



2021 Produced Water Treatment Research

**NM Produced Water Research Consortium Year-end Review
December 1-2, 2021**



BE BOLD. Shape the Future.

Background: NM 2019 Produced Water Act

- The Act encourages the **fit-for-purpose treatment and reuse** of produced water outside the oil and gas sector to:
 - Enhance fresh-water sustainability;
 - reduce or eliminate fresh water use in the oil and gas sector; and
 - support new economic development opportunities.
 - At the same time maintain public and environmental health and safety



Example: potential uses of treated produced water

Water could be treated to fit-for-purpose specifications for possible uses including:

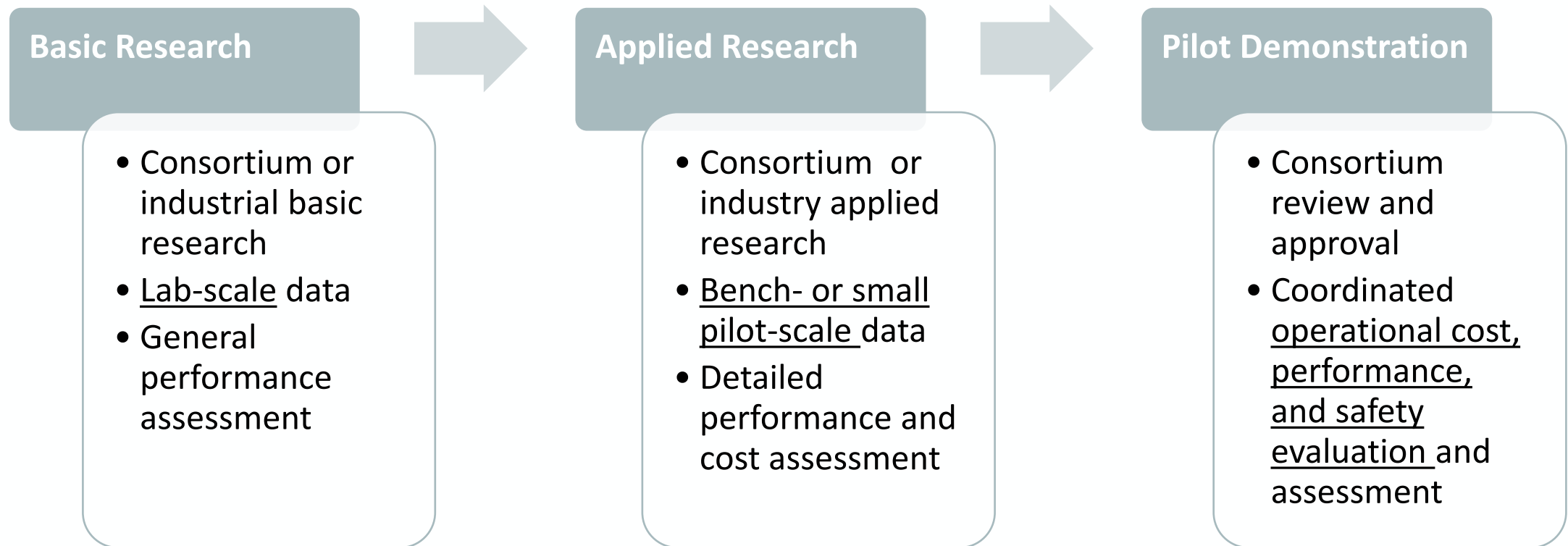
- Road construction;
- Rangeland rehabilitation;
- Agriculture;
- Industrial applications;
- Municipal landscaping (parks, golf courses);
- Mining, mineral recovery;
- Wholesale water sales and transfer;
- Surface water augmentation



Water Quality Targets for Various Applications

Produced Water Quality (ppm) TDS	Application	Common Water Quality Requirements (ppm) TDS	Typical Treatment Process
Conventional 10K to 50K 50%<35K 50%>35K	“Clean Brine”	pH 6-8, Turbidity <25 NTU, ORP<250 mv, organics <30ppm	pretreatment, conditioning
	Water Supply Augmentation	300-3,000	chemical/membrane
	Agriculture	Class 1 <700, <60% Na, B<0.5 Class 2 2000, 60-75% Na, B<2.0 Class 3 >2,000, 75% Na, B~2	membrane
	Rangeland	4,000 – 10,000	membrane
Unconventional 60K to 300K 25%<100K	Rangeland	4,000 – 10,000	thermal
	Surface Flow	600-2,000	thermal
	Mineral Recovery, mining	>100,000	pretreatment/conditioning
	Wholesale water sales	2,000 – 5,000	thermal/chemical/membrane
	Road Construction	10,000 to 100,000	pretreatment/conditioning

