IN COLLABORATION WITH
THE WATER RESEARCH FOUNDATION

WATEREUSE® 2023 SYMPOSIUM
MARCH 5-8, 2023 • MARRIOTT MARQUIS ATLANTA
ATLANTA, GA

REIMAGINING WATER TOGETHER

Produced Water Treatment and Reuse Efforts in Support of the EPA WRAP

Panel on State Efforts on Treatment and Reuse of Produced Water

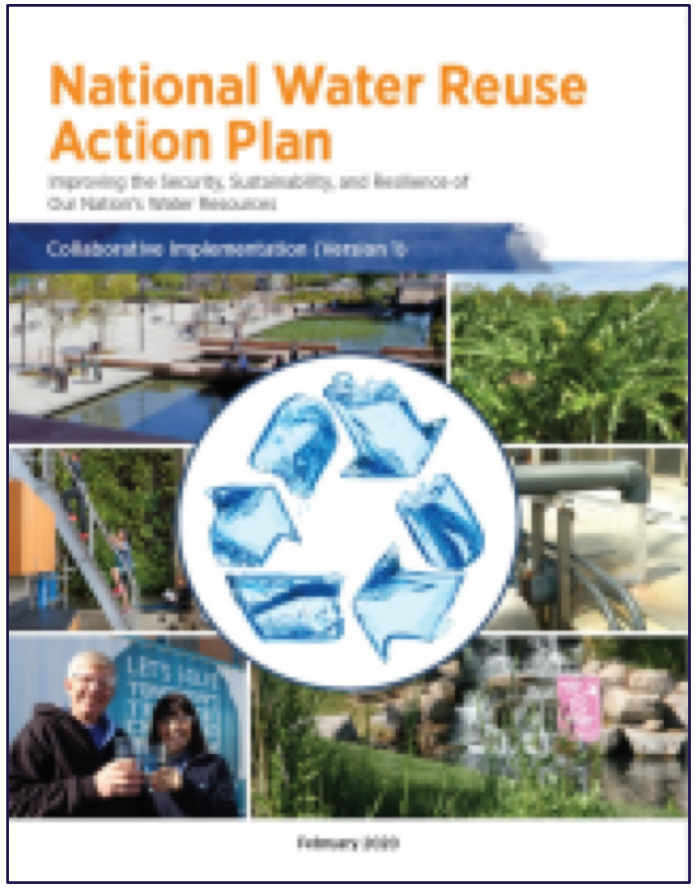
Mike Hightower – NM PW Research Consortium
Sean Thimons – US EPA ORISE Fellow
Danny Reible – TX PW Consortium
Will Stringfellow - CA

March 7, 2023

Presentation Overview

- Discussion of EPA's National Water Reuse Action Plan,
  - Produced water treatment and reuse milestones,
  - National applicability and emerging trends
- Overview of produced water, variations in quality, current treatment requirements, and reuse issues and challenges
- Information on state produced water treatment and reuse programs and updates from – NM, TX, CO, CA
- Audience questions and panel discussion of current and emerging trends and challenges of the safe fit-for-purpose treatment and reuse of produced water

