Produced Water *Research* 2020 Update

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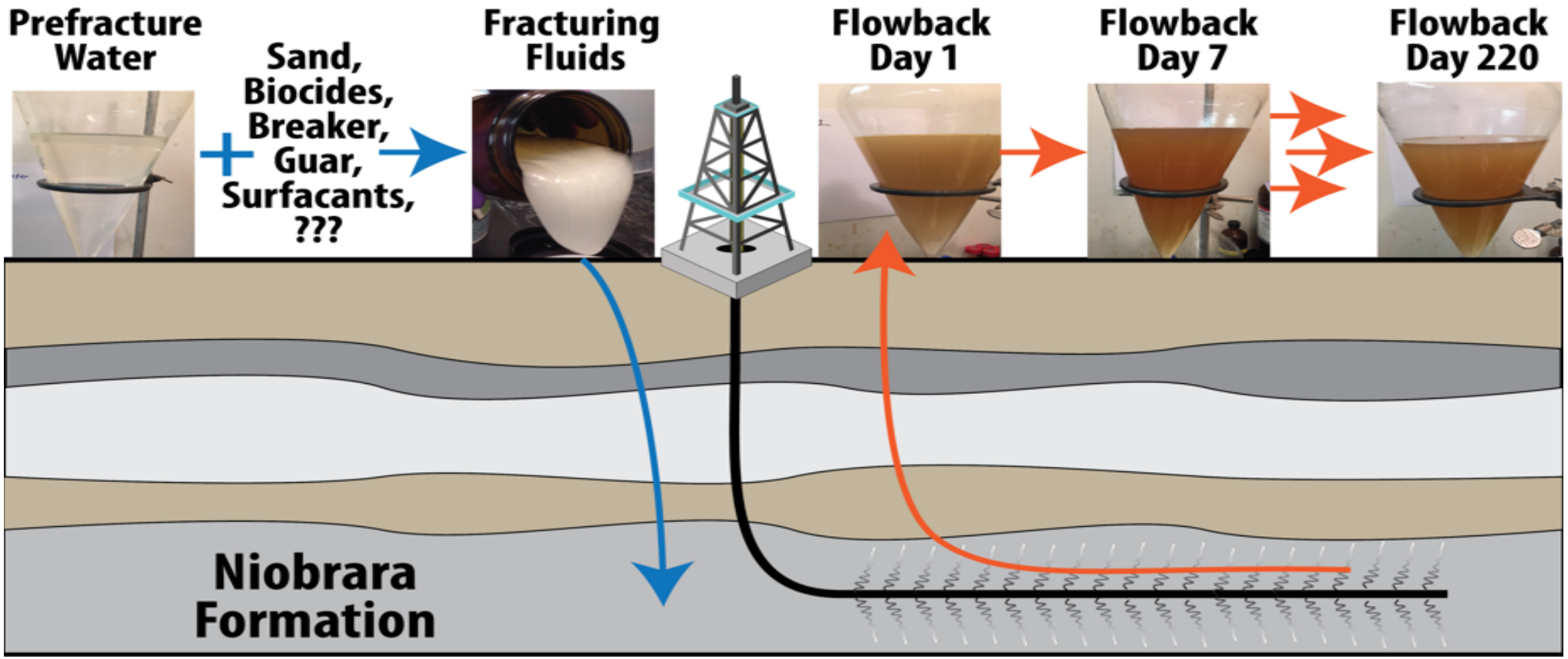
EARTH • ENERGY • ENVIRONMENT

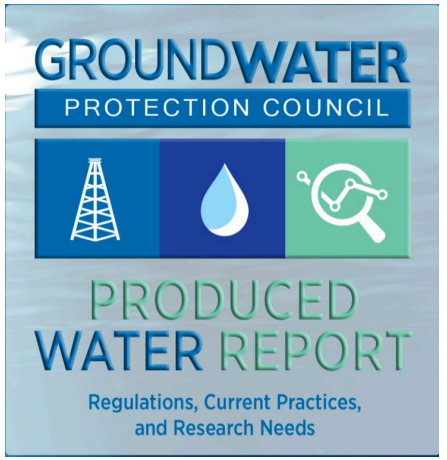
Produced Water



Rosenblum J., et al., . Chemical and Physical Characterization of Flowback and Produced Water Over Time from a Hydraulically Fractured Well. Science of the Total Environment, 2017(596),369-377

Rosenblum J., et al., Organic Chemical Characterization of a Hydraulically Fractured Wells Fracturing Fluid, Flowback, and Produced Water Over Time. Environmental Science & Technology. 2017

GWPC Produced Water Report (2019)



- Describe the current state of science and policies around produced water and potential beneficial reuses of produced water
- **Module 1**: Current legal, regulatory, and operational frameworks of produced water management
- **Module 2**: Produced water reuse **in** unconventional oil and gas operations
- **Module 3**: Produced water reuse and research needs **outside** oil and gas operations

New Mexico Produced Water Consortia

- Produced water research consortium
- Framework to fill knowledge gaps
- Establish regulations and policies for the treatment of produced water

For Immediate Release
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Consortium formed by New Mexico State University, Environment Department to lead nation in filling scientific gaps in produced water treatment

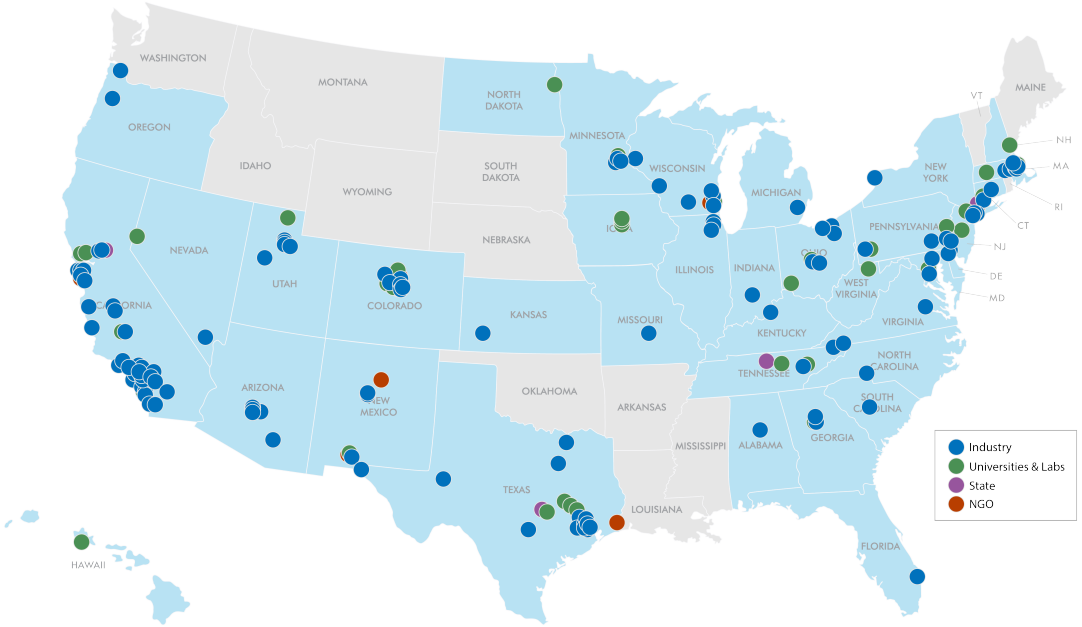
DOEs Low Cost, Efficient Treatment Technologies for Produced Water (FOA-2004)

- "Fit-for-purpose" water or "beneficial reuse" water
- **$4.6 million budget**
- Winners
    1. Electrocoagulation
    2. Membranes for resource recovery
    3. Membrane-based treatment for organics removal
    4. Fouling-resistant Zwitterionic Membrane

Department of Energy (DOE)
Office of Fossil Energy (FE)

LOW COST, EFFICIENT TREATMENT TECHNOLOGIES FOR PRODUCED WATER
Funding Opportunity Announcement (FOA) Number: DE-FOA-0002004
FOA Type: Initial
CFDA Number: 81.089

DOEs - Desalination Hub



- Department of Energy
  - $100 million over 5yrs

- “Goal is to accelerate transformative research to lower the cost and energy required to produce clean water from non-traditional water sources”
  - seawater, inland brackish, industrial/municipal wastewater, and **produced water from oil and gas**

