

# **WATER RESEARCH AT THE PETROLEUM RECOVERY RESEARCH CENTER**

**NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY**

**ROBERT BALCH**

**DIRECTOR**

**Created by New Mexico Statute: NMSA 1978, Article 9 as a division of New Mexico Tech:** Primary Duty: “to engage in theoretical and practical research into the recovery of petroleum and other energy resources”

**Primary Focus today is:**

**60% Carbon Storage and Hydrogen**  
**20% Produced Water and Sustainability**  
**20% traditional hydrocarbon research**



**\$172,377,089** in active research portfolio

**26** active projects

## The PRRC has Impact

**Jobs:** PRRC currently creates 57 direct jobs in the state including 23 full-time staff, 6 supported Faculty at NMT and 28 Students funded on research projects in FY22

**To the State:** Funded research supports entities across the state with nearly \$10 Million spent in FY22 including funds allotted to partner universities, national labs, and companies in the state. The PRRC’s carbon storage research portfolio alone exceeds \$130 million, with projects impacting both San Juan and Permian basin communities. PRRC Researchers enjoy a high profile in Carbon Storage research, both nationally and internationally

**University Support:** The PRRC supports the university, and in FY22 directly contributed \$1.44 million to NMT including: \$1.02 million in overhead and direct support and \$427,936 in student contracts and faculty Support. We actively train students for careers in sustainable energy development.

# Water Filtration with Hollow Fiber Membranes

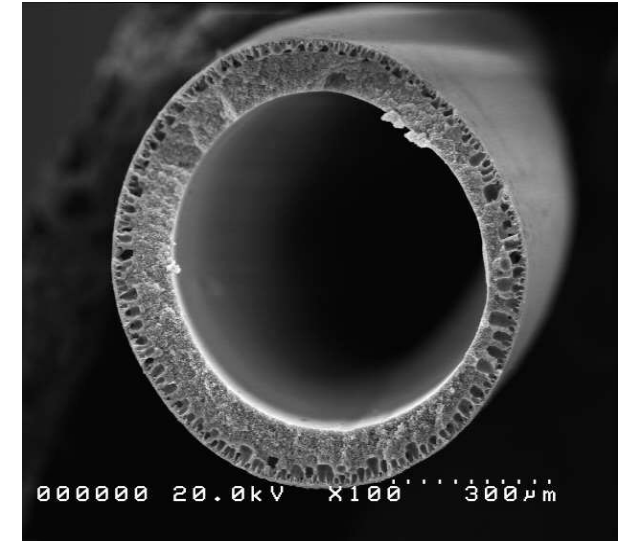
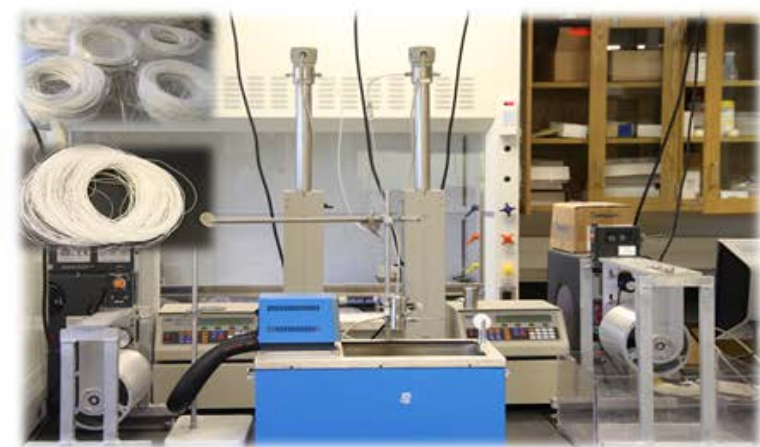
Project Title	Award Number	Duration	Amount	Funding Agency
1. Development of a highly efficient and novel distillation-assisted membrane for direct lithium extraction from geothermal brines	DE-EE0010879 (under negotiation)	10/2023-09/2026	\$650,000	EERE/DOE
2. Advanced Hybrid Membrane Process for Simultaneous Recovery of Clean Water and Lithium from High Salinity Brines	R23AC00431 (under negotiation)	01/2024 - 12/2025	\$500,000	DOI/BOR
3. Permanently Hydrophilic Membrane for Organic Matters Removal from Oilfield Produced Water	R21AC00268	09/2021 - 09/2023	\$500,000	DOI/BOR
4. Pilot-scale validation of a novel Janus hollow fiber membrane based DCMD process for high salinity produced water desalination by using waste heat	R21AC00212	09/2021 - 03/2024	\$299,752	DOI/BOR
5. Hydrophilic-omniphobic hollow fiber membrane-based DCMD and crystallization for zero liquid discharge of high salinity produced water	R21AC00154	04/2021 - 03/2023	\$500,000	DOI/BOR
6. Development of a Novel Janus hollow fiber membrane based DCMD Process for Cost-Effective and Energy-Efficient Desalination of High Salinity F/P Water	R17AC00143	10/2017 - 06/2019	\$221, 946	DOI/BOR
7. Development of a Portable and Scalable Hollow Fiber Membrane Based Ultrafiltration-Nanofiltration (UF-NF) Process for Water Remediation	WFSP-18	04/2018 - 06/2019	\$245, 960	State of New Mexico
8. A Portable, Two-Stage, Antifouling Hollow Fiber Membrane Nanofiltration Process for the Cost- Effective Treatment of Produced Water	12123-16	06/2014 - 09/2016	\$858, 678	DOE/RPSEA
9. Scalable and Efficient Membrane Distillation and Adsorption Process for High-Purity Water and Lithium Recovery from Produced Water in New Mexico	Pending	01/2024-12-2026	\$1,500,000	DOE
10. Pilot-scale Demonstration of a Membrane Distillation and Crystallization Process for Zero Liquid Discharge of Produced Water	Pending	04/2024 - 03/2026	\$600,000	DOI/BOR

