Prelude to the Future of Shale Gas Development: Well Spacing and Integration for the Fayetteville Shale in Arkansas

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I. INTRODUCTION

The Fayetteville Shale[1] spans across Arkansas in a belt, approximately fifty miles from north to south, running from the north through the central part of the state to the Mississippi River on its eastern flank and encompassing 9,000 square miles.[2] The deposition is an unconventional[3] "tight sand" resource, characterized by low permeability, which requires reservoir stimulation to enhance the permeability so the gas may be produced. The Fayetteville Shale is as "tight as a tick" with permeability measured by nanodarcies as opposed to millidarcies. The Barnett Shale[4] play in Texas is the first modern shale gas development and the progenitor of the present shale-gas boom in the United States. The successful development of the Fayetteville Shale in Arkansas is a

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1. The Fayetteville Shale is a Mississippian-age shale that is the geological equivalent of the Caney Shale in Oklahoma and the Barnett Shale in North Texas. The Fayetteville formation is composed mainly of a black, fissile, concretionary, clay shale. Dark gray, fine-grained limestones are commonly interbedded with the shales in north central Arkansas. The middle to lower stratigraphic section of the Fayetteville Shale is represented by an organic-rich facies consisting of black and pyritic shale, with subordinate amounts of interbedded siliceous chert and siltstone. The most prolific gas production from the Fayetteville Shale is associated with horizontal wells that have been completed with multi-stage fracs in the middle to lower portions of the formation. The thickness of the Fayetteville Shale ranges from less than fifty feet in the western portion of the play to over 550 feet in the eastern portion.

2. U.S. DEP'T OF ENERGY, MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES: A PRIMER 19 (2009), available at http://www.netl.doe.gov/technologies/oil-gas/publications/EPreports/Shale_Gas_Primer_2009.pdf.

3. *See id.* at 15.

> Wells in conventional gas reservoirs produce from sands and carbonates (limestone and dolomites) that contain the gas in interconnected pore spaces that allow flow to the well bore. Much like a kitchen sponge, the gas in the pores can move from one pore to another through smaller pore-throats that create permeable flow through the reservoir.

Id.

4. "[T]he fledgling Barnett Shale play in Texas produces 6% of all [the] natural gas produced in the lower 48 States." *Id.* at ES-1.

consequence of the advancement in hydraulic fracturing (fracing) and horizontal drilling[5] technology developed in the Barnett Shale. The first Fayetteville Shale well was drilled in 2004, and there are currently 1,841 producing Fayetteville Shale wells in the state.[6] The first wells drilled were vertical wells, but they were not very productive.[7] Ninety percent of the wells[8] drilled into the "sweet spot" of the Fayetteville Shale play, known as the B-43 area,[9] are horizontal wells.[10] Fracing along the lateral section of the horizontal well increases the extent of the productive area of enhanced permeability, and also, the extent of well-bore drainage of the horizontal well over the fractured vertical well.[11] Horizontal wells also offer the opportunity to reduce the environmental footprint of surface-producing operations.[12] One surface well location can support several subsurface horizontal laterals and, therefore, avoid multiple surface well locations, access roads, and gathering-pipeline locations.

Like its progenitor, the Barnett Shale, the Fayetteville Shale will become one of the major gas producing fields in the lower forty-eight. The success achieved in Texas and Arkansas in shale gas development will not be unique, however. Shale gas and other unconventional gas resources now comprise 46% of the total gas production in the United States.[13] By 2011, 50% to 60% of newly discovered reserves will come

5. Horizontal wells are drilled vertically and then turn on a tight radius before proceeding horizontally through the gas-bearing strata. For a detailed description of horizontal drilling, see Bruce M. Kramer, *Pooling for Horizontal Wells: Can They Teach an Old Dog New Tricks?*, 55 ROCKY MTN. MIN. L. INST. 8-3 (2009).

6. *See* ARK. OIL & GAS COMM'N, FAYETTEVILLE SHALE GAS SALES INFORMATION, WELL COMPLETIONS, WELL TOTALS, AND MONTHY GAS SALES (2010), http://www.aogc.state.ar.us/Fayprodinfo.htm (follow link and see spreadsheet at bottom of page). An additional 200 to 300 wells have been drilled and completed but are not yet online for lack of gathering lines or pipelines. *See id.*

7. "Vertical wells drilled into the [Fayetteville] Shale produce next-to-nothing. . . . No such vertical well stands a chance of making a profit." Thomas A. Daily, *Lawyering the Fayetteville Shale Play—Welcome to My World*, 44 ARK. LAWYER 10, 11 (2009).

8. This estimate is provided by Ed Ratchford, Oil and Gas Geologist for the Arkansas Geological Survey, and Jay Hansen, Geologist for the Arkansas Oil and Gas Commission.

9. Cleburne County Office of Economic Development, http://cleburnecountyarkansas.com/id10.html (last visited Jan. 31, 2010). The most active area of natural gas development, known as the B-43 area, stretches from western Conway County through eastern White County. *See id.* This "sweet spot," where geologists believe the shale gas is in the greatest reserve, is located in five central Arkansas counties: Cleburne, Conway, Faulkner, Van Buren, and White. *Id.* "Leases cover 4,000 square miles across north-central Arkansas, an area just smaller than the 5,000-square-mile Barnett Shale field in northern Texas . . . ." Peggy Harris, *Natural Gas Exploration Explodes on Arkansas Scene*, TUSCALOOSA NEWS, Mar. 4, 2007, at 7B.

10. "A vertical well may cost as much as $800,000 . . . to drill compared to a horizontal well that can cost $2.5 million or more." U.S. DEP'T OF ENERGY, *supra* note 2, at 47. As of 2009, horizontal wells in the Fayetteville Shale were running around $4 million per well. Daily, *supra* note 7, at 42 n.14.

11. "Horizontal drilling provides more exposure to a formation than does a vertical well. This increase in reservoir exposure creates a number of advantages over vertical drilling. Six to eight horizontal wells drilled from only one well pad can access the same reservoir volume as sixteen vertical wells." U.S. DEP'T OF ENERGY, *supra* note 2, at ES-3.

12. *Id.*

13. *Id.* at 8.

from shale gas reservoirs.[14] The technology of hydraulic fracing, horizontal well drilling, and producing and managing of unconventional gas reservoirs will improve, thus reducing costs and increasing productivity. Shale gas reservoirs, along with other unconventional gas resources, will be a "strategic part of the nation's [future] energy and economic growth."[15]

The purpose of this article is to examine the unique problems involved in developing the Fayetteville Shale in Arkansas, with an emphasis on the Arkansas Oil and Gas Commission's (AOGC) well-spacing and pooling regulations for Fayetteville Shale wells. A brief history of the AOGC's practice in formulating drilling units will be examined to illuminate the present Fayetteville Shale regulations. Likewise, this article ponders what, if anything, the Arkansas experience portends for the future of oil and gas law and the development of unconventional gas resources.

