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Managing Unconventional Oil and Gas Development as if Communities Mattered

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MANAGING UNCONVENTIONAL OIL AND GAS DEVELOPMENT AS IF COMMUNITIES MATTERED

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> The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. . . . As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people.
>
> —Pennsylvania Constitution, article I, section 27[1]

ABSTRACT

The advent of horizontal oil and gas drilling into relatively impermeable shale rock, and the companion technological breakthrough of high-pressure, multi-stage fracking that frees hydrocarbons along the substantial length of these horizontal wells, has fundamentally altered the oil and gas industry. The Energy Information Administration has gone so far as to predict that North America could become a net energy exporter as early as 2019, largely as a result of the explosive growth of this "unconventional" oil and gas development.[2] *Despite its promise, managing unconventional oil and gas development has proved challenging, and many of the communities that find themselves hosting this development have begun to push back in the face of serious public health and community impact concerns. Some communities have gone so far as to enact complete bans on "fracking," the shorthand way that unconventional development is often described. Yet notwithstanding many legitimate concerns, the flexibility made possible by drilling wells horizontally two, three, and even five miles in length provides an opportunity to manage unconventional oil and gas development in a manner that greatly reduces health and environmental impacts.*

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1. PA. CONST. art. 1, § 27. In *Robinson Township* v. *Commonwealth*, 83 A.3d 901, 951 n.39 (Pa. 2013), the Supreme Court of Pennsylvania found this provision to be self-executing, creating "a constitutional right personal to each citizen" that is enforceable by the courts.

2. U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2015 WITH PROJECTIONS TO 2040, at 18 (2015), http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf [hereinafter ANNUAL ENERGY OUTLOOK 2015]. The United States will likely become a net energy exporter if the price of oil remains high. *Id.* At lower prices, more domestic oil will be consumed and less will be produced. *Id.*

Efforts to impose proactive management regimes that would effectively address these adverse impacts have thus far proved elusive. Effective management was especially challenging when the prices for oil and gas were high and developers rushed to cash in. But as the price of these commodities collapsed, and as development has waned, an opportunity has emerged to forge a new dialogue over a smarter approach to unconventional oil and gas development that might be deployed when the inevitable boom mentality returns. A smarter approach recognizes that the flexibility afforded by horizontal drilling can minimize the adverse impacts of development even while making development more efficient.

Many in the industry will likely resist a system that requires a far more substantial role for regulatory agencies, especially during the planning phase of development. But once the affected parties understand that oil and gas development can be carried out in a manner that is both efficient and compatible with community health and values, then the prospects for a productive relationship should brighten. Let the hard work of building that relationship begin.

INTRODUCTION

Over the past decade, unconventional oil and gas plays have revolutionized the domestic oil and gas industry. Oil and gas are, of course, finite natural resources. They can be developed only so long as they can feasibly and economically be extracted from the ground. Not so long ago, many experts predicted that the world had reached or would soon reach peak oil—the point where humans had used more than half of the recoverable hydrocarbon resources. Further development would presumably occur under the cloud of mining an ever diminishing resource that was more difficult and expensive to access. While a few naysayers remain, talk of peak oil seems to have largely gone away.[3] This change in perspective about oil and gas resources has come about almost entirely because of the evolution of horizontal drilling and the recognition that such drilling when combined with fracking of low permeability rocks, especially shale rock, can yield commercial quantities of oil and gas at a reasonable cost. Suddenly, the development of hydrocarbon resources that had seemed so implausible only a few years earlier became accessible, and before long these "unconventional" oil and gas resources proved to be lucrative new sources of oil and gas.

But with the new technologies and the resulting rush to develop unconventional resources have come a new series of environmental challenges that have yet to be resolved. With horizontal drilling comes high-pressure hydraulic fracturing, or "fracking". And developing these fracked wells presents a range of environmental problems that, in many cases, go well beyond the problems associated with conventional oil and gas development. Although fracking itself has been around for more than half a century, fracking a horizontal well that might be two or three miles long in a lateral direction requires the use of significant quantities of fracking fluids at extremely high pressures—far more water introduced at far higher pressures than are used to frack a conventional well. These big frack jobs typically require multiple pump trucks to create the pressure, and hundreds of water tanker trucks to deliver the fracking fluids. A substantial portion of that fracking water will return to the surface as "flowback,"[4] accompanied by many new contaminants including volatile organic compounds.[5] This

3. *See* Robert J. Samuelson, Opinion, *The Retreat of 'Peak Oil'*, WASH. POST (June 14, 2015), https://www.washingtonpost.com/opinions/the-retreat-of-peakoil/2015/06/14/76a24ae4-1124-11e5-9726-49d6fa26a8c6_story.html (commenting on the economics of price and demand in the oil market).

4. *See* U.S. ENVTL. PROT. AGENCY, DRAFT PLAN TO STUDY THE POTENTIAL IMPACTS OF HYDRAULIC FRACTURING ON DRINKING WATER RESOURCES 36 (2011), http://yosemite.epa.gov/sab/sabproduct.nsf/0/D3483AB445AE61418525775900603E79/$File/Draft+Plan+to+Study+the+Potential+Impacts+of+Hydraulic+Fracturing+on+Drinking+Water+Resources-February+2011.pdf [hereinafter DRAFT PLAN] (stating that while the amount of flowback depends on the shale formation, the percent of flowback ranges from a low of 25% to a high of 75%); *see also* Kevin J. Garber et al., *Water Sourcing and Wastewater Disposal for Marcellus Shale Development in Pennsylvania*, 32 ENERGY & MIN. L. INST. 340, 344 (2011) (noting that flowback in the Marcellus Shale tends to be lower at about 10–30%).