1. J. Yu, R. Balch, et al. **Method and System for Treating for Produced Water**. U.S. Patent Application No.: 14/726,090, pending.
2. J. Yu, R. Balch, et al. **Methods of Preparing Dual-Layer Polyvinylidene Fluoride Hollow Fiber Membranes and Uses Thereof**. Application Number: 63/053,256, 2021\*.

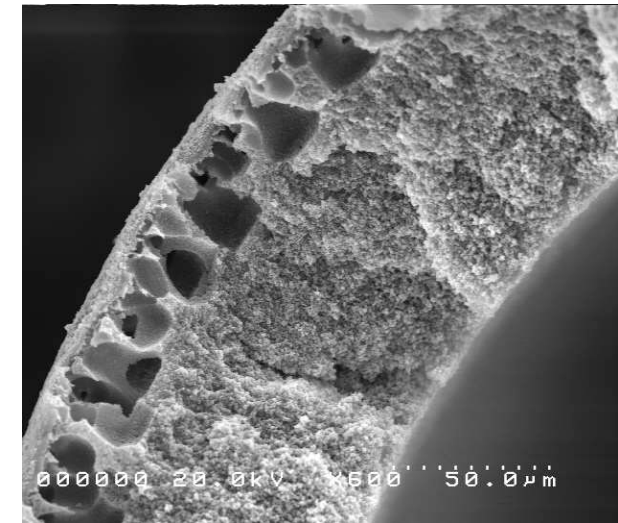
\*The patent is co-filed in the **United States, China, India, Europe, and Japan**.