II. THE RULE OF CAPTURE AND COMMON POOL EXPLOITATION

Gas has been produced from wells in Arkansas since 1901, or before,[16] and oil has been produced since the discovery of the El Dorado Field in Union County in 1921.[17] The development of oil and gas resources in the state in the early days of the industry was governed by the rule of capture,[18] which permitted each landowner the unrestricted right to drill and produce from wells located on-tract without incurring liability for off-tract drainage.[19] Because oil and gas are produced from subsurface reservoirs which may, and frequently do, underlay numerous separately owned tracts, the rule of capture simply mandated the classic "common pool exploitation" of the reservoir.[20] In this situation, each tract owner, to ensure recovery of her "fair share" of the reservoir, was encouraged to produce as much oil and gas from the "common pool" (the "common source of supply") as fast as possible. The resultant "race" to the depletion of the reservoir wasted oil and gas reserves, as well as economic resources, and jeopardized property rights. The rule

14. *Id.* at ES-1.
15. *Id.* at 10.
16. W. Henry Rector, *Legal History of Conservation of Oil and Gas in Arkansas, A Symposium*, *in* LEGAL HISTORY OF CONSERVATION OF OIL AND GAS 19 (Am. Bar. Ass'n 1938).
17. *Id.* at 19.
18. Osborn v. Ark. Territorial Oil & Gas Co., 146 S.W. 122, 124 (Ark. 1912) (recognizing the existence of the rule of capture in Arkansas) (dictum). For a general discussion of the rule of capture as applied to oil and gas jurisprudence, see Bruce M. Kramer & Owen L. Anderson, *The Rule of Capture—An Oil and Gas Perspective*, 35 ENVTL. L. 899 (2005).
19. For a discussion of the rule of capture, see 1 EUGENE KUNTZ, KUNTZ: A TREATISE ON THE LAW OF OIL AND GAS § 4.2, at 115-19 (1987).
20. *See* Richard J. Pierce, Jr., *State Regulation of Natural Gas in a Federally Deregulated Market: The Tragedy of the Commons Revisited*, 73 CORNELL L. REV. 15, 22 (1988).

of capture was not benign in Arkansas. The history of oil and gas production in the state is replete with examples of excessive well density, undue surface waste, and physical waste of oil and gas.[21] The most poignant example of the physical waste was the "underground waste" that occurred in the Smackover Field due to the widespread and long term flaring of gas that destroyed the reservoir pressure and limited the field's recovery to a shadow of the reserves that could otherwise have been yielded.[22]

III. THE ARKANSAS OIL AND GAS CONSERVATION ACT OF 1939

The Arkansas Oil and Gas Conservation Act (Act) was enacted in 1939 to control and regulate the production of oil and gas.[23] The Act is representative of the numerous state oil and gas conservation provisions enacted in the 1930s to remedy the evils associated with common pool exploitation by modifying the rule of capture and regulating the drilling and production of oil and gas. The Act established the AOGC to administer the production and conservation sections of the Act.[24] The AOGC is authorized to promulgate rules and regulations to ensure the proper administration and enforcement of the Act.[25] The Act, as well as the AOGC's rules and regulations, is enforced by a fine of no more than $2,500 for each violation as well as each day of violation.[26] Production in violation of the Act—known as illegal oil, gas, or product—is sanctioned[27] and subsequent dealing, such as selling, purchasing, or refining

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21. *See generally* J. Scott Parker, *A Changing Landscape: Environmental Conditions and Consequences of the 1920s Union County Oil Boom*, ARK. HIST. Q. 31-52 (2001); Rector, *supra* note 16.

22. W. Henry Rector summed up the waste of oil and gas that occurred in the infant days of production in Arkansas, when the importance of maintaining the reservoir energy pressure to ensure ultimate maximum recovery from the reservoir was not universally recognized:

> The manner in which the El Dorado and Smackover fields were operated is a disgrace to the industry. Millions of barrels of oil were allowed to escape, polluting the waters of Smackover Creek and thereafter the Ouachita River. The conservation of gas produced with the oil was unheard of, billions of cubic feet being allowed to go to waste. The excuse was that the wells were oil wells; that the gas was merely incidental; that the oil could not be lifted without liberating the gas; and that as the production of oil was the supreme object of the operators, they could not be concerned with the gas. Only a small portion of the gas produced was devoted to utilitarian purposes. Oil wells and gas wells producing richly saturated gas would sometimes catch fire and be allowed to burn for weeks at a time. Great craters formed in portions of Smackover field and raging infernos consumed billions of feet of gas, creating conflagrations which could be seen for fifty miles.

Rector, *supra* note 16, at 19.

23. The Akansas Oil and Gas Conservation Act (Act) originated from Act No. 105 of 1939. The Act's conservation statutes begin at section 15-72-101 of the Arkansas Code.

24. ARK. CODE ANN. § 15-71-101 (1994).

25. ARK. CODE ANN. § 15-71-110(d) (Supp. 2009).

26. ARK. CODE ANN. § 15-72-103(a)(1) (Supp. 2009). Additionally, the filing of a false entry or statement of fact, or the omission of full, true, and correct entries, or mutilation or alteration of any report or transaction, in an attempt to evade any Arkansas Oil and Gas Commission (AOGC) rule, regulation, or order is a misdemeanor and punishable by a $5,000 fine or imprisonment for six months, or both. ARK. CODE ANN. § 15-72-104(a)(1)-(4) (1994).

27. ARK. CODE ANN. § 15-72-102 (4)-(6) (Supp. 2009) (defining illegal gas, illegal oil, and illegal

of illegal oil, gas, or product is prohibited.[28] The administration and enforcement of the Act, including all AOGC activities, is funded exclusively by a tax on production of liquid hydrocarbons.[29]

The purpose of the Act is to prevent waste and protect correlative rights.[30] The common occurrences of physical waste of oil and gas associated with the rule of capture are proscribed by the Act.[31] The following are expressly prohibited: (1) "inefficient, excessive, or improper use" of reservoir energy, including dissipation of reservoir energy that reduces ultimate maximum recovery;[32] (2) "inefficient storing of oil and the locating, spacing, drilling, equipping, operating, or producing of any oil or gas well" that reduces ultimate maximum recovery or causes excessive surface usage;[33] (3) "producing oil or gas in such [a] manner [causing] unnecessary water channeling or coning;"[34] (4) operating wells with inefficient oil-gas ratios;[35] (5) "drowning with water . . . any stratum . . . capable of producing oil or gas;"[36] (6) permitting "the escape into the open air of gas in excess of the amount that is necessary for the efficient drilling or operation of a well producing both oil and gas;"[37] and (7) permitting gas to escape from a well producing gas.[38] Any act or practice that results in underground waste is proscribed even if not specifically defined by the Act.[39]

A. Limiting the Density of Drilling: The Drilling Unit

Central to modifying the rule of capture to limit the excess density of drilling is the well-spacing scheme encompassed by the Act. To avoid the unnecessary and uneconomical wells that marked the rule of capture, the Act originally established "drilling units" that permit only one

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product). The penalty for producing illegal oil or gas is a fine of not more than $2,500 a day for each and every act of violation. ARK. CODE ANN. § 15-72-103(a)(1).