- Colorado School of Mines
  - Leading the unconventional produced water “road mapping”

NAWI
National Alliance for Water Innovation

Innovation in Intensified Brine-Management Solutions for High-Salinity Streams

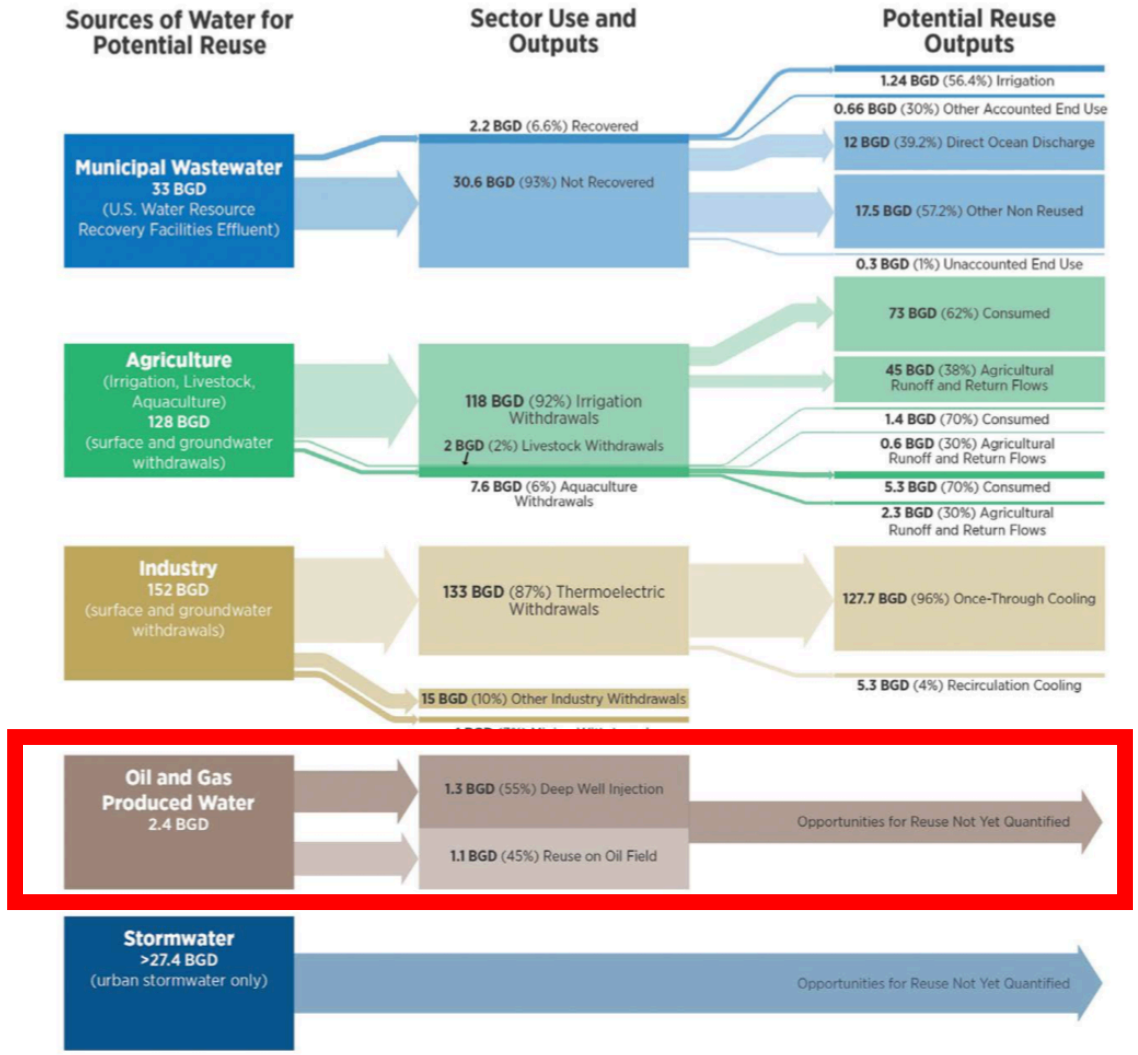
- $8 million Budget for Research
  - 2-year study duration
- Novel treatment processes for “non-traditional” high saline water sources (e.g., produced water)

