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Mid- Continent Water Management for Stimulation Operations

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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

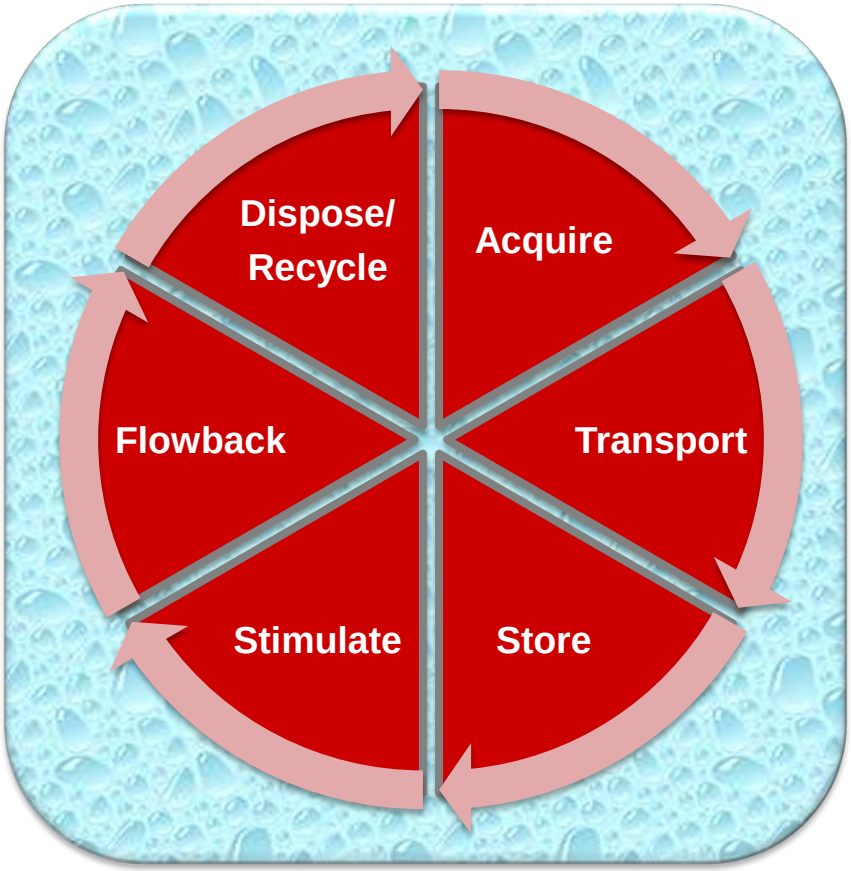
- No Water

- 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