28. ARK. CODE ANN. §§ 15-72-404, 15-72-406 (1994).

29. ARK. CODE ANN. § 15-71-116(a)(1) (Supp. 2009).

30. ARK. CODE ANN. § 15-72-101 (1994). The Declaration of Policy of the Act reads as follows:

> In recognition of past, present, and imminent evils occurring in the production and use of oil and gas, as a result of waste in the production and use thereof in the absence of coequal or correlative rights of owners of crude oil or natural gas . . . this law is enacted for the protection of public and private interests against such evils by prohibiting waste and compelling ratable production.

Id.

31. ARK. CODE ANN. § 15-72-105 (1994) ("Waste of oil or gas as defined in this act is prohibited.") The statutory definitions of waste appear at ARK. CODE ANN. § 15-72-102(15) (Supp. 2009).

32. ARK. CODE ANN. § 15-72-102(15)(A).

33. *Id.* § 15-72-102(15)(B).

34. *Id.* § 15-72-102(15)(D).

35. *Id.* § 15-72-102(15)(E).

36. *Id.* § 15-72-102(15)(F).

37. *Id.* § 15-72-102(15)(I).

38. *Id.* § 15-72-102(15)(K).

39. *Id.* § 15-72-102(15)(G).

well in the reservoir to each drilling unit.[40] As initially required by the Act, and as practiced for many years, the AOGC established drilling units by determining the maximum area that one well would efficiently and economically drain based on the geologic and engineering characteristics of the reservoir.[41] The AOGC delineated the geographic area of efficient and economic drainage on the surface of the earth and designated the area as a drilling unit. Drilling units were fashioned as squares and rectangles that corresponded to the rectangular system of legal descriptions of land that applies exclusively in Arkansas. Thus, a 640-acre spacing involves drilling units composed of governmental sections, 160-acre spacing involves drilling units composed of quarter sections, 80-acre spacing involves drilling units based on half-quarter sections, 40-acre spacing involves drilling units composed of quarter-quarter sections, and 10-acre spacing involves quarter-quarter-quarter sections.[42] The Act required the well to be located at the center of the drilling unit unless geologic disadvantage or topographical conditions, including surface improvements, prevented drilling at that location.[43] Later, the AOGC permitted drilling anywhere within the unit not prescribed by an external set back location restriction.[44] In the event that surface topographical features prohibited drilling at a prescribed location, an exception location that permitted an off-pattern well could be authorized with a penalty in the form of a lower well allowable to avoid any drainage attributed to the off-pattern well.[45]

The Arkansas well-spacing scheme also protects the correlative rights of the mineral interest owners who produce from the drilling units that overlay the reservoir.[46] The Act specifically recognizes that a producer is entitled, subject to reasonable requirements for prevention of waste, to his "just and equitable share" in the reservoir.[47] A producer's just and equitable share of the reservoir is the amount of production, "which is substantially in the proportion that the quantity of recoverable oil and gas in the developed area of the producer's tract in the pool bears to the recoverable oil and gas in the total developed area of the

40. Act of Mar. 31, 2003, § 1, 2003 Ark. Acts 964 (amending ARK. CODE ANN. § 15-72-302(b)(1)(2)(A)). The Act originally provided that a "'drilling unit' means the maximum area which may be efficiently and economically drained by one (1) well." *Id.*

41. *See id.*

42. Rarely, if ever, did the AOGC cross-section lines or quarter-section lines in establishing drilling units.

43. Act of Mar. 31, 2003, § 1, 2003 Ark. Acts. 964 (amending ARK. CODE ANN. § 15-72-302(c)(1)).

44. *See* ARK. CODE. ANN. § 15-72-302(c)(1) (Supp. 2009).

45. *Id.* § 15-72-302(c)(1)-(2).

46. The term "correlative rights" refers to the reciprocal rights and duties shared by all landowners in the common source of supply. *See* 1 KUNTZ, *supra* note 19, § 4.3, at 119.

47. ARK. CODE ANN. § 15-72-302(d)(1).

pool."[48] This is generally known as the "fair share" principle.[49] The correlative rights of the producer in the drilling unit is further protected because the AOGC cannot require the producer to drill unnecessary wells to recover his just and equitable share.[50] More importantly, the AOGC must protect his tract from net uncompensated drainage unless offset protection wells, in addition to the drilling unit well, have been drilled on the unit to protect against drainage.[51]

B. Forced Integration

Forced integration, known in most other oil and gas jurisdictions as "compulsory pooling," is ancillary to the establishment and operation of the drilling unit under the Act.[52] The establishment of a drilling unit limits that area to one well for the reservoir. The oil and gas lessees (typically referred to as working interest owners) along with any unleased mineral owners, may agree on a plan of development for the drilling unit and voluntarily pool their interests.[53] Voluntary pooling "merges" the separately owned tracts located within a drilling unit into one tract, so that drilling anywhere on the unit satisfies the provisions of any oil and gas lease within the unit, including the secondary term of the habendum clause, regardless of the location of the unit well.[54] Likewise, voluntary pooling apportions royalty on a surface-acreage basis.[55]

If the parties do not agree to pool voluntarily, the Act mandates the AOGC, upon the application of any mineral owner or oil and gas lessee, to force-integrate all tracts and interests for unit development.[56] Forced integration is the remedy that permits development of the drilling unit in the event that the mineral-interest owners cannot agree to pool voluntarily. The integration order authorizes the drilling, completion, equipping, and operation of a well on the unit[57] and designates the operator of the well.[58] The unleased mineral owner is accorded an array of choices in the integration order.[59] She may elect to participate in the