NAWI
National Alliance for Water Innovation

Funding Opportunity Announcement (FOA):
FOA #: NAWI-BP12020

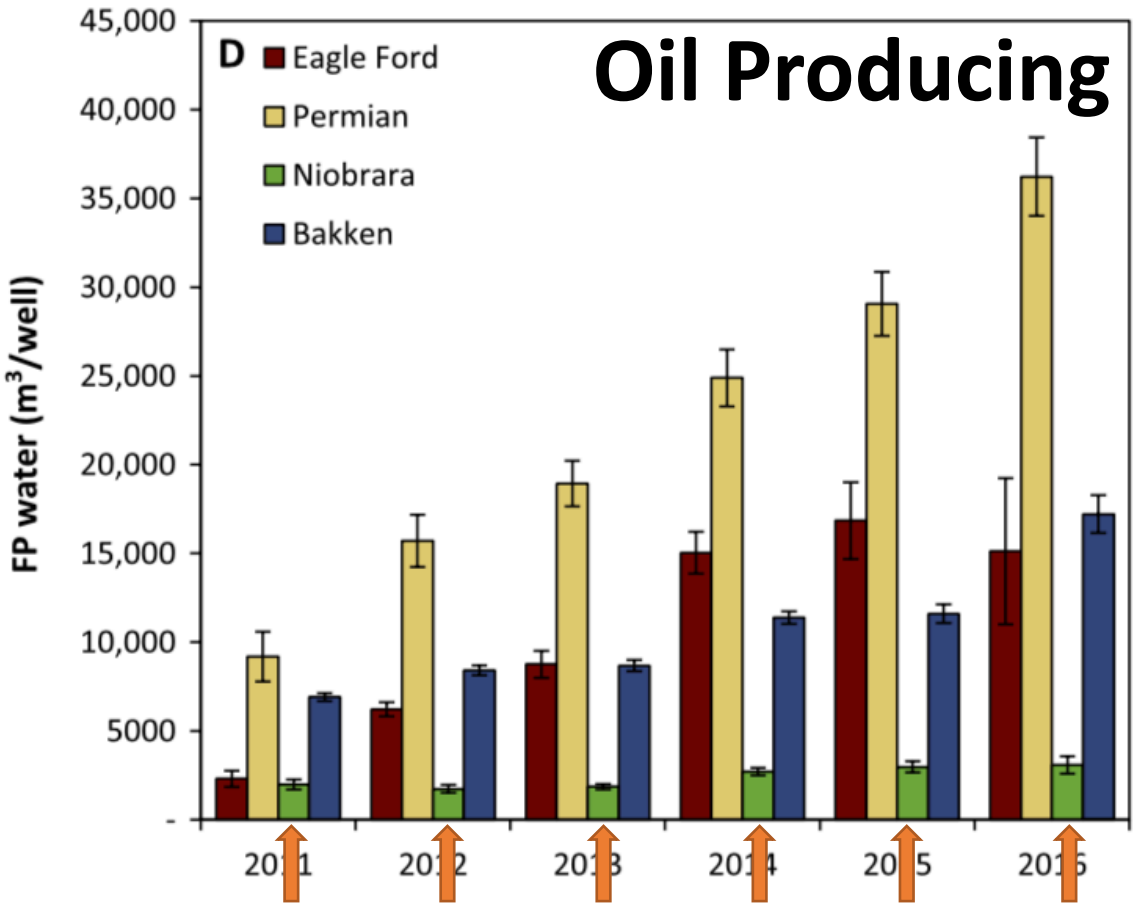
USEPAs Water Reuse Action Plan

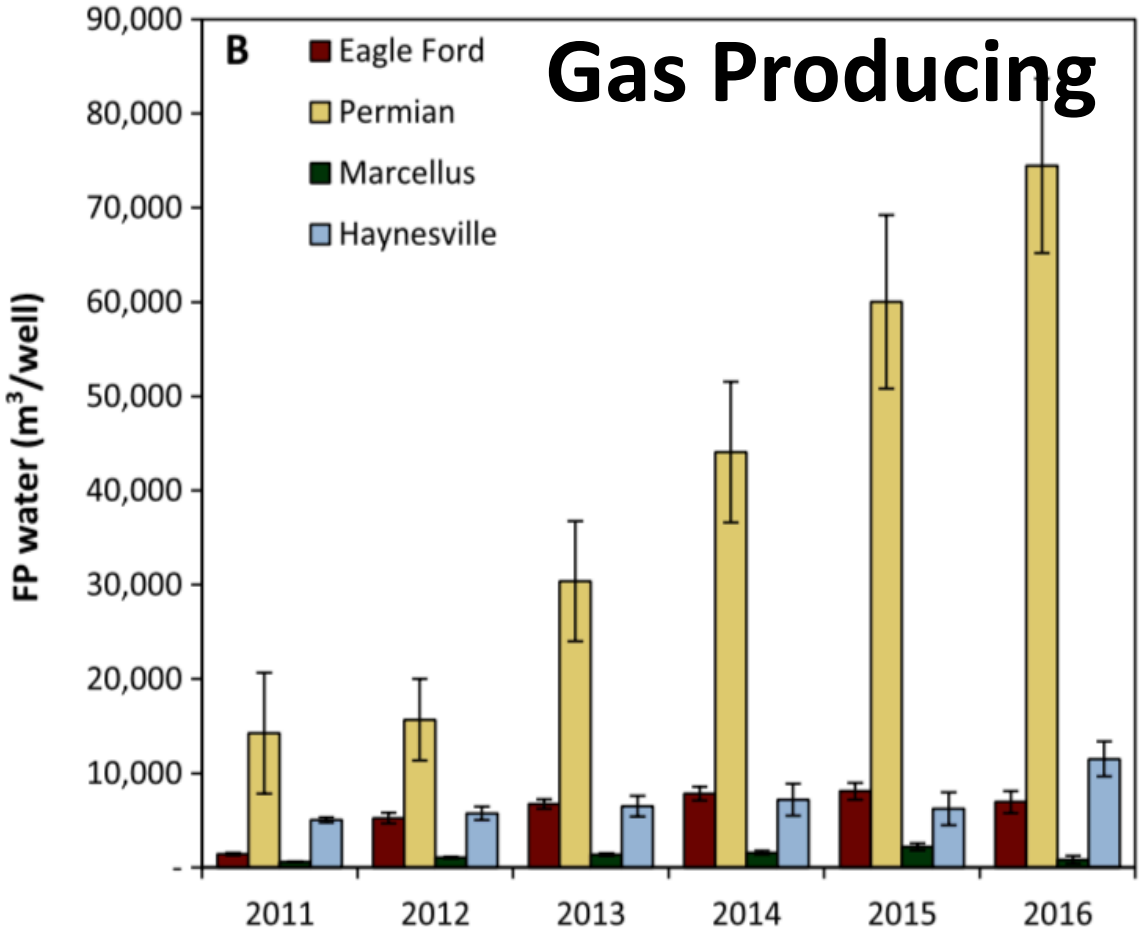
Figure 2. Estimated daily volumes (e.g., discharges, needs, withdrawals, consumptive uses) and current uses of sources of water in the United States.



Note that not all flows and associated percentages in Figure 2 add up to 100 percent.

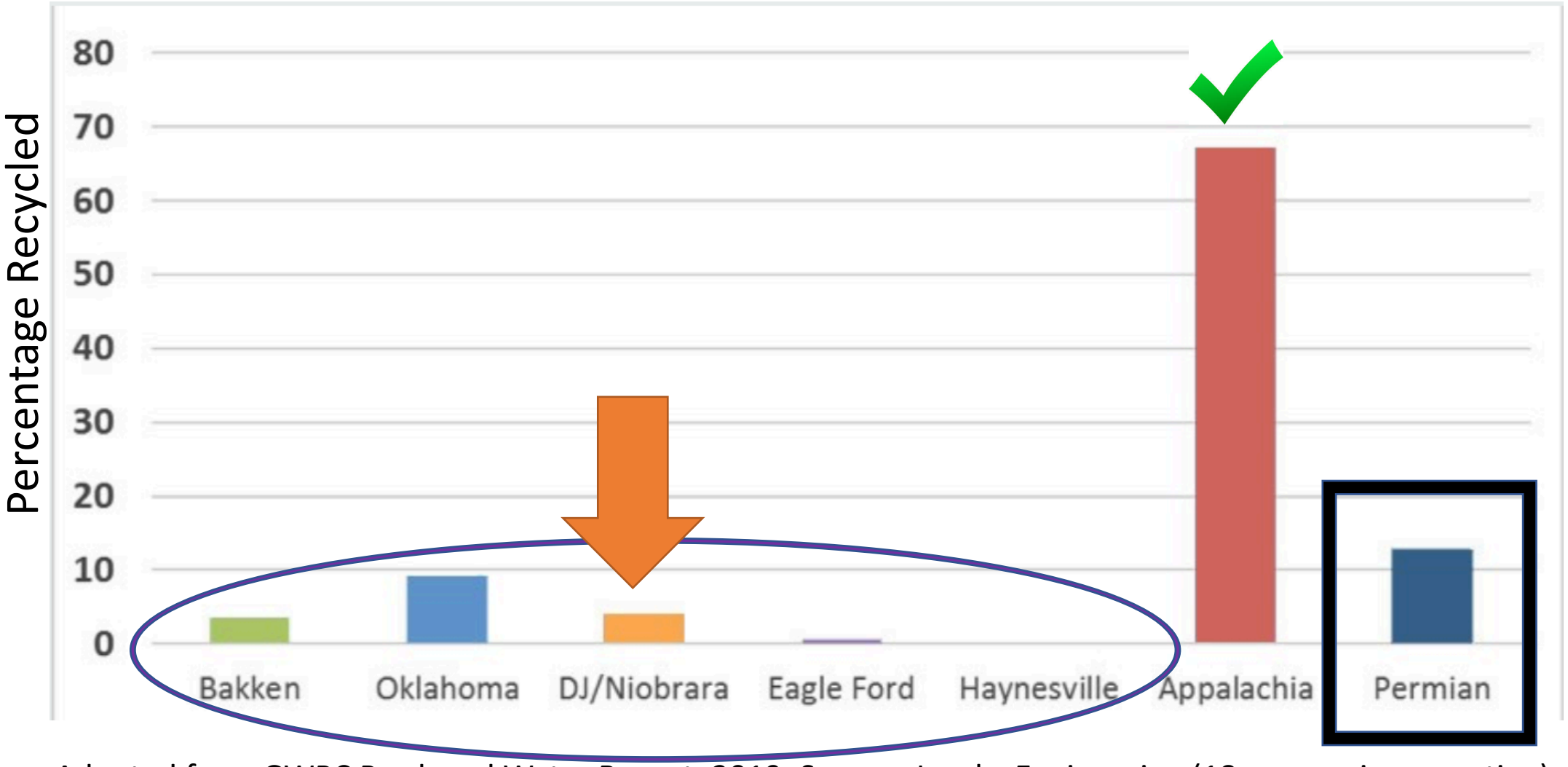
Water volumes increasing over time





1) Veil, J. (2015). **U.S. produced water volumes and management practices in 2012.** Prepared for the Ground Water Protection Council. http://www.gwpc.org/sites/default/ les/ Produced%20Water%20Report%202014-GWPC_0.pdf.
2) Kondash et al., 2018

Reuse in the Oil Field



Adopted from GWPC Produced Water Report, 2019; Source: Jacobs Engineering (18 companies reporting)

