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Underbalanced Drilling: Can it Solve the Economic, Environmental and Regulatory Taking Problems Associated with Fracking? 49 J. Marshall L. Rev. 511 (2015)

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UNDERBALANCED DRILLING: CAN IT SOLVE THE ECONOMIC, ENVIRONMENTAL AND REGULATORY TAKING PROBLEMS ASSOCIATED WITH FRACKING?

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I. INTRODUCTION: HYDRAULIC FRACTURING AT THE CROSSROADS—THE CURRENT INTERPLAY OF ECONOMIC, ENVIRONMENTAL, AND REGULATORY ISSUES CONFRONTING THE U.S. OIL AND GAS INDUSTRY

In December of 2015, the U.S. Congress approved, and President Obama quickly signed, an omnibus spending bill authorizing export of U.S. crude oil for the first time in forty years.¹

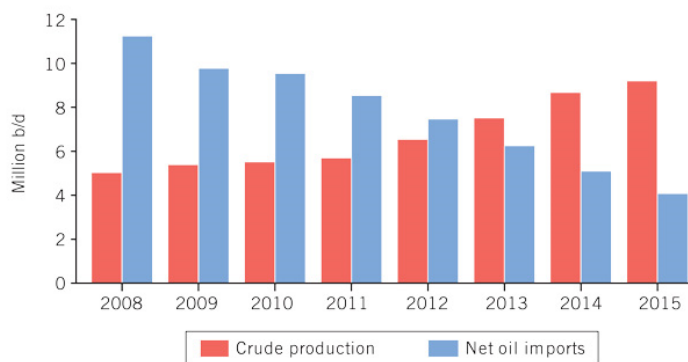
* The authors would like to thank J. Andrew Stables, Research Analyst, in the Chicago office of Clarion Associates, Inc. for the research assistance he provided on this article.

1. Amy Harder & Lynn Cook, *Congressional Leaders Agree to Lift 40-Year Ban on Oil Exports*, WALL ST. J. (Dec. 16, 2015), www.wsj.com/articles/congressional-leaders-agree-to-lift-40-year-ban-on-oil-exports-1450242995.

Republicans had been seeking such approval for years as a result of the huge turnaround in oil production in the United States. In exchange for their support, Democrats obtained a number of environmental and energy concessions including approval of an extension of wind and solar income tax credits.² In a bit of irony, however, the bill was enacted within days of the 2015 climate accord by world leaders in Paris that included pledges to significantly decrease use of fossil fuels.

The impetus for the milestone change in oil export policy was the 90% increase in U.S. crude oil production since 2008.³ As Figure 1 indicates,⁴ there has been a corresponding 75% decline in U.S. imports, and in 2013 U.S. crude oil production exceeded imports for the first time since 1991.⁵

Figure 1: U.S. Crude Oil Production and Net Oil Imports, 2008–2015



Source: IEA, OGI analysis

And, as Figure 2 shows, the United States is now the largest combined producer of oil and gas in the world, having surpassed Russia in 2012 and in 2014 surpassing even Saudi Arabia in the production of oil alone.⁶

2. *Id.*

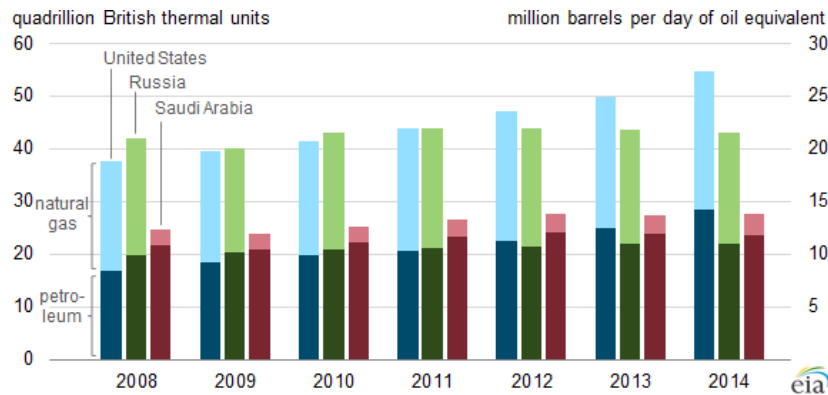
3. Oil & Gas Journal, *US Crude Production, Net Oil Imports*, www.ogj.com/content/dam/ogj/print-articles/volume-113/jan-05/150105OGJsxu-z05.jpg.

4. *Id.* at fig.5.

5. U.S. Energy Information Administration, *Petroleum and Other Liquids*, <http://topforeignstocks.com/wp-content/uploads/2015/01/US-Oil-Production-to-Imports-Chart.png>.

6. U.S. Energy Information Administration, *U.S. remained world's largest producer of petroleum and natural gas hydrocarbons in 2014* (Apr. 7, 2015), www.eia.gov/todayinenergy/detail.cfm?id=20692. Petroleum production includes crude oil, natural gas liquids, condensates, refinery processing gain, and other liquids, including condensates, refinery processing gain, and other liquids, including biofuels. Barrels per day oil equivalent were calculated using a conversion factor of 1 barrel oil equivalent = 5.55 million British thermal units (Btu).

Figure 2: Estimated U.S., Russia, and Saudi Arabia Petroleum and Natural Gas Production, 2008–2014



The principal cause of this surge in production in the United States has been the development since 2000 of ever more cost effective means of horizontal drilling combined with hydraulic fracturing of “unconventional”⁷ reservoirs of oil and gas.⁸ From an estimated 344 horizontally drilled and fracked⁹ wells in 2000 (about 1% of all U.S. wells drilled), the annual number of wells drilled horizontally increased to 1,810 in 2005 and surged to 14,560 drilled

7. The U.S. Environmental Protection Agency (USEPA) has defined “unconventional hydrocarbon resources” as “those whose extraction has become economical only with the advances that have occurred in modern hydraulic fracturing (often coupled with directional drilling) in recent years.” USEPA, *Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources* (External Review Draft), EPA/600/R-15/047, 2015, page 2-4, ll. 27–32. It contrasts that with “conventional” resources defined as “those that can be extracted using long-established technologies.” *Id.* The same USEPA report lists three types of unconventional formations containing hydrocarbons: shales; tight formations (sometimes called “tight sands”) consisting of low-permeability sedimentary rocks; and coalbeds containing methane. *Id.*

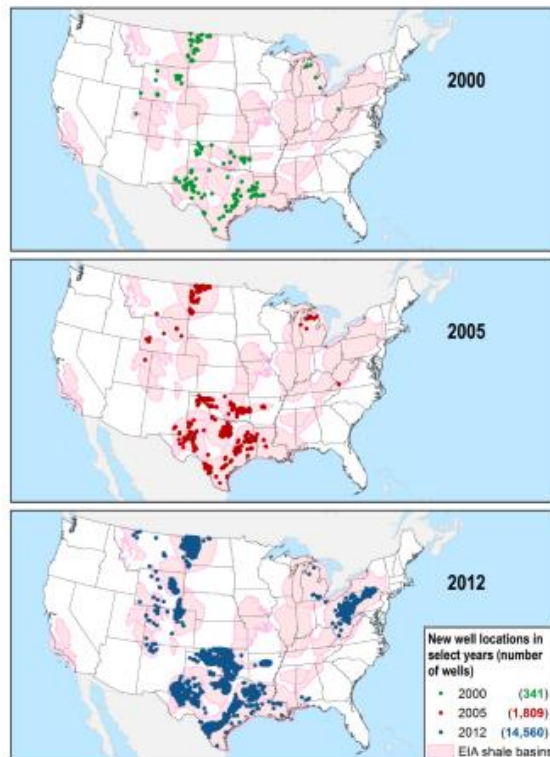
8. Hydraulic fracturing has also been widely used for years in traditional vertically drilled wells as well. One source of information cited by the USEPA estimates that in 2000 approximately 12,800 new wells were “fracked” in the United States. USEPA, *Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources*, June 2015, at 2-25, Line 30. The same USEPA reports other industry studies as concluding that hydraulic fracturing as a recovery technique was used for only 57% of new production wells but by 2009 had increased to “79% of all wells and more than 95% of ‘unconventional’ wells.” *Id.* at 2-27, ll. 28–29. Ten of eleven states responding to an Interstate Oil and Gas Compact Commission (IOGCC) survey in 2012 reported that hydraulic fracturing was involved in between 78% and 99% of all new wells drilled in 2012. *Id.* at 2-27, ll. 31–33.

9. In this article, we are using the commonly accepted words “fracked” and “fracking” as shorthand for the hydraulic fracturing process. Most oil and gas industry professionals and published industry sources prefer the word “fracing” but the popular press and media more typically refers to the process as “fracking.”

in 2012, accounting for about 41% of all new production wells in the later year.¹⁰

As the map of U.S. shale formations in Figure 3 shows,¹¹ that dramatic increase in wells drilled horizontally with hydraulic fracturing as the resource recovery method has been concentrated principally in four distinct regions of the country where unconventional formations have been the play.

Figure 3: Location of U.S. Horizontal Wells that Began Producing Oil or Natural Gas in 2000, 2005, and 2012



The states that have been the primary locations of the boom in horizontal drilling combined with fracking are as follows: Pennsylvania, West Virginia, and Ohio in the East; Texas, Oklahoma, and Louisiana in the mid-south; and Colorado, Wyoming, and North Dakota in the West.

10. United States Environmental Protection Agency, *Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources*, June 2015, page 2-25, Lines 29–33. The USEPA report discusses the various sources of well count data, some of which contain significantly different numbers.

11. *Id.* at 2-24 fig.2-16.

In some of those states—New York, Pennsylvania, Ohio, Colorado, and Texas in particular—the boom in oil and gas drilling has prompted concerns about the environmental consequences of hydraulic fracturing when compared with traditional oil and gas exploration. Horizontal drilling combined with hydraulic fracturing is quite different from traditional conventional oil and gas extraction.¹² Hydraulic fracturing is not a well drilling process but rather a resource recovery or “completion” process. Once the well is drilled into the horizontal formation, fluids containing a mixture of water, chemicals, and sand are injected under pressure great enough to fracture the rock formations in which the oil and gas is contained.¹³ The fracturing allows the oil and gas to escape into the well bore and rise to the surface where it is captured.¹⁴ The fracking process requires enormous amounts of water—fracking occurs in stages as the horizontal well bore is extended into the formation and the longer the horizontal extension the more stages (and water use).¹⁵

Water use varies from one shale play to another across the United States. In West Virginia, Pennsylvania, and Ohio, fracking a single well requires, on average, between 3.9 million and 5.0 million gallons of water.¹⁶ In Texas, the median water use per fracked well has been estimated to be between 3.1 million and 4.7 million gallons in five of the largest plays, including the Barnett Shale, but only 840,000 gallons per well in the Permian basin where more than half of Texas wells are located.¹⁷ Texas contains ten of the twenty-five counties across the nation where fracking water use in 2011 and 2012 “was greater than or equal to 30% of 2010 total water consumption”¹⁸ countywide.

That by itself has created controversy and generated opposition to fracking in many parts of the country, especially the west and southwest where groundwater is often the primary source of water for domestic and agricultural use. But an even greater environmental issue is raised by the fate of the injected fluids. Once

12. The number of producing gas wells in 2014 in these states as reported by the U.S. Energy Information Administration was 98,279 in Texas, 70,400 in Pennsylvania, 38,346 in Colorado, 32,967 in Ohio, and 7,119 in New York. U.S. Energy Information Administration, *Number of Producing Gas Wells* (Jan. 29, 2016), www.eia.gov/dnav/ng/ng_prod_wells_s1_a.htm.

13. PETROWIKI, *PEH: Hydraulic Fracturing*, [http://petrowiki.org/PEH%3A Hydraulic_Fracturing](http://petrowiki.org/PEH%3A%20Hydraulic_Fracturing).

14. *Id.*

15. *Id.*

16. USEPA, *Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources*, (External Review Draft), EPA/600/R-15/047, 2015, page 4-33, Lines 29–32.

17. *Id.* at 4-20 ll. 4–12.

18. *Id.* at 4-21 n.1. Not all the water for fracking comes from either groundwater or surface water resources. Reused hydraulic fracturing wastewater accounts for a significant percentage of the needed water in some of the unconventional formation plays.

the fracturing process has been completed, pressure in the well bore is reduced, and the fluids return to the surface as flowback combined with water produced by the formation itself.¹⁹ This flowback and produced water is stored at the surface, typically in an impoundment lagoon but sometimes in tanks, until it can be moved offsite either by tanker truck or, less frequently, by pipeline.

But not all of the fluids pumped into the formation can be recovered immediately through flowback. The high pressure required for fracking can force fluids from the well bore into the rock formations through which the well bore passes. Some of the fluid stays in the formation for weeks or months and returns to the surface over time mixed with the produced hydrocarbons. But about 70% or more of the fracking fluids on average are never recovered and remain in the formation from which they have the potential to migrate into other formations or even into groundwater.²⁰

19. The Institute for Energy and Environmental Research for Northeastern Pennsylvania, *What is flowback, and how does it differ from produced water?*, <http://energy.wilkes.edu/pages/205.asp>.

20. *See e.g., id.* (noting that, in relation to the Marcellus shale formation, “the volume of recovery is anywhere between 20% and 40% of the volume that was initially injected into the well.”). The USEPA reports that “[d]ata from 271 wells in the Marcellus Shale in West Virginia reveals the variability of recovery from wells in the same formation and that the amount of injected fluid recovered was less than 15% from over 80% of the wells.” USEPA, *Hydraulic Fracturing Drinking Water Assessment*, June 2015, page 5-42 (internal citation omitted).

Figure 4: Aerial View of Typical Well Head Site Prepared for Hydraulic Fracturing²¹



There are environmental contamination risks during the injection process stages as well as during the flowback period. The chemicals used in fracking are brought to the well head in chemical storage tanker trucks, and then mixed in slurry blenders and containment tanks connected to a series of manifolds, surface lines, and hoses, any of which can leak during the setup, mixing, and pumping process. The photo in Figure 4 is an aerial view of a typical well head site during the hydraulic fracturing process.²²

Impoundment lagoons can leak, contaminating soils and surface water resources, and spills during tanker truck loading and unloading or from pipe and hose line breaks have also occurred. The types of chemical spills that may occur due to fracking can be classified as follows: on-site well pad spills before or during the fracking fluid injection process, spills during the process of recovering fluids post-fracking, transportation related spills, drilling mud spills, and spills associated with post-fracking disposal of recovered fluids in underground injection wells.²³

21. FracFocus, *Site Setup*, <https://fracfocus.org/hydraulic-fracturing-how-it-works/site-setup>.

22. *Id.*

23. USEPA, *Hydraulic Fracturing Drinking Water Assessment*, June 2015, page 5-42.

The EPA estimates that “one-third of chemical spills on or near the well pad related to hydraulic fracturing resulted from equipment failure” and that there are “spill vulnerabilities specific to each piece of equipment.”²⁴ The equipment used at a fracking site for chemical mixing and injection includes “chemical storage trucks; oil storage tanks/tanker trucks; a slurry blender; one or more high pressure, high-volume fracturing pumps; the main manifold; surface lines and hoses; and a central control unit.”²⁵ As the EPA puts it, the risks of a spill increase with every equipment breakdown or failure, a common occurrence in such a complex system for mixing and injecting chemicals, and an event requiring “disconnection and reconnection of various pipes, hoses, and containers.”²⁶

How frequently do spills occur? The USEPA has completed a detailed study of reports on the number of spills in Pennsylvania and Colorado. In Pennsylvania, there have been a number of separate studies using varying criteria. One study estimated that spills of hydraulic fracturing fluids, flowback/produced water “occur at a rate of 0.4 per 100 wells fractured” while another estimated “3.3 to 12.2 spills per 100 wells installed.”²⁷ The EPA studied various Colorado spill reports and concluded there were “1.3 reported spills on or near the well pad for every 100 hydraulically fractured wells.”²⁸ Based on the various criteria used in the Pennsylvania and Colorado reports and studies, the USEPA concluded that “hydraulic fracturing-related spill rates in Pennsylvania and Colorado range from 0.4 and 12.2 per 100 wells.”²⁹ Based on that analysis, and an estimated 25,000 to 30,000 wells fractured each year between 2011 and 2014, there are between 100 and 3,700 fracking related spills annually.³⁰

The wastewater, once collected and transported from the well site, is sent to disposal sites. While some of the wastewater is used again in the fracking process, much of it is treated and then discharged to surface water bodies. According to the USEPA, about 40% of the wastewater collected nationally, however, is sent to deep Class II injection wells authorized by the Underground Injection Regulations that implement the Safe Drinking Water Act.³¹ That underground injection of wastewater raises additional environmental concerns related to potential groundwater contamination and earthquakes.

24. *Id.* at 5-28.

25. *Id.*

26. *Id.*

27. *Id.* at 5-48.

28. *Id.* The EPA study also reported that there were 15,000 wells fracked in Colorado between January 2006 and April 2012. *Id.*

29. *Id.* at 5-50.

30. *Id.* at 5-50 ll. 17-19.

31. USEPA, *Hydraulic Fracturing Drinking Water Assessment*, June 2015, 7-9.

But as discussed in detail later in this article, fracking has raised a wide variety of other environmental concerns as well. These include the following: the additional acres needed at the well head (in comparison to traditional drilling and recovery) to support the complexities of the chemical storage, mixing, pumping, and flowback recovery processes; truck traffic; noise; night time high intensity lighting needed during a typical fracking operation which operates day and night; and methane escaping into groundwater wells.³²

The environmental concerns have prompted new oil and gas drilling regulations in many states, as well as local and even statewide moratoria and bans on use of hydraulic fracturing technology in some parts of the country. The oil and gas industry and organizations representing owners of royalty interests have responded that moratoria and outright bans are a form of uncompensated “regulatory taking” of their vested property interests in their oil and gas leases and subsurface mineral rights. A later section of this article summarizes some of the more significant legal issues involved in the enactment of those regulations, bans, and moratoria.