48. *Id.*
49. *See* Wronski v. Sun Oil Co., 279 N.W.2d 564, 569-70 (Mich. Ct. App. 1979) (discussing the "fair share" principle).
50. ARK. CODE ANN. § 15-72-302(a)(1).
51. *Id.* § 15-72-302(a)(2).
52. *See* ARK. CODE ANN. § 15-72-303(b) (Supp. 2009).
53. *Id.* § 15-72-303(a).
54. For a modern treatment of the Voluntary Pooling Clause contained in the oil and gas lease, see Mitchell E. Ayer, *Navigating the Pooling Clause Waters: New and Recurring Issues*, 53 ROCKY MTN. MIN. L. INST. 33-1 (2007).
55. 3 EUGENE KUNTZ, KUNTZ: A TREATISE ON THE LAW OF OIL AND GAS § 42.5(f), at 415-16 (1989).
56. ARK. CODE ANN. § 15-72-303(b).
57. ARK. CODE ANN. § 15-72-304(b)(1) (1994).
58. *Id.* § 15-72-304(b)(2).
59. *See generally* ARK. CODE ANN. § 15-72-304; ARK. OIL & GAS COMM'N, GENERAL RULES & REGULATIONS B-43(g)-(h) (2009), *available at* http://www.aogc.state.ar.us/OnlineData/Forms/Rules

well, paying her proportionate share of the costs and taking her proportionate share of the revenues attributable to her proportionate share of the production.[60] Having paid her well costs up front, she takes her share of the risk by participating in the well. Another option is for the unleased mineral owner to go "non-consent" and be "carried" by the participating owners who pay her share of the costs that are subsequently, if ever, recovered from her proportionate share of the revenue.[61] Because the participating owners are taking the risks of her share of the costs, the AOGC will assess a "risk factor" penalty against the carried interest based on the geologic risk.[62] The risk-factor penalty is usually 400%—her proportionate share of the costs times four—unless the prospect involves extraordinary risk, which will enhance the risk factor penalty.[63] Once payout occurs, the costs and risk-factor penalty are recovered from her share of the revenues, and the non-consenting party recovers her proportionate share of the production.[64] Additionally, the Act generously accords the non-consenting unleased mineral owner a 1/8 royalty share pending payout.[65] Finally, the unleased mineral owner can elect to be "leased," in which she receives a competitive royalty, but not less than a 1/8th share, plus a bonus based on a "reasonable consideration" to be determined by the AOGC.[66] If the unleased mineral owner fails to make an election, she will be deemed to be leased.[67]

The working interest owner—the lessee who holds an oil and gas lease from a mineral owner in the unit—may participate in the drilling of the well by paying its share of the costs or by electing to go non-consent.[68] If the working interest owner fails to specify its election, it is deemed to have elected to go non-consent.[69]

Once the AOGC promulgates an integration order for a drilling unit, all operations on any part of the unit, including the drilling or operation of a well, are deemed to be as if the operations were conducted on each separately owned tract and interest in the drilling unit.[70] Likewise, production from any part of the drilling unit shall be deemed to be

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60. ARK. CODE ANN. § 15-72-304(b)(3); *see* Daily, *supra* note 7, at 41.

61. *See* ARK. CODE ANN. § 15-72-304(b)(4); Daily, *supra* note 7, at 41.

62. Daily, *supra* note 7, at 41; *see also* ARK. CODE ANN. § 15-72-304(b)(4).

63. Daily, *supra* note 7, at 42 n.19.

64. "*Payout* is that point where the other 7/8 of revenue equals the amount of all drilling completion and equipment costs, multiplied by the *risk factor penalty* plus 100% of subsequent operating expenses." *Id.* at 42 n.20 (emphasis in original).

65. ARK. CODE ANN. § 15-72-304(d).

66. *Id.* § 15-72-304(b)(4), (d).

67. Daily, *supra* note 7, at 41.

68. ARK. CODE ANN. § 15-72-304(b)(4).

69. Daily, *supra* note 7, at 41.

70. ARK. CODE ANN. § 15-72-305(b) (Supp. 2009).

production from every tract or interest located in the unit.[71] In effect, the Act dictates that the integration order has the same effect on oil and gas lease terms, including the secondary term requirement of production in the habendum clause, as to the voluntary pooling of the lease interests.[72]

IV. A BRIEF HISTORY OF DRILLING UNITS IN ARKANSAS

For many years, the drilling units established by the AOGC were "production units." Before the AOGC had jurisdiction to establish drilling units—a common source of supply—a reservoir had to be discovered. For many years now, the AOGC has required a party drilling a discovery well in the reservoir to appear before the agency and seek field rules, which established drilling units, within six months of completion of the discovery well or before three producing wells were drilled in the reservoir, whichever occurred first.[73] The "field rules" establish a drilling unit or units for the applicants' completed well or wells and also for the direct and offsets to the newly established productive drilling units. The practice is a modified well-by-well approach to establishing drilling units.

Exploratory drilling units were authorized by legislative amendment to the Act in 1985.[74] An exploratory drilling unit must be comprised of a governmental section or its equivalent and must be prospective of oil or gas, or both.[75] When 50% of working interest owners or unleased mineral owners from the proposed unit area agree to pool, the AOGC has the authority to integrate the remaining non-consenting working interest owners or unleased mineral owners.[76] The established exploratory drilling unit, along with the right of forced integration, is limited to a period of one year from the date of the order, or alternatively, one year from the cessation of unit drilling or production operations.[77] The primary benefit of the addition of the exploratory drilling unit to the Act is that it provided the remedy of forced integration to assist in the leasing of exploratory prospects.

From 1939 to the advent of the Fayetteville Shale Play in 2004, the oil and gas production regulated by the Act and the AOGC was from conventional reservoirs. The administration of the Act by the AOGC during this lengthy period reflects Justice Holmes's admonition that

71. *Id.*
72. *See* 3 KUNTZ, *supra* note 55, § 42.5(f), at 418.
73. ARK. OIL & GAS COMM'N, GENERAL RULES & REGULATIONS, *supra* note 59, at B-38(a).
74. Act of 1985, No. 881 (codified at ARK. CODE ANN. § 15-72-302(e)(1)-(3) (Supp. 2009)).
75. ARK. CODE ANN. § 15-72-302(e)(2).
76. *Id.*
77. *Id.* § 15-72-302(e)(3).

"the life of the law has not been logic: it has been experience."[78] Moreover, the AOGC's practices in establishing drilling units is a classic example of the diversity that exists in state regulation of oil and gas production under conservation acts.[79] The Arkansas well-spacing scheme is *sui generis*, unique in the oil and gas regulatory world.

The rationale underlying the Arkansas experience in administering the Act's well-spacing scheme, harking back to the political struggle to adopt the Act and subvert the common law rule of capture, was expressed by the aphorism "one cup, one straw."[80] This has sometimes been expressed as the unwritten "Rule of One."[81] Fundamental fairness, as well as equal opportunity, dictated that each drilling unit was only entitled to one well in the reservoir. Accompanying the one cup, one straw proposition was the view that if a producer shouldered the risk and paid for its share of the costs of a producing well, the AOGC was not going to meddle with the configuration of the drilling unit by deleting a tract from the unit or otherwise diluting the ownership interest. This proposition was known in Arkansas as the principle of "vested rights."[82] Strict adherence to the Rule of One also obviated the need to deal with vested rights issues resulting from either downsizing or reforming established and developed drilling units.