5. DRAFT PLAN, *supra* note 4, at 36.

flowback must be carefully managed to minimize the risk to humans and wildlife from water and air pollution.

Notwithstanding the many new problems often attending horizontal drilling, there is a silver lining because unconventional development actually offers many potential advantages in terms of minimizing environmental impacts. These advantages and the means for realizing them are described in conjunction with an assessment of the environmental problems in Part III of this Article.

Beyond well development itself, much infrastructure is needed to support unconventional oil and gas development, including, for example, compressor stations for natural gas, storage tanks to hold the recovered resources, and gathering lines and pipelines for transporting them to market. All of these facilities pose their own environmental challenges, especially for protecting air quality and the health of people who live, learn, and work near oil and gas development.

To be sure, many of these problems exist with conventional oil and gas development. But the breakneck pace of unconventional development in some parts of the country, and the special problems that such development poses, have so exacerbated the environmental risks and so inflamed some communities that they are increasingly drawn to efforts to enact outright bans of oil and gas development, or its chief surrogate—fracking.[6]

This Article is offered to engage policymakers, community leaders, and the oil and gas industry on ways to retool unconventional oil and gas development to better protect communities and oil and gas workers, even while promoting the efficient development of oil and gas. It begins with a description of unconventional oil and gas development and the technologies that have evolved to support it. This is followed by a lengthy discussion of the environmental problems associated with that development. Even as the environmental costs are considered, however, the Article acknowledges the substantial opportunities that unconventional development offers for more sensible and cost-effective production of oil and gas resources. In addressing these costs and in laying out the opportunities, the focus is on better planning, and the need for regulators to become more proactive in their approach to regulating oil and gas development.

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6. *See, e.g.*, Aleem Maqbool, *The Texas Town that Banned Fracking (and Lost)*, BBC NEWS (June 16, 2015), http://www.bbc.com/news/world-us-canada-33140732 (describing the fight in Denton, Texas to ban fracking); *see also* Karen Antonacci, *Longmont's Fracking Ban Due Before State Supreme Court*, BOULDER DAILY CAMERA (Dec. 5, 2015), http://www.dailycamera.com/news/boulder/ci_29207184/longmonts-fracking-ban-due-before-state-supreme-court (discussing legal challenges to Longmont, Colorado's voter-approved ban on hydraulic fracturing).

Four particular categories of impacts are addressed: (1) surface impacts; (2) impacts on water resources; (3) air quality impacts; and (4) community impacts. In the course of laying out these impacts, this Article proposes various strategies for responding to them with a particular focus on the necessity of good planning. The Article concludes with additional recommendations for designing an effective and adaptive regulatory program for unconventional oil and gas resource development.

I. THE EVOLUTION OF UNCONVENTIONAL OIL AND GAS DEVELOPMENT

In order to understand how unconventional oil and gas development evolved, and why it has achieved such explosive growth, one must first understand the geology associated with unconventional hydrocarbon formations. Understanding its evolution also requires some familiarity with the technological innovations that have made the unconventional oil and gas boom possible. This Part addresses those issues and helps to explain why the conflicts surrounding unconventional oil and gas development are likely to be relevant for the foreseeable future.

A. Unconventional Hydrocarbon Deposits

Conventional oil and natural gas deposits occur in underground reservoirs that are both porous, meaning capable of holding substantial liquids or gases, and permeable, meaning capable of transmitting the liquids or gases through the formation. By contrast, unconventional sources are porous but not permeable. They can hold the hydrocarbons, but because they are impermeable, they cannot, in their natural condition, efficiently transmit hydrocarbons through the well to the surface. Historically, the low permeability of unconventional oil and gas formations led many in the oil and gas industry to conclude that unconventional resources were simply too costly to develop. That all changed with the advent of horizontal drilling and high-pressure hydraulic fracturing or fracking.[7]

Most of the discussion about unconventional oil and gas development today focuses on shale deposits, but the term "unconventional development" encompasses several other types of low-permeability formations including, most notably, tight sands and coal bed methane (CBM). The *Oil and Gas*

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7. *See* MICHAEL RAINER & MARY TIEMANN, CONG. RESEARCH SERV., R43148, AN OVERVIEW OF UNCONVENTIONAL OIL AND NATURAL GAS: RESOURCES & FEDERAL ACTION 1 (2015), https://www.fas.org/sgp/crs/misc/R43148.pdf (describing the advance in hydraulic fracturing technology in the oil and gas industry).

