



**Comm. Craddick / TRRC -
Recycling and Conservation**

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WATER SOLUTION
May 22, 2014**

multi-chem®
A HALLIBURTON SERVICE

Halliburton Produced Water Recycle – Current Considerations

- Produced water does not have to be treated to a discharge quality level to be reused as a frac fluid for well stimulation. Halliburton treats for only the incompatible solids to minimize surface waste generation and return all the remaining produced water components back into the reservoir as a frac fluid.
- Produced water can be recycled to offset freshwater requirements. Current challenges include logistics, storage, disparate blending, contaminant removal/ conditioning and H₂S neutralization.
- Operators need economic volumes of water to encourage PW recycle.
- Regulators around the country are amending rules to accommodate produced water for recycle versus historic waste management directives.
- The economic incentives to recycle produced water considers sourcing, disposal and logistic costs.

Water Solutions Products & Services

Markets

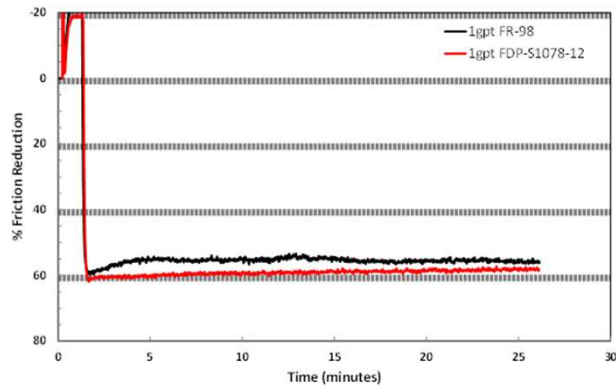
- Unconventional
- Offshore
- Mature Fields



CleanWave™



SeaWave™- Offshore



High TDS FR's
FDE-1078



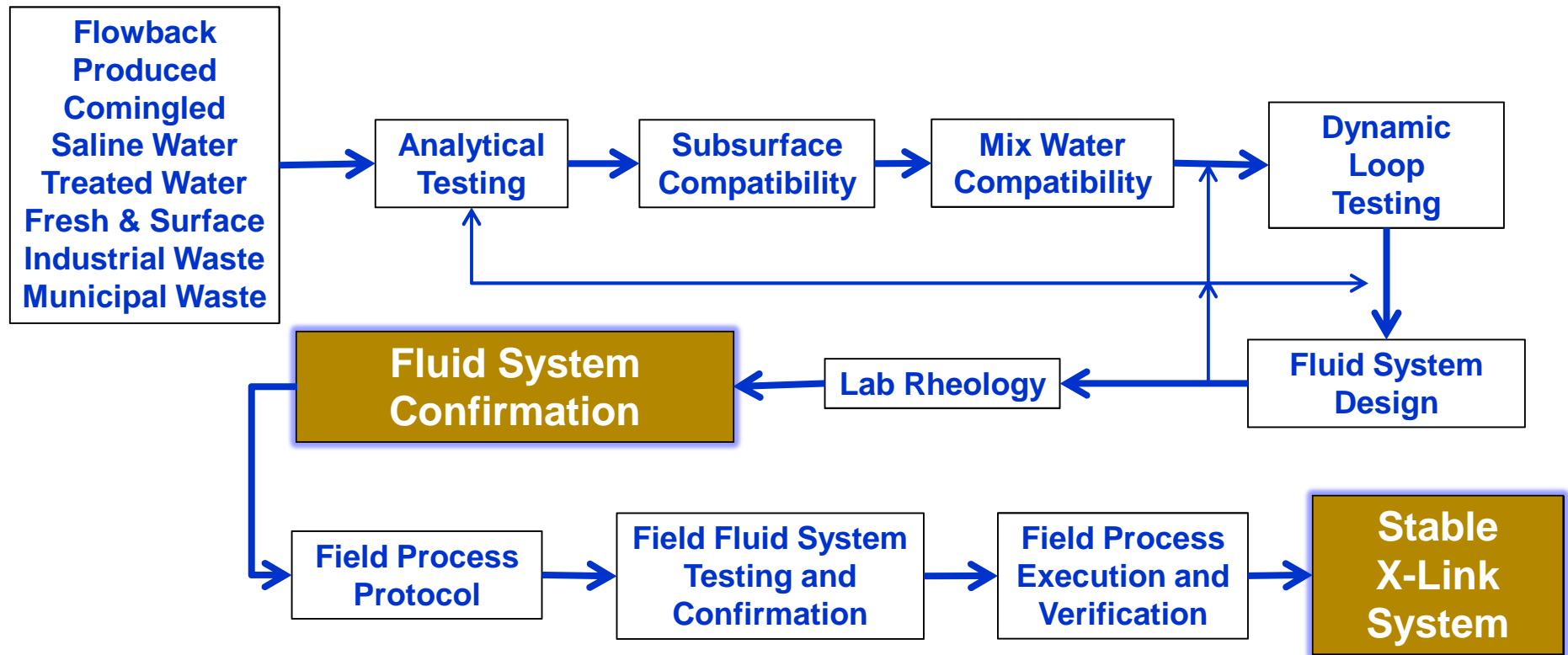
UniStim™ & MC Scale
inhibitors, Biocides etc