The AOGC also adhered to the rectangles and squares on the surface of the earth that corresponded with the rectangular survey system of legal descriptions to draw the drilling units.[83] The AOGC eschewed drawing geologic units whose surface unit boundaries corresponded with the boundaries of the subsurface reservoir.[84] The eight-inch well bores of the vertical producing wells in the reservoir provided insufficient direct evidence of the porosity, permeability, and size of productive sand to delineate with confidence the subsurface boundaries of the reservoir. Moreover, when the field rules for the reservoir were estab-

78. OLIVER WENDELL HOLMES, THE COMMON LAW 1, (Little, Brown, & Co. 1881).

79. Owen L. Anderson, "*State Conservation Regulation—Single Well Spacing and Pooling—Vis-À-Vis Federal and Indian Lands," Special Institute on Federal Onshore Oil and Gas Pooling and Unitization*, *in* Federal Onshore Oil and Gas Pooling and Unitization 2-1 (ROCKY MT. MIN. L. FOUND. 2006).

80. The aphorism "one cup, one straw" was the explanation for the Arkansas well-spacing scheme under the Act provided by the former Chairman of the AOGC, Boyd Alderson, who served many years on the commission, was a player in the industry prior to 1939, and witnessed the political process that resulted in the adoption of the Act.

81. Thomas A. Daily & W. Christopher Barrier, *Well, Now, Ain't That Just Fugacious!: A Basic Primer on Arkansas Oil and Gas Law*, 29 U. ARK. LITTLE ROCK L. REV. 211, 242 (2007); Dorsey Ryan, *Optimal Density*, 39th ANN. NAT. RES. L. INST. 1, 2 (ARK. BAR ASS'N. 2000). Ryan, the chief proponent of increased density in the North Arkansas gas fields, described the rule as the "infamous rule of one."

82. The late Ned Price, a south Arkansas oil producer and long time member of the AOGC, was a passionate proponent of the "vested rights" principle in administering the Arkansas well-spacing scheme.

83. Daily & Barrier, *supra* note 81, at 242-43.

84. *Id.*

lished, there were too few producing wells in the reservoir to provide the well control necessary for the formation of geologic units. Not only would the AOGC not fashion geologic units, it would also not gerrymander the configuration of the drilling units on the surface in an attempt more closely to approximate the geographic confines of the subsurface reservoir. The AOGC would not cross section lines or quarter section lines in the configuration of the drilling units. The objective was uniform-sized drilling units, fortuitously arranged on the basis of the rectangular survey system of legal descriptions, in an orderly pattern that spanned the developed field and avoided the presence of "windows."[85]

In the early days of the Act, the non-associated gas fields of the Arkoma Basin in north Arkansas were developed on 640-acre drilling units.[86] The 640-acre drilling units were based on the AOGC's determination that 640 acres was the area that one well would economically and efficiently drain. Over the course of time, 640-acre drilling units, based on governmental sections, became the norm for gas drilling units in north Arkansas. As older fields matured and greater knowledge of the geology of the gas fields accumulated,[87] doubts existed as to whether the one-unit well was efficiently and economically draining the units.[88] Nevertheless, the Rule of One reigned supreme in Arkansas and increased the density of drilling; permitting "infill" drilling in the large units was not an option. Evidence that the existing unit well was not economically and efficiently draining the drilling unit would not elicit an additional unit well from the AOGC. An additional well in a drilling unit would be authorized only if the applicant could prove that the second well produces from a reservoir separate and distinct from the reservoir of the unit well.[89] Unlike Oklahoma, there is no case law or statute in Arkansas that permitted modification of an AOGC order establishing drilling units due to the subsequent acquisition of geological data that signaled a change of condition in the reservoir.[90]

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85. A "window" is acreage in the oil and gas field that is not included in an established drilling unit. If such acreage was smaller than the drilling units prescribed by the field rules, an off-pattern drilling unit, with a reduced well allowable, would be required to avoid a takings claim under Arkansas or federal due process constitutional provisions. The policy of avoiding "windows" was part of the motivation of AOGC's refusal to cross section lines in configuring drilling units.

86. Ryan, *supra* note 81, at 7.

87. In the earlier formative period of the Arkansas Conservation Act, oil and gas deposits in Arkansas were thought to underlay the subsurface in a "blanket" fashion. Modern theory is that subsurface hydrocarbons mainly lie within prehistoric river channels. Daily & Barrier, *supra* note 81, at 243. In North Arkansas most gas deposits were deltaic river channels. *Id.* at n.193.

88. Ryan, *supra* note 81, at 1, 7-8.

89. *Id.* at 7, 8, 11-12.

90. *In re* Peppers Ref. Co., 272 P.2d 416 (Okla. 1954). The Oklahoma Supreme Court opined in *Peppers* as follows:

> To hold that the Commission could never modify a well-spacing pattern established by a previous order not appealed from, upon a showing of characteristics about a common

Well spacing pursuant to state oil and gas conservation regulatory schemes has been subject to criticism. The criticism is based on the fact that all well-spacing regulations are premised on assumptions about reservoirs that seldom, if ever, pertain.[91] The assumptions are that reservoirs are homogeneous, wells drain radially, and any drainage from the unit will be compensated by drainage into the unit. Homogenous reservoirs share common characteristics of porosity, permeability, acre feet of productive sand, and hydrocarbon content throughout the reservoir. Reservoirs, however, are typically heterogeneous with the characteristics varying in the reservoir. The lack of homogeneity may prevent radial drainage and permit uncompensated drainage to occur within the drilling units. Consequently, too many wells may be drilled in the reservoir at less-than-optimal locations and the reservoir may not be efficiently drained.[92]

The traditional criticism also asserts that correlative rights may go unprotected. One tract may have geologic advantages over the other tracts in the unit so that it contributes more production to the unit well than its proportion of surface acreage in the unit.[93] Or, the subsurface reservoir may not underlay all of the surface acreage in the unit. This criticism is particularly relevant in Arkansas because unit costs and production are conspicuously allocated on the basis of the surface acreage that each tract contributes to the unit.[94] Given the AOGC's long standing history in drawing surface grid-based drilling units,[95] it is unlikely

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> source of supply, and the withdrawals therefrom, that were not known or anticipated at the time of the original order, would "tie the hands" of the Commission and often prevent it from performing its statutory duties under our Oil and Gas Conservation Act.

Id. at 424.

91. Owen L. Anderson & Ernest E. Smith, *Exploratory Unitization Under the 2004 Model Oil and Gas Conservation Act: Leveling the Playing Field*, 24 J. LAND RESOURCES & ENVTL. L. 277, 281 (2004).

92. *Id.*

93. Christy M. Schweikhardt, *Horizontal Perspective: Texas Oil & Gas: Law in Light of Horizontal Drilling Technology*, 34 S. TEX. L. REV. 329, 341 (1993); Anderson, *supra* note 79, at 2-5 to 2-8.