Colorado Center for a Sustainable

WE²ST

Water-Energy Education, Science, and Technology

MINES™

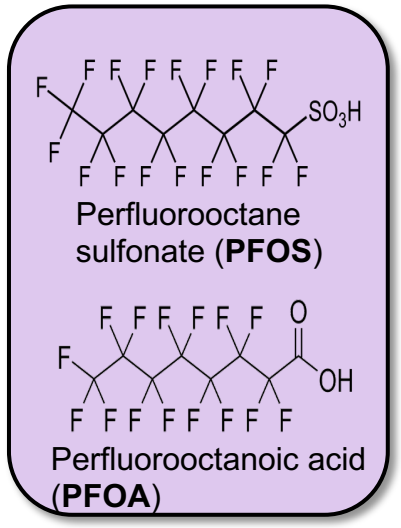
The Motivation

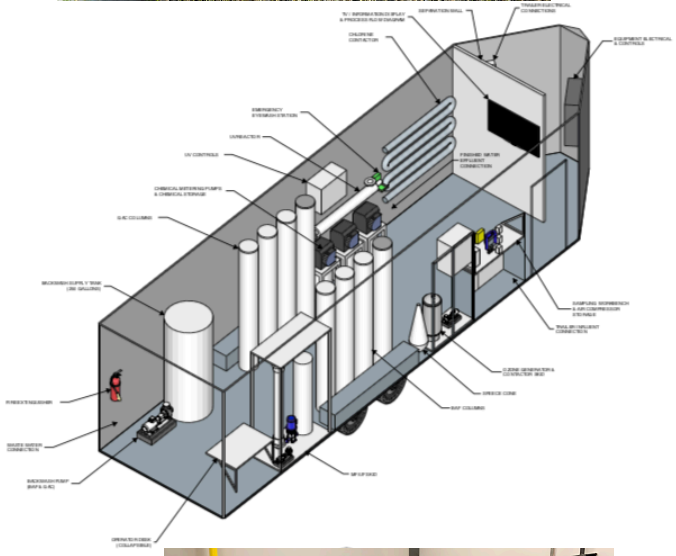
- Establish a center for the development of innovative industrial water/wastewater treatment technologies and solutions
- Collaborate with industry, government, and academia
- Cross-Scale Water treatment technologies development
- Located in NE Denver

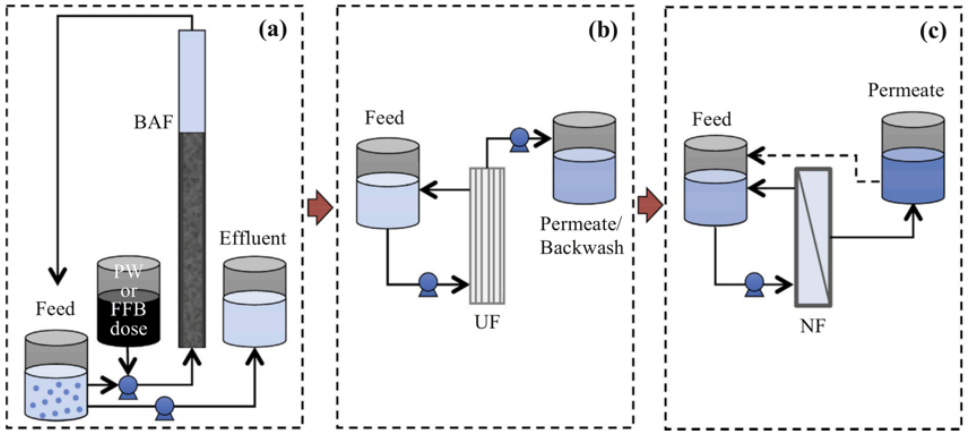
Energy Partners LP

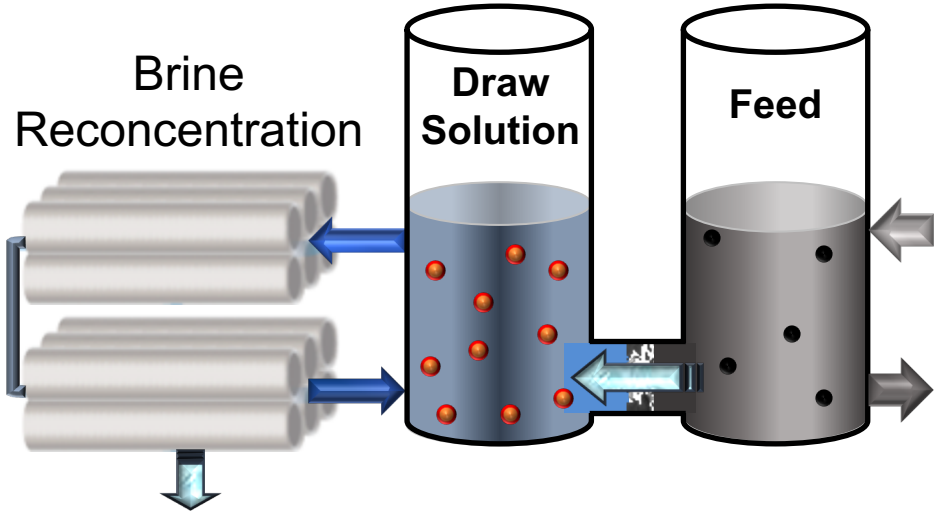
Research at WE²ST

- Emerging Contaminants
  - PFAS
- Direct Potable Reuse
  - Mobile Pilot
- Water Energy
  - Solar- and Wave-Reverse Osmosis pilots
- Produced Water