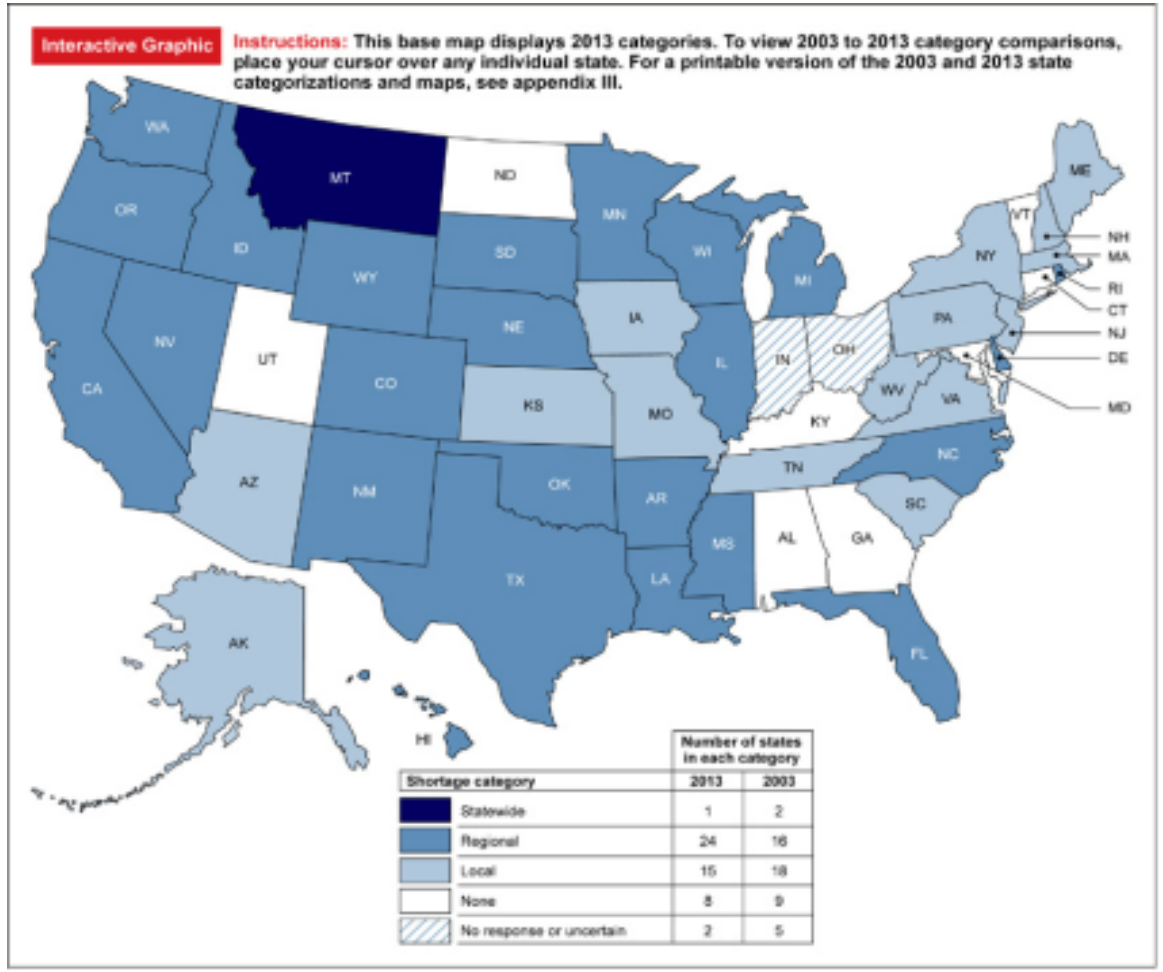
EPA National Water Reuse Action Plan



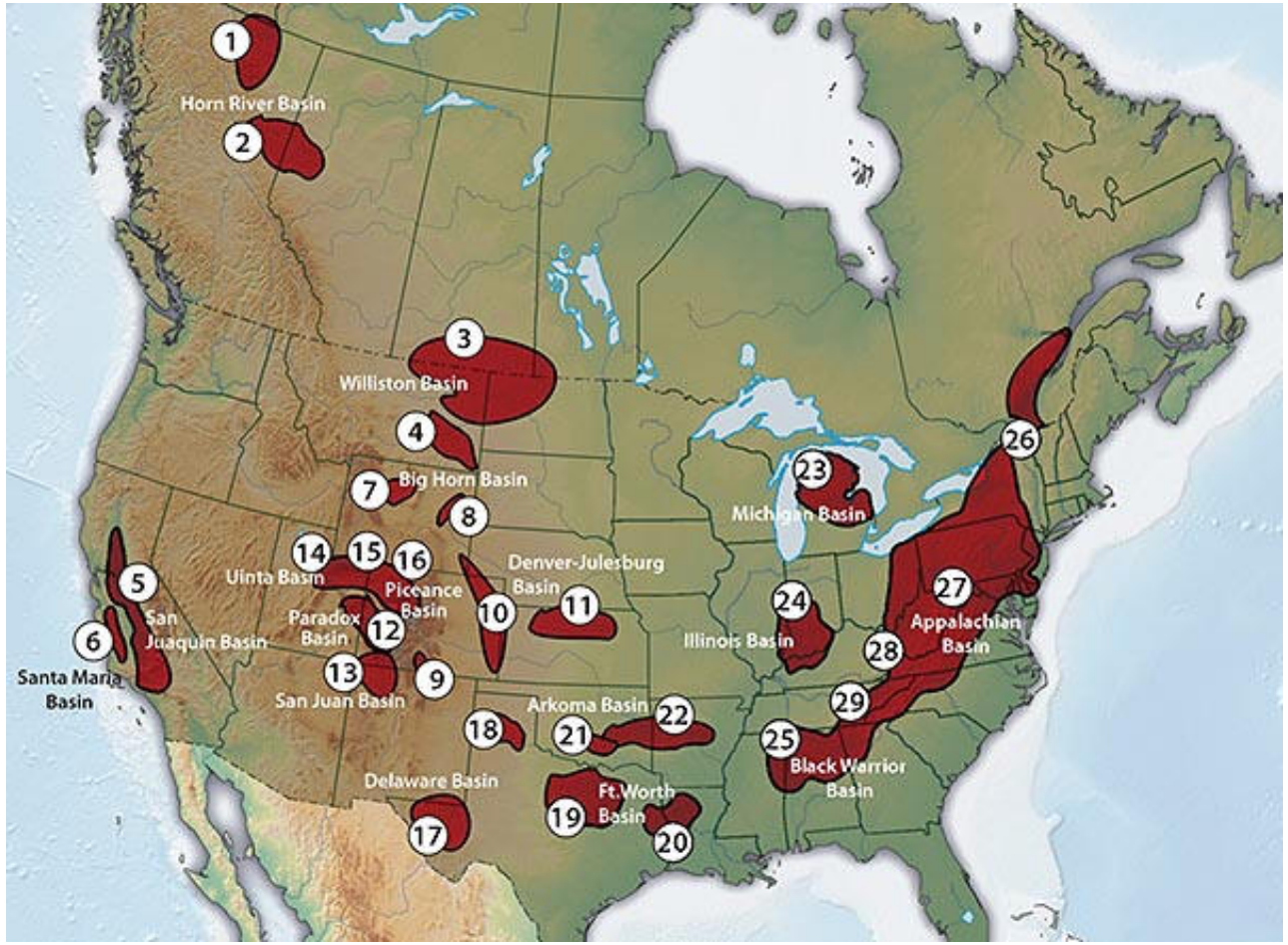
Two of the United Nations' Sustainable Development Goals **are water reuse as key to a more sustainable future.**

- Focus on the fit-for-purpose treatment and reuse of waste water
- Five major programmatic areas:
  - Thermo-electric cooling water
  - Agricultural waste water
  - Municipal waste water
  - Produced water
  - Storm water
- Produced water milestones in Section 2.4.2 of the WRAP include collaboration and outreach with WRA, GWPC & PWS