94. The AOGC's order establishing a drilling unit must provide that once a well is commenced on the unit all royalty, overriding royalty, production payments, or similar interests are automatically integrated. ARK. CODE ANN. § 15-72-305(a)(1) (Supp. 2009); *see* Daily *supra* note 7, at 41.

95. Although there is no holding of the Arkansas Supreme Court sustaining the AOGC's methodology for establishing drilling units, dicta favoring the scheme does appear in *Amoco Prod. Co. v. Ware*, 602 S.W.2d 620 (Ark. 1980). In that case, Amoco Production Co. (Amoco) discovered the Chalybeat Springs oil and gas field in Columbia County, Arkansas. *See id.* at 621-22. The reservoir was approximately seven miles in length with a width varying from a half mile to two miles. *Id.* at 621. Early on it was discovered that the field had a gas cap that laid on top of the oil formation. *Id.* at 622. Unitization of the field was required to implement a pressure maintenance program that reinjected gas produced from the wells back into the reservoir to maximize the recovery of oil. *Id.* Ware, the plaintiff, was the mineral owner of an 80-acre tract leased to Amoco that was situated on the north boundary of the reservoir. *Id.* A producing well had not been drilled on a drilling unit that included Ware's tract. *Id.* Before Amoco could get the field-wide unitization plan approved by the AOGC, Murphy Oil Company, which owned a lease on most of the 80 acres to the north of plaintiff's tract, sought a drilling permit for a 160-acre unit that encompassed Ware's tract. *Id.* The geological evidence indicated that Murphy's tract did not underlie the common source of supply. *Id.* The Chalybeat Springs field ended at about the north line of plaintiff's tract. *Id.* The commission granted the

that the criticism will incite any change in the practice.

Although no empirical examples exist of waste or failure to protect correlative rights occurring in Arkansas because spacing regulations designed for homogeneous reservoirs were applied to heterogeneous reservoirs, it could have occurred in the state, particularly as to the gas fields in north Arkansas, which are known to contain heterogeneous reservoirs. The most salient historical criticism, however, would likely be the failure to drill infill wells in large units that were not being efficiently drained by the unit well. It is problematic that the reluctance to permit infill wells led to underground waste, condemning hydrocarbons to remain in the reservoir because of the inability to produce economically in the future. Moreover, there can be no doubt that the Act, the AOGC, and its well-spacing scheme have over time eliminated the drilling of legions of unnecessary and uneconomical wells, prevented waste, and protected correlative rights.[96]

A. The 2003 Legislative Amendment

The inability to drill infill wells to recover gas not being drained by the unit and problems in establishing separation of reservoirs, in which multiple reservoirs—sometimes vertically stacked—underlay a 640-acre drilling unit, made a mockery of the Rule of One's well-spacing regulations.[97] Consequently, in 2003, the legislature amended the well-spacing

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drilling permit and created the 160-acre drilling unit despite objections from Amoco that there was little or no oil under Murphy's tract and that the creation of the drilling unit would permit Murphy to unfairly share in the oil and gas beneath Ware's land, which would dilute plaintiff's royalty interest. *See id.* Amoco filed a notice of appeal of the AOGC's ruling, but dropped the matter after entering into a unitization agreement that permitted Murphy's newly established drilling unit to participate in the field-wide unit. *Id.* Ware then sued Amoco for damages and lease cancellation alleging, *inter alia*, that Amoco breached the implied covenant to appeal the AOGC's decision. *Id.* The trial court ruled in favor of Ware and granted lease cancellation. *Id.* The Arkansas Supreme Court reversed the trial court, holding that there was no implied covenant to appeal the AOGC's decision. *Id.* at 624-25.

To have considered the validity of the AOGC decision on appeal would have constituted an impermissible collateral attack on the agency's order. *See id.* at 624. Thus, the issue of the validity of the AOGC's decision was not before the court in *Ware*. However, in discussing the facts of the case, the court noted that the AOGC "generally determines what a drilling unit is on the basis of acreage rather than geographical formations underneath the earth." *Id.* at 622. More importantly, the court observed:

> It is suggested that no one holding an interest outside the geological perimeter of the field should be permitted to share in the proceeds. That is a nice concept. However, drilling units and unitization are normally, if not always, determined by acreage, and not by geographical lines that indicate whether oil may or may not be under the surface. What lies underneath the ground cannot be determined exactly unless wells are drilled.

Id. at 624.

96. Despite the traditional criticism of well-spacing regulation, it is obviously an improvement over the rule of capture. Professor Owen Anderson, a critic of such traditional well-spacing regulation, states: "The bottom line on drilling-unit regulation is that, while far from perfect, it is a great improvement over unfettered drilling under the rule of capture." Anderson, *supra* note 79, at 2-8.

97. Daily, *supra* note 81, at 243.

regulations.[98] The amendment created a statutory presumption in favor of the 640-acre unit composed of a governmental section, though it permitted the AOGC to establish a larger or smaller unit. The AOGC is specifically authorized to permit additional wells in the unit and regulate the spacing between the multiple-unit wells.[99] Deleted from the Act is the requirement, universally recognized by oil and gas conservation lawyers and academicians, that drilling units be established on the basis of the maximum area that one well would efficiently and economically drain. Statutory guidance to the AOGC on the parameters to be used in drawing drilling units no longer appears in the Act. One may infer that the legislature, adopting the norm of the 640-acre square mile unit as the presumptive standard, intended by implication for the AOGC to apply a standard of "reasonableness" in fashioning drilling units under the amended Act.

Regardless of the theory that underlies the presumption of a 640-acre, or square mile, statutory unit, the practice before the AOGC on well spacing in the north Arkansas gas fields has radically changed. As opposed to hearing evidence on the acreage that a single well would economically and efficiently drain, the AOGC hears evidence on the "most effective and efficient manner of locating multiple wells for the effective, but cost-efficient, removal of the maximum amount of oil or gas from a square mile unit."[100] The emphasis is on economic efficiency based on the geologic characteristics of the reservoir. One may argue that economic efficiency is not foreign to the traditional formula of maximum area of economic and efficient drainage, and, thus, the change in the standard in Arkansas is not necessarily profound. Whatever one may think of the dearth of the statutory standards for delineating drilling units, it is difficult to argue that the amendment is not an improvement over the Rule of One.

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98. The amended statute, now defines a unit and the AOGC's regulatory authority as follows:

> (A) As used in this subchapter, "drilling unit" means a single governmental section or the equivalent unless a larger or smaller area is requested by an owner, as defined in [Arkansas Code Annotated section] 15-72-102, within the drilling unit to be established and a larger or smaller area is established by order of the commission. The drilling unit shall constitute a developed unit as long as a well is located thereon that is capable of producing oil or gas in paying quantities.
>
> (B) The commission shall have the continuing authority to:
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> (i) Designate the number of wells that may be drilled and produced within a drilling unit; and
>
> (ii) Regulate the spacing among multiple wells drilled and produced within a drilling unit.

