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Mid-Continent Water Management for Stimulation Operations

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Related Modeling
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Why Is Water Important to the Petroleum Industry?

- Water is the most common and most heavily used fluid in the petroleum industry
- Water is produced along with oil and gas from nearly every well
- Water is used as a base fluid in production, drilling, and completion operations
- Water will be produced, recycled, injected, mixed, cleaned, and reinjected
- **Water's use and protection are emotionally charged subjects in many communities**

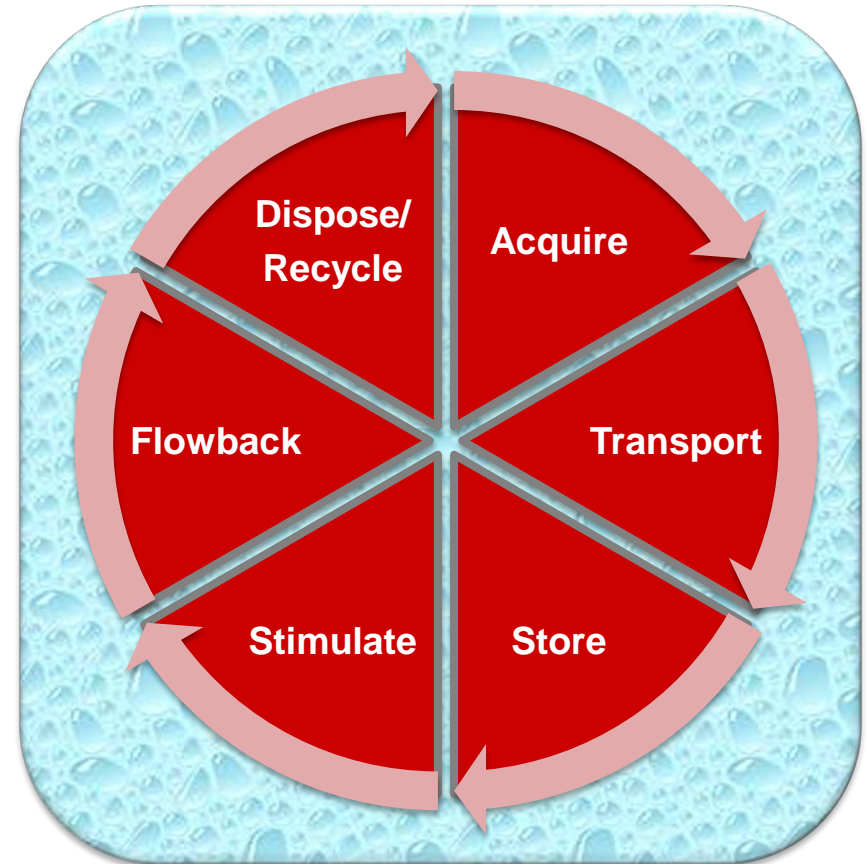


Significance of Water to Our Business

- **More than ever, water is an integral part of the success of oil and gas operations. So, think about this**
- **No Water**
- **No Hydraulic Fracturing**
- **No Oil and Gas Resource Plays**

Water Management Cycle

- **Water source**
 - *Subsurface aquifers*
 - *Rivers, lakes or ponds*
 - *Rural or urban water supplies*
 - *Gray Water*
 - *Acid Mine Drainage*
- **Water transport**
 - *Pipeline*
 - *Trucking*
- **Water storage**
 - *Frac Tanks (500 bbls)*
 - *Modular Tanks (up to 40,000 bbls)*
 - *Portadam (size as required)*
 - *Pits or ponds (100,000+ bbls)*
- **Water treatment and reuse**
 - *Physical*
 - *Chemical*
- **Water disposal**
 - *Evaporation*
 - *Water disposal wells*



Water Sources

- Subsurface Aquifers using water wells
- Ground Water from naturally occurring or man made ponds



Water Sources

- Area lakes and streams



Water Transportation



Poly Pipe Cross Sections

12" SDR 11 HDPE



8" SDR 11 HDPE

Water Storage



Why Is Water Storage Important?