Laboratory, Bench, and Pilot-scale Treatment Technology Research and Demonstration Efforts



NMED 2021 Treatment Research Project Requirements

- Treated produced water cannot be placed on the ground. Must be disposed in O&G field per regs by:
 - Recombining with PW in the field, or
 - Recombine and place in a storage facility and delivered back to O&G field for disposal
- Special handling conditions required if produced water is shipped to out-of-state treatment or testing facilities
- Treated produced water at an OCD approved PW recycling facility could be placed back into a larger recycling stream and used for well completions

2021 Treatment Studies

Company	Project	Projected Date	Status
Kanalis Resources	RO treatment of 10,000 ppm TDS San Juan Basin produced water for ag applications	April through October 2021. Treat 20 bbls of water at BGNDRF and conduct greenhouse studies	Treatment completed in April, water at 200-500 ppm TDS, greenhouse studies by October.
zNano Membranes	Polymeric-based ceramic membrane for pretreatment of produced water to “clean brine”	June - August 2021 At BGNDRF, 100 bbls per week	Completed testing in early August. Test report underway.
Crystal Clearwater Resources	Low-temperature distillation of produced water	Pilot-testing in November – December in Permian Basin	System to be moved to NM from Canada in early October 2021
Katz Water Technologies	Thermal treatment of produced water	Pilot-testing in Permian Basin	Negotiating site
Hydrozonix	Ozone pre-treatment of produced water to “clean brine” standard	Pilot-testing in Permian	Negotiating site
Hilcorp	Membrane distillation of produced water	Pilot-testing in December in San Juan Basin	Start scheduled for mid-December
Marah Water Services	Electro-coagulation/cavitation treatment of produced water	Pilot-testing in Permian	Negotiating site
Bechtel	Thermal desalination of produced water	Bench testing in April 2022	At Bechtel test facility in Houston
Eureka	Thermal desalination and mineral recovery of produced water	2022	Negotiating water supply

2022 Treatment Research Plans

- Complete 2021 proposed and Consortium funded projects and identified complementary (self-funded) research
- Incorporate 2022 NMED Pilot-project guidance into spring 2022 RFP for additional Consortium-funded pilot and bench scale projects
- Pursue and support additional complementary research projects (self-funded, or federal funded projects)
- Consider joint produced water treatment projects with other participating state produced water research organizations

2021 Pilot Project Descriptions

- **Kanalis Resources – Nyle Khan**
- **Crosstek (zNano-membranes) – Julian Arroyo**
- **Crystal Clearwater Resources – Mike Hightower**
- **Hilcorp – Mike Hightower**



Bench-Scale Treatment of Low Salinity Produced Water from the San Juan Basin, New Mexico

