NATIONAL
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MONITORING
CONFERENCE

2020

Sampling and Analytical Considerations for Produced Water

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Not All Produced Water Is The Same

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The Weakest Link

- Emphasis on sampling

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Future Trends

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About NGL Energy Partners

- # 179 on Fortune 500
  - $17.2B Revenue FY 2019
- Water Midstream….all the rage in 2019
  - >1.7MM BBL/Day under management
  - >200 UIC wells
  - >600 miles of large diameter piped infrastructure

About NGL Energy Partners

Not All Produced Water is the Same

Produced water is a complex phase liquid that varies by;

- Basin characteristics
  - Variability within the basin
- Stacked plays present different zones with distinct properties
- Predominant petroleum products
- Age
- Completion technique
- **Surface equipment (More on this later)**

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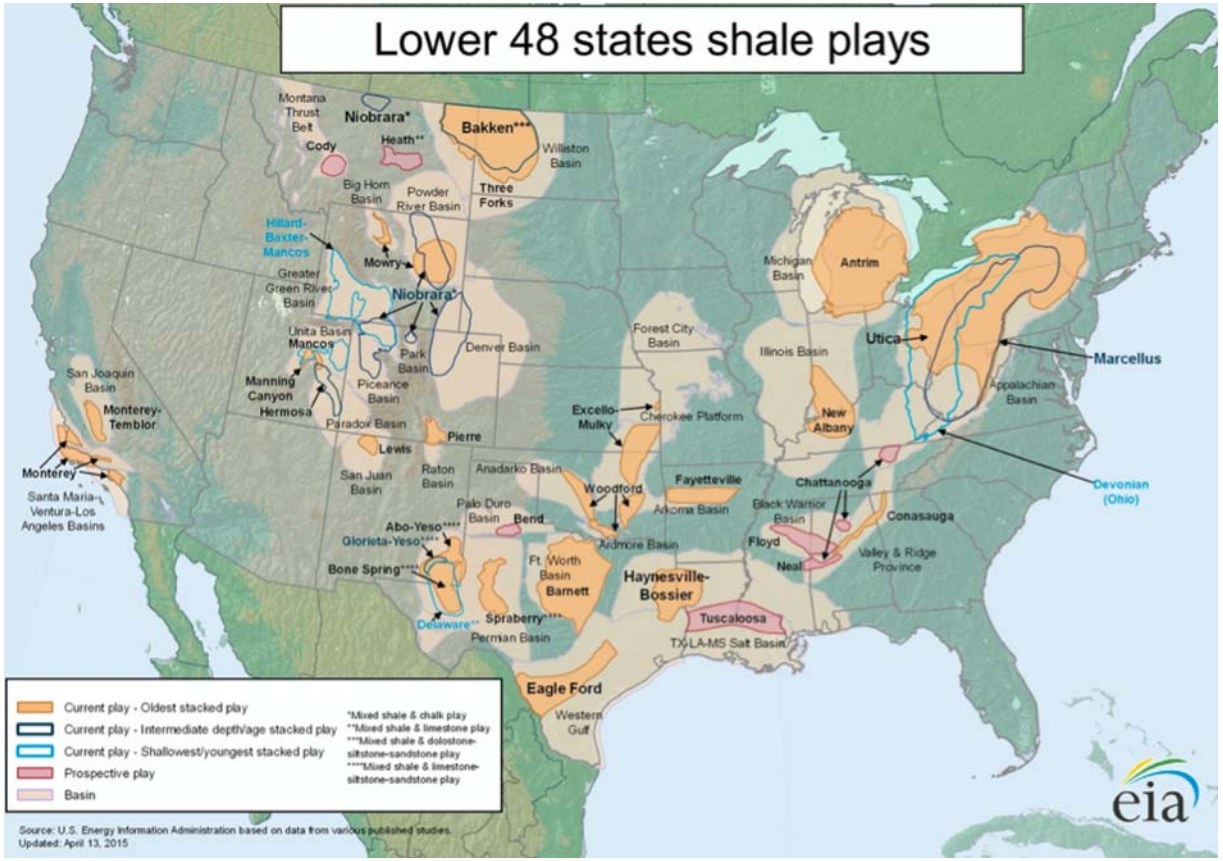
Not All Produced Water is the Same