- **Water is the base fluid and biggest component of any hydraulic fracturing operation**
- **Water volumes required for typical completions range from 100,000 to 500,000 barrels per well**
- **Water must be stored near the operation in sufficient quantities to finish a job at the desired pump rate**
- **In the first 90 days after fracturing, a well can produce from 30 to 80% of its load back**
- **To recycle water there has to be enough storage for both the produced water and the processed water**
- **Water must be stored in a manner that is economically and environmentally sound**

Frac Tanks

Capacity

500 barrels

Transported by Truck

Number needed for a 250,000 BBL slick water frac

500

Normally use 15 to 20 frac tanks on a job



Fresh Water Impoundment – Lined

Size can vary

*Operational Requirements
Terrain*

Cost to Construct

\$150,000 to \$200,000

**Number needed for a
250,000 BBL slick water
frac**

1



Recycled Water Impoundment - Lined

Impoundments

Designed by professional engineer
Permitted by the state

Size can vary

Operational requirements
Terrain
This pit is 480,000 barrels

Cost to Construct

\$500,000 including engineering, land, legal and construction



Fresh Water Impoundment - Unlined

Impoundments can be

Naturally occurring

Man made

Size can vary

Operational Requirements

Terrain

Cost to Construct

\$75,000 to \$150,000

**Number needed for a
250,000 BBL slick water
frac**

1



Large Capacity Above Ground Moveable Tanks

**Size Can Range by
type and make of tank**

Rectangular

2,200 to 15,400 BBL

Circular

4,500 to 42,000 BBL

Portadam

Determined by user



Above Ground Tank Options



Load Recovery

Flow Back

- Using pipeline and transfer pumps
- Capacity over 500 BPH
- Replenish frac water supply

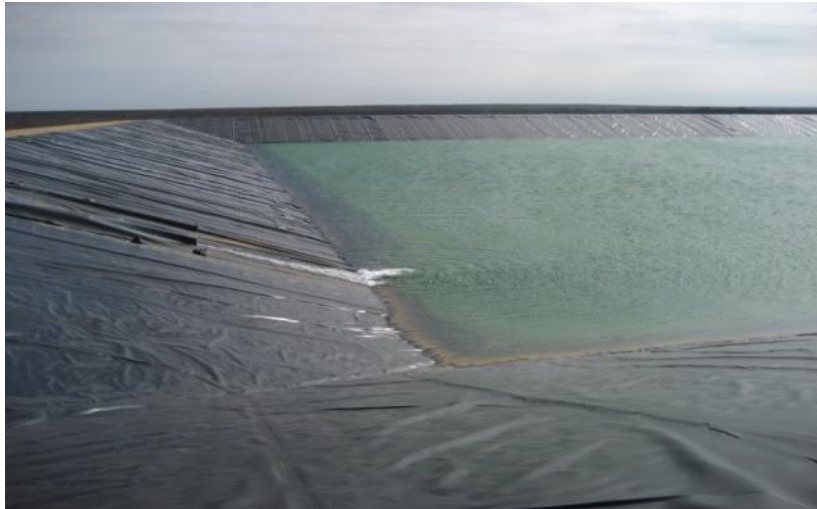


Trucking

- Could have 100 trucks per day to haul water from a well flowing 500 BPH
- Determine break even between pumping/pipeline changes and trucking costs plus disposal fees



Water Treatment and Reuse



Recycling Challenges

- **Fresh water**
 - *Few problems with frac fluid chemistry*
- **Produced water & flow back water**
 - *Must be cost neutral*
 - *Minerals can interfere with frac gel*
 - *Water quality varies widely*
 - *May cause scale or bacteria growth*
- **Study needed determine water quality targets**
 - *Results specific to a basin or formation*
 - *Results will point to type of water treatment needed*
- **Regulations**
 - *Recycle or produced water pits often have to be permitted*
 - *OK and TX require design, certification, and construction supervision by a professional engineer*

Treatment Options

There are a number of treatment options available to producers, with options including dilution, settling, chemical treatment, filtration, clarification, electro-coagulation, and distillation.