CleanStream™

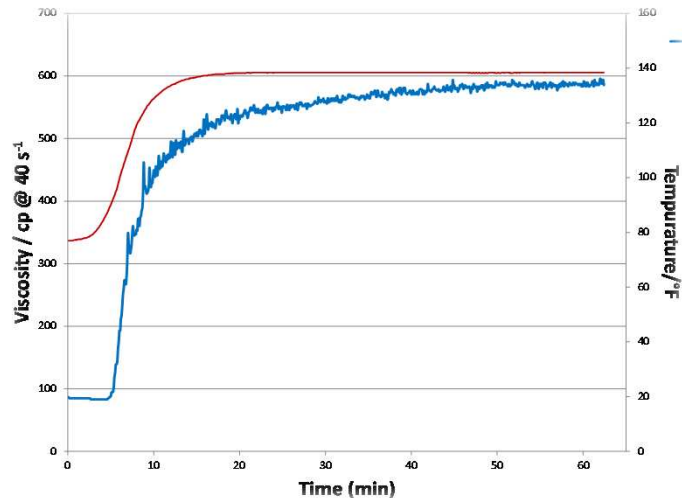
H2O Forward – Fluid System Integrity Process

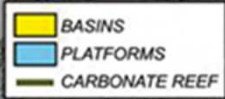
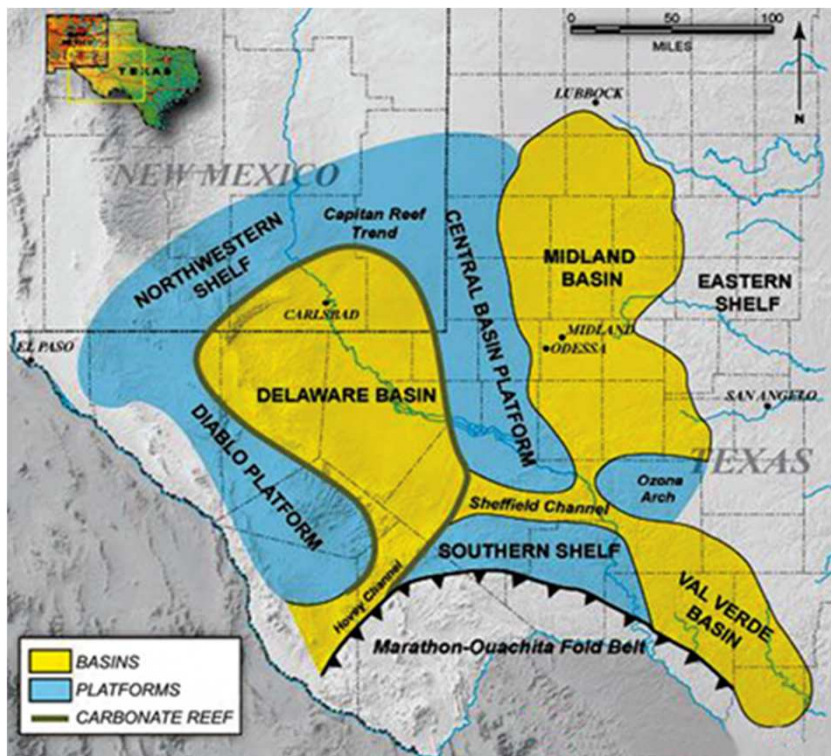
Impaired water sources to cost efficient recovery / reuse.....



