The Fragile Future of Aquifer Storage and Recovery

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TABLE OF CONTENTS

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I. INTRODUCTION

Buda, Texas—a small town that lies between Austin and San Antonio, on the banks of Onion Creek and above the Edwards Aquifer—is perhaps best known, though it is not particularly well known, as the "Wiener Dog Capital of Texas."[1] Buda's claim to this title is based upon its annual dachshund races, which are opposed by the Dachshund Club of America but lauded by locals, tourists, and the international press as an "event that combines the pageantry of the Kentucky Derby and the excitement of NASCAR with dachshunds, animals known for their small stature."[2] Buda is certainly unusual in relying so heavily upon dachshunds for tourism revenue, but wiener dogs aside, Buda has much in common with other American communities, especially those in many western and some southern states.

For example, as part of the fastest growing county in Texas, Buda has seen explosive growth of more than 80% in the last decade[3]—growth that has taxed many civic and natural resources, including the community's water supply. And like many fast growing American communities, Buda's residents and businesses have had to reckon with the stresses of development on dwindling water supplies while also confronting the impacts of climate change[4] and recent extreme weather events.[5]

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1. *E.g.*, BUDA LIONS CLUB, budalions.com [https://perma.cc/7Z46-RGLU] (listing, inter alia, local wiener dog-friendly lodging information and providing links to photos of past competitions).

2. Moses Leos III, *20 Years Strong: Wiener Race Success Grows from Short Scamper to National Event*, HAYS FREE PRESS NEWS-DISPATCH (May 3, 2017), https://haysfreepress.com/2017/05/03/20-years-strong-wiener-race [https://perma.cc/HR68-8MKJ]; *see also Dachshund Racing: Dogs in a Hurry*, ECONOMIST (Apr. 30, 2009), https://www.economist.com/united-states/2009/04/30/dogs-in-a-hurry [https://perma.cc/2JE2-ULCF] (describing the event and noting the Dachshund Club of America's opposition).

3. Kalyn Norwood, *Boomtown: Kyle and Buda Grow More Than 80 Percent as Austin's Growth Spills Over*, KVUE (Jan. 7, 2019, 11:47 AM), www.kvue.com/article/news/local/boomtown-kyle-and-buda-grow-more-than-80-percent-as-austins-growth-spills-over/269-614326404 [https://perma.cc/LRE3-KANZ].

4. *E.g.*, Forrest Wilder, *What Climate Change Means for Texas in 11 Charts*, TEX. OBSERVER (May 8, 2014, 3:15 PM), https://www.texasobserver.org/climate-change-means-texas-11-charts [https://perma.cc/T9DJ-P8KD].

5. *See* JJ Velasquez, *Hays County Begins Recovery After Flooding Damages Public Property, Roads*, COMMUNITY IMPACT (Apr. 27, 2015, 3:14 PM), https://communityimpact.com/austin/news/2013/11/18/hays-county-begins-recovery-after-flooding-damages-public-property-roads [https://perma.cc/Y9FN-GMML].

These factors led Buda's residents, nearby academic institutions, interested businesses, and local and state officials to explore an engineered solution to intensifying cycles of drought and flood and Buda's steadily decreasing supply of freshwater.[6] More specifically, in 2019 Buda implemented a pilot "aquifer storage and recovery" program—a controversial water storage technique that is rapidly growing in popularity around the country.[7] In essence, aquifer storage and recovery is a technique that communities can use in order to capture excess surface water at times of relative abundance, treat this water on the surface to drinking water standards, and then inject it underground for storage so that it can be withdrawn during future water shortages.[8]

Here, too, Buda has much in common with communities elsewhere in Texas,[9] as well as in Colorado,[10] Oklahoma,[11] and several other states.[12] In these jurisdictions, state legislatures, state agencies, and local governments have reformed state water laws, altered local land use controls, revised procedures for obtaining water permits, and taken a variety of other actions in order to make projects like Buda's more commonplace.[13] And federal

6. *See* Yoojin Cho, *Saving Storm Water to Manage Flood and Drought? Researchers Say It's Possible*, KXAN (May 14, 2019, 3:38 AM), www.kxan.com/news/local/austin/saving-storm-water-to-manage-flood-and-drought-researchers-say-its-possible [https://perma.cc/ZU7R-59R8].

7. Katherine Jose, *Buda Aquifer Storage Bill Signed into Law; Effective Immediately*, COMMUNITY IMPACT NEWSPAPER (June 28, 2019, 10:54 AM), https://communityimpact.com/austin/san-marcos-buda-kyle/editors-pick/2019/06/28/buda-aquifer-storage-bill-signed-into-law-effective-immediately [https://perma.cc/46BW-LT2Z].

8. *Id.*

9. *See, e.g.*, H.B. 655, 84th Leg., Reg. Sess. (Tex. 2015) (amending, inter alia, section 11.153(b) of the Texas Water Code to streamline the approval process for aquifer storage and recovery projects).

10. *See, e.g.*, H.B. 18-1199, 71st Gen. Assembly, 2d Reg. Sess. (Colo. 2018) (adding section 37-90-107.6 of the Colorado Revised Statute, which authorized the state Groundwater Commission to create rules for the approval and regulation of aquifer storage and recovery plans); COLO. WATER CONSERVATION BD., COLORADO'S WATER PLAN: COLLABORATING ON COLORADO'S WATER FUTURE, at 6-27, 6-129, 6-155, 9-44, 10-4, 10-5, H-11 (2015), https://drought.unl.edu/archive/plans/Water/state/CO_2015.pdf [https://perma.cc/LYN6-B2GH] (discussing the need for and efforts to support ASR projects in Colorado).

11. *See, e.g.*, OKLA. ADMIN. CODE §§ 785:32-3-2, :32-3-5, :32-3-6, :32-3-7, :32-5-2, :32-5-3 (2019) (enacting new rules by which the Oklahoma Water Resources Board can approve and regulate aquifer storage and recovery projects).

12. *See infra* notes 42, 179–94, 302 and accompanying text (discussing recent revisions to California's ASR controls and recent California ASR projects).

13. *See infra* Parts II, IV (discussing respectively the history of and the law governing aquifer storage and recovery projects).

agencies are now beginning to encourage aquifer storage and recovery as a way to mitigate the risks posed by increased development, recurring drought, and climate change.[14]

Such efforts to store excess surface water underground—whether they are at the pilot stage, as in Buda, or whether they have been part of local and statewide water planning for decades, as in many parts of California, Florida, and other states[15]—fit a larger pattern. In the past decade, water shortages and extreme weather events have put new pressures on American water law and water storage techniques.[16] In response, regulators, legislators, and the popular press have frequently and increasingly touted the merits of underground storage of excess surface water to address the pressures on existing water supplies and to mitigate the damage caused by flooding events.[17]

Artificial groundwater recharge techniques, including the aquifer storage and recovery approach adopted by Buda, have particular appeal in regions where low precipitation rates, impermeable surface geology, or both limit the rate of natural aquifer recharge. This includes many states in the American south and west, where slowly recharging aquifers filled with prehistoric groundwater represent a precious inheritance that has, until recently, seemed impossible to replace.[18] To continue the analogy, if such aquifers are an inherited resource, and if precipitation and the resultant surface water flow represent current income, then artificial recharge techniques can be compared to retirement accounts, which prudent water users can build up in the present against future uncertainty and, perhaps, for future generations.[19]

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14. *E.g.*, FED. EMERGENCY MGMT. AGENCY, FACT SHEET: AQUIFER STORAGE AND RECOVERY (2017), www.fema.gov/media-library-data/1487160966426-3774ec4315295499f45a25bc8915c90/ASR_Fact_Sheet_Feb2017_COMPLIANT.pdf [https://perma.cc/RXE7-3FPB].

15. *See infra* Part II (discussing the history of aquifer storage and recovery in the United States, including projects that run back decades in California, Florida, and other states).

16. *See, e.g.*, Tim Gray, *As Fresh Water Grows Scarcer, It Could Become a Good Investment*, N.Y. TIMES (July 11, 2019), https://www.nytimes.com/2019/07/11/business/fresh-water-shortage-invest.html [https://perma.cc/AUE2-2QR7]; *see also* Jesse Reiblich & Christine A. Klein, *Climate Change and Water Transfers*, 41 PEPP. L. REV. 439, 442, 478–508 (2014) (providing a survey of state water allocation law and efforts to ensure adequate water supply in the face of climate change).

17. *See, e.g.*, Mark Gold, Opinion, *Making Los Angeles Completely Water Self-Sufficient Won't Be Easy or Cheap. But It Can Be Done*, L.A. TIMES (Mar. 19, 2018, 4:15 AM); Katie Riordan, *Hurricane Harvey Sparks Renewed Push for Underground Water Storage Projects*, TEX. TRIB. (Oct. 18, 2017, 12:00 AM) (quoting Texas legislators arguing for more aquifer storage and recovery projects based on recent severe storms in the state).

18. DAVID OWEN, WHERE THE WATER GOES: LIFE AND DEATH ALONG THE COLORADO RIVER 157–58 (2017).

19. *See id.*

These efforts are crucial because many communities in the United States are running out of groundwater at increasing rates and without an alternative supply in sight.[20] This means that without dramatic decreases in consumption or some new system of water savings, many parts of the United States will face unprecedented water shortages in the coming years.[21] To complete the analogy, without substantial increases in water savings through techniques like artificial recharge, there will be nothing left in the relevant accounts for many U.S. communities, which have been treating their groundwater supplies "like a spendthrift with lackluster accounting skills."[22]

Most readers will already know that an aquifer is nothing more than an area of permeable underground cracks and spaces through which groundwater can move and rest, and that when water seeps down through surface precipitation to fill empty spaces in an aquifer, the aquifer is said to be "recharging."[23] The catchall term "artificial groundwater recharge" applies to any human action designed to increase the water that naturally enters an aquifer, and it will frequently be referred to in this Article as simply "artificial recharge." Artificial recharge can refer to traditional tools for recharging aquifers, such as canals drawn over porous surface spaces or irrigation furrows cut through impermeable surface areas.[24] But artificial recharge can also refer to the injection of water from the surface directly into an aquifer through pump and well systems.[25] Similarly, managed aquifer recharge (MAR), a term once used more frequently outside the United States but increasingly used within this country, covers a broad array of human efforts to replenish groundwater, ranging from simple surface trenches to injection wells.[26]

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20. Andrew Amelinckx, *Even Without a Drought, We're Depleting Groundwater at an Alarming Pace*, MOD. FARMER (July 30, 2015), https://modernfarmer.com/2015/07/ogallala-aquifer-depletion [https://perma.cc/RUP9-KW8A].

21. *See, e.g.*, *id.*

22. *See, e.g.*, *id.* (relying upon Kevin Dennehy, then-groundwater resources program coordinator at the United States Geological Survey, to complete the analogy discussed above).

23. U.S. GEOLOGICAL SURVEY, OPEN FILE REPORT NO. 93-643, WHAT IS GROUND WATER? 1 (2019), https://pubs.usgs.gov/of/1993/ofr93-643/pdf/ofr93-643.pdf [https://perma.cc/9FDF-76HK].

24. *Artificial Groundwater Recharge*, U.S. GEOLOGICAL SURV., https://water.usgs.gov/ogw/artificial_recharge.html [https://perma.cc/V8UZ-VRNH].

25. *See id.*

26. *E.g.*, WILLIAM M. ALLEY & ROSEMARIE ALLEY, HIGH AND DRY: MEETING THE CHALLENGES OF THE WORLD'S GROWING DEPENDENCE ON GROUNDWATER 167 (2017).

As suggested above, much of the recent interest in artificially recharging aquifers in the United States has been fueled by recent periods of extreme drought punctuated by short periods of relative abundance—and, sometimes, dramatic surface flooding—across many regions of the country.[27] These extreme weather events have focused attention around the country on diminishing groundwater resources in recent years.[28] Most obviously, in places where the local water cycle has been marked by severe droughts, people have begun to recognize that short and unusually intense bursts of abundant surface water supply present opportunities to replenish not only surface reservoirs but also depleted aquifer levels.[29] Indeed, some residents of traditionally drought-stricken states argue that even the most damaging surface flooding events can provide opportunities to recharge depleted aquifers, viewing every drop of floodwater that is not diverted underground or stored aboveground as a wasted opportunity.[30]

Moreover, artificial groundwater recharge techniques offer obvious advantages to surface reservoir storage in relatively hot and dry areas, even beyond their potential to help manage intensifying cycles of drought and flood. Surface reservoirs frequently lose substantial stored water to evaporation, especially in hot and dry places; moreover, surface reservoirs frequently involve significant construction costs and disruption to both built and natural environments.[31] In contrast, where suitable aquifer storage space is present, artificial recharge projects can be far more efficient, they

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27. *See, e.g.*, MARK ARAX, THE DREAMT LAND: CHASING WATER AND DUST ACROSS CALIFORNIA 92–94 (2019) (describing the interaction of flood and drought as motivating factors behind artificial recharge efforts in California's San Joaquin Valley).

28. *E.g.*, *id.*

29. Bridget R. Scanlon et al., *Enhancing Drought Resilience with Conjunctive Use and Managed Aquifer Recharge in California and Arizona*, 11-035013 ENVTL. RES. LETTERS 1, 1 (2016), https://iopscience.iop.org/article/10.1088/1748-9326/11/3/035013/pdf [https://perma.cc/NT9X-RBRS].

30. *See, e.g.*, Mihir Zaveri, *Harris County Eyes Putting Water to Better Use After Recent Floods*, HOUS. CHRON. (Apr. 24, 2017, 10:15 PM), https://www.houstonchronicle.com/news/science-environment/article/Harris-County-eyes-putting-water-to-better-use-11095900.php [https://perma.cc/X254-FDBG]; *see also* Jim Carlton, *Rains Expose a New Water Problem in California: Storage*, WALL ST. J. (Mar. 6, 2017, 4:20 PM), https://www.wsj.com/articles/rains-expose-a-new-water-problem-in-california-storage-1488835216 [https://perma.cc/TL7L-HQG9] (noting that recent floods in California have sparked interest in water infrastructure investment including both surface reservoirs and artificial recharge projects).

31. *See, e.g.*, Noah S. Diffenbaugh, *What California's Dam Crisis Says About the Changing Climate*, N.Y. TIMES (Feb. 14, 2017), https://www.nytimes.com/2017/02/14/opinion/what-californias-dam-crisis-says-about-the-changing-climate.html [https://perma.cc/AU39-V9MV] (arguing that increased demand, climate change, and aging dams and surface reservoirs require "build[ing] infrastructure that enables us to use excess runoff to recharge groundwater aquifers"); Zaveri, *supra* note 30 (comparing recent plans for artificial recharge in and around Houston to models from California's Central Valley, Florida, and Washington).

are frequently cheaper to construct, and they may create far less environmental disruption than surface projects with similar capacity.[32]

In contrast to the catchall terms of artificial recharge and MAR, the term "aquifer storage and recovery" (ASR)—the approach to water storage and recovery recently chosen by Buda and the principal subject of this Article—is much more specific, picking out a particular set of "unorthodox" techniques for storing excess surface water underground.[33] ASR seems unusual to many because, unlike many forms of artificial recharge that rely, at least in part, on natural filtration processes to clean and transfer excess water from the surface to storage space in an aquifer,[34] ASR systems directly inject treated water into an aquifer for storage.[35] And unlike other forms of artificial recharge that may also rely on direct injection through wells drilled into aquifers, ASR systems are built both to store *and recover* available water *in the same surface location*, frequently in the short- or medium-term future.[36] ASR systems accomplish this by using the same well systems—often referred to as "dual-use" well systems—for both injection of treated surface water and recovery of water stored in the aquifer.[37] The dual-use nature of ASR wells, and the opportunity for relatively short-term storage and recovery times that such wells provide, are what differentiate ASR

32. *See* Diffenbaugh, *supra* note 31.

33. Robert Glennon & Clark Taylor, *Desalination Versus Duct Tape: (Dis)Incentives to Securing Water Supplies*, 108 J. AM. WATER WORKS ASS'N 56, 56 (2016).

34. Although ASR seems unorthodox to many in this country, in other parts of the world it is more widely accepted. ASR's greater acceptance beyond the United States, its history within the United States, and its relationship to other forms of artificial recharge will be discussed at greater length in Part II.

35. *What Is Aquifer Storage & Recovery?*, U.S. GEOLOGICAL SURV. (Jan. 15, 2013, 12:44 PM), https://sofia.usgs.gov/sfrsf/rooms/hydrology/ASR [https://perma.cc/5NRC-E2M9]. More specifically, the United States Geological Survey (USGS) defines ASR as "a water-storage technology" involving "storage of available water through wells completed into aquifers, with subsequent retrieval from these same wells during dry periods." *Id*.

36. Frederick Bloetscher et al., *Lessons Learned from Aquifer Storage and Recovery (ASR) Systems in the United States*, 6 J. WATER RESOURCE & PROTECTION 1603, 1604 (2014).

37. *See id.*; Claudia C. Faunt, *Aquifer Storage and Recovery*, U.S. GEOLOGICAL SURV., https://www.usgs.gov/centers/ca-water/science/aquifer-storage-and-recovery?qt-science_center_objects=0#qt-science_center_objects [https://perma.cc/BCY3-5T36] (noting that artificial recharge and conjunctive use are catchall and interchangeable terms that "do[] not necessarily imply the active water storage activities used in ASR").

systems from other forms of artificial recharge, even those that also involve injection wells for water storage.[38]

ASR is also unorthodox from a legal perspective—at least under American water law—because the potential for relatively short-term storage and retrieval of excess surface water in available aquifer space challenges the long-standing and problematic division between surface water rights and groundwater rights present in many American jurisdictions.[39] Other types of artificial recharge projects that involve natural filtration processes often have years- or decades-long horizons. Indeed, in some artificial recharge projects, the primary purpose of diverting excess surface water underground is to prevent saltwater intrusion, to prevent subsidence, or to address other side effects of a depleted aquifer, rather than storage for specific future uses or users.[40] Such projects take on the character of public infrastructure projects, with costs and rights to store and recovery shared broadly or channeled through utilities, and with recovery rights—if they are at issue at all—so widely dispersed or mixed in with broader access rights to the groundwater supply as to be relatively uncontroversial.[41]

But the time frame for retrieval of aquifer-stored water in an ASR project is usually intended to be much shorter, and the beneficiaries of stored water rights in an ASR project are usually more tightly defined than in many artificial recharge projects. After all, the prospect of removing stored water from an aquifer relatively quickly and cheaply is part of ASR's appeal, and many ASR projects are confined to a specific community or town rather than a larger region.[42] As a result, figuring out property rights in surface water and

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38. *See* Faunt, *supra* note 37; *see also* Bloetscher et al., *supra* note 36, at 1604 (noting that ASR projects "are different from the other aquifer storage strategies because the associated injection and recovery wells are generally the same wells").

