Water Management in Urban Corridors – Incentivizing Water Recycling and Discharge

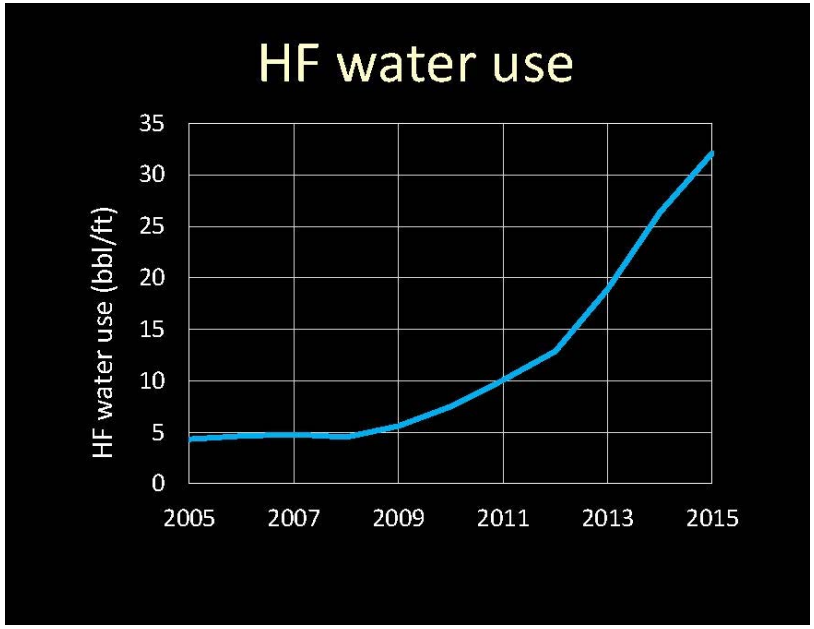
Lisa Henthorne, Water Standard

Agenda

- Water Recycling and Discharging PW/Flowback
  - Is it important?
  - Challenges in urban corridors
- Drivers and Methods
  - Public perception
  - Regulations
  - Treatment requirements
  - How to assess options and solutions
    - Water management plan

How Much Water Are We Using?

- Consumption of 70-140 billion gallons of water per year for frac'ing operations, equivalent to 40-80 cities of 50,000 persons
- Per well consumption is rising based on shift to super fracs
- Recycling is slowly increasing, particularly in water-stressed regions, presently at 5-10% of demand



Scanlon, 2017

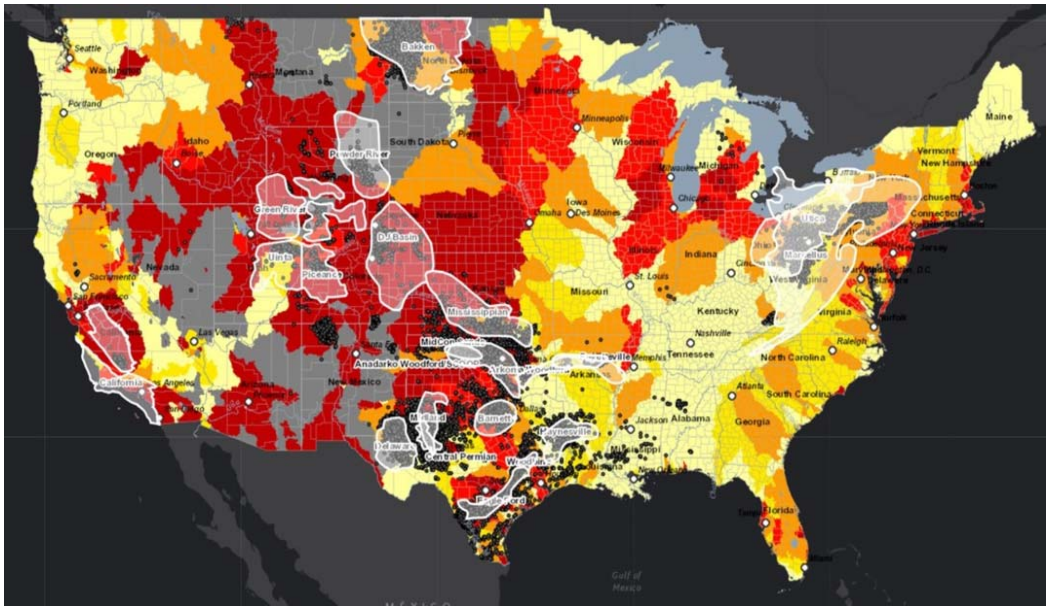
- Water usage accounts for 0.02% of U.S. renewable water resources
  - In 50 years we will have eliminated 1% of our country's entire water supply via SWD's
  - Local impact much greater

