Hydrology in Water Law Proceedings /Santa Fe - August 2020

Panel on “What is Produced Water”

Technical Perspective on Produced Water Treatment Legal, Social, Environmental, and Economic Issues

Mike Hightower, Program Director
New Mexico Produced Water Research Consortium

What is Produced Water?

- “Produced water is the fluid (often called brine) brought up from the hydrocarbon bearing strata during the extraction of oil and gas and includes, where present, formation water, injection water, and any chemicals added downhole or during drilling, production, or maintenance processes.”
- brine – water with a salinity greater than sea water (>35,000 ppm) total dissolved solids (TDS)
- formation water – naturally occurring water in the geologic formation
- injection water - water and chemical additives used in hydraulic fracturing to enhance production.
- Produced water = 4-10 times oil produced

Summary of Input on Oil and Gas Extraction Wastewater Management Practices Under the Clean Water Act

EPA-821-S19-001

U.S. Environmental Protection Agency

Engineering and Analysis Division

Office of Water

1200 Pennsylvania Avenue, NW

Washington, D.C. 20460

Final May 2020

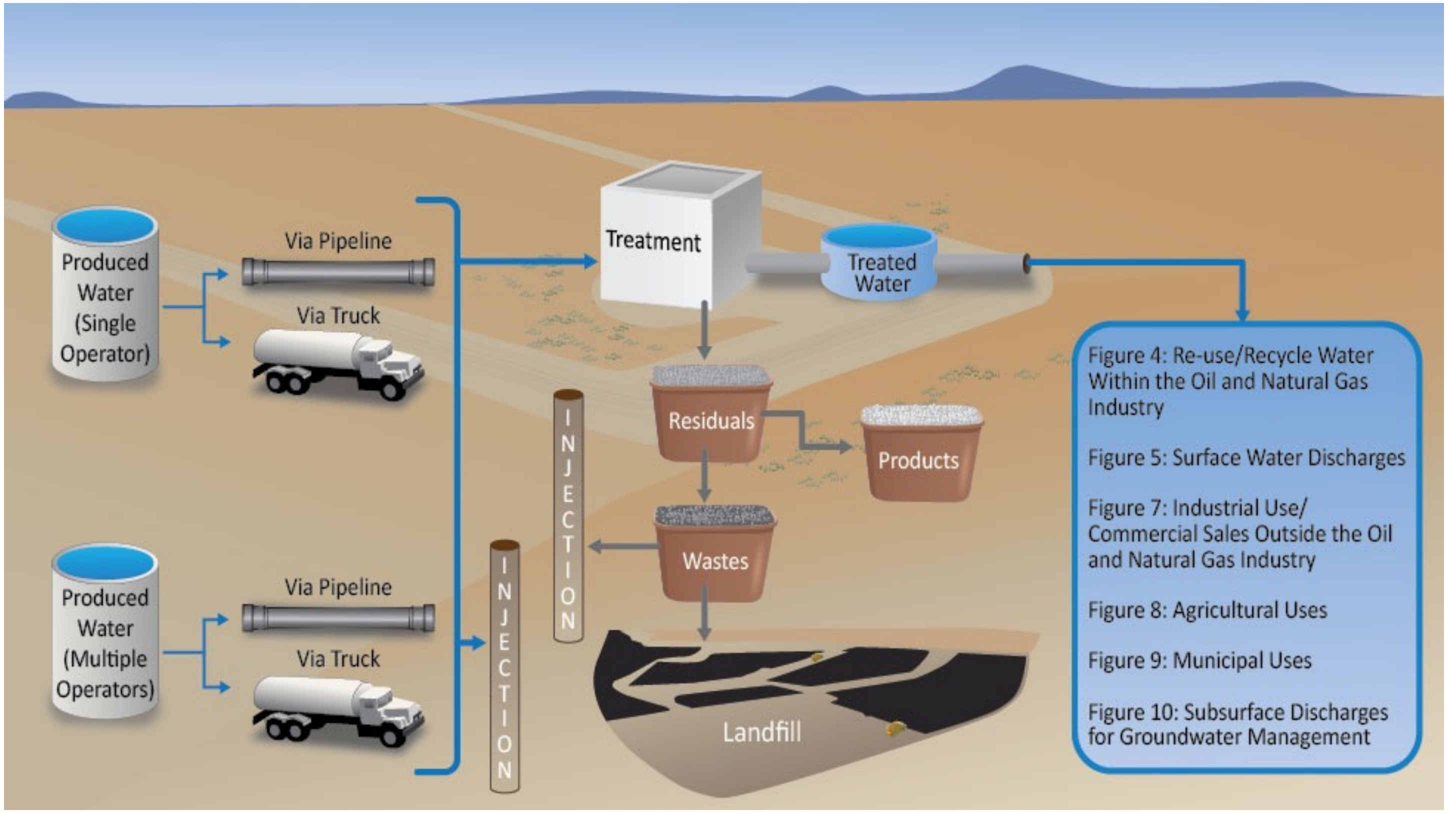
2019 NM Produced Water Act, HB 546

- Through the Act, statutory and regulatory authority for the reuse of produced water was modified:
  - Reuse inside oil and gas sector remains under the Oil Conservation Division (OCD) of the NM Energy Minerals and Natural Resources,
  - Reuse outside the oil and gas sector was designated to the NM Environment Department.
- Technically, establishes a framework for treated produced water to become a market commodity, displacing fresh water use, and when reused become a "water of the state" in many cases.
- Improves fresh water sustainability:
  - Produced water reuse reduces fresh water demand
  - Creates a new water supply for NM - while protecting public and environmental health and safety.

