INNOVATING TEXAS' WATER:
EXPLORING THE POTENTIAL FOR PRODUCED WATER

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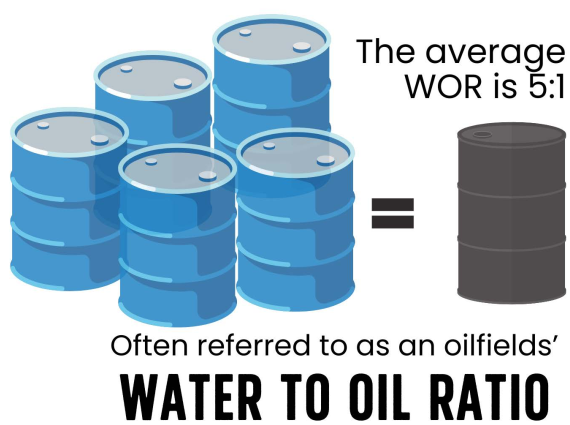
INTRODUCTION

Oil wells typically pump more water than oil (Bennett, 2023). In the last 15 years, the Permian Basin of West Texas has transitioned from a declining conventional oil basin to a "Super Basin," which is defined as a basin that has a cumulative production of more than 5 billion barrels of oil equivalent (Zartler, 2017). Unconventional oil and gas production—characterized by the widespread application of hydraulic fracturing, or "fracking"—has opened previously untapped oil resources that are now accessed through horizontal drilling resulting in long lateral wells (see **Figure 1**). The oil boom of the twenty-first century in Texas has been, in large part, driven by the innovative drilling technologies. This unconventional oil and gas production in the Permian Basin–a region with limited freshwater resources–has coincided with a large increase in the amount of water needed for drilling and fracking, and in the volumes of water produced. This combination of large amounts of produced water in an area of freshwater scarcity presents both challenges and opportunities for the Texas oil industry.

WHAT IS PRODUCED WATER?

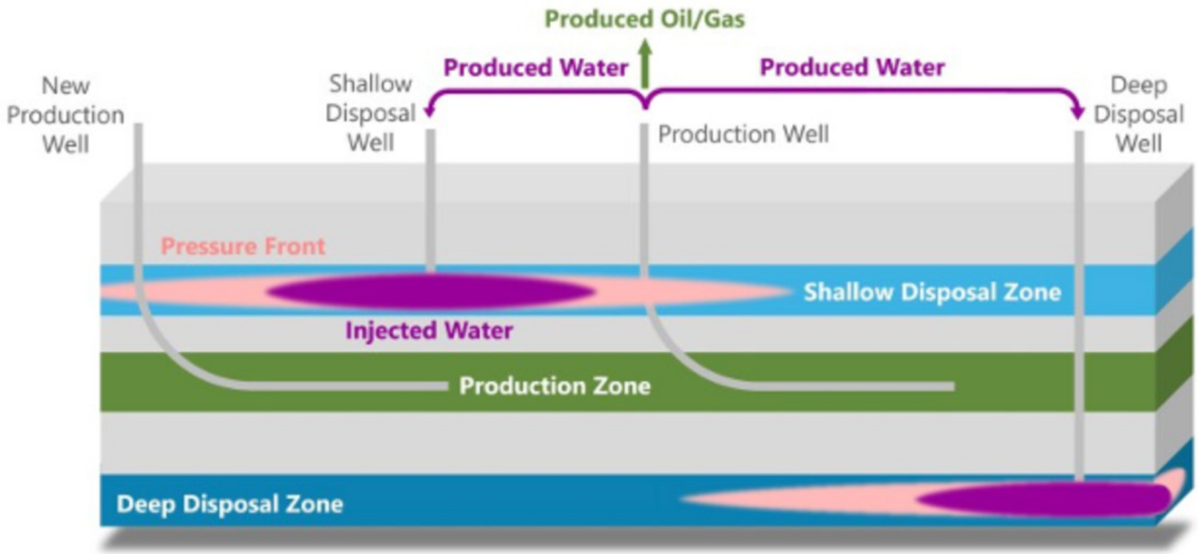
In August 2024, Texas produced an average of 5.8 million barrels of oil each day that month (EIA, 2024). In every barrel of oil produced, anywhere from three to twelve times the amount of water is also produced as a by-product. Depending on where the oil production occurs, the depth of well, and the use of conventional or unconventional oil and gas production, different amounts of wastewater are generated. Volumes are dependent upon the formation and basin of the oilfield, but also vary based on the producing well age, where produced water generally increases over the lifetime of a well (Texas Produced Water



The average WOR is 5:1. For every barrel of oil, 5 barrels of produced water are generated.