39. For a short introduction to the foundations of American groundwater law and the connection between these foundations and out-of-date scientific theories, see Zachary Bray, *Texas Groundwater and Tragically Stable 'Crossovers*,*'* 2014 BYU L. REV. 1283, 1290–92. For a short introduction to the diversity of American groundwater law across various states and the fractured nature of groundwater and surface water law, see generally ROBERT W. ADLER, ROBIN KUNDIS CRAIG & NOAH D. HALL, MODERN WATER LAW: PRIVATE PROPERTY, PUBLIC RIGHTS, AND ENVIRONMENTAL PROTECTIONS 215–79 (2d ed. 2018).

40. *See, e.g.*, Katja Luxem, *Managed Aquifer Recharge in California*, AM. GEOSCIENCES INST. (Sept. 2017), https://www.americangeosciences.org/geoscience-currents/managed-aquifer-recharge-california [https://perma.cc/9CE4-YRHE] (describing subsidence prevention and saltwater intrusion, as well as water storage, as goals of MAR projects in Silicon Valley and Orange County).

41. *See id.*

42. *Compare* Jose, *supra* note 7 (describing ASR project in Buda, Texas), *and* Christian E. Petersen & Kenneth Glotzbach, *Aquifer Storage and Recovery for the City of Roseville: A Conjunctive Use Pilot Project*, WATER ENV'T FED'N TECHNICAL EXHIBITION & CONF. 8634, 8634–35 (2005) (describing an ASR project in the city of Roseville,

groundwater that have passed through an ASR system is particularly important. Unfortunately, figuring out such rights can be complicated, especially given the fractured nature of legal regimes for surface and groundwater in much of the United States: American water law was formed by an antiquated understanding of the hydrologic cycle, and as a result states have traditionally had separate legal systems for surface water and groundwater rights.[43] For example, in many states, it has been difficult to protect an ASR operator's legal rights to treated surface water once it is injected into an aquifer, which obviously undermines the viability of such projects.[44]

Despite the "unorthodox" technical and legal questions ASR poses, it offers many advantages over surface storage and even other forms of artificial recharge. First, ASR can be used where surface storage or other methods of artificial recharge are not viable—for example, in places where surface evaporation rates are very high, or where impermeable subterranean barriers exist between the aquifer and the surface.[45]

Second, ASR systems involve a relatively small surface footprint compared to surface dam and reservoir systems as well as artificial recharge systems that involve large surface recharge basins.[46] The relatively small size and scalability of ASR projects can provide greater flexibility than surface systems for water managers and local planners as they design and implement water storage projects, and it can also substantially reduce the system's cost as well as the disruption to the surface environment.[47]

California), *with* Luxem, *supra* note 40 (describing MAR projects over large California water districts).

43. *See* Bray, *supra* note 39, at 1290–94; *see also* Melissa K. Scanlan, *Droughts, Floods, and Scarcity on a Climate-Disrupted Planet: Understanding the Legal Challenges and Opportunities for Groundwater Sustainability*, 37 VA. ENVTL. L.J. 52, 78–79 (2019) (describing some of the past difficulties associated with establishing property rights in aquifer-stored water in a number of western states). The challenging nature of establishing recovery rights in water that passes through ASR systems will be discussed in more detail in Part III.

44. *See generally, e.g.*, Scanlan, *supra* note 43 (discussing, inter alia, the difficulties associated with determining ownership of water stored in aquifers based on the potential multiplicity of overlying landowner claims, and the conflict between overlying landowners and water storers). The challenging nature of establishing recovery rights in water that passes through ASR systems will be discussed in more detail in Parts III and IV.

45. Danielle Kalisek, *Is It Time for Texas To Welcome ASR?*, 9 TXH2O 10, 10–12 (2014).

46. *See* Bloetscher et al., *supra* note 36, at 1604 (noting, among other benefits, that the dual-purpose injection wells in ASR systems may allow communities to size infrastructure like treatment plants for average conditions rather than seasonal fluctuations).

47. *Id.*

Third, the relative accessibility of storing treated water in aquifers through dual-use wells means that ASR systems essentially combine many of the benefits of both surface reservoir systems and other artificial recharge systems.[48] In other words, at least in theory, it should be relatively easy to get water out of an ASR system, just as it is relatively easy to get water out of a surface reservoir—but at the same time ASR offers a way around the high costs, evaporation loss, and environmental disruption associated with surface storage. As a result, advocates for the increased use of ASR suggest that it may be uniquely well-suited to improve the "conjunctive management" of water resources—an approach to managing water resources in a way that recognizes the hydrologic connection between water on the surface and water underground.[49]

The combination of these potential advantages of cost, size, scalability, ease of retrieval, efficiency of storage, and diminished impact on the surface environment work together to give ASR systems a straightforward and powerful appeal.[50] At first blush, ASR can look like a silver bullet to a host of related and serious water supply and environmental problems.[51] But there is something "deceptively simple" about this appeal: the basic idea can be explained very quickly, but the legal and technical aspects of ASR are complicated and involve real drawbacks.[52] As a result, ASR deserves closer scrutiny, and it deserves to be scrutinized on its own, rather than as part of a larger portfolio of potential water storage techniques, which is how it has been covered in the legal academic literature to date.

The importance of taking a close and hard look at ASR specifically is underlined by the terminological confusion around ASR and artificial recharge. Part of the confusion around these terms is due to the fact that ASR has become somewhat faddish. As a result, the boosters of some artificial recharge projects that do not involve dual-use wells tout their projects as involving "ASR," even if they do not make use of dual-use wells; indeed, some boosters

48. *See* Barton H. Thompson, Jr., *Beyond Connections: Pursuing Multidimensional Conjunctive Management*, 47 IDAHO L. REV. 273, 308–09 (2011) (suggesting that in the future "ASR will often be an ideal means of off-loading the need to use a multi-purpose dam and reservoir for storage purposes").

49. *See id.*

50. *See, e.g.*, ROBERT W. ADLER, RESTORING COLORADO RIVER ECOSYSTEMS: A TROUBLED SENSE OF IMMENSITY 251–52 (2007) (arguing that "[r]eplacing some reservoirs with ASR projects" might reduce environmental problems and allow some water currently wasted to be reallocated to environmental restoration "without losing the ability to store water for human use in times of drought and during dry seasons of the year").

51. *See* SEAMUS MCGRAW, A THIRSTY LAND: THE MAKING OF AN AMERICAN WATER CRISIS 244–45 (2018).

52. *Id.* The potential drawbacks of ASR and the complicated state and federal legal environment for ASR projects will be explored in more detail in Parts III and IV.

slap an ASR label on projects even if they do not involve aquifer recharge at all.[53]

This terminological confusion is bad enough in its own right, but it also makes it even easier for the public to draw incorrect conclusions about fundamental aspects of ASR projects or to mistake ASR projects with very different sorts of activities. For example, in Denver, local officials and engineers associated with an ASR project had to emphasize repeatedly to concerned residents that "[t]his is not fracking," and that the drilling equipment and wells associated with the project were for storing and recovering water treated to drinking standards, rather than injecting chemicals for oil and gas exploitation.[54] In addition, the legacy of legal uncertainty about water rights associated with ASR has exacerbated public confusion and skepticism about ASR, even in jurisdictions that have recently changed the law to address this uncertainty. As one water manager has put it, without education the general public and even some water professionals may think that ASR is nothing more than taking "perfectly good potable water and dumping it down a hole in the ground" without any reasonable legal safeguards for its recovery from competing nearby groundwater users.[55] As will be shown in Part IV, some jurisdictions have lacked or may continue to lack these safeguards—but public skepticism about ASR exists even in jurisdictions where those issues are less pressing.

Some measure of public misunderstanding about many ASR projects is understandable and perhaps even predictable, especially in light of the terminological confusion about ASR specifically and artificial recharge more generally in both the academic literature and in some statehouses. But this confusion must be addressed if ASR projects are to become as widespread as ASR's many defenders hope. What is also required is a direct

53. *See, e.g.*, Robert Glennon, *Water Exchanges: Arizona's Most Recent Innovation in Water Law and Policy*, 8 ARIZ. J. ENVTL. L. & POL'Y, Summer 2018, at 1, 6 (describing one recent Arizona project, called an ASR program by its supporters, as involving "a bit of smoke and mirrors" and a "legal fiction").

Issues related to this terminological imprecision, and the ways in which various actors can and have exploited this imprecision and related legal ambiguities, will be explored at greater length in Parts III and IV below.

54. *See* Jay Adams, *Big Drilling Rigs in Denver: It's Not What You Think*, DENV. WATER (Nov. 1, 2016), https://denverwatertap.org/2016/11/01/big-drilling-rigs-denver-not-think [https://perma.cc/KB2C-X3TL] (attempting to address the top misconception about a recent ASR project in Denver).

55. Dave Rydman, *Lessons Learned from an Aquifer Storage and Recovery Program*, 104 J. AM. WATER WORKS ASS'N. 52, 57 (2012).

and honest reckoning with the many problems associated with ASR projects in many parts of the country over the past few decades—and to do this, it is necessary to consider ASR in some measure of isolation from other artificial recharge techniques.

These problems will be discussed in substantial detail in Parts III and IV below, but a short summary here will be useful. To begin, not every accessible aquifer with storage space is appropriate for ASR: some aquifers contain chemicals or minerals that are not suitable for consumption, and which can leach out of the solid material into the water as a result of the well drilling and injection processes.[56] Well clogging is also a recurring problem, which can be caused by mechanical failures, chemical or mineral contamination, or biological fouling, all of which can ruin both the specific ASR project as well as potentially contaminate portions of the underlying aquifer.[57] Legal uncertainty, both about recovery rights in properly stored water as well as liability for contamination of the underlying aquifer, is also a major problem that has prevented adoption of ASR in many jurisdictions and contributed to project abandonment in states where ASR has been tried.[58] Finally, much of the information about the performance of specific projects or even all ASR projects within particular jurisdictions is either incomplete or questionable, which means that it is difficult to assess how serious and how widespread the drawbacks surrounding some ASR projects have been and will continue to be.[59]

In sum, it is critical to examine ASR on its own, washing away the confusion surrounding its technical background, alleged benefits, potential downsides, related techniques, and above all its legal status.[60] In the legal academic literature, ASR has frequently been lumped together with other types of artificial recharge[61]—techniques that are far less risky, and which present

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56. *See* MCGRAW, *supra* note 51, at 245.

57. *See, e.g.*, FREDERICK BLOETSCHER, AM. WATER WORKS ASS'N, AQUIFER STORAGE AND RECOVERY 33–37 (2015) (suggesting that well clogging and subsequent abandonment may be the most significant recurring technical problem for ASR).

58. *See, e.g.*, Scanlan, *supra* notes 43, at 78–79, and accompanying text (outlining some issues caused by legal uncertainty around property rights associated with ASR); *see also infra* Part IV (gathering sources suggesting that legal uncertainty about both property rights and liability is the single greatest present problem associated with ASR).

59. *E.g.*, Sydney T. Bacchus et al., *Fractures as Preferential Flowpaths for Aquifer Storage and Recovery (ASR) Injections and Withdrawals: Implications for Environmentally Sensitive Near-Shore Waters, Wetlands of the Greater Everglades Basin and the Regional Karst Floridan Aquifer System*, 7 J. GEOGRAPHY & GEOLOGY 117, 123–24 (2015). The problems with the existing literature about ASR—particularly the legal and technical problems associated with some ASR projects—will be discussed at greater length at the outset of Part III.

60. *Cf., e.g.*, Thompson, *supra* note 48, at 295–96 (discussing ASR as one of many potentially valuable tools to enhance conjunctive management of surface and groundwater).

61. *See, e.g.*, Christina Hoffman & Sandra Zellmer, *Assessing Institutional Ability to Support Adaptive, Integrated Water Resources Management*, 91 NEB. L. REV. 805, 859–

less pressing technical and legal challenges. While ASR has been considered in isolation by scientists, engineers, the business community, and academics in other disciplines, this Article presents the first such sustained examination of ASR in the legal academic literature. And given how important—and how confusing—the legal treatment of ASR has been to date,[62] such an examination is overdue.

Part II of the Article explores the history of ASR, distinguishing it from other forms of recharge and focusing on the evolution of groundwater law in the United States and the earliest jurisdictions to allow ASR projects. Part III examines the problems with ASR, focusing on how gaps in the law have stalled progress on existing ASR efforts and made some jurisdictions reluctant to allow even limited experiments with ASR projects. Part IV looks at the current legal landscape for ASR projects, paying particular attention to the costs of complexity involved in multiple state law groundwater regimes, the disconnect between systems of surface and groundwater law in many states, and the interplay between state water laws and relevant federal controls, including but not limited to the Safe Drinking Water Act.[63] Finally, Part V offers suggestions for legal reform, with particular attention paid to changes in state law that might be made in jurisdictions with significant potential for ASR development.

II. THE HISTORY OF ASR IN THE UNITED STATES

The relevant terminology is confusing and often used imprecisely, especially by lawyers whose misuse can be particularly problematic,[64] so it may be useful to revisit this point before examining the history and development of ASR in the United States. Artificial recharge is used as a catchall term for processes used to replenish water in aquifers, perhaps to address problems of surface subsidence, saltwater intrusion, or for long-

60 (2013) (discussing an ASR program outside Wichita, Kansas, and lumping ASR together with direct and indirect types of artificial recharge as examples of desirable integrated water resources management).

62. *See supra* notes 43–44 and accompanying text; *see also* MALCOLM PIRNIE, INC. ET AL., AN ASSESSMENT OF AQUIFER STORAGE AND RECOVERY IN TEXAS 101–02 (Tex. Water Dev. Board Report No. 0904830940, 2011) ("The principal challenges for ASR in the United States are primarily the legal and regulatory frameworks which, in many states, have not yet caught up with the application of this technology.").

63. 42 U.S.C. §§ 300f–300k (2012).

64. *See supra* notes 53–55 and accompanying text.

term aquifer viability as well to replenish reserves of drinking water.[65] ASR, on the other hand, refers to a narrower and more recently developed set of techniques used both to store water in aquifers and to withdraw it from subterranean storage for human use in fairly short order—ASR systems can be designed for long-term storage, but they are frequently used more like surface reservoirs than other types of artificial recharge.[66] In other words, all ASR is artificial recharge, but not all artificial recharge is ASR.

The first and historically oldest type of artificial groundwater recharge systems are surface recharge systems, which rely upon and attempt to enhance natural percolation and filtration processes in order to move excess precipitation underground.[67] Despite the many different forms they may take, the common central idea behind surface recharge systems is an old one: for centuries, if not millennia, communities in arid environments have used surface trenches, pits, or tanks to catch excess rainwater and replenish surficial aquifer systems for drier seasons, instead of relying solely on surface reservoirs with potentially higher rates of evaporation.[68] In addition to minimizing the loss of stored water through evaporation, the process of gradually passing source water through soil and rock can remove or reduce contaminants present in the source water.[69] The effectiveness of surface recharge systems at water purification obviously varies, depending on the time involved for recharge, the quality of the source water, whether or not the source water was treated prior to entering the recharge system, and the geological formations through which the source water is introduced to the aquifer.[70]

Beyond surface recharge systems is another method of artificially recharging an aquifer, in which water is introduced directly into the aquifer through

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65. *E.g.*, 21 OFFICE OF GROUND WATER & DRINKING WATER, EPA/816-R-99-014u, THE CLASS V UNDERGROUND INJECTION CONTROL STUDY: AQUIFER RECHARGE AND AQUIFER STORAGE AND RECOVERY WELLS 1–2 (1999) [hereinafter UNDERGROUND INJECTION CONTROL STUDY].

66. *See* Thompson, *supra* note 48, at 295–96 (comparing ASR systems to surface reservoir systems).

67. *See* R. DAVID G. PYNE, AQUIFER STORAGE RECOVERY: A GUIDE TO GROUNDWATER RECHARGE THROUGH WELLS 11–12 (2d ed. 2005) (surveying ancient artificial recharge systems).

68. *Id.*; *see also* ALLEY & ALLEY, *supra* note 26, at 24–28.

69. *See* COMM. ON GROUND WATER RECHARGE, NAT'L RESEARCH COUNCIL, GROUND WATER RECHARGE USING WATERS OF IMPAIRED QUALITY 3–8, 97–131 (1994) ("Depending on the operation and the constituents of the recharge water and soil . . . filtration of suspended solids, parasites, and bacteria; sorption of trace elements, bacteria, and viruses; precipitation of phosphates and trace metals; biodegradation of organics; recarbonation of high pH effluents; and denitrification [may occur].").

70. *See id.* at 12. "It is useful to think of the entire artificial recharge operation as a water source undergoing a series of treatment steps during which its composition changes," dependent upon a host of different factors. *Id.*

an injection well, without using natural filtration processes from the surface.[71] Unlike the surface filtration methods for recharging aquifers that have been used for centuries in some locations, artificial recharge systems that make use of injection wells depend on both advances in pumping technology and hydrogeological knowledge that were not available until the mid-twentieth century. There are plenty of artificial recharge systems that use injection wells but are not, strictly speaking, ASR. In these systems, the injection wells work only one way: they put excess surface water back in an aquifer without relying on surface filtration.[72] ASR is best thought of as a subset of artificial recharge systems that use injection wells, and a relatively novel one at that—central to ASR is the dual-use wells for injection and retrieval, sometimes under relatively short time horizons.

