



Austin

October 5, 2016

INNOVATIVE WATER MANAGEMENT SOLUTIONS

TAMEST SHALE TASK FORCE

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WHY DO WE NEED WATER?



General Operations

- Drilling fluids, water floods,
- Produced water management

Frac

- Simple Chemistry
- Incompressible fluid
- Carries sand /prop
- Safe
- Safe in reservoirs

WATER TYPES – QUALITY - VALUE



- Fresh surface
 - Fresh Aquifers
 - Agricultural
 - Effluent
 - Industrial -Alternative
 - Brackish
 - Produced
-
- Transport Costs
 - Chemical components
 - Alternative Uses

WATER MANAGEMENT-- PUTTING THE PUZZLE TOGETHER...



- Availability & cost
- Transportation
- Quality Needs
- Treatment options
- Infrastructure
- Frac Chemistry
- On time delivery
- Disposal
- Residual waste
- Risk management

- Oil Field Technology
- Operations = simple
- Flexibility

FRAC TYPES AND WATER NEEDS



Classic Gel Fracs

- All about creating gel that carries sand into the reservoir (shale), then breaking gel to allow flow.
- Sensitive to pH, Boron, iron, TSS, TDS

Slickwater Fracs

- More water, less chemicals. Mostly friction reducer, biocides, maybe surfactant. Rate instead of viscosity.