Journal describes tight sands as "low-permeability sandstone reservoirs that produce primarily dry natural gas."[8] Like shale deposits, tight sands are typically developed through horizontal drilling and fracking. Tight sands are a substantial gas play currently producing about 25% of the total domestic gas supply.[9]

Coal bed methane was historically viewed as a nuisance gas, posing particular risks to underground coal miners. Over the last several decades however, developers have recognized that many coal seams hold enough methane to support commercial production. While drilling techniques for CBM wells are constantly evolving, most CBM development involves relatively shallow vertical wells using much lower pressures for fracking than is necessary for shale rock. National CBM production peaked in 2008 and has been gradually declining since then, although it still contributes about 9% of the domestic natural gas supply.[10]

Most of the discussion about unconventional oil and gas development today focuses on shale formations. Shale gas production has grown rapidly from just 2% of the market in 2001 to about 25% today.[11] As Figure 1 below suggests, shale gas production remains on a rapid upward trajectory and is projected to capture nearly half of the domestic natural gas market by 2035.

Perhaps as importantly, shale and other tight formations are an increasingly important source of domestic oil. The Energy Information Administration (EIA) recently estimated that about 4.2 million barrels per day of crude oil were produced domestically from tight oil resources in 2014,[12] comprising approximately 49% of United States oil production.[13] The slump in oil prices that began in the middle of 2015 has slowed new development and a rebound in price may be necessary if these production

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8. Dave Summers, *The Differences in Fracking Tight Sand and Shales*, OILPRICE.COM (Aug. 6, 2014), http://oilprice.com/Energy/Natural-Gas/The-Differences-In-Fracking-Tight-Sand-And-Shales.html. Tight sands may also be a significant source of oil although the sandstone formations that hold these deposits are often discussed interchangeably with shale oil formations. *See* Deborah Gordon, *Understanding Unconventional Oil*, CARNEGIE PAPERS, May 2012, at 10, 11, http://carnegieendowment.org/files/unconventional_oil.pdf (referring to sandstone formations as tight shale oil).

9. Summers, *supra* note 8.

10. *See Natural Gas: U.S. Coalbed Methane Production*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/dnav/ng/hist/rngr52nus_1a.htm (depicting the 2008 peak and subsequent decline in CBM production).

11. U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2012 WITH PROJECTIONS TO 2035, at 93 (2012), http://www.eia.gov/forecasts/archive/aeo12/pdf/0383(2012).pdf.

12. *Frequently Asked Questions: Does EIA Have Data on Shale (or Tight) Oil Production?*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/tools/faqs/faq.cfm?id=847&t=6 (last updated Apr. 30, 2015).

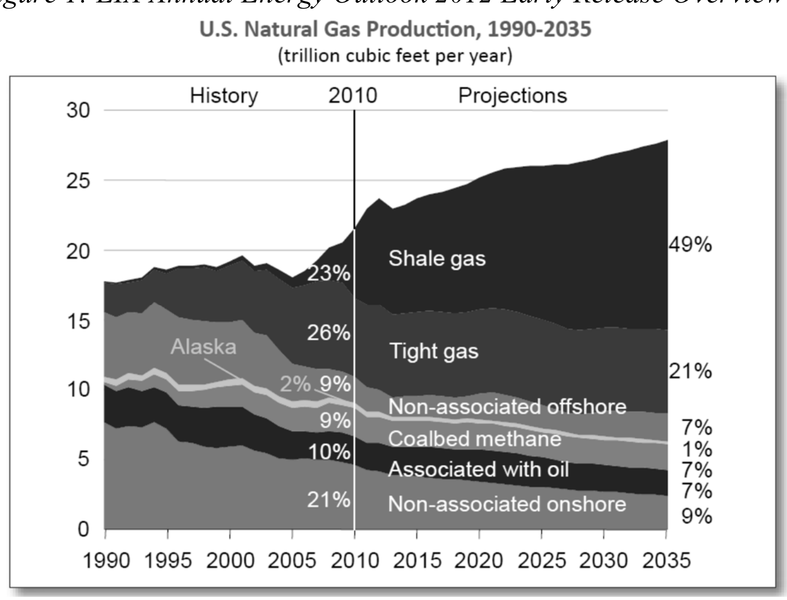
13. *Id.*

trends are going to continue.[14] Nonetheless, the prospects for new oil and gas production had brightened sufficiently to lead the International Energy Agency to proclaim in 2012 that:

> A renaissance of the US energy sector is reshaping the world's energy landscape, with far-reaching implications. The United States currently relies on imports for around 20% of its primary energy demand, but rising production of oil, shale gas and bioenergy means that it becomes all but self-sufficient in net-terms by 2035.[15]

This remarkable transformation of the American oil and gas industry was possible only because of the technological innovations that grew out of a successful partnership between that industry and the federal government. That is the subject of the next Part of this Article.

Figure 1: EIA Annual Energy Outlook 2012 Early Release Overview[16]



14. ANNUAL ENERGY OUTLOOK 2015, *supra* note 2, at 17–20.

15. INT'L ENERGY AGENCY, WORLD ENERGY OUTLOOK 2012, at 49 (2012), http://www.iea.org/publications/freepublications/publication/WEO2012_free.pdf.

16. U.S. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2012: EARLY RELEASE OVERVIEW 1 (2012), http://www.eia.gov/forecasts/archive/aeo12/er/pdf/0383er(2012).pdf.