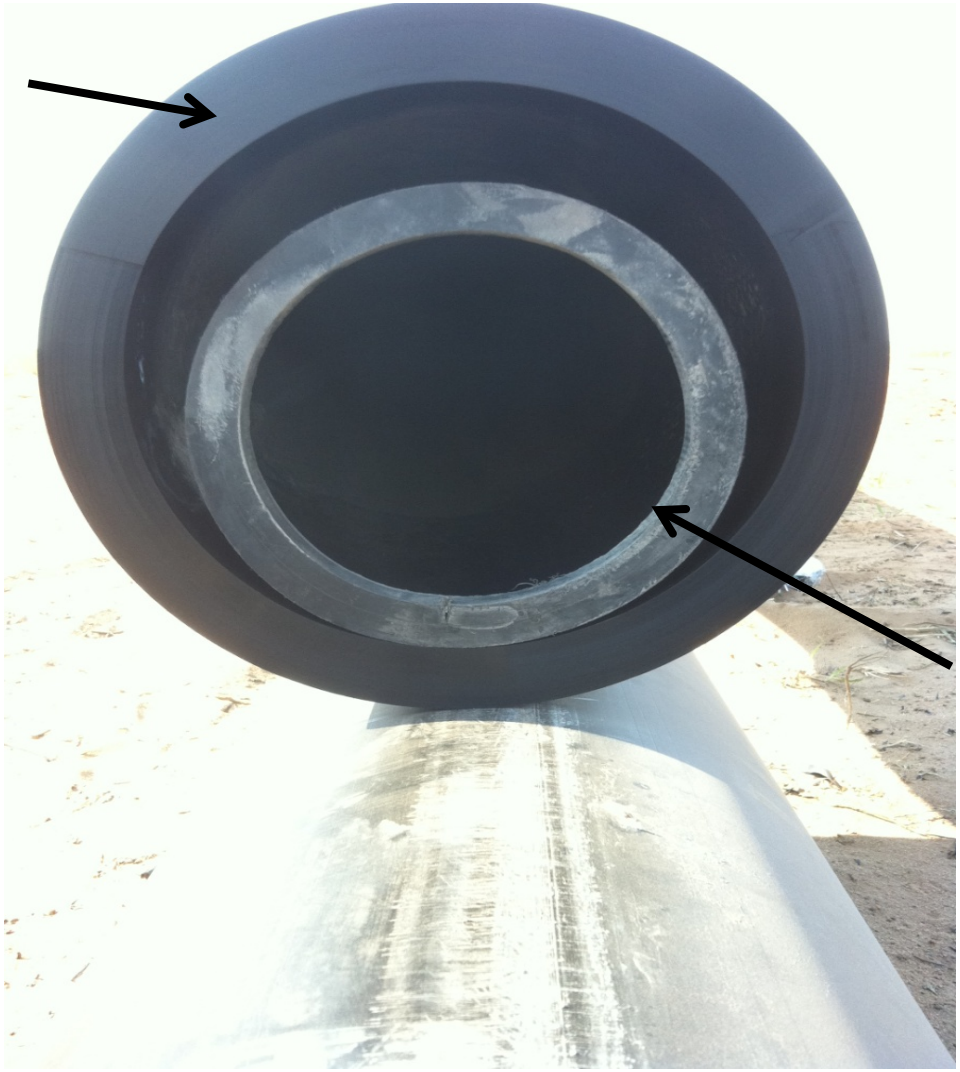
Water Sources

- 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

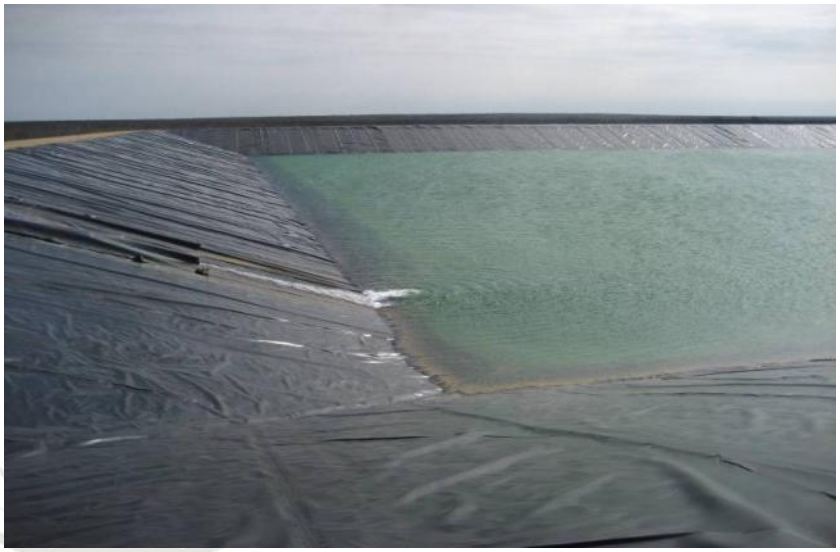
Load Recovery

Flow Back

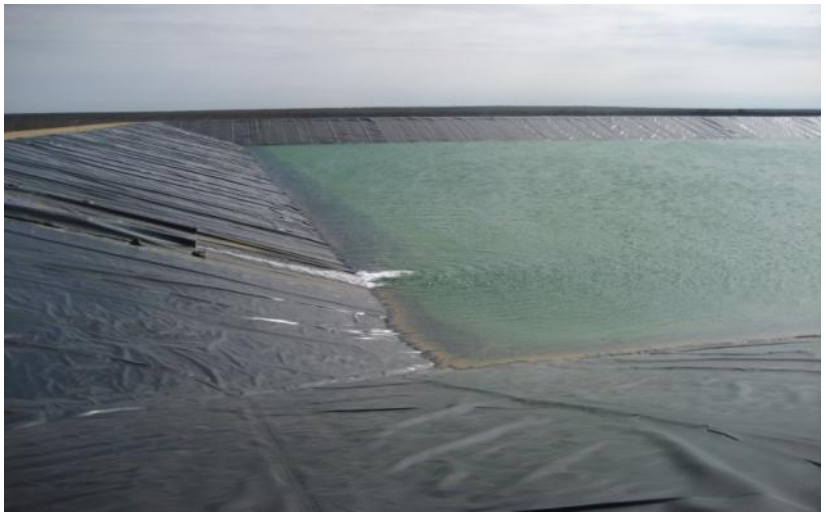
- Using pipeline and transfer pumps
- Capacity over 500 BPH
- Replenish frac water supply