ARK. CODE ANN. § 15-72-302(b)(2)(A)-(B)(ii) (Supp. 2009).

99. *Id.* § 15-72-302(b)(2)(B)(i)-(ii).

100. Daily & Barrier, *supra* note 81, at 244. The authors further note that "[s]ometimes this will involve a single well for each separate reservoir within the unit. Other times, the AOGC will find the necessity for multiple unit wells within single tight reservoirs." *Id.*

V. DRILLING UNITS IN THE FAYETTEVILLE SHALE

The AOGC draws prospective drilling units for the Fayetteville Shale and other unconventional gas reservoirs in Arkansas. Each governmental section in each county in which the Fayetteville Shale is known or thought to exist is covered on a county-by-county basis.[101] The drilling units in the counties are labeled as either "exploratory drilling unit[s]" or "established drilling unit[s]," the latter being production units.[102] Once a producing well has been completed on an exploratory unit, that unit, and the offset units contiguous to it, become production units.[103]

Sixteen vertical or horizontal wells, or a combination thereof, may be drilled in an exploratory drilling unit.[104] For vertical wells, that amounts to a forty-acre spacing pattern. For horizontal wells, even though sixteen is permitted, the external and internal unit well-location restrictions have the potential to allow six to eight horizontal wells in the unit. The internal well-location restriction requires multiple wells in the unit to be spaced 448 feet apart with an allowed 20% variance.[105] This restriction may be waived by obtaining written consent from all unit working interest owners.[106] The external well-location restriction, designed to protect other drilling units from drainage, requires all wells to be set back a distance of 560 feet from any unit boundary line or any other drilling unit's well.[107] Exception location wells may be granted by the AOGC for topographical or geologic advantage reasons.[108] The 560-foot setback creates a buffer zone of 1,120 feet that extends around any drilling unit.

Horizontal wells are drilled vertically and then turn on a tight radius before proceeding horizontally through the gas-bearing strata. The well bore for a horizontal well is defined by the AOGC rules as the entire perforated length of the lateral section of the horizontal well.[109] Consequently, based on that definition, a horizontal well involves a long narrow cylinder of a producing reservoir. The cylinders may be arranged in such a fashion to achieve effective and cost-efficient drainage

101. Rule B-43(c) provides that spacing rules are applicable to all "conventional and unconventional sources of supply in Arkansas, Cleburne, Conway, Cross, Faulkner, Independence, Jackson, Lee, Lonoke, Monroe, Phillips, Prairie, St. Francis, Van Buren, White and Woodruff Counties, Arkansas." ARK. OIL & GAS COMM'N, GENERAL RULES & REGULATIONS, *supra* note 59, at B-43(c).
102. *Id.* at B-43(f).
103. *Id.*
104. *Id.* at B-43(i)(4).
105. *Id.* at B-43(i)(3).
106. *Id.*
107. *Id.* at B-43(i)(2).
108. *Id.* at B-43(i)(5).
109. *Id.* at B-43(a)(2)(C).

of the reservoir.[110]

The AOGC permits horizontal wells to extend into more than one drilling unit when the majority in interest of working interest owners seeks authorization from the commission and voluntarily agrees to the allocation of costs and the proceeds from production.[111] Administrative approval[112] of the "cross unit" well by the Director of the AOGC, which avoids a hearing and a decision by the commission, is authorized if the affected drilling units have been previously integrated.[113] The costs and proceeds of production for the "cross unit" well are allocated by drawing a "cylindrical unit" around the perforated well bore. The costs and proceeds shared between each participating drilling unit are based on the proportion of the cylindrical unit (the calculated area) that is located in each such drilling unit.[114] The cylindrical unit is drawn by dividing a circle with a radius of 560 feet at both the beginning point and the ending point of the perforated lateral well bore and inserting a rectangle 560 feet in width on both sides of the perforated horizontal lateral.[115] It should be noted that the cylindrical unit is not a formal "drilling unit" under the Arkansas well-spacing regime, but is merely a basis for allocating costs and proceeds of production from cross unit wells.

Permitting horizontal wells to extend into, or encroach upon, ad-

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110. Daily, *supra* note 81, at 244 ("These cylinders are then laid side by side and/or end to end in patterns that accomplish remarkably effective and cost-efficient drainage while, at the same time, reducing surface impact.").

111. ARK. OIL & GAS COMM'N, GENERAL RULES & REGULATIONS, *supra* note 59, at B-43(o).

112. A proposed amendment to Rule B-43 is winding its way through the administrative process. The amendment modifies the requirements for cross unit wells that are subject to administrative approval pursuant to Rule B-43(o). The purpose of the amendment is to prevent operators from holding a drilling unit by production during the secondary term of the unit leases by extending a short, insignificant horizontal lateral into the unit pursuant to a cross unit horizontal well. The amendment requires that to secure administrative approval of a cross unit well, one of the following must exist as to each drilling unit:

> (1) a well that is producing or capable of producing, and is not an exception-location well, be located entirely within the drilling unit; or that such a well will be drilled and completed or drilled and awaiting completion within six months of the date of the spudding of the administratively approved cross unit well; or
>
> (2) that there is one well or a combination of multiple wells, including cross-unit wells, producing or capable of producing, that have a combined perforated lateral length within the drilling unit of not less than 4,160 feet; or
>
> (3) within twelve months from the date of the spudding of the administratively approved cross unit well, one well or combination of multiple wells, including cross unit wells, with a combined perforated lateral length of not less than 4,160 feet, will be producing, capable of producing or awaiting completion, on the drilling unit; or
>
> (4) at least 75% of the fee mineral ownership within each drilling unit that does satisfy above requirements that agree in writing to the drilling of the well.

See ARK. OIL & GAS COMM'N, GENERAL RULES & REGULATIONS B-43 (2009) (proposed amendment).

113. ARK. OIL & GAS COMM'N, GENERAL RULES & REGULATIONS, *supra* note 59, at B-43(o)(1).

114. *Id.* at B-43(o)(1)(A)-(B).

115. *Id.* at B-43(o)(1)(A). The "half circle" drawn at the beginning and ending of the perforated horizontal well bore is a modification for horizontal wells of the theory of radial drainage, inherent in the doctrine of compensatory drainage, applied to traditional vertical wells. *See* Anderson, *supra* note 79, at 2-9.

joining drilling units facilitates the production of gas situated in the 1,120-foot buffer zones that are situated between the productive areas of the drilling units and that are designed to protect against drainage. Otherwise, the gas would be stranded, and optimum development of the reservoir would be precluded.

