THE CHALLENGES AND OPPORTUNITIES OF BENEFICIALLY REUSING PRODUCED WATER

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I. INTRODUCTION

In 1901, a geyser erupted in Jefferson County, Texas, spewing oil over 100 feet into the air.[1] Spindletop forever changed Texas' and the country's economic landscape. Within one year, several of today's largest oil and gas companies had started their businesses near the well field.[2]

In the early 2000s, another oil field breakthrough altered the energy landscape: hydraulic fracturing, or fracking. Fracking combined existing fracturing techniques with horizonal drilling, making it possible to access oil and gas reserves in tight shale formations. As a result, production grew quickly. Today, more than ninety-five percent of all wells utilize this technology.[3]

Although oil and gas development has been a boon to state and national economies, it is not without its challenges. One such challenge is water. Hydraulic fracturing requires large amounts of water in the exploration and development of a well. This drilling process frees oil and gas from the tight shale and generates large quantities of wastewater referred to as "produced water."[4] The chemistry and quantity of produced water can vary greatly from place to place.

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1. *Spindletop History*, LAMAR UNIV., https://www.lamar.edu/spindletop-gladys-city/spindletop-history.html (last visited Nov. 8, 2023).

2. *Id*. These include Gulf Oil Corporation, Sun Oil Company, and the precursors of Texaco and Exxon. *Id*.

3. *America's Progress at Risk: An Economic Analysis of a Ban on Fracking and Federal Leasing for Natural Gas and Oil Development*, AM. PETROLEUM INST. 1, 4 (2020).

4. Some research refers to the portion of injected water that returns to the surface as "flowback water"; however, consistent with the literature on produced water reuse, this article will refer to all the water that flows back to the wellhead as produced water.

Typically, produced water includes a mixture of groundwater, injected fluids, and residuals of fracking chemicals used in these operations. In addition, injected fracking fluids mix with naturally occurring heavy metals and radioactive materials that are dissolved from the shale formation. Historically, the vast majority of produced water has been disposed of in Class II disposal wells, while a portion has been reinjected for enhanced oil recovery.[5]

In the last twenty years, thirty percent of the contiguous United States experienced moderate drought conditions and twenty percent experienced severe drought.[6] As states search for new water sources to meet growing demand, many are evaluating the possibility of treating and reusing wastewater from oil and gas development in other sectors, including industry, aquifer recharge, surface water discharge, and land application for agricultural irrigation, livestock watering, or rangeland restoration.

Conversations about produced water reuse have prompted concerns about its safety. Significant data gaps exist in the current understanding of the pollutants of concern contained in produced water and the associated public health and environmental risks for each type of reuse. Discussions of increased beneficial reuse usually include a disclaimer that water treatment is needed. This assumes that an appropriate treatment technology is in place that can treat water sufficiently to be safe for the environment and human health, but a lack of information about the produced water and applicable toxicity benchmarks generates uncertainty.

Few, if any, regulatory standards are present to manage the human health and environmental risks associated with the reuse of produced water. The Clean Water Act (CWA) regulates point-source discharges of contaminants into jurisdictional surface waters; however, toxicity standards do not exist for many chemicals that may be present in produced water. While the CWA bans point source discharges of produced waters nationally, it contains an exception allowing discharges west of the 98th meridian under certain circumstances. Currently, the Environmental Protection Agency (EPA)'s implementation of the Clean Water Act does not guard against non-point source discharges into surface water bodies. Other federal laws, including those intended to protect drinking water, certain species,

5. John Veil, *U.S. Produced Water Volumes and Management Practices in 2017*, GROUNDWATER RSCH. & EDUC. FOUND. 1, 8 (Feb. 2020).

6. *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States*, U.S. ENV'T PROT. AGENCY 1, 2 (Dec. 2016).

agriculture, or the labor force may be implicated by reuse, but do not have rules that specifically contemplate this practice.

Despite the lack of applicable federal regulations or standards, several states already reuse or discharge produced water in a limited capacity. The desire to expand reuse has led to the creation of consortiums to consider the benefits and concerns of reuse and recommend solutions. Some states have passed legislation encouraging increased recycling of this water, particularly in the energy sector where costs and risks are lower compared to other potential uses, but more focus is needed on the development of protective regulatory programs.

This article evaluates the opportunities and risks of beneficially reusing produced water and provides recommendations for the development and expansion of this practice that protects human health and the environment. Part II reviews the origins of produced water and its makeup, and describes how this water has been historically managed. This frames the context for the growing call to beneficially reuse this water outside of the oil and gas sector.[7] Part III discusses the non-regulatory challenges to many reuse scenarios, including risks of reusing this water in ways that would increase human and environmental exposure.[8] Part IV reviews federal and state laws that, while not written for this purpose, might be implicated in various beneficial reuse scenarios.[9] It also provides a comprehensive look at how various states are approaching the move to beneficial reuse.[10] Finally, Part V lists regulatory and nonregulatory recommendations to assist states that are inclined to increase the reuse of produced water.[11] Recommendations include clarifying regulatory authority, filling data gaps and reporting related to the chemical consistency of the water, minimizing risk by prioritizing reuse of produced water in the oil and gas sector, and reviewing waste management exemptions in the context of beneficial reuse.[12]

II. Generation and Management of Produced Water

Unconventional drilling techniques, like hydraulic fracturing, require large amounts of water and produce wastewater. Growing

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7. *See* discussion *infra* Part II.
8. *See* discussion *infra* Part III.
9. *See* discussion *infra* Part IV.
10. *See* discussion *infra* Part IV.
11. *See* discussion *infra* Part V.
12. *See* discussion *infra* Part V.

water challenges demand that water be used more efficiently. As a consequence, many western states want to beneficially reuse produced water. At the same time, producers need alternatives to traditional disposal techniques, which are expensive and have additional challenges like decreasing storage capacity and seismicity.

A. *Origins of Produced Water*

Water frames the oil and gas production timeline. Water is needed to complete wells and is a waste byproduct of production that requires management.[13] The expansion of unconventional oil and gas (UOG) drilling and production, such as hydraulic fracturing, in the early 2000s greatly increased water usage and produced water, raising concerns about water demand and produced water disposal.[14]

Well stimulation through fracturing has been used for decades, but the real surge of unconventional wells in the early 2000s was due to the combination of fracturing techniques with horizonal drilling.[15] This amalgamation made it economically feasible to extract oil and gas from formations that had previously been impractical for production due to low permeability.[16] Fracking quickly became a significant part of U.S. petroleum production and increased overall drilling dramatically.[17] Between 2011 and 2014, an estimated 25,000-30,000 fracking wells were drilled annually in the United States and by 2015, more than fifty percent of national oil production and nearly seventy percent of gas production used this technology.[18]

Fracking is the creation or extension of existing fractures in the rock formation material through the use of explosive charges, followed by injections of large volumes of water under pressure to increase rock permeability.[19] "[M]ulti-stage hydraulic fracturing of a single horizontal shale gas well can use an average of about 12 million gallons

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13. Veil, *supra* note 5.

14. NES Fircroft, *A Brief History of Fracking* (July 31, 2022), https://www.nesfircroft.com/blog/2019/07/a-brief-history-of-fracking; Ceres, *Hydraulic Fracturing & Water Stress: Water Demand by the Numbers* (Feb. 3, 2016), https://www.ceres.org/resources/reports/hydraulic-fracturing-water-stress-water-demand-numbers.

15. Robin Beckwith, *Hydraulic Fracturing: The Fuss, the Facts, the Future*, J. OF PETROLEUM TECH. 24, 40–41 (Dec. 2010); GROUNDWATER PROT. COUNCIL, Produced Water Report at 9 (2019).

16. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 9, 35, 37.

17. *Id*. at 37.

18. U.S. ENV'T PROT. AGENCY, *supra* note 6, at ES-6.

19. Carl T. Montgomery and Michael B. Smith, *Hydraulic Fracturing: History of an Enduring Technology*, J. PETROLEUM TECH. 26, 27 (Dec. 2010).

of water."[20] A proppant material, such as sand, is added to the water to maintain the newly fractured openings.[21] A proprietary blend of chemicals is also included that may contain friction reducers, biocides, and scale inhibitors.[22] Water that naturally occurs in the formation mixes with the injected blend, increasing the fluid volume that is then pumped back up the borehole. Once the slurry reaches the surface, the hydrocarbons are separated out and the waste liquid that remains is called "produced water,"[23] which contains a mixture of oil and gas, injected chemicals and sands, and formation water.[24]

B. *After the Frac*

Once the produced water reaches the surface and the product is separated out, the remaining liquid must be managed. "Produced water is the largest volume byproduct associated with oil and gas exploration and production."[25] Because produced water contains a mixture of production chemicals, it cannot be easily reused.[26] The vast majority of produced water is injected into Class II Underground Injection Control (UIC) deep formation disposal wells.[27] There are approximately 180,000 Class II wells in the United States that collect an average of two billion gallons of fluid every day.[28] Unfortunately, the injection of this water means that it is no longer available for other uses. Producers in areas without a suitable formation for permitting as a Class II well must transport waste to another location for injection, which is

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20. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 37. A hydraulic fracking operation can have significant localized impacts on water availability. *Id*.

21. *See* KATIE GUERRA et al., U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, OIL AND GAS PRODUCED WATER MANAGEMENT AND BENEFICIAL USE IN THE WESTERN UNITED STATES, SCIENCE AND TECHNOLOGY PROGRAM REPORT NO. 157, 36 (Sept. 2011) (noting proppant gets its name because of its ability to prop fractures open and allow the release of product).

22. *Id*.

23. Veil, *supra* note 5, at 14.

24. *Id*; John Pichtel, *Oil and Gas Production Wastewater: Soil Contamination and Pollution Prevention*, APPLIED AND ENV'T SOIL SCI. 2–5 (2016). Here, "produced water" refers to the mix of fluids brought to the surface during oil and gas exploration in unconventional wells. Unless otherwise noted, water produced from coal bed methane exploration is not included.

25. Veil, *supra* note 5, at 8. "On average, about 7 to 10 barrels, or 280 to 400 gallons, of water are produced for every barrel of crude oil." GUERRA et al., *supra* note 21, at 5.

26. Veil, *supra* note 5, at 8.

27. *See id*. (91.5% of the produced water was disposed of through injection. Of this amount, 43.6% was injected for enhanced oil recovery, and 38% was injected at non-commercial disposal wells).

28. U.S. ENV'T PROT. AGENCY, *Class II Oil and Gas Related Injection Wells*, https://www.epa.gov/uic/class-ii-oil-and-gas-related-injection-wells.

expensive and risks spills during transport.[29]

While injection has been a widely accepted disposal technique, the sharp increase in produced water as a result of the rapid growth of fracking wells created new problems. Seismic events related to the large injection volumes raise questions about its suitability as a long-term disposal alternative.[30] The capacity of disposal formations has also been called into question.[31] In areas without adequate storage available or with a concerning increase in seismic activity, reuse has become an increasingly desirable alternative.[32]

Although the majority of produced water is managed through injection, some disposal does occur at the surface. In 2017, approximately 5.5% of produced water was released into surface water bodies[33] and land application is sometimes used.[34] Both land application and surface water discharge can only occur with higher quality produced water to avoid soil and water contamination.[35] Evaporative ponds are also used in a very limited capacity; however, the rate of water accumulation significantly outpaces evaporative losses.[36]

Unconventional wells are often located in areas of water scarcity, such as Texas, Colorado, and other parts of the Western U.S.[37] Development of these wells requires a significant outlay of water over a relatively short time period, increasing concerns about depletion.[38] Some oil and gas producers have sought ways to alleviate the pressure on fresh water through recycling and reuse at the wellhead for enhanced oil recovery (EOR).[39] Reclaimed water is often blended with additional water from another source before being reinjected.[40] Exact volumes of produced water used for EOR are not known because there is no national reporting requirement.[41] Produced water can also be

29. GUERRA et al., *supra* note 21, at 7–8.

30. Bridget Scanlon et al., *Can We Beneficially Reuse Produced Water From Oil and Gas Extraction in the U.S.?*, 717 SCI. OF THE TOTAL ENV'T 2 (2020).

31. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 34.

32. *Id.*

33. Veil, *supra* note 5, at 41.

34. GUERRA et al., *supra* note 21, at 7.

35. *Id.*

36. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 57.

37. Scanlon, *supra* note 30, at 2.

38. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 37, 44.

39. C.E. Clark & J.A. Veil, *Produced Water Volumes and Management Practices in the United States* 30, Argonne National Laboratory Report (2009).

40. Veil, *supra* note 5, at 15.

41. Scanlon, *supra* note 30, at 2.

used for the initial fracturing of a well, although this has not been done on a wide scale.[42]

Beneficial reuse of produced water is often used as a catch-all phrase to include numerous land application scenarios, such as rangeland restoration, irrigation for food and non-food crops, livestock watering, or ice and dust suppression.[43] Generally speaking, existing permitting for land application, or land farming, allows for the spreading of waste soil or water as a disposal or treatment strategy. Land application for waste disposal purposes should be distinguished from other reuse alternatives that claim to serve a beneficial purpose to the land, ecosystem, or other end users. While limited examples of beneficial reuse exist, reuse of produced water outside the oil and gas sector is not currently informed with adequate data.

