

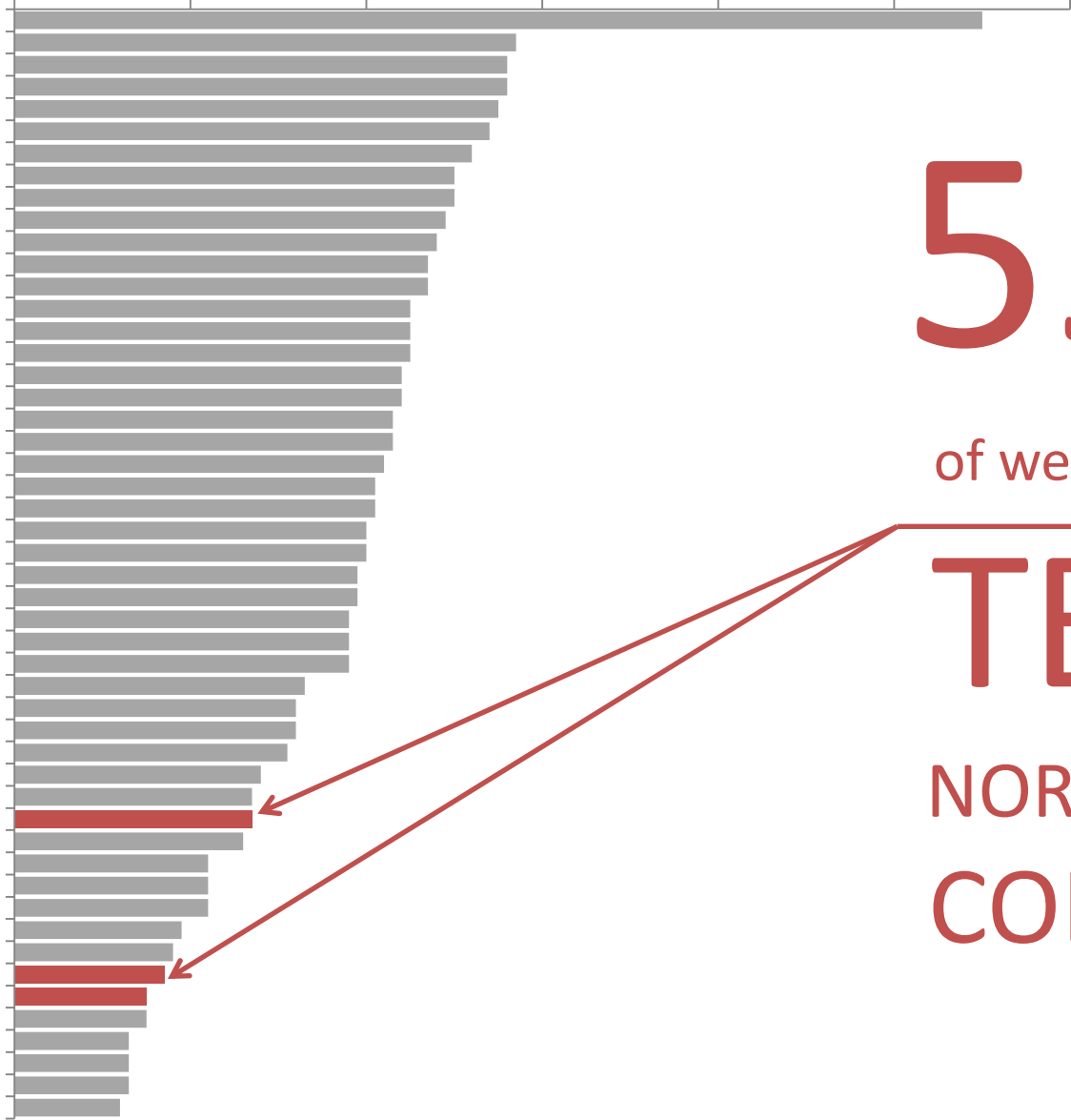
# Slickwater vs. Crosslink Gels: Identifying Which Frac Fluid Works Better with Produced Water (A Recycling Case Study)



# AVERAGE ANNUAL PRECIPITATION

0 20 40 60 80 100 120

- Hawaii
- Louisiana
- Alabama
- Mississippi
- Alaska
- Florida
- Tennessee
- Georgia
- North Carolina
- Arkansas
- South Carolina
- Connecticut
- Kentucky
- Delaware
- Massachusetts
- New Jersey
- Rhode Island
- West Virginia
- Maryland
- Virginia
- New Hampshire
- Maine
- Pennsylvania
- Indiana
- Missouri
- New York
- Vermont
- Illinois
- Ohio
- Washington
- Oklahoma
- Iowa
- Michigan
- Wisconsin
- Oregon
- Kansas
- Texas
- Minnesota
- California
- Nebraska
- Nevada
- Idaho
- South Dakota
- North Dakota
- Colorado
- Montana
- Arizona
- New Mexico
- Wyoming
- Utah