Compared to artificial recharge more generally, ASR is a relatively new approach to storing water in an aquifer, but this novelty is only relative, because ASR systems have been in use for decades. The first ASR system in the United States was developed in New Jersey in 1968 to provide both seasonal storage and recovery of treated drinking water in order to meet peak summer demand with water reserved in wetter months.[73] A second ASR project was then developed, also in New Jersey, followed by halting and eventually abandoned projects in Florida and Virginia in the early 1970s.[74]

The growth of ASR remained slow through the 1980s and early 1990s, at least in the United States. Only about twenty ASR sites were operational in the United States by the mid-1990s,[75] and much of this growth occurred in Florida, where a number of sites were rapidly abandoned because of poor recovery rates or contamination from arsenic leaching.[76] However, beginning in the late 1990s, ASR began to grow much more rapidly: by 2005 there were more than seventy operational ASR projects in the United States,[77] and by 2015 more than two-hundred ASR projects were either in

71. *See Aquifer Recharge and Aquifer Storage and Recovery*, U.S. ENVTL. PROTECTION AGENCY, https://www.epa.gov/uic/aquifer-recharge-and-aquifer-storage-and-recovery [https://perma.cc/SJS5-NR2X].

72. Melissa Rohde, Janny Choy & Geoff McGhee, *Recharge: Groundwater's Second Act*, STAN. WOODS INST. FOR ENV'T, http://waterinthewest.stanford.edu/groundwater/recharge [https://perma.cc/8QMQ-AKU8] (providing examples and diagrams of artificial recharge systems, including those that use injection wells).

73. PYNE, *supra* note 67, at 19.

74. *Id.* at 19–20.

75. *Id.* at 20.

76. BLOETSCHER, *supra* note 57, at 25.

77. PYNE, *supra* note 67, at 20.

testing or operational in this country.[78] Perhaps more importantly, many states have been revising their statutory and regulatory controls for ASR, in many cases with the intent of removing procedural complexity from the permitting and oversight controls relevant to new and ongoing ASR projects.[79] From a legal perspective, the future for ASR is as bright in this country as it has ever been. But ASR projects can have many side effects—aquifers are fragile and remote things, which are easy to mess up and hard to clean up. Part III will explore ASR's potential side effects, paying particular attention to the way that these technical problems influence and are influenced by the existing federal and state controls on ASR projects.

III. THE POTENTIAL DRAWBACKS OF ASR

As noted in Part I, the basic ideas behind ASR are straightforward, and its merits, once explained, are relatively easy to understand. Nevertheless, it is also easy to mistake ASR wells for very different types of drilling activity—wells for hydraulic fracturing, for example.[80] In addition, public confusion and skepticism about ASR have been fueled by difficult terminology, clunky acronyms, and the relatively new developments in drilling technology and hydrology that have made dual-use aquifer storage and recover wells possible. As a result, a lack of public awareness and the related potential for public confusion the most significant obstacles that work against more widespread adoption of ASR.

But the confusion and uncertainty around ASR go beyond the terminology involved, the legal and technical novelty that surrounds many ASR projects, or even the need for public education about water issues generally. Beyond these problems, the fragmentary nature of the academic literature on the subject has created another significant obstacle to more widespread adoption of ASR. For example, much of the information about the performance of specific projects, or even all ASR projects within particular jurisdictions, is either incomplete, unavailable, unpublished, or published in gray literature.[81]

Moreover, regulatory agencies responsible for ASR oversight are sometimes tardy or noncompliant when academic researchers request information about past permitting practices or the current performance of ASR sites.[82] And even when regulatory agencies comply with requests for information, it can be difficult, if not impossible, to verify the claims that ASR operators make about recovery rates and compliance with the relevant water quality

78. BLOETSCHER, *supra* note 57, at 19–21.
79. *See* discussion *infra* Part V.
80. *See, e.g.*, *supra* notes 53–55 and accompanying text.
81. *E.g.*, Bacchus et al., *supra* note 59, at 123–24.
82. *Id.*

standards for water that is pumped back up from ASR dual-use wells.[83] Some of these problems are not specific to ASR: in general, the collection of even basic data about groundwater quality and aquifer health is spotty in many parts of this country.[84] But ASR's relative novelty amplifies the problems caused by the spotty nature of the available data, the uneven nature of the relevant academic literature, and, at least until recently, the dearth of useful metrics to study whether individual projects are succeeding or failing.[85]

Data about ASR may be spotty, but there is enough information from a number of different states to review the many potential side effects that ASR projects can cause, and the remainder of Part III will review these side effects. In summary, the most serious problems associated with ASR involve the contamination of water in the storing aquifer—contamination that can be caused or exacerbated by ASR in multiple ways, as Section III.A will demonstrate.[86] While contamination of the aquifer may be the most serious side effect, the most frequent problem that emerges for ASR systems is clogging of the dual-use injection and recovery wells, which can occur due to physical particles in the injected water or biological growth that fouls well filters, as Section III.B will demonstrate.[87]

Clogging and contamination, in turn, can lead to abandonment of the entire project, which in its own turn can exacerbate potential problems of contamination for the underlying aquifer if the injection wells are not properly plugged and sealed.[88] Moreover, the costs of water produced through ASR—

83. *See, e.g.*, Sydney T. Bacchus et al., *What Georgia Can Learn from Aquifer Storage and Recovery (ASR) in Florida*, *in* GEORGIA WATER RESOURCES CONFERENCE 2015, at 1, 4–5 (Robin John McDowell, Carson A. Pruitt & Robert Bahn eds., 2015) (noting that while the reported recovery rate for some studied ASR sites was 90%, the actual verified recovery rate for these sites was only 17%).

84. *E.g.*, Janny Choy et al., *Groundwater Data: California's Missing Metrics*, STAN. WOODS INST. FOR ENV'T (2014), http://waterinthewest.stanford.edu/groundwater/metrics/index.html [https://perma.cc/KBQ6-GXXE].

85. *See* W. Benjamin Smith, Gretchen R. Miller & Zhuping Sheng, *Assessing Aquifer Storage and Recovery Feasibility in the Gulf Coastal Plains of Texas*, 14 J. HYDROLOGY 92, 94–98 (2017) (noting that public data for Texas aquifers is insufficient to apply success factors for ASR drawn from past academic studies and proposing a new set of success factors based on the available data).

86. *See* discussion *infra* Section III.A.

87. *See* Christopher J. Brown, Kirk Hatfield & Mark Newman, *Lessons Learned from a Review of 50 ASR Projects from the United States, England, Australia, India, and Africa*, *in* CONF. PROC. OPENSIUC (2006), http://opensiuc.lib.siu.edu/cgi/viewcontent.cgi?article=1040&context=ucowrconfs_2006 [https://perma.cc/CN8D-H3W2].

88. *See, e.g.*, Bloetscher et al., *supra* note 36, at 1620–21.

the costs of retrieving water from aquifer storage after its initial period of recharge—may vary tremendously, influenced by differences in the quality of both the source water and the storage aquifer, the amount of water treatment needed prior to and following aquifer storage, and the presence or absence of chemical reactions while the recharged water is in aquifer storage. Each of these problems will be reviewed in turn, with special attention paid to the ways in which these technical problems interact with the existing legal controls regarding the permitting and operation of ASR projects.

A. Aquifer Contamination and ASR

Despite the age-old history of artificial recharge techniques around the world, any human intervention in an aquifer raises the possibility of unintended side effects. At the most superficial level, all forms of artificial recharge require surplus surface water, and where surplus surface water is unavailable, recharge of all types will fail. In addition, for surface recharge systems to work, water must be able to percolate through the relevant subsurface geological formations to reach the relevant aquifer, which means that surface recharge may be simply impossible in some geologic settings.[89] In other geologic settings, surface recharge may be possible, but chemical reactions between the recharging water and the surface geology may release dangerous or toxic compounds that contaminate the aquifer even as it is replenished.[90]

In contrast to recharge systems that rely upon surface filtration, ASR operations are much less limited by surface geology. Where surface filtration is difficult or impossible, ASR wells can punch through the problematic surficial formations to reach the aquifer.[91] And even where natural percolation from the surface to an underlying aquifer is possible, in situations where potential contaminants exist at or near the surface, ASR may be much safer than other forms of artificial recharge.

On the other hand, the absence of surface filtration and the reliance on deep wells to directly inject and remove water for storage can increase the risks associated with ASR relative to other forms of artificial recharge. When something goes wrong with an ASR system, it often goes wrong directly in the aquifer itself, without any intervening geological formation or passage through an aquifer from injection to removal sites to remove

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89. ALLEY & ALLEY, *supra* note 26, at 170–71.

90. *Id.* at 171.

91. *See* Rydman, *supra* note 55, at 53 (noting that ASR was more appropriate than surface recharge methods for replenishing the aquifers in Antelope Valley, California, due to clay formations and dense residential development that limited the aquifer's ability to accept recharge by surface percolation in the areas of greatest need).

or dilute the problem. Contamination of the underlying aquifer can also happen more quickly with ASR than other types of artificial recharge—though obviously contamination can occur equally quickly with other types of artificial recharge that rely on single-use injection wells.

ASR projects can pose a risk of contamination in at least two ways. First, water treated on the surface to meet the standards necessary for injection under the Safe Drinking Water Act[92] may be relatively rich in oxygen compared to its destination aquifer.[93] This means that the injected water may release problematic trace metals from the confining geological material into the storing aquifer.[94] And this, in turn, may contaminate the water within the aquifer—including but not limited to water withdrawn from the ASR dual-purpose wells at times of surface need.[95]

Given the geological diversity of ASR sites around the country, the list of potentially problematic trace metals found leaching into aquifers associated with ASR projects is a long one, including but not limited to arsenic, uranium, and mercury, with arsenic the most frequently occurring trace metal contaminant.[96] Part of the problem with this leaching contamination issue is that the relevant geochemistry is highly specific to the region and, often, the specific aquifer in which water is stored.[97] For example, arsenic and other trace metals have been the most significant leaching problem in Florida ASR projects, but high radon levels in recovered water have been particularly notable in Oregon and Washington, while high iron levels have been a problem in some New Jersey wells, and mercury levels have been a particular problem at some California sites.[98] In a country as physically diverse as the United States, this means that it has been and will remain difficult to apply single technical fixes across the country.

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92. 42 U.S.C. §§ 300f–300k (2012).
93. Bloetscher et al., *supra* note 36, at 1625.
94. *See id.*
95. *Id.*; *see also* RONALD S. REESE, REVIEW OF AQUIFER STORAGE AND RECOVERY IN THE FLORIDAN AQUIFER SYSTEM OF SOUTHERN FLORIDA (U.S. Geological Survey Water Res. Investigations Report 2004-3128, 2004), https://pubs.usgs.gov/fs/2004/3128/pdf/fs-2004-3128-Reese.pdf [https://perma.cc/4HAS-M5EN] (noting the potential for release of arsenic and radionuclides into ASR-stored water).
96. *See* PYNE, *supra* note 67, at 276–77 (noting, in addition to the contaminants listed above, the additional presence in some ASR projects of problematic levels of nickel, chromium, cobalt, and zinc); Brown, Hatfield & Newman, *supra* note 87 (noting the presence of manganese and radon contamination in some ASR projects).
97. Bloetscher et al., *supra* note 36, at 1625.
98. *Id.*

Second, water injected through an ASR system may directly contaminate water in the aquifer, even if there is no problematic reaction with the aquifer's confining geologic material. This can occur in a number of ways as well. Even water treated on the surface may contain pathogens or contaminants, sometimes referred to as disinfection byproducts, which can form during the treatment process as the disinfectant reacts with organic material already within the treated water.[99] Such organic compounds may be relatively common in sources of treated surface water that frequently are considered for ASR storage, including but not limited to treated effluent, recycled water, and stormwater.[100] Disinfectant byproducts are a problem for water stored on the surface as well, but they may degrade at much slower rates when stored underground.[101] In addition, treatment of the injected water with disinfectants on the surface may lead to the formation of toxic compounds in the aquifer, when residual disinfectants remaining in the injected water react with organic compounds already in the aquifer.[102]

Concerns about ASR-related aquifer contamination are neither abstract nor purely hypothetical. Although ASR is a relatively new technology, its future in some jurisdictions has already been threatened by aquifer contamination.[103] The reasons for this are easy to see: when realized, the threat of aquifer contamination undermines the rationale for ASR, destroying water reserves and contaminating the environment rather than preserving them. And the chilling effects of even short-lived aquifer contamination on ASR adoption may not be confined to the jurisdiction where contamination

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99. *See* MARY SHALEEN-HANSEN, WASH. ST. DEP'T ECOLOGY, PUB. NO. 17-10-035, GUIDANCE FOR AQUIFER STORAGE AND RECOVERY AKART ANALYSIS AND OVERRIDING CONSIDERATION OF THE PUBLIC INTEREST DEMONSTRATION 10 (2017), fortress.wa.gov/ecy/publications/documents/1710035.pdf [https://perma.cc/UV9K-XQM2].

100. Lucy K. Infeld, Sarah N. Munger & Rachel K. Roberts, *Aquifer Storage and Recovery: Opportunities and Practical Considerations*, A.B.A. (July 22, 2019), www.amercanbar.org/groups/environment_energy_resources/publications/st/20190723-aquifer-storage-and-recovery [https://perma.cc/3HDF-7YNW] (citing *Aquifer Recharge and Aquifer Storage and Recovery*, *supra* note 71).

101. SHALEEN-HANSEN, *supra* note 99, at 10.

102. Rydman, *supra* note 55, at 53–54 (discussing concerns that treating injected water disinfected with chlorine might lead to aquifer contamination, when residual disinfectant left in the injected water reacts with organic compounds in the aquifer, forming trihalomethanes (THMs)); *see* Bloetscher et al., *supra* note 36, at 1625–26 (noting that disinfection by-products (DBPs) can generate THMs as well as haloacetic acids in aquifers involved in ASR projects, and that concerns about DBPs have shut down several ASR projects).

103. *E.g.*, R.E. Price & T. Pichler, *Naturally Occurring Arsenic in the Upper Floridan Aquifer, Southwest Florida: Implications for Aquifer Storage Recovery*, *in* GROUND WATER/SURFACE WATER INTERACTIONS 388, 388 (2002), https://pdfs.semanticscholar.org/447a/227a41f1bf3aa95a36daed6cbbe409749af0.pdf [https://perma.cc/U9M4-PAAZ] ("The future of ASR in Florida . . . is unclear because of the discovery of elevated arsenic (As) levels during the recovery cycle testing of several ASR facilities throughout southwest Florida.").

occurs. For example, ASR-related contamination of some aquifers in Florida led to widespread skepticism about the technique in neighboring Georgia in the late 1990s, including a fifteen-year Georgia state legislative ban on ASR projects,[104] which will be discussed in greater detail in Part IV below.[105] Although Georgia's ASR ban has since expired, opposition to ASR projects in Georgia remains strong, even though pressures on Georgia's existing water supply have grown steadily more intense in recent years.[106]

Some have argued that these chemical contamination issues may sideline relatively few ASR projects outright, as they can be solved with treatment of water either prior to recharge, upon withdrawal, or both.[107] Others have argued that contamination issues are most significant early in an ASR project's cycle.[108] Over time, at least for many ASR projects, both the contamination of the overall aquifer and problems with the recharged water in the zone of potential recovery near the ASR system's wells can be managed and minimized, in part because scientists and engineers have learned from early struggles against ASR-related aquifer contamination.[109] But others have argued that the present risks of contamination are actually more significant than presently believed, at least in some parts of the country, because water injected through ASR systems may move through underexamined

104. *See* Kristina Torres, *Despite Critics, Georgia Lays Groundwork to Manage Aquifer Storage*, ATLANTA J. CONST. (Aug. 6, 2017), https://www.ajc.com/news/state—regional-govt—politics/despite-critics-georgia-lays-groundwork-manage-aquifer-storage/ZJaFKa7XN0ol4QGaJiDcRM [https://perma.cc/YP2S-HSUE]; *see also* Bacchus et al., *supra* note 83, at 7–8 (arguing that Georgia should continue to reject ASR projects based on Florida's experience with ASR-related arsenic contamination of aquifers, among other issues).

105. *See infra* notes 174–77 and accompanying text.

106. Torres, *supra* note 104; *see* GA. WATER COAL., 2014'S WORST OFFENSES AGAINST GEORGIA'S WATER (2015), https://gawater.org/wp-content/uploads/2016/09/03FloridanAquifer.pdf [https://perma.cc/5ZCG-UK3R] (arguing that Georgia's legislature should immediately adopt another ban against ASR, based on ASR-related aquifer contamination in Florida).

107. *See* Bloetscher et al., *supra* note 36, at 1625 (noting the treatment undertaken by several different ASR projects to deal with a number of contaminants, and concluding that "[c]hemical leaching issues" and "[o]vercoming geochemical problems" is possible with treatment techniques as well as modifications to the injected water).

108. *See* E.A. Antoniou, B.M. van Breukelen & P.J. Stuyfzand, *Optimizing Aquifer Storage and Recovery Performance Through Reactive Transport Modeling*, 61 APPLIED GEOCHEMISTRY 29, 38–39 (2015).

109. *See id.*

subterranean fractures in the geological materials confining the relevant aquifers.[110]

The technical uncertainty over the risk of contamination for ASR is an obstacle to ASR that is exacerbated by the legal uncertainty around ASR operators' potential liability for subterranean trespass or other similar claims in cases of inadvertent aquifer contamination, as Part IV will discuss in greater detail. Moreover, even if the most serious ASR-related cases of aquifer contamination decline dramatically in future years, the costs of treating aquifer contamination and the potential for greater liability exposure may deter many future ASR projects. In addition, many aquifers are among the purest sources of water found in nature—at least in their natural state.[111] The prospect of potentially compromising the quality of such a resource in order to protect its quantity is often a difficult choice, at best, for many communities to make. Finally, as will be discussed in greater detail below, the cost of successfully treating ASR-related aquifer contamination may contribute to the abandonment of ASR projects, by increasing the cost of water ultimately recovered from ASR beyond alternative sources of storage and supply. But before turning to the unpredictable costs and the potential for abandonment of ASR projects, it will be useful to turn to another problem that frequently occurs in conjunction with contamination of the wider aquifer—namely, clogging of the wells at the heart of the ASR system.