B. The Role of Technology Innovations in Unconventional Oil and Gas Development

While debate over fracking has garnered most of the public's attention, fracking itself is not new, and has been around since the 1940s.[17] The real innovation that made the boom in unconventional development possible was horizontal drilling, and that innovation came about as the result of a remarkable partnership between the federal government and private industry. The story of this successful partnership is nicely explained in a report issued in 2012 by the Breakthrough Institute.[18] It is a story about federal funding of energy research centers and labs that worked collaboratively with industry partners to carry out demonstration projects and pioneer the development of new technologies. These included diamond-tipped drill bits that are hard enough to drill through rock and sophisticated enough to turn a full 90° even while deep underground, and microseismic imaging techniques that are essential to the efficient mapping of the geologic formations that hold hydrocarbon resources. Government research and development support was also critical to the further development of multi-stage hydraulic fracturing techniques. Due to the length of the horizontal well bore, a well cannot generally be fracked all at once, and research was crucial in assisting the industry to understand how to frack a well in sections beginning with the section farthest from the well pad. All of these innovations have contributed immeasurably to the success of horizontal wells.

But why was horizontal drilling so important? Unlike vertical drilling or even directional drilling, horizontal drilling allows a developer to access a hydrocarbon formation over a lateral length of several miles or more.[19] This offers huge advantages in terms of resource recovery. Since many shale formations are relatively uniform over a large geographic area, a horizontal well enables developers to recover hydrocarbons along the multiple horizontal lines going off in many different directions from a single well pad, rather than along a single vertical line. This is important because a good

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17. *See* Carl T. Montgomery & Michael B. Smith, *Hydraulic Fracturing: History of an Enduring Technology*, J. PETROLEUM TECH., Dec. 2010, at 26–27, http://www.ourenergypolicy.org/wp-content/uploads/2013/07/Hydraulic.pdf (stating that fracturing can be traced to the 1860s with its formal introduction into commercial use in the late 1940s).

18. ALEX TREMBATH ET AL., BREAKTHROUGH INST., WHERE THE SHALE GAS REVOLUTION CAME FROM: GOVERNMENT'S ROLE IN THE DEVELOPMENT OF HYDRAULIC FRACTURING IN SHALE (2012), http://thebreakthrough.org/blog/Where_the_Shale_Gas_Revolution_Came_From.pdf.

19. A company called Reelwell is developing a technology that could extend the reach of horizontal wells out 20 km or more. *Extended Reach Drilling*, REELWELL, http://www.reelwell.no/Extended-Reach-Drilling (last visited Apr. 11, 2016).

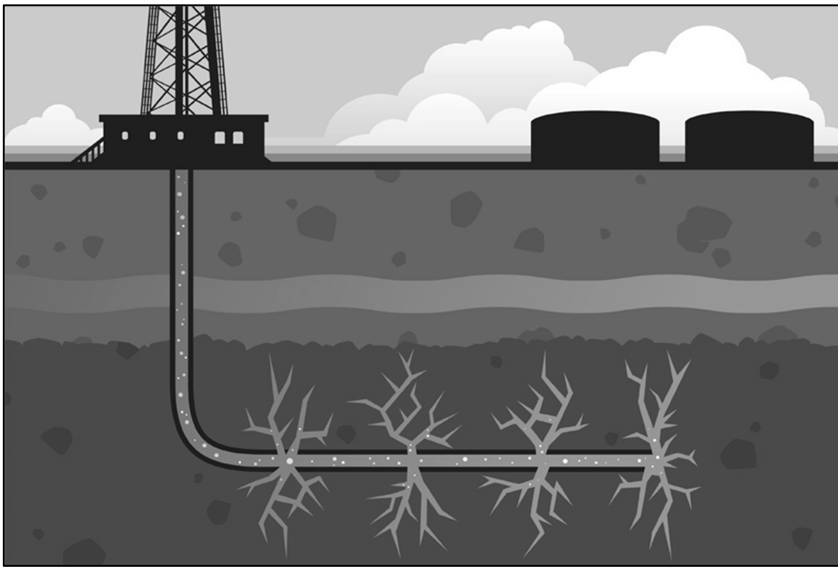
recovery from shale rocks with low permeability likely requires access to a substantial amount of the shale formation.[20] Moreover, once the developer understands the geology of a formation and its hydrocarbon content, the risk that the developer will hit a dry well, as with conventional vertical drilling, essentially goes away since the horizontal well developer is not trying to find a permeable sweet spot in the formation.

Once the horizontal well is drilled, the operator must still frack the well, which involves shooting small holes in the well pipe and then forcing fracking fluid into the bore hole at tremendous pressures. The fluid is forced through the holes in the pipe and then cracks the shale rock, thereby opening pathways that allow the hydrocarbons to move through the well and to the surface. The frack fluid consists primarily of water, but also contains a range of chemicals that vary depending largely on the frack operator. It also contains "proppants,"[21] which are designed to lodge in the cracks created by the frack so that the pathways remain open. Fracking is most easily understood by seeing it portrayed graphically as in Figure 2.

20. Les Bennett et al., *The Source for Hydraulic Fracture Characterization*, OILFIELD REV., Winter 2005/2006, at 42, 44–46. A horizontal well is fundamentally different than a vertical well, which typically seeks to recover oil and gas from a high-permeability formation, often from an anomaly identified through seismic or other techniques in the rock. *Id.*

21. Proppants are often just sand particles, sometimes coated, but they can also include man-made ceramic materials. *Critical Proppant Selection Factors*, HEXION FRACLINE, http://www.hexionfracline.com/critical-proppant-selection-factors (last visited Apr. 11, 2016).