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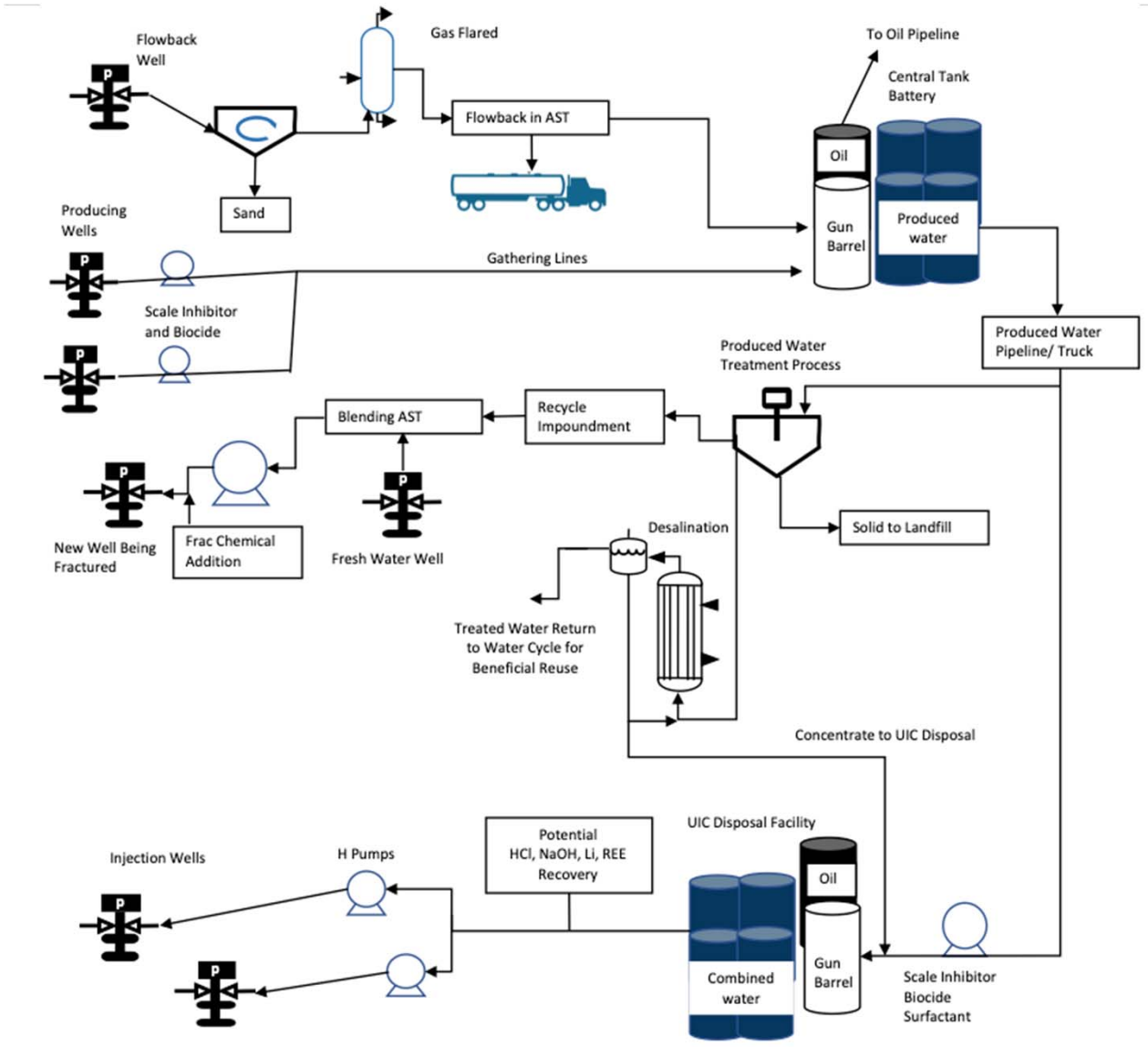
Highly complex systems rivaling industrial wastewater treatment trains

Rapidly changing flow and characteristics

Simplified Produced Water Line Diagram

Understanding your samples origination point in the process is crucial to interpreting the data.