B. Well Clogging and ASR

At least in the United States, aquifer contamination through injection of treated surface water may be the most significant threat to existing and future ASR projects.[112] But clogging of the dual-use wells used to inject and retrieve water from the aquifer is probably the most common problem for ASR systems, both in the United States and around the world.[113] This clogging can be caused by buildup of physical particles in the injected water or near the injection wells as well as air entrainment, which is simply the buildup of air bubbles in pipes and pore spaces in the aquifer.[114] ASR clogging can also be caused by the growth of microorganisms introduced with or fostered

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110. *See* Bacchus et al., *supra* note 59, at 117–18.

111. *See* Infeld, Munger & Roberts, *supra* note 100.

112. *See* Bloetscher et al., *supra* note 36, at 1620 (surveying all ASR sites in the United States and discussing aquifer contamination issues and well clogging as the two most significant issues facing ASR in the United States).

113. *Id.*; *see* Hoon Young Jeong et al., *A Review on Clogging Mechanisms and Managements in Aquifer Storage and Recovery (ASR) Applications*, 22 GEOSCIENCES J. 667, 667–68 (2018) (noting that clogging and contamination are the "two major issues" for ASR development).

114. *See* Brown, Hatfield & Newman, *supra* note 87.

by nutrients in the recharged water.[115] These nutrients, and the teeming microorganisms that come to feed upon them, can foul up injection and recovery wells as impermeable mats of dead microorganisms and slime grow up around filters in the system.[116]

As one might expect, clogging has proved to be a persistent problem for many ASR projects because it is often related to aquifer contamination concerns. For example, clogging of the dual-use wells may be caused by some of the same minerals that leach into injected water or by organic contaminants in the injected water.[117] Moreover, clogging of the dual-use wells may exacerbate preexisting contamination issues, as both injected and recovered water pass through clogs that are themselves sources of chemical or biological contaminants.[118] In addition, some of the most common fixes for certain types of well clogging—such as including a disinfectant in the injected surface water to deal with biological well clogging—can lead to aquifer contamination issues when that disinfectant reaches the aquifer and reacts with its confining geological materials.[119]

Although clogging has been and remains a relatively frequent problem, several U.S. ASR projects have managed to solve it relatively easily, at least compared to contamination in the underlying aquifer.[120] More specifically, many of the clogging problems that have beset ASR projects in the United States have been managed with cyclical flushing of the well system.[121] But even where clogging problems can be managed relatively easily, the techniques used to manage these problems can drive up the costs of operating an ASR system even as they decrease the yield of acceptable water recovered from temporary aquifer storage. As will be seen below, cost and recovery issues that frequently lead to the abandonment of ASR projects are another substantial obstacle to the growth of ASR in the United States, and costs

115. PYNE, *supra* note 67, at 224.
116. *See* Brown, Hatfield & Newman, *supra* note 87; *see also* PYNE, *supra* note 67, at 224–26 (discussing air entrainment and biological clogging at greater length).
117. *See, e.g.*, Bloetscher et al., *supra* note 36, at 1620, 1624
118. *Id.* at 1624.
119. *Id.*
120. *E.g.*, Brown, Hatfield & Newman, *supra* note 87.
121. *See, e.g.*, *id.* (noting that the desired frequency of cyclical back flushing to clear well clogging will depend on a number of factors, including the relevant geology of the aquifer).

associated with clogging have frequently been a cause of ASR project abandonment, even where technical solutions for the clogging exist.[122]

C. Abandonment, Cost, and Recovery Issues with ASR

Sections III.A and III.B have shown that aquifer contamination and well clogging are both significant problems in their own right, which may impose substantial costs on people who have no connection to the associated ASR project, and for which there may be no good technical solutions in some cases. But even where these problems of contamination and clogging can be managed, they may drastically alter the cost of water recovered from the relevant ASR system beyond alternative sources of storage and supply. In addition to the clogging and contamination issues discussed above—and sometimes because of these problems—many ASR sites are abandoned or fall into disuse because the project is simply unable to provide enough recovered water after injection to be economically competitive with other forms of water storage and supply.

This is an obvious problem for ASR projects, especially because estimating the cost of water recovered from an ASR system is an inherently tricky business even in the best of cases, both for the technical reasons outlined in Part II and for the legal issues discussed below in Part IV. In addition to the wide range of estimated costs associated with ASR projects, the actual costs of recovering usable aquifer-stored water from an ASR system are often quite different than the initial estimates.[123] There are many causes for these discrepancies between estimated and actual costs of recovery: unforeseen differences in the quality of both the source water and the storage aquifer; unexpectedly high amounts of water treatment needed prior to and following aquifer storage; and finally, unpredictable geochemical reactions while the recharged water is in aquifer storage.[124]

Whether because of contamination or clogging or simply because of incorrect estimates about the costs of water recovery, many ASR projects have been abandoned. In fact, according to one recent survey, as many of a quarter of all ASR projects in the United States have been abandoned.[125]

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122. Bloetscher et al., *supra* note 36, at 1620–21 (noting that out of more than two-hundred ASR sites surveyed, clogging was cited as the main reason for the abandonment of eleven sites, and clogging was mentioned as a major problem at another twenty-nine inactive sites).

123. *See, e.g.*, Brown, Hatfield & Newman, *supra* note 87 (noting that in a survey of nineteen ASR sites, the costs per cubic meter of water recovered ranged from $0.34 to $9.27).

124. *See* Bloetscher et al., *supra* note 36, at 1626 (noting that recovery cost and related treatment costs were cited as a reason to abandon 20 ASR sites).

125. *Id.* at 1604–05.

Abandoned ASR projects are not evenly distributed. Across the United States, Florida has the largest number of ASR programs of all types, active or abandoned, and California, New Jersey, Arizona, and Oregon also have high absolute numbers of ASR sites.[126] These states have very different approaches to groundwater law, different geology, and different water needs. What they all have in common is that they are among the leading jurisdictions in both total ASR sites and *abandoned* ASR sites.[127] The high rates of ASR abandonment due to clogging, aquifer contamination, and uncertain recovery costs in states with little in common besides their relatively high early rates of ASR experimentation suggest that ASR abandonment will remain a persistent problem for many years.

The uncertain costs of recovery and the potential for abandonment that have dogged many ASR projects over the past few decades are particularly tricky problems to resolve because they often are not immediately apparent. Discrepancies between the cost of recovered water and the initial estimates may take months to become evident, and construction and design flaws or faults in the underlying geology may not manifest for years. Yet when they do, they can ruin ASR projects and frustrate the local governments and water users who have invested not only in the project's construction but in its apparent initial success.[128] And as noted above, the costs of recovered water produced through ASR—the cost of retrieving water from aquifer storage after initial recharge—varies tremendously, influenced by differences in the quality of both the source water and the storage aquifer, the amount of water treatment needed prior to and following aquifer storage, and the presence or absence of significant geochemical reactions while the recharged water is in aquifer storage.[129]

Despite these problems, many of ASR's most enthusiastic supporters believe that the side effects of ASR are more manageable or less widespread than they may appear, and that the present statutory and regulatory controls

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126. *Id.* at 1617.
127. *Id.*
128. *See* Michael R. Blood & Elliot Spagat, *Millions Spent on California Water-Storage Plans That Leaks*, WASH. POST (Aug. 24, 2013), https://www.washingtonpost.com/national/health-science/millions-spent-on-california-water-storage-plan-that-leaks/2013/08/24/7747a842-0cfb-11e3-b87c-476db8ac34cd_story.html [https://perma.cc/WCB4-8367] (quoting local water managers who claim that the Las Posas Aquifer Storage and Recovery Project, which was supposed to "drought-proof" its service area, has been leaking injected water from its relevant subterranean storage zones).
129. Brown, Hatfield & Newman, *supra* note 87.

on ASR today are too restrictive.[130] Indeed, some advocates for increased ASR development argue that overly restrictive legal controls in fact pose a greater challenge to the optimal future use of ASR than the problems outlined above.[131] Many of these ASR advocates point to the relatively looser legal controls on ASR projects in other countries, especially countries that rely on ASR more than the United States, to support their argument that this country's restrictions on ASR are unnecessarily onerous and complex.[132]

On the other hand, critics of ASR development believe that current controls on ASR are far too lax, and that the technical problems outlined above far outweigh the merits of most ASR projects.[133] For such critics of current ASR practice, the statutory and regulatory limits on ASR projects should, if anything, be increased to protect fragile aquifers and public drinking supplies.[134] Both sides of this argument and the larger current legal landscape for ASR will be analyzed at greater length in the remainder of this Article.

IV. THE CURRENT LEGAL LANDSCAPE FOR ASR

Part III explored the many technical challenges that ASR projects in the United States have faced and likely will continue to face—challenges that have led to the abandonment of individual ASR projects and slowed the growth of ASR in many jurisdictions. Yet Part III also introduced the claim, one made by many of ASR's boosters, that the legal obstacles to ASR's growth are more significant than the technical challenges outlined above. The legal obstacles to ASR's growth in the United States have been significant, especially in some jurisdictions,[135] and in many ways they have been substantially related to the complexity of the legal controls over water use in the United States.

But there are many types of decisions about water use, water rights, and development that are complicated in this country: overlapping local, state, and federal legal and regulatory regimes generally apply to many different

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130. *See, e.g.*, PYNE, *supra* note 67, at 410–11 ("[W]hether or not the technical issues [associated with ASR] can be resolved economically at any particular site, the legal and regulatory issues can be complex, expensive, time-consuming, and of uncertain outcome.").

131. *See, e.g.*, MALCOLM PIRNIE, INC. ET AL., *supra* note 62, at 101–02 ("The principal challenges for ASR in the United States are primarily the legal and regulatory frameworks which, in many states, have not yet caught up with the application of the technology.").

132. *See, e.g.*, PYNE, *supra* note 67, at 411 (arguing that the present United States "regulatory framework endeavors to protect the nation's aquifers against contamination, but does it in such a way that benign ASR practices . . . are difficult to implement," and cautioning other countries against adopting the U.S. regulatory framework for ASR).

133. *See generally, e.g.*, Emily J. Markesteyn, *Aquifer Storage and Recovery: A Bad Alternative*, *in* GEORGIA WATER RESOURCES CONFERENCE 2015, *supra* note 83, at 1.

134. *See* Bacchus et al., *supra* note 59, at 142–43 (arguing that substantial environmental harm has been done in Florida as a result of the "lack of regulatory oversight for ASR").

135. *See supra* note 105 and accompanying text; *infra* notes 174–77 and accompanying text.

types of water use and development decisions.[136] In other words, ASR is not unique in this respect. And there are other types of relatively novel water development techniques that implicate multiple and complicated legal controls in the United States, just as ASR does, but for which the legal complexity has become more manageable as American lawyers and academics have developed a greater understanding of the relevant technical and legal challenges.[137] Finally, successful and long-running ASR projects have been developed in California and Texas—the states that historically have had both the most complicated and, perhaps, the most unfavorable legal regimes for such projects.[138]

All of this means that those boosters of ASR who identify both legal complexity and substantive legal roadblocks as the chief obstacles to the adoption of ASR are right, at least up to a point: the law relevant to ASR is very complex, and there have been substantial legal obstacles to ASR's adoption. But to suggest that the obstacles to the adoption of ASR are purely or chiefly legal overstates the case.[139] What makes ASR unusual at this point in its evolution are not purely legal obstacles but a tangled web of legal and technical obstacles, complicated by substantial technical disagreement about the significance of these technical obstacles as discussed in Part III, and compounded by terminological confusion and lack of awareness among the broader public, as discussed in Parts I and II. In short, the law governing ASR is complicated because ASR itself is complicated, and it is a mistake to suggest otherwise.

The state and federal legal controls on ASR primarily address a few recurring problems: who has the right to divert and treat surface water for subterranean storage; who has the right to withdraw and use treated surface water stored

136. *E.g.*, Craig Anthony (Tony) Arnold, *Introduction: Integrating Water Controls and Land Use Controls: New Ideas and Old Obstacles*, *in* WET GROWTH: SHOULD WATER LAW CONTROL LAND USE? 1, 34 (Craig Anthony (Tony) Arnold ed., 2005).

137. *Cf., e.g.*, Michael Pappas, *Unnatural Resource Law: Situating Desalination in Coastal Resource and Water Law Doctrines*, 86 TUL. L. REV. 81, 83 (2011) (addressing the legal ambiguities raised by relatively modern desalination techniques in the context of property, water law, and coastal resource doctrines). For an example of how desalination and ASR have been linked together by scholars as relatively novel tools to address environmental harms and water shortages, see, for example, ADLER, *supra* note 50, at 251 (noting that technological advances in desalination, like ASR, may address existing and future water needs with less environmental impact than alternative approaches).

138. *See infra* Sections IV.B.1, IV.B.2.

139. *Cf.* PYNE, *supra* note 67, at 410–11 ("Whether or not the technical issues [associated with ASR] can be resolved economically at any particular site, the legal and regulatory issues can be complex, expensive, time-consuming and of uncertain outcome.").

in an aquifer; and finally, who is liable for unintended harms to an aquifer that are caused or exacerbated as a side effect of ASR projects?[140] Section IV.A looks at how recovery rights and potential trespass liability for ASR projects play out against the background of state groundwater law. Section IV.B looks at specific and varying state responses to ASR, using California, Texas, and Florida as examples of how states have tried to make ASR projects more feasible given the varied state groundwater law already in place in these jurisdictions. Finally, Section IV.C looks at federal law relevant to ASR projects, concluding with a short examination of litigation currently pending before the Supreme Court that might dramatically impact future ASR projects across the country.

A. ASR and State Groundwater Law

Depending on the jurisdiction, state groundwater law may limit ASR operators' ability to pump recharged water out of subterranean storage. Similarly, state groundwater law may also limit ASR operators' recourse against surface neighbors who attempt to pump recharged water, injected as part of an ASR project, for the neighbors' own purposes. The remainder of this Section looks at the background principles of state water law that address these problems, before Section IV.B examines individual state law approaches to ASR, focusing the specific statutory and regulatory systems set up to control ASR in some states, as well as recent reforms made by some jurisdictions to accommodate future ASR projects.

1. ASR, Recovery Rights, and the Roots of U.S. Groundwater Law

For much of human history, erroneous theories about the origins of underground water and its relationship to surface water and precipitation held sway.[141] Groundwater was thought to be independent from both precipitation and surface water,[142] and this ignorance caused the law of groundwater and the law of surface water to develop on separate tracks. As a result, at common law, courts applied the rule of capture to groundwater

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140. *See, e.g.*, Infeld, Munger & Roberts, *supra* note 100 (listing problems of water rights associated with the right to fill an aquifer, the problem of "[t]oo [m]any [s]traws" regarding rights to withdraw from the aquifer, and problems of water quality within the aquifer after an ASR project begins).

141. Bray, *supra* note 39, at 1290–92; *see* A. DAN TARLOCK ET AL., WATER RESOURCE MANAGEMENT: A CASEBOOK IN LAW AND PUBLIC POLICY 545 (6th ed. 2009) ("[C]omic but sad . . . [and] important problem in [early] groundwater law: initial allocation was based on myths rather than geohydrology.").

142. TARLOCK ET AL., *supra* note 141, at 545 (noting that through the seventeenth century, scientists thought groundwater could not be "derived from rainfall because the supply was assumed to be insufficient and the ground to be too impervious").

disputes, drawing from and in turn drawn upon by the common law's approach to other subterranean fugitive resources.[143] During the twentieth century, most American jurisdictions realized the problems created by applying the rule of capture to groundwater, beginning with cases like *Meeker v. City of East Orange*.[144]

In *Meeker*, a New Jersey court noted that the rule of capture was traditionally justified based on the historical "difficulty of proving . . . facts respecting water that is concealed from view"—a difficulty that by the early 1900s was already "often readily solved" by advances in geology and hydrology.[145] The court in *Meeker* also observed that without the historic difficulty of observing changes in groundwater, the entire justification for applying the rule of capture to groundwater "at once vanishes."[146] Accordingly, the court in *Meeker*—like courts and legislatures in many other jurisdictions—abandoned the rule of capture for groundwater in favor of alternative approaches.[147]

Since the early twentieth century, as many jurisdictions began to abandon the longstanding rule of capture in cases like *Meeker*, state groundwater law has varied widely across the various states. There are a number of reasons for this variety of approaches, including the historic scientific ignorance of groundwater and the hydrologic cycle, the traditional disconnect between surface water and groundwater law, and the gradual departure from the rule of capture has caused state groundwater law to vary widely across jurisdictions.[148] Most jurisdictions rejected the rule of capture decades ago, and even in Texas where it still persists, it must coexist with local

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143. *See* Bray, *supra* note 39, at 1291–93, 1294 (noting the connection between early groundwater law and the law of other fugitive resources).

144. 74 A. 379 (N.J. 1909). *Meeker* was one of the earliest cases to reject the rule of capture, and certainly one of the most clearly reasoned and written such rejections, but it was by no means the very first such rejection. For example, decades earlier, New Hampshire courts rejected the rule of capture in a line of cases relied upon by the court in *Meeker*. *See* Swett v. Cutts, 50 N.H. 439, 443 (Sup. Ct. 1870); Bassett v. Salisbury Mfg. Co., 43 N.H. 569, 573 (Sup. Ct. 1862). *See generally Meeker*, 74 A. at 626–27.

145. *Meeker*, 74 A. at 384.

146. *Id.*

147. *See id.* at 385 (rejecting the rule of capture and holding "that the reasoning upon which the doctrine of 'reasonable user' rests is better supported upon general principles of law and more in consonance with natural justice and equity").