The transition of produced water treatment for reuse under environment department management is an emerging trend – OK, CA, TX, UT, and EPA

NM Produced Water Research Consortium

Established under an MOU between the NM Environment Department and New Mexico State University in September 2020 to: coordinate a focused research, development, and evaluation program for produced water reuse; fill science and technical gaps to accelerate development of innovative technologies and collection of cost and performance data; collaborate with state and federal health and resource agencies, academia, industry, and NGOs and their associated technical experts; and address fit-for-purpose treatment requirements for a range of applications such as industry, construction, agriculture, rangeland, municipal, aquifer storage, surface supplies, etc. as identified in the 2019 NM Produced Water Act. This presentation provide background technical information on the general benefits, issues, and challenges of the use of produced water use outside oil and gas as understood today.



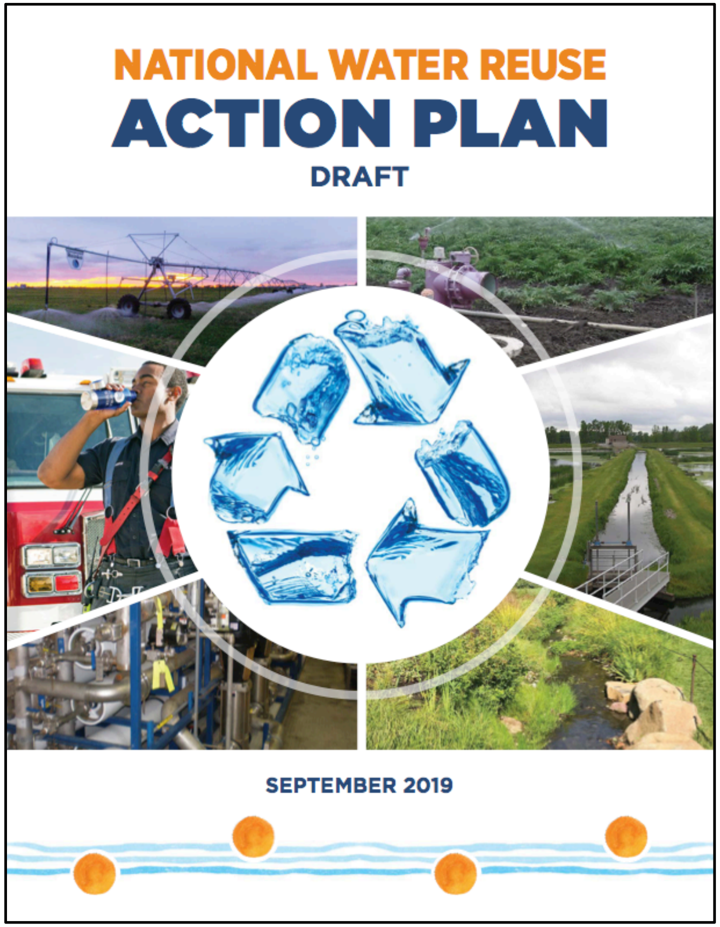
EPA 2020 National Water Reuse Program

Water Reuse Drivers

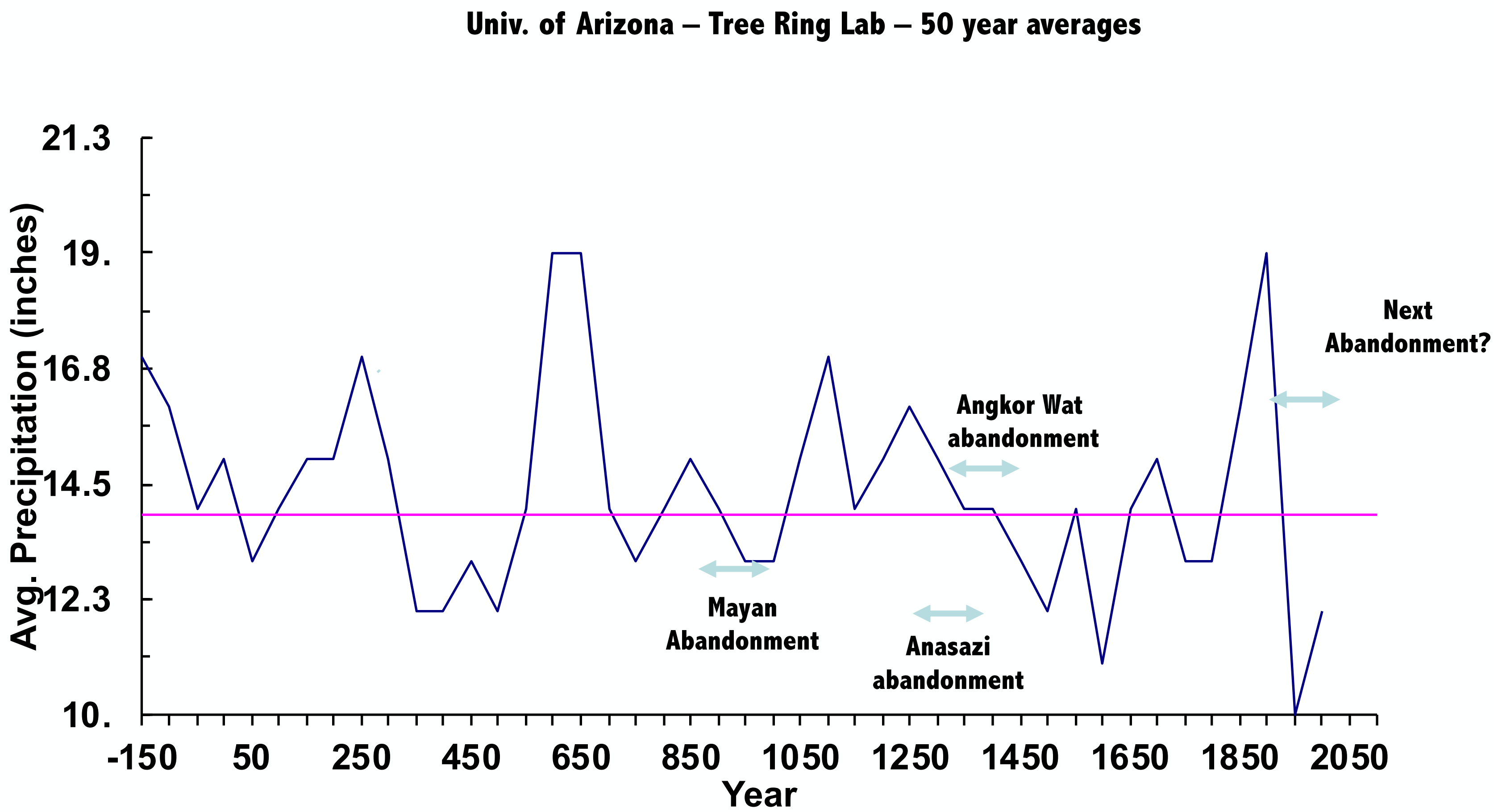
"Within the next 10 years, 40 out of 50 state water managers expect to face freshwater shortages in their states. In certain situations, water conservation and efficiency measures may not be enough to meet anticipated increases in demand."