Figure 2: Basic Fracking Diagram[22]



II. THE ENVIRONMENTAL COSTS AND OPPORTUNITIES ASSOCIATED WITH UNCONVENTIONAL OIL AND GAS DEVELOPMENT

Large-scale oil and gas development imposes significant environmental costs. Such costs are not limited to unconventional oil and gas development, but unconventional development poses unique challenges. Serendipitously however, unconventional development also offers significant opportunities to minimize impacts, especially on the human environment.[23] What follows is a review of the environmental costs and opportunities presented by unconventional development. Central to this discussion is a story about how poor planning has exacerbated the environmental problems associated with oil and gas development, and how careful, well-conceived planning can be used to minimize those problems and bring communities together.

22. *NIOSH Reports on Worker Exposure to Crystalline Silica During Hydraulic Fracturing*, INDUS. SAFETY & HYGIENE NEWS (July 16, 2014), http://www.ishn.com/articles/99074-niosh-reports-on-worker-exposure-to-crystalline-silica-during-hydraulic-fracturing.

23. U.S. DEP'T OF ENERGY, ENVIRONMENTAL IMPACTS OF NATURAL GAS DEVELOPMENT AND PRODUCTION 1 (2014). This is not meant to diminish the potentially important adverse impacts on landscapes and ecological resources, including wildlife habitat. These issues, however, are not the focus of this Article.

A. Surface Impacts and the Role of Planning

The surface impacts associated with a single oil and gas well are generally modest. Significant impacts result largely from the cumulative impacts associated with multiple wells, and with multiple wells comes the obvious challenge of managing development efficiently.

One of the key strategies for promoting the efficient development of conventional resources is "unitization," which is compulsory in every major producing state except Pennsylvania and Texas.[24] Unitization involves the consolidation of mineral interests for the purpose of maximizing the efficient production of the shared resource.[25] Unitization typically requires a developer to submit a plan to the appropriate state agency, which can then force minority interests in a shared hydrocarbon pool to participate in the unit.[26] Unitization promotes the efficient development of oil and gas resources by incentivizing the developer to locate and space a limited number of wells in a manner that optimizes resource recovery.[27]

Unconventional development differs from conventional development in that the oil and gas resource is captured not from a common pool but rather by fracturing the impermeable shale bed that holds the hydrocarbon resource. Conventional unitization is thus unnecessary because there is no risk that a developer is going to drain the resource under the surface owned by another landowner. The resource cannot be drained until it is fracked. But unitization-type principles might still be helpful for developing unconventional oil and gas in two ways. First, where a developer wants to develop oil and gas along a lengthy lateral well, she must generally acquire the property rights along the entire length of the well. If one or more surface owners hold out, development can be stymied. Forcing minority property owners to participate through a unitization-type program could promote efficient development of the resource.

Second, and more importantly, the ability to drill a well two or more miles horizontally into a formation provides the developer and regulatory

24. Bruce M. Kramer, *Unitization: A Partial Solution to the Issues Raised by Horizontal Well Development in Shale Plays*, 68 ARK. L. REV. 295, 301 (2015); *see also* PATRICK H. MARTIN & BRUCE M. KRAMER, CASES AND MATERIALS ON THE LAW OF OIL AND GAS 877 (9th ed. 2011) (noting that only Texas does not enable a state agency to adopt unitization measures). Both Pennsylvania and Texas, however, support compulsory pooling, which differs from compulsory unitization in that it tends to involve the pooling of property interests only insofar as is necessary to meet state requirements for obtaining a well permit such as well spacing. *Id.* at 879. Compulsory pooling generally occurs following the application of an interested party whereas unitization is usually initiated by the state oil and gas agency for purposes of promoting efficient development and avoiding waste. *Id.* at 877.

25. *Id.*

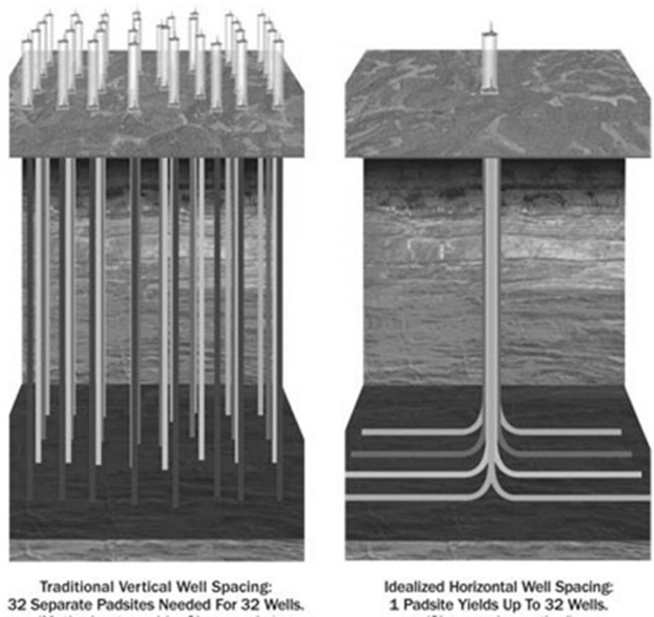
26. *Id.*

27. *Id.*

agencies with tremendous flexibility as to where to site well pads for purposes of optimizing recovery of the resource and protection of the community and the local environment. Unlike conventional development, the siting of the well pad from the perspective of efficient development of the resource is probably less important than for conventional wells subject to unitization, since unconventional development generally occurs in relatively uniform formations that extend for miles in every direction. The siting of well pads might therefore be better conceived as a joint exercise among the community, the regulatory agency, and the developer. A limited number of well pad sites might be approved for development, subject to the approval of a development plan that maximizes resource recovery from individual pads even while minimizing environmental and community impacts.