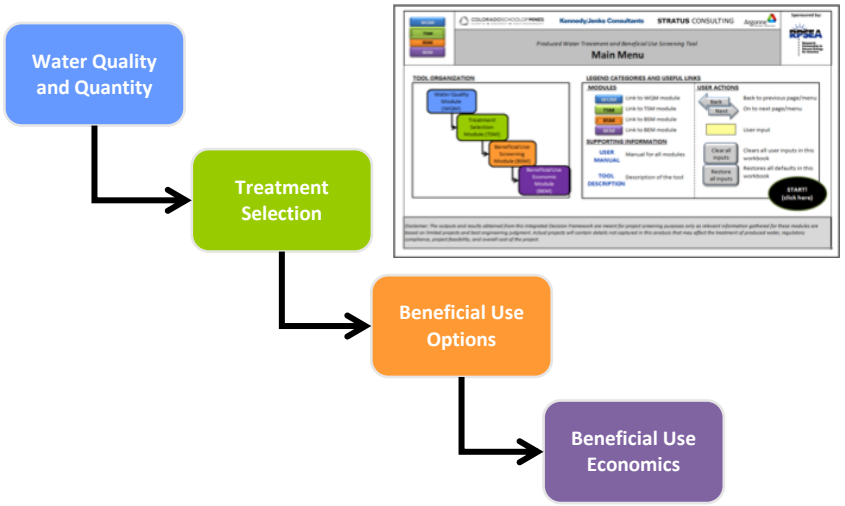


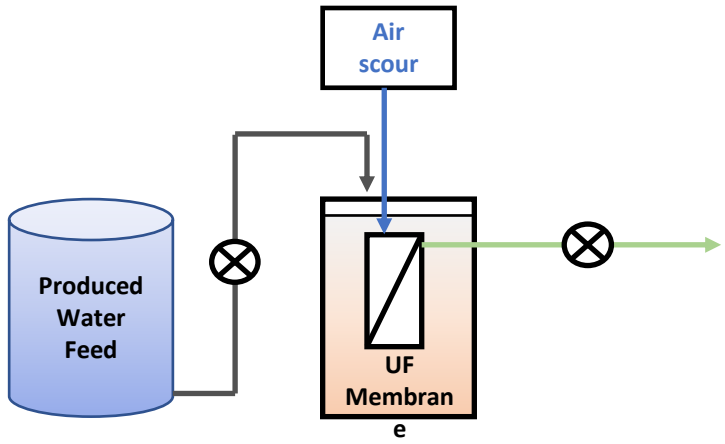






Colorado School of Mines Produced Water Research

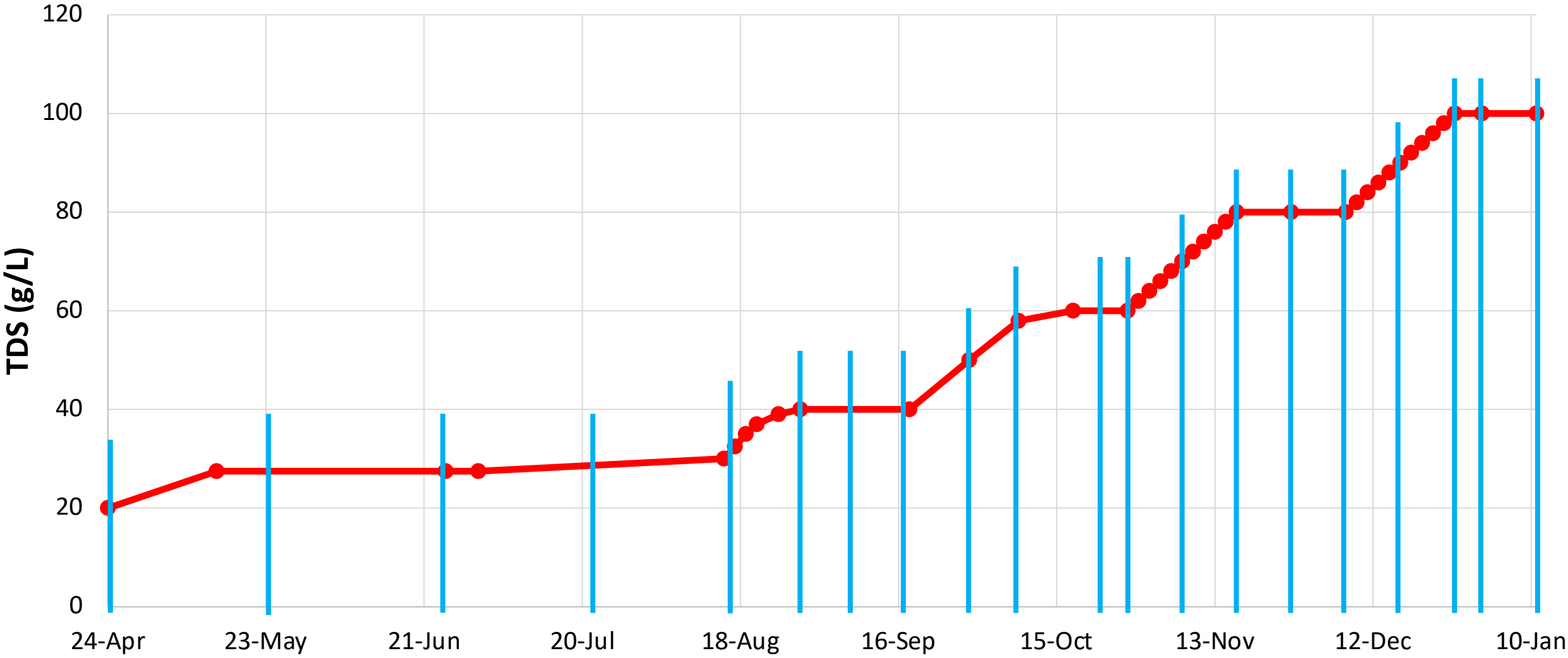




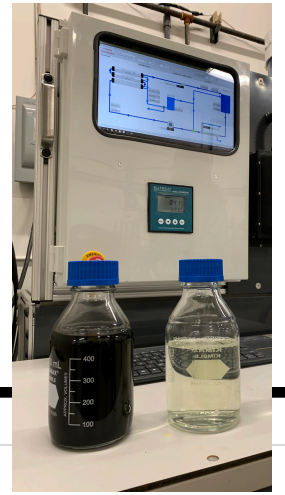
Combining Treatment Processes

- The Goal
  - Remove multiple contaminants in a single process
- The Systems
  - Membrane bioreactor (MBR)
    - Suspended growth / Continuous flow
- Fear in O&G around biological processes

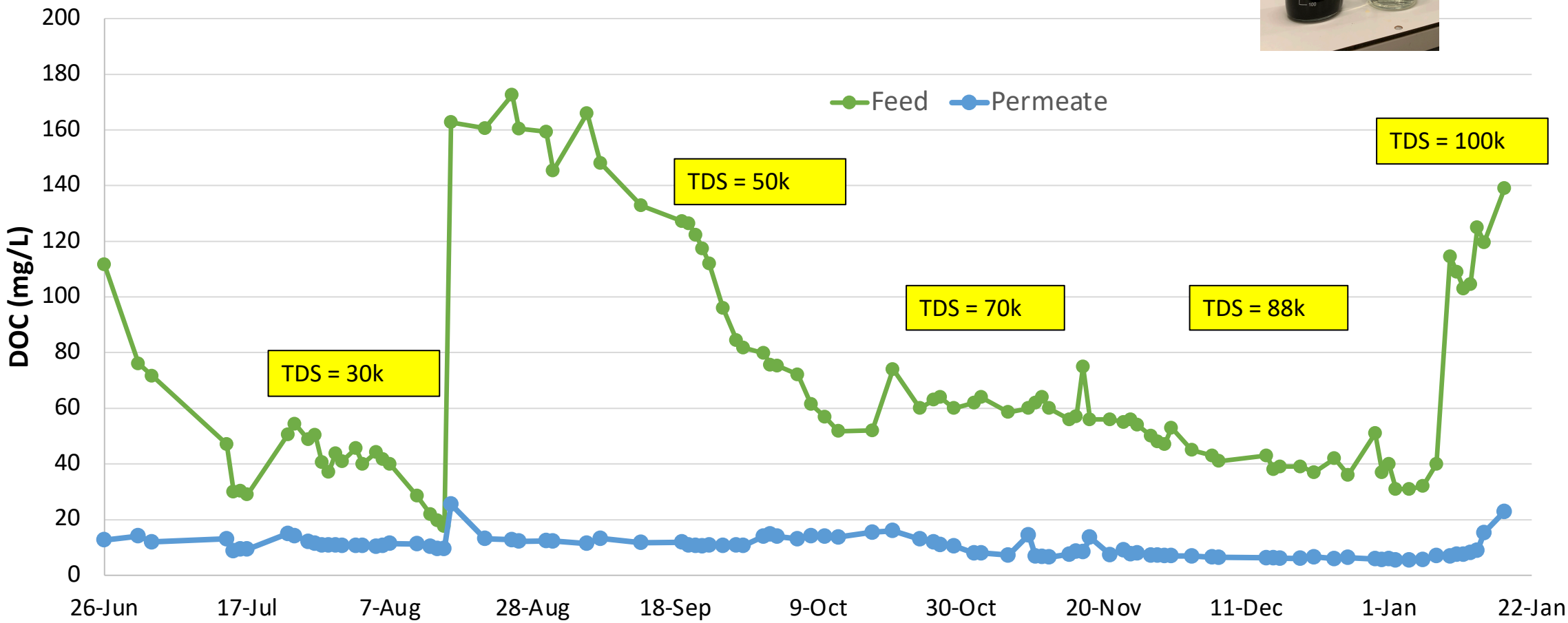
Membrane Bioreactor Acclimation Timeline



