As part of an extended reach field development program, a major operator required a horizontal water injector to be drilled to provide pressure support to nearby existing production wells. During the planning phase, offset data revealed what to expect in the depleted reservoir sandstones. The main challenge was a potentially narrow margin between the equivalent circulating density (ECD) and fracture gradient when drilling the 8-1/2-in. hole section. The ECD target set by the customer was 0.5 ppg below the minimum fracture gradient of 17.2 ppg, with a flow rate > 500 gpm and a fluid density >12.4 ppg, at 120-140°F BHST.

An excess of 7,100 bbl of BaraECD® high-performance drilling fluid would need to be mixed onsite, in sub-zero temperatures. Demonstrating that this fluid could be mixed and maintained, delivering consistent, sub-fracture gradient ECD, with no loss of performance, or risk of weight fluctuations, was key to “proof of concept.” It led to this (record-breaking) well and paved the way for future wells, extending the development phase of the field.

It was proven in the laboratory that BaraECD, with BDF™-919 as the primary rheological component and micronized ilmenite as the weighting agent, would provide suitably low PV and robust but fragile, non-progressive gels capable of maintaining ECD below 17.2 ppg at >500 gpm, as modeled in DFG software. Static aging showed excellent sag resistance over 3, 5, and 14 day periods and VSST profiles were obtained for operational comparison.

Temperatures in this region can drop as low as -5°F in December, which can be problematic when mixing high-performance NAF with products that are miscible in base oil at varying temperatures.

Run at 2,800 psi / 5.4 bpm, the use of a BaraShear™ pump provided some temperature during mixing, but also ensured full dispersement of non-soluble products (like BDF™-919).

7,100 bbl BaraECD was prepared, with an average PV of 20, Tau Zero of above 4, and a 10-minute gel of 14 (lb/100ft³), within 5% of the laboratory proven specifications.
RESULTS
The Halliburton Baroid team successfully executed the mixing and maintenance of an ultra-low rheology NAF, providing all the characteristics required to drill and complete a shallow, extended reach water injector well. This was accomplished in challenging Arctic conditions with no downtime, loss of performance, or weight fluctuations, while staying below the required fracture gradient. The optimized formulation was replicated at the LMP and maintained throughout the production interval, delivering the section at its predicted TD, and throughout the completions phase without any issues. Project highlights are as follows:

» No additional products utilized to obtain laboratory achieved specifications in the LMP
» Measured ECD kept below fracture gradient at all times with DFG modeling, while staying within 30 psi of observed annular pressure loss
» Zero weight fluctuations observed during re-entry in the wellbore for liner cementing and casing cleanup operations
» Validation of fluid for use in next well application achieved by post-well analysis of PWD data and DFG simulations

This chart highlights BaraECD performance by mapping DFG modeled ECD (red dots) over the actual (PWD measured) ECD. The purple crosses are the modeled ECD expected from the next best NAF.