The best way to appreciate the advantages that might be realized from planned development of unconventional oil and gas is to describe it visually. The left side of Figure 3 illustrates conventional development with vertical wells. It is not hard to see the significant impacts to the surface that result from full-field development of a conventional oil and gas field. The right side of the diagram shows how surface impacts in an unconventional play can be greatly minimized by drilling multiple wells from a single pad in many different directions. Since horizontal wells often extend two miles or more, unconventional development offers the potential for developing oil and gas throughout a large circular area with a diameter of four miles or more. Not only does this mean far fewer surface impacts, it greatly enhances the potential to site the well pad in a location that is remote from homes, schools, and other inhabited structures, thereby reducing adverse human health impacts from air pollution. While the final site location may not be the first choice for the oil and gas company, the good will generated by engaging and working with local communities to find a location that best serves both the needs of the community and the developer should more than compensate for the modest oil and gas production restraints that such negotiations might cause.

Figure 3: Horizontal Fracking Allows for Fewer Wellheads[28]



Multiple-well development from a single pad will also yield development efficiencies by allowing operators to consolidate infrastructure needs around a single site. A single power line can be brought to the site to meet electric power needs, but given the significant power requirements to drill, frack, and develop multiple wells, the potential for using a small natural gas generator, possibly with methane produced on-site, might eliminate the need for a power line altogether. Greater efficiencies for capturing and transporting methane can also be achieved at a multiple-well site, thereby making it more cost-effective to transport the gas to gathering lines and pipelines.

Efficient management of water needs is likewise enhanced when multiple wells are drilled from a single pad. A large frack of a horizontal well can require more than five million gallons of water, which translates to about 800 tanker trucks full of water.[29] Careful planning at a multiple-well pad

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28. *Ohio Shale Plays*, OHIO OIL & GAS ASS'N, http://www.ooga.org/?page=OhioShalePlays (last visited Apr. 12, 2016).

29. L. Poe Leggette et al., *Federal Regulation of Hydraulic Fracturing: A Conversational Introduction*, 33 ENERGY & MIN. L. INST. 797, 818–19 (2012) (noting that the average horizontal frack job in the Marcellus formation requires from three to six million gallons of water); *see also FAQs: Hydraulic Fracturing ("Fracking")–How Much Water Does the Typical Hydraulically Fractured Well*

could allow for the more efficient treatment, recycling, and reuse of flowback[30] from the well for future fracks, which could significantly reduce necessary truck trips. Fresh water supply trucks might even be eliminated altogether by installing a pipeline to the well pad, something that might not be practical for a single well, or even for a well pad with just a handful of wells. The massive pump trucks designed to generate the pressure necessary to carry out frack jobs might also be replaced with on-site pumping stations.

After fracking, much of the injected fluids may return to the surface as flowback. While the amount varies with the type of formation and other geologic conditions, managing that wastewater presents another significant challenge.[31] In addition to some toxic constituents of the frack fluid itself, flowback returns to the surface with toxic organic compounds, heavy metals, and other toxic substances that it picks up from inside the fracked formation. Once again, a multiple-well pad development plan could prove advantageous. Since each frack of a well at a multiple-well pad requires significant quantities of water, a sophisticated system for treating, recycling, and storing flowback in closed storage tanks until it is needed for future fracks could help address a myriad of problems associated with open waste pits, such as volatile organic compound (VOC) emissions and the risks to birds and other wildlife that might come in contact with the water. Moreover, recycling the flowback means that less water will be needed for future fracks, thereby minimizing the impact on local water supplies and reducing the number of trucks needed to transport water to and from the site.

A final benefit that might result from promoting multiple wells on a single well pad is the efficient management of workers. Housing workers on site might look far more attractive when housing units can remain on the job

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Require?, U.S. GEOLOGICAL SURV., http://www.usgs.gov/faq/categories/10132/3824 (last updated Feb. 24, 2016) (citing water uses ranging from 1.5 million gallons in the Bakken Formation to 15.8 million gallons in the Horn Rover Shale formation in British Columbia).

30. Garber et al., *supra* note 4, at 348.

31. *Id.* at 344 ("Anywhere from 10-30 percent of hydraulic fracturing fluid used in fracking Marcellus wells is brought back to the surface after fracking."); *see also* U.S. GEOLOGICAL SURV., A FRAMEWORK FOR ASSESSING WATER & PROPPANT USE & FLOWBACK WATER EXTRACTION ASSOCIATED WITH DEVELOPMENT OF CONTINUOUS PETROLEUM RESOURCES (2014), http://pubs.usgs.gov/fs/2014/3010/pdf/fs2014-3010.pdf ("Estimates of the proportion of hydraulic fracturing water that emerges as flowback water range from 5 to 40 percent of the injected volume."); GROUND WATER PROT. COUNCIL & ALL CONSULTING, NAT'L ENERGY TECH. LAB., U.S. DEP'T OF ENERGY, MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES: A PRIMER 66 (2009), http://energy.gov/sites/prod/files/2013/03/f0/ShaleGasPrimer_Online_4-2009.pdf ("In various basins and shale gas plays, the volume of produced water may account for less than 30% to more than 70% of the original fracture fluid volume.").