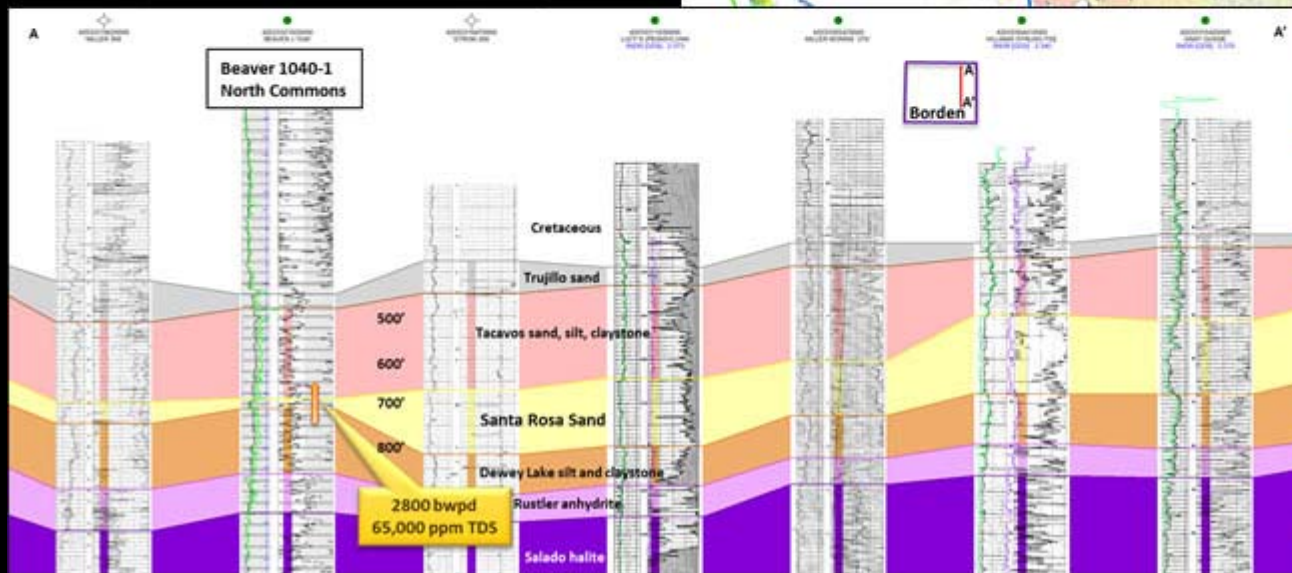
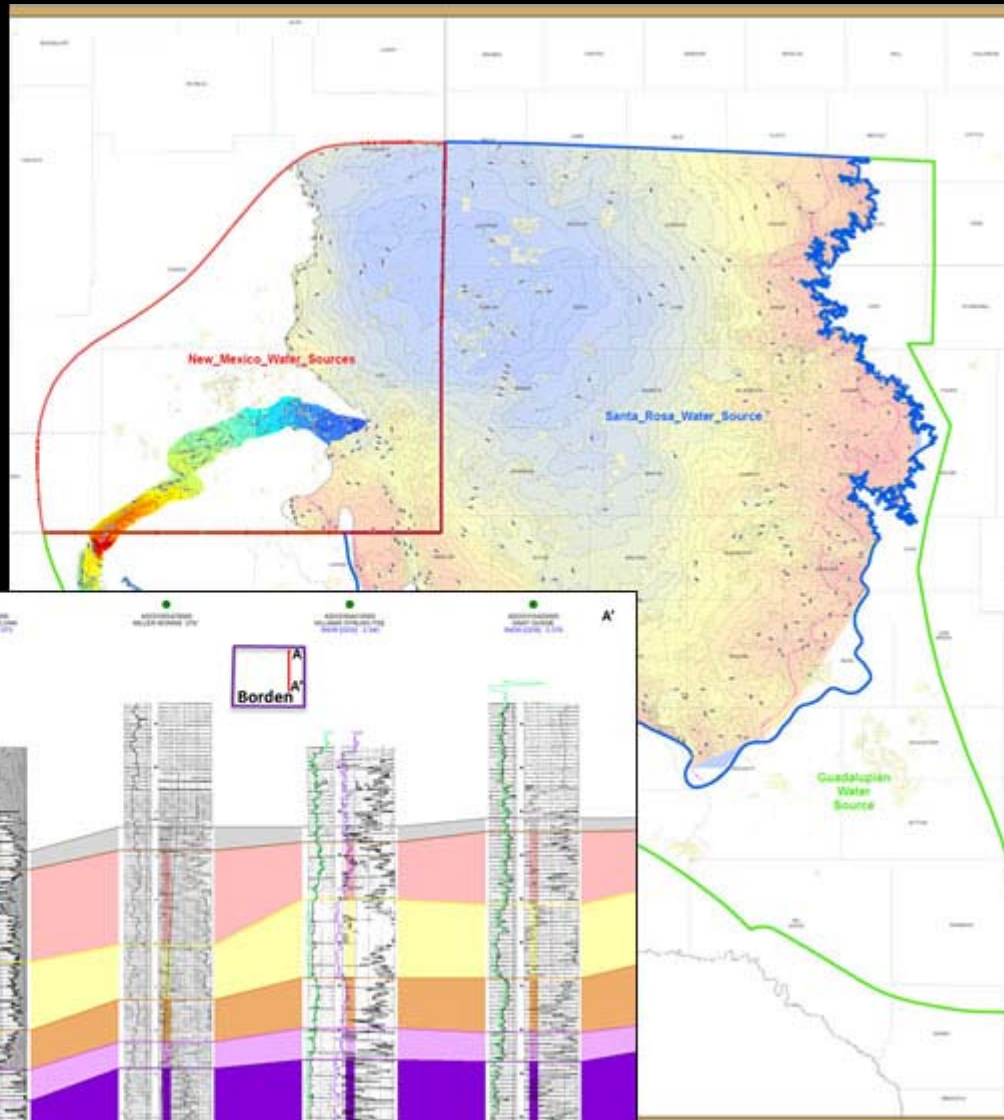
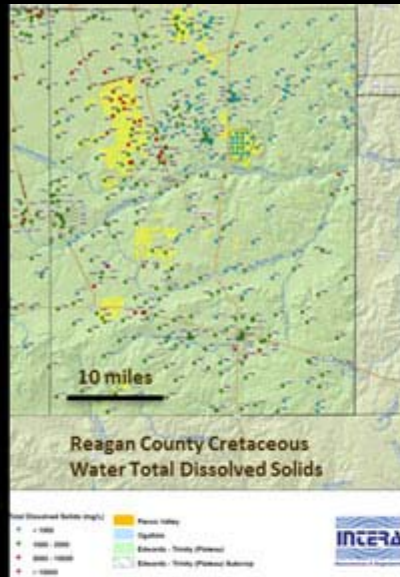
We started simple. Engaged friends.

BARNHART PROJECT--DELIVER THE GOALS



- Enable Apache program
- NO FRESH WATER
- Cost effective
- No negative impact on fracs
- Dependable, Reliable
- Lead Industry
- Advance Technology
- Develop Expertise

SUBSURFACE WATER – UNDERSTAND IT!!!