"Water managers and users are increasingly evaluating reuse options to help diversify and extend their supplies - two of the United Nations' Sustainable Development Goals identify **water reuse as key to a more sustainable future.** "

New Mexico was identified by the EPA as the lead for research on produced water reuse

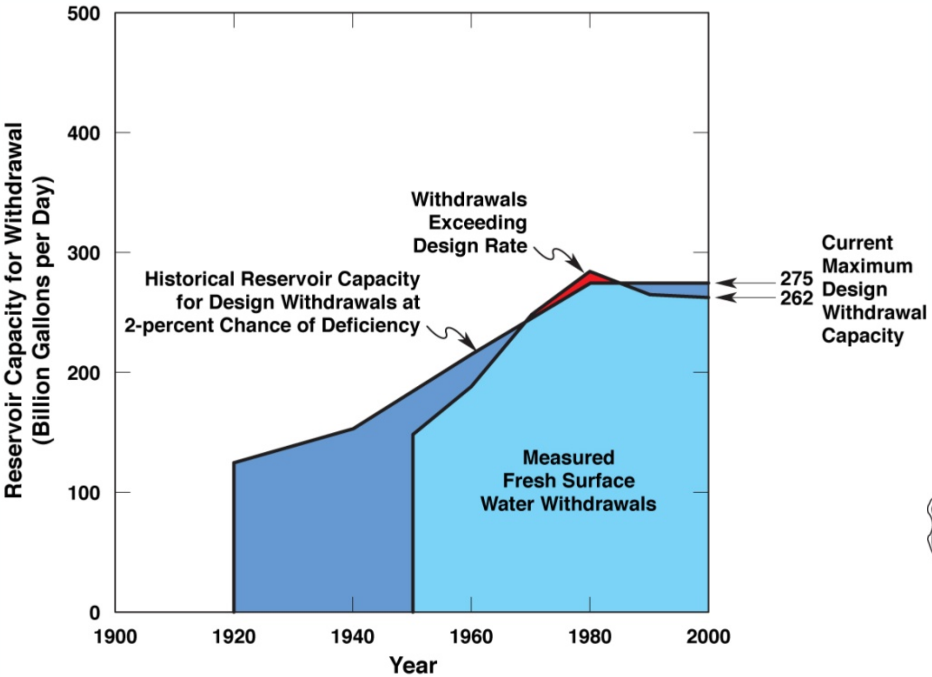


Climate Issues Driving Produced Water Reuse in the Western U.S.



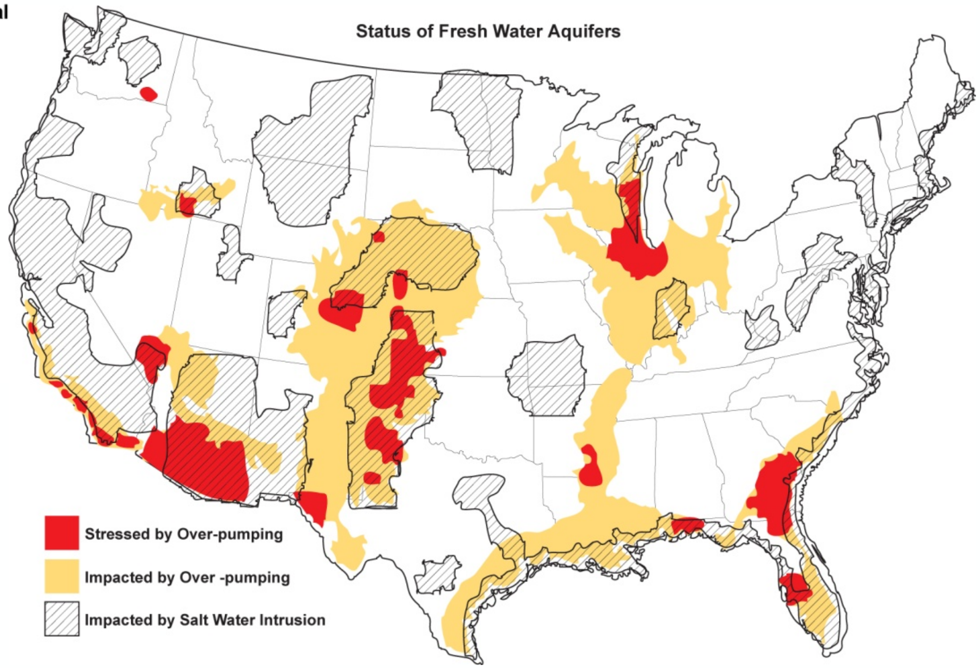
The mid-latitudes are in the 100th year of a 300 yr arid cycle

Fresh Water Availability Issues Driving Produced Water Reuse



(Based on USGS WSP-2250 1984 and Alley 2007)