Produced Water Reuse can Address State Water Stress

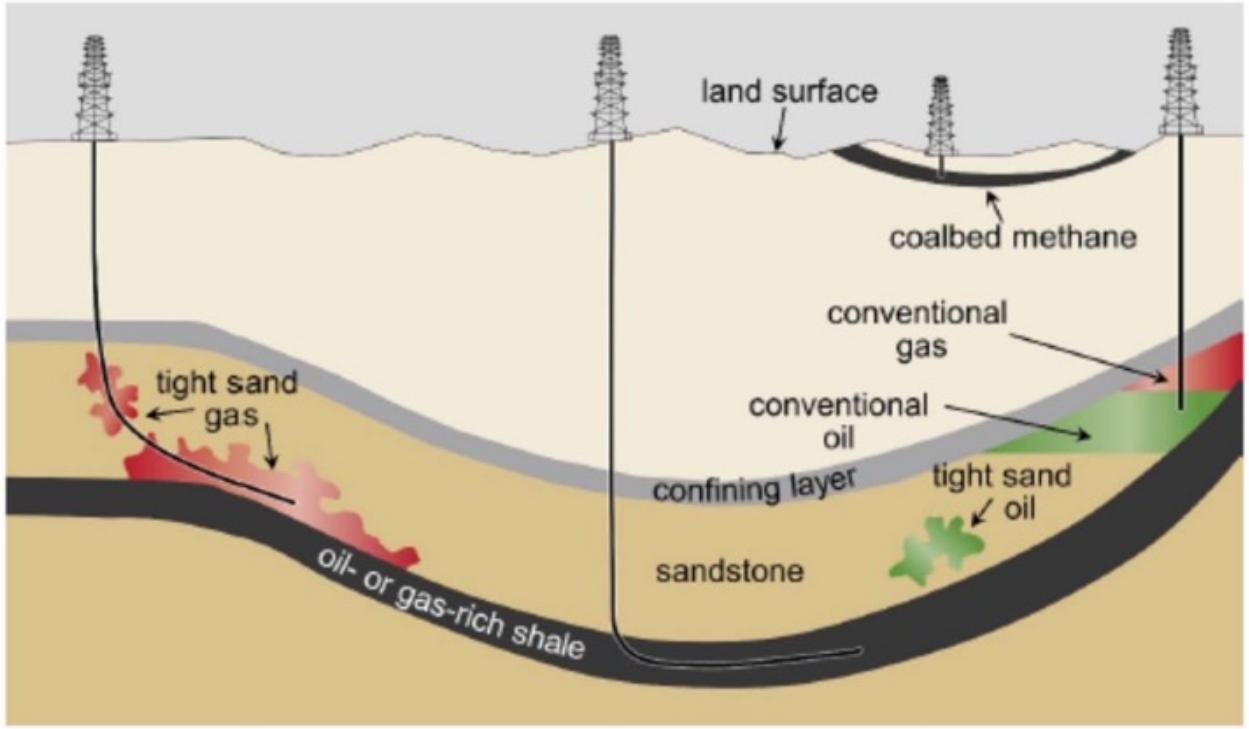


Sources: GAO analysis of state water managers' responses to GAO survey; Map Resources (map).



Produced Water Varies Significantly by Location

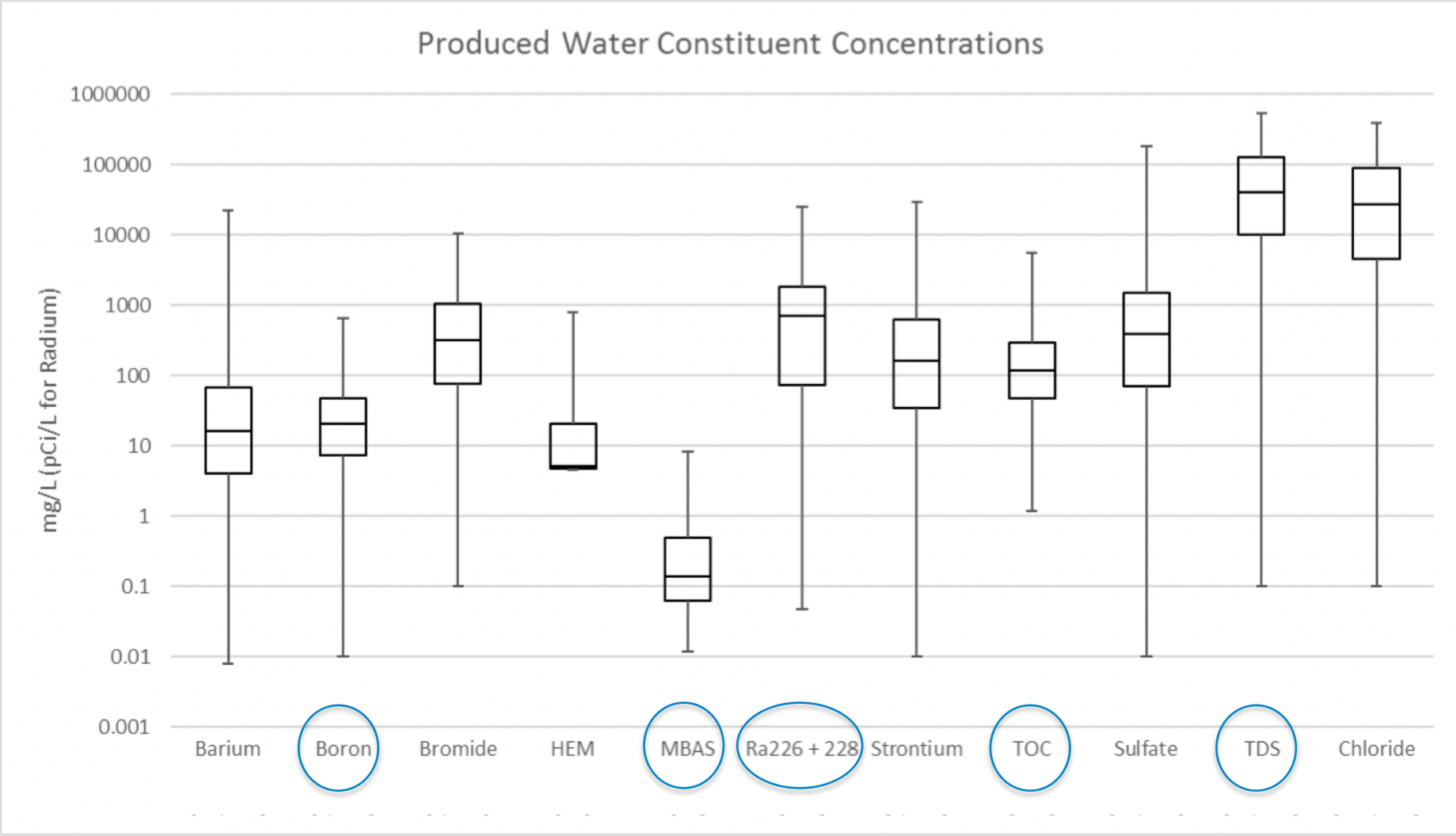
- Water can be 4-100 times the volume of oil produced (1 bbl oil = 4-100 bbls of water)
- Produced water can contain high levels of minerals and organic compounds from geology and hydrocarbon contact plus drilling and completion chemicals
- Quality varies by location, formation, and type of well