PRODUCED WATER TREATMENT TECHNOLOGIES



Chemicals
Ozone oxidation
Nano-filtration
Hydrocyclones
Deionization
UV
MVR Evaporator, RO,
EC...and many more

CHLORINE DIOXIDE : IDEAL PROPERTIES

- ▲ A **free-radical** gas and selective **oxidizer**
 - ▲ **Degrades** in days, sometimes hours
 - ▲ Partitions into water/oil and acts as **surfactant**
 - ▲ Cleaves **bacterial DNA** molecules
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- **Widely used to clean municipal drinking water**
 - **Oilfield upgrade: more robust modules**



INEFFICIENT AT LARGE SCALE

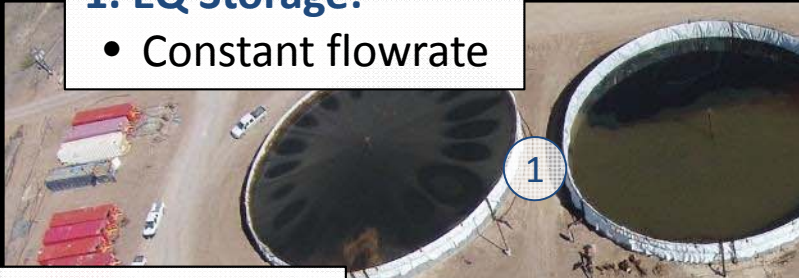
- Major solids stratification
- Residence time required
- Over-treat by 20%
- Time-intensive treatment
- Inefficient chemical dispersion
- Redundant storage tanks needed



PRODUCED WATER RECYCLE 2.0 – INLINE PROCESS

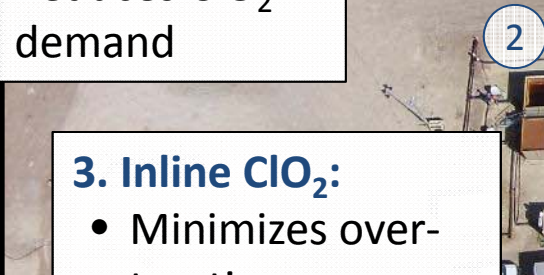
1. EQ Storage:

- Constant flowrate



2. Pre-treatment:

- Reduces ClO_2 demand



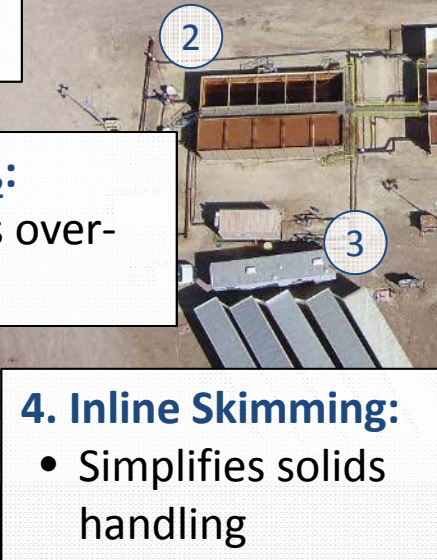
3. Inline ClO_2 :

- Minimizes over-treating



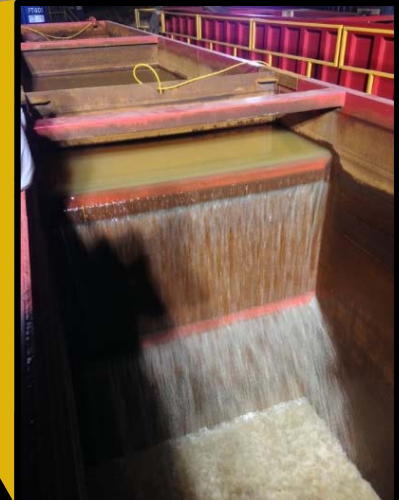
4. Inline Skimming:

- Simplifies solids handling



5. Weir Tank:

- Continuous Ops.
- $< 10 \text{ mg/L Fe}$
- $< 100 \text{ mg/L TSS}$

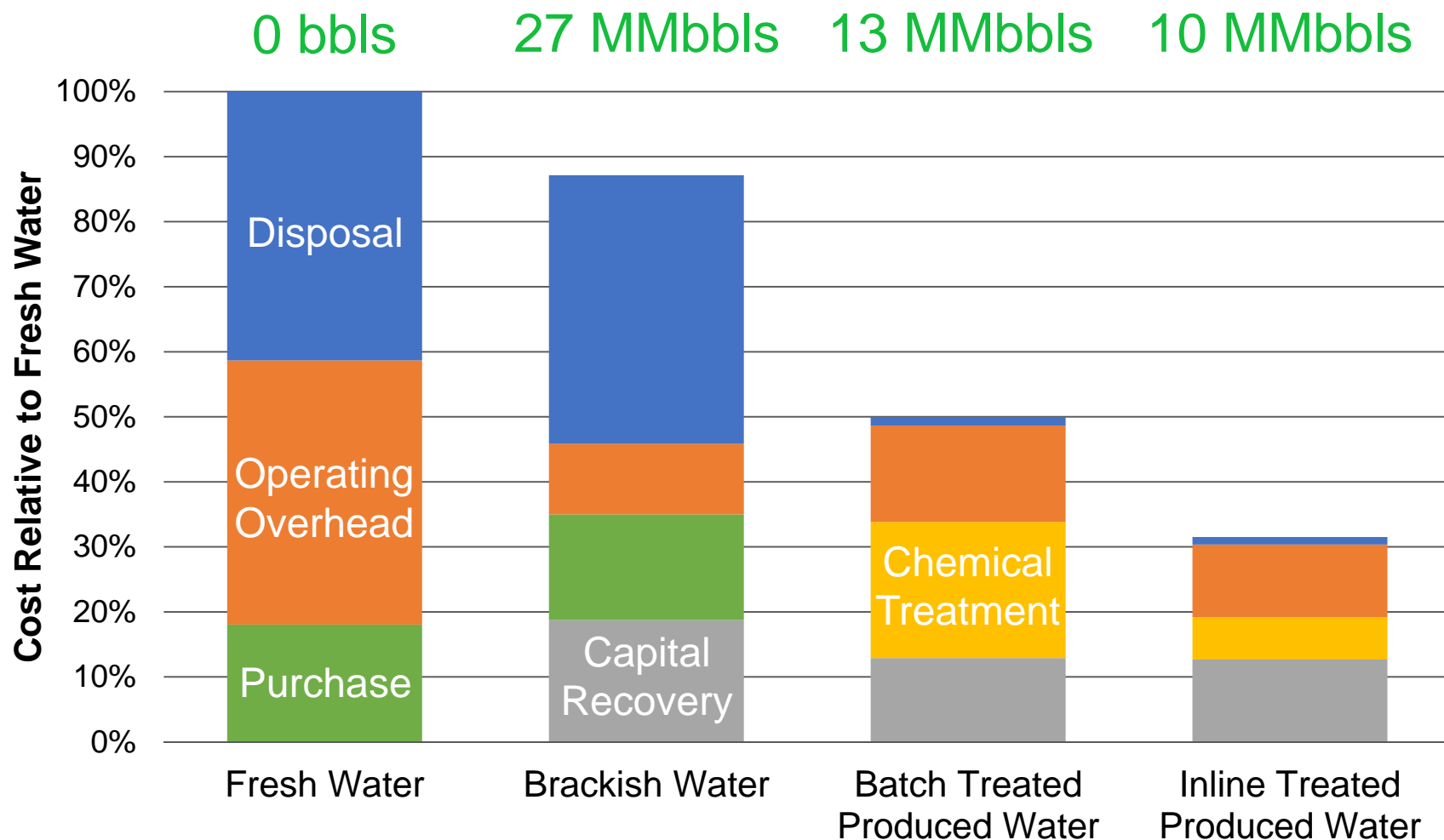


MAJOR BENEFITS BARNHART



- No fresh water used
- 80, 000 Truckloads off the road /year
- Avoided water disposal fees and trucking costs
- Dependable frac water @ lower cost