III. TOXICITY AND RISK POTENTIAL OF PRODUCED WATER

For many, parallel concerns related to disposal challenges and water shortfalls present an obvious solution. The water that would normally be injected into Class II disposal wells can be treated and put to another use, thus alleviating both problems. Unfortunately, viewing the beneficial reuse of produced water as a silver bullet for unmet water demands is problematic.

All forms of beneficial reuse of produced water require some level of treatment.[44] "The level of treatment necessary when considering reuse of produced water depends on the quality needs for the intended use."[45] While reuse advocates state that water can be cleaned, treatment is often very difficult, not possible, or cost-prohibitive for many of the constituents commonly found in produced water.[46] Additionally, neither tests nor risk levels exist for many of the constituents of concern.[47]

Environmental concerns related to produced water disposal are not new. Since the mid-1800s, worries about potential soil, surface water, groundwater, ecosystem, and human health impacts have been

42. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 32.

43. Earl L. Hagstrom et al., *Produced Water-Emerging Challenges, Risks, and Opportunities*, 28 ENV'T CLAIMS J. 122, 128 (2016).

44. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 11.

45. *Id.*

46. Scanlon, *supra* note 30, at 9. Water treatment systems can have a high energy footprint. *Id*. at 2.

47. *Id*.

raised.[48] Because produced water can include a myriad of chemicals, salts, and hydrocarbons, a release can cause long-term damage to the environment.[49] In West Texas, the Texon scar is a 2,000-acre stretch of barren land dotted with dead mesquite trees caused by a produced water spill one hundred years ago.[50] Damage caused by these accidental releases portends what can result if water is reused without proper treatment of the constituents contained therein.[51]

Water quality is a critical factor in assessing the produced water's usefulness in other sectors. Accordingly, the water quality required for effective risk management determines cost calculations for treatment and transport.[52] "The physical and chemical properties of produced water vary considerably depending on the geographic location of the field, the geologic formation, and the type of hydrocarbon product being produced."[53] A study of produced water in Colorado showed substantial variation in water quality even between counties.[54]

The primary constituents of concern in produced water are: salt content, oil and grease, hydrocarbon related compounds, toxic compounds used in the hydraulic fracturing process, toxic compounds dissolved from natural deposits in the formation, and naturally occurring radioactive materials (NORM).[55] A 2016 EPA study found literature reports that included 600 different chemicals that have been identified in produced water samples; however, more recent studies have found many more.[56] Chemicals listed include "polycyclic aromatic hydrocarbons (PAHs); benzene, ethylbenzene, toluene, and xylene (BTEX); phenols; trace elements (e.g., boron); and fossil fuel-related organic compounds . . . ."[57] Concerns related to hydraulic fracturing

48. GUERRA et al., *supra* note 21, at 8.

49. *Id.*

50. John Flesher, *Drilling Boom Brings Rising Number of Harmful Waste Spills*, ASSOCIATED PRESS (Sept. 9, 2015), https://apnews.com/39786bbf509e412a9feb9b58a6534a36/drilling-boom-brings-rising-number-harmful-waste-spills.

51. *See id*. (noting an analysis found 21,651 spills, between 2009 to 2014, totaling 175 million gallons of wastewater).

52. Scanlon, *supra* note 30, at 3.

53. Veil, *supra* note 5, at 11, 15.

54. Flannery C. Dolan et al., *Assessing the Feasibility of Using Produced Water for Irrigation in Colorado*, 640 SCI. OF THE TOTAL ENV'T 619, 623 (2018).

55. Veil, *supra* note 5, at 16.

56. Cloelle Danforth et al., *An Integrative Method for Identification and Prioritization of Constituents of Concern in Produced Water from Onshore Oil and Gas Extraction*, 134 ENV'T INT'L 4 (2020) (identifying 1,198 produced water chemical constituents in an initial literature review).

57. Hagstrom, *supra* note 43, at 126.

and water contamination led to a national chemical disclosure registry called FracFocus in 2011.[58] The publicly available database is a central location where oil and gas producers can report information related to the ingredients used in hydraulic fracturing fluids.[59] Although reporting was initially voluntary, all producing states now require some level of disclosure.[60]

Despite the large accumulation of data in FracFocus, many reporting loopholes limit the ability to fully understand fracking fluids' chemical composition.[61] The exact chemical formula of a company's hydraulic fracturing fluid is subject to trade secret protections.[62] Although producers must still report the "generic class or category" of the hazardous or toxic chemical, they are not required to include the specific quantities, which is critical to assessing a risk profile.[63] Instead, the words "trade secret," "confidential," or a similar indicator is entered to indicate data that is protected.[64] This concession can result in significant awareness gaps.[65] In California, "38% of the substances used for fracking in the state are not known because oil companies used non-specific names or reported them as trade secrets, confidential business information, or proprietary information."[66] The risks of many of these chemicals are also often unknown.

A. *Potential Receptor Pathways*

Risk exposure levels vary depending on the receptor and the people or applications that will encounter or use the water.[67] An effective risk assessment necessitates an understanding of who or what will come into contact with the water and under what conditions that

58. U.S. ENV'T PROT. AGENCY, *Analysis of Hydraulic Fracturing Fluid Data from the FracFocus Chemical Disclosure Registry 1.0* 1 (Mar. 2015).

59. *Id.*

60. *Chemicals and Public Disclosure*, FRACFOCUS, https://www.fracfocus.org/learn/chemicals-public-disclosure (last visited Sept. 15, 2023).

61. *See Issue Brief: Fracking in California: Wastewater Handling and Disposal* 1 PAC. INST. (Feb. 2016) https://pacinst.org/wpcontent/uploads/2016/02/PI_IssueBrief_FrackinginCalifornia_WastewaterHandlingAndDisposal.pdf (last visited Sept. 17, 2023).

62. Leah A. Dundon et al., *The Real Value of Fracfocus as a Regulatory Tool: A National Survey of State Regulators*, 87 ENERGY POL'Y 496, 497 (Dec. 2015).

63. Danforth et al., *supra* note 56, at 4 (2020) ("Only 91 (7.6%) chemicals that were reported in FracFocus were found in the constituents identified in produced water.").

64. Dundon et al., *supra* note 62, at 497.

65. *See* PAC. INST., *supra* note 61, at 1.

66. *Id.*

67. Hagstrom, *supra* note 43, at 131.

contact may occur.[68] Depending on the type of reuse, a host of receptors may be implicated and the overall risk increases when the number of receptors involved is high.[69] Additionally, water use in one sector should consider potential receptors beyond that contemplated use.[70]

The use of treated produced water for agriculture is an oft-promoted reuse scenario because of that sector's water demands; however, this use creates many potential exposure pathways.[71] Contaminants can be taken up in the plant's root system or transferred directly onto the plant surface from soil or water.[72] The lack of understanding of when uptake happens and for which particular crops results in risk pathways that cannot be ruled out.[73] Farmworkers may also be exposed through direct dermal and respiratory exposure of volatilizing chemicals.[74] Human and livestock pathways through ingestion of food crops irrigated with this water are also a possibility.[75] The potential for direct human contact may necessitate higher water quality standards than those required for plants.[76]

Livestock and wildlife can interact with treated produced water through direct watering or as a result of land application projects such as rangeland restoration.[77] Primary exposure pathways are water and soil ingestion.[78] Other pathways include dermal absorption, inhalation, and ingestion of plants.[79] Animals can generally tolerate lower water qualities than humans, but remain susceptible to hydrocarbon toxicity and total dissolved solids (TDS). Additionally, once livestock and wildlife have been exposed, questions arise as to the risks incurred by

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68. *Id.*

69. *See id*. at 128–33 (comparing the large number of potential receptors for agriculture and stream augmentation to a much smaller number for industrial reuse).

70. Hagstrom, *supra* note 43, at 128–33.

71. *See*, *e.g.*, GROUNDWATER PROT. COUNCIL, *supra* note 15, at 29; Dolan et al., *supra* note 54, at 620.

72. PAC. INST., *supra* note 61, at 36.

73. Matthew Heberger & Kristina Donnelly, *Oil, Food, and Water: Challenges and Opportunities for California Agriculture* 20, PAC. INST. (Dec. 2015), https://pacinst.org/publication/oil-food-and-water-challenges-and-opportunities-for-california-agriculture/.

74. Hagstrom, *supra* note 43, at 132 Fig. 4.

75. *Id*. at 129.

76. *Id*. at 131.

77. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 116–17.

78. AM. PETROLEUM INST., *Publication No. 4733: Risk-Based Screening Levels for the Protection of Livestock Exposed to Petroleum Hydrocarbons* 1-1 (July 2004).

79. *Id*. at 3-3; "Treated produced water irrigation for crops like hay or livestock feed has not been widely studied . . . ." GROUNDWATER PROT. COUNCIL, *supra* note 15, at 113.

anyone consuming the animal's meat.[80] In the case of livestock, consumption would likely be by humans, but consumption of wildlife by other wildlife should also be better understood.

Streamflow or wetland augmentation is another potential reuse scenario that implicates many receptors, raising concerns similar to those associated with agricultural or other land application runoff of produced water into surface water.[81] These point and non-point source discharges can impact aquatic life, wildlife, or drinking water quality.[82] Heavy metals and other trace elements, which are common in produced water, do not biodegrade and accumulate in the environment.[83] Aquifer recharge using treated produced water has similar environmental and human health impacts and, if groundwater becomes contaminated, it is difficult to remediate.[84]

B. *Sector-Specific Reuse Hazards*

The quality of produced water determines its suitability for beneficial reuse.[85] "A major water quality consideration is the feasibility and cost of treating the produced water to be fit for the intended purpose."[86] Many of the chemicals known to be included in produced water are dangerous to a variety of receptors if present in high enough quantities.[87] Unfortunately, that threshold, or benchmark, is not always known.[88] Benchmark criteria may vary considerably depending on the intended beneficial reuse and potential receptors.[89] Regulatory frameworks that dictate the limits of produced water reuse must include a decision framework that considers situational complexities and meets the water quality objectives for a specific end use.[90]

Water quality discussions related to reuse often focus on TDS, but quantifying TDS alone is not a sufficient analysis for most forms of

80. AM. PETROLEUM INST., *supra* note 78, at 1-1. Although the report focuses on exposure to accidental releases of petroleum hydrocarbons, the toxicity reference levels are applicable to treated produced water exposures. *See id*.

81. *See* Hagstrom, *supra* note 43, at 122, 129.

82. *See id*.

83. PAC. INST., *supra* note 61, at 37; Hagstrom, *supra* note 43, at 129.

84. Hagstrom, *supra* note 43, at 130.

85. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 11.

86. *Id*.

87. Hagstrom, *supra* note 43, at 126.

88. *Id*. at 126, 132.

89. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 11.

90. Hagstrom, *supra* note 43, at 131.

beneficial reuse because of the fragility of human and environmental receptors.[91] High TDS may serve as an indication that water is unsuitable for reuse, but it is only the beginning.[92] EPA's list of standards for public water supplies includes exposure guidelines for approximately ninety contaminants, compared to over 1100 chemicals that have been found in produced water.[93] Drinking water standards predate the significant increase of produced water associated with unconventional drilling and never contemplated this type of source water.[94] The EPA sets their legal contaminant limits to reflect levels "that protect[] human health and that water systems can achieve using the best available technology."[95] Without toxicity information for many constituents, it is impossible to demonstrate whether water has been treated sufficiently to meet EPA's goal.[96]

Similar unknown risks are present for livestock or wildlife. Manageable levels of TDS will vary based on the species and the duration of time the animal consumes the water.[97] High TDS above 10,000 mg/L and other chemicals can be harmful to animals and/or pose a threat to human health when the animals' meat is consumed.[98] Consumption of high levels of hydrocarbons can lead to neurotoxicity, fetal toxicity, organ failure, and fatal poisoning.[99] The National Science Foundation has listed recommended levels for approximately fifteen constituents in addition to TDS, but more research is needed to understand risk profiles for reuse.[100]

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91. Scanlon, *supra* note 30, at 3–4.

92. TDS levels in produced water vary from 3,000 to 300,000 mg/L. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 8. "Fresh water" contains less than 1,000 milligrams per liter TDS; however, water with more than 500 mg/L of TDS is undesirable for human consumption and many industrial uses. *Id*. at 6. High TDS concentrations can inhibit the ability to effectively analyze the water toxicity. Danforth et al., *supra* note 56, at 679.

93. *Compare Drinking Water Regulations*, ENV'T PROT. AGENCY, https://www.epa.gov/dwreginfo/drinking-water regulations#:~:text=Overview,that%20water%20systems%20must%20follow (last visited Sept. 17, 2023), *with* Cloelle Danforth et al., *An Integrative Method for Identification and Prioritization of Constituents of Concern in Produced Water from Onshore Oil and Gas Extraction*, 134 ENV'T INT'L 4 (2020).

94. *See* U.S. ENV'T PROT. AGENCY, *supra* note 93.

95. *Id.*

96. GUERRA et al., *supra* note 21, at 37–39.

97. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 11, 28–29.

98. *Id*. at 27. Livestock exposed to non-treated produced water has resulted in illness or death. Matthew Heberger & Kristina Donnelly, *Oil, Food, and Water: Challenges and Opportunities for California Agriculture*, PAC. INST. 20–21 (Dec. 2015).

99. AM. PETROLEUM INST., *supra* note 78, at 2-1.

100. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 28.