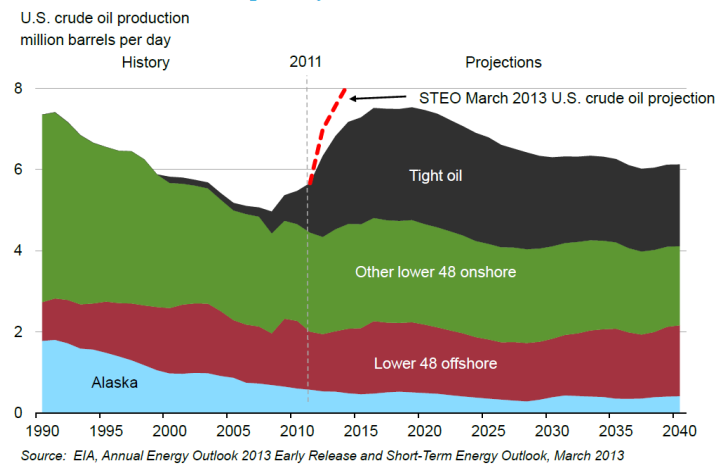
The market value of those investments in mineral rights acquisitions and royalty rights leases were substantial, at least at the peak of the hydraulic fracturing boom during 2010 through 2012, as evidenced by the surge in prices paid by the oil and gas industry for the rights to drill for oil and gas in unconventional formations. Rents—sometimes called “signing bonuses”—for drilling sites were increasing rapidly as the fracking boom developed. In Ohio, Pennsylvania, and New York, signing bonuses that were at only \$2.00 to \$5.00 per acre pre-2000 had increased to \$30 per acre by 2005, more than \$2,000 per acre in 2008, and typically ranged between \$5,000 and \$10,000 per acre in 2012. The *Oil and Gas Monitor* reports that “historically, in the eastern United States, oil and gas royalties were in the range of 12 to 14 percent” of the price obtained for the produced resource.³³ At least

32. For a discussion of these types of site related issues, see, e.g., New York State Department of Environmental Conservation, *Final Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program: Regulatory Program for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs Findings Statement*, June 2015. See also, Suzanne Goldenberg, *Fracking hell: what it's really like to live next to a shale gas well*, THE GUARDIAN, Dec. 14, 2013, www.theguardian.com/environment/2013/dec/14/fracking-hell-live-next-shale-gas-well-texas-us, and Union of Concerned Scientists, *Science, Democracy and Fracking: A Guide for Community Residents and Policy Makers Facing Decisions Over Hydraulic Fracturing*, www.ucsusa.org/sites/default/files/legacy/assets/documents/center-for-science-and-democracy/fracking-informational-toolkit.pdf.

33. Terrence M. Fay, *Fracking: Economic and Environmental Considerations*, OIL AND GAS MONITOR (July 2, 2012), www.oilgasmonitor.com/fracking-economic-environmental-considerations/2536/. A study by the

one production company has paid rates as high as 20% in fracking boom areas.³⁴ Both Pennsylvania and New York have state laws guaranteeing a landowner royalty payments equal to at least 12.5% of the “value of production.”³⁵

Figure 5: U.S. Crude Oil Production Million Barrels Per Day History



Those agreements – and the corresponding effect on the value of the property interests – were signed at a time when forecasts for future oil and gas prices were much different than they are now in early 2016. As recently as April of 2013, it was projected that U.S. oil and gas production would continue to surge and level off at about 7.8 million barrels per day by 2020 (as shown in the graphic above).³⁶ The forecast production surge is due completely to an expected dramatic growth in oil production from unconventional tight shale formations using hydraulic fracturing.³⁷

Pennsylvania Chapter of the National Association of Royalty Owners, as referenced in a 2013 Allegheny Institute publication, reported that royalty payments were “typically not above 12.5 percent in the beginning, but as the boom progressed the royalty share has ranged up to 20 percent, depending on the individual contract.” ALLEGHENY INSTITUTE FOR PUBLIC POLICY, *Marcellus Royalty Payments Rising Rapidly* (May 30, 2013), www.alleghenyinstitute.org/marcellus-royalty-payments-rising-rapidly/.

34. Fay, *supra* note 33.

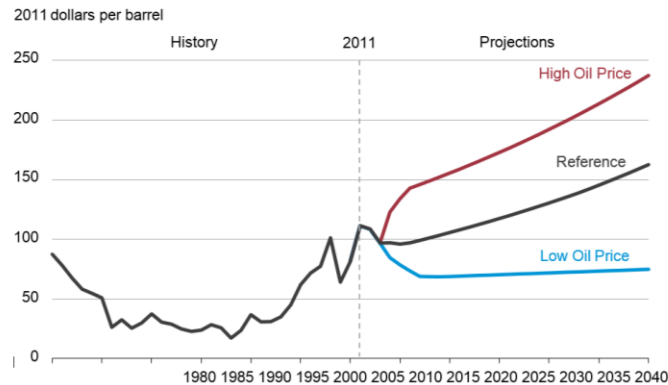
35. Richard Roddewig & Rebel Cole, *Real Estate Value Impacts from Fracking: Industry Response and Proper Analytics Techniques*, 39(3) REAL ESTATE ISSUES 4, <http://ssrn.com/abstract=2688724>.

36. Adam Sieminski, *Outlook for shale gas and tight oil development in the U.S.*, U.S. ENERGY INFORMATION ADMINISTRATION 13 (Apr. 4, 2013), www.eia.gov/pressroom/presentations/sieminski_04042013.pdf.

37. *Id.*

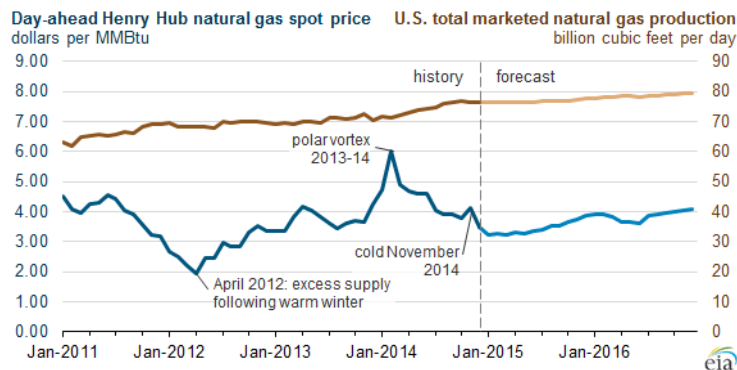
That 2013 forecast was based on the "reference" (most likely) forecast that oil prices would rise to about \$120 per barrel, as shown in figure 6 on the next page.³⁸

Figure 6: 2013 Forecast of Future Oil Prices



And as recently as January of 2015, forecasters were predicting that U.S. natural gas production prices, despite the drop from \$6.00 to \$3.50 per MMBtu would hold steady at a price above \$3.00 per MMBtu in early 2015 and then gradually rise to \$4.00 per MMBtu during 2015 and 2016 as shown in the graphic below.³⁹

Figure 7: 2016 Forecast of Future Natural Gas Prices



38. Adam Sieminski, *U.S. Energy Outlook*, U.S. ENERGY INFORMATION ADMINISTRATION 5 (Jan. 14, 2013), www.eia.gov/pressroom/presentations/sieminski_01142013.pdf.

39. U.S. Energy Information Administration, *Day-ahead Henry Hub natural gas spot price*, www.eia.gov/todayinenergy/images/2015.01.28/main.png.

So what has happened to the value of the property interests in tight shale resources given current oil and gas prices and production forecasts? Are the optimistic forecasts from 2013 still viable as of January 2016 when crude oil prices – contrary to the reference line for 2016 in the graph above – are at less than \$30 per barrel, 50% lower than even the lowest early 2013 oil price forecast and natural gas prices are at \$2.00 per MMBtu, 66% lower than the price paid two years earlier?

Three things have fundamentally altered the economic outlook for oil and gas and therefore the value of investments in oil and gas deposits in the United States. First, crude oil demand has been significantly lower than was forecast in 2013 due to recent economic problems in Europe, China and in other developing countries, driving down commodity demand (and prices) including crude oil and gas prices.⁴⁰

Second, OPEC – much to the surprise of many analysts and contrary to its reaction in prior economic downturns – has not cut production in order to provide price support. Instead, Saudi Arabia, the largest OPEC member, has continued to pump crude at high production volumes, putting further downward pressure on oil prices and contributing to the lowest prices for crude since the early 1990s.⁴¹ Because Saudi Arabia's production costs are among the lowest in the world, as shown in the chart on the following page,⁴² it can profitably produce at prices even lower than the current \$37 per barrel average production cost in the U.S. and still make a substantial profit.

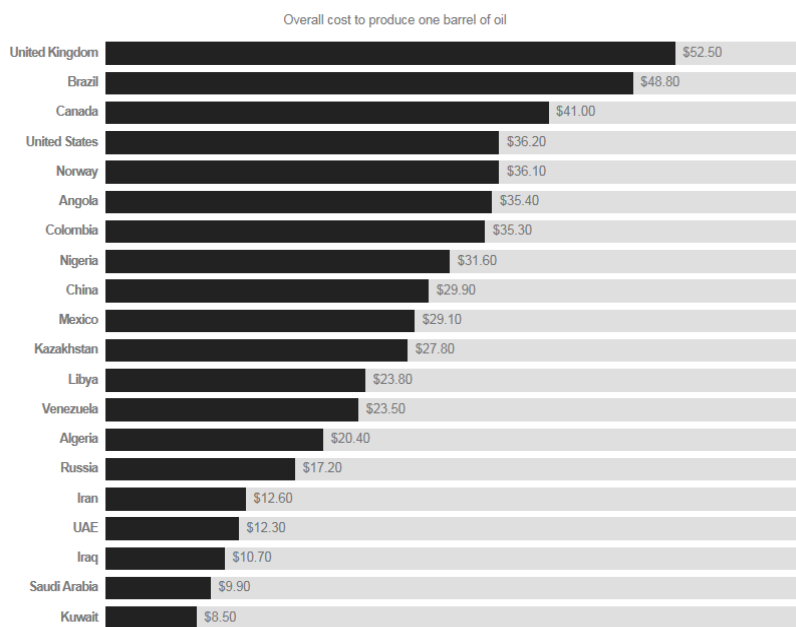
40. See Jason Bordoff, *Don't Get Used to Cheap Gas*, WALL ST. J. (Sept. 18, 2015), <http://blogs.wsj.com/experts/2015/09/18/dont-get-used-to-cheap-gas/>.

41. *Id.*

42. Alanna Petroff & Tal Yellin, *What it costs to produce oil*, CNN (Nov. 14, 2015), <http://money.cnn.com/interactive/economy/the-cost-to-produce-a-barrel-of-oil/index.html?id=EL>. The notes to the graphic state the following:

This chart was compiled using data from more than 15,000 oil fields across 20 nations. The production costs were calculated by including a mix of capital expenditures and operational expenditures. Capital expenditures included the costs involved with building oil facilities, pipelines and new wells. Operational expenditures included the costs of lifting oil out of the ground, paying employee salaries and general administrative duties.

Id.

Figure 8: Overall Cost to Produce One Barrel of Oil

And third, the drop in foreign natural gas prices lowered the incentive for U.S. gas producers – already impacted since 2011 by a huge drop in natural gas production prices – to continue to produce gas from tight shale gas formations for sale in the international market.⁴³ The chart below shows the drop in the spot Asian market price of liquefied natural gas compared to the total export cost of U.S. LNG gas to Asia.⁴⁴

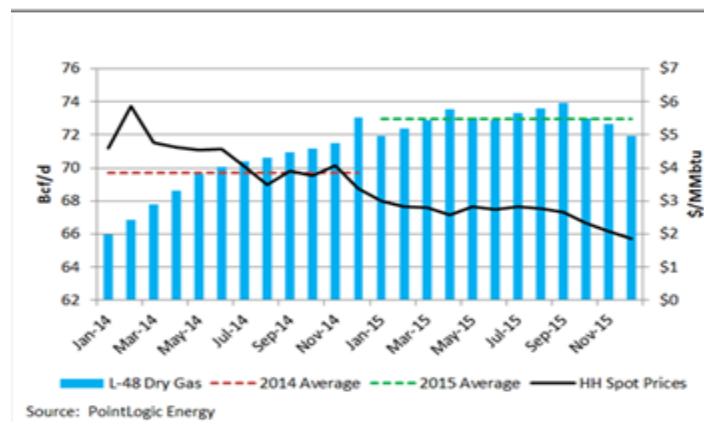
43. Dan Murtaugh, *Engie Says Nobody Is Making Money off U.S. Natural Gas Exports*, BLOOMBERG (Sept. 24, 2015), www.bloomberg.com/news/articles/2015-09-24/engie-executive-says-nobody-is-making-money-off-u-s-gas-exports.

44. *Id.*

Figure 9: Drop in the Spot Asian Markey Price of Liquefied Natural Gas



Figure 10: L-48 Dry Natural Gas Production



While much of the oil and gas industry news coverage during 2015 and early 2016 has been on the steep drop in crude oil prices, the price for domestic U.S. natural gas began to collapse in 2014 as shown in the graphic below.⁴⁵ Between January of 2014 and December of 2015 the spot production natural gas price dropped by about 66%.⁴⁶

In response, U.S. oil and gas producers have been trying to cut costs with considerable success. But as explained later in this article, fracking costs cannot be reduced to levels much lower than now.

So this article deals with the following questions:

As a result of the strong environmental opposition combined with the huge drop in oil and gas prices – and the high fixed costs of hydraulic fracturing -- has the U.S. oil and gas boom ended?

Or are there new -- or old but overlooked -- production technologies that are more environmentally friendly, more

45. PointLogic Energy, *L-48 Dry Natural Gas Production*, fig.5, https://client.pointlogicenergy.com/CMSMedia/4350c9ff-80b0-478b-a4d0-272fb3fb57a2/GTP--1-6-16_5.png?LastModified=635876103750711860.

46. *Id.*

productive, and less costly and allow U.S. producers to continue to compete profitably in the face of tougher environmental regulations and low cost Saudi and Middle-East oil?

What has the declining price for gas and oil done to regulatory taking concerns? Are the mineral rights and lease/rent rights that were so valuable five years ago now worthless, especially in regions where fracking bans and moratoria have been legally imposed?

In this article, we will explore “underbalanced drilling,” (UBD) a long-standing but also long-overlooked alternative to hydraulic fracturing that increases production, cuts costs, and eliminates most of fracking's environmental risks. It is beginning to attract increasing oil and gas industry attention thanks to improvements in the well head and blowout technology it employs and the demonstrated success it has recently shown in many current U.S. shale plays.

So the central question this article asks is as follows:

Is underbalanced drilling the solution to the economic, environmental and regulatory taking headwinds confronting the American oil and gas industry?

A. Opposition to Fracking: Types and Causes of Concern

Opposition to fracking takes many forms. Some environmental groups oppose fracking on basic principle -- the United States should be discouraging rather than encouraging more oil and gas drilling because of the relationship between fossil fuels consumption, CO₂ emissions, and global warming. For example, the Natural Resources Defense Council (NRDC) website includes the following statement:

Americans shouldn't have to trade their safe drinking water, clean air, climate, health or communities for energy. NRDC is working to build a clean energy future—one centered on clean, safe, renewable sources of power, used efficiently, that ends our dependence on fossil fuels as quickly as possible. Energy efficiency and renewable energy must be our country's top energy priorities because they are the quickest, cleanest, and cheapest solutions to global warming and other pollution problems.⁴⁷

Other environmental groups focus their concerns about fracking on more specific localized risks of surface water, groundwater, and soil contamination rather than the larger issues of hydrocarbon use in general, global warming, and climate change. For example, Earthworks, which describes itself as "a nonprofit organization dedicated to protecting communities and the environment from the

47. Natural Resources Defense Council, *Unchecked Fracking Threatens Health, Water Supplies*, www.nrdc.org/energy/gasdrilling/.

adverse impacts of mineral and energy development while promoting sustainable solutions,"⁴⁸ emphasizes the on-site and near-site groundwater, surface water, and soil contamination risks associated with the fracking process as the primary basis of its opposition to the process.⁴⁹ Others, such as the California Chapter of Friends of the Earth are concerned about the large quantities of water that fracking requires even in locations already stressed by water shortages due to prolonged droughts.⁵⁰

And some national groups are focused on just one or two specific risks associated with fracking. For example, the Ground Water Protection Council is focused primarily on exactly what the organization's name implies: the groundwater use issues, including contamination risks, associated with hydraulic fracturing.⁵¹ But it has also taken one of the lead roles in coordinating efforts related to understanding the seismic activity risks associated with fracking and deep well injection of byproducts of the fracking process.⁵²

At a more basic grass roots local government and neighborhood level, concerns can be even more narrowly focused. In rural areas of Pennsylvania, local grass roots opposition to fracking is often based on a claimed link between fracking and high levels of methane in tap water. In Bethlehem, Pennsylvania, for example, an organization identified as Lehigh Valley Gas Truth was founded in 2010 to call for a statewide moratorium on natural gas shale drilling due to its effects on the air and water supplies, including the migration of methane into tap water sources.⁵³

Another locally based group in Oklahoma, Stop Fracking Payne County (SFPC), is focused on an alleged connection between fracking related activities and the significant rise in the state's seismic activity since 2008.⁵⁴ This group has led active public presentations, distributed anti-fracking yard signs, and circulated petitions to place a moratorium on fracking throughout the county, facilitating much of its communication through Facebook.⁵⁵

48. EARTHWORKS, *About Earthworks*, www.earthworksaction.org/about.

49. See, e.g., Earthworks, *Hydraulic Fracturing 101*, www.earthworksaction.org/issues/detail/hydraulic_fracturing_101#.Vl3ptWeFPet.

50. See, e.g., Ross Hammond, *No fracking way: Keeping hydraulic fracturing out of California* (May 21, 2013), www.foe.org/news/archives/2013-05-no-fracking-way-keeping-fracturing-out-of-cali.

51. See GROUNDWATER PROTECTION COUNCIL, *What Is Hydraulic Fracturing?* www.gwpc.org/programs/water-energy/hydraulic-fracturing, (information on groundwater use and contamination issues).

52. GROUNDWATER PROTECTION COUNCIL, *Class II Injection Wells: Injection Wells Related to Oil and Gas Activity*, www.gwpc.org/programs/water-energy/energy-related-injection.