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	•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	•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	•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	•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	•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	•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	•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.

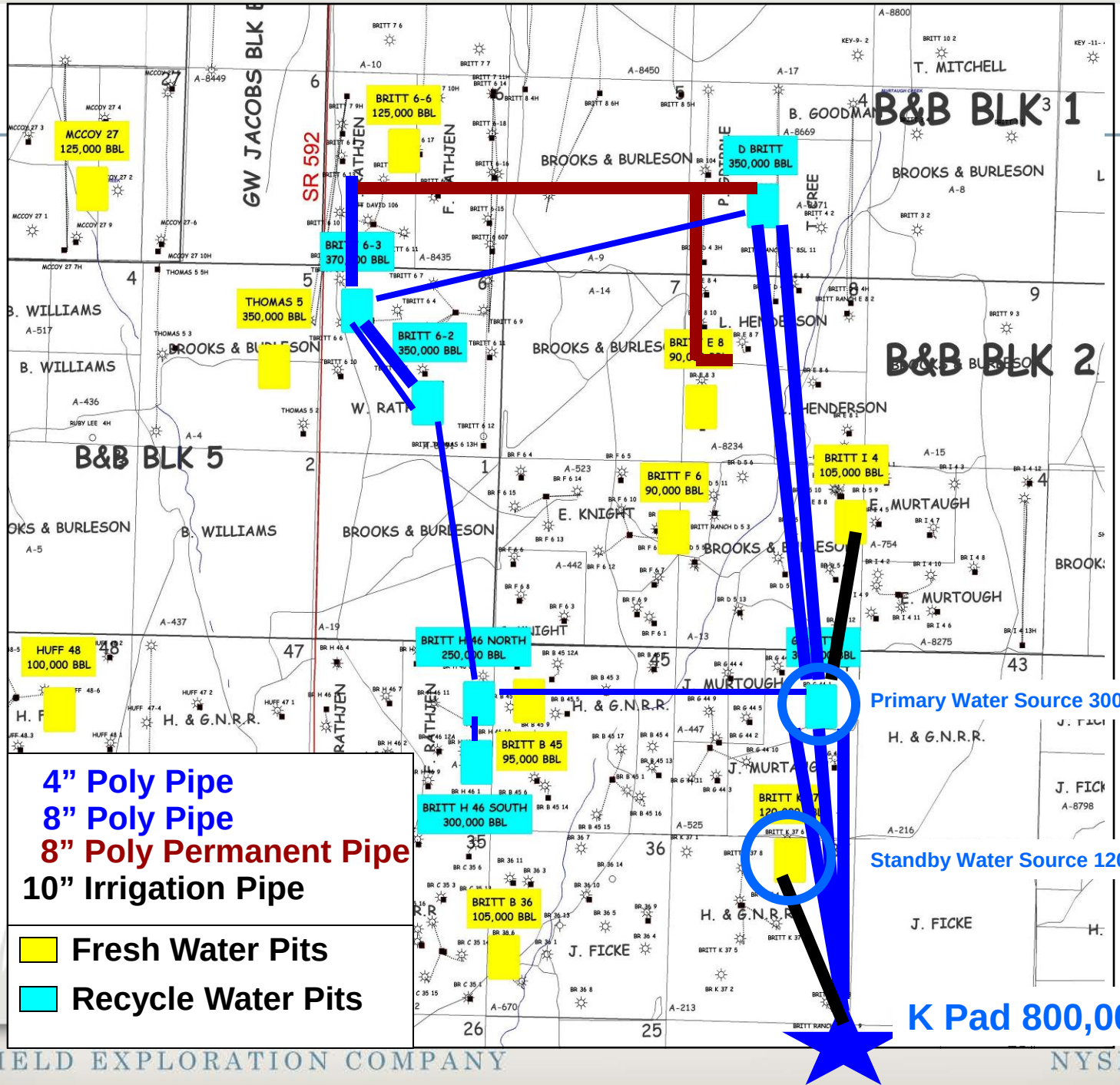
Water Disposal

- **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*


MCCOY 27
125,000 BBL
BRITT 6-6