Salts and other chemicals can also have deleterious impacts on aquatic resources.[101] Sodium chloride has a potentially toxic effect on aquatic species and can physically alter soil structure.[102] Although there is a greater understanding of toxicity in aquatic environments as compared to terrestrial, aquatic researchers note a lack of understanding as to how salts and other constituents may affect some organisms.[103] Point source discharges into jurisdictional waters require a CWA permit that would mitigate many TDS concerns; however, regulatory obligations do not capture the full picture of the potential impacts of produced water on water resources.[104] A study of produced water released for agricultural beneficial reuse detected "over 50 geogenic and anthropogenic organic chemicals not specified in the effluent limits . . . including hydrocarbons, halogenated compounds, and surfactants."[105] A complete evaluation of downstream impacts could not be completed because complete health thresholds were only available for eight chemicals, and values used by the study had limited applicability because they did not consider mixture effects.[106] Waters entering surface waterbodies from a non-point source, such as farm runoff, livestock operations, or rangeland restoration projects, do not require permitting or testing.[107] Non-point source additions would likely increase as more produced water is reused.

Agriculture is the largest consumptive user of freshwater in the U.S.; therefore, use of treated produced water for irrigation could alleviate pressure on water needed for other sectors.[108] As with other potential uses, the ability to use treated produced water depends on the quality of the water, characteristics of the local soil, and crop type.[109] Critical parameters include salinity, sodicity, and elemental toxicity.[110] Salinity level tolerance varies by crop and can decrease yields, while other factors can impact the soil's physical properties,

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101. Aida M. Farag & David D. Harper, *A Review of Environmental Impacts of Salts from Produced Waters on Aquatic Resources*, 126 INT'L J. OF COAL GEOLOGY 157 (2014).

102. *Id*. at 158.

103. *Id*. at 157.

104. *See* discussion, *infra* Part IV(A)(1).

105. Molly C. McLaughlin et al., *Water Quality Assessment Downstream of Oil and Gas Produced Water Discharges Intended for Beneficial Reuse in Arid Regions*, 713 SCI. OF THE TOTAL ENV'T 1 (2013).

106. *Id*.

107. *See* Pichtel, *supra* note 24, at 13.

108. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 29.

109. Pichtel, *supra* note 24, at 12; Dolan et al., *supra* note 54, at 620.

110. Pichtel, *supra* note 24, at 12.

slowing or preventing growth.[111] Agricultural projects using produced water reduced TDS through treatment and dilution with supplemental freshwater.[112] Irrigation water is not always regularly tested for toxins known to be present in produced water.[113] Health impacts from ingesting products grown using treated produced water, whether by livestock or humans, are also unknown.[114]

Knowing what constituents are in produced water and the quality needed for an end user are critical for evaluating reuse projects.[115] Beneficial reuse of produced water based solely on existing regulatory frameworks risks unpredictable and potentially hazardous outcomes.[116] Despite the lack of regulations specific to reuse, there is a patchwork of federal and state laws that may apply or provide guidance as to how such programs should be approached.

IV. Current Regulations Applicable to Produced Water Reuse

Few, if any, federal or state regulatory programs are directly applicable to most beneficial uses of produced water. Regulations that do apply have significant gaps in standards because their passage predates the reuse of this water. EPA's 2016, 600-page report, focusing on the potential impacts of hydraulic fracturing on drinking water resources, cites no laws tailored to the protection of water resources from produced water reuse even though the report lays out potential concerns and exposure pathways.[117] While the focus of the report is broader than produced water reuse, the lack of regulation is illustrative of the challenges that reuse presents. Despite the absence of laws or regulations written for the purpose of beneficial reuse, some federal and state laws may be triggered by certain reuse scenarios. State practice in regions currently reusing this water in a limited capacity provides examples of how beneficial reuse may be approached.

A. *Federal Law*

Existing federal laws implicated by reuse scenarios often focus on

111. *Id.*

112. Heberger & Donnelly, *supra* note 98, at 31.

113. *Id*. at 36.

114. *Id*. at 19–20.

115. Veil, *supra* note 5, at 13. "Reuse of produced water is more feasible when less chemical additives are used in the hydraulic fracturing process." Dolan et al., *supra* note 54, at 625.

116. Groundwater Prot. Council, *supra* note 15, at 98.

117. U.S. Env't Prot. Agency, *supra* note 6.

exposure recipients or the potential impacts triggered by actions such as a release into ground or surface water. Water quality laws limit point source discharges into qualifying waters, while other laws focus on the protection of animals, plant species, or human safety.[118] Some categories of reuse are essentially unregulated at the federal level.

1. Clean Water Act

The Clean Water Act was promulgated in 1972 "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[119] Among other things, the CWA established the basic structure for regulating discharges of pollutants and maintaining existing requirements to set water quality standards for all contaminants in surface waters.[120]

Discharges fall into two basic categories: point source and non-point source (NPS).[121] A point source is a clear point of discharge including "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, etc."[122] Non-point sources include diffuse discharges such as overland runoff or agricultural return flows.[123]

a. *Point Source Discharges*

Through the CWA, the EPA and individual states, through delegation from the EPA, have authority to regulate wastewater discharges to surface waters through the National Pollution Discharge Elimination System (NPDES) program.[124] A NPDES permit is required before a point source can discharge into jurisdictional waters.[125] The permit must protect the physical, chemical, and biological integrity of the surface water and its protected uses to ensure that no toxins are discharged in toxic amounts.[126] A permit includes technology-based and water-quality-based standards and sets

118. EDITH ALLISON & BEN MANDLER, PETROLEUM AND THE ENV'T 21-4 (2018).

119. 33 U.S.C. § 1251(a).

120. *Id*; *Summary of the Clean Water Act*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/laws-regulations/summary-clean-water-act (last visited Sept. 17, 2023).

121. *See* 33 U.S.C. § 1362(14).

122. *Id*.

123. *Basic Information about Non-Point Source (NPS) Pollution*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/nps/basic-information-about-nonpoint-source-nps-pollution (last visited Sept. 17, 2023).

124. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 16–17.

125. *Id*.

126. *Id*.

discharge limits at their most protective levels.[127] Minimum discharge standards are already available for many common industry-specific pollutants; however, there are no standards for many possible fracking constituents because beneficial reuse of produced water was not contemplated when the existing standards were established.[128]

In the Eastern U.S., the NPDES program prohibits direct discharges from an oil and gas waste site; however, west of the 98th meridian, where the land is generally very arid, qualifying produced water has been recognized by law to have some permissible uses.[129] Produced water may be released if it is "of good enough quality to be used for wildlife or livestock watering or other agricultural uses and . . . is actually put to such use during periods of discharge."[130] Releases west of the 98th meridian must achieve effluent limitations attainable through use of the best practicable control technology available and shall not exceed the listed daily maximum limitation.[131] Instead of numeric limitations, the guidelines for these discharges contain only two discrete considerations — a Total Maximum Daily Load (TMDL) for oil and grease, and a narrative standard that water be of "good enough quality" for the claimed uses.[132] Technology-based limits are left to the best professional judgment of the state/federal permit writer in individual permitting systems. Unfortunately, without toxicity standards, "good enough quality" cannot be effectively ascertained and baseline effluent standards do not consider, and likely would not be protective of, many reuse receptors.[133] Additional narrative and/or numeric standards added by states are the only opportunity to supplement protections for many potential exposure pathways.[134]

b. *Non-Point Source Discharges*

Land application or agricultural runoff that enters surface water is categorized as a NPS. Because of the diffuse nature of infiltration into surface water, a NPDES permit is not required, though the CWA still

127. *Id*. at 18.

128. *See id.* at 16–18.

129. *Compare* 40 C.F.R. § 435.32, *with* 40 C.F.R. § 435.50.

130. 40 C.F.R. § 435.51(c).

131. 40 C.F.R. § 435.52.

132. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 19. The oil and grease limit of 35 mg/L is over forty years old. 40 C.F.R. § 435.52(b); Heberger & Donnelly, *supra* note 98, at 39.

133. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 19.

134. *Id*. Although conventional produced waters may be treated and discharged through a municipal wastewater treatment plan or centralized waste facility, discharge standards were not set in consideration of treated produced water. *See* 40 C.F.R. Part 437.

has jurisdiction.[135] Rule 319 establishes a national program to control NPS pollution, but gives states the authority to implement studies and improvement programming.[136] States are obligated to identify NPS-impaired waterways and ascertain the type and source of contamination and then address NPS pollution through the development of assessment reports; adoption of management programs to control NPS pollution; and implementation of those management programs.[137] These management plans shall identify "best management practices and measures which will be undertaken to reduce pollutant loadings."[138]

Impaired waters may be designated due to point source and/or NPS discharges, requiring the development of TMDLs, which specify the maximum quantity of pollutants permitted for the water to meet the water quality standards.[139] NPS pollution control is largely voluntary and promotes watershed protection. A regulatory issue for land application of produced water would only arise in areas that have established a pollution management goal for impaired water.

Although enforcement under NPS provisions does not mirror that of the NPDES program, states could lose grant opportunities through the NPS program for failure to implement their plans. A large amount of NPS pollution could significantly limit point source permitting for the waterway; however, a TMDL would only require limits on NPS for the cause of impairment. Because there are not numeric water quality standards for the majority of the contaminants found in produced water, surface waters cannot be assessed for those impairments.

2. Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) is the primary federal law that protects U.S. drinking water supplies.[140] This law authorizes the EPA to establish minimum quality standards for the surface and groundwater resources utilized for the purpose of public use.[141] UIC regulations also fall within the SDWA, which protects Underground

135. *See* 33 U.S.C. § 1251(a).

136. 33 U.S.C. § 1329.

137. 33 U.S.C. § 1329 (a)(1).

138. 33 U.S.C. § 1329 (b)(2)(A).

139. Water Quality Standards are criteria designated by the state based on a specific water use.

140. 42 U.S.C. § 300f *et seq*. Between 2000 and 2013, an estimated 3,900 public water systems serving more than 8.6 million people had at least one hydraulically fractured well within one mile of their water source. U.S. ENV'T PROT. AGENCY, *supra* note 6, at ES-8.

141. 42 U.S.C. § 300g–1.

Sources of Drinking Water (USDW) from the subsurface injection of fluids (including produced water) through the construction, operation, maintenance, and closure of injection wells.[142] As with NDPES permitting, states can apply for "primacy" to be granted the authority to implement SDWA within their jurisdictions.[143]

The National Primary Drinking Water Regulations (NPDWR) are standards that public water systems must follow to protect public health by limiting contaminant levels.[144] Regulated constituents are grouped into the following categories: microorganisms, disinfectants, disinfection byproducts, inorganic chemicals, organic chemicals, and radionuclides.[145] The EPA has established minimum standards for approximately ninety different contaminants.[146] As with NPDES toxicity limits, these standards do not specifically contemplate reuse of produced water. For contaminants not included on the NPDWR, the Unregulated Contaminant Monitoring Program collects data for contaminants suspected to be present in drinking water, but does not have health-based standards set under the SDWA.[147] The EPA must publish this "Contaminant Candidate List" every five years and identify which will be added to the list of regulated contaminants.[148]

Land application of produced water could trigger the SDWA if any listed contaminants reach a public water supply, creating enforcement risks for a water supplier unable to sufficiently reduce contaminant levels.[149] Injection of treated produced water for the purposes of aquifer storage and recovery must also meet SDWA standards if the groundwater is a public water supply.[150] Because the SDWA does not apply to private wells serving fewer than twenty-five individuals, many individual wells have no recourse under this law.[151]

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142. 42 U.S.C § 300h *et seq*.

143. *Id*.

144. 42 C.F.R. § 141.21 *et seq*.

145. *Id*.

146. 42 C.F.R. § 141 *et seq*; *National Primary Drinking Water Regulations*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/sites/production/files/2016-06/documents/npwdr_complete_table.pdf (last visited Sept. 17, 2023). A contaminant is defined as "any physical, chemical, biological, or radiological substance or matter in water." 42 U.S.C. § 300f(6).

147. *Learn About the Unregulated Contaminant Monitoring Rule*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/dwucmr/learn-about-unregulated-contaminant-monitoring-rule (last visited Sept. 17, 2023).

148. *Id*.

149. *See* 42 C.F.R. § 141.21 *et seq*.

150. *Id*.

151. *See* 42 U.S.C. §§ 300f(4)(A)–(B). "[A]pproximately 14% of the population obtained

3. Species Protection Laws

While some federal laws are implicated through discharge into water resources, other laws focus on the potential impacts to non-human users of that water. These laws focus on the exposure of protected species to environmental conditions or human conduct that would place the species at risk. Both the Migratory Bird Treaty Act and the Endangered Species Act (ESA) focus on the outcomes of a person's actions rather than their intent, making them perilous in beneficial reuse categories where exposure to protected species is probable.

The Migratory Bird Treaty Act of 1918 makes it a federal crime "to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, [or] possess . . . any migratory bird" native to the United States or its territories.[152] As written, penalties can be assessed for impacts regardless of intent.[153] Anyone seeking to bring a claim under this Act needs to demonstrate harm and causation.[154] Violations can result in civil and criminal penalties including fines and prison.[155]

The ESA may also be triggered if listed species are harmed by produced water exposure.[156] The ESA attempts to conserve and protect endangered and threatened species and their habitats by making it a federal crime to "take" a listed species.[157] Much like the Migratory Bird Treaty Act, prohibited actions in the ESA are written broadly.[158] To commit a "take" means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" regardless of the intent of the actor.[159]

The ESA focuses on direct damage to the species as well as activities that might have an indirect harm.[160] This includes extending protections to areas where the species live, eat, or breed.[161] The ESA

drinking water from non-public water supplies." U.S. ENV'T PROT. AGENCY, *supra* note 6, at ES-4. Of these, an estimated 3.6 million people obtained their drinking water from non-public supplies in counties with at least one hydraulically fractured well. *Id*. at ES-8.