53. LEHIGH VALLEY GAS TRUTH, www.facebook.com/lehighvalleygastruth/info/?tab=page_info.

54. STOP FRACKING PAYNE COUNTY, *About Us*, <https://stopfrackingpaynecounty.wordpress.com/>.

55. STOP FRACKING PAYNE COUNTY, www.facebook.com/groups/1424950051091596/.

In suburban areas of Dallas and some other Texas cities, the central concern of neighborhood groups is often the "aesthetics" of fracking operations and the land use conflicts created by "industrialized" oil and gas operations in or adjacent to residential neighborhoods.⁵⁶ Oil and gas leases and/or deeds separating the mineral estate from the surface estate created decades ago often established the right to drill and extract in areas later zoned for residential use. Odors, truck traffic, noise, and lights -- oil and gas drilling often proceeds all day and night -- have been a principal cause of opposition in many Texas locales.⁵⁷ For example in Denton, Texas, which enacted a ban on fracking in November of 2014, the *Houston Chronicle* reported the root cause as follows:

What set off residents in Denton, more than anything else, was wells drilled too close to homes and a city park. They objected to the noise and the smells and the traffic congestion that comes with drilling projects. In many ways, this is the ultimate NIMBY case.⁵⁸

B. The Industry and Regulatory Response to Fracking Opposition: Lessons from Pennsylvania, New York, Illinois, Colorado, and Texas

The regulatory response to fracking concerns has varied widely from state to state across the United States. There are differences between the states in the level and type of state preemption of local control of the regulation of the fracking process. That variation is apparent from a comparison of fracking regulation in the following five states: Pennsylvania, New York, Illinois, Colorado, and Texas.

About 75% of Pennsylvania and all of southwestern New York state overlay the Marcellus Shale, one of the most significant tight oil and gas resources in the United States.⁵⁹ In both, the state level of government has pre-empted the right of local governments to regulate the fracking process.⁶⁰ Both states, however, allow local governments some authority to use their home rule and zoning/land

56. See, e.g. Jim Malewitz, *Dissecting Denton: How a Texas City Banned Fracking*, THE TEXAS TRIBUNE (Dec. 15, 2014), www.texastribune.org/2014/12/15/dissecting-denton-how-texas-city-banned-fracking/.

57. *Id.*

58. Loren Steffy, *Steffy: Industry's bad manners led to Denton fracking ban*, HOUSTON CHRONICLE (Nov. 15, 2014), www.chron.com/opinion/outlook/article/Steffy-Industry-s-bad-manners-led-to-Denton-5895609.php.

59. USEPA, *Oil and Gas Extraction in the Mid-Atlantic*, www.epa.gov/foia/oil-and-gas-extraction-mid-atlantic.

60. David L. Schwan, *Preemption Update: Local Attempts to Preempt State Regulation of Hydraulic Fracturing*, www.americanbar.org/content/dam/aba/administrative/litigation/materials/2015-joint-cle/written_materials/01_fracked_up_preemption_update.authcheckdam.pdf.

use authority to impose limited restrictions on the location of oil and gas wells.⁶¹

The Pennsylvania Oil and Gas Act (POGA) contains the following sweeping language related to local control of oil and gas drilling, including fracking: “The Commonwealth, by this enactment, hereby preempts and supersedes the regulation of oil and gas wells as herein defined.”⁶² However, other language in the state statute creates an exception for local government regulations enacted pursuant to their general land use planning and zoning authority.⁶³

There have been at least three court cases in Pennsylvania challenging local regulation of oil and gas wells on the basis of the preemption language in the state statute. Two upheld local land use regulations related to the location of oil and gas wells. In *Penneco Oil Co., Inc. v. County of Fayette*, regulations prohibiting oil and gas wells within 200 feet of residential dwellings or less than 50 feet from a lot line or right of way and imposing landscaping and fencing requirements were upheld.⁶⁴ In *Huntley & Huntley, Inc. v. Borough Council of Borough of Oakmont*, 964 A.2d 855 (Pa. 2009), a zoning law permitting drilling in some zoning districts but prohibiting it in others zoned for residential use was upheld as was the community’s related authority to impose “aesthetic” restrictions to preserve neighborhood character.⁶⁵ Both of those decisions said such local zoning and land use authority was not preempted by POGA since local zoning “serves different purposes than from those enumerated in the Oil and Gas Act.”⁶⁶

A third Pennsylvania case, however, narrowly defined the boundary between permissible local zoning controls of oil and gas production and impermissible interference with the actual operation of the wells themselves. In *Range Resources – Appalachia, LLC v. Salem Twp.*, 964 A.2d 869 (Pa. 2009), the Pennsylvania Supreme Court ruled that a local government ordinance requiring, among other things, insurance bonding, well head regulations, pre-drilling water testing, and site restoration after drilling, were preempted by the state Oil and Gas Act.⁶⁷

The New York Oil, Gas and Solution Mining law enacted in 1971 gives the state level of government exclusive authority to issue oil and gas permits and specifically states that it is intended to

61. *Id.*

62. Pa. Oil and Gas Act, 58 PA. CONS. STAT. §§ 1-701 7, 601, 602 (2011) [hereinafter POGA].

63. 58 PA. CONS. STAT. Ch. 33.

64. *Penneco Oil Co., Inc. v. County of Fayette*, 4 A.3d 722 (Pa. Commw. Ct. 2010).

65. *Huntley & Huntley, Inc. v. Borough Council of Borough of Oakmont*, 964 A.2d 855 (Pa. 2009).

66. *Id.* at 866.

67. For a discussion of all three cases, see David L. Callies & Chynna Stone, *Regulation of Hydraulic Fracturing*, 1 J. INT’L & COMP. L., 1 (2014).

“supersede all local laws or ordinances relating to the regulation of the oil, gas and solution mining industries.”⁶⁸ However, in two cases,⁶⁹ the New York Court of Appeals ruled that local government zoning authority actually allows a community to ban fracking related oil and gas drilling, which approximately 200 communities have done in New York State.⁷⁰ As in Pennsylvania, the New York court decisions prohibit local governments from regulating the operation of oil and gas wells as distinct from their location. In other words, local government may regulate the “where” but not the “how” of oil and gas operations⁷¹ given the state’s “interest in establishing uniform procedures for oil and gas exploration and operations.”⁷²

Despite the similarities between the New York and Pennsylvania stories, New York has done something that Pennsylvania has not – enacted a statewide ban on fracking. That was the result of a seven-year process during which the state studied both the economic and environmental issues as well as possible health impacts of hydraulic fracturing.⁷³ In 2008, former Governor David Paterson imposed a temporary moratorium on permits for wells using hydraulic fracturing technology while various state agencies studied the issue, held hearings, and solicited public comment.⁷⁴ In December of 2014, Governor Andrew Cuomo announced that the fracking ban would be permanent,⁷⁵ and in June of 2015 the New York Department of Environmental Conservation (NYDEC) issued its Final Environmental Impact Statement stating

68. N.Y. ENVTL. CONSERV. LAW § 23-0303(2).

69. *Wallach v. Town of Dryden*, 16 N.E. 3d 1188 (N.Y. 2014) (the two cases, *Wallach v. Town of Dryden* and *Cooperstown Holstein Corp. v. Town of Middlefield*, were consolidated on appeal).

70. In June of 2014, the *Wall Street Journal* reported that 170 New York State communities had banned oil and gas drilling. Joseph De Avila, Mike Vilensky, & Russell Gold, *New York Communities Can Ban Fracking, Court Rules*, WALL ST. J. (June 30, 2014), www.wsj.com/articles/new-york-towns-and-cities-can-ban-fracking-court-rules-1404145435. However, the *Boston Globe* reported that it was 200 communities as of December 2014. Andrew Ba Tran, *Where communities have banned fracking*, BOSTON GLOBE (Dec. 18, 2014), www.bostonglobe.com/news/nation/2014/12/18/where-communities-have-banned-fracking/05bzzqiCxBY2L5bE6Ph5iK/story.html. The same *Boston Globe* story reported that the New York state total accounted for about one-half of the approximately "400 cities, towns, counties, districts, and states [that] have attempted to ban fracking or practices associated with fracking." *Id.*

71. *Wallach*, 16 N.E.3d at 1202.

72. Callies & Stone, *supra* note 67, at 32.

73. Freeman Klopott, *N.Y. Officially Bans Fracking With Release of Seven-Year Study*, BLOOMBERG (June 29, 2015), www.bloomberg.com/news/articles/2015-06-29/n-y-officially-bans-fracking-with-release-of-seven-year-study.

74. Sarah Hoye, *New York Governor Pauses Fracking*, CNN (Dec. 13, 2010), www.cnn.com/2010/US/12/13/new.york.fracking.moratorium/.

75. Timothy Cama, *NY to Ban Fracking*, THE HILL (Dec. 17, 2014), <http://thehill.com/policy/energy-environment/227429-new-york-to-ban-fracking>.

that no individual or site-specific permit applications for wells using high-volume hydraulic fracturing will be processed; and that high volume hydraulic fracturing will be prohibited in New York State" because of its "unavoidable adverse environmental impacts and uncertainty regarding the science surrounding high-volume hydraulic fracturing and its potential impacts to public health . . ."76

The alternative considered and rejected by the NYDEC was a limited fracking ban in specifically mapped environmentally sensitive areas of the state such as in and around state parks and surface water resources as well as above important groundwater resources.⁷⁷ That alternative would also have allowed local governments to impose wider ranging bans as well, an outcome that the NYDEC concluded was unacceptable for two reasons.⁷⁸ First, the combination of the sensitive area mitigation measures and existing local government bans would effectively prevent fracking above 63% of the Marcellus Shale resource area.⁷⁹ Second, such limitations would mean that the potential economic benefits from "employment, income, and tax generation associated with high-volume hydraulic fracturing would be substantially less (in the tens to hundreds of millions of dollars) than originally projected . . ."⁸⁰

Pennsylvania, in contrast to New York, has actively encouraged fracking. It was 2004 when it first became widely understood that hydraulic fracturing could turn the Marcellus Shale underlying much of Pennsylvania into one of the most significant natural gas plays in the United States. Since then, the state has enacted a wide array of policies to encourage fracking. As a result, between January of 2005 and March of 2012, "the Pennsylvania Department of Environmental Protection issued 10,232 drilling permits, and denied only 36 requests."⁸¹ Among the many state government actions to encourage fracking were the following: an exemption from environmental assessments before drilling in state parks; enactment of Act 13 giving the Public Utility Commission authority to overturn local zoning regulations that unduly burden fracking and requiring local governments to adopt regulations to allow drilling; enabling oil and gas companies to take private property for "injection, storage and removal" of hydrocarbons; and passage of a budget bill that authorized the Department of Community and Economic Development to "expedite

76. N.Y. DEPT' ENVTL. CONSERV., *Final Supplemental Generic Environmental Impact Statement*, 41 (2015).

77. *Id.*

78. *Id.*

79. *Id.*

80. *Id.* at 39.

81. SourceWatch, *Pennsylvania and fracking*, www.sourcewatch.org/index.php/Pennsylvania_and_fracking.

any permit or action pending in any agency where the creation of jobs may be impacted."⁸²

Illinois, another state with a long history of oil and gas production, is only now becoming a serious target for tight shale development. Much of the state is in the Illinois Basin, a historically important geologic structure with a history of oil and gas production dating back to the 1860s.⁸³ In the past 150 years, more than 155,000 oil, gas and injection wells have been drilled in the state, and as of 2014 there were about 32,100 production wells and 10,500 Class II injection wells in Illinois.⁸⁴ Illinois oil production peaked in 1940 at 147.6 million barrels.⁸⁵ Illinois natural gas production, by comparison, has been increasing over the last fifteen years, rising from 147 million cubic feet in 2000 to 2,579 million cubic feet in 2014.⁸⁶ Yet most of the wells in Illinois and elsewhere in the Illinois Basin today⁸⁷ are older stripper wells producing an average output of 1.5 b/d/well,⁸⁸ putting the state in 16th place for oil and 32nd for gas nationally among oil and gas producing states in 2015.⁸⁹

Although the Illinois Oil and Gas Act has long regulated conventional drilling, there was little interest in unconventional plays in the state until the past five years. Recent preliminary investigation of the New Albany shale indicates technically recoverable reserves in excess of 11 trillion cubic feet of natural gas and 189 million barrels of oil.⁹⁰ As a result, the Illinois General Assembly in 2011 began to consider legislation to regulate unconventional hydraulic fracturing.

The bill, eventually enacted in June of 2013 as the Illinois Hydraulic Fracturing Regulatory Act, has been hailed by many as a model for the rest of the country, because it "contains some of the strongest protections against water pollution [from fracking] in the

82. *Id.*

83. Ill. Dep't Natural Res., *About Oil and Gas in Illinois*, www.dnr.illinois.gov/OilandGas/Pages/AboutOilAndGasInIllinois.aspx.

84. *Id.*

85. Ill. State Geological Survey, *History of Oil and Gas Production in Illinois*, www.isgs.illinois.edu/outreach/geology-resources/history-oil-and-gas-production-illinois.

86. U.S. Energy Information Administration, *Illinois Dry Natural Gas Production*, www.eia.gov/dnav/ng/hist/na1160_sil_2a.htm.

87. In April of 2014, the three states in the Illinois Basin (Illinois, Kentucky and Indiana) "combined produced about as much oil as North Dakota produced in a single day -- slightly more than 1.1 million barrels." Dan Sharp, *Four Bakken-like plays emerging across the nation's midsection*, BISMARCK TRIBUNE (Sept. 11, 2014), http://bismarcktribune.com/bakken/breakout/four-bakken-like-plays-emerging-across-the-nation-s-midsection/article_8d75c61c-39c8-11e4-98bf-af0a259878c1.html.

88. Rachel Seeley, Editor, *Illinois shale exploration remains in limbo as regulators consider draft fracking rules*, 5 OIL & GAS J. 5 (2014), www.ogj.com/articles/uogr/print/volume-2/issue-5.

89. U.S. Energy Information Administration, *Illinois: State Profile and Energy Estimates*, www.eia.gov/state/?sid=IL.

90. Sharp, *supra* note 87.

nation,"⁹¹ and will influence "debates and strengthen rules about oil and gas extraction in other states"⁹² Among the water usage and water quality protections are the following:

- mandatory pre-drilling submission of a water management plan including information on the source of water to be used, volume, and rate of withdrawal;
- a mandatory plan for "handling, storage, transportation, and disposal or reuse of hydraulic fracturing fluids and hydraulic fracturing flowback" including specific identification of any injection wells to be used;⁹³
- baseline pre-drilling testing of surface and groundwater resources near a proposed well;⁹⁴
- post-fracking re-testing of surface and groundwater resources near operating wells;
- mandatory setbacks from water sources including public water supply intakes;
- when post-fracking contamination of water is discovered, fracking companies are required to prove that fracking was not the cause and the implementing regulations state that there is a presumption that any water pollution found within 1,500 feet of a fracking well is caused by fracking unless the company can prove otherwise;⁹⁵
- prohibition on open wastewater storage ponds -- wastewater must be kept in closed tanks;⁹⁶
- waste fluid controls including reuse requirements or disposal by injection in deep underground containment wells and mandatory well shut downs when fracking fluids migrate to the surface;
- mandatory post-fracking reports to regulators concerning total water used in the fracking process;

91. Jennifer Cassel, *Illinois' Hydraulic Fracturing Regulatory Act: A Successful Compromise*, outline of presentation made at *Fracking, Energy Sources, Climate Change & Real Estate*, The John Marshall Law School, 14th Kratovil Conference on Real Estate Law & Practice, Sept. 29, 2015.

92. Sofia Plagakis, *Illinois Passes Strongest Fracking Bill in Country*, CENTER FOR EFFECTIVE GOVERNMENT (June 19, 2013), www.foreffectivegov.org/blog/illinois-passes-strongest-fracking-bill-country.

93. 225 ILL. COMP. STAT. 732/1-35(b)(11).

94. The testing must be done within 1,500 ft. 225 ILL. COMP. STAT. 732/1-80(b).

95. 225 ILL. COMP. STAT. 732/1-80(b).

96. The act included an "unforeseeable circumstances" exception for temporary storage in open air ponds in Sec. 1-75(c). However, in the implementing regulations, this exception was limited to only a one-week period of time following an unexpected backflow of large volumes of wastewater. After seven days, the wastewater must be removed from the open storage pond.

- mandatory pollution control reports to Illinois regulators every two to three years after a drilling permit is granted;
- power granted the public to challenge a company's invocation of the "trade secret exception" to the requirement that chemicals used in fracking be disclosed.

While many similar provisions have been included in regulations enacted in other states, Illinois goes further than most in terms of mandatory pre-drilling water testing, setbacks, wastewater storage, company liability for pollution, and disclosure of fracking chemicals.

Some have commented that the Illinois legislation and accompanying regulations go beyond the rules in other states in one very important regard because "the Act protects against contamination by requiring best engineering practices for well construction, easements & maintenance."⁹⁷ However, the words "best engineering practices" do not appear in the Act or in the implementing regulations. Instead, with reference only to the temporary on-site use of lined waste water storage pits, Section 1-75(c)(2)(C) of the Act states that "the lined pit shall be constructed, installed, and maintained in accordance with the manufacturers' specifications and good engineering practices to prevent overflow during any use."⁹⁸ And the only mention of "best practices" is in the following language related to reports by the Illinois Department of Natural Resources:

Two years after the effective date of the first high volume horizontal hydraulic fracturing permit issued by the Department, and every 3 years thereafter, the Department shall prepare a report that examines the following . . . identification of the latest scientific research, best practices, and technological improvements related to high volume horizontal hydraulic fracturing operations and methods to protect the environment and public health.⁹⁹

Neither the Act nor the implementing regulations, however, specifically mandate "best practices"¹⁰⁰ to be followed by the fracking industry in Illinois. However, given the authority granted the Illinois Department of Natural Resources to regulate fracking, the IDNR could impose what it considers to be "best engineering practices" as part of its permitting responsibilities.

97. Jennifer Cassel, *Illinois' Hydraulic Fracturing Regulatory Act: A Successful Compromise*, outline of presentation made at *Fracking, Energy Sources, Climate Change & Real Estate*, The John Marshall Law School, 14th Kratovil Conference on Real Estate Law & Practice, Sept. 29, 2015.

98. 225 ILL. COMP. STAT. 732/1-75(c)(2)(C).

99. 225 ILL. COMP. STAT. 732/1-97(b).

100. The closest language is in Section 240-850 of the implementing regulations requiring "standard engineering practices" to be used in the construction of "new concrete storage structures. ILL. ADMIN. CODE, tit. 62, § 240.850(d)(7).