Surface and Groundwater Sourcing

- Considerations
  - Limited supply
  - Distance from site
  - Public perception
    - Disruption from trucking
    - Use of limited source supply
    - Risk of contamination of aquifers
  - Influence on the environment
    - Bakken operator: What difference does it make since that water was just going into the river?
  - Though limited in supply, freshwater is often inexpensive relative to treatment of PW/flowback

What are the Challenges?

- Cost of water increasing in some areas and negative public perception growing
- Long-term impacts on the environment and available water supply, especially in water-stressed regions
- Low costs of SWD disposal, often less than $0.50/bbl
- Infrastructure required and water demands move and change
- Legal and regulatory challenges

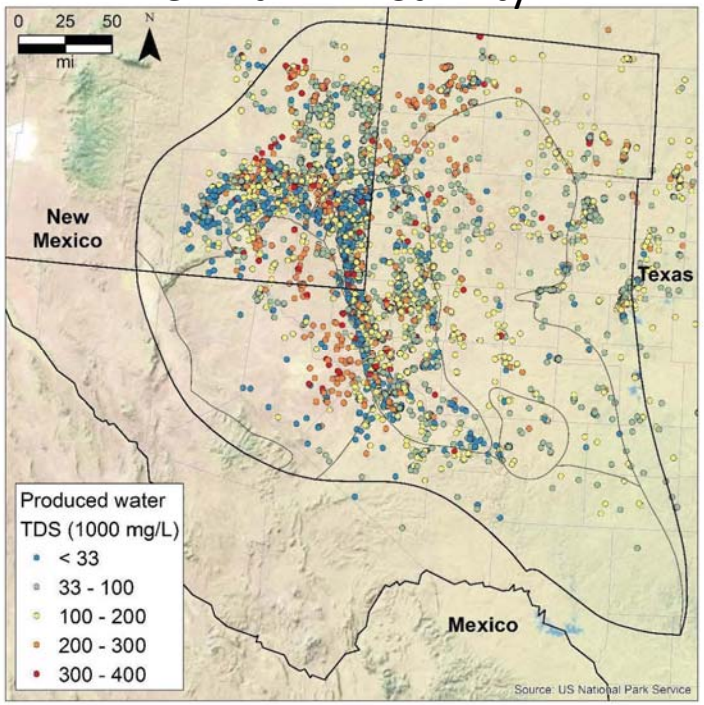


World Resources Institute, 2014

Other Challenges

- Treatment for recycle cost-effective; treatment for discharge more expensive and limited data
- Salinity in some areas too high for cost-effective treatment for discharge
- SWD's being limited due to seismic issues

Permian PW Salinity



Permian, USGS PW database

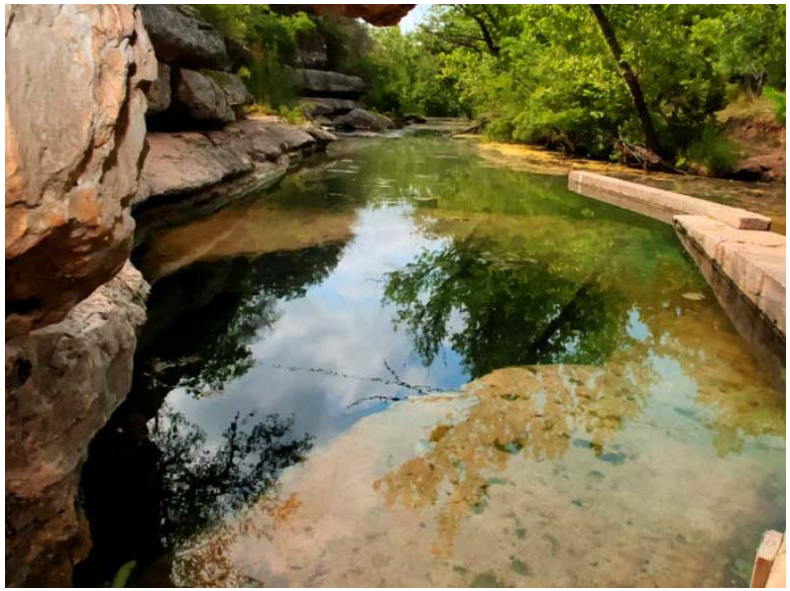
Water Recycling – Benefits and Risks

- Benefits
  - Good stewards of water resources – community intangible benefits
  - Reduces water purchase and SWD disposal costs – water balance
  - Reasonable costs of $0.15-60/bbl
  - Mobility can be reasonably integrated to accommodate shifting water demands