55%

of wells drilled 3Q13

TEXAS

NORTH DAKOTA

COLORADO

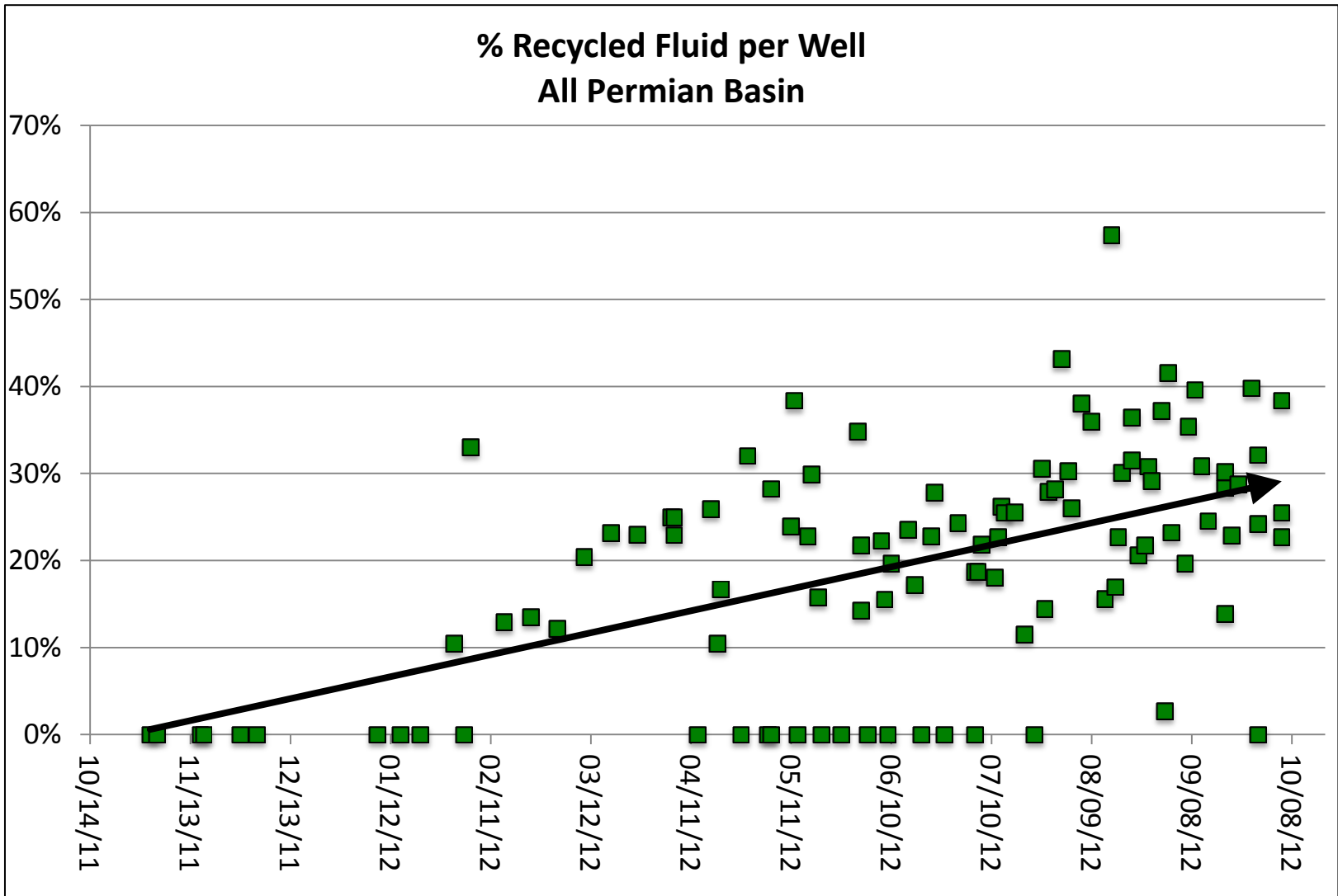
**freshwater constraints + disposal constraints = need to recycle**

# Slickwater vs. Crosslink Gels

Slickwater	Crosslink Gels
Friction Reducer can be effected	Gel Compatibility is an issue
Friction reducer can be adjusted on the fly	Difficult to adjust gel on the fly
Little sensitivity to blend rate	High sensitivity to blend rate
Fluid consistency not an issue	Fluid consistency is an issue
No Boron concerns	Boron is a concern