148. *See* ADLER, CRAIG & HALL, *supra* note 39, at 278–79.

and regional water control districts in part of the state.[149] Those states that first rejected the rule of capture, like New Jersey in *Meeker*, tended to replace it with something like the reasonability approach adopted in *Meeker*, though today states differ in the different ways that they define and regulate reasonable use of groundwater when conflicts emerge.[150]

For example, the American rule for reasonable use, the first departure from the rule of capture, simply required that the groundwater withdrawn be put to a reasonable use on the overlying tract.[151] Other states, beginning with California, adopted a correlative rights approach, giving more protection to overlying landowners in times of shortage by emphasizing the need for sharing use rights when supplies are scarce.[152] Still other states have drawn upon section 858 of the Restatement (Second) of Torts, which provides a multifactor test to determine the relative reasonability of competing users.[153] In contrast to these diverse approaches based on reasonable use, many western states, which had already rejected the common law riparian approach for surface water in favor of rules based on prior appropriation, a first-in-time rule with roots in mining law,[154] simply applied that same rule of prior appropriation to groundwater as well.[155]

In sum, there are five more or less distinct doctrinal approaches that different jurisdictions apply to groundwater conflicts: the old rule of capture, largely but not entirely rejected by most jurisdictions; three different approaches to reasonable use, known variously as the American rule, the correlative rights doctrine, and an approach drawing on the Restatement (Second) of Torts; and last, the prior appropriation doctrine.[156] This diversity of approaches can create complexity for ASR operators—although the

149. *See* BRAY, *supra* note 39, at 1286 n.9, 1289, 1296, 1300–11 (discussing the rise of groundwater control districts, the Edwards Aquifer Authority, and other local and regional groundwater control agencies in Texas).

150. *See generally* ADLER, CRAIG & HALL, *supra* note 39, at 184, 189, 196–97.

151. *Id.* at 184.

152. *Id.* at 189.

153. *Id.* at 196–97.

154. *See, e.g.*, Coffin v. Left Hand Ditch Co., 6 Colo. 443, 447 (1882) (rejecting riparian doctrine because "[i]mperative necessity, unknown to the countries which gave [riparian doctrine] it[s] birth, compels the recognition of another doctrine in conflict therewith"). For a highly readable analysis of the roots of western prior appropriation law in the rules and ideology prevalent in western mining camps and frontier communities, see generally DAVID SCHORR, THE COLORADO DOCTRINE: WATER RIGHTS, CORPORATIONS, AND DISTRIBUTIVE JUSTICE ON THE AMERICAN FRONTIER (2012).

155. *See* ADLER, CRAIG & HALL, *supra* note 39, at 178–79.

156. *See, e.g.*, *id.*; JAMES RASBAND ET AL., NATURAL RESOURCES LAW & POLICY 908, 908–13 (3d ed. 2016) (noting that state approaches to groundwater are "generally divided into the five categories" discussed above, but that "the law in any particular state is more likely . . . to employ elements" of multiple categories as a result of legislative and regulatory changes that "overlie and supplant the common law" doctrines discussed here).

doctrines are diverse at the state level, which mitigates some of the effort and information burden on ASR operators, unless they wish to operate in multiple states. More importantly, however, under the law of some jurisdictions the relative water rights of both ASR operators and their neighbors may complicate ASR in a variety of ways, as will be discussed immediately below and in the sections on California, Florida, and especially Texas law later in Part IV.

2. ASR, Trespass, and State Groundwater Law

An additional potential set of state law restrictions over ASR involve possible trespass claims that might arise from the unintended side effects of ASR projects. At common law a landowner's rights above and below the surface estate were often referred to by the *ad coelum et ad inferos* maxim, according to which the soil owner's estate stretched above and below the earth, to the heavens and the depths below.[157] Accordingly, using aquifers to store excess water through either artificial recharge generally or ASR more specifically might seem to violate the old *ad inferos* common law rule as, for example, water introduced underground by landowner/aquifer recharger Adam eventually migrates, over time, to a point underneath the surface estate of a neighboring landowner Beatrice. The point is particularly important where recharged water carries contaminants or where it reacts with the confining geology to contaminate the aquifer—in such a case, Adam has tainted water underneath Beatrice's surface estate.

Given the relatively long history of artificial recharge in both the United States and elsewhere, the potential liability of Adam to Beatrice for trespass in such a case was presented by artificial recharge before the recent growth of ASR. Several courts that have addressed the issue of trespass in the context of artificial recharge have concluded that a neighboring landowner like Beatrice does not have a claim for trespass against a landowner/aquifer recharger such as Adam. For example, in *Board of County Commissioners v. Park County Sportsmen's Ranch, L.L.P.*, the Colorado Supreme Court confronted exactly this issue.[158]

The conflict in *Park County Sportsmen's Ranch* began after the eventual defendant in that case sought a conditional permit for an artificial recharge

157. As every former first-year student of property has learned—even if later forgotten, or at least skipped over in the first-year property casebook—the full text of the maxim is *cujus est solum*, *ejus est usque ad coelum et ad inferos*.
158. 45 P.3d 693, 715 (Colo. 2002).

project involving six reservoirs for surface recharge and dozens of extraction wells for eventual transport to the distant city of Aurora.[159] This led neighboring landowners and the relevant county's Board of Commissioners to file suit claiming that the defendants' temporary storage of surplus water in the aquifer underlying plaintiffs' surface estate constituted trespass under the *ad coelum et ad inferos* doctrine.[160] The Colorado Supreme Court rejected plaintiffs' claim, holding that plaintiffs lacked property rights in both the underground water and the subterranean water-bearing capacity of the aquifer, and noting that similar claims also had been rejected by the Ohio Supreme Court and by an appellate court in Arizona just a few short years before.[161]

In addition to *Park County Sportsmen's Ranch* and the cases it relies upon, courts in California and Nebraska have reached conclusions almost as inhospitable to the possibility of trespass claims arising from artificial recharge.[162] This is obviously good news for those who wish to decrease the legal complexity facing current and future ASR operators. More specifically, such decisions are likely to help the adoption and development of ASR in new places: if state courts are relatively hostile to subterranean trespass claims, it will minimize the potential liability that ASR operators face under state law for inadvertent contamination of the relevant aquifer or other unintended side effects.

Not every recent case in which subterranean trespass has been litigated has proven to be so dismissive of such subterranean trespass claims, and therefore so favorable for ASR. For example, in *Environmental Processing Systems, L.C. v. FPL Farming Ltd.*, a case involving treated wastewater

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159. *Id.* at 696–97.

160. *Id.*

161. *Id.* at 701 (first citing Chance v. BP Chemicals, Inc., 670 N.E.2d 985 (1996); and then citing W. Maricopa Combine, Inc. v. Ariz. Dep't of Water Res., 26 P.3d 1171, 1176 (Ariz. Ct. App. 2001)).

162. *See generally* Cent. & W. Basin Water Replenishment Dist. v. S. Cal. Water Co., 135 Cal. Rptr. 2d 486 (Cal. Ct. App. 2003); *In re* Application U-2, 413 N.W.2d 290 (Neb. 1987), *superseded by statute*, NEB. REV. STAT. § 46-296(5), (6), *as recognized in In re* Applications T-141 Through T-146, No. A-93-193, 1993 Neb. App. LEXIS 485, *7.

Developments in Nebraska's groundwater statutes and subsequent appellate opinions have not altered the Supreme Court of Nebraska's reasoning in *In re* Application U-2 that is relevant to this Article. In particular, the court recognized in that case that "underground water storage is not held in neatly confined reservoirs or bins, but is available as nature presents the situation to humans trying to avail themselves of something furnished by nature—the underground strata making water storage possible." *In re* Application U-2, 413 N.W.2d at 296. The court also recognized that it would be "completely unrealistic to pretend [that stored water] . . . will remain in storage precisely under" any particular lands; rather, the stored water will, "of necessity . . . move into the entire natural storage field, following the laws of nature." *Id.* As a result, the court concluded that the relevant water project should not be invalidated "on that account alone." *Id.*

injected 8,000 feet into an aquifer that then migrated under a neighboring landowner's surface estate, the Texas Supreme Court repeatedly declined to address whether an alleged trespass claim could proceed on such facts.[163] Subsequent parties have argued that the court's refusal to address this issue meant that it impliedly recognized the possibility of such a claim—an argument that the Texas Supreme Court has since rejected, in *Lightning Oil Co. v. Anadarko E&P Onshore, L.L.C.*, without resolving whether or not such a trespass claim could proceed on such facts.[164] In sum, in jurisdictions where the highest court has taken the approach followed in *Park County Sportsmen's Ranch*, ASR operators may have little to fear about potential liability on non-statutory common-law trespass claims. But in jurisdictions where the issue has not been litigated, or where the state's highest court has declined to address the issue, some measure of liability risk on trespass claims may remain, although the definite trend in recent decisions from most jurisdictions is bearing against this risk.

B. State-Specific ASR Controls

Section IV.A immediately above examined the ways in which preexisting state law regarding groundwater rights and subterranean trespass might generally affect ASR operations. In addition to these background principles of law that are or might be generally applicable to artificial groundwater recharge, as artificial recharge generally and ASR projects more specifically have grown more common, many states have enacted legislation and regulations that specifically target these methods of underground water storage. In particular, many western states have statutes on the books that expressly authorize artificial recharge and, in some instances, protect at least some of the water rights of groundwater recharge operators.[165]

For example, the California Water Code expressly recognizes that storing water underground, including diverting streams and flowing surface water

163. 457 S.W.3d 414, 416–17 (Tex. 2015). *FPL Farming* was argued before the Texas Supreme Court twice. *See generally* 457 S.W.3d 414; FPL Farming Ltd. v. Envtl. Processing Sys., L.C., 351 S.W.3d 306, 314–16 (Tex. 2011). Both times, the Texas Supreme Court declined to rule whether subterranean trespass claims could be made on such facts, unlike the court in *Park County Sportsmen's Ranch*. *See generally FPL Farming Ltd.*, 57 S.W.3d 414; *FPL Farming Ltd.*, 351 S.W.3d 306.

164. 520 S.W.3d 39, 51–52 (Tex. 2017).

165. *See* GEORGE A. GOULD, DOUGLAS L. GRANT & GREGORY S. WEBER, CASES AND MATERIALS ON WATER LAW 412–13 (7th ed. 2005) (gathering examples of various statutes from western states specifically authorizing and controlling artificial groundwater recharge).

to accomplish such storage, is a beneficial use of water so long as the water is stored and used for a beneficial purpose.[166] In addition, if the entity storing water underground is a public water district, the California Water Code also precludes anyone else from exercising any property rights in the stored waters.[167] To provide two more examples, Arizona and Nevada statutes both establish multilayered systems of permits for subterranean storage and recovery,[168] and Arizona statutes specifically authorize, and sometimes require, public entities to engage in artificial groundwater recharge.[169] State-specific legislation providing at least some protection to artificial recharge operators is not confined to the Southwest: for example, Nebraska statutes recognize that underground storage is a beneficial use, authorize public water suppliers to apply for permits for artificial recharge, and provide that such a recharger can levy fees for withdrawals of recharged water by others.[170]

In addition to the artificial recharge legislation and regulation discussed immediately above, several states have statutes or regulatory programs on the book that target ASR specifically, though given ASR's relatively brief history these rules naturally tend to be of relatively recent vintage.[171] For example, California's State Water Board has promulgated discharge requirements for ASR projects that inject drinking water into groundwater, finding that ASR projects "will improve statewide water management by increasing local storage that will be responsive to the needs of local communities and environmental resources," help fulfill the state's "vast conjunctive use potential," and reduce the strain on particularly stressed aquifers.[172] In Texas, recent legislation has streamlined the relevant portion

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166. CAL. WATER CODE § 1242 (West 2019). In states with systems of surface or groundwater rights that are at least partially based on prior appropriation, water used or appropriated must be put to a beneficial use. *See, e.g.*, ADLER, CRAIG & HALL, *supra* note 39, at 121 (noting that as traditionally understood "beneficial use is the 'basis, the measure, and the limit' of an appropriative right" (quoting UTAH CODE ANN. § 73-1-3 (West 2019))).

167. CAL. WATER CODE § 60351 (West 2019) ("To the extent that ground water supplies are replenished under this act no person shall acquire any property or other right in the waters distributed by the district for replenishment purposes.").

168. ARIZ. REV. STAT. ANN. §§ 45-811.01 to -815.01 (2019) (governing underground water storage, savings, and replenishment); NEV. REV. STAT. §§ 534.0145 to .340 (2019).

169. *See* GOULD, GRANT & WEBER, *supra* note 165, at 412.

170. *See* NEB. REV. STAT. §§ 46-233, -295, -299 (2019).

171. *See* PYNE, *supra* note 67, at 378–80 (noting that in 2005, Arizona, Colorado, Florida, Iowa, Kansas, New Mexico, Nevada, Oregon, Utah, and Washington had ASR-specific statutes or regulations on the books).

172. STATE WATER RES. CONTROL BD., WATER QUALITY ORDER 2012-0010, GENERAL WASTE DISCHARGE REQUIREMENTS FOR AQUIFER STORAGE AND RECOVERY PROJECTS THAT INJECT DRINKING WATER INTO GROUNDWATER (2012) [hereinafter WATER QUALITY ORDER 2012-0010], http://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2012/wqo2012_0010_with%20signed%20mrp.pdf [https://perma.cc/FPZ4-B3ET].

of the Texas Water Code, making the approval process for ASR projects more predictable and less procedurally complex, while directing the Texas Water Development Board to evaluate additional aquifers that might be suitable for ASR.[173]

In recent history, only the state of Georgia has banned ASR outright. In 2001, Georgia legislators enacted a moratorium on ASR based on concerns about potential contamination of the Floridan aquifer.[174] As the chief proponent of the moratorium noted, "We don't want dirty water in our aquifer. . . . Water is such a precious commodity, and when it's messed up, it's messed up—you can't just go cleaning it up by pumping it through some sort of coffee filter."[175] However, the moratorium was ultimately allowed to expire in 2014,[176] despite opposition from local and state environmental groups.[177]

Although opposition to specific ASR projects and to ASR in general has arisen in other states besides Georgia,[178] the end of Georgia's ban

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173. *See infra* Section IV.B.2 (reviewing TEX. WATER CODE ANN. § 11.155 (West 2019)).

174. Craig Pittman, *Georgia Leery of Aquifer Storage*, ST. PETERSBURG TIMES, Mar. 28, 2001, at 6B.

175. Robert Sargent Jr. & Ramsey Campbell, *Well Bill Pumps up a Dispute*, ORLANDO SENTINEL (Apr. 10, 2001), https://www.orlandosentinel.com/news/os-xpm-2001-04-10-0104100186-story.html [https://perma.cc/2R4J-L8RM] (quoting Representative Anne Mueller); *see* Pittman, *supra* note 174.

Opposition to ASR in Georgia was based in part on concerns about problems arising with many of the ASR wells drilled in Florida—and subsequently abandoned—in the 1980s and 1990s. Georgia legislators and the Georgia public were also concerned about draft legislation in Florida, ultimately abandoned, that would have ended the requirement that water injected into aquifers through ASR be purified prior to recharge. *See* Pittman, *supra* note 174 (quoting Representative Mueller again, who argued that the draft Florida ASR legislation was "dumber than dirt").

176. Mary Landers, *Aquifer Injection Gets Another Look After Ban Ends*, SAVANNAH MORNING NEWS (Aug. 3, 2014, 10:47 PM), https://www.savannahnow.com/article/20140803/NEWS/308039823 [https://perma.cc/P2DE-3VAN].

177. *See, e.g.*, ALTAMAHA RIVERKEEPER & GA. WATER COAL., PROTECT OUR WELL WATER AND AQUIFERS: BAN AQUIFER STORAGE AND RECOVERY IN GEORGIA, http://www.altamahariverkeeper.org/oldsite/events/pdf/Fact-Sheet-ASR.pdf [https://perma.cc/8CBU-MM5E]; Chris Manganiello, *Restore Protection for Floridan Aquifer*, GA. WATER WIRE (Feb. 20, 2015), https://gawaterwire.wordpress.com/2015/02/20/restore-protection-for-floridan-aquifer [https://perma.cc/9G3G-EMAU] (urging legislators to vote for a revival of the moratorium on new ASR projects).

178. *See, e.g.*, PYNE, *supra* note 67, at 400–02 (discussing opposition to ASR from environmental nongovernmental organizations and some state legislators in Florida and in Kerrville, Texas).

means that those state statutes and regulations that do specifically refer to ASR are all, to some degree, permissive—but the degree of permissiveness varies by jurisdiction, and many jurisdictions have deliberately altered their groundwater doctrine and relevant permitting processes in recent years to facilitate ASR projects. Space does not permit a full survey of the laws relevant to ASR in every state, but the subsections below provide windows into salient examples that have already been discussed repeatedly in this Article: namely California, Texas, and Florida.

1. ASR and California Groundwater Law

California's baroque system of common law, statute, and regulations probably presents the most confusing labyrinth of any state's water law. California's water law system is the product of myriad departures from both riparian and prior appropriation principles on the surface,[179] the correlative rights doctrine applied to some of the most valuable and overdeveloped aquifers,[180] and a long history of accommodating heavily engineered solutions to surface and groundwater shortages.[181] With respect to groundwater more specifically, the application of the correlative rights doctrine to aquifers that have been depleted for decades to serve heavily developed cities and some of the most intensively farmed agricultural areas of the country has traditionally frustrated regional and statewide water planners.[182]

As one scholar has put it, California's traditional approach to groundwater control almost seems designed more for unpredictable high-stakes litigation than for prevention-oriented planning.[183] And although episodes of past intensive litigation have created bright-line and relatively consistent rules for the sources of groundwater at stake in those particular cases, much of the rest of the state's approach to groundwater has been characterized by an inconsistent and frequently toothless patchwork of special management districts and local ordinances.[184] Despite this confusing patchwork of controls, there are several relatively longstanding ASR projects in California that were developed decades ago and that have been productively managed

179. *See* ADLER, CRAIG & HALL, *supra* note 39, at 128–33 (describing the history and practice of the California doctrine for surface water rights, then locating the California doctrine within a larger taxonomy of dual-system surface water regimes that incorporate riparian and prior appropriation principles).

180. *See generally* Scanlan, *supra* note 43, at 63–64. As noted above, in theory the correlative rights approach protects overlying landowners the most in times of shortage, but its loose approach to reasonable use is often seen as an incentive for litigation. *See supra* note 152 and accompanying text.