152. 16 U.S.C. § 703; 50 C.F.R. § 10.13.

153. *See* 16 U.S.C. §§ 703–12; 50 C.F.R. § 10.13 (listing no intent obligation); 50 C.F.R. pt. 10 (Oct. 4, 2021), https://www.govinfo.gov/content/pkg/FR-2021-10-04/pdf/2021-21473.pdf.

154. *See* 16 U.S.C. § 703.

155. 16 U.S.C. § 707.

156. *See* 16 U.S.C. § 1538(a)(1).

157. 16 U.S.C. § 1531 *et seq.*

158. *See* 16 U.S.C. § 1532(19); 16 U.S.C. § 1538(a)(1).

159. 16 U.S.C. § 1532(19).

160. 16 U.S.C. § 1531(b).

161. *Id.*; 16 U.S.C. § 1532(5).

applies both to individual and government actors.[162] As with the Migratory Bird Treaty Act, the ESA has a strict liability standard and no intent to harm is required and punishment for violations includes criminal and civil penalties.[163]

Exposure pathways, including surface water pooling created through land application, could attract protected species and expose them to chemicals at toxic levels.[164] This is analogous to concerns regarding the effect of pesticide applications on endangered and threatened species.[165] If it can be shown that any aspect of the land application or other reuse is "taking" a listed species, penalties may be assessed and force the cessation of any activity causing the concern.[166]

4. Agricultural and Labor Laws

Land application of produced water to grow food crops or raise livestock for human consumption may also trigger the Food Quality Protection Act (FQPA), which established new safety requirements on the use of pesticides by mandating health-based standards for pesticides used in foods and providing special protections for babies and infants.[167] The FQPA requires the EPA to make a safety finding when setting tolerances for pesticides that can be used with "a reasonable certainty [of] no harm."[168] Safety findings should consider aggregate risks to children from exposure to a pesticide from multiple sources, and cumulative exposure to pesticides that have common mechanisms of toxicity.[169] This assessment considers the special susceptibility of children to pesticides by using an additional tenfold safety factor when setting risk tolerances.[170] Although produced water is not a pesticide, pesticides or similar chemicals could be in the waste stream and may overlap with limitations set by these laws.[171] Unlike

162. 16 U.S.C. §§ 1536, 1538.

163. *See* 16 U.S.C. § 1538(a)(1); 16 U.S.C. § 1540(a)–(b).

164. *See* 16 U.S.C. § 1538(a)(1); 16 U.S.C. § 703.

165. *See, e.g.*, *Protecting Endangered Species from Pesticides*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/endangered-species (last visited Sept. 17, 2023).

166. *See* 16 U.S.C. § 1540(a)–(b).

167. 21 U.S.C. § 346a *et seq*.

168. 21 U.S.C. § 346a(b)(2)(A)(ii).

169. *Summary of the Food Quality Protection Act*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/laws-regulations/summary-food-quality-protection-act (last visited Sept. 17, 2023).

170. 21 U.S.C. § 346a(b)(2)(C).

171. *See* 7 U.S.C. § 136(u) (defining pesticides to include (1) any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant,

pesticides, most chemicals of concern that may be present in produced water have no regulations set for acceptable exposure concentrations in food or residues on the surface of produce, nor are there safe consumption standards set for fruits, vegetables, or grain.[172]

Water quality limitations for food and vegetable agriculture are managed by the Food and Drug Administration (FDA).[173] The overall guidelines set by the FDA state that "[a]ll agricultural water must be safe and of adequate sanitary quality for its intended use."[174] Operators are required to regularly inspect their systems and evaluate the likelihood and foreseeable risk for entry of harmful constituents. The Food Safety Modernization Act requires the FDA to prevent illness through food products. While much of the law focuses on microbial concerns that can lead to food-borne illnesses, it also requires facilities to perform a hazard analysis for things including biological, chemical, physical, radiological hazards, and natural toxins that may affect food.[175] The FDA monitors foods for a few dangerous chemicals including acrylamide, benzene, dioxins and PCBs, ethyl carbamate, furan, perchlorate, and radionuclides.[176] In addition to testing the end product, sampling of water used in agriculture is also required.

Agricultural operators "must deliver any treatment of agricultural water in a manner to ensure that the treated water is consistently safe and of adequate sanitary quality for its intended use and/or consistently meets the relevant microbial quality criteria . . . ."[177] In December 2021, the FDA published a rulemaking to amend regulations and add "provisions for comprehensive pre-harvest agricultural water assessments that would help farms identify potential sources of contamination and effectively manage their water."[178] This rule would add new provisions for pre-harvest agricultural water assessments to identify hazards, including agricultural water sources.[179] Although these seem primarily focused on detecting food-borne illness concerns, it may also provide obligations if produced water is used for irrigation.

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and (3) any nitrogen stabilizer).

172. Heberger & Donnelly, *supra* note 98, at 38.

173. *See* 21 C.F.R. § 112 *et seq*.

174. 21 C.F.R. § 112.41.

175. 21 U.S.C. § 350g(b).

176. *Chemical Contaminants and Pesticides*, U.S. FOOD & DRUG ADMIN., https://www.fda.gov/food/chemical-contaminants-pesticides (last visited Sept. 15, 2023).

177. 21 C.F.R. § 112.43(a)(2).

178. Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption Relating to Agricultural Water, 86 Fed. Reg. 69,120, 69,121 (Dec. 6, 2021).

179. *Id*.

As discussed previously, water quality for livestock is also a concern. Constituents of interest for livestock use include salts, pH, total dissolved solids, toxic compounds, organophosphates and hydrocarbons, excess minerals, compounds including nitrates, sodium sulfates and iron complexes, and microorganisms.[180] Currently, the biggest limitation on water quality for livestock is the health and morbidity of the animals and associated cost implications rather than regulations.[181] The quality of the water is also important to farmers and ranchers who might see damage to land or livestock.

Farmworkers may also need protections.[182] Exposure pathways include physical contact with contaminated water or soil and inhalation of volatilized chemicals.[183] Exposure to benzene and PAHs can have both short and long-term health impacts while other toxics need evaluation.[184] Although "[b]enchmarks are not readily available for the protection of farmers/workers handling reclaimed produced water," this does not mean there are no protections.[185]

The primary law protecting workers from hazards is the Occupational Health and Safety Act (OSHA).[186] The oil and gas industry is exempt from some OSHA regulations;[187] however, these exceptions might not apply in the agricultural reuse context.[188] Despite potential overlaps from existing regulations, there is no indication that the FDA, USDA, or OSHA have considered potential harms specific to the reuse of treated produced water in agriculture.[189] Other laws associated with wastewater treatment, reuse, and disposal occur at the state level.

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180. AM. PETROLEUM INST., *supra* note 78, at 4-1–4-20.

181. *Id*.

182. *See*, *e.g*., Heberger & Donnelly, *supra* note 98, at 41–42 (providing anecdotal examples of oil and gas-related exposures for California farmworkers).

183. Hagstrom, *supra* note 43, at 132 fig.4.

184. Heberger & Donnelly, *supra* note 98, at 43.

185. Hagstrom, *supra* note 43, at 132; *see* 29 U.S.C. § 651, *et seq*.

186. *Id*. OSHA has some exemptions based on the size of the business, which could leave workers at small operations at risk. *See* 29 C.F.R. § 1904.1 (providing a partial exemption for employers with ten or fewer employees.).

187. *See*, *e.g*., 29 C.F.R. § 1910.1028(a)(2).

188. Sarah Logan Beasley, *Hydraulic Fracturing and Our Food System: Emerging Issues Related to Recycling Wastewater for Agricultural Purposes,* 32 J. LAND USE & ENV'T L. 167, 183–90 (2016); *Permissible Exposure Limits – Annotated Table,* US DEP'T OF LABOR OSHA, https://www.osha.gov/annotated-pels/table-z-1 (last visited Oct. 18, 2023).

189. *See* Hagstrom, *supra* note 43, at 132 ("[L]imited benchmarks are available for protection of crops and livestock.").

B. *State Management of Produced Water Reuse*

As in the federal context, there is very limited representation of produced water reuse standards in state law, particularly for use outside the oil and gas context.[190] However, several states have limited practices of reuse while others are contemplating its implementation.[191] State practice provides insights as to how this water may be managed and regulated going forward. Discussions on the expansion of reuse shows some states preferring a more methodical risk-based approach while others appear to have a willingness to apply limited existing legal frameworks across reuse scenarios.

1. California

According to the California Water Board (Board) website, "[r]ecycled produced water has been used to irrigate crops in the areas east and north of Bakersfield for at least 30+ years."[192] In this location, four oil companies annually send approximately 50,000 acre-feet of produced water to four irrigation districts to be used in food-crop agriculture.[193] The water is first treated by gravity separation, dissolved air flotation and, in some cases, filtered through walnut shells before it is sent to the irrigation districts for blending with fresh surface and groundwater before use.[194] Due to concerns about the unknown toxicity of fracking fluid constituents, the Board has never approved reuse of treated produced water from hydraulic fracturing for use on food crops.[195]

The State of California has not developed water quality standards for produced water reuse because of the small volume that is beneficially reused and the variety of beneficial reuse options.[196]

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190. *See id*. at 127.

191. *Id.*

192. *Frequently Asked Questions About Recycled Oilfield Water for Crop Irrigation*, CAL. WATER BDS. (Apr. 5, 2016), https://www.waterboards.ca.gov/publications_forms/publications/factsheets/docs/prod_water_for_crop_irrigation.pdf. Recycled water is defined as "water which, as a result of treatment of waste, is suitable for a direct beneficial use . . . that would not otherwise occur and is therefore considered a valuable resource." Cal. Wat. Code § 13050(n).

193. CAL. WATER BDS., *supra* note 192.

194. Liza Gross, *A California Water Board Assures the Public that Oil Wastewater Is Safe for Irrigation, But Experts Say the Evidence Is Scant*, INSIDE CLIMATE NEWS (Feb. 6, 2022), https://insideclimatenews.org/news/06022022/a-california-water-board-assures-the-public-that-oil-wastewater-is-safe-for-irrigation-but-experts-say-the-evidence-is-scant/.

195. CAL. WATER BDS., *supra* note 192.

196. Arian Edalat & Eric M. V. Hoek, *Techno-Economic Analysis of RO Desalination of Produced Water for Beneficial Reuse in California*, 12 WATER 1850, 3 (2020).

"Crops grown with produced water are regulated under waste discharge requirements (WDRs) adopted by California Regional Water Quality Control Board, Central Valley Region, (Central Valley Water Board)" and permitted on a case-by-case basis.[197] The Board's reuse program requires extensive monitoring of the produced water for constituents to ensure no negative impacts are associated with the use of this water.[198]

A Kern County permit for agricultural application of produced water provides additional information about the Board's approach.[199] Water is tested before application for several types of constituents including organic compounds, oil and grease, total petroleum hydrocarbons, individual hydrocarbons, and radium.[200] Some effluent limits for constituents like oil and grease and boron are included.[201] The permit also identifies local topography, crop types, irrigation methods, and whether produced water will be blended with fresh water prior to application.[202] Permit objectives focus on protecting beneficial uses of groundwater, groundwater wells near the reservoir, water quality results from the wells, and antidegradation analysis.[203] Use of this water for irrigation is specifically exempted from state waste disposal regulations.[204]

In response to safety concerns about the water posed by the local community, the Central Valley Water Board convened a Food Safety Expert Panel (Panel) in 2016 to "review[] produced water reuse on agriculture, related constituents, and if they pose a threat to public health."[205] The Board made clear that discharge practices would be modified or terminated if the committee determined the practice threatened public health.[206] Reopener provisions were included in permits reflecting this commitment.[207]

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197. Joshua G. Mahoney, Rebecca T. Asami & Dr. William T. Stringfellow, *Draft Food Safety Project White Paper*, CAL. REG'L WATER QUALITY CONTROL BD. 1 (Sept. 8, 2021), https://www.waterboards.ca.gov/centralvalley/water_issues/oil_fields/food_safety/data/white_paper/foodsafety_whitepaper.pdf; Edalat & Hoek, *supra* note 196, at 4.

198. CAL. WATER BDS., *supra* note 192.

199. *See* Cal. Reg'l Water Quality Control Bd. Cent. Valley Region, Order No. R5-2019-0024 (2018). The permit prohibits discharge of produced water into surface water. *Id*. at 17.

200. *Id*. at 3.

201. *Id*. at 9–10.

202. *Id*. at 6–8.

203. *Id*. at 10–14.

204. *Id*. at 14–15.

205. CAL. WATER BDS., *supra* note 192.

206. *Id*.

207. *See*, *e.g*., *id*.