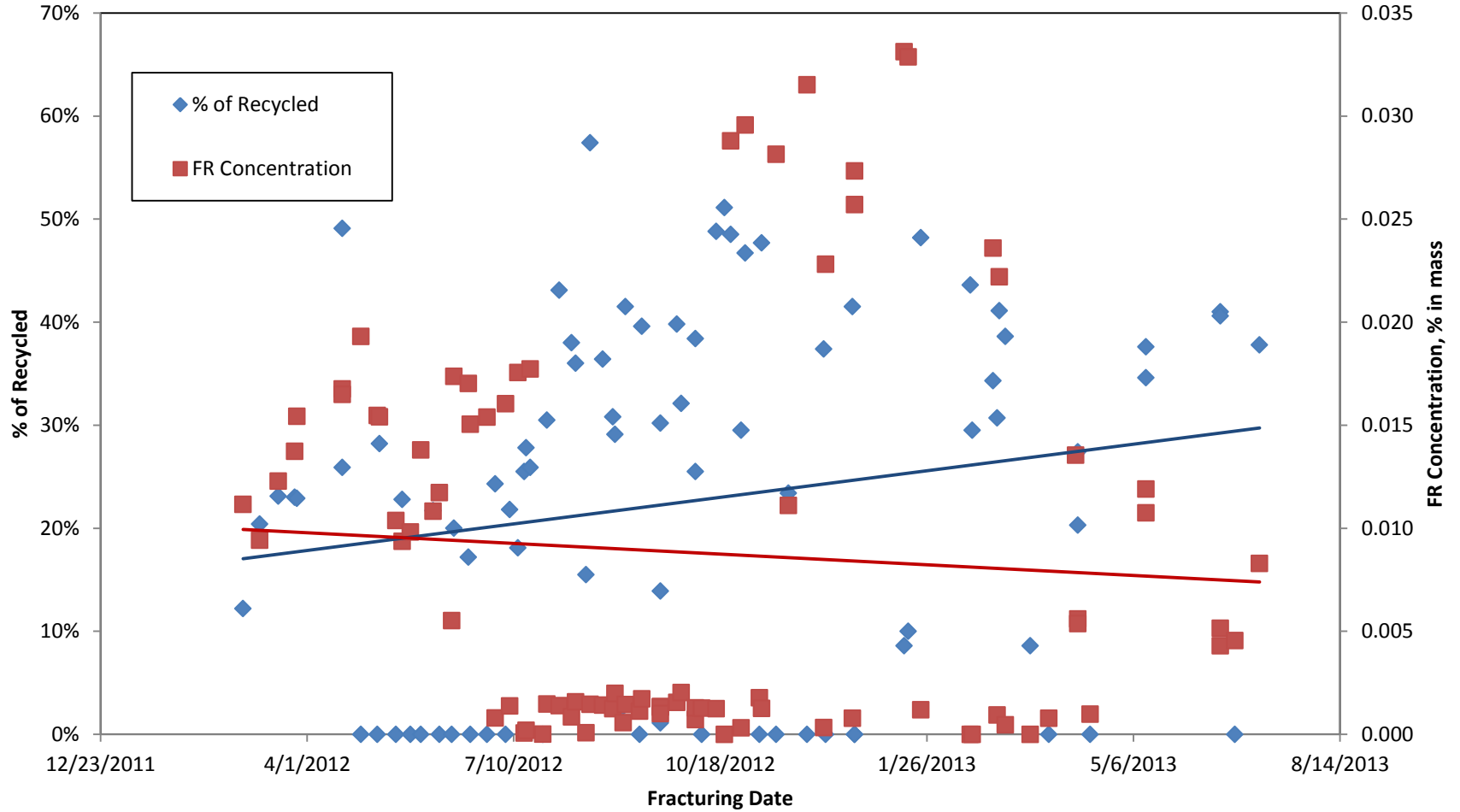
# Permian Basin

## *Slickwater Recycle Rate*

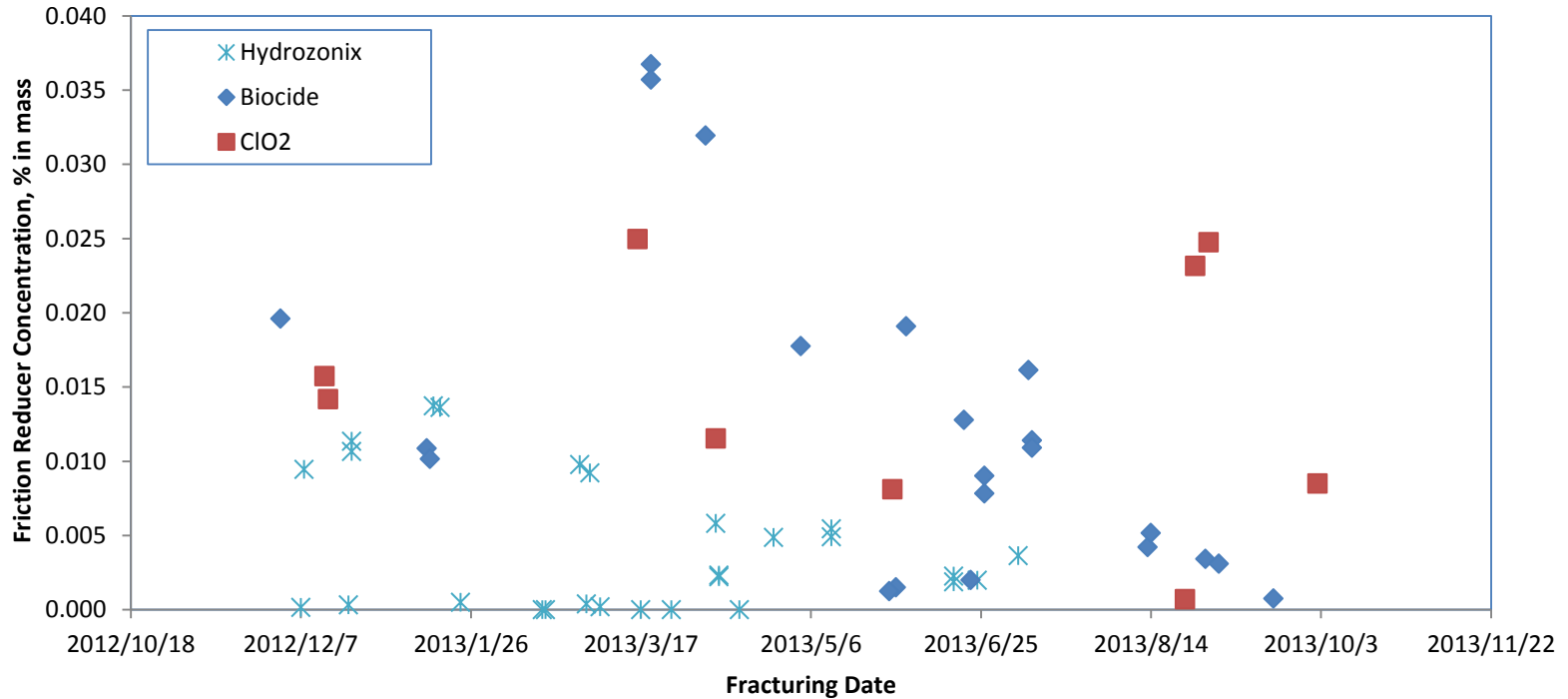


# Permian Basin

## Slickwater: FR vs. Recycle Rate



# Permian Basin *Slickwater: HZO vs. Biocide vs. Chlorine Dioxide*



Water Treatment Technology	# of Wells	FR Concentration, % in mass
Biocide	22	0.0123
ClO <sub>2</sub>	9	0.0146
Hydrozonix	27	0.0042