181. *See* ARAX, *supra* note 27, at 49–53.

182. Scanlan, *supra* note 43, at 81.

183. *Id.*

184. *See id.* at 82–83.

through the present, particularly in regions stressed by drought, intensifying agriculture, rapid development, or all three.[185]

California's water law remains a confusing labyrinth, but in the last decade—spurred on by the pressures of drought, development, and climate change—state agencies and the state legislature have deliberately turned toward more systematic management of both ground and surface water resources.[186] These efforts at reform have included attempts to streamline procedures for artificial recharge generally and ASR specifically. Two of these reforms are particularly important for the future of ASR in California.

First, in 2012, California's State Water Resources Control Board (State Water Board) issued an order finding that existing and future ASR projects could substantially improve state water management, especially for some of the state's most taxed groundwater resources in the Central Valley.[187] In addition to these findings, the 2012 order set forth a series of procedural reforms to streamline the review and permitting process and provide a general baseline of water treatment requirements for certain "low-threat" ASR projects.[188] "Low-threat" is a key modifier: the State Water Board's 2012 order does not automatically apply to existing ASR projects, and regional water boards retain authority and substantial discretion to regulate individual projects more stringently than the baseline provided by the order.[189] In this way, the 2012 order provides greater predictability and procedural clarity to ASR operators without compromising on monitoring safeguards and other controls meant to prevent ASR's potential side effects.[190]

Second, in 2015, after decades of inaction at the state level while other western states implemented comprehensive statutory and regulatory approaches for managing groundwater,[191] California passed the Sustainable

185. *See, e.g.*, *Aquifer Storage and Recovery*, MONTEREY PENINSULA WATER MGMT. DISTRICT, mpwmd.net/water-supply/aquifer-storage-recovery [https://perma.cc/W9A3-7WPV] (describing the development from 1996 through the present of a multiphase ASR project); *see also* Petersen & Glotzbach, *supra* note 42 (describing an ASR project in Roseville, California, that dates back to 2004).

186. *See* John J. Perona, *A Dry Century in California: Climate Change, Groundwater, and a Science-Based Approach for Preserving the Unseen Commons*, 45 ENVTL. L. 641, 642–43 (2015).

187. WATER QUALITY ORDER 2012-0010, *supra* note 172.

188. *Id.*

189. *Id.*

190. *See id.*

191. Perona, *supra* note 186, at 643.

Groundwater Management Act (SGMA).[192] Perhaps most relevant for ASR, the SGMA sets sustainability as a goal for the statewide management of groundwater[193] and then empowers local Groundwater Sustainability Agencies to manage surface property and water rights, treat and manage water, supervise surface water diverted for underground storage, and control groundwater extraction and allocation.[194] In combination with the State Water Board's 2012 order, the SGMA has provided both a measure of predictability for ASR approval, established a set of goals for which ASR will likely prove a useful tool, and created local bodies with authority and responsibility to address both the potential benefits and the drawbacks of ASR projects.

2. ASR and Texas Groundwater Law

Texas's system of water law is characterized by its longstanding retention of the rule of capture.[195] As noted above, the rule of capture once formed the basis for groundwater law in every U.S. jurisdiction,[196] but it now has been reduced essentially to Texas, and even there it has been modified.[197] The rule of capture is probably the state groundwater doctrine that is the least hospitable to ASR, because it provides ASR operators with no baseline of security in the water that they have injected for storage in an aquifer. In theory, the rule of capture should apply some measure of simplicity and legal predictability to water law disputes—it is often called the law of the "deepest well" or the "biggest pump," which is easy enough for any misbehaving kindergartner to understand—but as applied in Texas in recent years it has been subject to so many epicycles and administrative modifications that even this virtue of clarity has been lost.[198]

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192. The SGMA was comprised of three separate bills. *See generally* Assemb. B. 1739, 2013–2014 Leg., Reg. Sess. (Cal. 2014); S.B. 1168, 2013–2014 Leg., Reg. Sess. (Cal. 2014); S.B. 1319, 2013–2014 Leg., Reg. Sess. (Cal. 2014). For a good descriptive summary of the SGMA's many provisions, see *Groundwater: Sustainable Groundwater Management Act*, U.C. DAVIS, http://groundwater.ucdavis.edu/SGMA [https://perma.cc/EP48-DR7H].

193. CAL. WATER CODE § 10720.1 (West 2019); *see id.* § 10721 (defining "sustainability goal," "sustainable groundwater management," and "sustainable yield" as objectives for state water management).

194. *See* CAL. WATER CODE §§ 10726, 10726.2, 10726.4 (West 2019).

195. Bray, *supra* note 39, at 1285–86.

196. *See supra* notes 144–50 and accompanying text.

197. *See* Bray, *supra* note 39, at 1299–311 (describing the evolution of rule of capture and modifications to same in Texas groundwater law, including the growth of local groundwater conservation districts); *see also* ADLER, CRAIG & HALL, *supra* note 39, at 224 (noting that Maine has also adhered to elements of the rule of capture "in spite of modern hydrology and other concerns").

198. *See* Bray, *supra* note 39, at 1286 n.9, 1299–311.

As a result, thanks to the rule of capture, the background of Texas groundwater law offers much less security to ASR operators than the groundwater law of other states. At the same time, the many exceptions to the rule of capture for groundwater as applied in Texas in recent decades force many of the same costs of complexity on ASR operators as is found in other states. In other words, Texas would appear to offer the worst of all possible worlds, or at least all possible U.S. groundwater legal regimes, to the would-be ASR operator.

But despite the unpredictable and inhospitable inherent nature of Texas groundwater law, several relatively long-standing ASR projects have flourished in Texas—even before the recent reforms discussed below. The story of ASR in Texas begins in the mid-1990s, when the Texas legislature enacted House Bill 1989, creating express statutory authorization for ASR projects within the state.[199] But by 2011, there were still only a handful of ASR projects within the state, largely because of Texas's longstanding adherence to principles of capture for groundwater generally.[200] As a study commissioned by the Texas Water Development Board observed, the inability of ASR operators "to protect the stored water with certainty" given the general application to the rule of capture "reduces or compromises many of the benefits and, as a result, the economics of ASR utilization" in Texas.[201]

In addition to the costs of reckoning with the rule of capture, until relatively recently would-be ASR operators in Texas also had to contend with substantial regulatory complexity at the state and local level in order to win approval for the injection wells necessary to put water in an aquifer for storage.[202] Texas groundwater law, influenced by the rule of capture, has always been relatively permissive about pulling water out of the ground in order to put it to use. But in contrast to the permissiveness traditionally associated with groundwater withdrawals in Texas, ASR operators—until recently—in many parts of the state had to win approval from a number of state as well as local authorities in order to *inject* water into Texas aquifers.[203] Additionally, both state and local agencies frequently imposed

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199. MALCOLM PIRNIE, INC. ET AL., *supra* note 62, at 3.
200. *See id.*
201. *Id.*
202. *See generally id.* at 60–88 (discussing the legal obstacles to Texas ASR in and prior to 2011, including the complicated state and local permitting process in Texas).
203. *See id.* at 77–82 (describing the permitting process for ASR operators in and prior to 2011, including the role of the Texas Commission on Environmental Quality and the role of local Texas groundwater conservation districts).

additional cumbersome special permitting requirements on ASR operators compared to other comparable water users.[204] If capture poses a relatively idiosyncratic problem for ASR in Texas, the problem of layered regulatory complexity—and, beyond the regulatory complexity itself, the absence of a consistent administrative path through these multiple layers of state and local review—has been, at least historically, a problem quite similar to the problem that regulatory complexity used to pose to ASR in California.

Put another way, until very recently it made little sense to store water in an aquifer in Texas, because there was substantial state and local regulatory complexity involved in getting a permit for the necessary injection well—and then once the water was stored underground, it was hard for an ASR operator to do anything to secure rights in the stored water against someone who might drill a bigger well or install a bigger pump. Those ASR projects that did exist in Texas against this backdrop of capture did so by relying on massive infrastructure—attempting to ensure that they would have the biggest pump and wells around for the foreseeable future—or by relying on other unique political, judicial, or geological conditions to overcome the rule of capture.[205] Capture, in other words, can be solved by at least some ASR operators who are willing and able to drill into deep enough aquifers, or acquire substantial surface estates, or wield enough political and economic power to deter competitors. But until recently, regulatory complexity seemed to be a more intractable problem.

In recent years, however, Texas legislators and regulators have worked to address this problem of complexity by providing clear pathways for ASR operators to both obtain permits and operate existing projects. Much like California, Texas has done this by singling out ASR and acknowledging its unique challenges and opportunities, rather than continuing to lump it in with other water uses.[206] More specifically, in 2015 Texas passed ASR-specific legislation, House Bill 655, in order to simplify and streamline the state permitting process for ASR-related injection wells, and to clarify the relative roles of both the relevant state agency, the Texas Commission on Environmental Quality (TCEQ), and local Texas groundwater conservation districts (GCDs).[207]

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204. *See id.*

205. *See id.* at 81–82. For a good and detailed discussion of ASR projects in Texas that have been developed to date, see, for example, Gregg Eckhardt, *Aquifer Storage and Recovery*, EDWARDS AQUIFER WEBSITE, https://www.edwardsaquifer.net/asr.html [https://perma.cc/45XM-HGJ8].

206. *See supra* notes 187–90 and accompanying text (discussing California's Water Order 2012-0010).

207. Mary K. Sahs, *Water Law*, 78 TEX. BAR J. 661, 661–62 (2015) (discussing House Bill 655). *See generally* H.B. 655, 84th Leg., Reg. Sess. (Tex. 2015).

As modified by House Bill 655, the Texas Water Code provides that the TCEQ is the sole permitting authority for ASR operators, thereby streamlining the permitting process for ASR operators.[208] At the same time, the modified statute still requires ASR operators to provide notice of the permit application and reporting of the well operation to the local GCD.[209] It also allows the GCD to regulate the operation if the operator exceeds the terms of the original permit.[210]

In 2019, the Texas legislature enacted three more bills specifically designed to encourage ASR development, though each was more limited than House Bill 655 in 2015.[211] The most significant of these bills, House Bill 720, expands the range of surface water that can be diverted into underground storage through ASR, expands the conditions under which surface water can be diverted, and provides incentives for surface water reservoir operators to consider ASR.[212] Taken together with the 2015 legislation, these recent bills underscore Texas's attempt to streamline the procedural legal complexity that previously faced potential ASR operators, while continuing to provide a role for local input and feedback over state-permitted ASR operations. Unlike Florida's approach, which will be explored below,[213] these Texas changes have created a body of ASR-specific controls tailored to the state, rather than a body of state law that attempts to control ASR along with desalination projects and waste disposal injection wells.

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208. TEX. WATER CODE ANN. § 11.153(b) (West 2019); *see* Sahs, *supra* note 207, at 661–62.

209. TEX. WATER CODE ANN. §§ 27.153(d), 36.453(a), (b), 36.454(b), (c) (West 2019); *see also* Sahs, *supra* note 207, at 661–62.

210. §§ 27.153(d), 36.453(a), (b), 36.454(b), (c); *see* Sahs, *supra* note 207, at 661–62.

211. *See, e.g.*, LEAH MARTINSSON, TEXAS ALLIANCE GROUNDWATER DISTRICTS: 86TH LEGISLATIVE SESSION WRAP-UP 3 (2019), https://texasgroundwater.org/wp-content/uploads/2019/06/86th-legislative-wrap-up.pdf [https://perma.cc/DTD3-C7B7] (discussing and describing House Bills 720, 721, and 1052).

212. H.B. 720, 86th Leg., Reg. Sess. (Tex. 2019) (amending TEX. WATER CODE §§ 11.023, 11.157, 11.158, 27.201 (West 2019)).

The second of the three 2019 ASR bills in Texas, House Bill 721, directed the Texas Water Development Board to conduct studies and a site survey for potential additional ASR sites in the state. H.B. 721, 86th Leg., Res. Sess. (Tex. 2019) (amending TEX. WATER CODE § 11.155 (West 2019)).

The third of the three 2019 ASR bills in Texas, House Bill 1052, authorizes a range of state financial assistance for future ASR projects even if they are not included in the State Water Plan. H.B. 1052, 86th Leg., Reg. Sess. (Tex. 2019) (amending TEX. WATER CODE §§ 16.131, 16.145, 16.146, 16.182, 17.957 (West 2019)).

213. *See* Section III.B.3.

And the result of these changes will likely be more ASR projects like Buda's.[214]

3. *ASR and Florida Groundwater Law*

In contrast to California and Texas, Florida has had a legal system relatively friendly to ASR for many decades. And for most of the past few decades Florida has had more ASR projects than any other jurisdiction, although as noted above, many of Florida's ASR projects have been abandoned.[215] Florida is also a much wetter state than California or Texas, though south Florida is prone to water shortages, and saltwater intrusion into depleted freshwater aquifers has been a problem for decades.[216] Since the mid-twentieth century Florida's approach to water law has been more thoughtful and comprehensive than California's patchwork approach or the historical free-for-all of Texas water law. For example, Florida—a traditionally riparian state with respect to surface water rights—began to apply similar controls to both surface and groundwater uses as early as the 1950s.[217] This departure from the traditional distinction between surface water and groundwater regimes occurred much earlier than many other states, many of which have continued to adhere to the common law's distinctions between surface and groundwater rights.[218]

Florida also adopted a systematic statutory approach to water rights earlier than many other states, largely thanks to the drafting of the comprehensive and thoughtful *Model Water Code* at the University of Florida,[219] which

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214. *See supra* notes 1–8 and accompanying text.

215. *See* Markesteyn, *supra* note 133.

216. Richard C. Ausness, *The Influence of the Model Water Code on Water Resources Management Policy in Florida*, 3 J. LAND USE & ENVTL. L. 1, 3 (1987).

217. *See* Christine A. Klein, Mary Jane Angelo & Richard Hamann, *Modernizing Water Law: The Example of Florida*, 61 FLA. L. REV. 403, 415–16 (2009) (citing Koch v. Wick, 87 So.2d 47 (Fla. 1956)) (noting Florida's early departure from the common law's "failure to appreciate the interdependence of surface and groundwater").

218. *See id.*; *cf.* notes 39, 43, 147–48 and accompanying text (noting the longstanding division between surface and groundwater law in many jurisdictions).

219. In 1968, Frank Maloney, Sheldon J. Plager, and Fletcher N. Baldwin, Jr., published *Water Law and Administration: The Florida Experience*. FRANK E. MALONEY, SHELDON J. PLAGER & FLETCHER N. BALDWIN, JR., WATER LAW AND ADMINISTRATION: THE FLORIDA EXPERIENCE (1968). This formed the basis for the publication in 1972 of *A Model Water Code with Commentary*, written by Maloney, Richard C. Ausness, and J. Scott Morris, which was intended as a proposed regulatory model for Florida as well as any eastern state. FRANK EDWARD MALONEY, RICHARD C. AUSNESS & JOE SCOTT MORRIS, A WATER CODE: WITH COMMENTARY (1972) [hereinafter A MODEL WATER CODE or MODEL WATER CODE]. The *Model Water Code* in turn formed the basis for Florida's Water Resources Act of 1972. For a good account of the development and a robust defense of the merits of both the Water Resources Act of 1972 and *A Model Water Code*, see Klein, Angelo & Hamann, *supra* note 217, at 416–25.

formed the basis for the Water Resources Act of 1972.[220] The Water Resources Act did not follow the *Model Water Code* in every respect: for example, the enacted statute failed to implement the model code's provisions on water quality, which effectively split the management of water quality between multiple state agencies.[221] But the Water Resources Act, like the *Model Water Code* on which it was based, was particularly farsighted in many ways, including its establishment of water management districts based on watershed boundaries rather than political lines, its consistent treatment of surface and groundwater as connected resources, and its emphases on environmental protection and comprehensive planning.[222] Since 1972, Florida water law has continued to develop along the lines generally articulated by the *Model Water Code* and the Water Resources Act.[223]

But challenges remain for Florida water law, many of which stem from inconsistencies between the Water Resources Act and the *Model Water Code* on which it was based.[224] For example, as noted above, the 1972 Water Resources Act effectively split the management of water quality and pollution control between multiple state agencies, and it also failed to give the local water management districts any direct pollution control authority, although the districts do take water quality into account when issuing permits.[225] This gap and the related overlap in Florida's regulatory scheme have remained to the present, leading to unnecessary regulatory complexity—sometimes parties apply for multiple permits when the state Department of Environmental Regulation and water management districts both wish to weigh in on potential water quality issues.[226] The split also creates the possibility of inconsistency when planning and other nonregulatory activities at the district level fail to adhere to water quality standards encouraged at the state level.[227]

Finally, the absence of direct pollution control authority at the local water management district level can make pollution control efforts in Florida

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220. 1972 Fla. Laws 1082 (codified as amended at FLA. STAT. ANN. ch. 373 (West 2019)).

221. Ausness, *supra* note 216, at 18–20. As noted above, Professor Ausness was one of the authors of *A Model Water Code*.

222. Klein, Angelo & Hamann, *supra* note 217, at 421–25.

223. *See id.* at 425–29 (discussing changes to Florida water law since 1972 and concluding that "the fundamental structure and policies of the 1972 legislation seem to have survived the test of time").

224. *See id.* (detailing additional challenges facing Florida water law).

225. Ausness, *supra* note 216, at 27–28.

226. *Id.*

227. *Id.*

less responsive to local concerns than efforts to address water shortages. This creates a regulatory structure that may permit, in relatively short order, a number of projects to address local water quantity issues, but which may be slower to respond if those projects compromise water quality, even if a number of such projects affect water quality in similar ways. And this, of course, is exactly what happened with the development of ASR in Florida in the past few decades. As discussed above, Florida quickly became the nation's leader in ASR projects—and several have been successful—but many of these projects have been abandoned or posed contamination risks that chilled the growth of ASR in Florida and in neighboring states.[228]

In addition, and unlike California or Texas, Florida lacks systematic and ASR-specific rules—while Florida law has contemplated ASR projects for many years, Florida has not recently enacted any ASR-specific comprehensive regulations or passed any ASR-specific statutes.[229] Instead, the Florida statutes and provisions of the Florida Administrative Code that are relevant to ASR refer to other types of water treatment like desalination or reclaimed water,[230] or permits for other types of underground injection.[231] This has created a relatively permissive approach for ASR projects—recall that Florida has by far more ASR projects than any other state.[232] But this flexibility has not provided ASR operators with much predictability regarding their rights and potential liabilities, nor has it provided much protection to Florida aquifers from the side effects listed above.