~\$1.50 - \$2.00/bbl	Dilution	<ul style="list-style-type: none"> • Involves blending flowback or produced water with freshwater during fracturing. • Not free - has a handling cost for frac tanks, containment, water transfer, etc.
~\$2.00 - \$2.50/bbl	Settling	<ul style="list-style-type: none"> • Must allow enough residence time in flow back pits or frac tanks for solids to settle. • Risks associated with storing raw water on location for long periods of time.
~\$2.00 - \$3.00/bbl	Filtration	<ul style="list-style-type: none"> • Bag filters, disk filters, or sand filters can be used. Other types available. • Issues can arise from expended filter sock disposal and bacteria introduction. • Water sources for back flushing system can be logistically difficult .
~\$2.50 - \$4.00/bbl	Chemical Precipitation	<ul style="list-style-type: none"> • Involves pH adjustment and the addition of polymers or other flocculants. • Issues can arise from excess sludge formation and sludge disposal. • Chemical drum or tote management can be logistically difficult on location.
~\$3.50 - \$4.50/bbl	Clarification	<ul style="list-style-type: none"> • Involves the use of equipment including DAFs or clarifiers. • Typically involves chemical precipitation in conjunction with clarification equipment • Advantages include few moving parts and less downtime
~\$4.50 - \$5.50/bbl	Electro-Coagulation	<ul style="list-style-type: none"> • Sacrificial plates create a hydrolyzed metal sweet floc that significantly lowers total suspended solids (TSS), greases and oil, and in some cases metals count. • High operating costs relative to other TSS treatment systems.
~\$5.50 - \$8.00/bbl	Distillation	<ul style="list-style-type: none"> • Highest effluent water quality. Can potentially be handled in freshwater impoundments with approved NPDES permits. • Highest operating costs due to energy requirements. • Energy cost can be mitigated by running off of compressor station waste heat or natural gas.