# Cross-linked gel fluids





# Cross-linked gel fluids



- Gel Compatibility can be maintained over narrow range.
- TSS, TDS, Chlorides and Boron are all issues.
- Once Gel recipe is developed water quality must remain in a narrow range to maintain gel compatibility
- Control of water quality is paramount

# Need for Fluid QA/QC on X-linked Gel Fracs

- Pre-frac circulation, pretest water, define blend
- Blend to correct ratios
- Monitor water quality real time
- Synchronize water transfer with pumping company



# Pre-Frac TESTING

- Blended Water Gel Compatibility Test
- Water Source- Freshwater and Produced
  - Chloride
  - Boron
  - TDS



# Pre-Frac TESTING

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Gel frac recycle  
and control system

## Consistent Water Quality

- Calibrate Pumps- Fresh & Produced
- Baseline TDS, Chlorides and Boron
- Chloride concentration optimized for **clay stabilization**

# Pre-Frac TESTING

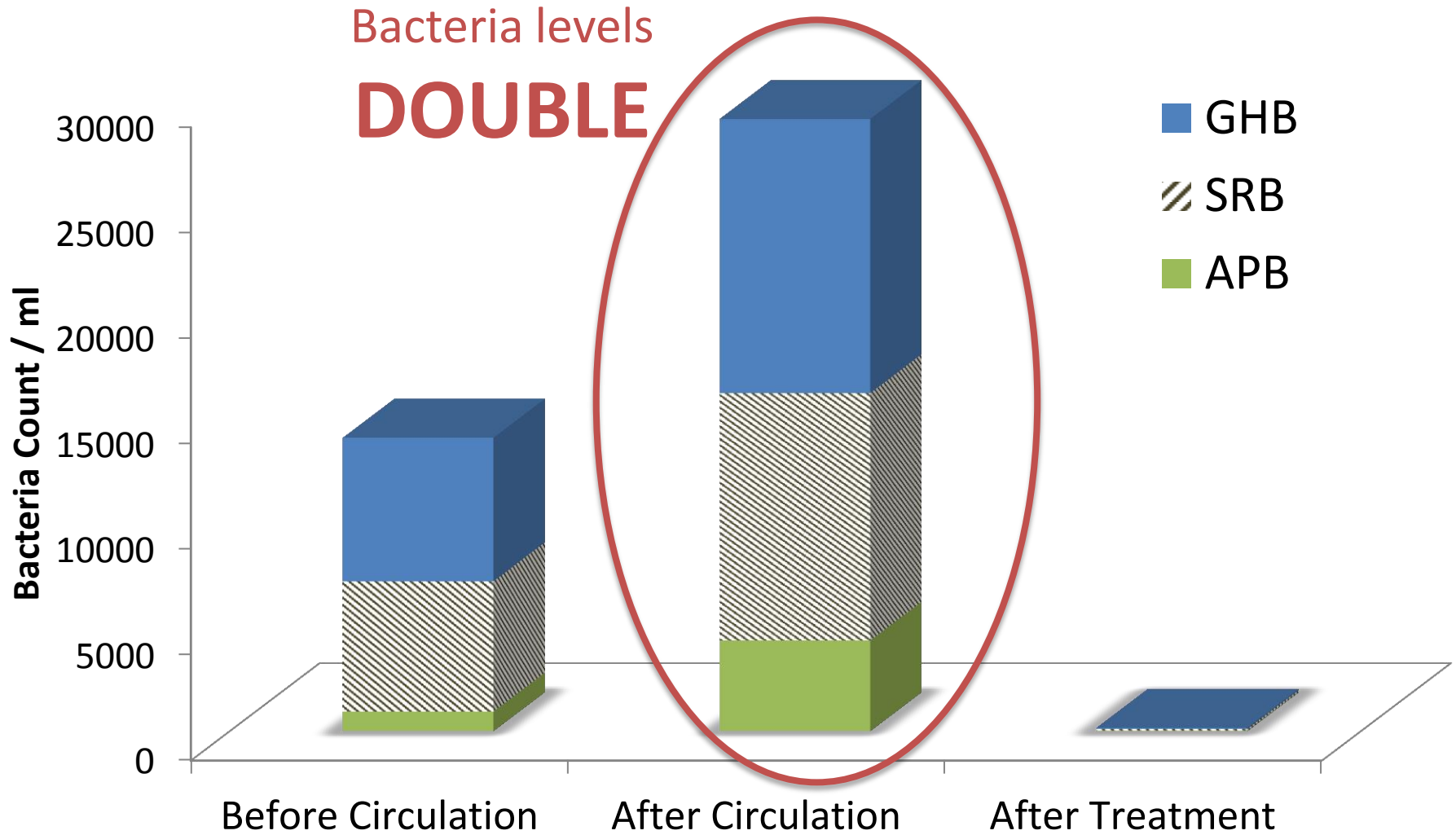
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Gel frac recycle  
and control system