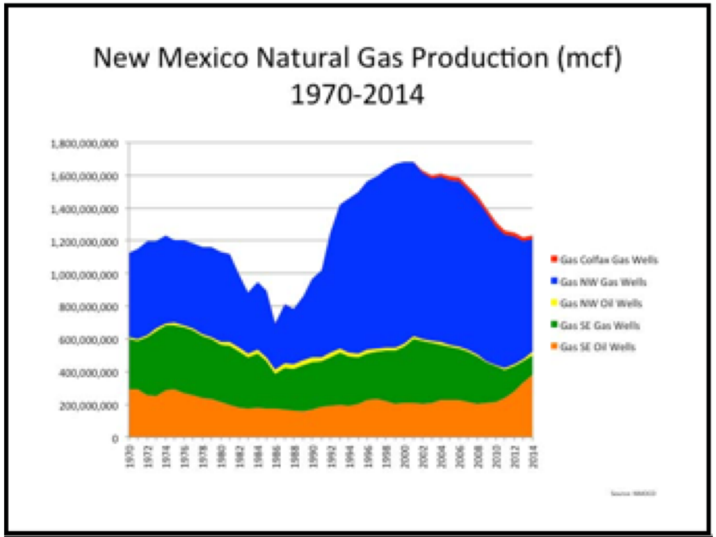
- No new surface water storage capacity since 1980

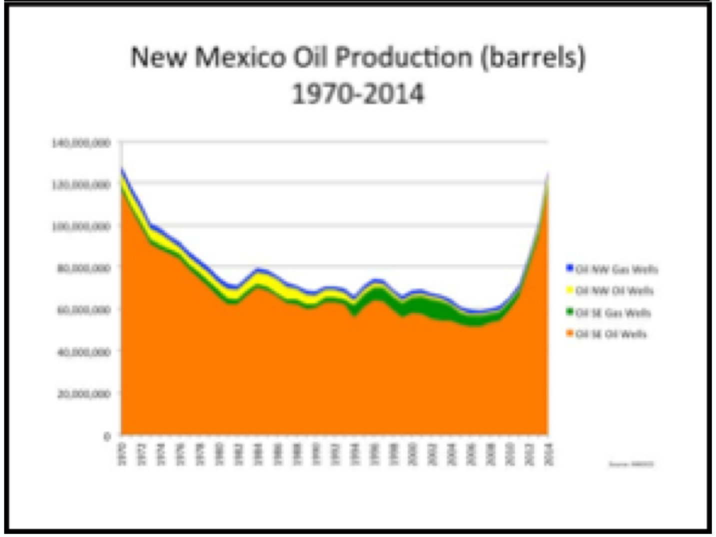


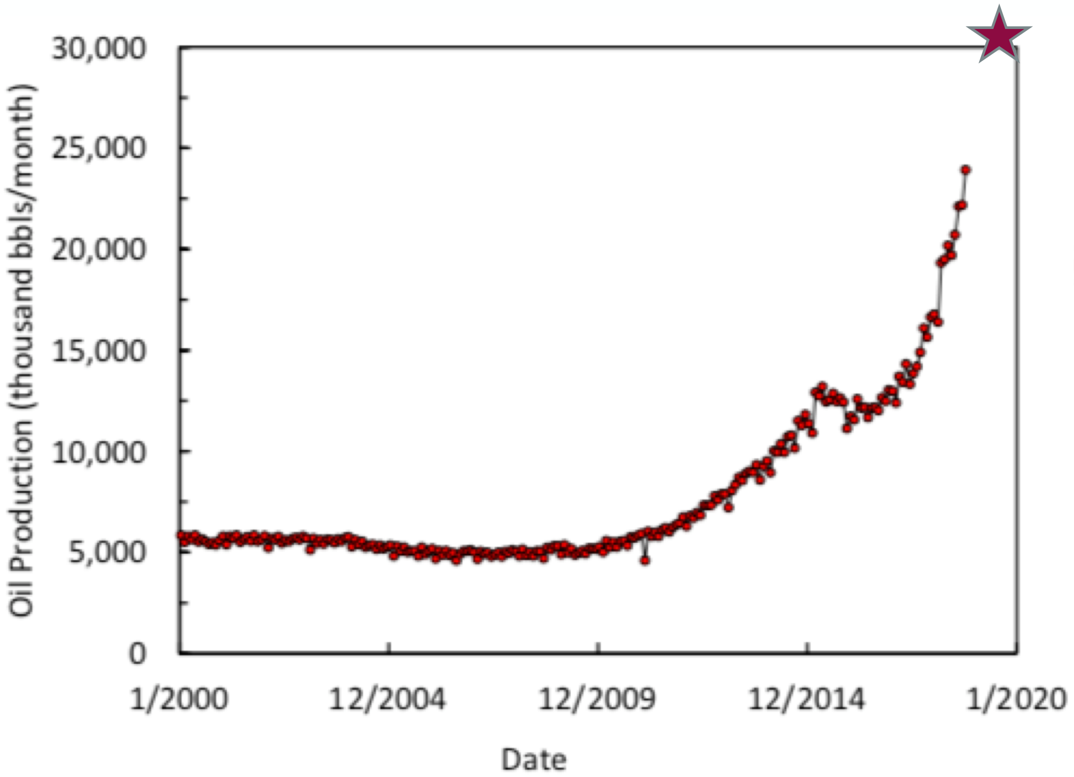
(Shannon 2007)