Figure 1

Diagram of Permian Basin Oilfield Water Production and Disposal Operations



Note: From Bruant, 2023, (https://jpt.spe.org/the-growing-pressures-of-produced-water-disposal).

Consortium, 2024). This water, referred to as produced water, is defined in Texas statute as "[f]luid oil and gas waste" (Texas Natural Resources Code, Section 122.001(2)). Estimates vary, but in 2020, the United States generated an estimated 240 billion gallons of produced water generated from oil and gas operations. In Texas, there is an estimated 33 million barrels of produced water generated every day. The common consensus among in research is that the oilfields in the Permian Basin in Texas alone generate more produced water than all other U.S. oilfields combined (Luedke, 2024). Produced water was previously seen as a liability that producers were responsible for disposing. As the demand for new water supply intensifies, Texas and its industries have a real opportunity to not only capitalize on previously unusable water, but to completely revolutionize the future water supply, thus creating a substantial, new source for the state.

WHERE DOES PRODUCED WATER COME FROM?

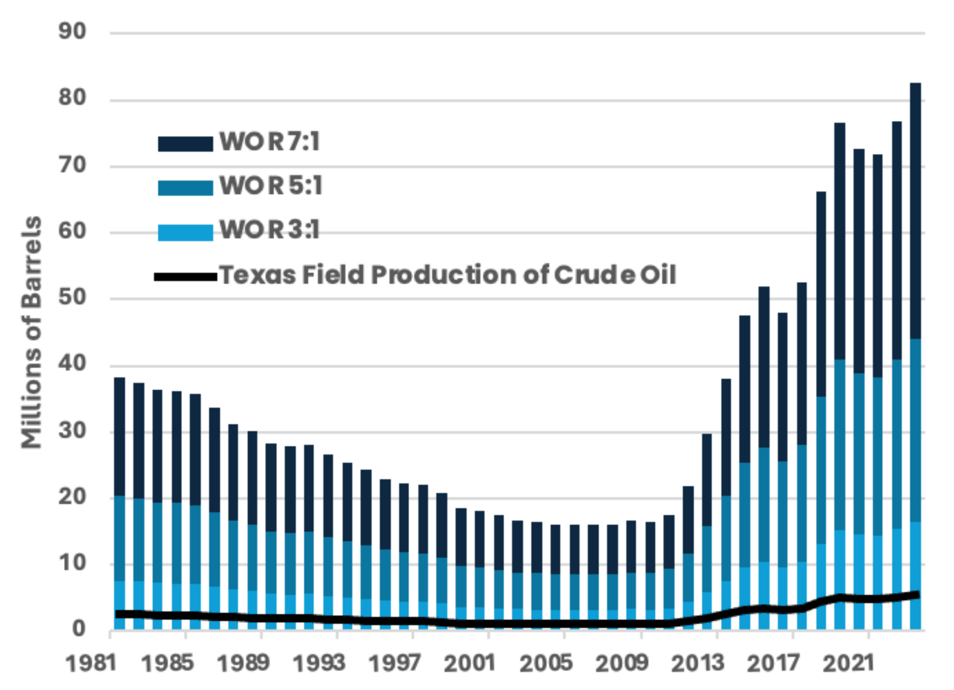
Some produced water originates from the water that is used to drill and frack a well—an average of 14.3 million gallons per well, or more than 340,000 barrels (Valder et al., 2021). Another source of produced water is the water that originates from the oil-bearing formations and is pumped up with the oil and frack water. Between three and seven barrels (or more) of water are typically generated for every barrel of oil, resulting in about 20 million barrels of produced water every day in the Permian Basin (Bennett, 2023). This produced water has high concentrations of salts, oil, grease, and organic and inorganic materials.

HOW IS PRODUCED WATER USED?

The oil industry has increasingly used produced water rather than freshwater for drilling and fracking operations (ALL Consulting, 2022). Using produced water helps conserve scarce freshwater (usually

Figure 2

Annual Total of Texas Field Production of Crude Oil Compared the Produced Water Generated based on Common Water to Oil Ratios (WOR)



Note: From EIA, 2024, (https://www.eia.gov/dnav/pet/hist/leafhandler.ashx?n=pet&s=mcrfptx2&f=m)

groundwater) for drinking water and irrigation uses in the arid Permian Basin. Water-handling companies have developed networks of centralized water treatment facilities to handle the produced water and then to deliver the water to drilling sites. For example, Baddour (2022) reported that XRI Holdings anticipated the increased demand for produced water for fracking as it planned to increase its 450-mile pipeline network with an additional 230 miles of extensions. The expanded pipeline network will help move produced water from recycling facilities to oilfield operations in the Permian Basin.

