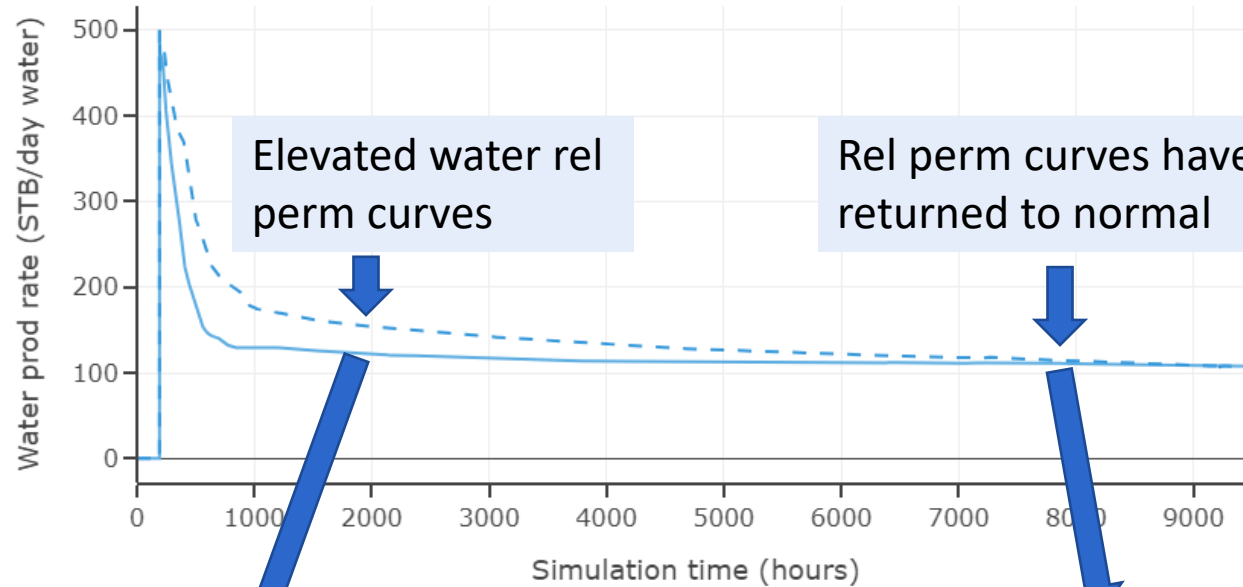
$$\lambda_{wb,w} = \min(1.0, \frac{d_{wb}}{d_{wb,ref,w}})$$

Don't forget, as water is leaked off, the average water bank thickness decreases and the water rel perms return to normal!

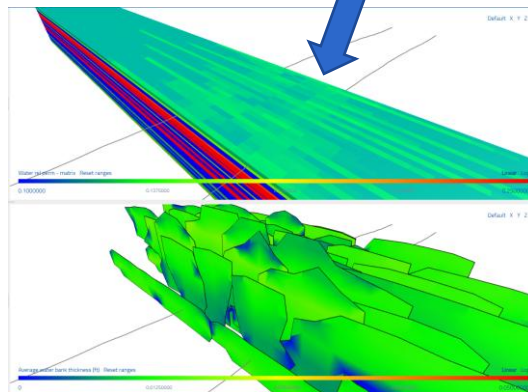
Decreasing water banking thickness vs. water rel perms



Water Banking - Results

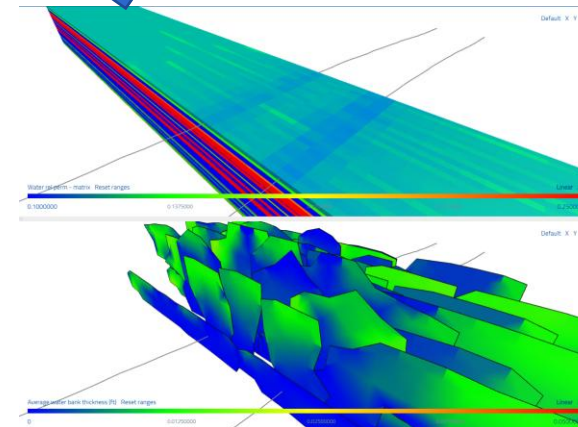


Note: The time it takes for the water banking to diminish is a function of the amount of water produced versus how much was pumped.