- All major groundwater aquifers overstressed

Produced Water Production Driving Reuse

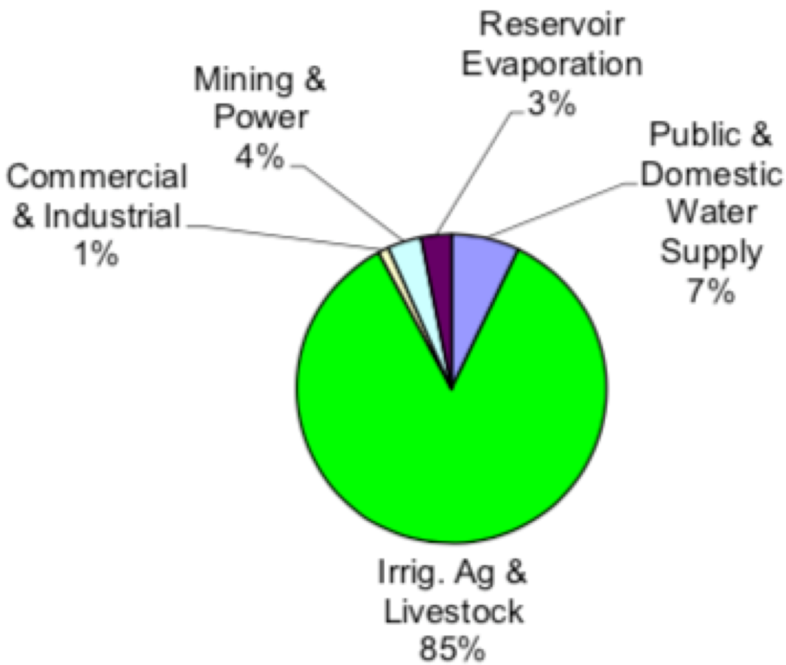






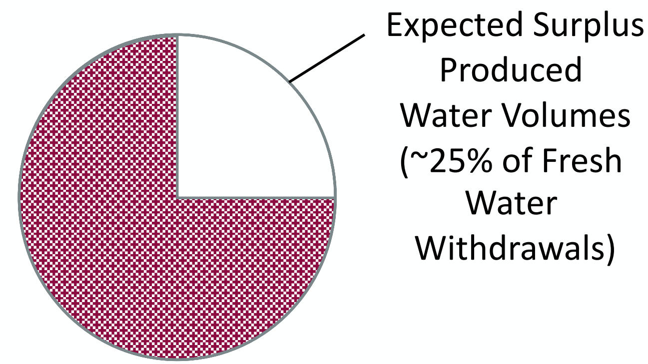
Average 4-5 bbls of produced water/ barrel of oil
~4 million bbls produced water/day (3 ABQ's)

Water Supply Impact Of Produced Water Reuse



Eddy & Lea Counties
Total withdrawals = 427,800 AF/yr (3.3 B bbls/yr)

Annual Fresh Water Withdrawal

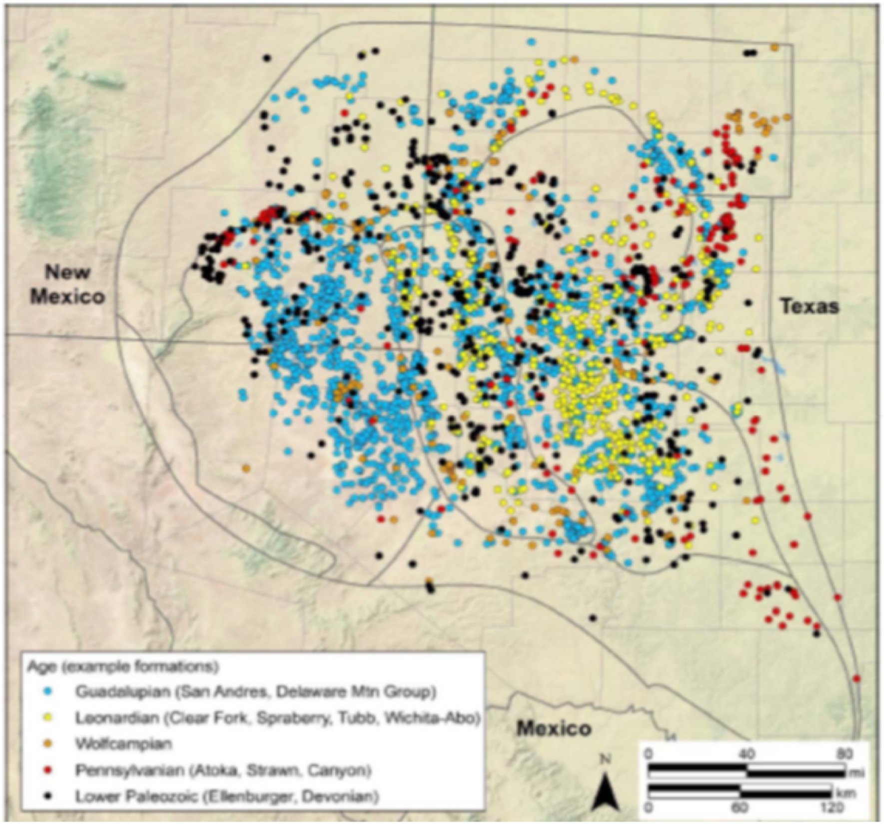


Surplus expected to be ~1 B bbls/yr (2-3 M bbls/day)