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High levels of variability within system components.

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Best Practices for Analytical Success

- Open lines of communication with engineer and lab PM
- Consistent naming conventions enabling data trending
- Complimentary techniques (TDS-Inorganics, TOC-Organics)
- Know and anticipate bias (TSS)
- Sense check results
- Sampler must document sample location and any anomalies
- Dilution is the solution

Understanding this helped us numerous times, two good examples;

- Water tanks that failed flashpoint
- Facility fire that failed TCLP Benzene

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Future Trends

- Treatability Testing
- Integration with real time monitoring
- Integration of higher and lower tech to compliment standard lab offerings
- Rising importance of solid project managers

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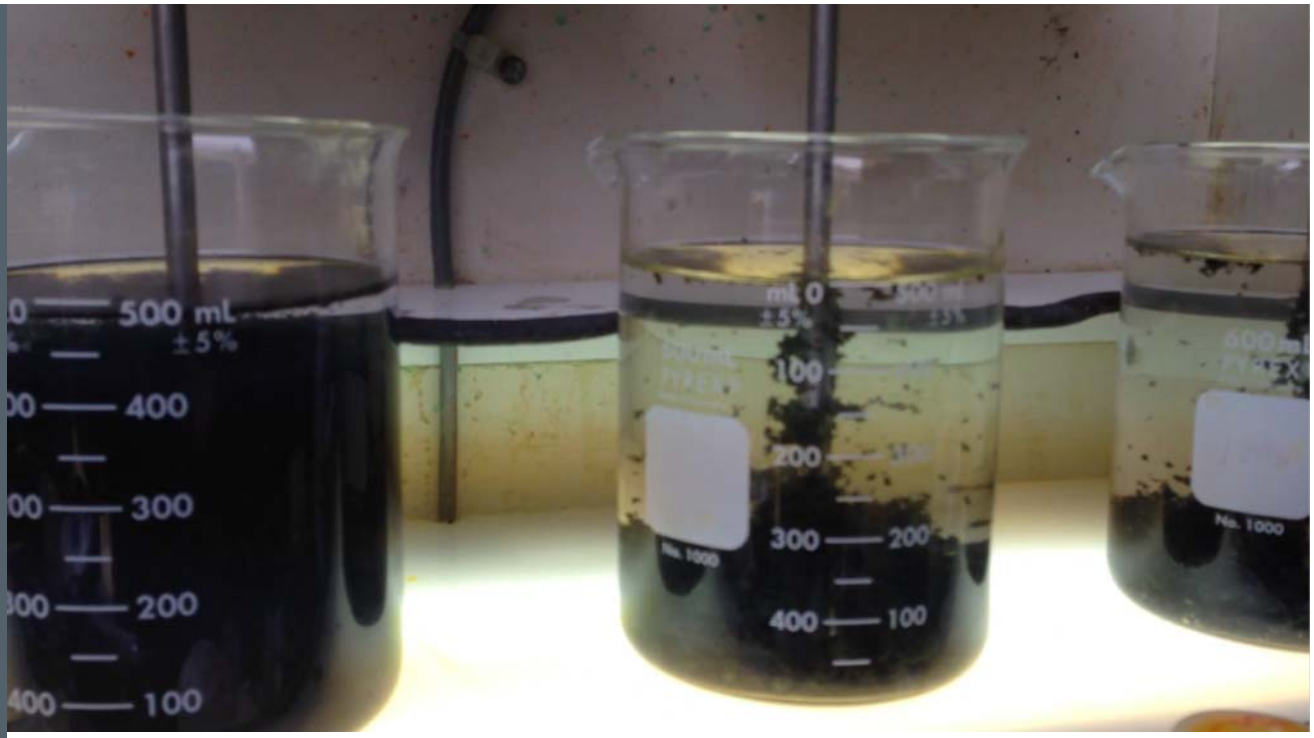
Treatability Testing