Dissolved Organic Carbon Removal

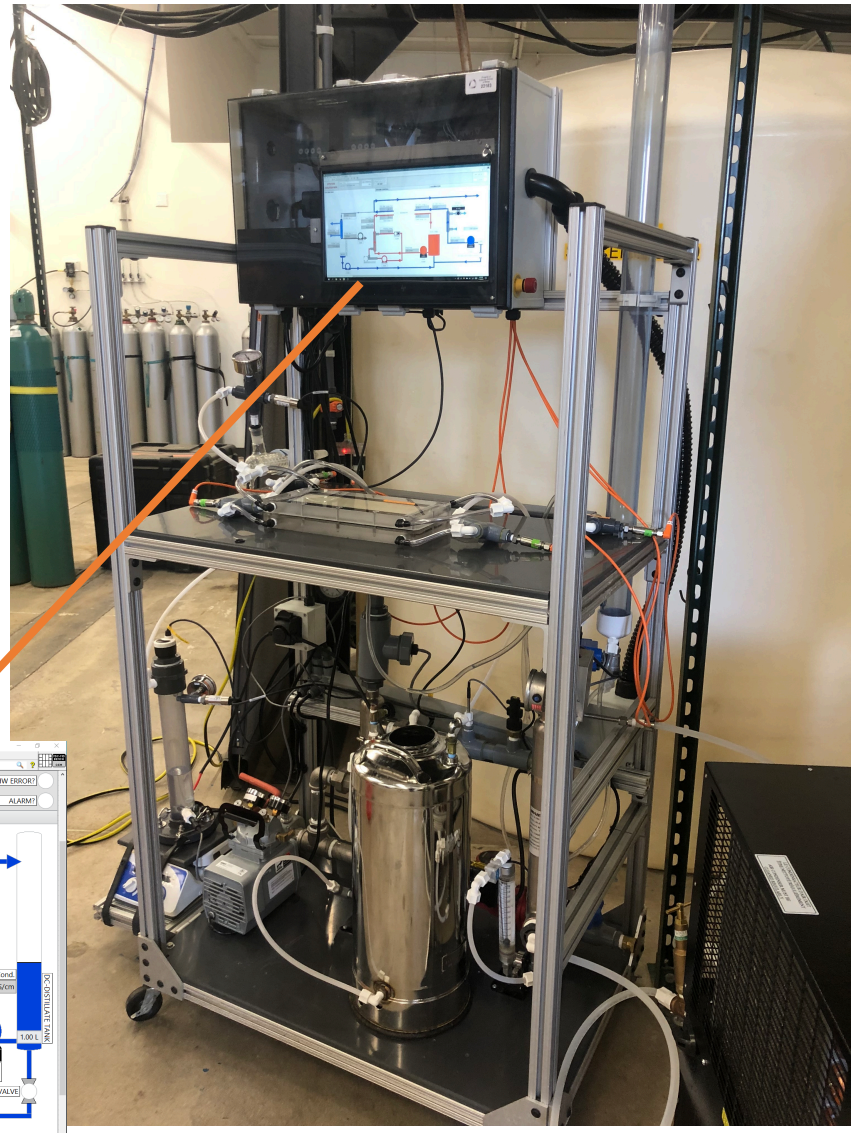


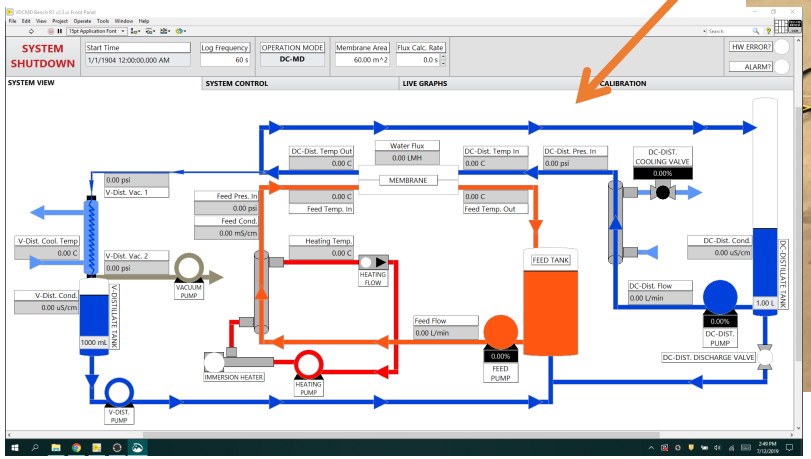
7 months of continuous operation



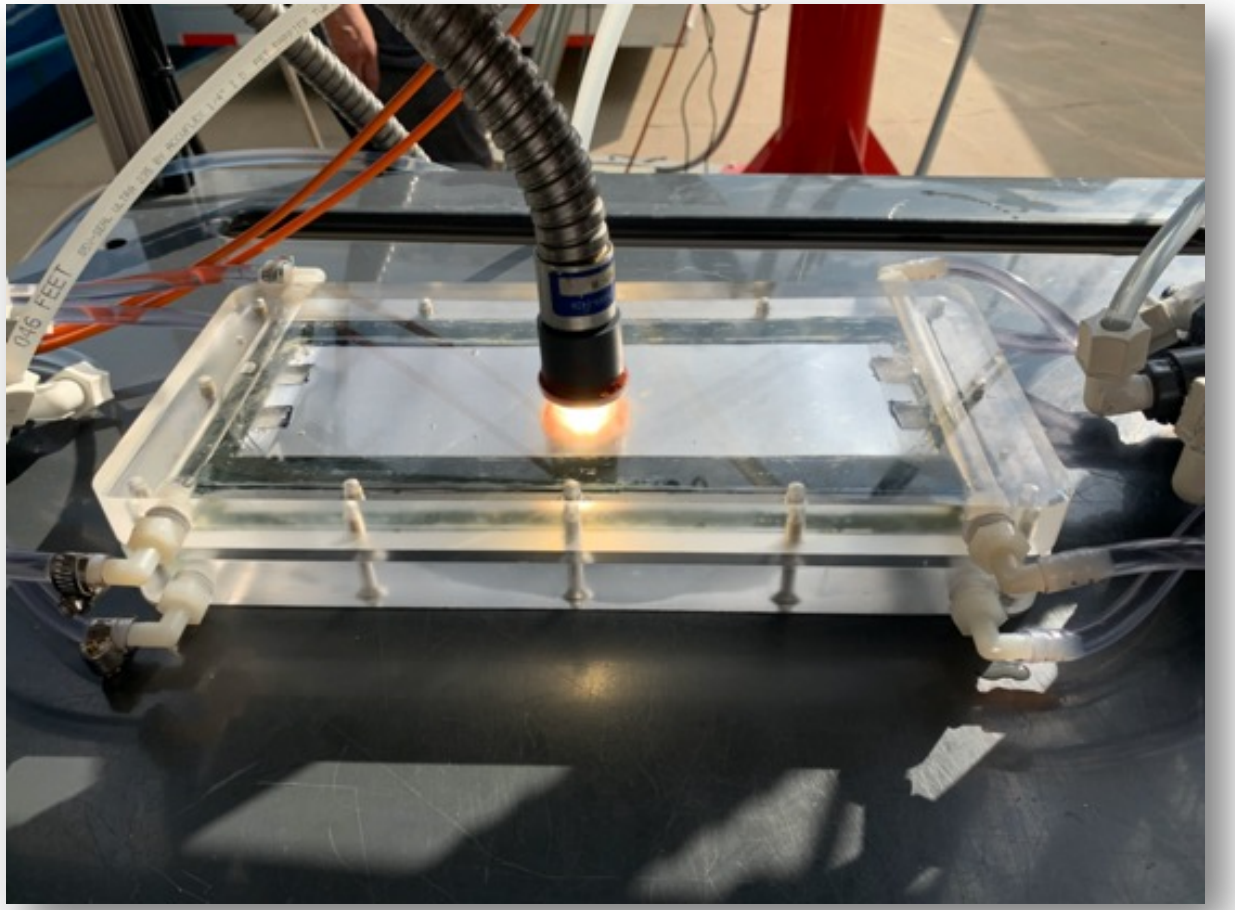
High-Salinity Desalination Research: Membrane Distillation

- Currently collecting MBR effluent for MD experiments
- Optimizing MD system
- Collaboration with UCLA, CU Boulder
  - Apply heat directly to membrane with solar concentrators (CU)
  - Additional energy savings
  - Produced clean distillate

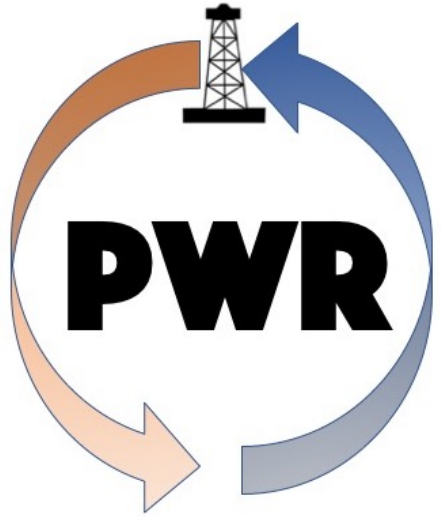




Preliminary Research



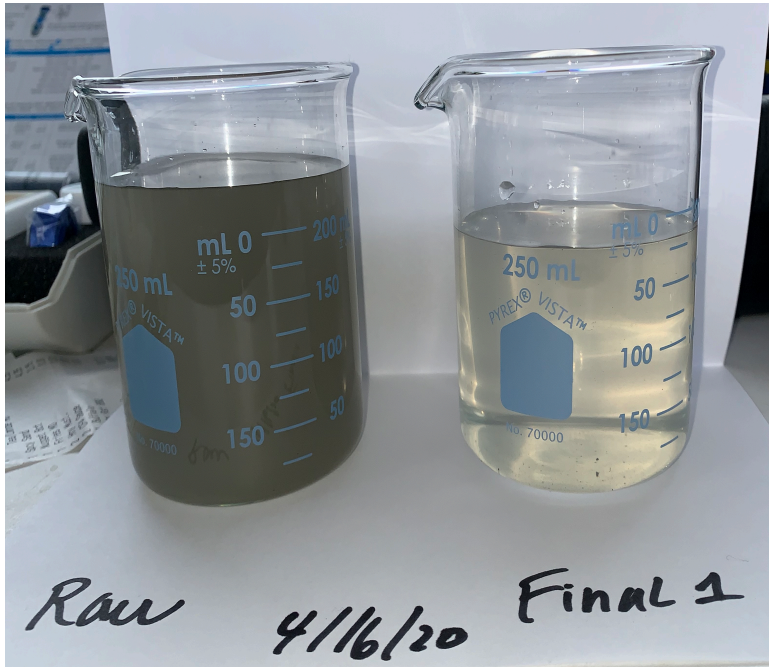
Case-study of onsite produced water recycling in the DJ-Basin (2/2020 – 4/2020)