Projected Produced Water Surplus

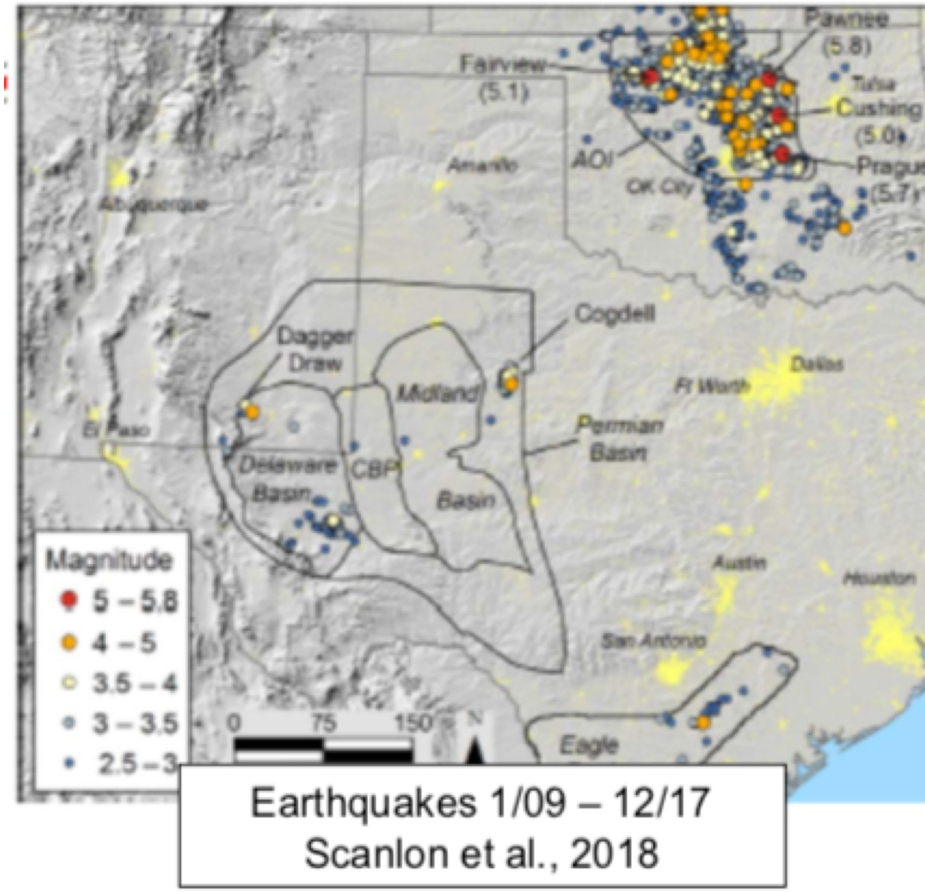
Produced Water Disposal Issues Driving Reuse

Produced Water Disposal



Running Out of Disposal Capacity

Produced Water Injection Seismicity



Public and Environmental Health and Safety Issues

- Produced water quality varies by depth, location (10,000 mg/L to > 300,000 mg/L)
- Often Na, Ca, Cl, and SO4 , high scaling
- Can contain hazardous constituents such as: Ra, Ba, Sr, metals, organics, organic acids
- Fracking chemicals –