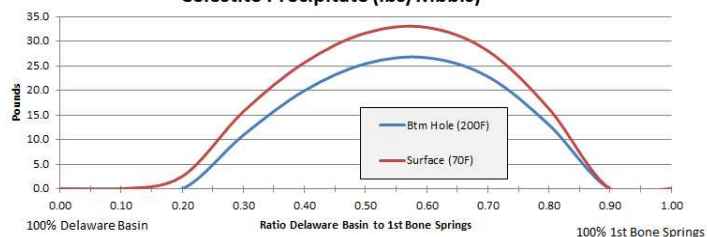
UniStim™ - Delaware Basin & Bakken Fracs Using 100% CleanWave™ Treated Produced Water

Source (mg/L)	Delaware	WATER CLASSIFICATIONS , BY THE AMOUNT OF TDS (mg/L)		Source (mg/L)	Bakken
Specific Gravity	1.207	Fresh water	< 1,000	Specific Gravity	1.186
pH	6.87	Brackish water	1,000 to 10,000	pH	7.20
Bicarbonate	160.94	Saline water	10,000 to 30,000	Chloride	170,624
Carbonate	0	Brine water	> 30,000	Sulfate	260
Chloride	179,469	Ocean water	> 30,000 to <40,000	Aluminum	6.28
Sulfate	8	Produced water	2,000 to 320,000	Boron	376
Aluminum	1.49			Barium	24.9
Boron	21.9			Calcium	15,700
Barium	4.76			Iron	1.10
Calcium	28,877			Potassium	5,970
Iron	4.2			Magnesium	992
Potassium	1,814			Sodium	81,900
Magnesium	4,287			Strontium	1,230
Sodium	67,596			TDS (mg/L)	270,432
Strontium	1,690			TSS (mg/L)	126.3
TDS (mg/L)	280,398				
TSS (mg/L)	11.2				

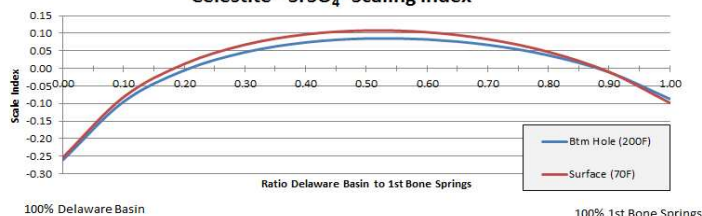




Celestite Precipitate (lbs/Mbbls)



Celestite - SrSO_4 - Scaling Index



Delaware Basin

	Dewey Lake
	Rustler
	Salado
	Castile
Delaware Mountain Group	Lamar
	Bell Canyon
	Cherry Canyon
Bone Spring	Brushy Canyon
	Avalon Shale
	1st Bone Spring Sand
	2nd Bone Spring Sand
	3rd Bone Spring Sand
	Wolfcamp
	Cisco
	Canyon
	Strawn
	Atoka
	Morrow

Midland Basin

	Dewey Lake	
	Rustler	
	Salado	
Whitenhorse	Tansill	
	Yates	
	Seven Rivers	
	Queen	
	Grayburg	
Word	San Andres	
	San Angelo	
	Clearfork	Wolfberry / Wolfork
	Upper Spraberry	
	Lower Spraberry	
	Dean	
	Wolfcamp	
	Cisco	
	Canyon	
	Strawn	
	Atoka	

2013 SPE Papers on High TDS Recycle PW

- SPE #163824 “Development and use of High TDS Recycled Produced Water for Crosslink-Gel Based Hydraulic Fracturing”
- SPE #165085 “Effects of Total Suspended Solids on Permeability of Proppant Pack”
- JPT Magazine Technology Update – June 2013
“Treatment Enables High-TDS Water Use as Base Fluid for Hydraulic Fracturing”
- SPE # 165641 “Recycling Water: Case Studies in Designing Fracturing Fluids Using Flowback, Produced, and Nontraditional Water Sources”

Thank You

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