Oil and Gas Production

Oil and gas production is from ancient seas, shallow plays, or coal plays

Produced Water Variability and Treatment Challenges

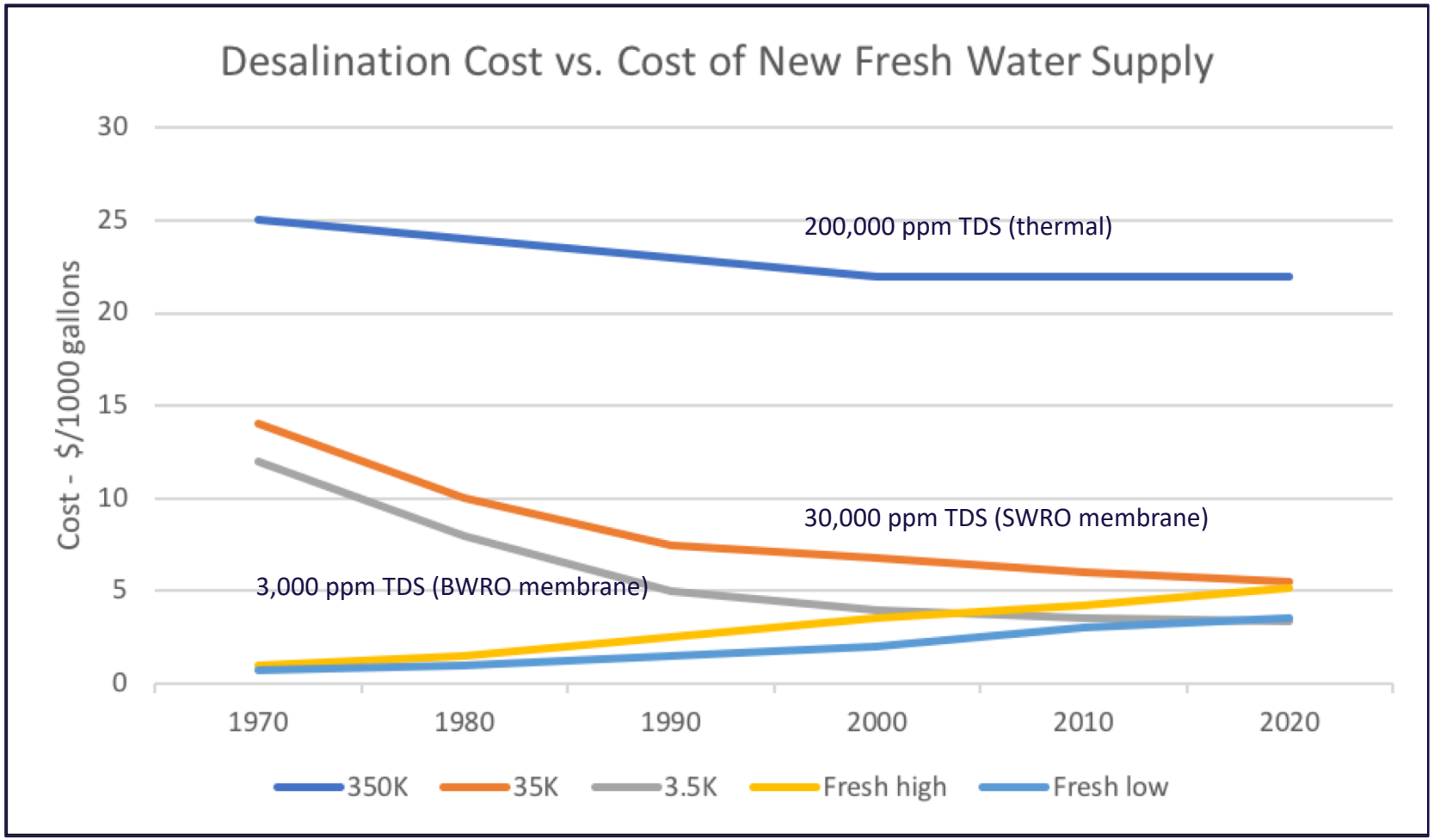


[EPA-821-S19-001]

Water Quality Requirements for Various Uses

Produced Water Quality (ppm) TDS	Application	Common Water Quality Requirements (ppm) TDS	Typical Treatment Process
Conventional 10K to 50K 50%<35K 50%>35K	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 >2000, 75% Na, B~2	Membrane
	Rangeland	4,000 – 10,000	Membrane
Unconv. 60K to 300K 25%<100K	Rangeland	4,000 – 10,000	Thermal
	Energy Development	Pumped hydro, hydrogen, geothermal	Thermal
	Surface Flow	600-2,000	Thermal
	Mineral Recovery	>100K (no discharge)	Pretreatment
	Road Construction	Up to 100,000	Pretreatment

Desalination is Becoming Cost-effective and Efficient for Produced Water Treatment



Produced water disposal
As low as $15/1000 gal

Common
Produced water disposal
$50-150/1000 gal

Desalination treatment is generally below 1000 mg/L TDS, but produced water often needs pre/post treatment

Produced Water Treatment and Reuse is Expanding

Region	PW Production (2017)	PW Disposal (Deep Well Injection)	PW Reuse Inside O&G Field	PW Reuse for EOR	PW Reuse/ Dispose Outside O&G Field	Examples of PW Reuse Outside O&G Field
Appalachian Basin	105 MMbbls (16.8×10^6 m^3)	PA: 1.1%, WV: 56%, OH: 89%.	PA: 96%, WV: 29%, OH: 9.1%.	PA: n/a, WV: 14%, OH: 1.3%.	PA: 1.6%, WV: n/a, OH: n/a.	n/a
Oklahoma	2844 MMbbls (455×10^6 m^3)	41.7%	n/a	44.9%	13.4%	n/a
Texas	9895 MMbbls (1583×10^6 m^3)	36.2%	n/a	46.1%	17.6%	n/a
California	3100 MMbbls (496×10^6 m^3)	22.4%	5.1%	59.3%	11.1%	Irrigation
Colorado	310 MMbbls (49.6×10^6 m^3)	47.1%	8.9%	32.5%	11.5%	Dust control; aquifer recharge and recovery; pits and surface water discharge.
Wyoming	1700 MMbbls (272×10^6 m^3)	14%	n/a	46%	37%	Surface water discharge; groundwater injection; dust control and road application; irrigation; land application; impoundment.
New Mexico	1240 MMbbls (196.9×10^6 m^3, 2019)	51%	10%	40%	n/a	n/a

Note(s): PW: produced water; MMbbls: million barrels; PA: Pennsylvania; OH: Ohio; WV: West Virginia; n/a: not available.

Jiang, W., Lin, L., Xu, X., Wang, H., Xu, P. (2022) Analysis of regulatory framework for produced water management and reuse in major oil and gas producing regions in the United States. Water 14 (14), 2162. https://www.mdpi.com/2073-4441/14/14/2162