Colorado is in the midst of a heated legal battle over the authority of local government to regulate fracking. Boulder, Larimer and Weld Counties located along the Front Range north of Denver have been experiencing significant horizontal drilling and hydraulic fracturing in the Wattenberg Field, a portion of the Denver Basin, in which more than 20,000 wells have been drilled since 1970, including horizontally fracked wells in recent years.¹⁰¹ In July of 2012, Longmont adopted a comprehensive set of regulations for oil and gas operations and then in November of 2012, voters in Longmont approved an amendment to the city charter that prohibited hydraulic fracturing and the storage or disposal of fracking wastes in the city.¹⁰² In 2013, Broomfield followed Longmont's lead and also voted to ban fracking and the storage of hydraulic fracking fluids.¹⁰³ In 2013, a ballot measure passed in Lafayette prohibiting not just fracking but all oil and gas extraction and related activities within the city limits and voters in Fort Collins approved a citizen-initiated ordinance imposing a five-year moratorium on hydraulic fracturing and storage of fracking wastes within the city's boundaries.¹⁰⁴

Those actions prompted a series of lawsuits by the Colorado Oil & Gas Conservation Commission as well as by the Colorado Oil & Gas Association. In *Colorado Oil & Gas Conservation Comm'n v. City of Longmont*,¹⁰⁵ the state entity charged with regulating oil and gas production requested the court to issue a declaratory judgment ruling that the Colorado Oil and Gas Conservation Act¹⁰⁶ preempted Longmont's authority to regulate oil and gas drilling and production.

However, the Boulder County Court stayed, and eventually dismissed that first case in light of developments in a second case involving Longmont, *Colorado Oil & Gas Ass'n v. City of Longmont*¹⁰⁷ which challenged the city's ban on fracking and storage of fracking waste. The Oil & Gas Conservation Commission as well

101. American Petroleum Institute, *Strategic Energy Resources Denver-Julesburg Basin – Wattenberg Field, Colorado*, (2008), www.api.org/~media/Files/Policy/Exploration/Energy-Resources/StrategicEnergyResources_Wattenberg.pdf.

102. Jack Healy, *With Ban on Drilling Practice, Town Lands in Thick of Dispute*, N.Y. TIMES, Nov. 25, 2012, www.nytimes.com/2012/11/26/us/with-ban-on-fracking-colorado-town-lands-in-thick-of-dispute.html.

103. *Broomfield Passes Fracking Ban While Pro-fracking Groups Sue*, HUFFINGTON POST (Dec. 4, 2013, 4:43 PM), www.huffingtonpost.com/2013/12/04/colorado-anti-fracking-broomfield_n_4385210.html.

104. John Aguilar, *Anti-fracking measures win in Lafayette, Boulder, Fort Collins*, DAILY CAMERA (Nov. 5, 2013), www.dailycamera.com/local-election-news/ci_24459893/fracking-bans-lafayette-broomfield-boulder-fort-collins.

105. Colo. Oil & Gas Ass'n v. City of Longmont Colo. Case No. 2012-CV-702 (Boulder County Dist. Ct.).

106. COLO. REV. STAT. §§ 34-60-101 to 34-60-130 (2014).

107. Colo. Oil & Gas Ass'n v. City of Longmont Colo., Case No. 2013-CV-63 (Boulder County Dist. Ct.).

as a local Longmont producer joined as plaintiffs and a number of public interest groups including The Sierra Club and Earthworks were intervenor-defendants. In July of 2014, the Court entered summary judgment for the plaintiffs and against Longmont, based on its interpretation of the Colorado Oil and Gas Conservation Act (COGCA) as allowing hydraulic fracturing.

The Colorado Oil & Gas Association also sued Fort Collins and Lafayette in an effort to overturn Fort Collins' five-year moratorium and Lafayette's outright prohibition on all oil and gas extraction. The trial court in the Fort Collins case ruled that even a temporary moratorium was prohibited under the pre-emption doctrine because of the state's significant interest in seeing oil and gas developed and the explicit authorization of oil and gas drilling in the state statute.¹⁰⁸ The same trial court judge handling the second Longmont case also heard the Lafayette case and ruled that Lafayette's total ban on oil drilling and extraction activities was preempted by Colorado state law.¹⁰⁹

Longmont and Fort Collins appealed the trial court decisions in the second *City of Longmont* case and the *City of Fort Collins* case.¹¹⁰ In an unusual action, the Colorado Court of Appeals in August of 2015 refused to issue a ruling, stating that the issue of local land use home rule authority versus possible state preemption was so significant that the state Supreme Court should hear the cases without any intermediate ruling since the cases would eventually get to the Supreme Court anyway.¹¹¹ In September of 2015, the Colorado Supreme Court agreed to hear the appeals. Oral arguments were held in December of 2015. A decision is expected in 2016.

At the heart of the Colorado cases is the reach of two earlier Colorado Supreme Court decisions, *County Comm'rs of La Plata County v. Bowen/Edwards Assoc.*, 830 P.2d 1045 (Colo. 1992),¹¹² and *Voss v. Lundvall Bros.*¹¹³ In the *Bowen/Edwards* case, an appellate court ruled that the Colorado Oil and Gas Conservation Act completely preempted local permitting of oil and gas wells

108. Colorado Oil & Gas Ass'n v. City of Fort Collins, Case No. 2013-CV-31385 (Larimer County Dist. Ct.).

109. Colorado Oil & Gas Ass'n v. City of Lafayette, Case No. 2013-CV-31746 (Boulder County Dist. Ct.).

110. Lafayette did not appeal reportedly due to the estimated cost of such an appeal. Jack Healy, *Heavyweight Response to Local Fracking Bans*, N.Y. TIMES, Jan. 3, 2015, www.nytimes.com/2015/01/04/us/heavyweight-response-to-local-fracking-bans.html?_r=0.

111. *Local Fracking Bans Could Go Before Colorado High Court Soon*, THE DENVER POST (Aug. 17, 2015), www.denverpost.com/news/ci_28655673/local-fracking-bans-could-go-before-colorado-high.

112. *County Comm'rs of La Plata County v. Bowen/Edwards Assoc.*, 830 P.2d 1045 (Colo. 1992).

113. *Voss v. Lundvall Bros.*, 830 P.2d 1061 (Colo. 1992).

under land use control authority.¹¹⁴ The Colorado Supreme Court reversed, noting that the Oil and Gas Conservation Act "requires uniform regulation of the technical aspects of drilling, pumping, plugging, waste prevention, safety precautions and environmental restoration," but does not preempt all local land use regulations aimed at the oil and gas industry.¹¹⁵

The *Voss* case involved a complete ban on drilling within the city limits of Greeley, Colorado, a home rule city.¹¹⁶ The Colorado Supreme Court overturned the Greeley ban on drilling for the following reasons:

Because oil and gas pools do not conform to the boundaries of local government, Greeley's total ban on drilling within the city limits substantially impedes the interest of the state in fostering the efficient development and production of oil and gas resources in a manner that prevents waste and that furthers the correlative rights of owners and producers in a common pool or source of supply to a just and equitable share of profits. In so holding, we do not mean to imply that Greeley is prohibited from exercising any land-use authority over those areas of the city in which oil and gas activities are occurring or are contemplated."¹¹⁷

While a total ban was ruled inappropriate, the *Voss* decision also stated that if local land use regulations "do not frustrate and can be harmonized with the development and production of oil and gas in a manner consistent with the stated goals of the Oil and Gas Conservation Act, the city's regulations should be given effect."¹¹⁸

The trial court in the second *Longmont* case ruled that there was "no way to harmonize Longmont's fracking ban with the stated goals of the Oil and Gas Conservation Act" and that "the state interest in production, prevention of waste and protection of correlative rights, on the one hand, and Longmont's interest in banning hydraulic fracturing on the other, present mutually exclusive positions."¹¹⁹

But are the positions mutually exclusive? What if state oil and gas regulations do not specifically mention fracking? What if banning fracking does not eliminate the opportunity to economically extract the oil and gas reserves under Longmont or the other Front Range communities? What if there is an alternative to fracking that eliminates the environmental issues caused by fracking, costs less to utilize as a resource recovery process, and actually results in greater productivity from the resource recovery zone? Would a local

114. *Bowen/Edwards Assoc.*, 830 P.2d at 1048.

115. *Id.* at 1058.

116. *Voss*, 830 P.2d at 1062 (Colo. 1992).

117. *Id.* at 1068.

118. *Id.* at 1069.

119. Order Granting Motions for Summary Judgment, July 24, 2014, in *Colorado Oil and Gas Association, et al. v. City of Longmont, et al.*, Case No. 2013-CV-63 (Boulder County Dist. Ct.).

fracking ban that allowed wells to be drilled and the resource recovered by a proven alternative technology be legal?

That is exactly what Longmont asks in its briefs and recent oral argument before the Colorado Supreme Court. It argues that the Colorado Oil and Gas Conservation Commission, the regulatory entity charged with implementing the state's COGCA has no rules or regulations for permitting fracking, regulating or monitoring the amount of fracking fluids, or the number of times a well may be fracked or the number of stages of fracture treatments, and allows "well operators to determine the number of wells and surface facilities at a fracking site."¹²⁰ As a result, Longmont argues, the State of Colorado has not preempted the field when it comes to regulation of fracking because it simply does not have any regulations related to that process and therefore no conflict exists between state and local law.

Another central question is also involved in the second *Longmont* case -- does a ban on fracking destroy the value of existing mineral rights, in other words, are fracking bans a regulatory taking?¹²¹ That issue was raised by a plaintiff-intervenor in the *Longmont* case, TOP Operating Company (TOP), an oil and gas production company with its principal holdings consisting of "undrilled lease acreage and producing oil and gas wells" in or adjacent to Longmont.¹²² The company had signed leasing contracts with the City of Longmont allowing TOP to undertake oil and gas development owned by the city and located on city owned lands.¹²³ The lease contracts with the city specifically authorized TOP to use "fracturing" and "re-fracturing" to access the resource. TOP argued that the fracking ban enacted by Longmont after TOP's contract with Longmont had been signed effectively destroyed the value of its lease rights.¹²⁴ TOP argued in its brief that "fracking is a standard and essential industry practice" and that "for the last twenty to thirty years, all wells drilled by TOP and virtually, if not

120. City of Longmont's Consolidated Response to Summary Judgment Motions of Top Operating Co., Colorado Oil and Gas Association, and Colorado Oil and Gas Conservation Commission, Paragraph 9, page 9, and Paragraph 12, page 10, filed May 30, 2014, in *Colorado Oil and Gas Association, et al. v. City of Longmont, et al.*, Case No. 2013-CV-63 (Boulder County Dist. Ct.)

121. The Oil and Gas Association argued before the Supreme Court in December 2015 that the five-year Fort Collins moratorium is, in effect, a five year fracking ban and also raises regulatory taking issues. Karen Antonacci, *Longmont's high hour case: Fracking ban still allows safe production*, BLOOMFIELD ENTERPRISE (Dec. 9, 2015), www.broomfieldenterprise.com/news/regional-news/ci_29224981/colo-supreme-court-hears-arugments-over-longmonts-fracking.

122. TOP Operating Company's Reply Brief in Support of Motion for Summary Judgment, Paragraph 2, page 2, dated June 24, 2014, in *Colorado Oil and Gas Association, et al. v. City of Longmont, et al.*, Case No. 2013-CV-63 (Boulder County Dist. Ct.)

123. *Id.*

124. *Id.*

all, wells drilled by other operators in the Wattenberg field . . . have been completed with hydraulic fracturing"¹²⁵ The company argues that it "cannot economically drill and complete these well without the ability to conduct hydraulic fracturing operations."¹²⁶ The President of the Colorado Oil and Gas Association goes further and states that since "'95 percent of all wells in Colorado are hydraulically fractured, any ban on fracking is a ban on oil and gas development."¹²⁷

The Longmont response is that banning fracking does not eliminate or even seriously interfere with the use or value of the mineral rights in a known producing area because "hydraulic fracturing is not the most effective or economical completion technology to recover hydrocarbons."¹²⁸ There are alternative technologies, it argues, most notably underbalanced drilling (UBD), that do not rely on fracking and cause less environmental damage and produce gas and oil at greater rates than fracked reservoirs.¹²⁹

The trial court did not hold an evidentiary hearing on either the environmental issues or the economic issues associated with Longmont's fracking ban. Instead, it issued summary judgment for the Plaintiff challengers to the Longmont fracking ban.¹³⁰ As a result, evidence related to the effectiveness of underbalanced drilling as an alternative to fracking (from both an environmental and economic point of view) has not yet been presented in a trial setting in Colorado. The Colorado Supreme Court is not expected to issue its decision in the case until well into 2016. It is possible that

125. *Id.* at 4.

126. *Id.*

127. Mark Jaffe, *Oil and gas industry sues Lafayette and Fort Collins on fracking bans*, THE DENVER POST (Dec. 3, 2013), www.denverpost.com/business/ci_24649775/oil-and-gas-in-dustry-sues-lafayette-and-fort (quoting Colorado Oil and Gas Association President Tisha Schuller).

128. City of Longmont's Consolidated Response to Summary Judgment Motions of Top Operating Co., Colorado Oil and Gas Association, and Colorado Oil and Gas Conservation Commission, Paragraph 52, page 27, filed May 30, 2014, in *Colorado Oil and Gas Association, et al. v. City of Longmont, et al.*, Case No. 2013-CV-63 (Boulder County Dist. Ct.).

129. Another alternative to fracking referenced by Longmont is propellant well stimulation in which charges are placed in the well bore and detonated to create fractures in the recovery formation. Use of propellant well stimulation eliminates the need for chemicals, acids, sand and large amounts of water to open up the formation. Before hydraulic fracturing was invented nitroglycerine was used to stimulate a reservoir through an explosion that fractured the rock. Modern day propellants such as Halliburton's StimGun technology are generally used before a frack job to break down the formation. The use of propellant in a long horizontal can be cost prohibitive, however. Propellants have another disadvantage that limits their use. The fractures only propagate out from the wellbore 10 to 15 feet compared to a hydraulic fracture that may propagate out 200 feet or more.

130. *Colorado Oil and Gas Association, et al. v. City of Longmont, et al.*, Case No. 2013-CV-63 (Boulder County Dist. Ct.), Order Granting Motions for Summary Judgments, Filed July 24, 2014.

one outcome would be for the Supreme Court to overturn the trial court's summary judgment ruling and remand the case for an evidentiary hearing including a comparison of the environmental and economics issues raised by fracking compared to underbalanced drilling. Other outcomes are also possible of course, including an affirmation of the summary judgment, or an alternative ruling dismissing the Plaintiffs' case.

One result of the Colorado situation to date is that the *Longmont* and *Fort Collins* cases have suddenly put underbalanced drilling in the spotlight. So too did the temporary moratorium and later fracking ban in the City of Denton, Texas, a community of about 125,000 located on the northern edge of the Dallas metroplex in the Barnett Shale area, which had long been home to gas production, and was the location where hydraulic fracturing was first used. As of 2013, the area within the city's jurisdiction contained about 438 wells, most of which were older wells that had been drilled vertically.¹³¹ However, owners of those older wells began to extend them horizontally and use hydraulic fracturing to capture more of the resource. The owners of the rights to those wells claimed that they had vested rights to undertake the horizontal drilling and fracking "without being subject to any of the city's new, stricter rules that include greater setbacks and other public safety measures."¹³² Between 2001 and 2014 more than 270 gas wells were fracked inside the city limits.¹³³

Concerned primarily by the truck traffic, noise, and lights of the drilling process in close proximity to residential homes, but also by an April 2013 well blowout that released benzene and other chemicals in a residential neighborhood causing temporary evacuations,¹³⁴ some residents joined together as "Frack Free Denton" to mobilize public opinion against fracking.¹³⁵

Their first step was to convince the City Council in May of 2014 to impose a temporary moratorium on fracking while the council studied possible revisions to its land use code that would eliminate concerns of homeowners.¹³⁶ Next, the group lobbied the City

131. City of Denton, *Gas Well Database*, www.cityofdenton.com/departments-services/departments-g-p/gas-well-inspections/gas-well-data-file-spreadsheet.

132. Peggy Heinkel-Wolfe, *Few Answers in April Gas Well Blowout*, DENTON RECORD-CHRONICLE, July 27, 2013, www.dentonrc.com/local-news/local-news-headlines/20130727-few-answers-in-april-gas-well-blowout.ece.

133. City of Denton, *Gas Well Database*, www.cityofdenton.com/departments-services/departments-g-p/gas-well-inspections/gas-well-data-file-spreadsheet.

134. Jim Malewitz, *Denton Council Punts Fracking Ban Proposal to Voters*, THE TEXAS TRIBUNE, July 16, 2014, www.texastribune.org/2014/07/16/denton-council-punts-fracking-ban-proposal-voters/.

135. Frack Free Denton, <http://frackfreedenton.com/>.

136. Jim Malewitz, *Denton Council Punts Fracking Ban Proposal to Voters*, THE TEXAS TRIBUNE, July 16, 2014, www.texastribune.org/2014/07/16/denton-council-punts-fracking-ban-proposal-voters/.

Council to permanently ban fracking, which the council refused to do by a five to two vote in July of 2014.¹³⁷ However, the group gathered enough signatures on petitions to place an initiative to ban fracking on the ballot in November of 2014.¹³⁸ It passed with 59% approval, and the City Council the next day enacted the ban on fracking in Denton.¹³⁹

In separate petitions, the Texas General Land Office and the Texas Oil and Gas Association sought declaratory judgments that Texas state law preempted the city's authority to ban fracking. The Texas Oil and Gas Association petition included the following regulatory taking allegation:

The ban will result in the total inability to develop hydrocarbon interests within the City because wells in Denton produce gas from the Barnett Shale, and the only way to produce such gas in commercial quantities is through the use of hydraulic fracture stimulation of this dense shale formation that would not otherwise economically produce."¹⁴⁰

The Supreme Court of Texas has recognized that, without the use of hydraulic fracturing, the Barnett Shale is wholly uncommercial, or, in the best of market conditions, only marginally commercial. Put another way, fracturing is "essential to the recovery of oil and gas in many areas," including the Barnett Shale.¹⁴¹

By one estimate, the mineral rights under the City of Denton had a market value of more than \$88.0 million as of 2013, of which 80% was owned by large corporations.¹⁴²

The City of Denton began to investigate alternatives to hydraulic fracturing, including underbalanced drilling (UBD), as a possible response to the oil and gas industry's regulatory taking claims.¹⁴³ But Denton's exploration of UBD technology as a viable alternative to fracking was halted when the State of Texas preempted local government authority to regulate fracking by enacting

137. *Id.*

138. Jim Malewitz, *Dissecting Denton: How a Texas City Banned Fracking*, THE TEXAS TRIBUNE, Dec. 15, 2014, www.texastribune.org/2014/12/15/dissecting-denton-how-texas-city-baned-fracking ("The town had company on Election Day. Voters in Athens, Ohio, and two California counties — three of the seven other communities that weighed in nationally — rejected the practice.").