228. *See, e.g.*, Mike Coates et al., *New Path to Permitting Aquifer Storage and Recovery Systems in Florida*, FLA. WATER RESOURCES J., Oct. 2013, at 46, 46–47 (describing how the "mobilization of arsenic" in Florida aquifers as the result of past ASR projects has contributed to "an uncertain regulatory climate surrounding ASR" as well as many inactive or abandoned ASR systems); *see also supra* notes 123–28, 215 and accompanying text.

229. *See supra* Sections III.B.1, III.B.2; *see also* BLOETSCHER, *supra* note 57, at 14–16 (describing state law relevant to ASR and noting which states have comprehensive ASR statutes or rules, such as California, and which have ASR projects but lack comprehensive and specific ASR statutes or administrative rules, such as Florida).

230. *See, e.g.*, FLA. STAT. ANN. § 180.06(3) (West 2019) (authorizing any municipality or private company "[t]o provide water and alternative water supplies, including, but not limited to, reclaimed water, and water from aquifer storage and recovery and desalination systems").

231. *See* FLA. ADMIN. CODE ANN. r. § 62-610.466 (2019) (providing that ASR systems must meet technical and permitting requirements set forth in Chapter 62-528 of the Florida Administrative Code, which governs underground injection control more generally).

232. *E.g.*, Bloetscher et al., *supra* note 36, at 1617–18.

C. Federal Controls on ASR

At the federal level, the injection wells at the heart of every ASR system are controlled by the Underground Injection Control program (UIC),[233] a series of regulations administered by the Environmental Protection Agency pursuant to the Safe Drinking Water Act (SDWA).[234] The SDWA, originally enacted in 1974, was designed to protect groundwater quality by establishing maximum contaminant goals and levels that would lead to national primary drinking water regulations.[235] As amended, it also requires that states prepare wellhead protection programs to protect areas near wells from contaminants.[236] It is frequently said to protect drinking water "from source to tap."[237]

The UIC regulations are designed to protect underground sources of drinking water (USDWs).[238] These are defined as any aquifer or potion of an aquifer that supplies a public water system with drinking water for human consumption.[239] Most activity under the UIC regulations has focused on what the program defines as "Class II" wells, which are used for the production of oil and gas.[240]

Neither the statutory provisions of the SDWA nor the regulations of the UIC program distinguish between injection wells used for artificial recharge projects or dual-use ASR wells. Instead, the SDWA provides that "underground injection" activities in general endanger "drinking water sources," and are therefore prohibited:

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233. 40 C.F.R. §§ 144.1–148 (2018). For a useful short summary of UIC insofar as it relates to injection wells used for artificial groundwater recharge, see BLOETSCHER, *supra* note 57, at 7–14; UNDERGROUND INJECTION CONTROL STUDY, *supra* note 65.

234. 42 U.S.C. §§ 300f–300k (2012).

235. *E.g.*, TARLOCK ET AL., *supra* note 141, at 630.

236. *Id.* at 630, 690. The EPA has no power to impose wellhead protection programs on states, but financial assistance for states that adopt such a program qualify for grants of 50–90% of the implementation costs. *Id.*

237. *E.g.*, EPA, UNDERSTANDING THE SAFE DRINKING WATER ACT 1 (2004), https://cfpub.epa.gov/watertrain/pdf/sdwa.pdf [perma.cc/V7KP-UQ2Y].

238. 40 C.F.R. § 144.3.

239. *Id.* More specifically, 40 C.F.R. § 144.3 defines a USDW as a nonexempt aquifer, or any portion of a nonexempt aquifer, "[w]hich supplies any public water system . . . [or] contains a sufficient quantity of ground water to supply a public water system" and which either "[c]urrently supplies drinking water for human consumption . . . [or c]ontains fewer than 10,000 mg/l total dissolved solids." *Id.*

The Director of the EPA may exempt certain aquifers, which otherwise would qualify as USDWs, under the procedures set forth in 40 C.F.R. § 144.7.

240. TARLOCK ET AL., *supra* note 141, at 690.

> [I]f such injection may result in the presence in underground water which supplies or can reasonably be expected to supply any public water system of any contaminant, and *if the presence of such contaminant may result in [a public water] system's not complying with any national primary drinking water regulation* or may otherwise adversely affect the health of persons.[241]

National primary drinking water regulations are defined in terms of "maximum contaminant level goals,"[242] which in turn are "set at the level at which no known or anticipated adverse effects on" health occur.[243]

In addition to the controls on injection activity directly within the text of the SDWA, the relevant UIC regulations classify all "[r]echarge wells used to replenish the water in an aquifer," all "[s]alt water intrusion barrier wells used . . . to prevent the intrusion of salt water into [a] fresh water [aquifer]," and all "[d]rainage wells used to drain surface fluid, primarily storm runoff, into a subsurface formation" as "Class V" wells.[244] Thus, the portion of the UIC regulations applicable to ASR—or indeed to any form of artificial recharge that makes use of injection wells—are those that refer to Class V wells. Other examples of Class V wells largely unrelated to artificial groundwater recharge include cesspools, dry wells used to inject waste into subsurface formations, and cooling water return flow wells.[245] Indeed, most of the more than 600,000 Class V wells have nothing to do with groundwater recharge generally or ASR specifically, but are instead relatively simple disposal systems for unwanted waste materials.[246] This legal connection between ASR dual-use wells and the waste disposal wells will appear again—it is implicated by recent litigation currently pending before the Supreme Court that will be discussed at the end of this Section.

With respect to the SDWA's reference to a baseline of compliance with any and all national primary drinking water regulations, the relevant UIC regulation specifies that no "*injection activity* [shall] allow[] the movement of fluid containing *any* contaminant into [UDSWs,] . . . if the presence of that contaminant may cause a violation of any primary drinking water regulation" or otherwise adversely affect health.[247] In other words, as will be discussed at greater length below, this regulatory interpretation of the

241. 42 U.S.C. § 300h(d)(2) (2012) (emphasis added).
242. *Id.* § 300g-1(a)(3).
243. *Id.* § 300g-1(b)(4)(A).
244. 40 C.F.R. § 146.5(e)(4), (6), (7) (2018).
245. *Id.* § 146.5(e)(2), (3), (5).
246. *Class V Wells for Injection of Non-Hazardous Fluids into or Above Underground Sources of Drinking Water*, U.S. ENVTL. PROTECTION AGENCY, https://www.epa.gov/uic/class-v-wells-injection-non-hazardous-fluids-or-above-underground-sources-drinking-water [https://perma.cc/W7LP-CUL8].
247. 40 C.F.R. § 144.12(a) (2018) (emphasis added).

SDWA works substantial limitations on the use of injection wells for artificial recharge generally and ASR more specifically, in part because it does not allow injection well operators to rely on the natural dilution and decontamination processes in aquifers themselves.[248]

The EPA directly implements the Class V UIC regulatory program in a handful of states as well as on most tribal lands, but states may obtain primary enforcement responsibility for injection controls over Class V wells if they meet the requirements set forth in the statute.[249] As a result, in most but not all jurisdictions, state agencies rather than the EPA have at least some responsibility for the UIC regulatory program and over Class V wells.[250] These states, also known as "primacy states," are those states that have been given primary enforcement responsibility to administer the UIC program themselves, using standards at least as strong as the federal program.[251] In states without primacy, known as "direct implementation" states, the EPA regional office directly administers the UIC regulations—although the EPA can also bring enforcement actions in primacy states, if the relevant state fails to take an enforcement action after sufficient notice.[252] Primacy states usually place regulation relevant to the UIC program under the state environmental or water protection agency, but in primacy states where the relevant water or environmental agency does not handle water quantity or water rights issues, then the UIC authority may rest with the relevant oil and gas agency.[253]

248. *Compare* 42 U.S.C. § 300h(d)(2) (2012) (prohibiting injections with contaminants if it might cause a public water system to fall out of compliance with any national primary drinking water regulation), *with* 40 C.F.R. § 144.12(a) (prohibiting injections with contaminants if the contaminant's presence in the USDW might violate any national primary drinking water regulation).

249. *See* 42 U.S.C. § 300h-1 (2012) (providing the criteria for state primary enforcement responsibility).

250. For a list of the various states' and territories' responsibilities for the UIC Program, see generally EPA, STATES' AND TERRITORIES' RESPONSIBILITY FOR THE UIC PROGRAM (2015), https://www.epa.gov/sites/production/files/2015-10/documents/primacy_status_table_revised_508c.pdf [https://perma.cc/H7PY-U982].

251. *See* EPA, AN OVERVIEW OF THE SAFE DRINKING WATER ACT 44 (2002), https://cfpub.epa.gov/watertrain/pdf/sdwa.pdf [https://perma.cc/L5AP-J2SD].

252. *Id.* at 44, 47.

253. BLOETSCHER, *supra* note 57, at 14–15. For a handy color coded series of maps of the various tiers of UIC primacy programs, see EPA, PRIMARY ENFORCEMENT AUTHORITY FOR THE UNDERGROUND INJECTION CONTROL PROGRAM, www.epa.gov/uic/primary-enforcement-authority-underground-injection-control-program [https://perma.cc/J9WB-BNSL].

The distinction between primacy and direct implementation means that the regulatory requirements that govern injection wells necessary for ASR differ significantly across jurisdictions, including those states where the greatest number of ASR systems and wells exist.[254] In general, control over Class V wells is primarily a matter of permitting: the UIC regulatory program focuses primarily on whether or not an injection project should be allowed to go forward.[255] However, some states with partial or full primacy over Class V wells depart from the federal requirements, imposing additional rules beyond the federal baseline.[256] Depending on the jurisdiction, these enhanced state requirements might include requirements that the injected water remain in a particular zone of the aquifer, or that no unapproved interchange of injected water with water from another aquifer should occur.[257]

All of this means that the most significant controls over ASR projects usually come from state agencies—which is consistent with the degree to which groundwater law has traditionally been confined to state rather than federal control. But there is one potential exception to this general trend—an exception that is related to a case that is currently pending in front of the U.S. Supreme Court, *County of Maui v. Hawai'i Wildlife Fund*,[258] and which has the potential to alter the future of ASR usage across the United States.[259] At issue in *Hawai'i Wildlife Fund* are a number of injection wells owned and operated by the county for wastewater disposal.[260] More specifically, sewage is treated by the county at a wastewater plant, then injected into deep wells, where some of it mingles with groundwater, and much of it eventually reaches the Pacific Ocean.[261]

The wells at issue in *Hawai'i Wildlife Fund* are not ASR wells; rather, they are designed and operated for wastewater disposal, not for reuse of the water.[262] Moreover, the potential contamination of the Pacific Ocean by this treated wastewater, rather than aquifer contamination, is the main substantive issue in the case.[263] For example, the Ninth Circuit opinion noted that the system injects roughly the equivalent of a permanently running

254. *E.g.*, UNDERGROUND INJECTION CONTROL STUDY, *supra* note 65, at 2.
255. BLOETSCHER, *supra* note 57, at 14.
256. *Id.*
257. *Id.*
258. 139 S. Ct. 1164 (2019) (mem.).
259. *See, e.g.*, Infeld, Munger & Roberts, *supra* note 100 (arguing that the Supreme Court's potential disposition of *Hawai'i Wildlife Fund*, argued on November 6, 2019, is a "variable that may affect the future of ASR usage in the United States").
260. Hawai'i Wildlife Fund v. County of Maui, 886 F.3d 737, 742 (9th Cir. 2018), *cert. granted*, 139 S. Ct. 1164 (2019) (mem.).
261. *Id.*
262. *Id.*
263. *Id.*

garden hose of treated effluent into the ocean at every meter along an 800-meter stretch of coastline.[264]

What makes *Hawai'i Wildlife Fund* so potentially significant for future ASR development is that the treated wastewater injection wells at issue in this case were properly permitted under the UIC regulatory program of the SDWA.[265] The chief legal issue in the case is whether these wells also should be governed by the Clean Water Act (CWA)[266] and the National Pollution Discharge Elimination System (NPDES).[267] Briefly, the Clean Water Act prohibits the "discharge of any pollutant by any person"[268] and defines such discharge as the addition of from "any point source."[269] A "point source," in turn, is defined as any conveyance from which pollutants are or may be discharged, not counting agricultural stormwater discharges or return flows from agricultural irrigation, but including any pipe, ditch, channel, tunnel, container, and so forth from which pollutants are or may be discharged.[270] The most frequently litigated issue of the CWA's application is its limitation to "navigable waters,"[271] defined in the statute as "the waters of the United States, including the territorial seas."[272]

Both the district court and the Ninth Circuit panel in *Hawai'i Wildlife Fund* held that the wastewater injection wells at issue were point sources that should be subject to the NPDES; that the operation of the wells and discharge of the effluent without an NPDES permit violated the CWA; and finally, that the county had fair notice of the CWA violation.[273] The key argument for the county—an argument rejected by the Ninth Circuit—was

264. *Id.*
265. Infeld, Munger & Roberts, *supra* note 100.
266. *See* Clean Water Act (CWA), 33 U.S.C. § 1251 (2012 & Supp. V 2017).
267. *See* 33 U.S.C. § 1342 (2012 & Supp. V 2017) (establishing the NPDES); *NPDES Permit Basics*, U.S. ENVTL. PROTECTION AGENCY, https://www.epa.gov/npdes/npdes-permit-basics [https://perma.cc/XC5T-MKYH] (last updated. July 12, 2019).
268. 33 U.S.C. § 1311(a) (2012 & Supp. V 2017).
269. *Id.* § 1362(12).
270. *Id.* § 1362(14).
271. *E.g.*, Rapanos v. United States, 547 U.S. 715, 723–29 (2006) (plurality opinion) (reviewing decades of litigation over the meaning of "navigable waters" under the CWA). *See generally* Michael P. Healy, *Law, Policy, and the Clean Water Act: The Courts, the Bush Administration, and the Statute's Uncertain Reach*, 55 ALA. L. REV. 695 (2004) (discussing the history and framing of such litigation before *Rapanos*).
272. 33 U.S.C. § 1362(7) (2012 & Supp. V 2017).
273. Hawai'i Wildlife Fund v. County of Maui, 886 F.3d 737, 744–45, 749–52 (9th Cir. 2018), *cert. granted*, 139 S. Ct. 1164 (2019) (mem.); Hawai'i Wildlife Fund v. County of Maui, 24 F. Supp. 3d 980, 988, 993–95, 1004–05 (D. Haw. 2014), *aff'd*, 886 F.3d 737 (9th Cir. 2018), *cert. granted*, 139 S. Ct. 1164 (2019) (mem.).

that because the wastewater injections first passed through an obviously non-navigable aquifer before reaching the obviously navigable Pacific Ocean, the CWA and therefore the NPDES should not apply.[274]

This issue highlights the potential significance of *Hawai'i Wildlife Fund* to future ASR development across the country. Although the injection wells at issue in this case are not ASR wells, if they are held to be subject to the NPDES because the water injected through them ultimately links up with navigable water, then many ASR wells also might be subject to the NPDES permitting regime. This would work a substantial expansion of federal oversight over future ASR projects.[275] Whether or not this is a bad thing, of course, depends on a number of factors, including but not limited to the degree to which one worries about aquifer contamination as a result of ASR projects.[276] The merits and faults of such a potential expansion of federal oversight over future ASR projects will be discussed along with several other issues in Part V below.

V. Suggestions for Reform

Part III of this Article examined the many technical problems with ASR. Part IV of this Article surveyed the legal landscape, including many of the obstacles identified by boosters of ASR. Part IV also pointed out the ways in which many of these alleged legal obstacles are deeply intertwined with the technical challenges that many ASR projects have and likely will continue to face. For example, it is certainly true that the Georgia statutory ban on ASR projects within that state was the greatest obstacle, legal or otherwise, to ASR development within that state until it was repealed.[277] But of course that legal ban was prompted by widespread technical failures with many ASR projects in the neighboring state of Florida.[278] In other words, it is impossible to understand the legal obstacles to ASR that existed in Georgia without understanding the many technical problems that existed and may still remain in many places.

In Part V, this Article will review and advance suggestions for reform of the state and federal law relevant to ASR. Part V will also critically examine a pair of related observations first introduced at the end of Part III: first, the idea that the biggest obstacles to future ASR development are legal rather than technical; and second, the idea that legal complexity is one of

274. *Hawai'i Wildlife Fund*, 886 F.3d at 745–49.
275. *E.g.*, Infeld, Munger & Roberts, *supra* note 100; *see supra* notes 233–53 and accompanying text (describing the UIC regulatory program).
276. *See supra* Section III.A.
277. *See supra* notes 174–77 and accompanying text.
278. *See supra* notes 174–77 and accompanying text.

the chief legal obstacles that ASR faces.[279] As the Georgia-Florida example illustrates, these observations can be literally true but also misleading: even when the legal obstacles to ASR in a particular jurisdiction amount to an outright ban, they are inseparable from the complicated technical challenges that many ASR projects face.

Before deciding whether the complexity of existing legislation and regulation is, in fact, the specific greatest obstacle for future ASR development, it is necessary to spend a moment unpacking "legal complexity." The notion of legal complexity is, unfortunately, almost as underexamined as the law related to ASR. Legal complexity means many different things to different people, and relatively little work has been done to unpack these multiple meanings.[280]

One key point that has emerged from the existing research on legal complexity is the distinction between legal standards and doctrines that are complex because they are inherently tricky or complicated and legal systems that are complex because they involve many different people or institutions interacting in complicated and unpredictable ways.[281] The first type of complexity is unavoidable in a world with tough problems, as complicated problems often require complicated rules to solve them.[282] Indeed, this feature of the world is not particularly legal, and it may be foolish to expect complex systems like ASR to be reducible to simple rules, legal or otherwise.