Nyle Khan – Kanalis Resources

Mike Hightower – NMPWRC

Zack Stoll – BGNDRF

NRCS Los Lunas NM

Dr. Manoj Shukla – NMSU Ag Sciences

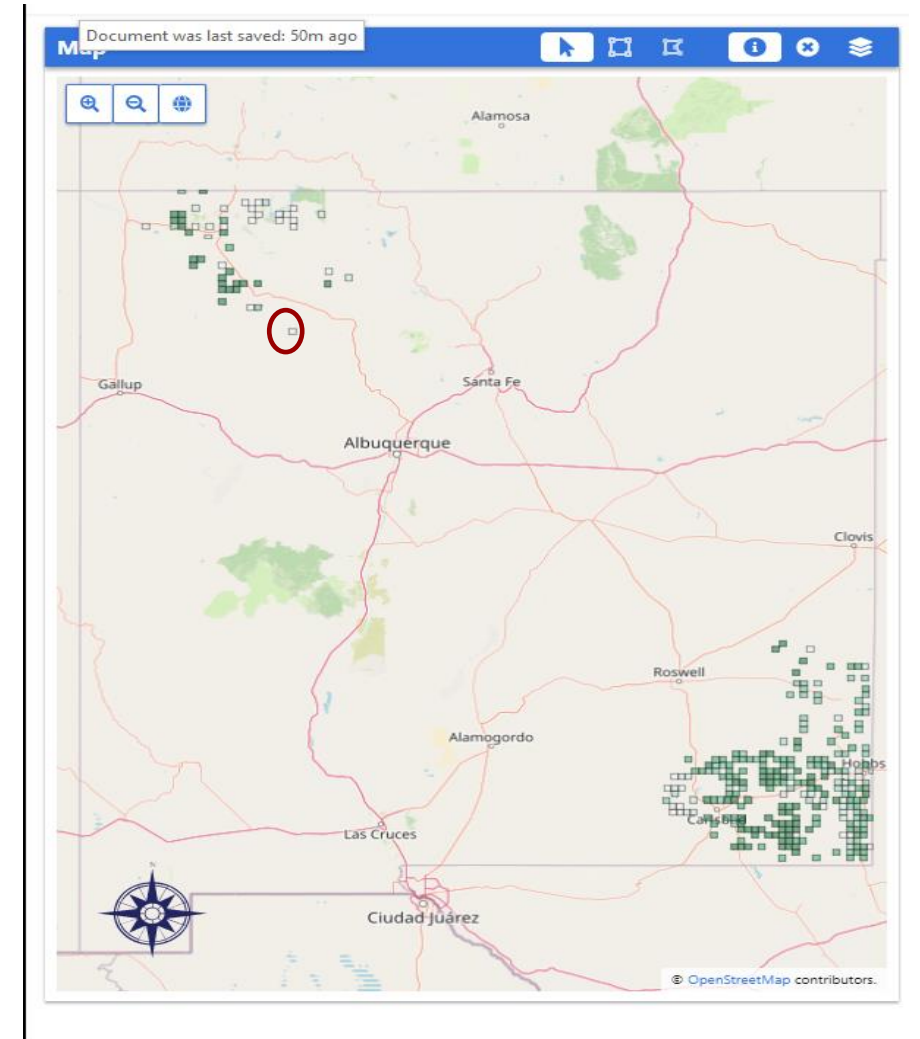
**NM Produced Water Research Consortium - Year-end Meeting
December 1, 2021**



“SEIZE THE OPPORTUNITIES”

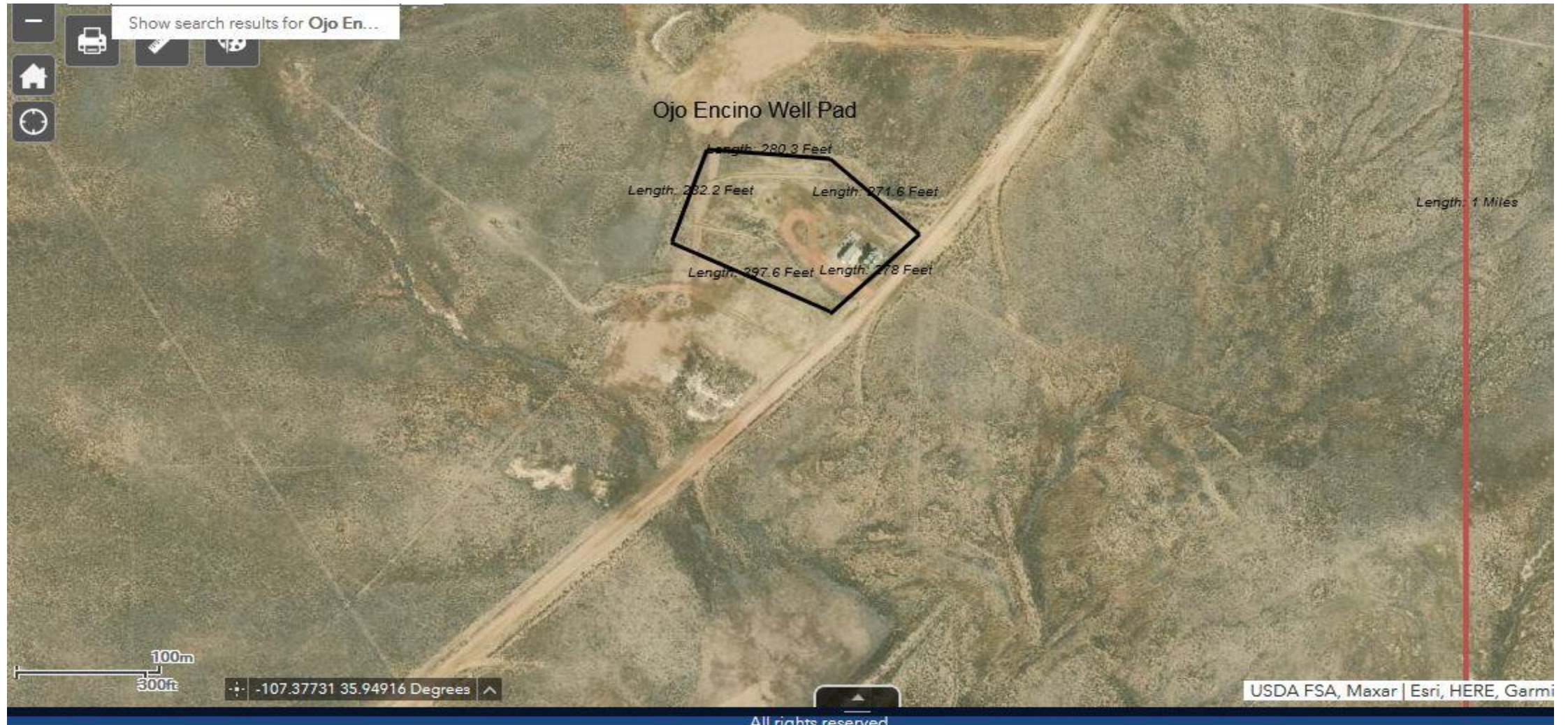
Kanalis Resources Produced Water Treatment Study