In 2021, the Board published the Panel's initial findings.[208] Their white paper identified almost four-hundred chemicals and constituents potentially present in the Central Valley project's produced water.[209] Within the list, 143 were identified as "chemicals of concern" and a literature review identified potential threats to human health and crop safety.[210] Crop sampling was also conducted to compare uptake in fields that used produced water with those that did not.[211] The Panel ultimately did not recommend against utilizing treated water for irrigation, but did identify data gaps and made several recommendations including the need to conduct fate and transport studies on the chemicals associated with oil development; examine the effect of produced water on soils; evaluate temporal and spatial variability in the quality of produced water reused for irrigation; evaluate and consider incorporating emerging monitoring approaches in this context; take steps to acquire missing hazard and water-concentration information for oil field additives and associated chemical constituents; publish a list of oil-field additives that could be considered hazardous; and organize a periodic review of potential additives and evaluate health risks.[212]

2. Texas

Texas does not have a regulatory process dedicated to the beneficial reuse of treated produced water, but does have a regulatory process for land application for oil and gas sector waste disposal.[213] The Railroad Commission (RRC), which is not the state's environmental agency, grants permits for land application of freshwater-based drilling fluids and associated cuttings, oil and gas waste including drilling

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208. CAL. REG'L WATER QUALITY CONTROL BD., *supra* note 197.

209. *Id*. at 2.

210. *Id*.

211. *Id*.

212. *Id*. at 2, 19, 21–26. Critics have challenged the report's conclusions citing inadequate science and a consultant's undisclosed ties to the oil and gas industry. Gross, *supra* note 194.

213. *See Application Information for a Permit to Land Apply Produced Water or Gas Plant Effluent*, TEX. R.R. COMM'N, https://www.rrc.texas.gov/oil-and-gas/applications-and-permits/environmental-permit-types/landfarming-landtreatment-and-land-application-facilities/land-apply-produced-water-or-gas-plant-effluent/ (last visited Sept. 15, 2023) (providing guidance of a land apply permit application). In January 2021, the EPA approved Texas' application to issue NPDES discharge permits from oil and gas operations, which includes produced water. Fed. Reg. Doc. 2021-02895 (Feb. 5, 2021), https://www.federalregister.gov/documents/2021/02/12/2021-02895/approval-of-the-application-by-the-state-of-texas-for-partial-national-pollutant-discharge.

fluids.[214] Consideration for these permits focuses on the topography that might be appropriate for land application, potential for the disposal to cause pollution of surface or subsurface waters, depth to shallowest fresh water, and distance to and depth of the nearest actively producing domestic water well within one mile.[215] The applicant must also provide plans to control stormwater runoff and retention of incoming wastes during wet weather.[216] Landfarming permits may also require mixing of the wastes into the soil through tilling, disking, or plowing.[217]

The RRC permit application requests information regarding the site including a description of the contours of the land application site, watercourse or drainage ways, and whether the site is located in a flood-prone area or wetland.[218] Factors such as wastewater quality, soil characteristics, topography, and depth to and quality of groundwater are also required.[219] Information about the source material must also be disclosed, including origin of waste, treatment the water may receive prior to land application, waste application method, and sampling results for fifteen basic parameters such as pH, TDS, chloride, and thirteen toxic pollutants including heavy metals, arsenic and benzene.[220] A permit may only issue if the project will not result in the pollution of surface or subsurface waters and permits "will contain conditions reasonably necessary to prevent . . . pollution," but the regulation does not include discharge standards.[221] While the RRC's land application permitting program is illustrative of what might be considered, it does not establish a regulatory program for beneficial use or produced water.

214. *Landfarming, Landtreatment, & Land Application Facilities*, TEX. R.R COMM'N, https://www.rrc.texas.gov/oil-and-gas/applications-and-permits/environmental-permit-types/landfarming-landtreatment-and-land-application-facilities/ (last visited Sept. 17, 2023).

215. TEX. R.R. COMM'N, *supra* note 213.

216. *Id*.

217. TEX. R.R. COMM'N, *supra* note 214.

218. TEX. R.R. COMM'N, *supra* note 213.

219. *Id*.

220. TEX. R.R. COMM'N., *supra* note 214. *See Land Application Permit for Produced Water or Gas Plant Effluent Water,* TEX. R.R. COMM'N, http://www.rrc.texas.gov/media/bc2loals/table2-landapply_analyses.pdf (last visited Nov. 9, 2023).

221. 16 T.A.C. § 3.8(6)(A). An existing permit can be modified, suspended or terminated if pollution "is occurring or is likely to occur as a result of the permitted operations." 16 T.A.C. § 3.8(6)(E)(i). Pollution is defined as "[t]he alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any surface or subsurface water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose." 16 T.A.C. § 3.8(a)(28).

Guinn Operating Company holds two land application permits from the RRC for produced water on properties located in Atascosa County, Texas.[222] These almost identical permits focus on the disposal of waste through land application and not beneficial reuse.[223] The permits apply to the land application of non-hazardous oil and gas wastes that are Resource Conservation and Recovery Act (RCRA) exempt, including produced water.[224] The wastewater cannot pool or migrate offsite to a watercourse or drainage way.[225] Water application must cease if the soil becomes saturated or during a rain event.[226] The application site "cells," referenced as "waste management units," must be surrounded by earthen dikes or other containment structures to avoid intermingling with storm water.[227] Quarterly reporting is required of soil and wastewater sampling; however, the only wastewater parameter listed with a limit is oil and gas.[228] The permits list no monitoring requirements for other potential chemicals.[229] In addition to these existing disposal projects, a frequently circulated PowerPoint presentation from Texas A&M AgriLife Research mentions a reuse agricultural pilot project, but no additional data or information has been published.[230]

In June 2021, Texas passed Senate Bill 601 (SB 601) to establish the Texas Produced Water Consortium (TxPWC) at Texas Tech University.[231] The stated purpose of the TxPWC is "to bring together

222. Tex. R.R. Comm'n, Permit to Apply Produced Water, Land Apply Permit LA-0380, (June 28, 2019) [hereinafter Tex. Permit 1]; Tex. R.R. Comm'n, Permit to Apply Produced Water, Land Apply Permit LA-0379, (June 28, 2019) [hereinafter Tex. Permit 2].

223. Tex. Permit 1, *supra* note 222, at 4; Tex. Permit 2, *supra* note 222, at 4. One permit allows 37,720 gallons per day while the other allows 31,500 gallons daily. Tex. Permit 1, *supra* note 222, at 4; Tex. Permit 2, *supra* note 222, at 4.

224. Tex. Permit 1, *supra* note 222, at 3; Tex. Permit 2, *supra* note 222, at 3.

225. Tex. Permit 1, *supra* note 222, at 4; Tex. Permit 2, *supra* note 222, at 4.

226. *Id*.

227. *Id*.

228. Tex. Permit 1, *supra* note 222, at 3 & 5; Tex. Permit 2, *supra* note 222, at 3 & 5.

229. Tex. Permit 1, *supra* note 222; Tex. Permit 2, *supra* note 222.

230. *See* Katie Lewis, Jaroy Moore, & Bill Weathersby, *Agricultural Reuse of Treated Produced Water*, https://www.owrb.ok.gov/2060/PWWG/Resources/Lewis_Katie.pdf.

231. Tex. S.B. 601, 87d Leg., R.S. (2021). In 2023, Colorado also passed legislation to create a produced water consortium "to make recommendations that are protective of public health, safety, and welfare; the environment; and wildlife." Col. H.B. 1242, § 34-60-135(2)(a), R.S. (2023). The bill also requires the Colorado Oil and Gas Conservation Commission (COGCC) to collect "robust data regarding the existing use, recycling, and disposal of water in oil and gas operations" and promulgate rules consistent with this goal. Col. H.B. 1242, § 1(2)(a)-(b), R.S. (2023). Operators are also now required to report fresh water and recycled water used in production as well as the volume of produced water that is produced from each well. Col. H.B. 1242, § 34-60-134 (2)(a)-(c), R.S. (2023). The bill prioritizes reuse in oil and gas operations. H.B. 1242, R.S.

information resources to study the economics of and technology related to, and the environmental and public health considerations for, beneficial uses of fluid oil and gas waste."[232] SB 601 defined the required TxPWC participants as Texas Tech, an agency advisory council, the stakeholder advisory council, technical and economic steering committees, and private entities.[233] The stakeholder advisory council's membership must include industry representatives from all phases of the oil and gas life cycle, environmental interests, and public water utilities.[234]

The primary obligations of the TxPWC are to study the economic, environmental, and public health considerations of beneficial reuses; evaluate the technology needed for treatment; and complete an initial report by September 1, 2022.[235] The report included suggested policy changes to enable beneficial reuse, guidance for permitting and testing standards, a pilot project for state participation, and an economic model for using fluid oil and gas waste in a way that is economical and efficient and that protects public health and the environment.[236]

A report was submitted to the legislature consistent with statutory obligations.[237] It recognized the potential for the beneficial use of treated produced water and focused on reuse in the Permian Basin.[238] In response to the report, a bill was passed in 2023 directing the TxPWC to "select a pilot project or program for consideration and implementation" and submit a follow-up report by October 2024.[239] A water infrastructure bill also passed that set aside money for "new water" projects including "produced water treatment projects, other than projects that are only for purposes of oil and gas exploration."[240] Approved by Texas voters in November 2023, $250 million will now go into a state fund for these "new water" projects.[241] It is unclear how the

(2023).

232. Act of June 21, 2021, 87th Leg., R.S., ch. 109 (to be codified at Tex. Educ. Code § 109.202).

233. *Id.*

234. *Id*. (to be codified at Tex. Educ. Code § 109.203(e)).

235. *Id*. (to be codified at Tex. Educ. Code § 109.204(a)&(a-1)).

236. *Id*. (to be codified at Tex. Educ. Code § 109.204(a-1)(1-4)).

237. TEXAS PRODUCED WATER CONSORTIUM, BENEFICIAL USE OF PRODUCED WATER IN TEXAS: CHALLENGES, OPPORTUNITIES AND THE PATH FORWARD 8 (2022), https://www.depts.ttu.edu/research/tx-water-consortium/downloads/22-TXPWC-Report-Texas-Legislature.pdf.

238. *Id*.

239. Tex. S.B. 1047, 88th Leg., R.S. (2021).

240. S. 28, 88th Leg., Reg. Sess. (Tex. 2021).

241. *Id*.; S. J. Res. 75, 88th Leg., Reg. Sess. (Tex. 2021); Erin Douglas & Pooja Salhotra, *Texas*

timing of the TxPWC pilot project relates to the funding and approval of produced water reuse projects.

3. New Mexico

In contrast to Texas, produced water in New Mexico cannot be permitted for any reuse that may involve contact with fresh water zones.[242] The New Mexico Environment Department (NMED) has publicly stated that it will not permit any reuses of treated produced water until further public outreach and research has been completed to better understand and prevent negative environmental impacts.[243] One stated concern is with data gaps related to the chemical constituents, possible treatments, and regulations for the safe application of treated produced water when used beneficially.[244] In an effort to fill these gaps, the state is partnering with academic institutions and engaging in community and tribal outreach.[245] Their ultimate goal is to draft regulations for a formal rulemaking with science-based standards that are protective of human health and the environment.[246]

In 2018, the EPA and several departments of the state of New Mexico signed a Memorandum of Understanding (MOU) to explore the opportunities, benefits, costs, and risks of reusing produced water in the state.[247] "The scope of the MOU pertains to proactively

Senate Moves to Set Aside Billions for Future Water Needs, TEXAS TRIBUNE (Apr. 3, 2023, 5:00 PM), https://www.texastribune.org/2023/04/03/texas-senate-bill-28-water-supply; TX Water Dev't Board, *Proposition 6 and Texas Water Fund Frequently Asked Questions*, https://www.twdb.texas.gov/home/tabs/doc/hot/SB_28-TexasWaterFund-FAQ.pdf; *Texas Proposition 6 Election Results: Create the Texas Water Fund*, N.Y. TIMES (Nov. 7, 2023) https://www.nytimes.com/interactive/2023/11/07/us/elections/results-texas-proposition-6-create-water-fund.html (showing the Texas Proposition 6 Election Results tally).

242. Rebecca Roose et al., *Produced Water Management in New Mexico*, N.M. ENV'T DEP'T 16 (Oct. 30, 2019), https://www.env.nm.gov/new-mexico-produced-water/wp-content/uploads/sites/16/2019/10/Produced-Water-Public-Meeting-Presentation_ENGLISH_Final-191030.pdf. New Mexico is the third largest oil and gas producer in the United States, generating an estimated 37.8 billion gallons of produced water annually. STATE OF N.M. & U.S. EPA, OIL AND NATURAL GAS PRODUCED WATER GOVERNANCE IN THE STATE OF NEW MEXICO—DRAFT WHITE PAPER 2–3 (2018), https://www.epa.gov/sites/default/files/2018-11/documents/oil_and_natural_gas_produced_water_governance_in_the_state_of_new_mexico_draft_white_paper_508.pdf.

243. Roose et al., *supra* note 242. NMED has also stated that untreated produced water will never be authorized for reuse outside of the oil and gas context. *Id*.

244. STATE OF N.M. & U.S. EPA, *supra* note 242 at 3.

245. Roose,et al., *supra* note 242.

246. *Id*. at 17.