139. *Id.*

140. Texas Oil and Gas Association v. City of Denton, Cause No. 14-080933-431, page 3, Section III, Paragraph (5).

141. Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 16 (Tex. 2008).

142. Malewitz, *supra* note 138.

143. Presentation by Terry Morgan, Esq., Terry Morgan & Associates, PC, special counsel to the City of Denton, Texas, Appraisal Institute annual meeting, Dallas, Texas, July 28, 2015.

HB 40 in May of 2015.¹⁴⁴ The bill went beyond any previous Texas legislation, clearly stating that all local government regulation of the oil and gas industry was preempted by the State of Texas.¹⁴⁵ Authority of local governments is now limited to regulations related to “reasonable setback[s],” pre-drilling notice requirements, traffic and noise control, and emergency response. However, controls adopted in exercising any of those limited powers must be “commercially reasonable” and must not hinder the operations of a “prudent operator.”¹⁴⁶

Given the wording of HB 40, and the costs of pursuing litigation to overturn the new state law, the Denton City Council voted in June of 2015 to repeal its fracking ban.¹⁴⁷

The interest in underbalanced drilling as a possible solution to environmental and regulatory taking issues in both Texas and Colorado raises the following questions to be explored in the rest of this article:

What is underbalanced drilling and how does it differ from traditional "overbalanced" drilling?

How does horizontal underbalanced drilling eliminate the environmental problems associated with fracking?

Does underbalanced drilling have other positives from a local land use regulation point of view?

What are the economics of underbalanced drilling compared to traditional overbalanced drilling combined with fracking?

How do the economics of underbalanced drilling affect regulatory taking claims by owners of oil and gas leases and subsurface mineral rights?

Is underbalanced drilling technically possible and economically feasible in all of the major unconventional oil and gas shale oil formations in the United States?

Do state and local governments have the legal authority to require underbalanced drilling rather than fracking?

If underbalanced drilling is the solution to the environmental and regulatory taking issues accompanying fracking, why has

144. Jim Malewitz, *With HB 40 Signed, Fracking to Resume in Denton*, THE TEXAS TRIBUNE, May 22, 2015, www.texastribune.org/2015/05/22/despite-ban-fracking-resume-denton/.

145. *Id.*

146. State of Texas Legislature, HB 40, p. 2, lines 5–10, and p. 3, lines 2–6, www.legis.state.tx.us/tlodocs/84R/billtext/pdf/HB00040F.pdf#navpanes=0.

147. Mose Buchele, *Denton Repeals Fracking Ban*, THE TEXAS TRIBUNE (June 17, 2015), www.texastribune.org/2015/06/17/denton-repeals-fracking-ban/.

it only recently started to appear as a subject in the debate concerning appropriate regulation of hydraulic fracturing?

What steps are needed to get underbalanced drilling more widely understood and accepted as an alternative to hydraulic fracturing?

C. Overbalanced and Underbalanced Drilling Differentiated

As an oil or gas well is drilled, it encounters fluids under pressure at various depths in the rock formations through which the drilling passes. As the drill bit passes through non-resource formations, groundwater under pressure is encountered. Eventually the well bore reaches the target oil or gas formation, which typically also contains water. The groundwater and oil and gas in the target resource have been compressed under pressure over past geologic eons. As the well is drilled, the pressurized liquids and gases in the various rock formations want to escape through the bore hole.

To keep those fluids from escaping to the surface during the drilling process, and to separate the targeted oil and gas from groundwater that also wants to mix with the recovered resource, "conventional" underground oil and gas formation exploration has historically involved an "overbalanced drilling" process. Four technologies are used in overbalanced drilling to stop the pressurized gases and liquids from escaping through the bore hole. First, ¹⁴⁸ steel casing is inserted down the well bore as drilling proceeds to line the hole and serve "as a barrier to lateral movement of fluids."¹⁴⁹ Second, the space between the metal casing and the surrounding rock strata is filled with a cement that is pumped down the bore hole displacing the mud, a mixture of water and bentonite

148. U.S. Environmental Protection Agency, *Hydraulic Fracturing Drinking Water Assessment*, June 2015, page 6-4, Lines 16-32, <http://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=244651>.

A long continuous section of casing is referred to as a casing string, which is composed of individual lengths of casing (known as casing joints) that are threaded together using casing collars. . . . In addition to conductor casing, which prevents the hole from collapsing during drilling, one to three other types of casing may also be present in a well One or more of any of these types of casing may be present in a well. Surface casing often extends from the wellhead down to the base (bottom) of the drinking water resource to be protected. Wells may also be constructed with liners, which are anchored or suspended from inside the bottom of the previous casing string, rather than extending all the way to the surface, and production tubing, which is used to transport the hydrocarbons to the surface.

Id.

149. *Id.* at 6-4 l. 7.

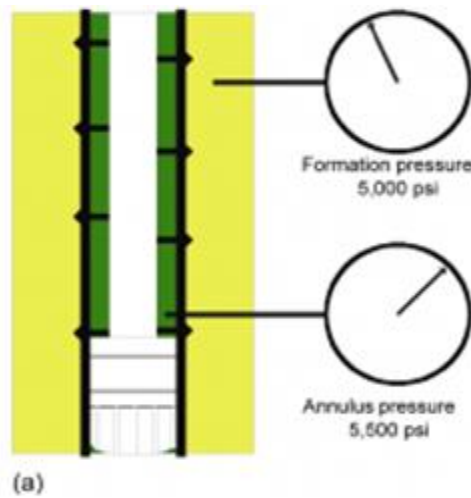
used to circulate the hole during drilling, which is forced to the surface by the pumped cement. When the cement hardens, it serves "as a barrier to unintended vertical movement of fluids"¹⁵⁰ up the bore hole and between the exposed rock strata and the exterior of the metal casing. Third, at the bottom of the bore hole in the resource recovery zone, a mechanical sealing device called a packer is installed around the mouth of a tube dropped through the metal casing. The packer prevents oil and gas and groundwater in the production resource zone from rising up the bore hole except through the resource recovery tubing that has been inserted. Fourth, and finally, fluid is pumped down the bore hole in the space between the production tubing and the steel casing and the fluid pressure is maintained at a level higher than the pressure of the fluids in the various formations (including the recovery zone formation) through which the well is drilled.

The over-pressurization of the casing (and therefore the bore hole) and the use of cement to seal the space between the rock strata and the metal casing is what gives "overbalanced" drilling its name. In overbalanced drilling "pressure on the bottom of the well will always be designed to be higher than the pressure in the formation."¹⁵¹ And it is that pressure that is the principal well control mechanism.¹⁵²

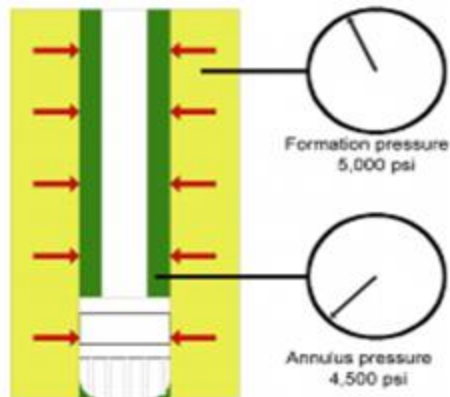
150. *Id.* at 6-4 l. 8.

151. PetroWiki, *Underbalanced Drilling*, [http://petrowiki.org/Underbalanced_drilling_\(UBD\)](http://petrowiki.org/Underbalanced_drilling_(UBD)).

152. One of the principal purposes of overbalancing the pressure in the well is to prevent "influxes of hydrocarbons, or kicks, from disrupting drilling or causing well control problems." Trent Jacobs, *Going Underbalanced in Unconventional Reservoirs*, J. PETROLEUM TECH., 51 (May 2015). A "kick" is also described as follows: "A kick is a well control problem in which the pressure found within the drilled rock is higher than the mud hydrostatic pressure acting on the borehole or rock face. When this occurs, the greater formation pressure has a tendency to force formation fluids into the wellbore. This forced fluid flow is called a kick. If the flow is successfully controlled, the kick is considered to have been killed. An uncontrolled kick that increases in severity may result in what is known as a 'blowout.'" PetroWiki, *Kicks*, <http://petrowiki.org/Kicks>.

Figure 11: Pressures in Conventional Drilling

While Figure 11¹⁵³ shows a vertical well, the same type of drilling process can be extended as the well turns to horizontal and extends into an unconventional shale formation. Typically, in overbalanced drilling, the steel casing is extended through the horizontal borehole in the shale formation as well, and cement is used to seal the space between the reservoir formation and the casing until the well is ready for production through the fracking process.

Figure 12: Pressures in Underbalanced Drilling

153. PetroWiki, *Underbalanced Drilling*, fig.1a [http://petrowiki.org/Underbalanced_drilling_\(UBD\)](http://petrowiki.org/Underbalanced_drilling_(UBD)).

In underbalanced drilling, as shown in Figure 12,¹⁵⁴ the process is quite different.¹⁵⁵ Steel casing and cement are not typically used in horizontal underbalanced drilling.¹⁵⁶ Instead, a “lighter” drilling fluid replaces the fluid column¹⁵⁷ and the pressure in the borehole remains lower than the pressure generated by fluids in the rock formations and recovery zone resource. Fluids, including water, oil and gas, are allowed to enter the borehole as drilling proceeds. The fluids moving up the bore hole are safely handled at the surface by special equipment while drilling continues uninterrupted.¹⁵⁸ The diagram shows a typical underbalance scenario in a vertical bore hole.

But the upward flowing fluids produced during underbalanced drilling must be controlled to avoid well-control problems. The fluids from the well are returned in a closed system at the surface to control the well. With the well flowing, the blowout preventer (BOP) system is kept closed while drilling. In conventional overbalanced operations, drilling fluids are returned to an open system with the BOPs open to atmosphere (see the diagram below).¹⁵⁹ Secondary well control is still provided by the BOPs, as is the case with conventional drilling operations.

154. PetroWiki, *Underbalanced Drilling*, fig.1b [http://petrowiki.org/Underbalanced_drilling_\(UBD\)](http://petrowiki.org/Underbalanced_drilling_(UBD)).

155. There is a third alternative called managed pressure drilling (MPD). "MPD uses equipment to fine-tune the wellbore pressure to what some people call, 'at balance' drilling, but by its definition, MPD does not allow for influxes [of fluids]." Jacobs, *supra* note 152, at 51.

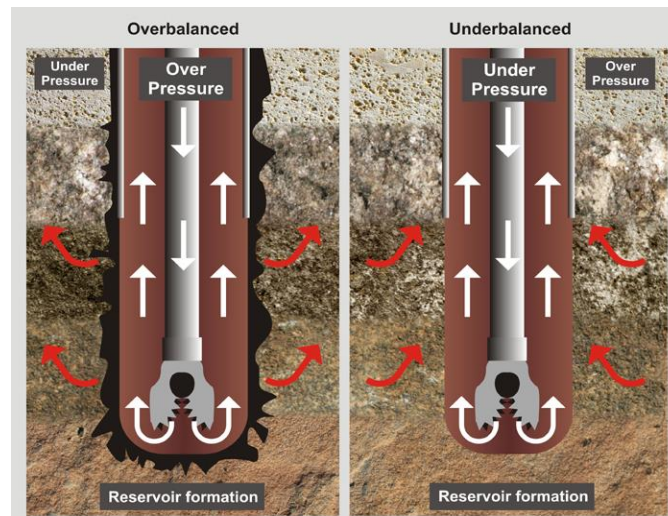
156. Steel casing (and cement) are used in upper parts of the bore hole as it passes through non-resource formations. Casing – also called a liner when small diameter pipe is used -- is required in the reservoir for hydraulic fracturing. Casing or liner is not required when drilling underbalanced in the recovery zone unless the reservoir is unstable. In that situation, a pre-perforated liner can be run in the horizontal well bore through the recovery zone.

157. PetroWiki, *Underbalanced Drilling*, http://petrowiki.org/Underbalanced_drilling/.

158. "On the rig, standard equipment includes a rotating control device, a choke, a mud gas separator (commonly called a gas buster), and production systems coupled with a flare to handle gas and oil coming up the wellbore." Jacobs, *supra* note 152, at 51. Although the gas resource that rises during underbalanced drilling is often flared, it can also be captured and marketed without the need for flaring, or it can be used to power a turbine that generates electricity that can be resold into the power grid system.

159. Frontender, *Underbalance Drilling Reservoir Characterization*, <http://frontender.com/blog/capabilities/reservoir-engineering/underbalance-drilling-reservoir-characterization/>.

Figure 13: Pressure Flows in Overbalanced and Underbalanced Drilling



II. IMPLICATIONS OF THE DIFFERENCES BETWEEN OVERBALANCED AND UNDERBALANCED DRILLING FOR HYDRAULIC FRACTURING ENVIRONMENTAL AND RESOURCE RECOVERY ISSUES

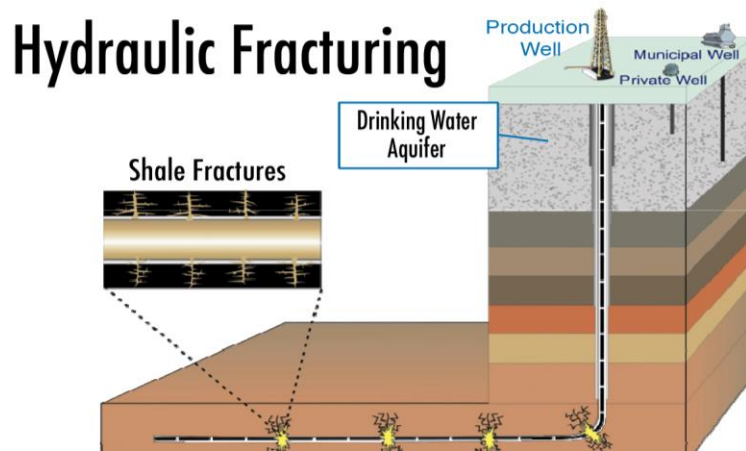
As explained above in this article, hydraulic fracturing is not a drilling process, but rather a resource recovery or "completion technique" used once the wellbore has been drilled. And -- this is the game changer -- hydraulic fracturing is seldom, if ever necessary, when the well has been drilled using underbalanced drilling.¹⁶⁰

Why is that? The image below shows a typical horizontal drilling and fracking operation in an unconventional shale play.¹⁶¹

160. The key is to maintain underbalanced conditions 100% of the time. If the well goes overbalanced even as little as 1% of the time, it will need to be hydraulically fractured. See PetroWiki, *Underbalanced Drilling*, [http://petrowiki.org/Underbalanced_drilling_\(UBD\)](http://petrowiki.org/Underbalanced_drilling_(UBD)).

161. Rachel Degenhardt, *EPA Investigates Fracking Impacts*, EHS Journal (Oct. 4, 2011), <http://ehsjournal.org/http://ehsjournal.org/rachel-degenhardt/epa-investigates-fracking-impacts-hydraulic-fracturing/2011/>.

Figure 14: Typical Horizontal Drilling and Fracking Operation in an Unconventional Shale Play



In hydraulic fracturing, once the horizontal extension of the steel cased and cemented bore hole has been completed using overbalanced drilling, charges are set off to blast holes through the casing and the cement at regular intervals along the horizontal portion of the well in the resource recovery zone. Then a proprietary mixture of sand, millions of gallons of water (and/or other liquids or gases), and chemicals are pumped at high pressure down the well and through the holes in the casing and cement. The pressurized mixture opens up (fractures) some of the naturally occurring cracks in the resource formation. Then the pressure in the well is reduced and the fracking fluids drawn back to the surface to allow the gas (or oil or both) to escape through the wellbore and to the surface where it is collected and transported/piped from the well site. The sand acts as a proppant and holds the fractures open.

By contrast, in underbalanced drilling, there is no need for steel casing and cement separating the resource formation from the borehole in the horizontal recovery zone.¹⁶² Instead, as drilling

162. As indicated above, in underbalanced drilling, steel casing and cement are used to seal the vertical portions of the borehole. The June 2015 draft U.S. EPA report on drinking water issues associated with fracking expressed water contamination concerns related to the mud and cement used in the vertical bore hole. See USEPA, *Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources*, (External Review Draft), EPA/600/R-15/047, 2015, page 6-25, ll. 30-31. However, the mud and cementing process in the vertical bore hole are the same as in a traditional oil and gas well. Drilling mud used to drill the surface hole is generally composed of two ingredients: water and bentonite. Bentonite seals off the aquifer and is used frequently in other applications such as to seal lined water storage reservoirs and even farm ponds. The bentonite used in oil and gas drilling only penetrates a foot or two into any aquifer encountered while drilling the surface hole. When

proceeds, the resource is allowed to enter the under pressurized bore hole and rise to the surface. As a result there is no need to blast holes through steel casing and cement (a process called perforating) and, no need to use a highly pressurized mixture of millions of gallons of water, proprietary chemicals, acids,¹⁶³ and sand to fracture the shale formation and stimulate the flow of the resource into the bore hole. In every unconventional shale play in the United States (including the tightest formations) the naturally occurring micro-fissures in the shale allow gas (and oil) to escape into the open uncased bore hole without any such artificial stimulation. And in the tightest lowest pressured formations, underbalanced drilling uses a mixture of mineral oil and nitrogen gas to reduce the hydrostatic pressure of the drilling medium below the pressure in the formation being drilled.

The result of using underbalanced rather than overbalanced techniques to drill the well is that hydraulic fracturing -- fracking -- is no longer necessary to recover the resource. As a result, the serious environmental concerns that accompany fracking are eliminated. None of the chemicals involved in fracking are used. Nor is sand necessary to the underbalanced drilling process since the micro-fractures in the shale do not need to be propped open. The mineral oil used in underbalanced drilling is non-toxic, biodegradable and recyclable. And since no water is used in the underbalanced drilling process, the concern about the large quantity of water needed for fracking is also eliminated as an issue, as is the concern about what to do with the water that is recovered from the hydraulically fractured well. In underbalanced drilling, 100% of the drilling fluid is recovered,¹⁶⁴ compared to an average of about 30% of all the fluids used in hydraulic fracturing.¹⁶⁵ The remaining 70% of the fracking fluids remain in the formation, creating potential migration issues in the ensuing years.