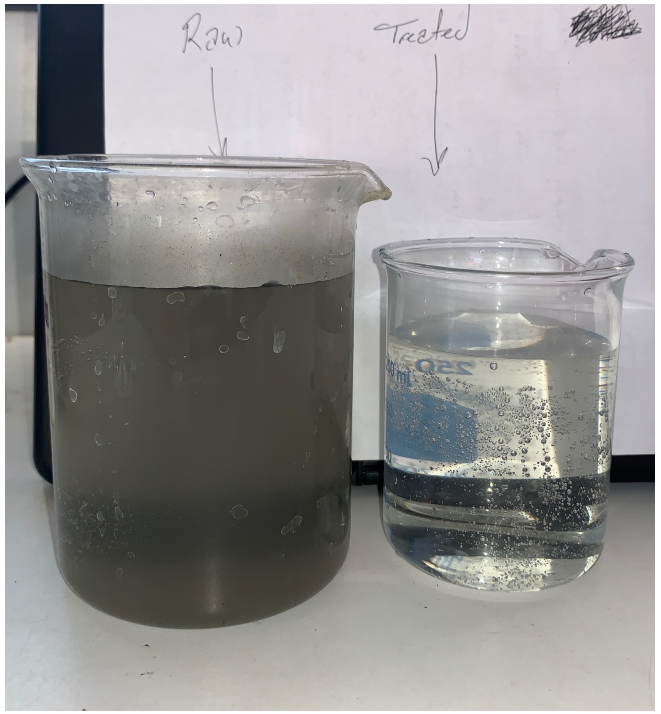


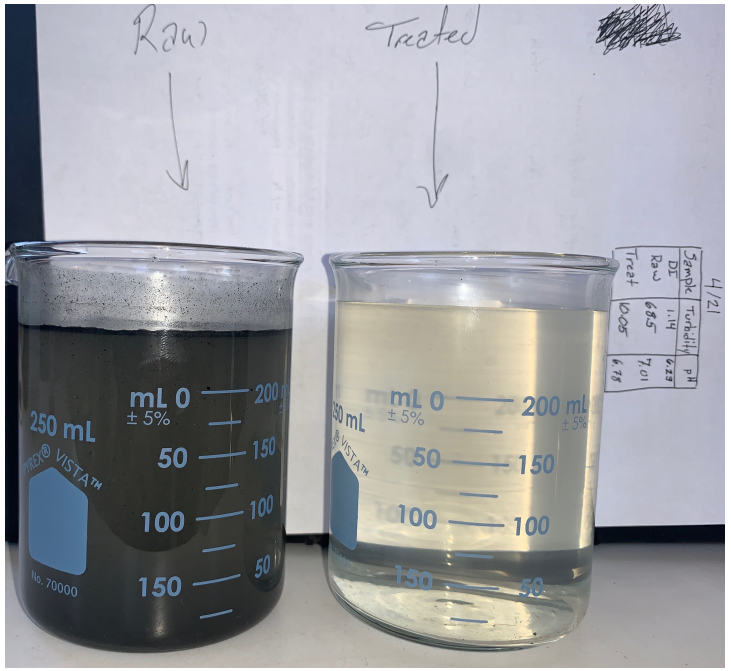
Weaknesses of Current Treatment Methods

- Filter Pods
  - 100 µm filter socks are commonly used for produced water recycle jobs in the DJ-Basin