247. *Memorandum of Understanding Between the State of New Mexico and the U.S.*

clarifying and understanding the existing regulatory and permitting frameworks, and associated policy decisions among the parties related to the re-use, recycling, and beneficial use of waters originating from oil and natural gas activities (produced water)."[248]

The MOU required the creation of a collaborative working group tasked with writing a white paper, which was published in November 2018, that would "synthesize the regulatory and permitting frameworks related to produced water" and identify data and policy gaps, potential reuse alternatives, and process opportunities associated with reuse.[249] In addition to federal regulations such as the CWA and the SDWA, the paper identified state laws that would apply to the beneficial reuse of produced water.[250] The primary state agencies involved would be: The New Mexico Oil Conservation Division (OCD), NMED, and The New Mexico Office of the State Engineer (OSE).[251]

Surface and groundwater quality regulations are dictated by the New Mexico Water Quality Act.[252] The Act vests authority for water quality management in the New Mexico Water Quality Control Commission (WQCC).[253] The WQCC is located within NMED, which is the state agency responsible for establishing standards and promulgating rules for surface water and groundwater consistent with the CWA.[254] The OCD is responsible for administering regulations related to "discharges from facilities for the production, refinement, pipeline transmission of oil and gas or products thereof, the oil field service industry, oil field brine production wells, geothermal installations and carbon dioxide facilities."[255]

To ensure water meets discharge specifications, the treatment facility would also need to receive a permit from NMED to discharge produced water on the land or subsurface.[256] There are no obligatory regulations for a Ground Water Discharge Permit; however, an

Environmental Protection Agency, STATE OF N.M. & U.S. EPA (July 16, 2018), https://www.epa.gov/sites/production/files/2018-07/documents/epa-nm-mou_produced-water_07-16-2018.pdf [hereinafter N.M. MOU].

248. *Id*. at 1–2. The MOU distinguishes between re-use water, which only requires "minimal treatment" before it can be repurposed and recycled water, which requires "significant treatment."

249. *Id*. at 4.

250. STATE OF N.M. & U.S. EPA, *supra* note 242 at 6–11.

251. *Id*. at 6.

252. *Id*. at 7.

253. *Id*.

254. *Id*.

255. *Id*. at 8 (quoting N.M. Stat. Ann. § 20.6.2.1201 (2018)).

256. *Id*.

applicant must have an approved plan to protect groundwater quality.[257] For irrigation, a plan should include information about water quality, potential for soil leaching of contaminants, and use of irrigation practices that avoid ponding and overwatering.[258]

A Ground Water Discharge Permit application, if issued after research is complete, would include a two-step public process that allows for notice and comment.[259] Permitting review and approval is focused solely on protecting groundwater quality.[260] Health implications associated with crop or livestock uptake are not under the NMED's jurisdiction.[261] Treated water intended for municipal use would follow a similar regulatory path, and testing is required to show compliance with SDWA standards.[262] Application for approval would need to be made to NMED's Drinking Water Bureau.[263] Discharge produced into surface water would require an NPDES permit from the EPA because NMED does not currently have delegation authority.[264]

In an effort to address data gaps and clarify regulatory jurisdiction over produced water, New Mexico passed House Bill 546 in 2019.[265] The Produced Water Act places land application of treated produced water outside the waste discharge definition and requires a permit from NMED's Groundwater Quality Bureau.[266] Although the OCD promulgated rules pertaining to the reuse of produced water that include provisions encouraging reuse in the oil and gas context, any use of produced water outside the oil and gas industry is now regulated by NMED.[267] The transfer of authority over produced water from OCD occurs once the water is delivered to the produced water treatment or recycling facility.[268]

House Bill 546 also requires the New Mexico Water Quality Control Commission to "adopt regulations for the discharge, handling,

257. *Id*. at 26.

258. *Id*.

259. *Id*.

260. *Id*.

261. *Id*.

262. *Id*. at 28.

263. N.M. Code R. §§ 20.7.10.200.A & 20.7.10.201.

264. STATE OF N.M. & U.S. EPA, *supra* note 242 at 20.

265. H.B. 546, 2019 Leg., Reg. Sess. (N.M. 2019).

266. N.M ENV'T DEP'T, *Produced Water Factsheet* 2, https://www.env.nm.gov/wp-content/uploads/sites/16/2019/10/Produced-Water-Factsheet_ENGLISH_-FINAL-191010.pdf; N.M. Code R. § 20.6.2.

267. N.M. ENV'T DEP'T, *supra* note 263, at 2; *See* N.M. Code R. § 19.15.34.

268. N.M ENV'T DEP'T, *supra* note 263, at 2.

transport, storage, and recycling or treatment of produced water or byproduct thereof outside the oilfield."[269] The New Mexico Produced Water Research Consortium was created by a MOU between the NMED and New Mexico State University to inform science-based regulatory policies for reuse through the use of tested science and technology.[270] Their work is underway.

4. Wyoming

Although Wyoming does not have an overarching regulatory program for land application of treated produced waters for a beneficial use, it was one of the first states to issue a permit for this type of use.[271] A pilot project permit was issued by the Wyoming Department of Environmental Quality (WDEQ) to Encore Green for a one-time application of approximately 7,000 barrels of treated produced water before December 27, 2020.[272] The permit prohibits water application when the ground is saturated, frozen, or covered by snow.[273] Water must be applied uniformly at an agronomic rate and cannot be allowed to pool or run-off, and discharge cannot occur within 300 feet of the high-water mark of a surface water body.[274] Discharge criteria for approximately 150 pollutants are included in the permit.[275] Constituents listed include pH, TDS, metals, volatile organic compounds (VOCs), semi VOCs, hydrocarbons, and pesticides.[276] ENCORE is required to at least triple test the water by batch; each

269. Roose et al., *supra* note 242, at 12. New Mexico has stated that the level of treatment needed will vary to ensure the water is "fit for purpose." *Id*. at 26.

270. *N.M. Produced Water Research Consortium*, N.M. STATE UNIV., https://nmpwrc.nmsu.edu/about/index.html (last visited Sept. 17, 2023).

271. *See* Wyo. Dep't of Env't Quality, Water Quality Div., Permit No. 19-283, 1 (Jan. 3, 2020) (permitting Encore Green to land apply produced water).Wyoming's environmental agency website states that land application permits are issued by the Produced Water Disposal & Treatment Permitting group. *Produced Water Disposal and Treatment*, WYO. DEP'T OF ENV'T QUALITY, https://deq.wyoming.gov/water-quality/water-wastewater/permitting/produced-water-disposal-treatment/ (last visited Sept. 17, 2023). Road application is available when "no other alternative is reasonably available for disposal." *Id*.

272. Wyo. Dep't of Env't Quality, *supra* note 271. The Wyoming Oil and Gas Commission regulates the application of waste if it occurs on a lease, but the Wyoming Department of Environmental Quality regulates the same activity in off-lease locations. GROUNDWATER PROT. COUNCIL, *State Oil and Natural Gas Regulations Designed to Protect Water Resources* 72 (4th ed. 2023), *available at* https://www.gwpc.org/wp-content/uploads/2023/05/State-Regulations-Report-2021-Published-May-2023-FINAL.pdf.

273. Wyo. Dep't of Env't Quality, *supra* note 271 at 1.

274. *Id*. at 2–3.

275. *Id*. at 3–7.

276. *Id*.

batch has a maximum of 1,000 barrels, and results must be submitted to WDEQ for approval prior to application.[277] All water that does not meet the defined criteria must be reported, and the WDEQ must be informed of the method and location of disposal.[278] A detailed Sampling and Analysis Plan must be submitted and approved by WDEQ before operations can begin.[279]

Wyoming also issued county-wide land application permits.[280] Laramie County holds a five-year permit that "authorizes the applicant to land apply uncontaminated produced water" in accordance with the permit conditions and requirements.[281] The permit limits application location, and prior notice and sampling are required before a discharge can occur.[282] The permit includes the same conditions as the Encore Green permit regarding proximity to surface water, land slope, pooling, as well as testing and analysis.[283] These land-apply permits have been issued with conditions intended to protect the environment. However, there is no indication that a full analysis or report has been completed that assessed the beneficial nature of land application or whether harm has been caused to the land or associated surface and ground waters.

Due to Wyoming's location west of the 98th meridian, entities may discharge surface water for agricultural or livestock propagation without a NPDES permit, but state permit requirements for surface water discharges have additional requirements for produced water.[284] Mirroring the language of CWA, Wyoming law requires that "produced water shall be of good enough quality to be used for wildlife or livestock watering or other agricultural uses . . . ."[285] Additionally, a discharge of produced water cannot be permitted if it "contain[s] toxic materials in concentrations or combinations which are toxic to human, animal or aquatic life" or "contain[s] substances that will settle to form sludge, bank or bottom deposits in quantities sufficient to result in significant aesthetic degradation, significant degradation of habitat for

277. *Id*. at 8.

278. *Id*. at 7.

279. *Id*. at 8.

280. *See, e.g.*, Wyo. Dep't of Env't Quality, Water Quality Div., Permit No. 20-184 (June 9, 2020).

281. *Id*. at 1.

282. *Id*. at 2, 4.

283. *Id*. at 3–4.

284. Wyo. Admin. Rules Env't Quality, Dept. of Water Quality Chapter 2, Appendix H; 40 C.F.R. § 435.52.

285. *Id*. at H(a)(i).

aquatic life or adversely affect public water supplies, agricultural or industrial water use, plant life or wildlife."[286] State regulations for produced water discharge permits include effluent limitations that are protective for stock and wildlife, and the state reserves the right to include more stringent requirements whenever necessary to assure compliance with Wyoming Water Quality Rules and Regulations.[287] Listed effluent limitations are included for chlorides, sulfides, TDS, and pH.

The University of Wyoming serves as an academic partner to the state for issues related to the beneficial reuse of produced water through the Center for Excellence in Produced Water Management (CEPWM).[288] Their stated mission is to "determine the cost points where water reuse is a viable option."[289] CEPWM lists economic and scientific analysis for the use of produced water to increase surface water inflows and increase drinking water inflow.[290]

5. Oklahoma

As in the other states discussed, Oklahoma does not have regulations specific to the permitting of produced water for beneficial reuse.[291] However, the Oklahoma Corporation Commission (OCC) does allow land application of produced water in limited circumstances.[292] The site must meet certain criteria, including slope and depth to bedrock limitations, and water quality must adhere to TDS and oil and gas standards.[293] The regulations also provide for sampling protocols, analysis, maximum application rates, and permit conditions.[294] Additionally, the OCC has promulgated rules governing

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286. *Id*. at H(b)(i, v).

287. *Id*. at H(b)(vii).

288. *See Produced Water Economics and Beneficial Reuse*, THE CTR. OF EXCELLENCE IN PRODUCED WATER MGMT., https://cepwm.com/produced-water-economics-and-beneficial-reuse/ (last visited Sept. 17, 2023) ("The Center is organized as a consortium of university researchers and representation from the oil and gas industry, government agencies, environmental organizations and other stake holders . . .").

289. *Id*.

290. *Id*.

291. GROUNDWATER PROT. COUNCIL, PRODUCED WATER REUSE IN OKLAHOMA: REGULATORY CONSIDERATIONS AND REFERENCES 4 (2015), https://rest.owrb.ok.gov/2060/PWWG/GWPC-Ok-Produced-Water-Project-Summary-Report.pdf.

292. *Id*. at 7.

293. OKLA. ADMIN. CODE §§ 165:10-7-17(d)(1–2).

294. *Id*. at (e–i).

the recycling of produced water.[295] Like in Texas, these regulations appear to provide a disposal alternative rather than allow land application as a beneficial reuse. Discharge to surface waters is not permitted without a NPDES permit issued by the EPA.[296]

Statewide surface and groundwater quality standards are set by the Oklahoma Water Resources Board (OWRB).[297] Groundwater quality standards consist of: "Designation of beneficial uses of groundwater, Classification of groundwater based on water quality criteria, and Protective Measures."[298] Beneficial use can be made of groundwater with a mean TDS concentration at or below 10,000 mg/L, although water with lower TDS may receive a classification designating it more appropriate for domestic water or as in need of protection.[299]

Oklahoma recently launched several initiatives to expand opportunities to reuse produced water.[300] In 2016, a 17-person produced water working group led by the Oklahoma Water Resources Board convened and released a report to "evaluate the data, issues and opportunities with produced water . . . ."[301] The report concluded that reuse of water in the oil and gas industry was the most cost effective alternative due to minimal treatment needs, the need for further study of water evaporation, and cost ineffectiveness of current water treatment alternatives for other reuse strategies.[302] The working group also suggested the reduction of legal barriers to reuse, further investigation of ways to facilitate reuse, and identification of research and funding needs to investigate the economic feasibility of treatment alternatives and reuse alternatives.[303] Risks associated with reuse include: legal ownership and value of water, transport and treatment costs, water treatment facility bonding, discharge permitting challenges, right-of-way issues, and legal custody of water as it relates

295. OKLA. ADMIN. CODE §§ 165:10-9-4 *et seq.*

296. OKLA. ADMIN. CODE §§ 165:10-7-18. Oklahoma has requested delegation from the EPA to gain authority to issue NPDES discharge permits from oil and gas operations. Mike Lee, *EPA May Let Oil Waste in Waterways. Is the Public at Risk?*, E&E NEWS ENERGY WIRE (Nov. 13, 2019), https://www.eenews.net/articles/epa-may-let-oil-waste-in-waterways-is-the-public-at-risk/.

297. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 8.

298. *Id*.

299. *Id*. at 8, 19.

300. *See Report of the Oklahoma Produced Water Working Group* 3, (Apr. 2017) [hereinafter *Oklahoma Report*] (noting that Oklahoma's Water for 2060 Act (HB 3055) established a statewide goal to consume the same amount or less water in 2060 than it consumed in 2010).