site for extended periods of time, and this might allow for a significant reduction in small truck traffic to and from the worksite.[32]

1. A Planning Protocol

Maximizing the efficiency potential of multiple well pads will, of course, require good planning. Ideally, such planning should evolve as a joint exercise between the developer, the regulatory agency, and the community, but the agency will likely have to establish a mandatory planning protocol to be followed before permit applications for new operations will be considered for approval. The process should begin with the prospective developer's assessment of the resource, which should be prepared without regard to property ownership issues.[33] The assessment should answer questions about the geology and development potential of the relevant shale bed or beds, the

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32. Oil and gas companies have begun to recognize the potential advantages of multiple-well development from a single pad. *Multi-Well Pads Are the Norm*, DEVON, http://www.devonenergy.com/featured-stories/multi-well-pads-are-the-norm (last visited May 15, 2016). Consider, for example, this remarkable list compiled by Devon Energy of the perceived advantages of multiple-well development:

> Placing several wells on one site reduces the company's impact on developable land. This is especially important in populated areas.
>
> Well pads generally are similar in size whether they contain one wellhead or a half-dozen, so placing multiple wells on the same pad can dramatically minimize surface disturbance.
>
> This process further reduces surface disturbance by eliminating the need for additional lease roads. This, in turn, decreases the company's road construction costs.
>
> Multi-well pads are far more efficient, because once a well is drilled, the rig moves only 20 feet or so to drill the next one. This also reduces truck traffic, which benefits our neighbors.
>
> In rural areas, Devon can be more flexible about where to place its wells. This gives landowners more input on both the placement of the wells and the construction of the road leading to those wells.
>
> Within an incorporated area, a multi-well pad reduces the uncertainty involved with the permit process. Most cities and towns require a permit for each new well. If five wells are to be placed on the same pad, the chances are greater that each of those five permits will be approved.
>
> Devon can more efficiently produce natural gas from a chosen reservoir by drilling horizontal wells in close proximity to each other.
>
> Devon often can reduce the number of storage tanks and liquid separators by consolidating the operations of several wells onto one pad. This further decreases the company's surface disturbance while reducing operating expenses.
>
> Multi-well pads allow Devon's lease operators to better manage the wells assigned to them while cutting their driving time.

Id.

33. The first developer may lack access to proprietary information held by a competitor, but the regulatory agency could insist—as a condition of the competitor's own right to develop—that sufficient information be shared with the initial developer to allow a robust analysis to go forward.

extent of this potential, and any faults or anomalies that may present development challenges. Although much of this information is likely available from the United States Geological Survey and relevant state agencies, and should therefore be made available to the public, information that is properly deemed proprietary might be withheld. The information that is available to the public should be included on an agency website with a clear message welcoming public comments and feedback at any time during the process for deciding whether to approve one or more drilling permits.

The assessment should be followed by the developer's proposed development plan. In accordance with a published agency policy, that plan should be designed to maximize recovery of the resource while minimizing the impact on local communities and protecting the ecological health of the affected area. The plan should include information about all infrastructure necessary to support development with a tentative plan describing the location of relevant support facilities.

Once a complete development plan has been submitted, the regulatory agency should begin the process of assessing the environmental impacts. Such assessments are, of course, required where major federal agency action or action with a federal handle is involved, such as approving applications for a permit to drill on public lands, but they should be required universally by all regulatory agencies involved in approving oil and gas development. By following such a process, the action agency will be in the position to describe the potential adverse environmental and community impacts from oil and gas development, possible cumulative impacts associated with development, alternative development plans and strategies, and issues about where to site well pads and facilities, including questions about appropriate setbacks from occupied buildings and public facilities. As importantly, the regulatory agency will also have a vehicle for engaging the public on the best ways to proceed with development if at all.

The environmental impact assessment (EIA) process should also engage the affected public regarding the timing and scope of development. While oil and gas developers may want to move as quickly as possible to develop their resources and move on to their next project, that may not be the best strategy from the perspective of the community or the environment.

Phased development that limits the amount of development over time might be better suited to controlling the adverse impacts associated with oil and gas projects. Phased development can reduce the amount and intensity of truck traffic, noise, and pollution, and can make it easier to manage ground and surface water resources that are impacted by development as well as frack water and flowback. Also, phased development means that an adaptive management scheme, whereby adjustments can be made to regulatory controls as more is learned about the impacts of development, will have a chance to work. While applying phased development at a single site or even across an entire state might not have much impact on the overall supply of oil and gas resources, broad agreement about applying such a strategy across an entire region could help avoid the risks associated with oversupply and the boom-and-bust cycles they create.[34]

Ideally, the EIA process will lead to a robust public dialogue and ultimately, to a revised development plan that addresses in a meaningful and appropriate way the problems raised during the environmental assessment phase. Among the challenges posed by the EIA process will be addressing the cumulative impacts of all past, present, and reasonably foreseeable future development, including but not limited to oil and gas development.[35] Likewise, an assessment of all reasonable alternatives to the proposed development project will have to be considered. This will likely be the place where alternative well pad numbers and sites are considered.[36] To help ensure that the EIA process is run efficiently, that the public can be effectively engaged, that the burdens on agency resources are minimized, and that a