- Complementary Research – Kanalis Resources Funded.
- Southern San Juan Basin Produced Water
 - Two SWD's SW of Cuba, New Mexico
 - Checkerboard area of the Navajo Nation
 - Located on BLM land, near Ojo Encino Chapter House
 - Produced water – almost no organics, 8600 -10,200 TDS, elevated temperature of 160F
- Treated water reuse considerations:
 - Range land application for soil conservation and grazing improvement
 - Livestock watering
 - Controlled environment agriculture
 - Water supply augmentation/reduce water hauling



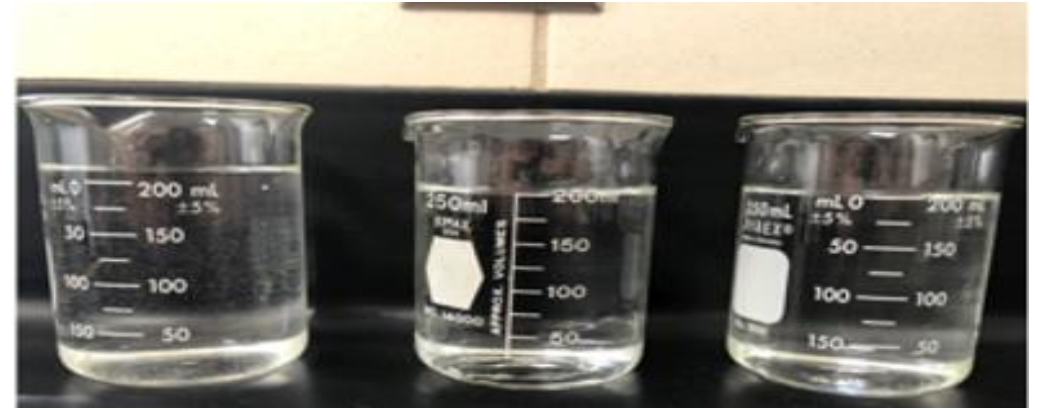
“SEIZE THE OPPORTUNITIES”

Site Location near Ojo Encino Chapter House



Summary of Bench-Scale Treatment Results

- Produced water treatment conducted at BGNDRF
 - Utilized BGNDRF RO treatment Skid
 - Treated 20 bbls of produced water
 - April 2021
- Single –pass RO treatment results
 - Permeate 250-400 ppm TDS
 - 35% permeate recovery
 - Standard dual-pass treatment would increase permeate recovery to over 60%
- Used permeate in NMSU greenhouse studies of range grass growth