Earthquake issues associated with hydraulic fracturing are also eliminated by UBD technology. Although there have been some studies indicating that the fracking process itself can cause earthquakes, most of the earthquake concern related to fracking

surface casing is run the cement displaces the drilling mud. Once it sets up it seals off the aquifer. Problems can occur in older wells due to casing rusting and cracking of the cement, both of which can jeopardize the integrity of the seal between the aquifer and the bore hole. That deterioration in the casing and cements can provide pathways for deeper fluids (including fracking fluids) to reach an aquifer. Reduction in cement integrity can be a greater issue in areas experiencing earthquakes.

163. Hydrochloric acid is often pumped "into the formation to dissolve some of the rock material to clean out pores and enable gas and fluid to flow more readily into the well." Earthworks, *Hydraulic Fracturing 101*, www.earthworksaction.org/issues/detail/hydraulic_fracturing_101#.Vl3ptWeFPet.

164. PetroWiki, Underbalanced Drilling (UDB), [http://petrowiki.org/Underbalanced_drilling_\(UDB\)](http://petrowiki.org/Underbalanced_drilling_(UDB)).

165. See USEPA, *supra* note 23.

relates to the disposal of fracking waste in combination with formation produced water by deep disposal well injection.¹⁶⁶ However, in Ohio, a study published in the Bulletin of the Seismological Society of America found evidence that the pressures needed to inject millions of gallons of water in fracking wells near fault lines may be a cause of earthquake activity.¹⁶⁷ Because underbalanced drilling does not use any water in the production zone, it eliminates the need for deep well injection of fracking wastewater. And because it does not use high pressure to crack open the natural fractures in the shale resource, it minimizes the risk of earthquakes due to drilling near fault lines.

Underbalanced drilling not only eliminates the environmental issues associated with hydraulic fracturing, but it also significantly reduces the cost of the recovery operation. A recent study of the cost of drilling horizontal wells and then using hydraulic fracturing to recover the resource in the Barnett Shale in Texas estimates a ten-stage fracking job costs on average \$3.8 million.¹⁶⁸ But that is an average based on ten or more years of fracking in Texas. The length of lateral wells has been increasing in recent years with a corresponding increase in the number of hydraulic fracturing stages and job costs in the resource zone.¹⁶⁹ Some recent wells have been

166. See, e.g., Kelly Connelly, David Barer, & Yana Skorobogatov, *How Oil and Gas Disposal Wells Can Cause Earthquakes*, National Public Radio, <https://stateimpact.npr.org/texas/tag/earthquake/>. This National Public Radio story on fracking related earthquakes states that "the culprit of earthquakes near fracking sites is not believed to be the act of drilling and fracturing the shale itself, but rather the disposal wells." *Id.* The U.S. Geological Survey (USGS) also reports that its "studies have shown a strong connection in many locations between the deep injection of fluids and increased earthquake rates." United States Geological Survey, *Induced Earthquakes*, <http://earthquake.usgs.gov/research/induced/>. The USGS has also gone on record as stating that "fracking is NOT causing most of the induced earthquakes. Wastewater disposal is the primary cause of the recent increase in earthquakes in the central United States." United States Geological Survey, *Induced Earthquakes: Myths and Misconceptions*, <http://earthquake.usgs.gov/research/induced/myths.php>.

167. Robert J. Skoumal, Michael R. Brudzinski, & Brian S. Currie, *Earthquakes Induced by Hydraulic Fracturing in Poland Township, Ohio*, BULLETIN OF THE SEISMOLOGICAL SOCIETY OF AMERICA (Jan. 2015), www.bssaonline.org/content/early/2015/01/01/0120140168.abstract; see also, Noah Rayman, *Study Links Ohio Earthquakes to Fracking*, TIME, Jan. 8, 2015, <http://time.com/3659649/fracking-earthquakes-ohio-study/>.

168. Chris Carpenter, *Applying Lessons Learned to Minimize Overall Investment in Unconventional Plays*, J. PETROLEUM TECH., 62 (Dec. 2015). This article summarized highlights of paper SPE 172973, "USD 40 Billion Learning Curve: Leveraging Lessons Learned To Minimize the Overall Investment in Unconventional Plays," authored by C. N. Fredd, SPE, J.L. Daniels, SPE, and J.D. Baihly, SPE, Schlumberger, presented at the 2015 SPE Middle East Unconventional Resources Conference and Exhibition, Muscat, Oman, January 26-28, 2015.

169. In staged hydraulic fracturing, the horizontal well is extended a specific length, and then fractured. Once that section has been fractured, the horizontal

drilled with 10,000 foot laterals and 100 fracking stages. The fracturing cost per stage depends upon the volumes of sand, chemicals and water being pumped into the reservoir. Costs in recent years typically varied from \$75,000 to \$200,000 per stage, but in late 2015 and early 2016 have dropped to a reported \$35,000 to \$75,000 per stage.

In underbalanced drilling, all fracking related costs are eliminated. The typical costs to drill a 6,000 foot lateral well using underbalanced drilling is currently about \$300,000 compared to a typical hydraulic fracturing cost of \$3,000,000 for the same lateral length requiring anywhere from ten to seventy-five stages to recover the resource.

Additionally, the elimination of hydraulic fracturing saves significantly on the overall cost of the entire drilling and production process. A recent study of the costs of drilling and fracturing horizontal wells in the Eagle Ford Shale play in Texas determined that the hydraulic fracturing process typically accounts for about 58% "of the financial investment over the history of the [well] development."¹⁷⁰

But proponents of overbalanced drilling have argued that it -- combined with hydraulic fracturing -- is the only way to economically recover the resources from tight shale formations. That was the argument made in the *Texas Oil and Gas Association* case against the City of Denton and the argument made in the *Longmont* case in Colorado. A careful examination of the data, however, indicates the proponents of fracking are wrong about the economics.

The use of heavy drilling fluids in overbalanced drilling combined with the need to cement the space between the resource zone and the casing results in significant formation damage. The pressure created by overbalanced drilling forces the drilling fluids (as well as some of the fines, clays and cuttings associated with the drilling process) into the oil and gas containing rock. That reduces the permeability of the skin (the portion of the reservoir closest to the well bore).¹⁷¹ One purpose of hydraulic fracturing is to crack through the damaged skin and open up undamaged portions of the reservoir so gas and oil can escape into the well bore. However, fracking can overcome only some of the damage to the reservoir, and, in fact, creates additional damage to the reservoir in the cracks it creates. Typically, in an unconventional shale play using overbalanced drilling, only about 5% to 10% of the resource can be recovered.¹⁷²

well is extended again, and fractured again, and so on.

170. Carpenter, *supra* note 168, at 62.

171. PetroWiki, *Formation Damage*, http://petrowiki.org/Formation_damage.

172. See, e.g., J. UNCONVENTIONAL OIL & GAS RESOURCES, 1-2 (2013), 1 (stating that "for producing fields in the North Americas, the recovery to date is

By contrast, underbalanced drilling (UBD) significantly reduces skin damage and preserves the near well bore permeability resulting in higher rates of recovery of oil and gas compared to overbalanced drilling combined with hydraulic fracturing. UBD allows the natural connection between microfractures and larger fractures to operate unimpeded. Evidence from various underbalanced drilling operations around North America, especially by Shell Oil which switched to underbalanced drilling in about 85% of its unconventional wells drilled in 2014 to early 2015,¹⁷³ indicates that recovery rates using UBD technology can be two to eight times higher¹⁷⁴ and production rates can be three to eight times higher than in fracked wells.¹⁷⁵

Another of the significant issues related to the use of horizontal drilling and fracking in unconventional shale formations is the rapid decline in productivity during the first few years of production life.¹⁷⁶ One study of the seven most significant shale oil and gas formations comprising almost 90% of U.S. tight formation production found that the average oil production declines ranged between 61% and 91%.¹⁷⁷ For gas production, the average decline rate over the first three years was between 74% and 82%.¹⁷⁸

The *Journal of Petroleum Technology* reports that in the Permian Basin in Texas, "some [underbalanced] wells drilled into underpressurized reservoirs are showing significantly better production curves than wells drilled into overpressurized reservoirs."¹⁷⁹ The best performing underbalanced wells in the Permian Basin¹⁸⁰ shale reserves showed "little to no decline a year

still relatively low, as low as 5-10% for certain types of reservoirs"); Rafael Andrea, *Evaluating Production Potential of Mature US Oil, Gas Shale Plays*, OIL & GAS J., Dec. 3, 2012, www.ogj.com/articles/print/vol-110/issue-12/exploration-development/evaluating-production-potential-of-mature-us-oil.html (stating that "recovery efficiency for the five major [shale gas] plays averages 6.5% and ranges from 4.7% to 10.0%"); and *Best Practices Increase EURs in Resource Plays*, THE AMERICAN OIL & GAS REPORTER, Jan. 2015 (describing the recovery rates in the Wolfcamp Shale play in West Texas as 3.0% to 5.0% for oil and 10% for natural gas).

173. Jacobs, *supra* note 152, at 50.

174. Randle Cade, Jeff Vickers, and Jeffrey Jennings, *Field Development: Producers Monetize Assets with UBD*, HART'S E & P, Jan. 2003.

175. See Kathy Moorhouse, *Under-Balanced Drilling Cuts Costs and Increases Productivity*, SHALE OIL & GAS BUSINESS MAGAZINE, Jan. 9, 2014, <http://shalemag.com/air-drilling-reduces-drilling-and-servicing-costs-and-increases-oil-and-gas-production-rates>.

176. See, e.g., J. David Hughes, *Drilling Deeper: A Reality Check on U.S. Government Forecasts for a Lasting Tight Oil & Shale Gas Boom*, POST CARBON INSTITUTE, Oct. 27, 2014, www.postcarbon.org/drillingdeeper.

177. *Id.*

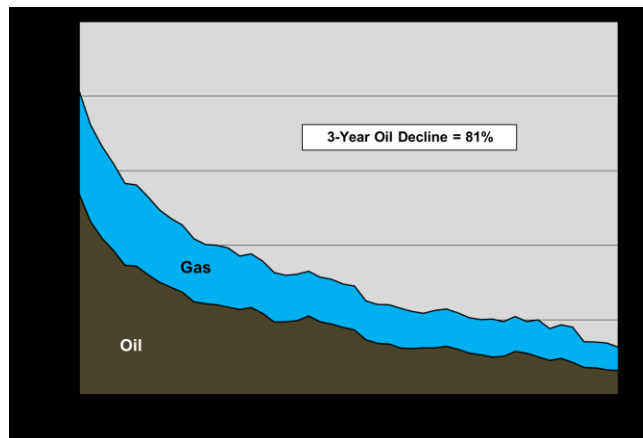
178. *Id.* at 7, 11.

179. Jacobs, *supra* note 152, at 51.

180. The Permian Basin underlays parts of west Texas centered around Midland and extends into southeastern New Mexico in and around Carlsbad. "It is the third largest source of tight oil production growth in the U.S. after the

on, and in others the decline rate is averaging around 10% a year."¹⁸¹ According to the *Journal of Petroleum Technology*, "this compares very favorably with a typical shale well decline rate that can be as steep as 80% in the first year."¹⁸² Another analysis of the Wolfcamp Play in the Permian Basin shows a 50% decline in overbalanced and fracked gas production after twelve months and 75% decline after thirty-six months, as shown in the graphic below.¹⁸³

Figure 15: Decline in Overbalanced and Fracked Gas Production



Underbalanced drilling in unconventional formations not only eliminates the cost of fracturing the recovery zone formation and improves production but it is less costly than traditional overbalanced drilling disregarding the recovery process once the well bore is completed. It reduces drilling costs in a variety of ways including the following:

- Reduced drilling time. The reduced pressure in the bore hole ahead of the bit means a faster rate of penetration (ROP) because "the bottomhole pressure compacting the area around the drill bit was eliminated."¹⁸⁴ Rates of penetration in overbalanced drilling are typically one to three feet per hour. Penetration rates can be up to four times faster using

Bakken and Eagle Ford" and "has been a prolific conventional oil and gas producer for nearly 100 years" with more than 400,000 wells drilled. Hughes, *supra* note 171, at 105 fig.2-66.

181. Jacobs, *supra* note 152, at 51.

182. *Id.*

183. Hughes, *supra* note 176, at 93.

184. Jacobs, *supra* note 152, at 54.

- underbalanced drilling.¹⁸⁵ That can dramatically cut down on the number of days a drilling rig needs to be on site.
- Increased drill bit life. Drill bits¹⁸⁶ are expensive to own, rent,¹⁸⁷ and maintain, and wear out quickly. The lowered pressure in the bore hole extends the life of each drill bit and that not only saves drill bit costs but also eliminates lost time involved in removing and repairing or replacing the drill bits.¹⁸⁸
 - Lower cost for drilling fluids and cement.
 - Smaller diameter well bores. There is less rock to remove so a faster smaller rig can be used for drilling and there are fewer cuttings to be disposed.

Some of the operational savings, however, are partially offset by additional costs associated with the equipment needed to safely conduct underbalanced drilling. Because oil, gas, water, and other fluids, including the drilling mud, come up the bore hole during underbalanced drilling, additional equipment must be installed on the drilling rig to control that upward flow and separate the components.¹⁸⁹ And there are additional costs for pre-engineering studies to determine if the resource formation is an appropriate one for underbalanced drilling and for additional on-site engineers and technicians to supervise and control the drilling process.¹⁹⁰

185. See Moorhouse, *supra* note 175 (indicating drilling rates are 2.6 times faster and reduce drilling time by 80 days, or almost 60%).

186. Drill bit technology has changed dramatically in recent years. PDC (polycrystalline diamond materials) bits "are one of the most important material advances for oil drilling tools in recent years" and "since their first production in 1976, the popularity of bits using PDC cutters has grown steadily, and they are nearly as common as roller-cone bits in many drilling applications." PetroWiki, *PDC Drill Bits*, http://petrowiki.org/PDC_drill_bits.

187. PDC bits are typically now rented rather than purchased. They are typically repaired on the drill site rather than replaced. If a bit is lost in the hole, the replacement cost can vary from \$30,000 to \$200,000 depending on the size of the bit.

188. Penetration rates normally double in underbalanced drilling and "sections have been drilled with only one bit where an overbalanced drilled well might need anywhere from three to five bits." PetroWiki, *Underbalanced Drilling (UBD)*, [http://petrowiki.org/Underbalanced_drilling_\(UBD\)](http://petrowiki.org/Underbalanced_drilling_(UBD)).

189. "On the rig, standard [additional] equipment includes a rotating control device, a choke, a mud gas separator (commonly called a gas buster) and production systems coupled with a flare to handle gas and oil coming up the wellbore." Jacobs, *supra* note 152, at 51.

190. Some studies have indicated that "underbalanced drilled wells are 20 to 30% more expensive than overbalanced drilled wells." PetroWiki, *Underbalanced Drilling (UBD)*, [http://petrowiki.org/Underbalanced_drilling_\(UBD\)](http://petrowiki.org/Underbalanced_drilling_(UBD)). However, that was a comparison of vertically drilled underbalanced wells rather than a comparison of the cost of a horizontally drilled UBD well to a horizontal well drilled using conventional overbalanced drilling.

But as an important industry reference source puts it, the additional upfront engineering necessary to plan an underbalanced drilling job “is not a good measure for the evaluation of UBD.”¹⁹¹ Any extra costs associated with the additional engineering studies, equipment, training and personnel costs are more than offset by the savings from elimination of the follow up fracking process as well as the additional productivity from the resource. The fracking resource recovery completion process is much more costly than the drilling of the hole.

The *Journal of Petroleum Technology* reported in May of 2015 that underbalanced drilling without fracking in the Permian Basin has reduced the capital costs by as much as 50%, from an average of roughly \$7.0 million to only \$3.5 million per well and in the Eagle Ford formation in South Texas, wells drilled and completed using UBD technology have cost between \$3.0 million and \$4.0 million compared to costs of \$6.0 to \$8.5 million for wells in the same formation using overbalanced drilling plus fracking.¹⁹² Recent business plans for underbalanced drilling forecast typical cost savings of 40% with even greater savings in the future as the economies of scale kick in due to wider use and commercialization of the underbalanced drilling process.

Add to that the “average three-fold increase in productivity of an underbalanced drilled well”¹⁹³ and the overall economics of underbalanced drilling are far more favorable than overbalanced drilling combined with fracking. In addition, because oil and gas flow to the well head even while drilling is underway, positive cash flow revenue can be generated sooner.¹⁹⁴

191. PetroWiki, *Underbalanced Drilling (UBD)*, [http://petrowiki.org/Underbalanced_drilling_\(UBD\)](http://petrowiki.org/Underbalanced_drilling_(UBD)).

192. Jacobs, *supra* note 152, at 52.

193. PetroWiki, *Underbalanced Drilling (UBD)*, [http://petrowiki.org/Underbalanced_drilling_\(UBD\)](http://petrowiki.org/Underbalanced_drilling_(UBD)).

194. At a rate of penetration of one to three feet per hour in an overbalanced drilling operation, a well with a vertical depth of 17,000 feet and then a horizontal extension of 9,000 feet – not unusual in the Bakken Shale in Montana and North Dakota – drilling would take between 361 and 1,083 days (about one to three years) of continuous drilling – without considering equipment and other problems causing stoppages -- before the first barrels of oil or cubic feet of gas could be recovered and sold. By contrast, again assuming a 17,000 foot depth to the reservoir formation, and a rate of penetration of 12 feet per hour, the resource would begin to be recovered and marketed within 60 days from the start of drilling. That significantly improves cash flow.

III. THE CENTRAL CONUNDRUM: IF UNDERBALANCED DRILLING ELIMINATES ENVIRONMENTAL ISSUES AND IS LESS COSTLY AND MORE PRODUCTIVE, WHY HAS THE OIL AND GAS INDUSTRY FAILED TO EMBRACE IT?

Given its environmental benefits and cost savings, why has the oil and gas industry continued to embrace overbalanced drilling plus fracking as the technology of choice in horizontal operations in unconventional shale plays? There are three reasons that can be summed up simply as follows: tradition, training, and vested interests.

In the early years of oil and gas exploration from the 1860s to the first two decades of the Twentieth Century, blowouts were a significant safety risk in the industry. The uncontrolled release of oil and gas during drilling once the resource zone was hit by the drill bit resulted in many catastrophic blowouts as well as the loss of much of the resource before the blowout could be brought under control.¹⁹⁵ A spark could ignite an explosion or raging inferno, a not uncommon event in the past history of the industry.