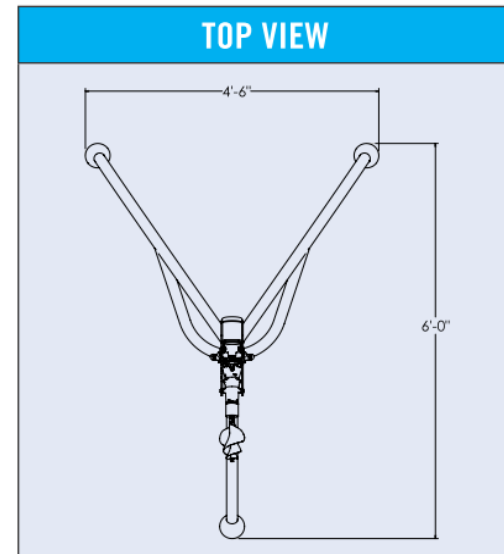
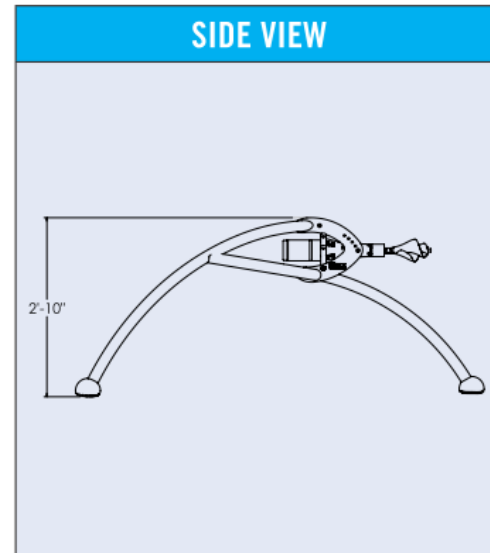
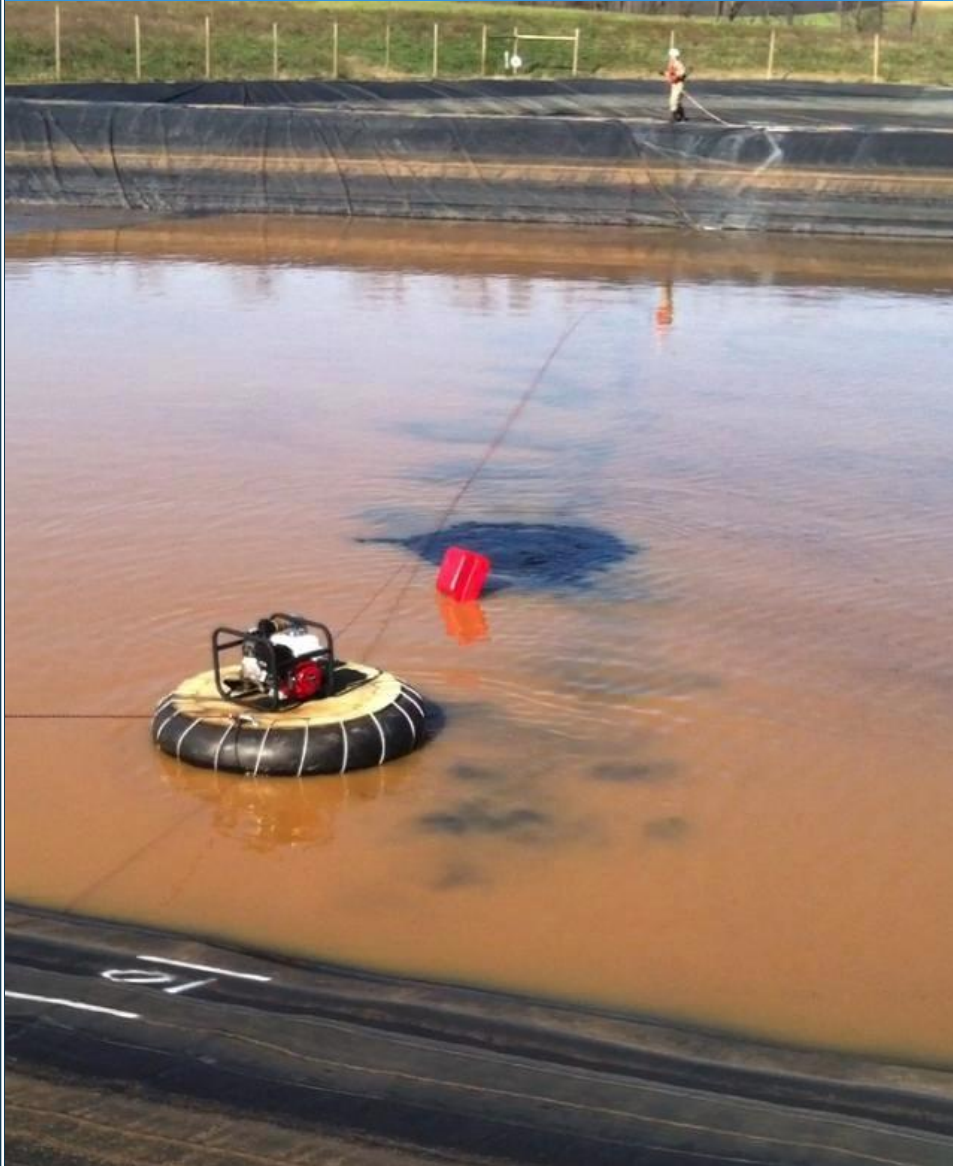
## Pre-frac circulation