- Risks
  - Water quality, regulations in some states, water balancing demand to supply, right-of-ways/transportation

Discharge/Beneficial Reuse – Benefits and Risks

- Benefits
  - Excellent stewards of water resources – public perception benefits
  - Water footprint minimized - environmental benefits and investor benefits
  - Additional treatment can be added downstream of recycle treatment



- Risks
  - Contamination of rivers and streams
  - Costs impacts can be significant – look for alternate beneficial treatment options
  - Schedule impact of permitting and piloting

Drivers and Guideposts

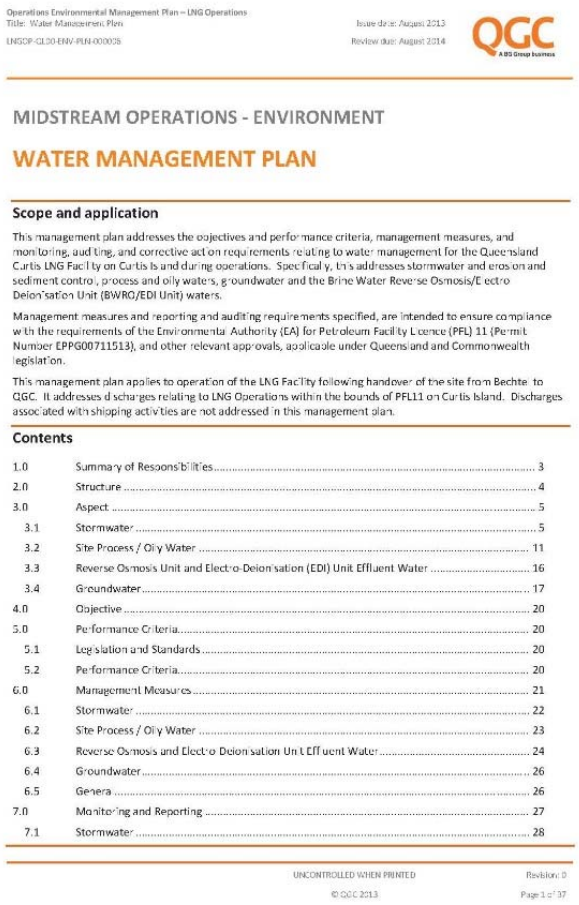
- Public perception
  - Urban corridors tend to have vocal, informed stakeholders
  - What's important: aesthetics, noise, air pollution, congestion, health impacts, environmental sensibilities, water resources, water pollution
- Regulations
  - State-by-state: options and requirements vary greatly
    - Local knowledge and access helpful in navigating the quagmire
    - Some states will provide preliminary assessment of discharge limitations
    - Where you discharge is critical

How To Move Forward

- Start with known data
- Meet with operations and stakeholders to assess needs
- Conduct options analysis
  - Water Management Plan methodology
    - Sourcing – alternative sources over freshwater
    - Recycling – adjacent operators (potential reg impact)
      - Specs and costs
    - Discharge – discharge options and treatment
    - Other – Blending for discharge, treating alternative impaired quality source for beneficial use or improved quality discharge, credits for alternative treatment

Workflow for WMP

1. Develop a Water Management Plan for asset (site and region specific)
2. Conduct water sampling/analyses (include BTEX and ammonia)
3. Evaluate economics, feasibility of options, and near/long-term impacts, including social and environmental, as well as sustainability goals
4. Work with state for permitting, if applicable
5. Develop treatment solution (often vendor-driven)



Operations Environmental Management Plan – LNG Operations
Title: Water Management Plan
LNGOP-QLD0-ENV-PLN-000005
Issue date: August 2013
Review due: August 2014

MIDSTREAM OPERATIONS - ENVIRONMENT

WATER MANAGEMENT PLAN

Scope and application

This management plan addresses the objectives and performance criteria, management measures, and monitoring, auditing, and corrective action requirements relating to water management for the Queensland Curtis LNG Facility on Curtis Island during operations. Specifically, this addresses stormwater and erosion and sediment control, process and oily waters, groundwater and the Brine Water Reverse Osmosis/Electro Deionisation Unit (BWRO/EDI Unit) waters.