# HFM's: Laboratory and Bench Scale

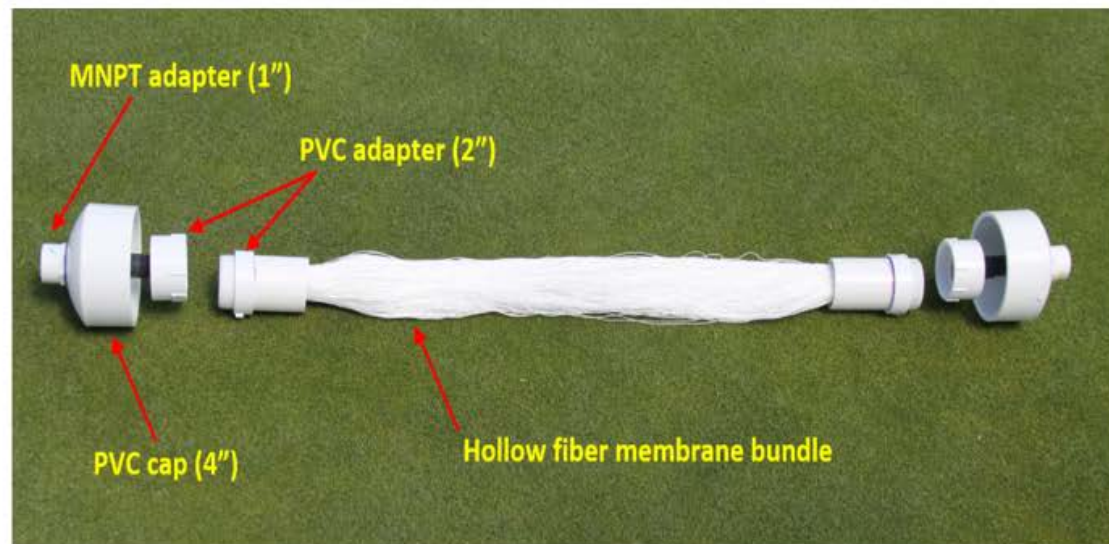
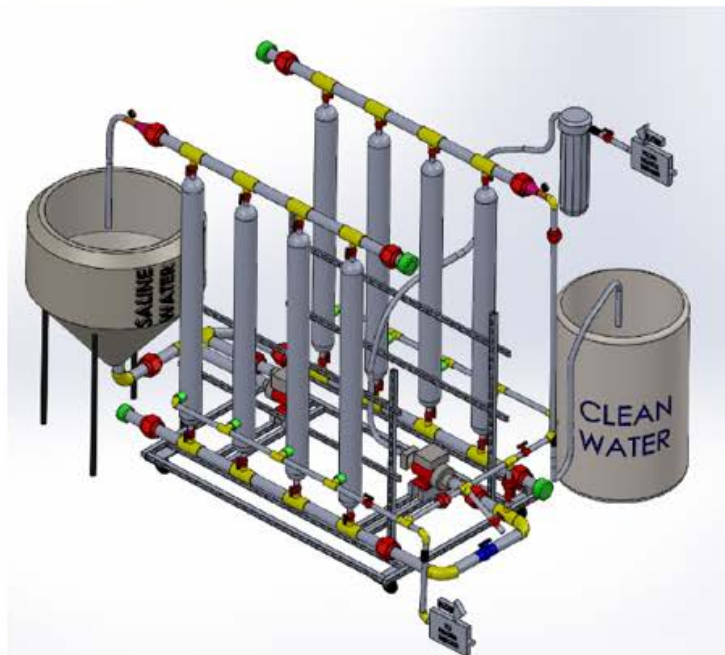
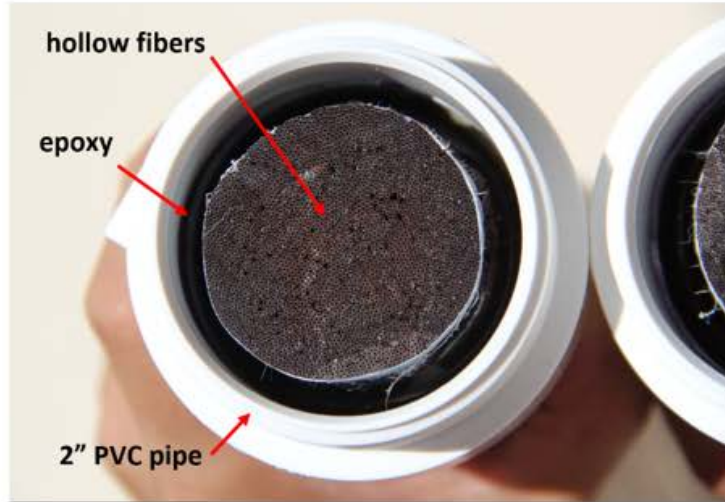


**Large scale apparatus for hollow fiber membrane fabrication.**





# Research Unit for Small Scale Field Tests



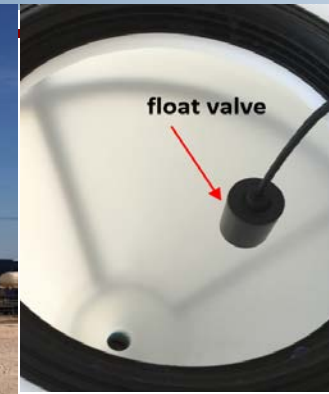


# Deployed at an Oilfield Site in SE New Mexico

During Research funding Agents provided for small scale testing in real field conditions