- One field sample creates multiple lab samples
  - Different media, different amounts, different phases
- Assist in remediation design, process optimization
- Currently done by
  - Chemical vendors (limited data output- zero QA/QC)
  - Niche engineering (High $/ suspect ability/ huge time delay results in changing chemical conditions)

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Integration with real time monitoring

- Field Data Solutions – vendor we partnered with to do some frac on the fly recycle continual monitoring projects.
- Allows verification of continual compliance
- Sends notifications for quality excursions
- Allows samplers to capture excursions and aid in trouble shooting
- A few simple probes can provide huge viability
- Because of remoteness of locations sampling and analytical may be weeks away- real time access gives managers more tools.

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Higher and lower tech to compliment lab methods

You will only find one of the above in my truck…

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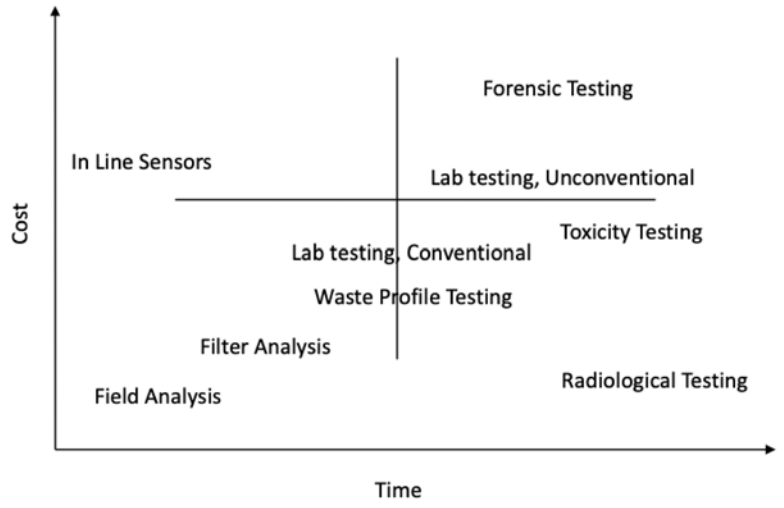
Higher and lower tech to compliment lab methods

Level	Use	Description	Parameters	Frequency
Tier 1	Continuous monitoring, bulk testing, KPI rapid analysis, process control	In Line Sensors	Flow, TSS, TDS, TOC, pH, ORP, Iron, H2S, TPH, level sensing, Carbonate,	Realtime, continuous and routine
		Field Parameters		
		Filter Analysis		
Tier 2	Detailed characterization, routine monitoring and Tier 1 data verification, NPDES discharge compliance, modeling treatment technology	Conventional Lab Testing	Wet chemistry, ICP, ICPMS, GC, GCMS, HPLC	Baseline, quarterly, when experiencing data excursions in Tier 1, as per permit/regulatory agency. Beneficial reuse investigation
		Unconventional Lab Testing	LCPMS, Gamma Spec, High Res GCMS	
Tier 3	Risk assessment and data capture for fate/transport modeling. Waste disposal profile generation	WET Testing	Acute and chronic toxicity	When evaluating technology and management processes. As per permit/regulatory agency
		Leachate Testing	TCLP, SPLP, LEAF testing of residual waste	
		Bio-mobility and accumulation testing	Tier 1,2,4 analysis of treated effluent on soil, plant, tissue samples	
Tier 4	Source apportionment, fingerprinting	SEM/EDS, FEEM, XRD, biomarker analysis, isotopic analysis		When evaluating technology and management process. Basic research for method development. Event response. Beneficial reuse investigations.



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Thank you, and I'll see you out there!

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