301. *Oklahoma Report*, *supra* note 300, at iii.

302. *See id.* at iii–iv; *see also id.* at 3-2 (stating that based on the data collected, the estimated cost of treatment for reuse in oil and gas could average $0.57 per barrel of water).

303. *See id.* at iv–v.

to potential spills.[304] The report focused primarily on economic challenges, but also expressed the goal to "[i]dentify toxicological risks and protective water quality targets to ensure that the environment and public health are adequately protected under various reuse scenarios."[305]

In May 2020, the governor signed Senate Bill 1875, known as the Oil and Gas Produced Water and Waste Recycling Reuse Act.[306] To motivate the development of treatment technology, the bill clarifies that ownership of produced water and waste is vested in the oil and gas producer until it is voluntarily transferred.[307] The bill also prevents liability for those processing or transferring wastewater into recycled water for further use in oil and gas production.[308]

A review of state practices demonstrates a clear interest in reusing produced water in one or more sectors. Legislation to create produced water consortiums and consider standards reflects a range of comfort levels with implementation. While the reuse of produced water presents opportunities to meet future water demands, execution is critical to minimizing risk.

V. HASTE MAKES WASTE: PROCEEDING WITH PRODUCED WATER

Freshwater availability challenges continue to dominate the news cycle, particularly in the Western U.S.[309] As states seek additional water sources, conservation and efficiency are part of the solution.[310] This means using less water and ensuring that all water used gets maximum gain. Consumptive, single-purpose use of water is being replaced by opportunities to treat, recycle, and reuse. When states do not have sufficient water for projected needs, disposal of produced water through deep injection seems less logical. The added challenges of limited waste storage capacity and cost of disposal encourage the

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304. *See id.* at 5-1 to 5-3.

305. *See id.* at v, 5-1 to 5-3, 6-2.

306. *Governor Signs Oil and Gas Produced Water and Waste Recycling and Reuse Act into Law*, OKLAHOMA SENATE, (May 19, 2020), https://oksenate.gov/press-releases/governor-signs-oil-and-gas-produced-water-and-waste-recycling-and-reuse-act-law [hereinafter Oklahoma Senate].

307. *Id.*; OKLA. STAT. 52 § 86.6 (2022).

308. Oklahoma Senate, *supra* note 306; OKLA. STAT. 52 § 86.6 (2022).

309. *See*, Ginger Zee & Kenton Geweke, *Why Parts of America are 'Certainly in a Water Crisis' and What Can Be Done About it*, ABC NEWS (Apr. 19, 2023) https://abcnews.go.com/US/parts-america-water-crisis/story?id=98484121.

310. *See*, Christopher Flavelle, *A Breakthrough Deal to Keep the Colorado River From Going Dry, for Now,* N.Y. TIMES (May 22, 2023) (discussing the new agreement on the allocation of water from the Colorado River).

beneficial reuse of produced wastewater. While reuse of produced water is an important opportunity, it should be executed with care and with respect to the protection of human health and the environment. To achieve this, states must first clarify regulatory authority, expand data-reporting, and create risk-based standards that consider all likely receptor pathways for each type of reuse.

A. *Reduce Unknowns and Close Data Gaps*

In contemplation of expanding the reuse of treated produced water, several initial questions must be answered. First, clarification related to regulatory authority, permitting, and oversight authority is needed. In addition to potential federal and state overlaps, intrastate agency confusion can occur where different agencies are dedicated to oil and gas permitting, water permitting, or environmental protection.[311] Second, safe produced water management depends on a clear understanding of the source water, which is currently limited by gaps in data and reporting requirements. Information will highlight gaps in protection, provide clarity to a party wishing to pursue reuse alternatives, and avoid unintended consequences.

1. <u>Define Regulatory Authority</u>

As states consider beneficial reuse, they must first delineate the boundaries of federal and state regulatory authority. Answers may vary depending on the type of reuse desired, whether the issue involves permitting or oversight enforcement, and if the state has been delegated permitting authority under federal law.[312] For example, any reuse that includes a point-source discharge into jurisdictional waters will involve the CWA, but the EPA would only be directly involved if the state does not have primacy over the permitting process.[313] By comparison, land applications, such as rangeland restoration, would likely only involve state permitting, if present, but could also involve the U.S. Fish and Wildlife through the ESA if a listed species is impacted.[314] Produced water used in agriculture may include reporting obligations to USDA as well as state agencies in some locations.[315] OSHA could also have inspection authority in locations where

311. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 122.

312. *See id*. at 31.

313. *See* discussion *supra* Part IV.A.1.a.

314. *See* discussion *supra* Part IV.A.3.

315. *See* discussion *supra* Part IV.A.4.

produced water use may impact the health and safety of employees.[316]

Within states, the variety of authorities that might have jurisdictional overlap can also lead to confusion and uncertainty. Depending on the state, and the desired reuse, the slate of implicated agencies may include those associated with water quality, oil and gas permitting, water permitting, waste, transportation, agriculture, and wildlife.[317] Any state seeking to pursue reuse as a water resource alternative should consider these overlaps and provide clear guidance for potential applicants because ambiguity can create confusion and delay reuse implementation.

States must delineate agency jurisdiction throughout the lifecycle of produced water. Clarity is important to ensure safety as well as define liability parameters between the various entities that might be involved including the producer, midstream operator, and end user. MOUs between oil and gas agencies and other state agencies with overlapping jurisdiction are effective tools to define obligations.[318] If current regulations are not sufficient, new rules must be promulgated that define when responsibility for the water transfers.

New Mexico provides a helpful model for how a state can clarify authority. The OCD has authority to regulate produced water within the Oil and Gas Act, while jurisdiction for water quality regulations is vested in the WQCC by the Water Quality Act.[319] This means that OCD implements rules pertaining to reuse of produced water in the oil and gas context, which includes provisions that encourage reuse in that sector,[320] but uses of treated produced water outside the oil field are regulated by NMED.[321] The transfer of authority between agencies is clearly delineated, only occurring once the water is delivered to the produced water treatment or recycling facility.[322] Water treatment facilities need a permit from NMED to discharge produced water on the land or subsurface.[323] Regulations for other beneficial reuse scenarios have not yet been promulgated, but would also fall under

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316. *See* discussion *supra* Part IV.A.4.

317. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 122; *see, e.g.*, GROUNDWATER PROT. COUNCIL, *supra* note 267, at 25–27 (noting the number of agencies implicated for various produced water activities).

318. *See* GROUNDWATER PROT. COUNCIL, *supra* note 267, at 103 ("These associations are very effective at bringing together state and federal agencies.").

319. STATE OF N.M. & U.S. EPA, *supra* note 242, at 7.

320. *See* N.M. Code R. § 19.15.34.

321. N.M. Env't Dep't, *supra* note 261, at 2.

322. *Id*.

323. STATE OF N.M. & U.S. EPA, *supra* note 242, at 8.

NMED's jurisdiction.

New Mexico also defines property interests and liability associated with produced water. The oil and gas owners and operators hold the initial possessory interest and are responsible for "all produced water that is produced from an oil or gas well."[324] They are required to "handle the use, disposition, transfer, sale, conveyance, transport, recycling, reuse or treatment of the produced water as a reasonably prudent operator."[325] Once the water has been sold, conveyed, or transferred to a "operator, transporter, pipeline, midstream company, plant, processing facility, refinery or entity that provides recycling or treatment services for produced water . . . ," possessory interests, responsibilities, and liabilities also transfer.[326]

New Mexico also entered into a MOU with the EPA to facilitate collaboration and ensure the development of reuse strategies protective of human health and the environment while seeking to "foster resource conservation and economic opportunity."[327] The scope of the MOU clarifies agency responsibilities by defining regulatory and permitting frameworks.[328] By attempting to understand interagency jurisdiction and the role of federal agencies, New Mexico has taken important steps to facilitate beneficial reuse and presents a model for other states seeking to do the same.

2. Expand Reporting Obligations

It is impossible to assess and protect against produced water reuse risks without a clear understanding of the location, quantity, and constitution of the source material. The first step is to quantify the amount, timing, and location of produced water that might be available for reuse.[329] Knowing this information will allow decision-makers to assess the potential for this water to solve regional fresh water supply challenges.

Once a clear picture emerges of how much water is potentially available for reuse, water quality must be assessed. Currently, there is a lack of transparency related to the myriad of chemicals and other constituents that may be present in produced water.[330] In reviewing the

324. H.B. 546, 2019 Leg., Reg. Sess. (N.M. 2019).
325. *Id*.
326. *Id*.
327. N.M. MOU, *supra* note 247, at 1.
328. *See id*.
329. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 106–07.
330. Pichtel, *supra* note 24, at 2.

impact of hydraulic fracturing on U.S. drinking water resources, the EPA notes that a lack of data prevented some analysis on the topic.[331] The report states that "[t]he limited amount of data collected before, during, and after activities in the hydraulic fracturing water cycle reduces the ability to determine whether these activities affected drinking water resources."[332] This report focused on drinking water impacts, but these deficiencies have similar impacts on the ability to assess any potential reuse type.[333] Although a growing number of jurisdictions require disclosure, many states still do not.[334] Even in states that require disclosure, significant information gaps in databases like FracFocus persist due to the ability of companies to avoid reporting by claiming trade secrets.[335]

States must find ways to protect companies' intellectual property, while still being able to assess what is safe to be released into the environment and promoting regulations that require more reporting and disclosure.[336] Reporting obligations should include information about quantities of produced water generated during drilling and exploration as well as its chemical makeup.[337] Produced water quality varies considerably based on location, so site-specific information is needed for states to determine the level of treatment needed for the desired end use.[338] Treatment level is an important part of assessing cost for any given reuse scenario.

Colorado's recent legislation provides an example of how a state may close data gaps. The state's recent House Bill 23-1242 increased mandatory water reporting for operators.[339] Beginning on September 1, 2023, monthly reporting is required for each well. Data includes the volume of all fresh and recycled or reused water used downhole, the total amount of produced water generated from the well, and the

331. U.S. ENV'T PROT. AGENCY, *supra* note 6, at ES-44-45.

332. *Id*. at ES-45.

333. *See id.*

334. *See* GROUNDWATER PROT. COUNCIL, *supra* note 272, at 37–38 (noting that as of 2021, 25 state agencies require reporting).

335. U.S. ENV'T PROT. AGENCY, *supra* note 6, at ES-13. "The project database is an incomplete picture of all hydraulic fracturing." *Id*. Seventy percent of well operators reported at least one constituent as confidential. *Id*. at ES-45.

336. DELIA MAYOR, CLEAN WATER ACTION/CLEAN WATER FUND, CLEAN WATER ACT REGULATION OF OIL AND GAS WASTEWATER DISCHARGES: A CALL FOR IMPROVED OVERSIGHT AND TRANSPARENCY 20, (Jan. 2020).

337. *See* H.B. 1242, § 234-60-134(2), Reg. Sess. (Col. 2023).

338. Hagstrom, *supra* note 43, at 127.

339. H.B. 1242, § 234-60-134(2-3), Reg. Sess. (Col. 2023).

volumes that were reused versus disposed of as waste.[340] The operator must note where any reuse occurred.[341] Beginning in 2024, operators must also submit quarterly reports with the volume of freshwater or recycled water sources used downhole.[342] Reporting obligations apply for the lifetime of a well and conclude only when the well has been plugged and the site decommissioned.[343]

Colorado's bill focuses on the reduction of freshwater use for oil and gas activities, but does not address reporting related to the chemicals in the produced water. Understanding of water quality is the next critical step for beneficial reuse of water outside the petroleum industry.

B. *Adopt Fit-for-Purpose, Risk-Based Standards*

Environmental damage created by above-ground disposal, surface water discharges, and unintended spills of untreated and undertreated produced water demonstrates the dangers of reusing this water without sufficient treatment.[344] The majority of reuse types require various treatments to ensure that the water is suitable for use.[345] As state and federal policy makers consider the viability of beneficially reusing produced water in various sectors, including rangeland rehabilitation, irrigation of non-food and food crops, and livestock watering, more focus is needed to develop protective regulatory standards that fit the desired purpose.[346] The range of reuse exposure scenarios for each reuse type adds to the complexity of regulatory oversight needed and highlights the data gaps that need to be filled for a legal program to be effective.

The suitability of produced water for a desired use is a function of the quality of the source water and the characteristics of the reuse site, including potential receptors.[347] Untreated produced water may contain a variety of constituents incompatible with many proposed reuses. Often, the water's consistency and toxicity levels are unknown

340. *Id*.

341. *Id*.

342. *Id*.

343. *Id*.

344. *See* U.S. ENV'T PROT. AGENCY, *supra* note 6, at ES-42.

345. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 97.

346. *Id*. ("Designing an appropriate treatment train will play a vital role in reducing potential risks to health and the environment."). Risk-based decision-making includes research, risk assessment, and risk management. *Id*. at 98.