- Agitate water
- Collect samples
- Engineer chemistry to match the fluid

# Why circulate?



# Circulation Options



# X-FRaC SYSTEM

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Gel frac recycle  
and control system

## Real-time measurement

- Total dissolved solids
- Chloride
- Boron
- General Water Quality



# X-FRaC SYSTEM

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Gel frac recycle  
and control system

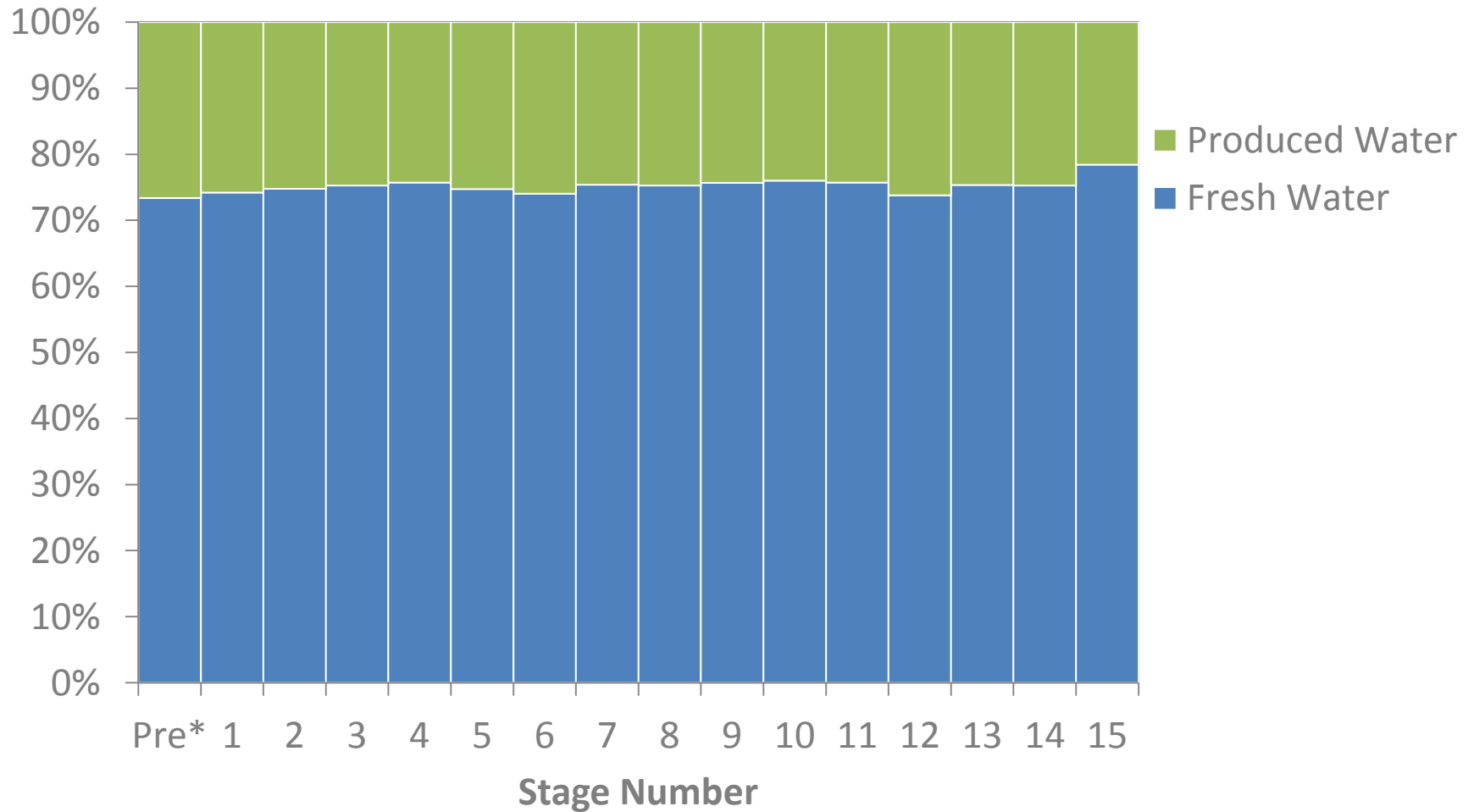
## Pump control

- Control pump RPMs
- Control blend ratios
- Adjust blends on-the-fly

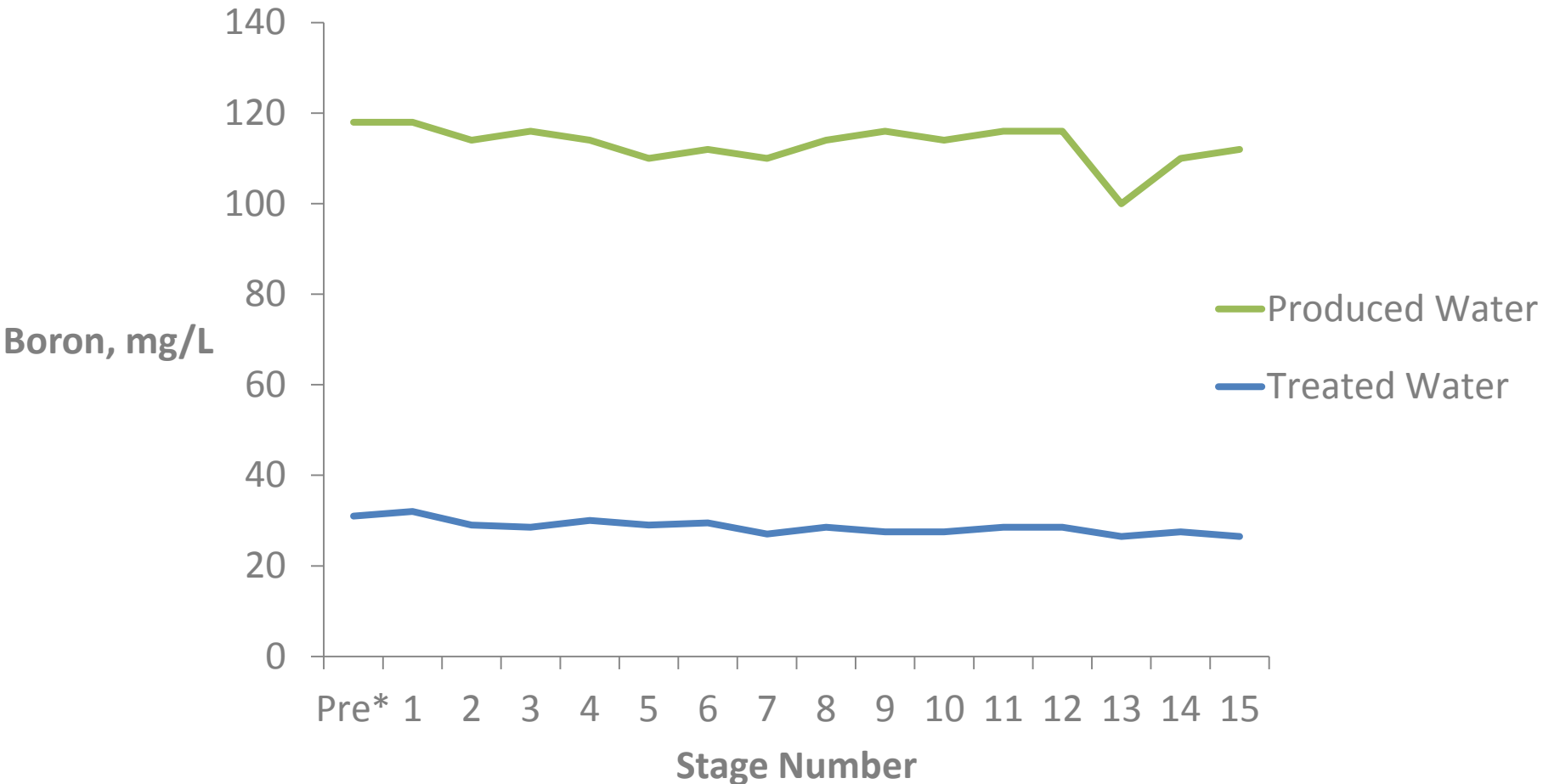
# Case study – Permian Basin

- 130,000 bbl frac
- 75% freshwater
- 25% produced fluid
- **Results**
  - Volumetric ratios
  - Boron
  - Chloride