VI. CONCLUSION

Though it may have been entirely fortuitous, the changes wrought by the 2003 Amendment to the Arkansas Oil and Gas Conservation Act have proven perfect for the Fayetteville Shale play. The 640-acre unit, based on applicability of the statutory presumption allowing vertical and horizontal wells, and authorizing a maximum of sixteen wells within the unit, permitted experimentation in the field to determine the most cost effective method of producing this unconventional gas resource. Although the horizontal well with its enhanced productivity and cost-effectiveness has eclipsed the vertical well as the primary method of Fayetteville Shale production, the vertical well remains an option that may be useful for the operator. There may be areas in the broad expanse of the Fayetteville Shale that are peculiarly susceptible to vertical-well development. Likewise, permitting cross-unit wells to span across multiple drilling units removes the length limitation on laterals for horizontal wells that is inherent in a 640-acre drilling unit scheme; thus, the length of laterals for horizontal wells are ultimately determined by technological advances in horizontal drilling and cost efficiencies. The conclusion is inescapable that the standard of reasonableness as a basis for configuring drilling units has contributed to the success of the Fayetteville Shale development.

A material distinction between conventional and unconventional oil and gas reservoirs is relevant to any assessment of the AOGC's drilling-unit regime for the development of the Fayetteville Shale in Arkansas. A conventional oil and gas reservoir is characterized by adequate porosity, permeability, and reservoir energy, which drives the oil and gas in the reservoir to the well bore. The conservation agency's well-spacing density pattern for conventional reservoirs is governed by conservation standards, such as the maximum area that one well will economically and efficiently drain—to be determined by the reservoir characteristics that dictate the extent of drainage and the economics of drilling wells. Decisions made on the basis of geological characteristics of the reservoir or the economics that exist at the time of the determination are not infallible, however. Unnecessary wells may result, and have resulted, in the development of conventional reservoirs even under modern well-spacing regimes. Or so say the critics. Tight-sand reser-

voirs, like the Fayetteville Shale, are different physical phenomena and are governed by one simple rule: no fracing, no production. The gas is trapped in the source rock, some of it being chemically bonded with the rock, and the reservoir must be fractured to produce gas. The spacing pattern for vertical and horizontal wells in tight-sand reservoirs, which require fracing for production, has more to do with economics and less to do with reservoir drainage than does the spacing of conventional reservoirs. With its focus on profitability, the discipline of the marketplace will likely be a primary mechanism to deter unnecessary shale gas wells. Consequently, there is less risk of unnecessary wells in the development of tight-sand reservoirs.

Physical waste and drainage should also have limited applicability to shale gas development. First, there is no natural reservoir energy mechanism that needs to be preserved to achieve maximum ultimate recovery in tight-sand reservoirs. Lack of permeability moots that problem. The area of the tight-sand reservoir that is fraced will produce gas. If an area is not fraced, the gas will remain in place. The actual rate of recovery of reserves from the reservoir and the amount of unrecoverable reserves will likely be a function of future technological developments, as opposed to agency spacing regulations. Moreover, correlative rights will be adequately protected by the unit setback line, which is designed to limit the fracing to the drilling unit and form a barrier that protects the offsetting drilling units from drainage.[116]

In assessing the performance of the AOGC's drilling-unit regime for developing the Fayetteville Shale in Arkansas, several benefits stand out. Establishing prospective drilling units at the inception of the play for the entire targeted area facilitates development of the resource. A drilling unit is in existence at the inception of the development for any individual lease prospect in the play. Anyone acquiring lease acreage in the existing drilling unit will know her share of unit ownership based on the amount of the proportionate share of the unit acreage. Voluntary pooling or forced integration is readily available at the outset to unitize the drilling unit so the unit well can be drilled. The expense of a hearing

116. External setback lines for drilling units producing from conventional reservoirs are established to protect adjacent units from drainage from the unit well, and, thus, are based on the geographic extent of the area of drainage of the unit wells. The 560-foot external setback line for Rule B-43 unconventional wells is based on the geographical extent of the area fraced by the unit wells. *See* ARK. OIL & GAS COMM'N, GENERAL RULES & REGULATIONS, *supra* note 59, at B-43(i)(1). Because the tight-sand Fayetteville Shale will not produce gas until it is fraced, drainage is avoided by establishing a setback line that protects the offset drilling units from the impact of the unit well's fracing job. Microseismic testing, the best available technology, is used to determine the maximum area of the impact of the unit well fracing jobs. For a discussion of hydraulic fracing of Fayetteville Shale wells in Arkansas, see J. DANIEL ARTHUR ET AL., HYDRAULIC FRACTURING CONSIDERATIONS FOR NATURAL GAS WELLS OF THE FAYETTEVILLE SHALE (2008), *available at* http://www.all-llc.com/publicdownloads/ALLFayettevilleFracFINAL.pdf.

before the AOGC will only be borne if forced integration of the unit is required.

Arkansas's method of well spacing permits a great deal of discretion in the operator and working interest owners of the unit—the entrepreneurs who are spending the money and taking the risk—as to the number and location of unit wells. A 640-acre drilling unit will hold a sizeable number of wells, either sixteen vertical wells or the maximum number of horizontal wells consistent with the external or internal location restrictions, likely six, eight, or more. The location of the wells within the interior of the unit setback line for all practicable purposes may be unrestricted if the working interest owners consent to any interior encroachment. The AOGC's rules permit horizontal wells to extend across drilling unit boundary lines.[117] This, in turn, permits formation of joint ventures between the mineral interest owners of the affected drilling units to drill extended horizontal wells. Ultimately, this practice will permit the industry to realize any cost efficiencies inherent in lengthy horizontal well laterals.

Finally, the well-spacing scheme has worked well for the Fayetteville Shale in Arkansas; indeed, one would have to describe it as a success. Many wells have been drilled and many will continue to be drilled in the future. A major gas-producing field of the lower forty-eight is in the making, which portends great economic benefits to the state. A jurisdiction with shale gas development in the future should consider the Arkansas tight-sand well-spacing regime.

Although it is understood that local practice and diversity are the hallmarks of state regulation of oil production by the numerous state conservation agencies administering well-spacing regimes, some aspects of the AOGC drilling-unit regime in the development of the Fayetteville Shale are worthy of imitation. Undoubtedly, one would be more than confident to anticipate that the broad structure of the Arkansas well-spacing scheme could be transplanted to a sister-state agency, with its own history, tradition, and experience of well spacing. However, some of the characteristics of the Arkansas experience could be imported. Providing room within the structure of the state's tight-sand well-spacing regulations for the industry to experiment, particularly with horizontal wells, is recommended. Promulgating regulations that permit extended horizontal laterals, including those involving multiple-unit development, which may ultimately lower drilling and production costs, is also recommended. Likewise, promulgating regulations that afford operators and working interest owners with discretion as to the amount and location of wells, particularly horizontal wells with laterals that limit

117. ARK. OIL & GAS COMM'N, GENERAL RULES & REGULATIONS, *supra* note 59, at B-43(i)(2).

the environmental footprint of surface operations, is also an important element for success.