347. Pichtel, *supra* note 24, at 10, 12.

for one or more receptors.[348] "The identity and concentration of these chemicals, their transformation products, and chemicals in produced water would be needed to characterize how chemicals associated with hydraulic fracturing activities move through the environment and interact with the human body."[349]

A series of evaluative steps should be followed to adopt fit-for-purpose standards to ensure the safe reuse of produced water. Information to consider includes the proximity of nearby water bodies and aquifers, the potential for human contact, and the risk to species, particularly if federally protected animals or their habitats may be affected.[350] Once the source water and the toxicity values for potential receptors are better understood, states must assess the exposure pathways for a desired reuse based on a location-specific inquiry.[351] When an accurate risk determination is not possible due to significant data gaps, the proposed reuse should be denied.[352]

Risk is a function of toxicity and the frequency and magnitude of human and ecological exposure.[353] Impacts from constituents of concern can be mitigated through a combination of treatment and reduction of exposure pathways.[354] Reuse options with numerous exposure pathways should only be allowed when significant treatment has been performed and water quality is high.[355] In contrast, when only minimal treatment is available, uses should be limited to those with fewer exposure risks.[356] Pilot projects, like those discussed in New Mexico and Texas, are important tools in understanding the impacts of reuse in a controlled environment. Once states have the necessary data, standards tailored to the type of reuse and based on the environmental and health goals can be proposed.[357] In addition to numeric standards,

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348. *See* U.S. ENV'T PROT. AGENCY, *supra* note 6, at ES-45.

349. *Id*.

350. *See* Hagstrom, *supra* note 43, at 131.

351. *Id*.

352. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 103. *See* discussion *infra* Part III.

353. U.S. ENV'T PROT. AGENCY, *About Risk Assessment*, https://www.epa.gov/risk/about-risk-assessment. Risk is "harmful effects to human health or to ecological systems resulting from exposure to an environmental stressor." *Id*.

354. *See* GROUNDWATER PROT. COUNCIL, *supra* note 272, at 32 ("The exposure effects of additives that can be contained in the treatment fluids can be mitigated by reducing exposure pathways.").

355. *See id.* (explaining that impacts from exposure to additives can be reduced by minimizing exposure pathways).

356. *See* GROUNDWATER PROT. COUNCIL, PRODUCED WATER REPORT 3 (2019) (advocating a fit-for-purpose analysis to avoid risks).

357. *See* Hagstrom, *supra* note 43, at 131.

narrative limitations for land application at the state level should be included to minimize harm. These include prohibiting the pooling of treated water and runoff into naturally occurring surface water bodies, especially small ponds and playa lakes which attract birds and other wildlife and can concentrate toxicity.

New Mexico's prioritization of science and data gathering before permitting provides a good model for a health-protective process.[358] There, the state environmental agency has clearly stated that no permitting will begin until a full assessment of potential impacts has been completed.[359] New Mexico is formally partnering with academic partners as well as federal agencies to identify and fill data gaps related to jurisdiction, source water chemistry, and toxicity values.[360] Oklahoma is also focused on identifying and characterizing risks to ensure protection of the environment and public health.[361] Effective research requires time to develop appropriate risk-based, fit-for-purpose standards. In the meantime, states wishing to move forward with reuse should prioritize low-risk options in response to water shortages.

C. *Prioritize Lower-Risk Reuse Options*

Many advocates for beneficial reuse are urging utilization of the water sooner rather than later.[362] One alternative is the prioritization of lower-risk options, including reuse in oil and gas, energy production, or other similar industries. This alternative recognizes the potential of produced water to alleviate freshwater challenges while continuing to protect human health and the environment.

In the energy sector, recycling water is not new and has increased nationally over the last few years.[363] Accurate numbers related to the quantity of recycled produced water are often unknown due to reporting gaps; however, some estimates report as much as forty-five percent of produced water is reused within conventional oil and gas operations for enhanced recovery, although quantities appear to vary

358. *See* discussion *supra* Part IV.B.3.

359. Roose et al., *supra* note 242, at 16.

360. *See* discussion *supra* Part IV.B.3.

361. *Oklahoma Report*, *supra* note 300, at v, 6-2.

362. *See* GROUNDWATER PROT. COUNCIL, *supra* note 15, at 123. "[T]he desire to use treated produced water . . . in lieu of disposal is understandable, the regulations or guidelines currently in place to ensure that the range of potential uses can safely achieved may be limited. Decision-makers . . . need to weigh potential benefits and risks." *Id*.

363. *See* GROUNDWATER PROT. COUNCIL, *supra* note 272, at 70 (noting the trend to more recycling and reuse in Pennsylvania, Texas, Ohio, and New Mexico).

based on location.[364] A Texas report stated that recycling and reuse comprised less than one to five percent of the Texas water management market, while some estimates are slightly higher.[365] These estimates demonstrate an underutilized capacity to reuse water in EOR.[366] Reuse water can be utilized to drill new wells and in hydraulic fracturing operations, although the ratio of injected fluid that is reused will vary based on regional chemistry.[367]

Reuse by the oil and gas industry is the best option from both a cost and risk standpoint. Recycled water avoids disposal, reducing costs and seismicity problems associated with traditional injection disposal.[368] Reuse in this sector also reduces the quantity of fresh water needed to drill and complete operations at new wells. Produced water is often co-located or within close proximity of the area where it is needed, reducing transportation costs and environmental and liability risks associated with spills.[369] Because of the low water quality needed for this purpose, as compared to other proposed uses, extensive and costly treatment is not needed.[370] This option is also most protective of human health and the environment because it minimizes contact with receptors. Industry reuse makes beneficial use of the water while other potential use options are being evaluated.

Lawmakers may consider incentivizing oil and gas reuse practices to bridge any financial gaps and avoid unintended consequences that may occur by leaving planning entirely up to the market.[371] Treatment for industry reuse can be costly and companies have an obligation to their shareholders to make prudent economic decisions.[372] Although the sale of water for use in other sectors may seem more profitable, this income does not internalize the potential risk externalities of reuse,

364. Blythe Lyons, et al., *Sustainable Produced Water Policy, Regulatory Framework, and Management in the Texas Oil and Natural Gas Industry: 2019 and Beyond*, TEX. ALL. OF ENERGY PRODUCERS (Sept. 23, 2019), https://texasalliance.org/executive-summary-sustainable-produced-water-policy-regulatory-framework-and-management-in-the-texas-oil-and-gas-industry-2019-and-beyond/.

365. Lyons et al., *supra* note 364, at 13.

366. *See* GROUNDWATER PROT. COUNCIL, *supra* note 15, at 9; Lyons, et al., *supra* note 364, at 13.

367. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 9; U.S. ENV'T PROT. AGENCY, *supra* note 6 at ES-14.

368. *See* GROUNDWATER PROT. COUNCIL, *supra* note 272, at 69 (noting that fluid recycling and reuse tends to lower cost in some cases).

369. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 9–10; Scanlon, *supra* note 30, at 2.

370. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 9–10; Scanlon, *supra* note 30 at 2.

371. *See* GROUNDWATER PROT. COUNCIL, *supra* note 15, at 44–45.

372. *Id*. at 30.

including loss of freshwater resources and environmental risks associated with other reuse alternatives. Financial incentives that protect freshwater for use in other sectors may be worthwhile in some areas.[373]

Prioritization of produced water reuse at or near the wellhead has already been considered by some states and companies. "Today, most mid and larger sized producing companies have corporate goals to reduce sourcing from fresh water, leaving more fresh water for agriculture, human consumption, aquatic life, and other industries."[374] Several states are doing the same. Colorado's legislation requires that rules be promulgated that require increased usage of recycled or reused produced water and corresponding reduction of freshwater use at oil and gas locations.[375] Oklahoma also concluded that reuse for oil and gas was the most viable and cost-effective option.[376] Limiting reuse in this way recognizes that produced water is initially a waste. Considerations of use in different areas with higher exposures requires additional scrutiny.

D. *Rethinking the RCRA Exemption*

A transition away from disposal towards beneficial reuse also triggers a categorization change of the water from a waste to a commodity. This shift prompts an evaluation of potential policy and regulatory implications of this redesignation.[377] Regulatory decisions related to waste disposal predate the widespread production of shale gas and any contemplation that the resulting wastewater might be utilized in other sectors. Because widespread consideration of these uses is recent, it is unclear how existing rules might apply in reuse situations.[378]

The primary federal law regulating waste disposal is the RCRA.[379] The goal of the law is to provide effective cradle-to-grave management

373. Lyons et al., *supra* note 364, at 19. In 2019, legislation was introduced in Texas to provide tax credits for documented produced water provided for aquifer storage and recovery. H.B. 3717, Reg. Sess. (Tex. 2019). The bill was left pending in committee.

374. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 40.

375. H.B. 1242, 74th Gen. Assemb., Reg. Sess. (Col. 2023).

376. Oklahoma Report, *supra* note 300, at iii–iv.

377. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 21.

378. *Id*. at 20–21.

379. U.S. ENV'T PROT. AGENCY, *Summary of the Resource Conservation and Recovery Act*, https://www.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act#:~:text=The%20Resource%20Conservation%20and%20Recovery%20Act%20(RCRA)%20gives%20EPA%20the,of%20non%2Dhazardous%20solid%20wastes.

of solid and hazardous waste that is protective of human health and the environment.[380] The 1976 law provided authority to the EPA to promulgate rules for the generation, transportation, treatment, storage, and disposal of qualifying wastes.[381] In 1988, the EPA codified rules on oil and gas production wastes, including produced water, to exempt them from RCRA requirements.[382] Without this exemption, most produced water would be subject to permitting and disposal obligations consistent with Subtitle C hazardous waste regulations.[383] An exemption was seen as necessary by industry to avoid a chilling effect on production created by the additional time and expense associated with regulatory waste disposal.[384] The EPA supported its decision with an assessment that state regulations related to disposal were sufficient to protect human health and the environment.[385] Unfortunately, the UIC and NDPES programs, on which the EPA relied, only apply to produced water reuse in a very limited capacity, if at all.[386]

Although environmental groups have called for the revocation of the exemption, operators have expressed apprehension about any potential changes.[387] Industry concerns may be appropriate for waste management, but it is questionable as to how the exemption should apply outside that context. Commonly cited advantages to beneficial reuse are avoided costs and other logistical issues, including limited storage and seismicity; however, reuse also provides the opportunity for additional revenue as this water is purchased and used by a new end

380. *Id*.

381. *Id*.

382. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 20; 40 C.F.R. § 261.4 (b)(5).

383. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 20.

384. *Id*. at 20–21; Lyons et al., *supra* note 364, at 29.

385. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 21; U.S. ENV'T PROT. AGENCY, *Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes*, 53 Fed. Reg. 25447 (July 6, 1988), https://archive.epa.gov/epawaste/nonhaz/industrial/special/web/pdf/og88wp.pdf. The EPA based their adoption of the oil and gas waste exemption on a 1987 report to congress chronicling their research data. *See* U.S. ENV'T PROT. AGENCY, *Management of Wastes from the Exploration, Development, and Production of Crude Oil, Natural Gas, and Geothermal Energy*, 1-1-1-2 (Dec. 1987) https://archive.epa.gov/epawaste/nonhaz/industrial/special/web/pdf/530sw88003a.pdf. Unfortunately, this study far predates the widespread use of hydraulic fracturing and did not contemplate this type of exploration or its resulting waste stream. *See* Lyons, et al., *supra* note 364, at 29.

386. *See* discussion *supra* Part IV.A.1.a-b. Class II disposal wells are not subject to any water quality requirement. GROUNDWATER PROT. COUNCIL, *supra* note 15, at 27.

387. Lyons et al., *supra* note 364, at 29.

user.[388] This distinction changes the analysis by moving water into the public sphere and should affect which regulations apply.

Beneficial reuse should not be permitted for untreated or inadequately treated water with hazardous constituent levels that would, under non-exemption conditions, trigger RCRA regulations.[389] Because the RCRA exemption was partially based on an assessment that waste would be managed in a safe manner, the lack of protections for non-disposal purposes increases risks during the produced water reuse lifecycle. As more water is transported away from wells to treatment facilities in preparation for reuse, operators are obligated by the cradle-to-grave safeguards that RCRA intended to provide. It is antithetical to claim that produced water is part of the solution to fresh water scarcity challenges while still enjoying a regulatory exemption that presupposes a hazardous waste designation.[390] While a retraction of the waste disposal exemption may not be warranted, clarifications and protections for beneficial reuse are appropriate.

VI. CONCLUSION

Oil and gas production requires water for drilling and exploration while also producing large amounts of water as a byproduct. Growing water resource challenges, particularly in the American West, have prompted policymakers to rethink the traditional paradigm of waste disposal through deep injection wells. Several states are considering a transition away from disposal of produced water towards treatment and beneficial reuse. This approach might alleviate water challenges and lessen disposal problems such as by limited space and seismicity, but it is not without risk. While produced water should be considered as a potential water resource, reuse should proceed with caution.

Repurposing produced water without a proper understanding of risks associated with its use could have serious negative impacts on human health and the environment. Produced water contains a myriad of chemicals and metals, but significant gaps in regulations, data, and reporting exist at the state and federal levels. There are also considerable unknowns related to the exact composition of the water and constituent toxicity levels. Before produced water is reused, it must be properly studied and risk classified, and exposure pathways should be mapped for each type of reuse. Toxicity studies must be completed

388. *See* Scanlon, *supra* note 30, at 2.

389. *See* 40 C.F.R. § 261.4 (b)(5).

390. *Compare* Lyons et al., *supra* note 364, at 19, *with id*. at 29.

to understand the benchmark exposures for constituents the water may contain even after treatment. Once these data gaps have been filled, regulations should be promulgated that set exposure standards for each specific reuse based on the exposure risk analysis and lower risk, reuse alternatives should be prioritized. Moving forward with beneficial reuse of produced water without first understanding the potential impacts may solve one problem while creating many more.