All-In Water Costs for Hydraulic Fracturing

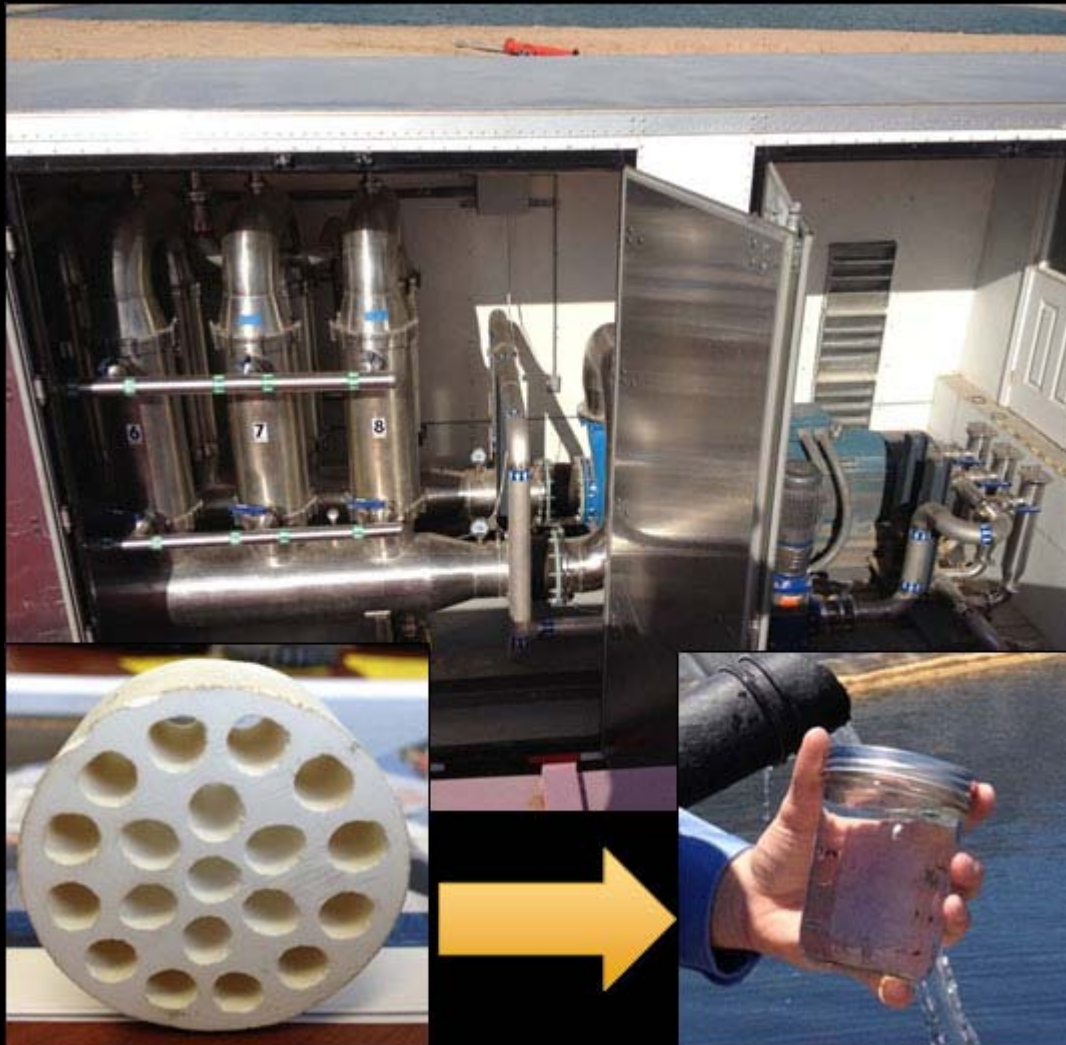


SPE-174956-MS • The New Reality of Hydraulic Fracturing: Treating Produced Water is Cheaper than Using Fresh • C.M. Barnes et al.