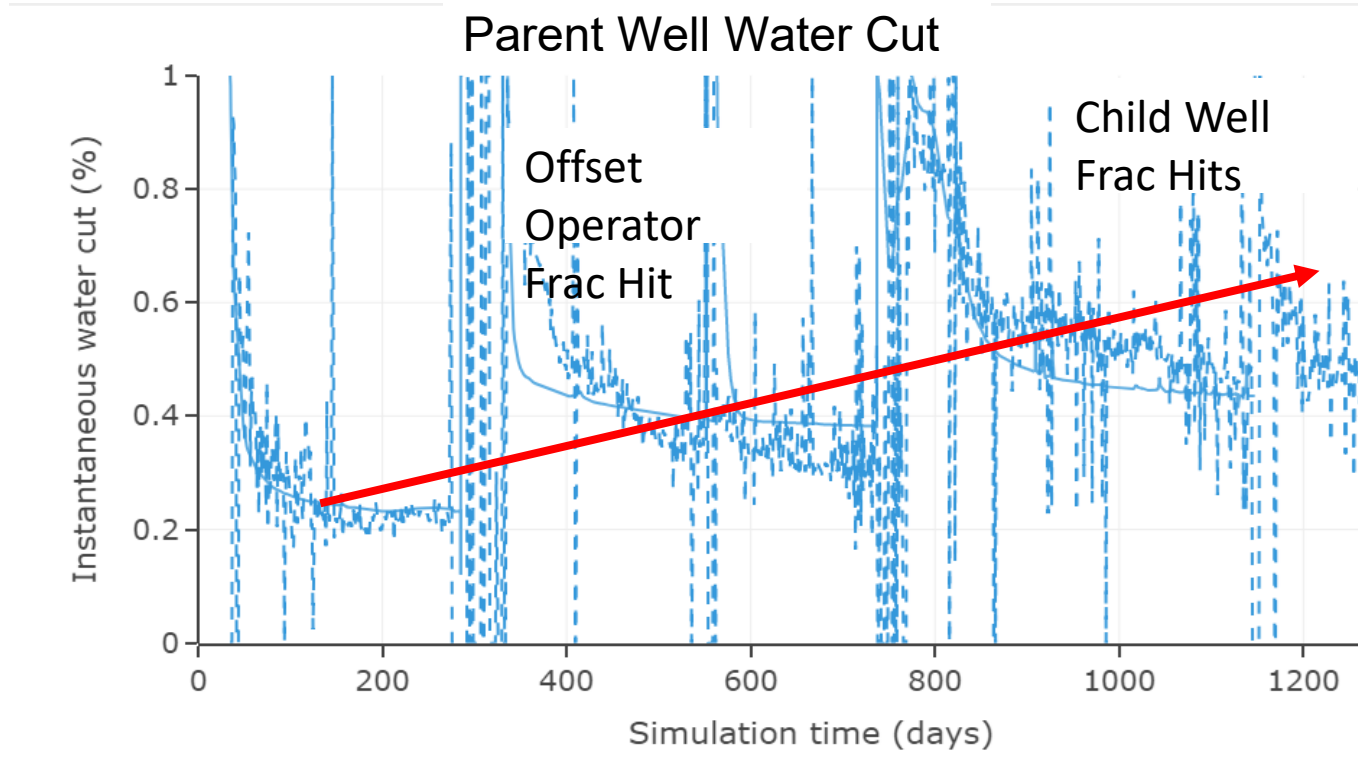


Water rel perm

Water bank thickness has been depleted in the propped regions



Water Banking – Results from Frac Hits



Successive frac hits have increased the 'Average water bank thickness' in the parent well. Eventually, given enough time, the water banking thickness would be diminished, and the water cuts would return to pre frac hit levels. However, since the water production is low after the first year, it will take a long time to diminish the water banking and return to the original water cut.

SPE-209152– Modeling of Parent Child Well Interactions, Ratcliff et al., 2022. Co-authored with Devon, modeled primary production, frac-hit-induced production losses, and damage remediation in a single continuous model.



Thank You!

Chris Ponnors

cponners@resfrac.com

Last updated Feb 2026