RPSEA – Site near Carlsbad

NM Legislative appropriation – Site near Clovis



heat treater (Produced water source)



clean water tank

evaporation tank



# Deployed at City of Clovis for SW Cheese



✓ 92.2% removal of total nitrogen  
✓ 96.1% removal of phosphorous and organic matter



Performs manufacture of trade-secret HFM Filter Bundles

- A Delaware Corporation, located in Socorro NM
- A wholly-owned subsidiary of the New Mexico Tech University Research Park Corporation (NMTURPC)
- Will take an exclusive all-fields option to the underlying, patent-pending technology from the NMTURPC
- NMTURPC is sole shareholder; team members will receive share benefits

# SMT Joint Venture with PESCO

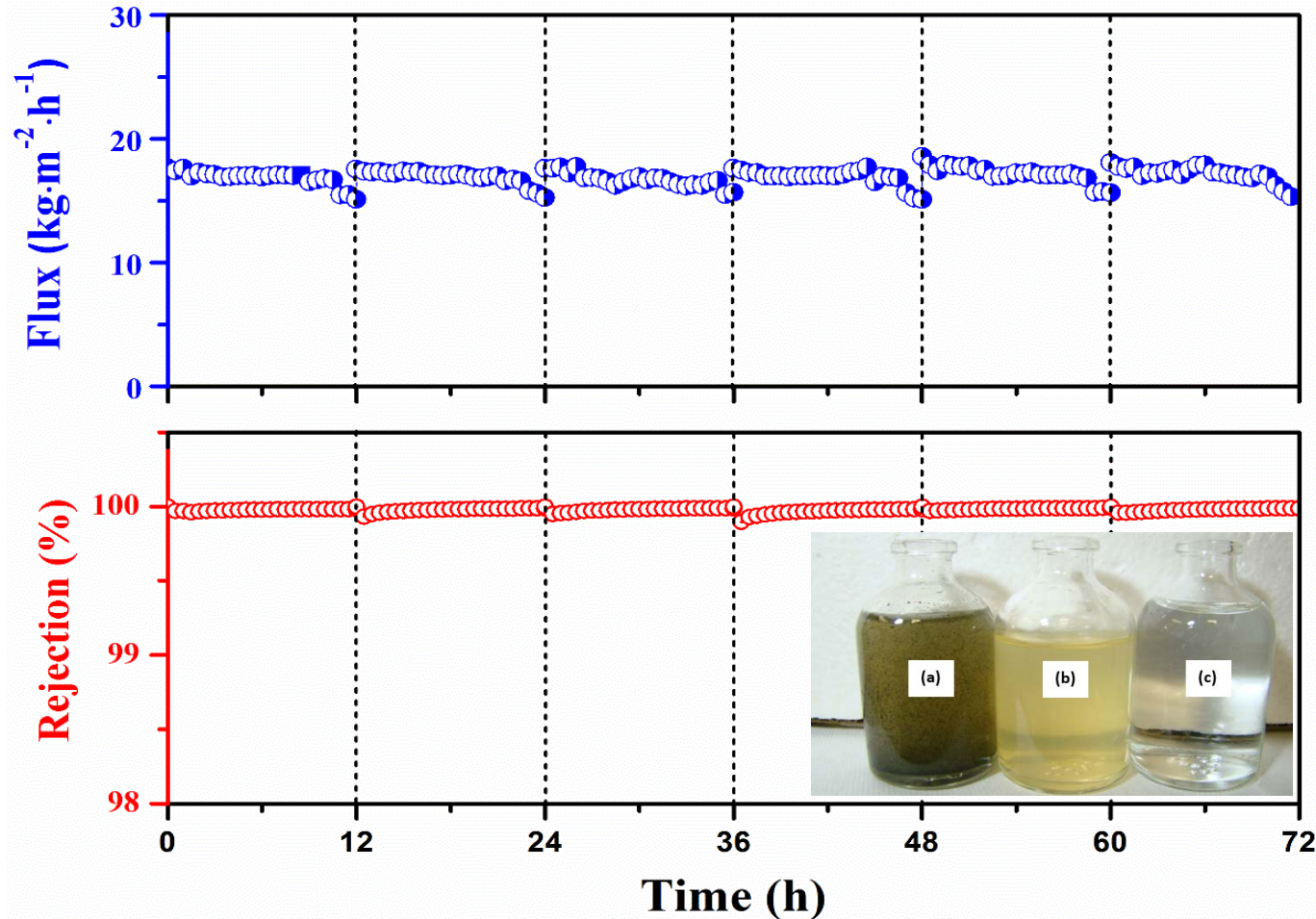
- PESCO is producing the production units containing the modules we will make at SMT
- We have a 50/50 partnership in the JV, Arid Water Technologies. (AWT)
- SMT's job is to provide modules to AWT
- SMT will retain all IP; license to AWT
- PESCO has manufacturing experience, a salesforce, and industrial contacts beyond NM
- This partnership has been in the works for over two year; parties know and trust each other