125,000 BBL
D BRITT
350,000 BBL
THOMAS 5
350,000 BBL
BRITT 6-2
350,000 BBL
BRITT F 6
90,000 BBL
BRITT I 4
105,000 BBL
HUFF 48
100,000 BBL
BRITT H 46 NORTH
250,000 BBL
BRITT B 45
95,000 BBL
BRITT H 46 SOUTH
300,000 BBL
BRITT B 36
105,000 BBL
SR 592
GW JACOBS BLK
B&B BLK 1
B&B BLK 2
B&B BLK 5
BROOKS & BURLESON
B. WILLIAMS
E. KNIGHT
E. MURTAUGH
J. MURTOUGH
H. & G.N.R.R.
J. FICKE
T. MITCHELL
B. GOODMAN
L. HENDERSON
W. RATHJEN
F. RATHJEN
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

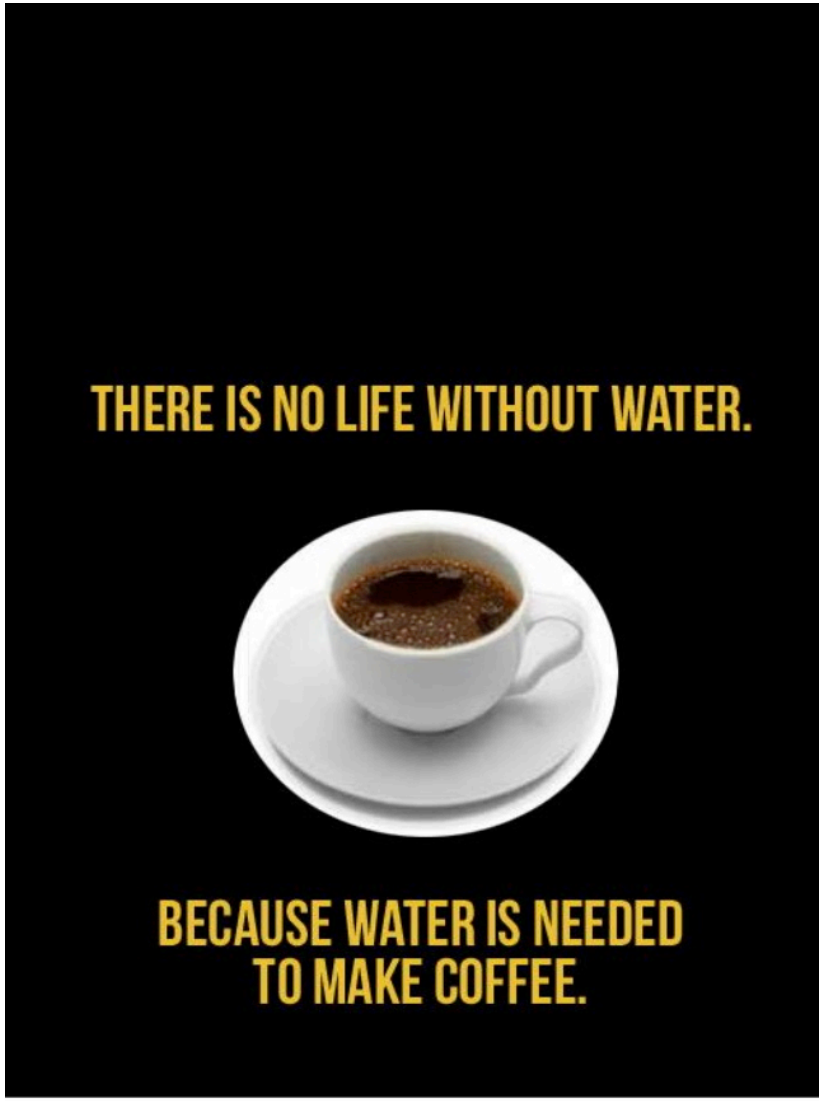
and

$ 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.