HOW IS PRODUCED WATER DISPOSED?

Even with an increased use of recycled produced water , there is a considerable amount of excess produced water that must be disposed of (see **Figure 2**). The principal option for disposal is injection into the deep subsurface. However, this option, while being the most economical, is becoming subject to regulatory restrictions. The restrictions are in response to the increasing frequency of seismic activity attributable to saltwater disposal. The Railroad Commission of Texas conducts a seismicity review which includes evaluation of fault hazards, monitoring of borehole pressures, seismicity monitoring, and other activities as part of the permit approval process for injection wells (Railroad Commission of Texas, n.d.). In recent years, the Texas Railroad Commission has identified several "seismic review areas" where injection wells are either prohibited or restricted in terms of injection volumes or target injection zones. Disposal of produced water into surface water is also possible. For example, the Texas Commission on Environmental Quality (TCEQ) has received permit applications for the surface disposal of treated produced water into the Pecos River (Pskowski & Baddour, 2024).

HOW CAN PRODUCED WATER BE TREATED?

Currently, there are efforts underway to evaluate the possible application of treatment technologies capable of providing produced water for beneficial use (Scanlon et al., 2020). Recycling produced water could reduce the amount of water disposed via injection wells and mitigate projected shortfalls in regional freshwater supplies. Although research indicates that most produced water is not yet economically treatable to drinking water standards (Texas Produced Water Consortium, 2024), it is possible that treated produced water may be usable for agricultural or other purposes.

Treatment of produced water is complicated by the general quality of the source water and the resultant need to undergo considerable treatment to reduce the concentrations of oil and suspended solids, as well as the occurrence of various dissolved solids, metals, and organic compounds. Furthermore, costs of treatment escalate with increasing salinity of the produced water.

There are two general types of treatment: membrane technologies and thermal technologies. Membrane technologies include electrodialysis, electrodialysis reversal, nanofiltration, and reverse osmosis. Reverse osmosis requires significant pre-treatment to remove silt and solids. Thermal technologies include multiple-effect distillation, mechanical vapor compression, and recompression. All of these technologies involve heating and evaporating the feed water followed by condensation of pure water.

Considering the large amounts of produced water generated where freshwater is scarce, produced water may represent a new, currently untapped water supply for some uses. For example, the Texas Produced Water Consortium (2022) has estimated that 256,000 acre-feet per year of produced water may be recoverable for treatment and beneficial use. Much of this water would be generated in the Region F water planning area, which is the West Texas region that has a projected annual water shortage of 102,000 acre-feet by 2070 (Texas Water Development Board, 2021). Most of this shortage is connected to irrigation use. Ultimately, using excess produced water to meet actual and projected water supply shortfalls for irrigation would require that the treatment technologies be economically feasible for agriculture. The "willingness to pay" costs of irrigation water are estimated to range between $227 and $347 per acre-foot (WestWater Research, 2024). In contrast, municipalities are generally willing to pay over $3,000 per acre-foot for water.

Any widespread use of produced water to help mitigate water shortages will be expensive to both treat to acceptable standards and transport to points of need. In 2023, the 88th Texas Legislature recognized the potential application of produced water to help alleviate water shortages by passing legislation to create a funding mechanism for such water projects. This legislation created Proposition 6, which voters approved by a wide margin in November 2023 to establish the Texas Water Fund with $1 billion in funding. Proposition 6 (Texas Water Development Board, 2024) also dedicated $250 million to the New Water Supply for Texas Fund, which will support the creation of new water sources, including produced water treatment projects and the development of infrastructure to transport water made available by these projects.

CONCLUSION

In summary, there are three converging developments—excess produced water, regional water shortages, and state-backed financing that prioritizes treatment and transport of produced water—that favor a serious effort to make produced water a potential supply to mitigate some water shortages in West Texas. Produced water is both an asset and a waste, requiring a combination of strategies and innovations to ensure continuing success of the Texas oil industry. The Texas Public Policy Foundation supports and encourages the combination of industry, academia, and state resources that will cooperate to make produced water an asset that benefits Texans. ■

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