  Water –98% to 99% by volume

  Sand - 1% to 1.9% by volume

  Friction reducer –0.025% polyacrylamide,

  Biocide – 0.005% to 0.05% amine,

  Surfactants - .5 to 2 ppm phosphate,

  Thickeners - guar gum & cellulose polymers,

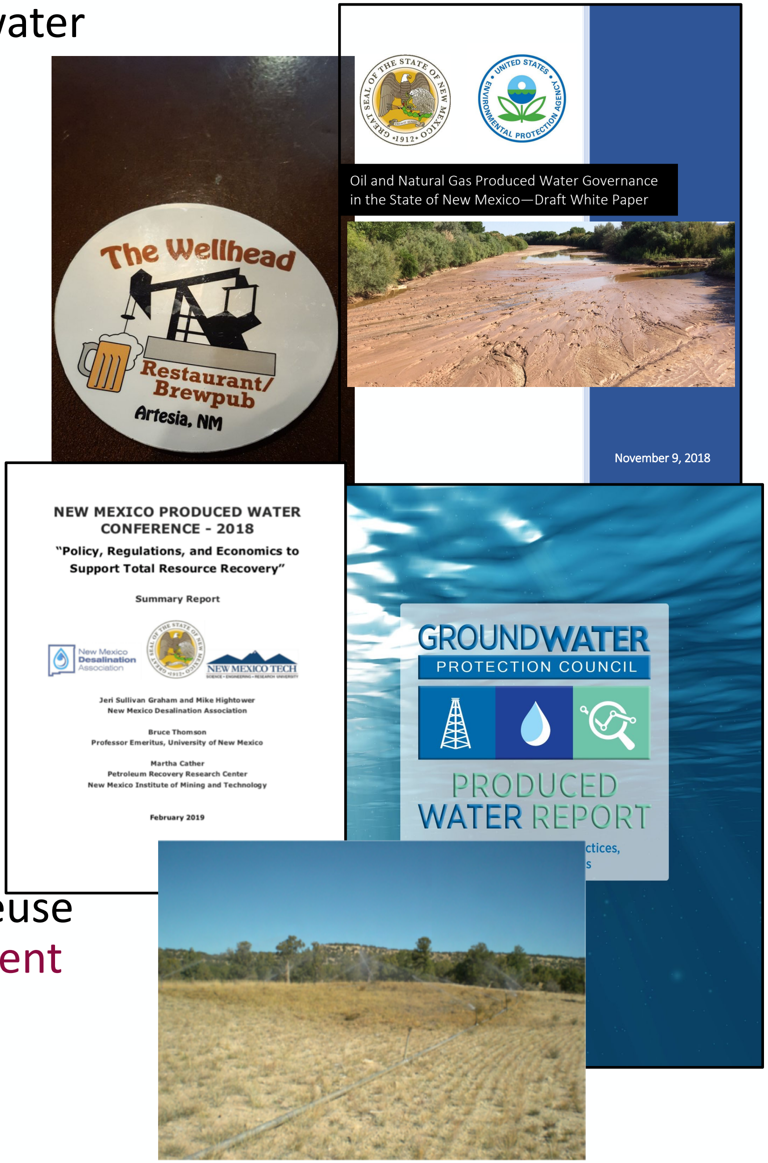
  Scale and Corrosion inhibitors, and

  other trace chemicals

REQUIRES SAFE HANDLING, TREATMENT, STORAGE, USE, AND RESIDUALS MANAGEMENT

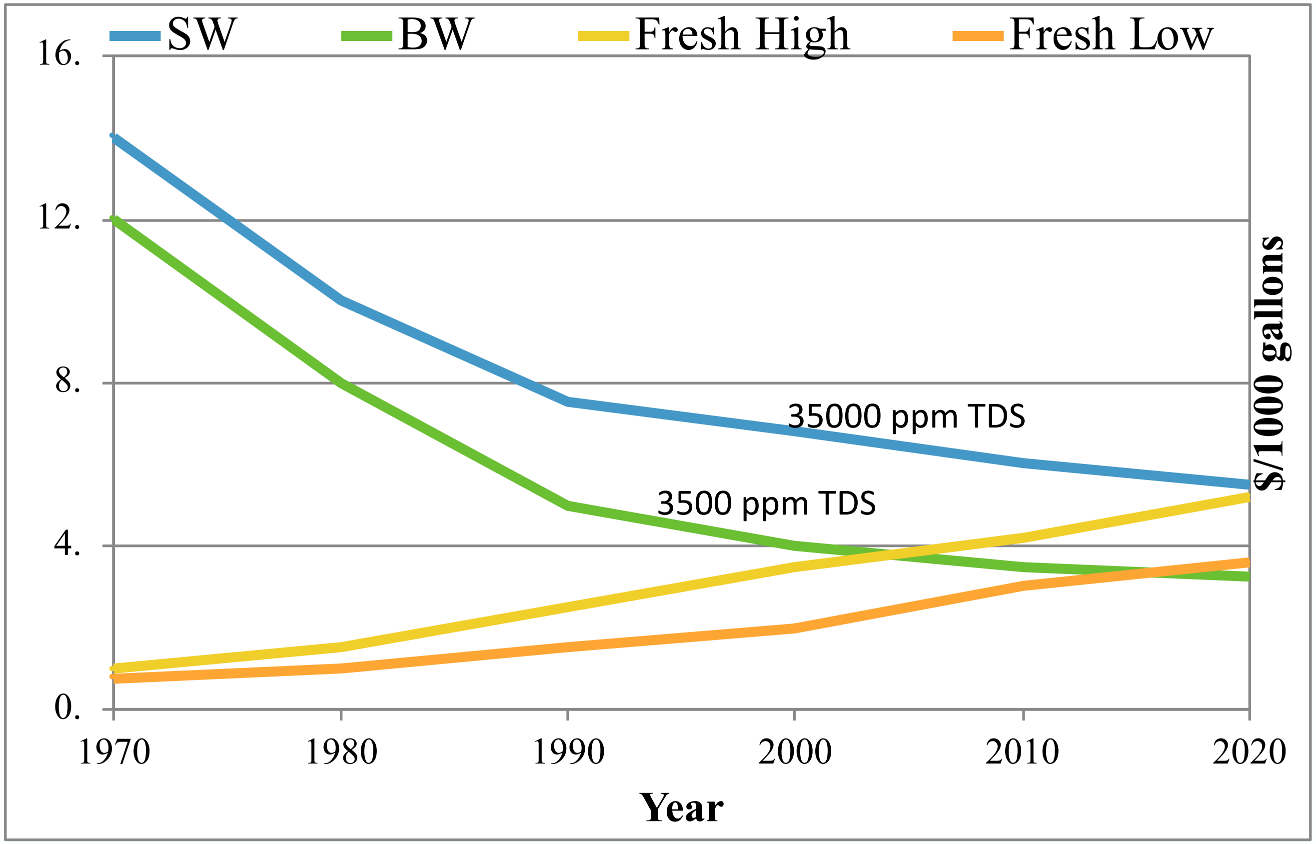
Long NM Produced Water Reuse History

- Sandia and Los Alamos conference on CBM produced water reuse in Denver for DOE – 2002 (20 oil companies)
- Permian Produced Water Reuse Workshop at NMJC in Hobbs with NM WRRI - 2003 (140 attendees, eight projects ongoing- Reed &Stevens, Yates, Devon, Chevron, Conoco, Sandia, LANL)
- NM Tech PRRC Produced Water Treatment Effort – 2003 -2007
- Significant industry and resource agency efforts from 2004-2015
- NM EMNRD working group on streamlining produced. water for reuse - 2015-2017
- EPA signs MOU with NM to explore produced water reuse options - 2018
- NM Desal Association Workshop on Produced Water Reuse – 2018 (160 attendees) - "pursue a cooperative treatment technology evaluation program"
- DOE and BOR expand desalination research funding to include produced water 2019



Desalination Water Treatment Costs Driving Produced Water Reuse

(EWRI Hightower 2018)



2000 Permian Basin Avg Produced Water Disposal costs $4/1000 gal

2020 Permian Basin Avg Produced Water Disposal costs $75/1000 gal

Social Benefits of Produced Water Reuse

Element	Value
Oil production value	$6-8 B
Gas production value	$5-7 B
General Fund direct revenues	$2 B
General Fund	$1B
Capital Outlay	$.4-.5 B
Taxes to local government	$.5 B
Percent of Budget from Oil and Gas Revenues	30%

(NM LFC Finance Facts, 2018)