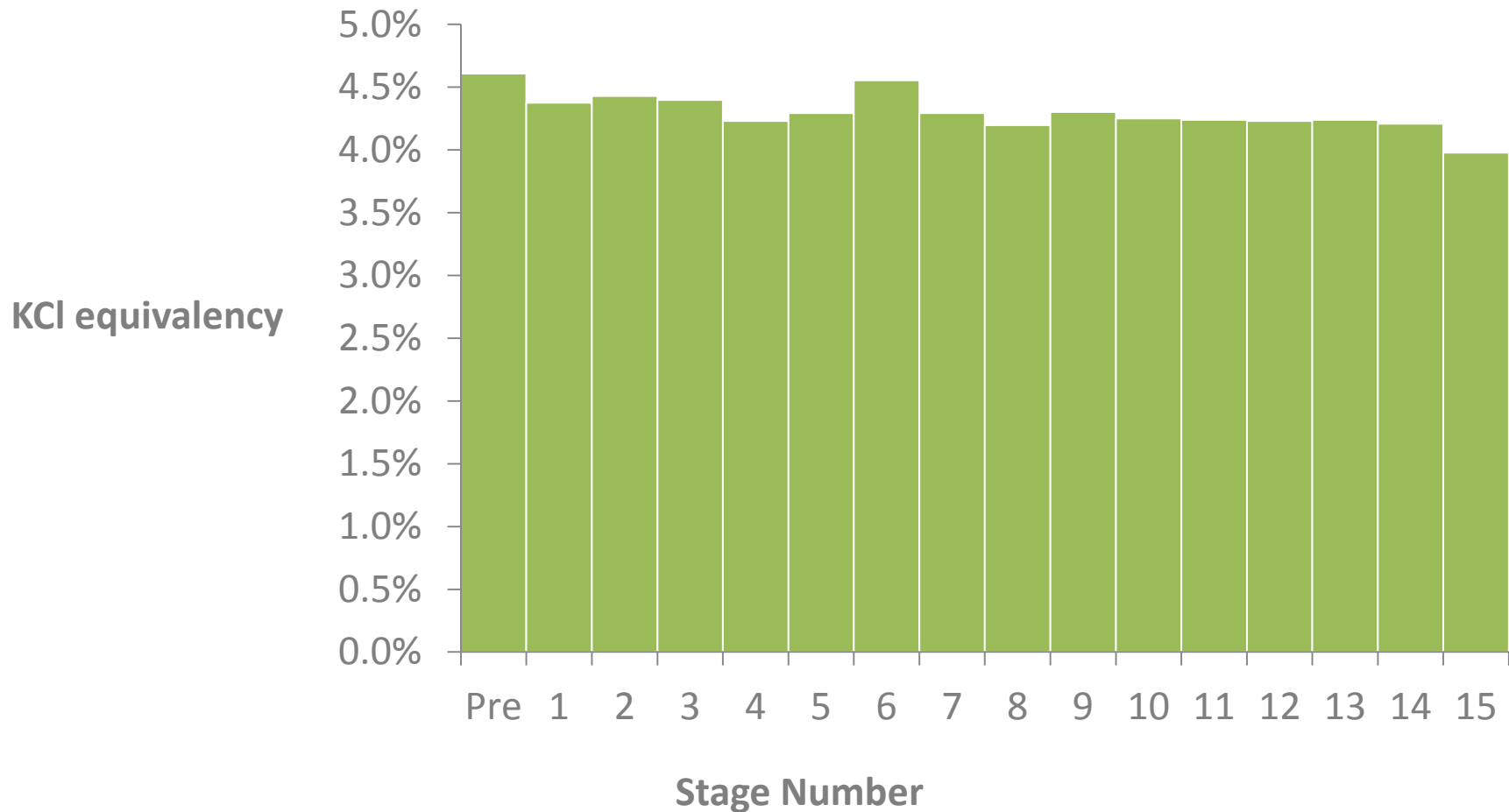
# Volumetric ratios



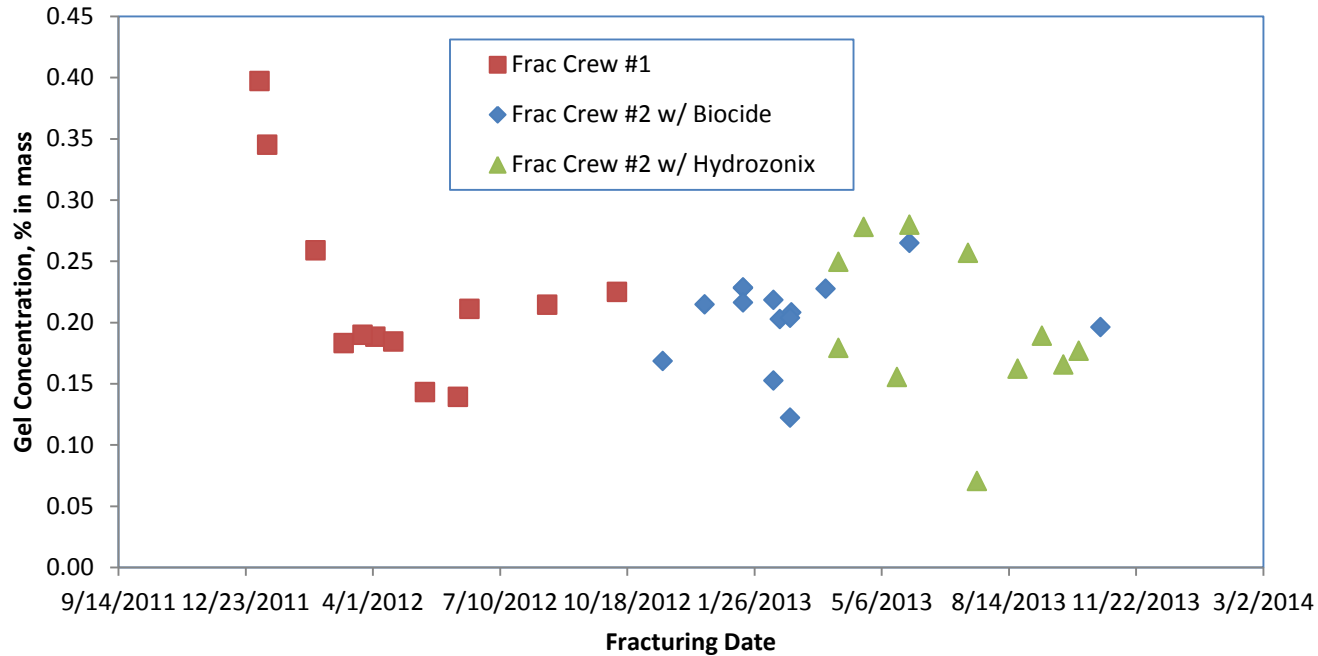
# Boron levels



# Potassium chloride (KCl) equivalency



# Gel Concentration vs. Recycle Rate



Frac Service	# of wells	Gel Concentration, % in mass	Gel to Proppant Ratio
Frac Crew #1	12	0.223	0.017 : 1
Frac Crew #2 w/ Biocide	14	0.204	0.029 : 1
Frac Crew # 2 w/ Hydrozonix	11	0.197	0.026 : 1

# Hydrozonix EF80

- Versatile bacteria treatment
- On-the-fly treatment onsite
- No negative impact on chemical compatibility



A sunset over a body of water with industrial buildings and a pumpjack in the background. The sky is filled with colorful clouds in shades of orange, yellow, and blue. The water reflects the colors of the sunset. In the background, there are several dark industrial buildings and a pumpjack. The word "Questions ?" is written in large white letters across the center of the image.

Questions ?

[www.hydrozonix.com](http://www.hydrozonix.com)