More interesting are the problems that arise from systematic legal complexity. Even if all of the legal rules relevant to a particular problem are relatively straightforward, the system itself may be unnecessarily complex because of complicated interactions between the people or agencies administering the system.[283] Here the claim that existing ASR law is unnecessarily complex finds safer ground. For example, recall that the substance of Florida's statutory controls on ASR is not very complex at all—instead, ASR is lumped in with a number of other engineered techniques

279. *See supra* notes 62, 131–32, 139 and accompanying text.
280. *See* J.B. Ruhl & Daniel Martin Katz, *Measuring, Monitoring, and Managing Legal Complexity*, 101 IOWA L. REV. 191, 197 (2015) (noting how poorly we understand the causes, consequences, cures, and nature of legal complexity).
281. *Id.* at 201–02.
282. *Cf. id.* at 201 ("Few dispute that law is complicated; whether it is complex in the systems context is another matter.").
283. *See id.* at 201–02 (explaining systems burdens and effects in the context of complexity science as they may be relevant to legal problems).

for addressing water shortages, such as desalination.[284] But the procedural and administrative system for permitting and then supervising ASR projects in Florida is relatively complex, with multiple state and local bodies whose respective roles are poorly defined.[285]

Armed with this understanding of legal complexity, the remainder of Part V will examine and advance a number of suggestions for reform of the legal controls on ASR. More specifically, Section V.A will examine critiques and suggestions for reform of federal controls on ASR projects. Section V.B will do the same for state controls on ASR projects.

A. Suggestions for Reform of Federal Controls on ASR

Section IV.C introduced the relationship between ASR, the SDWA, and the UIC regulatory program. Some enthusiastic proponents of ASR claim that the SDWA and the UIC regulatory program work as an unnecessary drag upon useful and efficient ASR projects. More specifically, such advocates for ASR believe that the SDWA and the UIC are too burdensome primarily because of their complexity: first, because the SDWA and the UIC are complicated in themselves; second, and perhaps more importantly, because the rules governing primacy and direct implementation states impose substantial information costs on would-be ASR operators to simply learn what the rules are for their desired project in the first place.[286]

Still others argue that the SDWA and the UIC are overly restrictive, but for substantive rather than procedural reasons. Pointing to the more lenient regulation of ASR in other countries, these advocates for the expanded use of ASR argue that it is a mistake to insist that water injected into an aquifer as part of an ASR project must comply with drinking water standards prior to storage.[287] For advocates of ASR who are also critics of the substantive standards of the SDWA and the UIC, part of the problem is that the standard of compliance with "national primary drinking water regulation[s]" at the heart of the SDWA acts as a one-way ratchet.[288] Over time, tools for measuring contaminants grow ever more sensitive and precise, which in turn increases

284. *See supra* note 230 and accompanying text.

285. *See supra* notes 224–32 and accompanying text.

286. *See, e.g.*, *Aquifer Storage & Recovery*, GROUND WATER PROTECTION COUNCIL, http://www.gwpc.org/programs/water-availability-sustainability/aquifer-storage-recovery [https://perma.cc/RF7S-QKHB] (noting that "regulatory complexity [is] an obstacle in many cases" for new ASR projects, due to the overlapping layers of federal and state controls created by the UIC program and primacy states).

287. PYNE, *supra* note 67, at 374–75, 381–82; *see* BLOETSCHER, *supra* note 57, at 5–6 (noting that "[w]hile ASR can be an attractive alternative to aboveground storage," the challenge of meeting the requirements for drinking water is an obstacle that must be addressed by regulatory agencies).

288. *E.g.*, PYNE, *supra* note 67, at 381–82 (quoting 42 U.S.C. § 300h(d)(2) (2012)).

public awareness and concern about drinking water contamination. This, in turn, means that drinking water regulations grow ever more restrictive and expensive to comply with, and because the SDWA's substantive standards are tied to this ever more stringent standard, the costs of compliance will also steadily rise, perhaps beyond the means of some ASR operators.[289]

It will be helpful to keep in mind the different types of legal complexity outlined above while evaluating these suggestions for reform. The substantive critique—the idea that the SDWA and UIC are too complex because the standards they require ASR operators to meet are too complicated and burdensome—is the easiest to unpack. To the extent that the UIC regulatory regime applying the SDWA's "national primary drinking water" standard is complex in this respect, it is because it is an inherently complicated attempt to solve a complicated problem. Safe drinking water is important; our scientific understanding of what might make drinking water unsafe can be expected to advance over time; moreover, fixing a contaminated aquifer is at best extremely difficult,[290] so the cost of a complicated standard may be worthwhile, even necessary, in order to prevent such substantial and complicated harm.

While the substantive complexity of the SDWA and UIC regulatory system for ASR projects is not necessarily unwarranted, in light of the harms involved, there is some procedural complexity involved in the system as well. For example, the difference between primacy states and direct implementation states is complicated and time consuming to explain, and it results in jurisdictional legal variety. This certainly imposes costs of procedural complexity in terms of the effort and information burdens needed to learn about and comply with the jurisdictional variations under the UIC program.[291] In other words, there is certainly systematic complexity here—but once it is explained, this complexity is reducible to a handy color coded map and table.[292] And by taking on this complexity, the system can allow for variety among states to apply standards for ASR and other injection wells that may make regional or local sense. The alternative would be a single national baseline for all relevant injection wells—even though geological and hydrological conditions vary enormously within some states,

289. *See id.*
290. *See, e.g.*, Ausness, *supra* note 216, at 2 (noting that groundwater pollution "is a matter of great concern because [it] is almost impossible to reverse once it has occurred").
291. *See* Ruhl & Katz, *supra* note 280, at 201–02 (discussing various costs of systematic legal complexity).
292. *See supra* notes 250, 253.

let alone across the country.[293] Accordingly, the cost of imposing potential interstate complexity on ASR operators who may wish to operate projects in multiple jurisdictions seems a modest cost to pay for this flexibility.

A final area of potential complexity in federal law that might become more applicable to ASR projects is presented by the issues raised in *Hawai'i Wildlife Fund*, and the possibility that ASR projects might be subject to permitting and other oversight under the NPDES and CWA as well as the UIC and SDWA if the Supreme Court affirms the lower courts' holdings. Some boosters of ASR have criticized this potential outcome as a development that "would impose an ill-suited regulatory scheme" on ASR systems, disincentivizing ASR operators from investing "in these environmentally beneficial water management practices."[294] Part of the concern is simply the burden that any regulation imposes; another part of the concern is attributable to the nature of the NPDES program. But part of the concern being raised by ASR boosters in response to the potential outcome of *Hawai'i Wildlife Fund* is related to complexity, above and beyond the substance of the CWA and the NPDES.

This is obviously an example of procedural complexity in terms of the effort and information burdens involved—just keeping the alphabet soup of the relative acronyms straight is a little complicated. Beyond the effort and information costs involved, extending the NPDES system to UIC-regulated injection wells carries the potential for additional costs of system complexity. When multiple legal doctrines or regulatory regimes can apply to the same action, they carry the potential for system burdens that go beyond the effort and information burdens noted above.[295]

Readers can judge for themselves the odds that the current Supreme Court will render the potential outcome in *Hawai'i Wildlife Fund* outlined above.[296] But even if this outcome comes to pass—even if future ASR activity is chilled by the sort of procedural complexity and system burdens contemplated above, then there are any number of relatively straightforward solutions that could be readily achieved. For example, if the Supreme Court affirms the lower courts' holdings in *Hawai'i Wildlife Fund*, then the CWA and SDWA could be rewritten or amended, providing a new and ASR-specific

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293. *See supra* notes 96–99 and accompanying text.

294. *See* Infeld, Munger & Roberts, *supra* note 100.

295. *See, e.g.*, Ruhl & Katz, *supra* note 280, at 201–02 (distinguishing between such oft overlooked "system burdens" of complex legal regimes and the "effort burdens" and "information burdens" associated with other types of legal complexity).

296. County of Maui v. Haw. Wildlife Fund, 139 S. Ct. 1164 (2019). The Supreme Court heard oral arguments on November 6, 2019. County of Maui, Hawaii v. Hawaii Wildlife Fund, SCOTUSBLOG, https://www.scotusblog.com/case-files/cases/county-of-maui-hawaii-v-hawaii-wildlife-fund [https://perma.cc/335G-X6UC]. At the time this Article went to press, *Hawai'i Wildlife Fund* remained undecided.

federal statutory and regulatory regime for ASR wells distinct from the wastewater and oil and gas injection wells. Such an approach could preserve the state jurisdictional variety currently found under the UIC's distinction between primacy states and direct implementation states[297]—under such an approach, it would be important to provide clear procedural paths for any given project, not identical procedural paths for all given projects. And while such an outcome might seem implausible, it also seemed implausible just a few short years ago that California and Texas would create streamlined procedural paths for ASR while retaining much of the substantive idiosyncrasies of their state water law.[298]

B. Suggestions for Reform of State Controls on ASR

Sections IV.A and IV.B reviewed the various state law controls that apply or that might apply to ASR projects. In particular, Section IV.A reviewed conflicts over recovery rights and potential trespass claims that have been or might be associated with ASR projects in different states, and which have been identified by some ASR advocates as potential obstacles to future projects.[299] Most obviously, complicated state water rights systems can give competing groundwater users claims to water injected into an aquifer by an ASR operator—and if that operator does not have substantial confidence in its ability to withdraw the injected water, then its incentive to maintain or develop ASR projects also will disappear.[300]

Accordingly, critics of certain state approaches to groundwater rights or trespass doctrines are surely right when they identify these approaches as potential barriers to ASR. But it is important not to overstate the case: both California and Texas, for different reasons, have perhaps the most substantively complicated and, in the case of Texas, substantively inhospitable systems of groundwater rights for ASR projects.[301] Yet ASR projects have been developed in both states and continue to be developed: the example of

297. *See supra* notes 249–57 and accompanying text.
298. *See supra* Sections IV.B.1, IV.B.2.
299. *See* PYNE, *supra* note 67, at 374–76 (discussing the ways that competing state law water rights claims can affect ASR projects in the absence of comprehensive state legislation or regulation); Bloetscher et al., *supra* note 36, at 1626–27 (noting that complications related to competing state law water claims and recovery rights are an ongoing problem for ASR development).
300. Bloetscher et al., *supra* note 36, at 1627.
301. *See supra* Sections IV.B.1, IV.B.2.

Buda discussed at the outset of this Article is but one such example.[302] In contrast, in Florida—a state with an enlightened water code,[303] and one which has long permitted ASR projects within its borders—over half of the ASR projects that have been developed have suspended operations or been abandoned due to contamination, clogging, cost issues, or a combination of all three.[304]

In addition to the complications arising from the water rights and trespass doctrines that have developed in various state courts, some advocates of ASR have also identified the alleged complexity of more comprehensive systems of state statutory and regulatory control as another substantial barrier to future ASR development, at least in those jurisdictions where they exist.[305] Accordingly, Section IV.B above reviewed these claims and the range of state statutory and regulatory approaches to ASR. In particular, Section IV.B focused on the statutory and regulatory schemes in the key jurisdictions of California, Texas, and Florida.

It may be easiest to think about the ASR-related statutory and regulatory complexity within states as representing a spectrum of approaches.[306] At one—procedurally complex—end of this spectrum are those states with a plethora of agencies, statutes, and regulations that each address one specific aspect of ASR control—such as surface water withdrawals, groundwater storage rights, and water quality or pollution issues.[307] At the other—procedurally straightforward—end of the spectrum are those states with statutes and regulations presenting a streamlined permitting and oversight process, with one agency that has primary if not sole responsibility over ASR projects while also serving as the primary contact for ASR operators.[308]

Critics of the alleged complexity of state law controls for ASR have a better argument to make on this point: the procedural complexity imposed on one end of this spectrum does impose real obstacles on the development of ASR, as the experiences of California and Texas before their recent

302. *See, e.g.*, Jim Smith, *What Is Woodland Public Works Working on Around Town? Here's a List*, DAILY DEMOCRAT, https://www.dailydemocrat.com/2019/04/03/woodland-public-works-crews-involved-in-infrastructure-projects [https://perma.cc/4YZ9-Z7CF] (last updated Apr. 3, 2019, 11:47 AM) (noting that two ASR wells in Woodland are currently injecting 2.6 million gallons of water per day into an aquifer beneath the community); *see also supra* notes 1–8 and accompanying text (discussing Buda's new ASR system).

303. *See supra* notes 217–23 and accompanying text.

304. Markesteyn, *supra* note 133, at 1.

305. *See* BLOETSCHER, *supra* note 57, at 12–13 (noting that the complexity of ASR-related regulations and the variety of administrative bodies responsible for ASR projects within states means that even "carefully laid plans might be frustrated").

306. *See, e.g.*, PYNE, *supra* note 67, at 380 (discussing the range of ASR-specific statutes and regulations across various states).

307. *See id.*

308. *See id.*

reforms show.[309] So too does the Florida experience demonstrate this point: although the procedural complexity and the relatively lax permitting and oversight associated with this procedural complexity probably contributed to the burst of ASR development in the 1990s and 2000s, it probably also contributed to the problems of contamination and abandonment that beset many of these projects in the years that followed.[310]

But the experiences of California and Texas after their recent regulatory and statutory reforms show that states can move quickly from the procedurally complex end of the spectrum to the procedurally straightforward end. Each of these states' systems for groundwater control were among the most procedurally complex in the country, both for ASR projects specifically as well as other types of artificial recharge and sustainable groundwater management more generally.[311] And both states are now arguably models, at least in part, for their procedurally streamlined approach to ASR permitting and oversight.

California's comprehensive revision of its overall approach to groundwater controls already has been hailed as a model by others.[312] But with respect to ASR controls more narrowly, Texas's recent statutory reforms may provide the best recent template for other jurisdictions to consider. Whereas California has addressed ASR through comprehensive regulation,[313] in the last half-decade Texas has enacted multiple ASR-specific statutes that provide a procedurally straightforward path with a single responsible state agency.[314] In addition to eliminating unnecessary procedural complexity, these statutory reforms have also created safeguards to ensure that local agencies are kept informed and have regulatory options if the scope of the project changes.[315] It is unusual, to say the least, for anything associated with Texas groundwater

309. *See supra* Sections IV.B.1, IV.B.2.

310. *See supra* Section IV.B.3; *see also* Bloetscher et al., *supra* note 36, at 1617–27 (discussing results of survey, including growth and abandonment of Florida ASR systems).

311. *See* Bloetscher et al., *supra* note 36, at 1626–27; *see also* Scanlan, *supra* note 43, at 83–85 (describing the historically disorganized state of California's groundwater law, and concluding that prior to passage of the SGMA, California was an extreme outlier compared to other western states).

312. Scanlan, *supra* note 43, at 80 (arguing that California under the SGMA can "provide a model for other jurisdictions that face [water] scarcity, weather extremes, and population pressures").

313. *See supra* Section IV.B.1.

314. *See supra* Section IV.B.2.

315. *See supra* Section IV.B.2.

law to be identified as a positive model for other jurisdictions to emulate,[316] but with respect to the state's new and developing approach to ASR controls, it is appropriate, and other jurisdictions should pay attention.

VI. CONCLUSION

ASR is a relatively new technology, but as Part II has shown, it has been around for decades in the United States, and it rests upon engineered approaches to artificial recharge of aquifers that reach back centuries if not millennia. Unlike such centuries old approaches to artificial recharge, ASR's progress has been marked by technical problems, especially in the United States, as Part III has shown. These problems of abandonment, contamination, well clogging, and unpredictable recovery rates have kept ASR in a state of perpetual youth. Its time has been coming for decades.[317] But its actual development has been halting and uneven.

According to some of ASR's boosters, these technical problems are a sideshow, because ASR's growth has been checked chiefly by existing or potential future legal obstacles, especially the allegedly unnecessary complexity of the federal and state controls that have come to be applied to ASR projects. These claims have some merit: for example, it is true that in many jurisdictions procedural complexity at the state law level imposed substantial system burdens on ASR operators. But these claims also can obscure the degree to which legal obstacles to ASR's development are deeply related to the technical problems that have blocked ASR's development as well.

More specifically, while many have criticized the existing system of federal controls on ASR projects as unnecessarily complex, much of this complexity may be warranted. For example, it is true that the relevant "national primary drinking water" standard imposed by the SDWA can be both difficult to meet and is to some degree a perpetually moving target. But there are reasons for this substantive complexity, which find support in the technical complexity and high costs of ASR-related problems, especially aquifer contamination. And where unnecessary procedural complexity does exist in state and federal law relevant to ASR, recent reforms enacted in Texas and California suggest that there are multiple ways to reduce this problematic complexity while retaining meaningful permitting and supervisory authority over current and future ASR projects.

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316. *See* Bray, *supra* note 39, at 1285–87 (noting that most scholars consider Texas groundwater to be a tragic outlier).

317. *See generally* Peter G. Scott, *Aquifer Storage and Recovery in the Columbia Basin: The Need for Action*, 21 PUB. LAND & RESOURCES L. REV. 35 (2000).

After surveying the technical and legal issues that surround ASR in the United States today, it is clear that ASR has enormous potential to alleviate the emerging groundwater crisis in many regions of the country. This future is fragile: ASR has already had to overcome an outright ban in one state. But it is a mistake to claim that this fragility is purely or primarily legal in nature, as some of ASR's most enthusiastic advocates have done.

Such a claim obscures the side effects of some ASR projects, including but not limited to aquifer contamination—which in the United States has been most problematic in Florida, the state with the most permissive legal regime for ASR and the most ASR projects to date. Moreover, as the examples of Texas and California show, the law relevant to ASR in most jurisdictions can be improved relatively quickly, without requiring wholesale revision of a state's water law. The future of ASR in this country will be informed by the degree to which other states adopt reforms like these—and the extent to which such reforms can guide existing and future ASR operators to maximize the amount of water stored and recovered while minimizing the potential for contaminating the nation's invaluable and irreplaceable aquifers.