- Filter socks do little for removing suspended solids until 5- 8 µm in the DJ

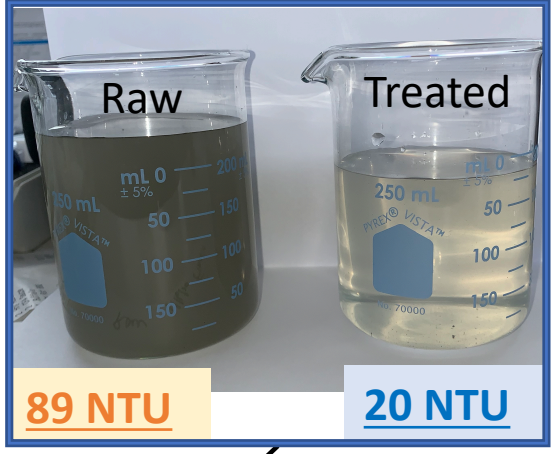


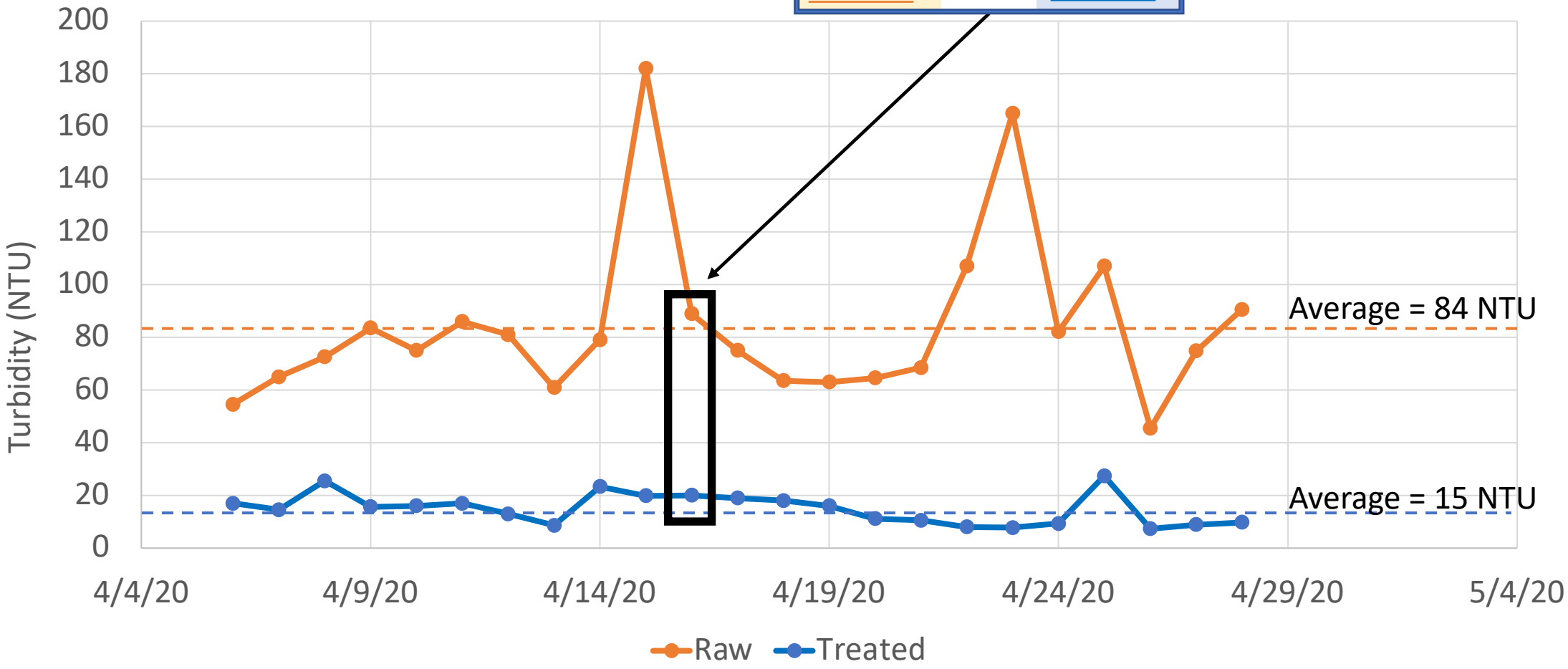




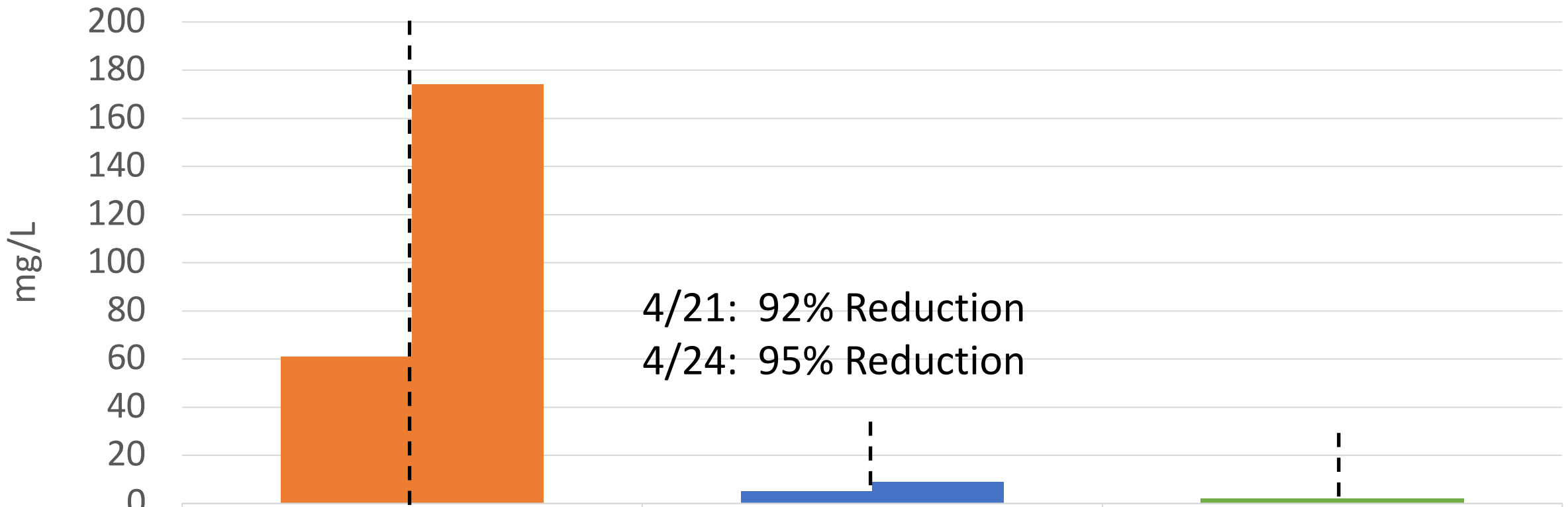
Influent vs. Effluent

83% Average Reduction in Turbidity



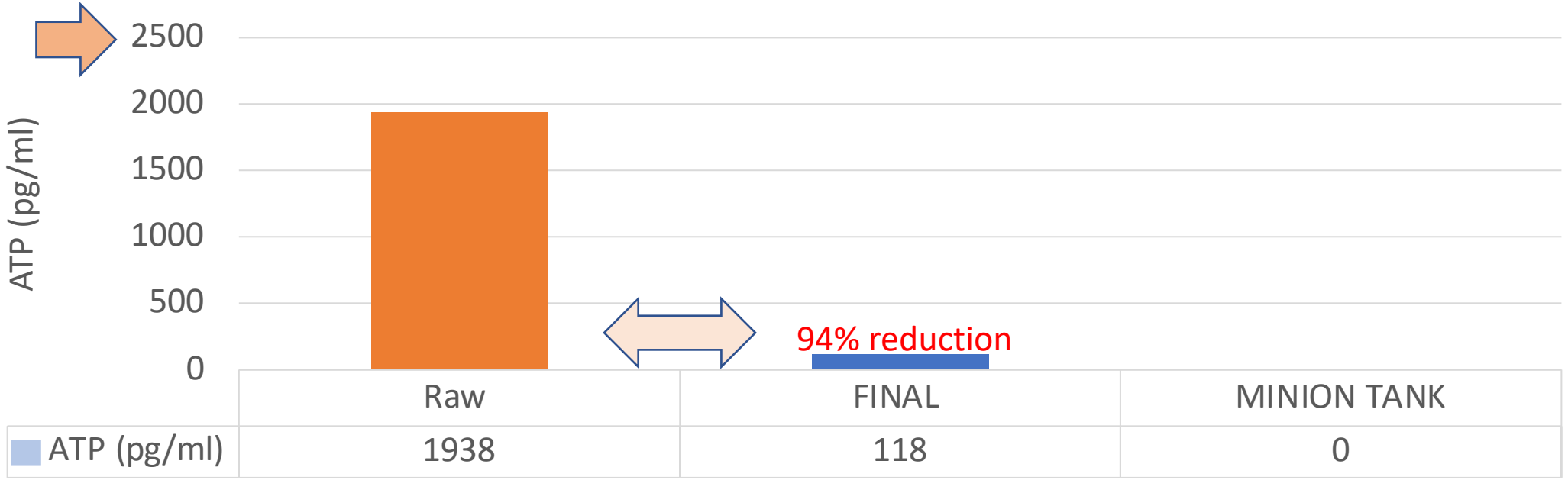


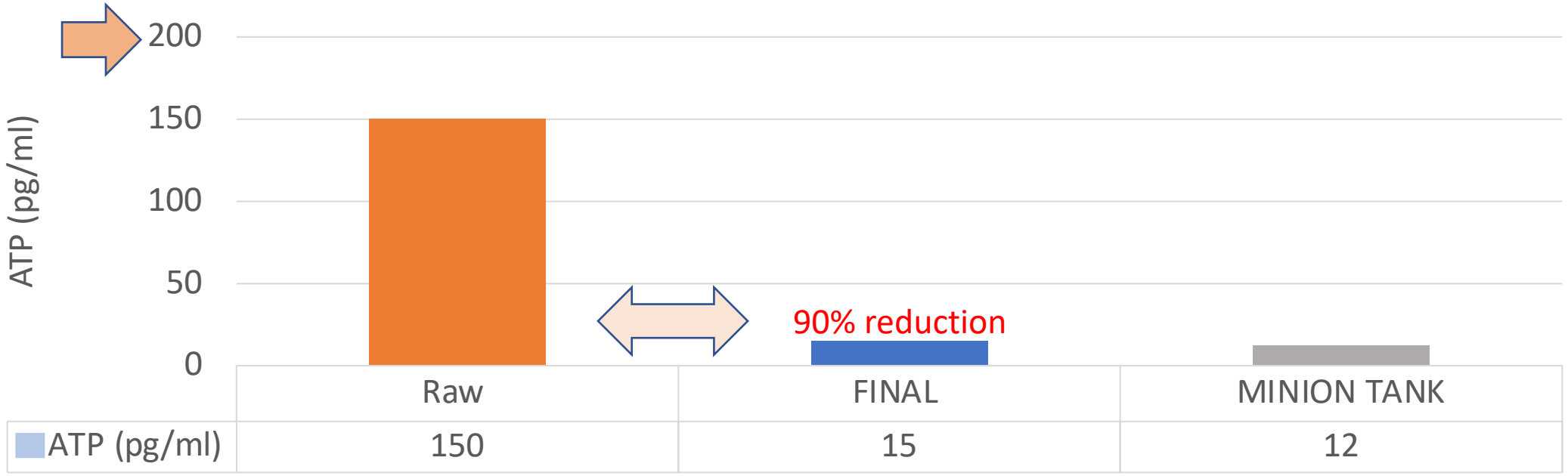
90% Reduction in Total Petroleum Hydrocarbons



	RAW	FINAL	MINION TANK
4/21/20	61	5	2
4/24/20	174	9	2

90% Reduction in ATP





Cost Savings

Monthly Savings by Recycling Produced Water in the DJ-Basin

5,500 bbls/day	
Monthly Savings	***$ 108,956#***

#This value includes all associated costs: Trucking, Containment, Pumps, Fuel, Labor, etc.

7,500 bbls/day	
Monthly Savings	***$ 197,543***

Acknowledgments

- Tzahi Cath
  - WE²ST Director and Mentor
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  - WE²ST Master Technician
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  - PhD Student
- Mason Manross
  - PWR Operations Manager
  - WE²ST Technician
- Zoma Foundation
- NGL Energy Partners
- Department of Energy
- Laurence Berkley National Lab

Questions

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