Management measures and reporting and auditing requirements specified, are intended to ensure compliance with the requirements of the Environmental Authority (EA) for Petroleum Facility Licence (PFL) 11 (Permit Number EPPG00711513), and other relevant approvals, applicable under Queensland and Commonwealth legislation.

This management plan applies to operation of the LNG Facility following handover of the site from Bechtel to QGC. It addresses discharges relating to LNG Operations within the bounds of PFL11 on Curtis Island. Discharges associated with shipping activities are not addressed in this management plan.

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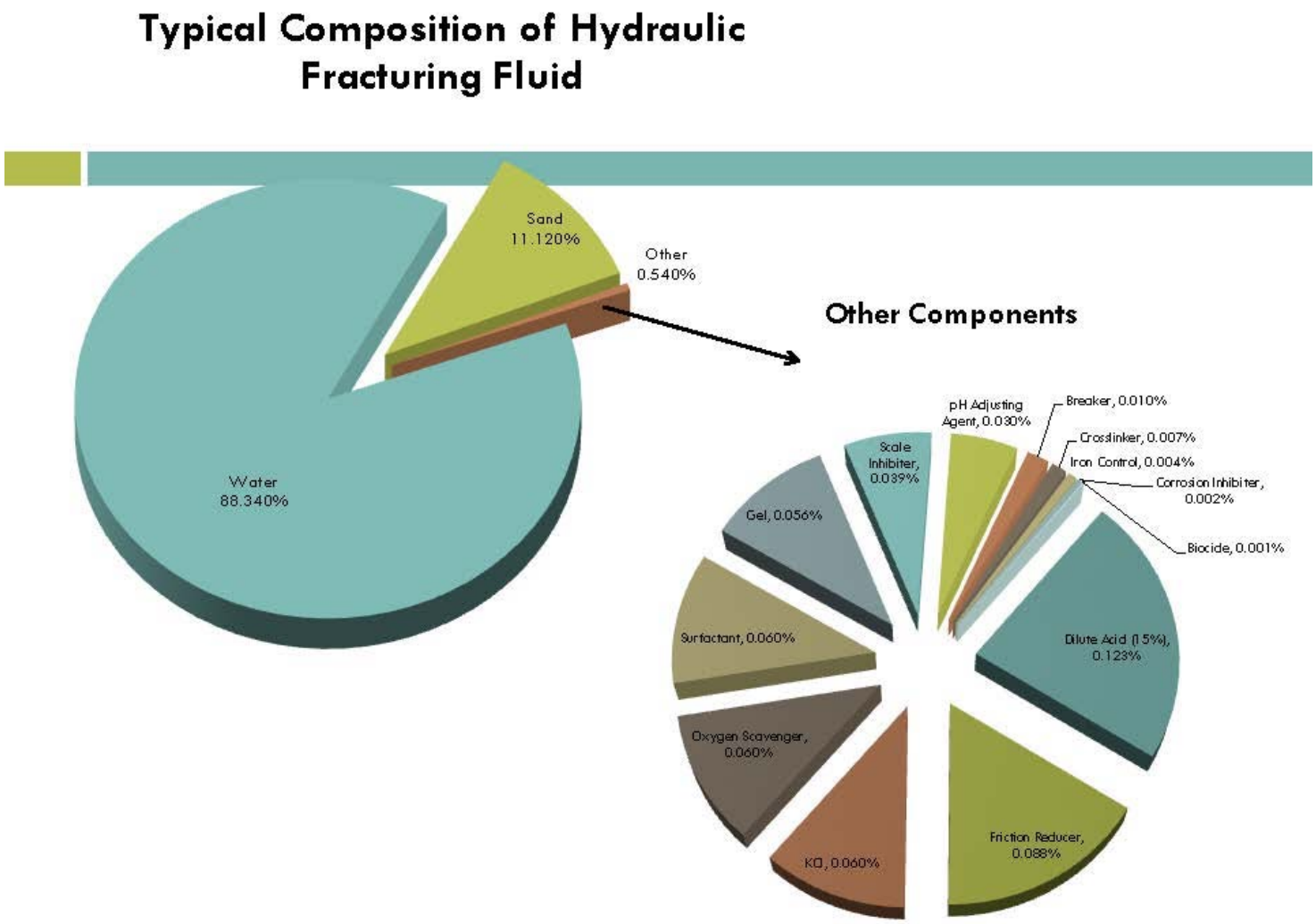
Conclusions

- Water management critical to economic production of hydrocarbons
- Current lack of knowledge of options
- Water Management Plan is the tool to address topic and result in best cost-effective long-term solution
- Technology is not the problem, but piloting may be required for discharge option
- Site and basins vary greatly in suitable treatment options, regulations and treatment costs
- We can greatly improve public perception around water issues related to unconventional production and protect the long-term value of our assets

Appendix

What's In It?