Well Water

Produced Water
Permeate

Raw Produced
Water

1243 PPM

231 PPM

8610 PPM



“SEIZE THE OPPORTUNITIES”

Summary of Greenhouse Studies of the Use of Treated Produced Water on Range Grass Growth



Wheatgrass



Alfalfa



Bromegrass (Medow)



Russian wildrye



Tall fescue (Teton)

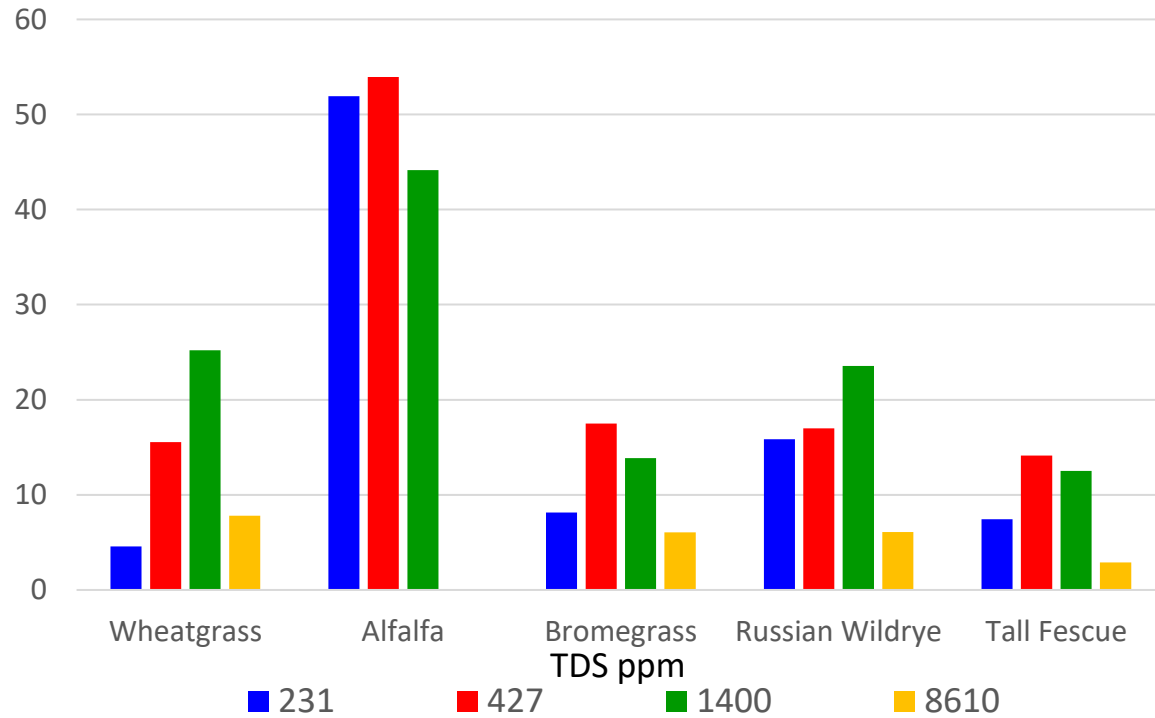
Treatment	TDS (ppm)
Desalinated produced water	231
City water	427
Diluted produced water	1400
Raw produced water	8610

Used NRCS (Los Lunas) recommended grass species: Rye, fescue, wheatgrass, bromegrass, & alfalfa