5000 gallons per day

# Flux and Salt rejection (>99.99%)



PW: Salinity=155,000 mg/L  
NPOC=57.6 mg/L

➤ **Operating conditions:**

T-Fed: 60°C;  
T-Permeate: 20°C;  
v-feed: 0.4 m/s  
v-permeate: 0.4 m/s

➤ Due to the complicate composition of PW, membrane regeneration was preformed for 30 mins every 12 hours.

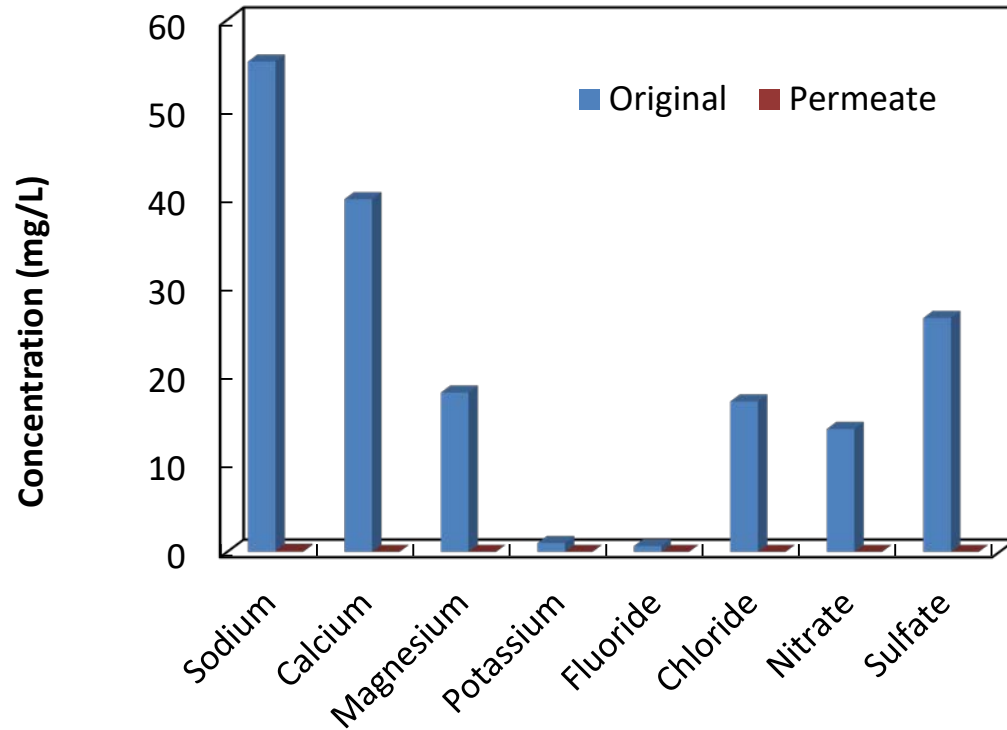
➤ No membrane wetting, **the salt rejection remains higher than 99.99%.**

➤ Water samples: (a) actual oilfield produced water; (b) pre-treated with a 50 μm filter; (c) product water.