By the mid-1920s, the introduction of rotary drilling techniques,¹⁹⁶ combined with a blowout preventer (BOP) and overbalanced drilling began to be widely used to control the pressure in the rock formations.¹⁹⁷ The most important safety role of the BOP was to counter the sudden surges in pressure -- "kicks" in oil and gas industry parlance -- that could be encountered as a reservoir was drilled.

195. The Spindletop Blowout in Beaumont, Texas, in 1901 resulted in a gusher that lasted nine days, reaching a height of 200 feet, and resulting in a loss of 900,000 barrels of oil. The Lakeview Gusher in California in 1910 also rose to 200 feet and lasted 18 months resulting in a loss of 9.0 million barrels. Only about half of the Lakeview Gusher oil that escaped was recovered.

196. The earliest wells were completed with cable bit drills. In that process, steam power was harnessed to a heavy iron bit, sometimes five feet long and weighing as much as two tons, that was repeatedly lifted and dropped down the hole crushing and chiseling the rocks below. The cable bit had to be removed every time it was necessary to remove the crushed rock from the hole. As a result, drilling was a slow process. The rotary drill bit that replaced cable drilling was part of a system that included pumping mud into the hole to wash out the pulverized rock while drilling continues.

197. In overbalanced drilling, a series of blowout preventers are attached in a stacked arrangement to the top of the drill pipe that runs down the center of the steel casing. The drill strings are routed through the blowout preventer and the drilling mud is then pumped down drill pipe. The column of mud creates the pressure that controls the pressure coming from the rock formations. The blowout preventer also then regulates the pressure that forces the mud back up through the annulus, the space between the drill pipe and the outer steel casing. It can also shut down the well when a serious kick is encountered and then additional "kill fluid" mud is added to the column to offset the increased pressure from the kick.

As a result of these safety concerns, the industry and its state regulators adopted overbalanced drilling as the accepted and now traditional method of drilling a well.

As a result, since the 1920s, petroleum engineers have been trained primarily in overbalanced drilling techniques. For instance, one of the top five petroleum engineering universities in the country, the University of Texas at Austin, lists work in overbalanced drilling as one of the main elements of its program in Drilling, Well Completions, and Rock Mechanics.¹⁹⁸ That creates a built-in bias in favor of traditional overbalanced drilling techniques in the petroleum engineering profession. The industry, as well as the state regulators and insurance companies, are comfortable with overbalanced drilling, understand its risks, and have well-defined standards of practice. By contrast, standards for underbalanced drilling are at an earlier stage of development and understanding.¹⁹⁹

But in recent years, advances in technology combined with newly invented equipment have made underbalanced drilling as safe as traditional overbalanced drilling.²⁰⁰ However, the owners and managers of more large engineering firms and drilling companies are not trained in underbalanced drilling methods and have a vested economic interest in continuing with the traditional and familiar overbalanced drilling process. Change is risky and retraining costly.

The same factors are at work in the hydraulic fracturing industry. Tapping the oil and gas in unconventional tight shale formations was not economically feasible until the development of commercially viable horizontal drilling technologies in the 1980s.²⁰¹ Rapid developments in steerable downhole motors and remote

198. University of Texas at Austin Center for Petroleum & Geosystems Engineering, *Drilling, Well Completions, and Rock Mechanics*, www.cpge.utexas.edu/?q=rp_drilling.

199. See, e.g., International Association of Drilling Contractors, *Underbalanced and Managed Pressure Drilling Operations – HSE Planning Guidelines*, www.iadc.org/wp-content/uploads/IADC-Risk-Guidelines-.pdf.

200. The key piece of technology that has significantly improved safety is the development of a downhole deployment valve to eliminate "snubbing," an expensive and dangerous procedure necessary when tripping drill pipe into or out of a live flowing well. Snubbing requires forcing a pipe or a tube into a well against the pressure of the well when the blowout preventer (BOP) is open.

201. According to the U.S. Energy Information Administration, the first successful horizontal well in the United States was drilled in 1929 in Texas, but the second, in Pennsylvania, was not drilled until 1944. But in the early 1980s, the first commercially successful horizontal wells were drilled in southwestern France and in the Mediterranean Sea offshore from Italy. The first commercially successful applications in the U.S. were by British Petroleum in Alaska's Prudhoe Bay reserves. U.S. Energy Information Administration, *Drilling Sideways – A Review of Horizontal Well Technology and Its Domestic Application*, (Apr. 1993), www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/drilling_sideways_well_technology/pdf/tr0565.pdf.

sensing equipment combined with flexible coiled drill pipe²⁰² tubing in the late 1980s quickly increased the use of horizontal drilling in the 1990s.

The U.S. Energy Information Administration in 1993 reported the following about the nascent state of horizontal drilling in the United States:

Horizontal drilling in the United States has thus far been focused almost entirely on crude oil applications. In 1990, worldwide, more than 1,000 horizontal wells were drilled. Some 850 of them were targeted at Texas' Upper Cretaceous Austin Chalk Formation alone. Less than 1 percent of the domestic horizontal wells drilled were completed for gas, as compared to 45.3 percent of all successful wells (oil plus gas) drilled. Of the 54.7 percent of all successful wells that were completed for oil, 6.2 percent were horizontal wells. Market penetration of the new technology has had a noticeable impact on the drilling market and on the production of crude oil in certain regions. For example, in mid-August of 1990, crude oil production from horizontal wells in Texas had reached a rate of over 70,000 barrels per day.²⁰³ (footnotes omitted).

By 2013, about 90% of all wells were being drilled horizontally²⁰⁴ and more than 90% of those used hydraulic fracturing to recover the resource.²⁰⁵ As a result, a huge industry has developed around the hydraulic fracturing technology. The industry is dominated by five key players -- Halliburton, Schlumberger, Baker Hughes, Weatherford, and Sanjel -- giving them significant marketing power and influence over development and application of technology and public policy. A 2013 U.S. Department of Justice investigation of possible anti-competitive practices by Halliburton and Schlumberger claimed that those two companies plus Baker Hughes "jointly control about 60 percent of

202. "Unlike standard drill pipe, which comes in 30-foot lengths equipped with threaded connectors at each end, and is stored in 3-section, 90-foot-long joints on the drilling or workover rig's pipe rack, coiled tubing is a continuous length of pipe that is stored wrapped around a large reel, in much the same fashion as thick electrical cable is stored and shipped. In operation, the tubing is straightened off the storage reel and led over a curved guide to and through a motorized injector head mounted atop the well control equipment stack, and thence through the control stack into the well. Tools are attached to the downhole end; wire cables can also be passed, and fluids circulated, through the tubing." *Id.*

203. *Id.*

204. Energy Economist, *Trends in Drilling Rig Count*, Oct. 18, 2010, www.energyeconomist.com/a6257783p/archives/ee101017rtrend.html.

205. Independent Petroleum Association of America, *U.S. Oil Technology Revolutionizing Development*, <http://oilindependents.org/u-s-oil-technology-revolutionizing-development/>.

the U.S. market"²⁰⁶ and their control of the specialized pumps²⁰⁷ and their dominance of the hydraulic fracturing process gives them an enormous vested interest in ensuring that hydraulic fracturing continues to be the preferred resource recovery method for tight formations. Their contracts to provide hydraulic fracturing services are "often long term and field wide" and a single contract is typically negotiated to cover all future wells in a particular production area.²⁰⁸

While such concentration of technology and expertise can create economies of scale and efficiencies, it also creates "barriers to entry for other players, meaning that the cost of beginning a fracking company -- obtaining the proper know-how, experts, and technology -- is now so high that new developers may resist entry into the field."²⁰⁹ And given the semi-monopoly position of a few key players, and the size of the U.S. hydraulic fracturing industry,²¹⁰ there is powerful resistance in the oil and gas industry to replacing the overbalanced drilling plus hydraulic fracturing process with an alternative technology such as underbalanced drilling.²¹¹ The key

206. Laurel Brubaker Calkins, *Halliburton, Schlumberger Accused in Fracking Price Suit*, BLOOMBERG (Aug. 2, 2013), www.bloomberg.com/news/articles/2013-08-01/halliburton-schlumberger-accused-in-fracking-price-suit.

207. According to a 2013 law review article, "Halliburton, Schlumberger, and BJ have a 75 percent U.S. market share for the high pressure pumps needed for fracking" and the dominance of those three companies in providing hydraulic fracturing contractual services is demonstrated by the U.S. EPA Memorandum of Understanding they signed related to the elimination of diesel fuel from hydraulic fracturing fluids. Timothy Fitzgerald, *Frackonomics: Some Economics of Hydraulic Fracturing*, 63 CASE W. RES. L. REV. 1337, 1354 n.51 (2013) (citing Howard Rogers, *Shale Gas -- The Unfolding Story*, 27 OXFORD REV. ECON. POL'Y 117, 132 (2011)).

208. Fitzgerald, *supra* note 207, at 1354.

209. Shalanda Helen Baker, *Is Fracking the Next Financial Crisis? A Development Lens for Understanding Systemic Risk and Governance*, 87 TEMP. L. REV. 229, 260–61 (2015).

210. A 2012 Bloomberg story estimated that \$30.0 billion was spent on fracking operations in North America in 2011, which represents about 87% of the worldwide market for hydraulic fracturing. Joe Carroll, *Fracking Market to Grow 19% to \$37 Billion Worldwide in 2012*, BLOOMBERG (Jan. 19, 2012), www.bloomberg.com/news/articles/2012-01-19/frack-market-to-grow-19-in-2012-to-37-billion-correct-. It estimated fracking service expenditures by region as follows: Oklahoma, \$5.0 billion; Canada, \$4.0 billion; south Texas and East Texas/Louisiana, \$3.5 billion each; Rocky Mountains, (including North Dakota), \$3.0 billion; and eastern U.S. (including Pennsylvania, West Virginia and Ohio), \$3.0 billion. *Id.*

211. Information on the size of the hydraulic fracturing industry in the U.S. is difficult to ascertain since the publicly traded companies do not clearly separate report their fracking related revenues as distinct from the other oil and gas service revenues they generate. An approximation of the size of the industry can be made, however. According to one website, excluding Texas, Maryland, and North Carolina, states for which the exact number of horizontal wells is difficult to determine, there were 20,785 active oil and gas wells in the United States in 2013, and another 15,257 wells drilled directionally that year.

players would rather tweak the current fracturing process than drop it and adopt a much simpler underbalanced drilling process that could be utilized by a greater variety of smaller players that would be much more difficult to dominate.

A. *Underbalanced Drilling: How Does It Eliminate Regulatory Taking Concerns?*

One of the principal arguments used by the oil and gas industry when opposing hydraulic fracturing moratoria, bans, and even strict environmental controls on fracking operations is that such regulations are an unconstitutional regulatory taking of private property for public use. As discussed above, in the *City of Longmont* case in Colorado, as well as in the controversy over the Denton, Texas moratorium and ban, the industry argued that horizontal drilling combined with fracking is the only economically viable manner in which to extract oil and gas from tight unconventional shale formations.

The basic rule related to regulatory takings jurisprudence was promulgated by Justice Holmes more than ninety years ago in the U.S. Supreme Court decision in *Pennsylvania Coal Co. v. Mahon*. At issue was the constitutional validity of Pennsylvania's Kohler Act, a statute prohibiting "the mining of anthracite coal in such way as to cause the subsidence of, among other things, any structure used as a human habitation, with certain exceptions, including among them land where the surface is owned by the owner of the underlying coal and is distant more than one hundred and fifty feet from any improved property belonging to any other person."²¹² Pennsylvania Coal Company had a subsurface mining deed dating back to 1878.²¹³ The Commonwealth of Pennsylvania admitted that, at least as to the facts of the particular case, that the statute would "destroy previously existing rights of property and contract."²¹⁴

The Pennsylvania Supreme Court upheld the statute as a legitimate exercise of the police power and constitutional under the U.S. Constitution. Justice Holmes framed the central issue as "whether the police power can be stretched so far" and, in a decision to which Justice Brandeis dissented, overturned the statute.²¹⁵ The

FracTracker Alliance, *Over 1.1 Million Active Oil and Gas Wells in the US* (Mar. 4, 2014), www.fractracker.org/2014/03/active-gas-and-oil-wells-in-us. If we assume that only 75% of those wells used hydraulic fracturing, and that the average cost of the fracturing process was only \$2.0 million, the total size of the U.S. fracking industry (not counting drilling) in 2013 was more than \$65.0 billion.

212. *Pennsylvania Coal Co. v. Mahon*, 260 U.S. 393, 412-13 (1922).

213. *Id.* at 412.

214. *Id.* at 413.

215. *Id.*

fact based "balancing test" formulated by Justice Holmes was as follows:

Government hardly could go on if to some extent values incident to property could not be diminished without paying for every such change in the general law. As long recognized some values are enjoyed under an implied limitation and must yield to the police power. But obviously the implied limitation must have its limits or the contract and due process clauses are gone. One fact for consideration in determining such limits is the extent of the diminution. When it reaches a certain magnitude, in most if not in all cases there must be an exercise of eminent domain and compensation to sustain the act. So the question depends upon the particular facts.²¹⁶

And in language related to subsurface coal that seems equally applicable to subsurface oil and gas for which a property interest and contract right has previously been established, Justice Holmes added the following:

It is our opinion that the act cannot be sustained as an exercise of the police power, so far as it affects the mining of coal under streets or cities in places where the right to mine such coal has been reserved. As said in a Pennsylvania case, 'For practical purposes, the right to coal consists in the right to mine it.' *Commonwealth v. Clearview Coal Co.*, 256 Pa. 328, 331, 100 Atl. 820, L. R. A. 1917E, 672. What makes the right to mine coal valuable is that it can be exercised with profit. To make it commercially impracticable to mine certain coal has very nearly the same effect for constitutional purposes as appropriating or destroying it.²¹⁷

Simply stated, the *Pennsylvania Coal* general rule, restated in hundreds of regulatory cases since, is "while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a taking."²¹⁸

More than fifty years later, the U.S. Supreme Court provided a significant restatement and further explanation of the balancing test of *Pennsylvania Coal* in a land use regulatory taking context. In *Penn Central Transportation Co. v. City of New York*, 438 U.S. 104 (1978), the court had before it a challenge to New York City's Landmarks Preservation Law. The railroad company had been denied a permit to construct a tower above Grand Central Terminal in Midtown Manhattan. Penn Central challenged the constitutionality of the landmarks law, and the specific application of the law to it. One of its arguments was that the air rights above the existing terminal building were a separate property interest that had been "taken" by the New York City and that "irrespective of the value of the remainder of their parcel, the city has 'taken' their right to this superjacent airspace, thus entitling them to 'just

216. *Id.*

217. *Id.* at 414.

218. *Id.* at 415.

compensation' measured by the fair market value of these air rights."²¹⁹ The U.S. Supreme Court affirmed the New York Court of Appeals²²⁰ and ruled that the denial of the permit was not a regulatory taking for which compensation must be paid.

Justice Brennan, writing for the majority, characterized landmark preservation as an environmental issue: "[H]istoric conservation is but one aspect of the much larger problem, basically an environmental one, of enhancing -- or perhaps developing for the first time -- the quality of life for people."²²¹

In applying the balancing test inquiry first stated in *Pennsylvania Coal*, the *Penn Central* court said it is necessary to analyze both the "economic impact of the regulation on the claimant and, particularly, the extent to which the regulation has interfered with distinct investment-backed expectations" as well as the "character of the government action."²²² As to the character of the action, when there has been an actual physical invasion of real property, "a 'taking' may more readily be found when the interference with property can be characterized as a physical invasion by government,²²³ than when interference arises from some public program adjusting the benefits and burdens of economic life to promote the common good."²²⁴

Opposition to hydraulic fracturing in many states and local communities is focused squarely on the environmental and "quality of life" issues considered important by Justice Brennan. And the types of land use and environmental regulations proposed to control the consequences of fracking do not result in a physical invasion.

But what about the "investment backed expectations" of the owners of the subsurface mineral rights or the oil and gas extraction permits and leases? Do the moratoria, bans, and environmental regulations related to fracking interfere with "distinct investment-backed expectations?"

When the price of crude was at \$100 per barrel, or even \$50 per barrel, a ban, or even a temporary moratorium, on fracking certainly interfered with reasonable "investment backed expectations" given the boom in tight formation production in the USA that the fracturing technology engendered. But are the

219. *Penn Cent. Transp. Co. v. City of New York*, 438 U.S. 104, 130 (1978).

220. A trial court had granted *Penn Central's* motion for a declaratory judgment that the denial violated the Fifth Amendment takings clause and the Fourteenth Amendment due process clause. An appellate court affirmed the trial court decision, but the New York Court of Appeals reversed the lower courts' decisions and upheld the landmark law from the constitutional challenge.

221. *Penn Central*, 438 U.S. at 108.

222. *Id.* at 123.

223. *See. e.g.*, *United States v. Causby*, 328 U.S. 256 (1946) (where the taking at issue involved aircraft flying at extremely low altitudes over the respondent's property).

224. *Penn Central*, 438 U.S. at 124.

“investment backed expectations” quite different when the price of a barrel of crude has dropped to the low \$30s and upper \$20s and the cost to fracture a multi-stage well exceeds the value of the oil and gas that can be produced from the well during the reasonably foreseeable future?

Two other elements of the *Penn Central* decision are also important to our analysis of how underbalanced drilling might eliminate regulatory taking concerns.

First, Justice Brennan took care to distinguish the New York City regulation from those scrutinized by the court in other “takings” cases, such as *Goldblatt v. Hempstead*, in which no ongoing use of the real property remained following the regulation.²²⁵ Justice Brennan emphasized that *Penn Central* could continue to use the railroad terminal just as it had for many decades.²²⁶ A fracking ban combined with regulations specifically allowing or even requiring underbalanced drilling would permit the oil and gas property rights to continue be used exactly as they had been, for the production of oil and gas.

And, second, just as Justice Brennan noted that the New York City landmark law was one “permitting Penn Central not only to profit from the Terminal but also to obtain a ‘reasonable return’ on its investment,”²²⁷ so too, at even the oil prices in the market as of early 2016, would a ban on hydraulic fracturing combined with regulations specifically allowing or even requiring underbalanced drilling.