COLLEGE STATION EFFLUENT RECYCLE



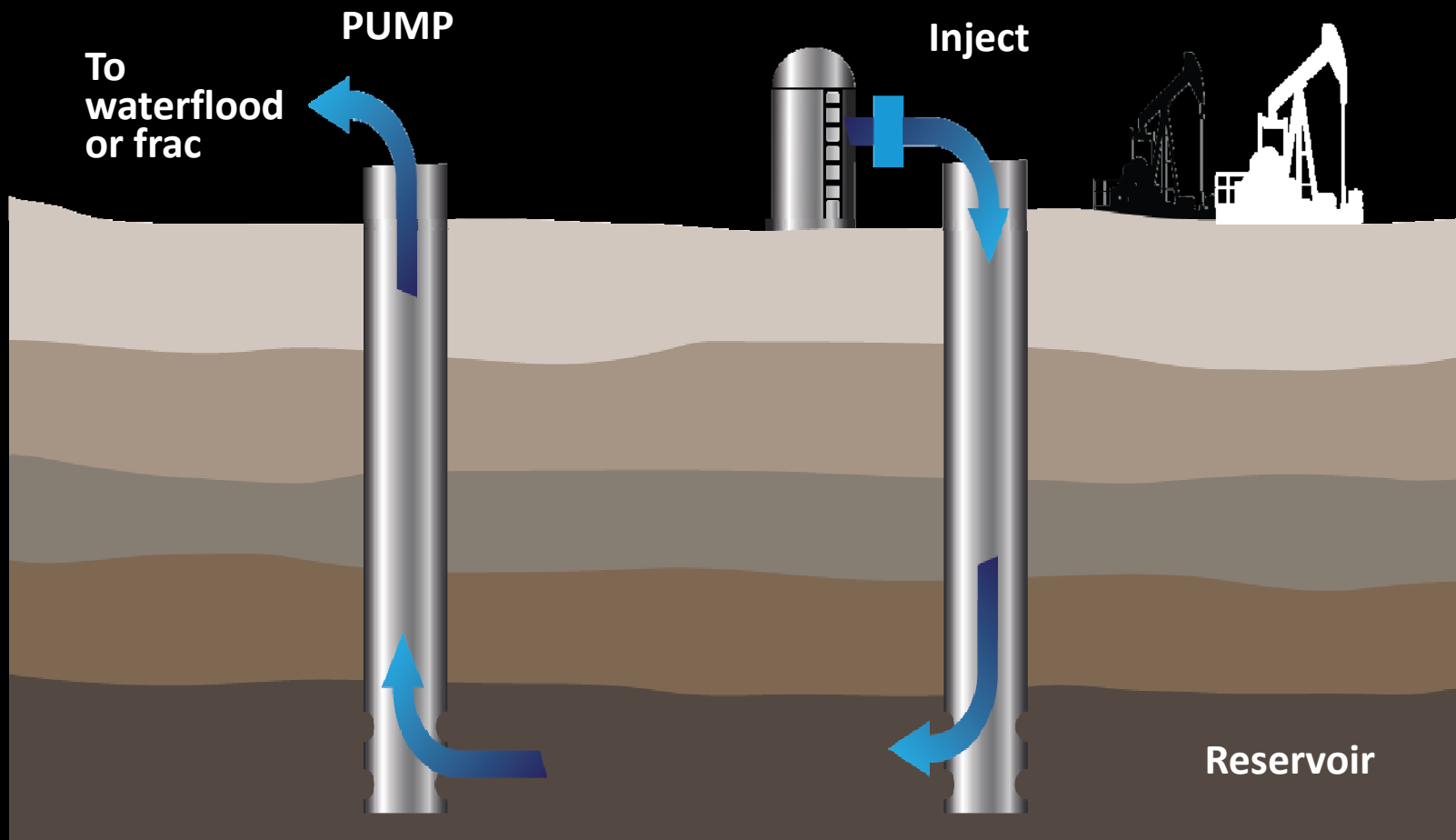
CERAMIC MICROFILTRATION



- Cross-flow filtration
- Ceramic membranes; coated nano-material
- Coating prevents organic fouling in the micro-pores
- Longer run-time w/ gels, FeS, emulsions, bacteria
- Otherwise, same as any other ceramic
- Throughput \propto water quality

MANAGING PRODUCED WATER

by injection & re-use



WATER ISSUES TO THINK ABOUT

- Is the risk of aquifer pollution be any different with HF than conventional oil and gas wells?
- Should we “protect” brackish or saline water sources?
- What standard should apply- cost of treatment?
- How to facilitate produced water recycle.
- Are we ready to manage water usage in Texas?
- How can we encourage sustainable solutions?





Thank you!