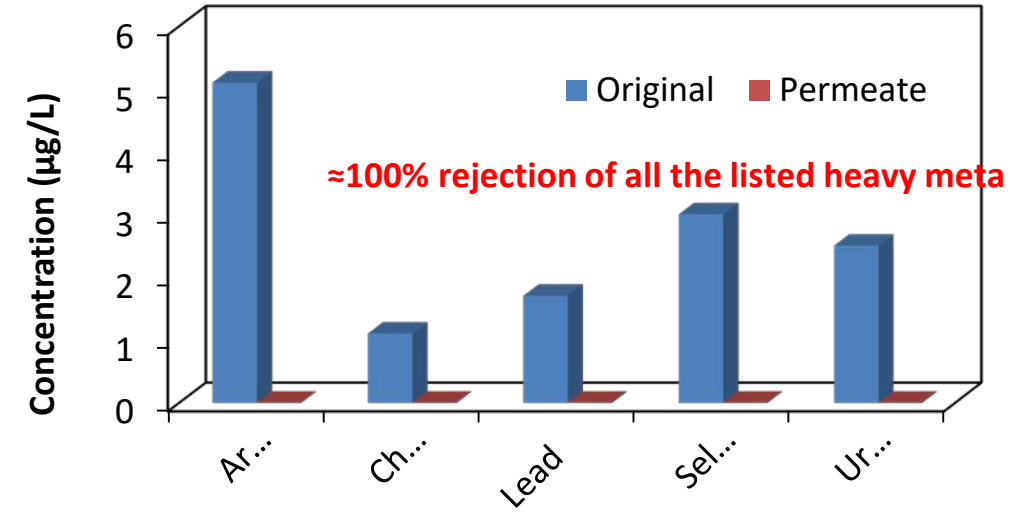
# Navajo Nation Chavez Springs water

Major Cations and Anions

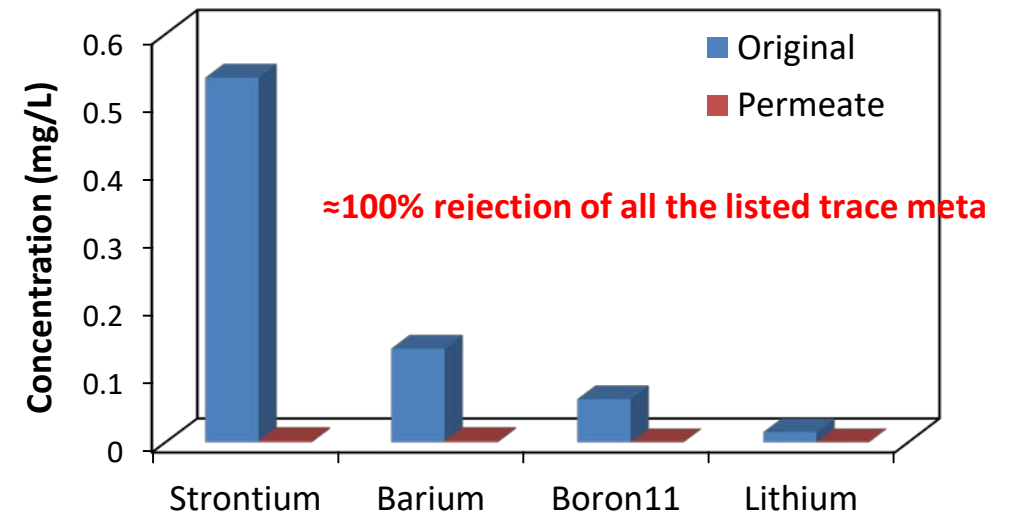


- ① >99.9% rejection of sodium;
- ② ≈100% rejections of the other major cations and anions.

Heavy Metals



Trace Metals



WATER FROM THIS WELL IS NOT SAFE TO DRINK!!

THIS WATER HAS BEEN TESTED & FOUND TO EXCEED NAVEJO EPA & US EPA HUMAN DRINKING WATER STANDARDS FOR URANIUM OR OTHER CONTAMINANTS! NN POLICY IS THAT LIVESTOCK USE ONLY WELLS ARE NOT TO BE USED FOR HUMAN DRINKING WATER.

*(Additional graffiti on the left side of the tank includes "WILGRIM" and "URANIUM" written in red and black.)*





## Navajo Tech / New Mexico Tech / PESCO Water Filtration Partnership

Replace this



### What is Our Goal?

*Help solve Navajo Nation and rural water issues by cleaning water from:*

- Windmills
- Stock tanks
- New Wells

### How Will We Do This?

*Public/private partnerships to address issues at the source*

- Clean water at the source using SMT/PESCO technology
- Self contained purification systems maintainable by local communities
- Provide water security and job opportunities in rural communities

With this



### Who will Operate These Systems?

*Local Support and Knowledge is Key*

- We will work with the Navajo Nation to make sure sites are acceptable to all
- Work With the Nation, Chapters, Communities, Families, and even individuals
- Train maintenance personnel at NTU, keep the solution local