Water Disposal

- Accelerated Evaporation



- Salt Water Disposal Well



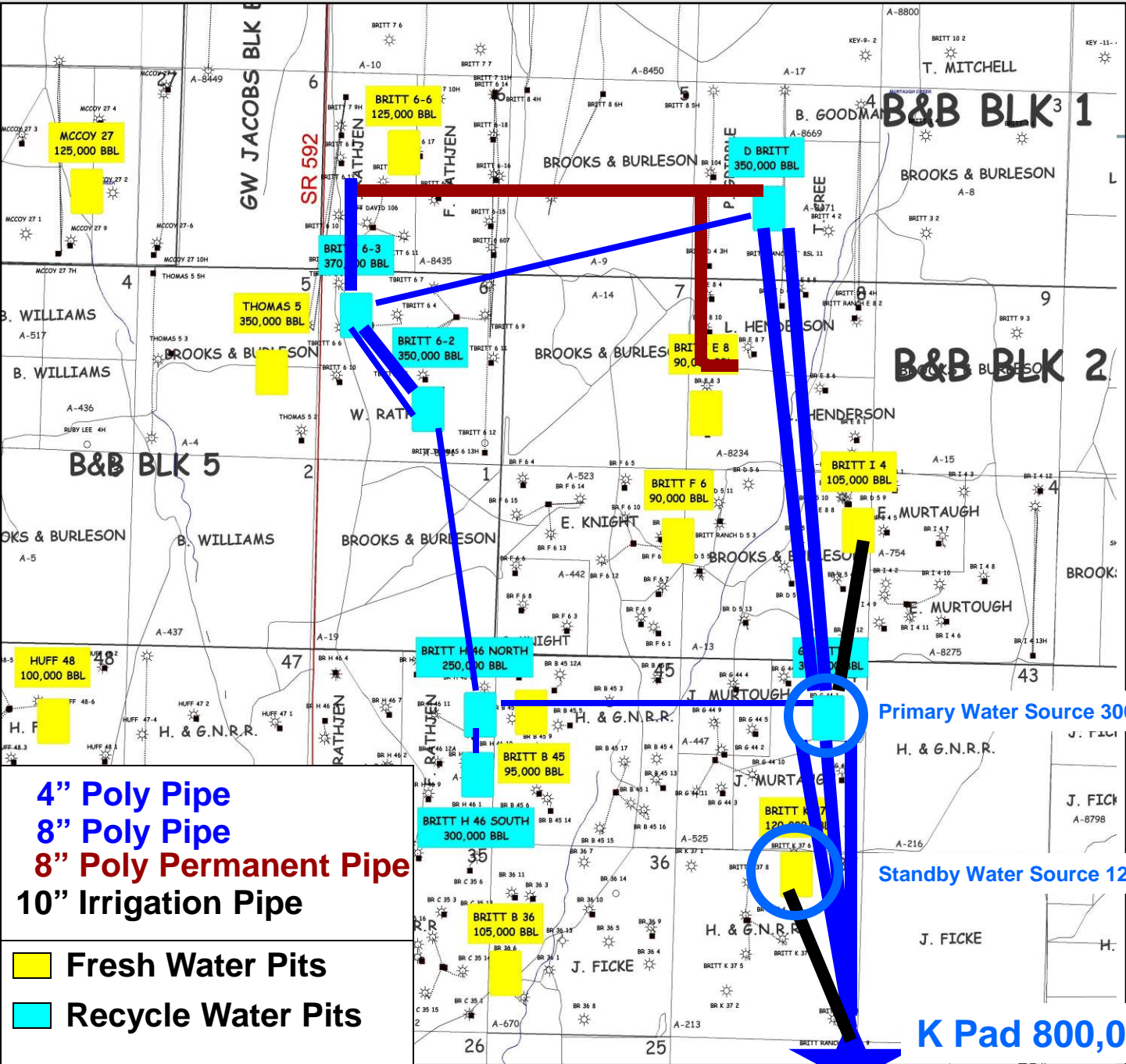
Newfield Mid-Continent Water Operations

General Comments

- **Granite Wash Operations recycle over 80% of water used**
 - *Flowback /Produced water has relatively low chloride content in the 10,000 to 20,000 ppm range*
 - *Transport produced water to recycle pits through poly lines*

- **Arkoma Operations reuses 6% of produced water**
 - *Flowback /Produced water has chloride content in the 30,000 to 70,000 ppm range*
 - *Transported to recycle facility by trucks*
 - *Cleaned and used as a brine source*
 - *Combined with fresh water*

- **Cana Woodford planning to recycle produced water**
 - *Flowback water has chloride content less than 20,000 ppm*
 - *Will transport to recycle facility by truck*



4" Poly Pipe
8" Poly Pipe
8" Poly Permanent Pipe
10" Irrigation Pipe

Fresh Water Pits
 Recycle Water Pits

Primary Water Source 300,000 bbl

Standby Water Source 120,000 bbl

K Pad 800,000 bbl

Why Newfield Recycles Water

- **Saving Fresh Water – 10 million barrels per year**
- **Saving Money – \$50 million per year**
- **Limited supply of fresh water due to drought**
- **Reduce the need to dispose of produced water**
- **Potential to reduce transportation costs**
- **Environmentally responsible**
- **Improved social license**



How Much Water Newfield Recycled

During the Last 5 years Newfield's Britt Ranch Fracturing Operations

50 Million Barrels

Fresh Water Saved

and

\$ 250 Million Saved

Why Would You Reuse Produced Water?

- **It saves fresh water**
- **It is environmentally responsible**
- **It improves your social license**



Questions!?!?!?

THERE IS NO LIFE WITHOUT WATER.



**BECAUSE WATER IS NEEDED
TO MAKE COFFEE.**