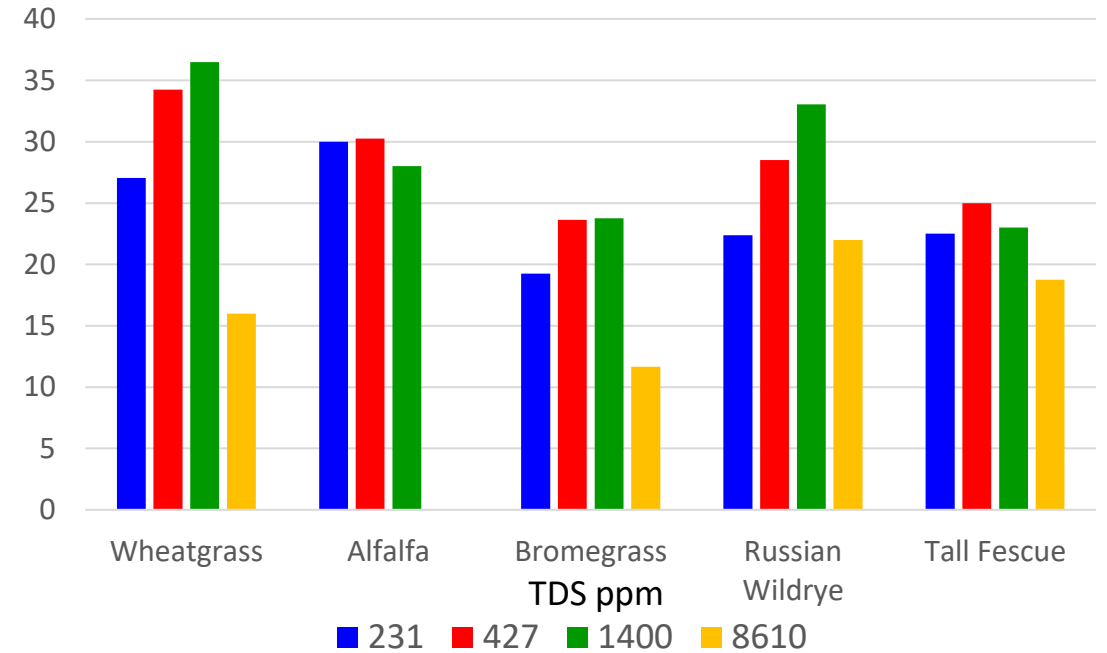
Measurements: Seed Germination; Leachate Fraction; Evapotranspiration; Leachate Water Chemical Analysis; Plant Heights, Chlorophyll Content & Temperature; Shoots Chemical Analysis

Summary of Greenhouse Studies of the Use of Treated Produced Water on Range Grass Growth, Cont.

Mean SPAD – Chlorophyll Measurement



Mean Height
cm



Produced Water Irrigation Effects on Forage Grasses

Dr. Akram Ben Ali, Dr. Manoj Shukla
Plant and Environmental Science
New Mexico State University



“SEIZE THE OPPORTUNITIES”

Comparison of Produced Water to Current EPA Standards

	PW	RO	EPA Standard Source	Key
pH	8.1	7.1		
TDS (mg/L)	8,610	231	Primary Drinking Water Regulations	
Conductivity (mS/cm)	12.69	0.98	Secondary Drinking Water Regulations	
TOC (mg/L)	0.65	1.1		
Turbidity (NTU)	0.33	0.32		

Elem	Name	PW	RO	EPA Standard	Units
				Primary	
Ba	Barium	0.0282	0.0045	2.0000	mg/L
Be	Beryllium	ND	ND	0.0040	mg/L
Cd	Cadmium	ND	0.0012	0.0050	mg/L
Cr	Chromium	ND	ND	0.1000	mg/L
Pb	Lead	ND	ND	-	mg/L
Se	Selenium	ND	ND	0.0500	mg/L
Cu	Copper	ND	ND	1.3000	mg/L
				Secondary	
Al	Aluminum	ND	ND	0.0500	mg/L
Fe	Iron	ND	0.0570	0.3000	mg/L
Mn	Manganese	ND	ND	0.0500	mg/L
Zn	Zinc	ND	0.0095	5.0000	mg/L
S	Sulfur	1,927.0000	108.9000	250.0000	mg/L

We are tracking EPA evaluation of other potential contaminants

“SEIZE THE OPPORTUNITIES”

Summary of Results to Date

- Rangeland/Grassland Applications
 - Grasses preferred slightly salty water to potable water
 - Bromegrass and Fescue well suited to for high desert environment
 - Alfalfa has exceptional results
- Potable Water Applications
 - Permeate passes current drinking water standards.
 - Local area water moved by trucks = expensive.
 - Interest from local Navajo for agriculture and livestock augmentation
 - Other possible potable water resource applications
- Next steps
 - 2nd and 3rd cut in NMST Las Cruces greenhouse
 - Comparison analysis to other grass studies
 - Complete soil testing
 - 2 acre Pilot planned with NRCS/NMST Las Lunas at site – Pending NMED and BLM approval
 - Possible Greenhouse Pilot next year – Pending NMED and BLM approval



“SEIZE THE OPPORTUNITIES”

Questions?



BE BOLD. Shape the Future.