Finally, there is another important aspect of the *Penn Central* decision of relevance to consideration of underbalanced drilling as a viable alternative to hydraulic fracturing. Justice Brennan emphasized that simply because New York City did not approve a 50-story office building above Grand Central Terminal does not mean it might not approve a shorter addition designed with more sympathy for the Beaux-Arts character of the existing structure.²²⁸ The Supreme Court said the following about the landmark commission’s denial of the railroad company’s permit application:

225. *Goldblatt v. Hempstead*, 369 U.S. 590 (1962). At issue in the *Goldblatt* case was an ordinance of the Town of Hempstead that prohibited sand and gravel mining in pits below the water table. *Goldblatt* had been operating a sand and gravel pit in the town for 30 years, and in recent years the excavation had been ongoing below the water table. The pit owner claimed the zoning ordinance deprived him of all beneficial use of his property. The U.S. Supreme Court upheld the ordinance.

226. In perhaps a tactical mistake, *Penn Central* had conceded at trial that it could earn a reasonable return from the existing terminal “and that the transferable development rights afforded appellants by virtue of the Terminal’s designation as a landmark are valuable, even if not as valuable as the rights to construct above the Terminal.” *Penn Central*, 438 U.S. at 129.

227. *Penn Central*, 438 U.S. at 136.

228. *Id.* at 136-37.

The Commission's report emphasized that whether any construction would be allowed depended upon whether the proposed addition 'would harmonize in scale, material, and character with [the Terminal].' Record 2251. Since appellants have not sought approval for the construction of a smaller structure, we do not know that appellants will be denied any use of any portion of the airspace above the Terminal.²²⁹

In sum, regulations that ban hydraulic fracturing while promoting underbalanced drilling, an alternative technology proven to produce the same, or better, production results at a significantly lower cost, would not constitute unconstitutional regulatory "takings" since it would assure a reasonable use of the mineral property interest that is economically viable.²³⁰

A later reiteration by the U.S. Supreme Court of the *Pennsylvania Coal* and *Penn Central* balancing test further enhances the legal status of underbalanced drilling as an alternative to hydraulic fracturing. In *Keystone Bituminous Coal Association v. DeBenedictis*, Justice Stevens, writing for the majority, reiterated the importance of factual analysis of the particular economics of every regulatory taking situation and the "heavy burden" placed on the owner of a mineral interest to demonstrate that there is no viable way to utilize the overall property interest in the resource in a profitable manner.²³¹ The *Keystone Bituminous* decision would support a state or local government position that shifts the burden of proof to the owner of a mineral estate or lease to demonstrate that underbalanced drilling is not economically viable.

Two other U.S. Supreme Court cases, *Lucas v. South Carolina Coastal Council* and *Palazzolo v. Rhode Island*, are also important to an analysis of regulatory takings issues as they affect restrictions on fracking.

229. *Id.*

230. In some of the locations where local moratoria, bans, or strict environmental regulations may thwart hydraulic fracturing, another portion of the *Penn Central* decision is also significant. Justice Brennan noted that New York's transferable development rights program for landmarks allowed Penn Central to transfer or sell the air rights "to at least eight parcels in the vicinity of the Terminal, one or two of which have been found suitable for the construction of new office buildings." *Penn Central*, 438 U.S. at 137. In some of the locations where fracking has been temporarily or permanently halted, the holder of the mineral rights could tap into the reservoir formation from other locations, including locations outside the jurisdiction of the local community imposing the moratorium or ban. As a result, such a ban or moratorium would not be a "taking" of the value of the property interest, but simply a shifting of the drill site to another location as a result of the increasing length of the horizontal wells that can now be drilled and fractured in the large tight shale formations.

231. *Keystone Bituminous Coal Association v. DeBenedictis*, 480 U.S. 470 (1987).

In *Lucas*, the Supreme Court established an alternative to the Penn Central takings rule. In the narrow set of circumstances when a land use regulation deprives a property owner of "all economically beneficial use" of a property, the Court established a new categorical rule that such an action constitutes an unconstitutional taking of property for which just compensation must be paid unless "background principles of nuisance and property law" have also restricted the owner's intended use.²³² A mineral rights owner or lessor or lessee of such rights would have to demonstrate that it could make no economic use of those property interests in order to overturn a fracking ban. Since underbalanced drilling is an economically viable alternative to hydraulic fracturing, a ban on fracking would not be subject to the *Lucas* categorical rule.²³³

At issue in *Palazzolo* was a series of unsuccessful attempts by a developer to obtain approval to develop a coastal property, much of which was in salt marsh and would require as much as six feet of fill before structures could be built. Justice Kennedy, writing for the majority, reiterated the *Penn Central* balancing test and required focus on the entire property interest.²³⁴ Even though a substantial portion of the property could not be developed due to the prohibition against filling wetlands, the upland portion of the property had substantial value and could be developed, leaving the owner with a reasonable economic use.

In sum, the regulatory takings decisions of the U.S. Supreme Court indicate that if underbalanced drilling is indeed an economically viable alternative to hydraulic fracturing, then oil and gas industry claims that fracking is the only economically viable resource recovery method, and therefore fracking bans constitute an illegal "taking" for which compensation must be paid, will not stand scrutiny. However, it likely will require a trial in which expert testimony pro and con on the merits of underbalanced drilling will be analyzed by a judge or jury. As indicated above, Colorado may be the first state where such a trial occurs if the Colorado Supreme Court remands the *Longmont* case for a hearing on that issue.

232. *Lucas v. South Carolina Coastal Council*, 505 U.S. 1003, 1029 (1992).

233. At least one commentator argues that even if all beneficial use of a mineral interest was denied as a result of a land use regulation, the categorical *Lucas* rule would not apply to owners of less-than-fee mineral interests based upon the historic principles of property law that apply to such interests in most states. See Patrick C. McGinley, *Bundled Rights and Reasonable Expectations: Applying the Lucas Categorical Taking Rule to Severed Mineral Property Interests*, 11 VT. J. ENVTL. L. 525 (2010).

234. *Palazzolo v. Rhode Island*, 533 U.S. 606, 631-32 (2001).

IV. UNDERBALANCED DRILLING AND THE FUTURE OF SHALE OIL AND GAS DEVELOPMENT IN THE UNITED STATES: A TEN POINT AGENDA FOR CHANGE

With crude oil and natural gas prices at their lowest levels in more than a decade, the economics of oil and gas production are forcing U.S. producers to find more cost effective means to produce oil and gas from tight formations. While the costs of hydraulic fracturing have been significantly reduced in recent years, the reductions in cost savings have not been able to keep pace with the declining producer prices.

And the price decline may not yet have bottomed out. Given their lower production costs, Saudi Arabia and some other OPEC nations will continue to drive down oil prices in order to slow U.S. production and continue to keep their market share. The increasing tension between Saudi Arabia and Iran – especially now that western economic sanctions on Iran have been lifted in exchange for Iran’s dismantling of its nuclear program – will also be an important factor keeping prices low. Saudi Arabia desires to keep prices low in order to reduce Iran’s oil export income.²³⁵ Iran, emerging from western sanctions, is anxious to increase production now that it can sell oil openly on the international market.²³⁶ The amount of oil Iran is expected to produce, combined with its low production costs, will also increase world supplies and lower prices. The wild card in all this, however, is whether the Saudi royal house can maintain its internal stability given the cutbacks in its domestic spending necessitated by its decline in oil revenues.²³⁷ By contrast, Iran, which has not been allowed to legally sell oil internationally for over a decade, is happy to be receiving oil sales revenues again even at the low early 2016 prices.

Given all of this economic uncertainty, the United States should be actively searching for technological advances that will lower oil and gas production costs while increasing productivity in order to assure future self-reliance and continuing profitability of the revitalized U.S. domestic oil and gas production industry. As this article has explained, underbalanced drilling is precisely such a technology. It not only can make production profitable at current

235. Christopher Harress, *Oil Prices 2016: Saudi Arabia, Iran Rivalry Fuels Grim Outlook Amid Slow China Economy, US Export Ban’s End*, INTERNATIONAL BUSINESS TIMES (Dec. 30, 2015), www.ibtimes.com/oil-prices-2016-saudi-arabia-iran-rivalry-fuels-grim-outlook-amid-slow-china-economy-2243060.

236. *Id.*

237. See Roula Khalaf, Lional Barber, & Simeon Kerr, *Oil price sounds Saudi Arabia wake-up call*, FINANCIAL TIMES (Dec. 22, 2015), www.ft.com/cms/s/0/38dc5da6-9d58-11e5-b45d4812f209f861.html#axzz44KjTCeRZ.

price levels but it also eliminates the environmental issues and regulatory taking problems associated with hydraulic fracturing.

Although U.S. producers, most notably Shell and some smaller operators, have begun to see the benefits of underbalanced drilling, U.S. federal and state regulators and energy agencies have taken little notice of the UBD technology. Neither the New York State environmental impact study process that led to its statewide ban nor the U.S. EPA draft report in 2015 on potential impacts of hydraulic fracturing on drinking water considered or even mentioned underbalanced drilling as an alternative to hydraulic fracturing. A search for the words “underbalanced drilling” on the website of the U.S. Energy Information Administration provides only one reference, an outdated April 1993 document produced during the early days of horizontal drilling.²³⁸

So what needs to be done to get underbalanced drilling recognized for exactly what it is – the solution to the economic, environmental and regulatory taking issues facing the U.S. oil and gas production industry?

There are at least ten items on the agenda.

Agenda Item No. 1. The U.S. Energy Information Administration and state regulators in key producer states such as Pennsylvania, Ohio, Colorado, North Dakota, Oklahoma, Louisiana, and Texas must take note of underbalanced drilling as a viable economic alternative to overbalanced drilling combined with hydraulic fracturing. As the U.S. rig count and production falls in response to current producer prices and fracking costs, oil and gas revenues to the states will also fall. Those states have an economic incentive to promote a technology such as underbalanced drilling that can increase production while reducing costs. Part of the problem to date in those states is that the governmental overseers of the oil and gas industry have been too quick to accept hydraulic fracturing industry claims that its processes are the only way to recover resources from tight formations. The regulators must become more skeptical of oil and gas industry claims that there are no economically viable alternatives to fracking.

Agenda Item No. 2. Industry analysts (as well as regulators and information agencies) must carefully watch what happens in New York. If the NYDEC had paid attention to underbalanced drilling as a viable alternative to fracturing, its economic analysis of the ban on fracking might have been quite different. However, the statewide ban on hydraulic fracturing may be just the opening that underbalanced drilling needs to gain attention nationally as a

238. U.S. Energy Info. Admin., *Drilling Sideways – A Review of Horizontal Well Technology and its Domestic Application*, April 1993, www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/drilling_sideways_well_technology/pdf/tr0565.pdf.

viable alternative to fracking. The New York fracking ban does not mean there will be no oil and gas production in New York State. Drilling and recovery of natural gas and oil from the Marcellus Shale is allowed – but not with hydraulic fracturing as the resource recovery technology. As a result, the industry in New York is experimenting more with underbalanced drilling. For example, Weatherford International, an oil and gas service company, reports that gas production was 4.5 times higher when using underbalanced drilling rather than hydraulic fracturing in Chenango County, New York.²³⁹ Such success stories, once the mainstream media begins to notice, will cause underbalanced drilling to be considered more frequently.

Agenda Item No. 3. Illinois must discuss and promote underbalanced drilling as one of its “best practices” in the annual reports required by its recently enacted fracking statute. The Illinois Hydraulic Fracturing Act passed in 2013 gives the state authority to examine “latest scientific research” and “best practices.” The Illinois Department of Natural Resources should identify underbalanced drilling as a “best practice” method “to protect the environment” as authorized by language in the new act. Given current oil and gas prices, and the cost structure of hydraulic fracturing, the only realistic way it may see any significant exploration in its Illinois Basin resources is if it actively promotes underbalanced drilling as a viable way for it to join the fracking boom. Since many have called the Illinois regulatory process a model for the nation, the rest of the country will immediately take note if Illinois regulators issue a study promoting the benefits of underbalanced drilling.

Agenda Item No. 4. A national environmental group must step up and take note of underbalanced drilling as a viable solution to the environmental issues caused by fracking. This is what it may take for federal and state regulators to realize the significance of underbalanced drilling as an alternative to hydraulic fracturing. The situation in Illinois could be the catalyst for this to happen. Environmental groups in Illinois engaged in across the table discussions with the oil and gas industry representatives to hammer out the compromises that led to the model fracking regulation in Illinois. If a major environmental group, such as the Midwest's Environmental Law and Policy Center that was heavily involved in the negotiations resulting in the Illinois Hydraulic Fracturing Act, published an issue paper on the environmental plusses associated with UBD, it would go far towards enhancing the status of the technology.

239. Weatherford, *Real Results: Underbalanced Drilling Operation Enables Successful Performance in Horizontal Well with Sensitive Vertical Fractures*, www.weatherford.com.

Agenda Item No. 5. Pay attention to what happens in Colorado. The Colorado Supreme Court decision in the Longmont case is expected sometime in 2016. If the Supreme Court sends the case back for a trial on the merits of the regulatory taking claim, evidence related to the economics of underbalanced drilling as a viable economic alternative to fracking will likely be presented. How that issue is framed and the result of the trial (and any subsequent appeals) will be watched closely around the country.

Agenda Item No. 6. The U.S. Environmental Protection Agency must study and publicize underbalanced drilling as a way to resolve environmental concerns associated with fracking. The U.S. EPA never focused on underbalanced drilling as an environmentally sensitive and economically viable alternative in its June 2015 draft report on drinking water issues related to fracking.

Agenda Item No. 7. The Bureau of Land Management (BLM) should promote underbalanced drilling as an alternative to fracking. There are more than 100,000 oil and gas wells on federal lands and more than 90% of new wells drilled on federal lands in recent years use hydraulic fracturing. In March of 2015, the BLM issued its final rulemaking related to its issues for oil and gas drilling on publicly owned land. It was the first update of its well drilling oversight rules in 30 years.²⁴⁰ While the rules did not ban hydraulic fracturing, they updated requirements for well-bore integrity, wastewater disposal, and disclosure of chemicals used in the fracturing process. However, a federal judge in Wyoming issued an injunction blocking implementation of the new rules on the basis that the BLM had exceeded its regulatory authority.²⁴¹ If the states suing the BLM from implementing the rules prevail, the agency could, within its existing authority, incorporate – or even require -- underbalanced drilling when it issues new leases. It could even give preferential leasing rates to underbalanced drillers as an incentive for producers to shift away from fracking to the alternative UBD technology.

Agenda Item No. 8. University oil and gas geology and technology programs must become more interested in underbalanced drilling as an alternative to hydraulic fracturing. Not only do they need to include more core programs in UBD, but also devote more research to improving the technology, reducing its costs, and demonstrating its positive economics when compared with fracking.

240. Bureau of Land Management, *Interior Department Releases Final Rule to Support Safe, Responsible Hydraulic Fracturing Activities on Public and Tribal Lands*, www.blm.gov/wo/st/en/info/newsroom/2015/march/nr_03_20_2015.html.

241. *State of Wyoming, et al. v. U.S. Department of the Interior, et al.*, U.S. District Court, District of Wyoming, Case 2:15-CV-00043-SWS, Document 130, www.eenews.net/assets/2015/09/30/document_pm_01.pdf.

Agenda Item No. 9. States, and local governments in states where local regulation of oil and gas operations has not been preempted by the state, must take a bold new approach and ban hydraulic fracturing while creating positive incentives for underbalanced drilling. The combination of the two would make it difficult for the oil and gas industry to argue -- and prove -- that the fracking ban was a regulatory taking. The incentive could take the form of tax relief for drillers using UBD technology, or perhaps public financial assistance. Like the Bureau of Land Management, many states -- and even local governments -- issue oil and gas drilling leases on their publicly owned land. They too could give preferential treatment to drillers proposing to use UBD technology. If Pennsylvania was able to encourage fracking with special incentives and exemptions, the same could be done elsewhere -- or even in Pennsylvania itself -- to encourage a change over from hydraulic fracturing to underbalanced drilling as the preferred technology.

Agenda Item 10. Wall Street must take notice of underbalanced drilling as a more environmentally friendly, more productive, and less costly alternative to hydraulic fracturing. Much of the boom in hydraulic fracturing between 2008 and 2012 in the United States was funded through various types of investment vehicles. During 2011 alone, KPMG estimates that U.S. shale gas development deals totaled \$46.5 billion.²⁴² A January 2012 *Bloomberg* story reported that "Chinese, French and Japanese energy explorers committed more than \$8 billion in the past two weeks to shale-rock formations from Pennsylvania to Texas after 2011 set records for international average crude prices and U.S. gas demand."²⁴³ With the collapse of oil prices in 2015 and early 2016, and the further weakening of natural gas prices, many previous investments in underperforming fracking assets will be put on the market at bargain prices in 2016.²⁴⁴ Investment banks need to become aware of the opportunity that underbalanced drilling creates to reposition these "distressed" assets (including master

242. KPMG Global Energy Institute, *Shale Gas: Global M&A Trends: Focus on Argentina, China and United States*, 2012, www.kpmg.com/FR/fr/IssuesAndInsights/ArticlesPublications/Documents/Shale-gas-global-m-and-a-trends.pdf.

243. Joe Carroll & Jim Polson, *Shale Bubble Grows on Near-Record Prices for Untested Fields*, BLOOMBERG (Jan. 9, 2012), www.bloomberg.com/news/2012-01-09/shale-bubble-inflates-on-near-record-prices-for-untested-fields.html.

244. The *Wall Street Journal* reported on January 11, 2016 that due to the crash in oil and gas prices, "as many as a third of American oil-and-gas producers could tip toward bankruptcy and restructuring by mid-2017" and that "(t)ogether, North American oil-and-gas producers are losing nearly \$2 billion every week at current prices." Nicole Friedman, *Oil Skids to 12-Year Low*, WALL. ST. J. (Jan. 11, 2016), www.wsj.com/articles/oil-prices-tumble-weighed-by-china-worries-1452481849.

limited partnership investments in oil and gas)²⁴⁵ for underbalanced drilling. Such a repositioning, combined with an investment in UBD equipment drilling platforms to create economies of scale in various parts of the country, strategic application of the UBD technology in the right formations, and post-production public relations campaigns demonstrating the UBD results, would make underbalanced drilling the preferred technology for continued profitable tight formation oil and gas production even at current price levels. In other words, "fund and build it, and they will come."

245. According to the *Wall Street Journal*, citing Dealogic, between 2009 and October of 2015, oil and gas related MLPs "raised more than \$100 billion from initial public offerings and follow-on stock sales." Dan Strumpf & Corrie Driebusch, *Once Hot, Master Limited Partnerships Reel From Sharp Selloff*, WALL ST. J. (Oct. 18, 2015), www.wsj.com/articles/once-hot-master-limited-partnerships-reel-from-sharp-selloff-1445190859.