Typical Composition of Hydraulic Fracturing Fluid
Sand 11.120%
Other 0.540%
Water 88.340%
Other Components
pH Adjusting Agent, 0.030%
Breaker, 0.010%
Crosslinker, 0.007%
Iron Control, 0.004%
Corrosion Inhibiter, 0.002%
Biocide, 0.001%
Scale Inhibiter, 0.039%
Gel, 0.056%
Surfactant, 0.060%
Oxygen Scavenger, 0.060%
KCl, 0.060%
Friction Reducer, 0.088%
Dilute Acid (15%), 0.123%

Recycle Water Quality

- Treatment Requirements
  - Low Total Suspended Solids (TSS) typically 10-50 mg/L
  - Hydrocarbon content < 40 mg/L
  - 100% bacterial kill
  - Low iron, typically < 10mg/L
  - pH 5.7-7.5

Disposal Management

- SWD Treatment Requirements
  - TSS < 100 mg/L

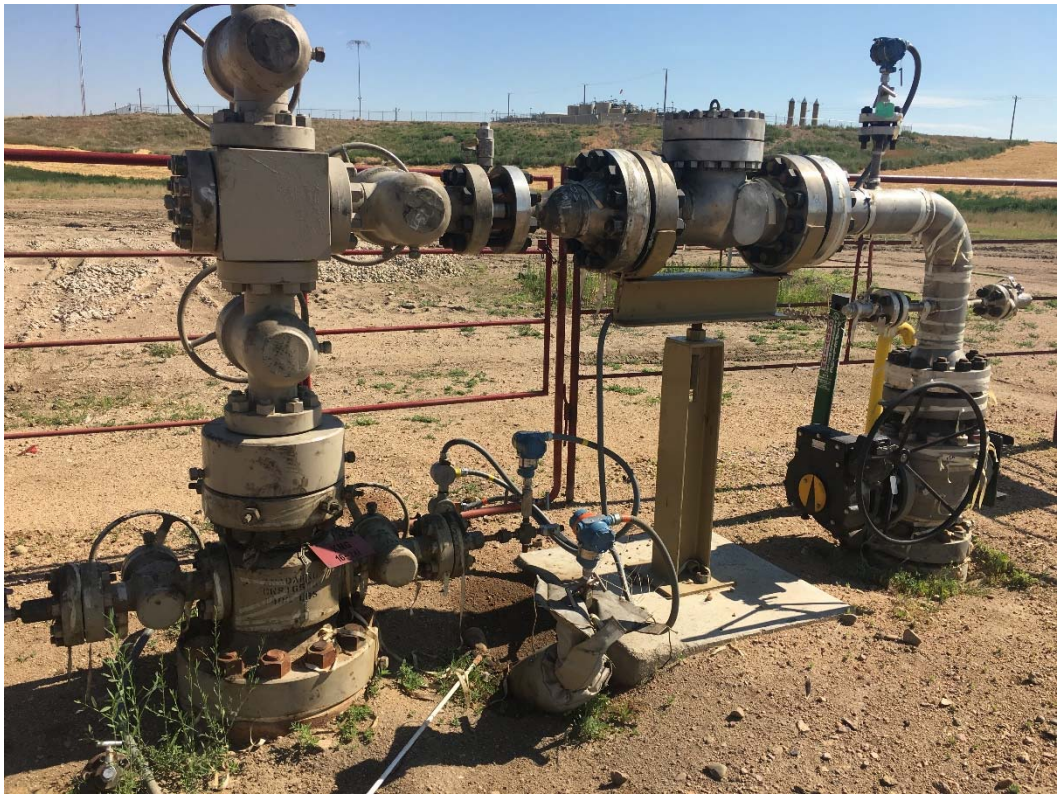


Photo courtesy of Water Standard