Supporting state economic growth and societal benefits

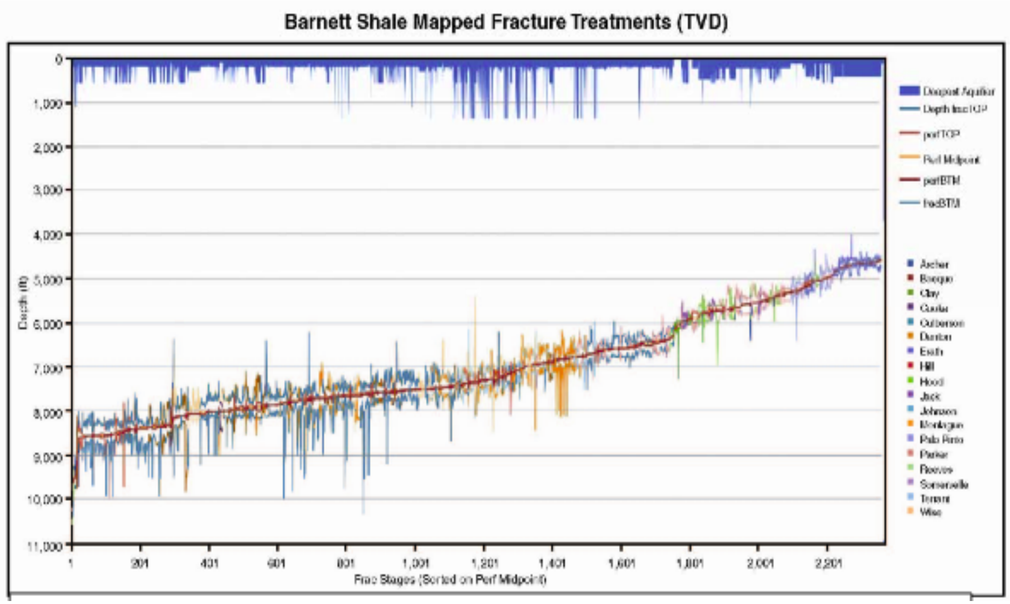
Cost/Benefit	Range of Values
Price of Oil (WTI)	$55.00
Price of Recycled Water per barrel	$0.50 - $7.00
Marginal Cost of Production & Taxes	$20 - $25
Marginal Cost of Water Disposal per barrel	$0.50 - $2.25
Marginal Cost of Transportation	$0.00 - $9.00
Marginal Cost of Recycling	$1.00 - $16.00
Marginal Private Value of Recycled Water	$0.25 - $1.75
Marginal Social Value of Recycled Water	$0.48 - $51.24

(Chermak & Patrick, 2018)

Public Education Challenges to Produced Water Reuse

POORLY UNDERSTOOD FACTS

- Oil and gas has other uses than just transportation
- Oil and gas production in NM is nearly 100 years old, fracking has been practiced over 50 years
- Technical peer-reviewed studies show aquifer contamination comes mostly from surface operations
- Oil and gas terminology can lead to misinterpretations – NY Times 2012
- "Unknown, poisonous, and hazardous proprietary chemicals" are a major concern for the public



"we oppose even entertaining the idea of using this on crops." "Because it's chemically altered, we believe it can never be returned to the evolutionary process as water." **NM Desal, 2018 Produced Water Forum Protestor.**

Wash Post Dec 8, 2018

Fracking, Produced Water, and Oil and Gas are not Synonymous

1) Growing evidence shows that regulations are simply not capable of preventing harm.

5) Natural gas is a threat to the climate.

6) Earthquakes are a proven consequence of drilling and fracking-related activities in many locations.

7) Fracking infrastructure poses serious potential exposure risks to those living nearby.

9) The risks posed by fracking in California are unique.

10) Fracking in Florida presents many unknowns.

11) The economic instabilities of fracking further exacerbate public health risks

12) Fracking raises issues of environmental justice.

13) Health professionals are increasingly calling for bans or moratoria on fracking, based on a range of potential health hazards and as reviews of the data confirm evidence for harm.

Peer review has different meanings

Emerging Trends in Hydraulic Fracturing

Physicians for Social Responsibility and Concerned Health Professionals of New York

Introduction to Fracking

Since the end of the 20th century, horizontal drilling has been combined with high-volume hydraulic fracturing as novel technologies for extracting dispersed oil and natural gas, primarily from shale bedrock, that would otherwise not flow to the surface. Typically, these unconventional extraction methods (collectively known as "fracking") take place on clustered multi-well pads where individual well bores extend vertically down into the shale formation and then turn horizontally, tunneling through the shale in various directions. These lateral tunnels can extend a mile or more underground.

To liberate the gas (methane) or oil trapped inside the shale, many small explosive charges followed by high volumes of pressurized fluid are sent into the shale layer to expand and extend its many naturally occurring cracks, bedding planes, and faults. Silica sand grains (or sometimes ceramic beads) are carried by the pressurized fluid into these spaces and remain there after the pressure is released, acting to prop open these now-widened fissures in the shale and allowing the methane or oil trapped within to flow up the well.

Fracking fluid consists of fresh water to which is added a sequence of chemicals that include biocides, friction-reducers, gelling agents, anti-scaling, and anti-corrosion agents. Some of the water used to frack wells remains trapped within the fractured zone and, as such, is permanently removed from the hydrologic cycle. The remainder travels back up to the surface. This flowback fluid contains not only the original chemical additives but also naturally occurring substances carried up from the shale zone, which often include brine, heavy metals, and radioactive elements.

Once in production, a fracked well continues to generate liquid throughout its lifetime. This produced water, which contains many of the same toxic substances as flowback fluid, is a second component of fracking waste, and it also requires containment and disposal. In addition, fracking waste includes solid drilling cuttings, which are typically laced with various chemical substances used to aid the drilling process. These cuttings, which can also contain radioactive elements, are typically disposed in landfills.

As fracking operations in the United States have increased in frequency, size, and intensity, and as the transport of extracted materials has expanded, a significant body of evidence has emerged to demonstrate that these activities are dangerous to people and their communities in ways that are difficult—and may prove impossible—to mitigate. Risks include adverse impacts on water, air, agriculture, public health and safety, property values, climate stability, and economic vitality, as well as earthquakes.

Researching these complex, large-scale industrialized activities—and the ancillary infrastructure that supports them—takes time and has been hindered by institutional secrecy. Nonetheless, research is gradually catching up to the last decade's surge in fracking from shale. A growing body of peer-reviewed studies, accident reports, and investigative articles has detailed specific, quantifiable evidence of harm and has revealed fundamental problems with the entire life cycle of operations associated with unconventional drilling, fracking, and fracked-gas infrastructure. Industry studies, as well as independent analyses, indicate inherent engineering problems including uncontrolled and unpredictable fracturing, induced seismicity, extensive methane leakage, and well casing and cement failures that cannot be prevented with currently available materials and technologies.