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34. Such an agreement would not be unprecedented, and state laws that promote market demand management have been upheld by the United States Supreme Court. For example, in *Champlin Refining Co. v. Corporation Commission of Oklahoma*, 286 U.S. 210 (1932), the Court considered a challenge to a 1915 Oklahoma statute that prohibited the production of oil and gas in a manner that constituted waste. "Waste" was specifically defined to encompass, among other things, production in excess of reasonable market demand. *Id.* at 226. The plaintiffs challenged various "proration" orders issued by the state that limited production at certain wells to a percentage of their total capacity. *Id.* at 228–30. The Court upheld the orders, finding that they were neither arbitrary nor discriminatory, and that they were appropriate to prevent waste as defined under Oklahoma law. *Id.* at 236. Following the Court's decision in *Champlin Refining Co.*, Kansas, New Mexico, Oklahoma, and Texas came together to approve the Interstate Compact to Conserve Oil and Gas with the stated purpose of conserving oil and gas and preventing physical waste. *See, e.g.*, TEX. NAT. RES. CODE ANN. § 90.007, art. I (1977); s*ee also* H.R. J. Res. 407, 74th Cong., 49 Stat. 939 (1935) (joint resolution providing Congress's consent to establish the Compact). Mindful of concerns that the Compact might be perceived as promoting price fixing, Article V expressly provides that "[i]t is not the purpose of this compact to authorize the States joining herein to limit the production of oil or gas for the purpose of stabilizing or fixing the price thereof . . . but [it] is limited to the purpose of conserving oil and gas and preventing the avoidable waste thereof within reasonable limitations." H.R. J. Res. 407, art. V. On the other hand, limiting production in excess of reasonable market demand, as was upheld in *Champlin Refining Co.*, would appear to be an appropriate goal of the Compact. Today, the Interstate Oil and Gas Compact Commission, which was established by the Compact to facilitate its implementation, includes 38 member or affiliate states and additional international and agency affiliates. *See Member States,* INTERSTATE OIL & GAS COMPACT COMM'N, http://iogcc.publishpath.com/memberstates/ (last visited May 15, 2016). Although it has not yet shown an inclination to do so, the Compact Commission could conceivably play a leadership role in addressing the market demand issues that currently face the oil and gas industry, and could promote strategies such as phased development as a tool for responding to the oversupply problem.

35. *See* 40 C.F.R. § 1508.7 (2015) (defining "cumulative impact" as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions . . .").

36. *Id.* § 1502.14.

decision is made in a timely fashion, the regulatory agency should emphasize maps and other visual aids that clearly depict where well pads are proposed for different alternatives, the location of structures used by people in relation to the proposed well pads, and any other geographic data that might be of interest to the public, the developers, or the decision makers.

Once these three steps in the planning protocol are completed—(1) resource assessment; (2) development planning; and (3) environmental and community impact analysis—the regulatory agency may approve the plan, but it must also be prepared to say no to the proposal unless it maximizes the efficient development of the resource, minimizes the impacts on the environment and the community, and avoids significant impacts entirely. Rejection of a plan need not be final. It might simply lead to some further refinement of the development plan with an appropriate level of public engagement. Moreover, no plan is perfect, but the unanticipated problems that will inevitably arise due to uncertainties and incomplete information can and should be addressed through a compulsory adaptive management program that allows for adjustments to reflect new information and changed conditions.

Of course, implementing some or all of these planning recommendations will require a fundamental change in the culture of both the companies that develop oil and gas resources and the agencies that regulate their activities. But that change can and should be understood for the simple, profound, and positive way that it should change the mindset of the key players. No longer will agencies be able to simply react to development proposals. Instead, they will play a proactive role, ensuring that development plans are designed not only to benefit the proponent of the plan, but also to best serve the interests of the public and the affected communities.

In 2008, Santa Fe County, New Mexico adopted an ordinance on oil and gas development that includes many of the planning ideas suggested here.[37] Before discussing the Santa Fe ordinance however, it bears acknowledging that the very fact of a detailed local ordinance regulating oil and gas is controversial because of the debate over a State's authority to preempt local regulation.[38] Suffice it to say that, in most states, local communities probably have some right to regulate oil and gas activities where that regulation is not inconsistent with State regulations. The scope of such authority, however, remains a subject of fierce debate and this debate has been playing out in

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37. Santa Fe, N.M., Ordinance 2008–19 (Oct. 12, 2008), http://www.santafecountynm.gov/userfiles/SFCOrdinance2008_19.pdf.

38. Keith B. Hall, *When Do State Oil and Gas or Mining Statues Preempt Local Regulations?*, 27 NAT. RESOURCES & ENV'T 13, 13 (2013).

various jurisdictions and contexts,[39] including in the context of outright fracking bans. The Santa Fe ordinance itself has been the subject of state legislative efforts to overturn it.[40] In any event, the issue of preemption is beyond the scope of this Article. The reason for discussing the Santa Fe ordinance is primarily to illustrate how some communities are beginning to think broadly about proactively managing oil and gas development.

The heart of the Santa Fe ordinance is section 9.6. That provision essentially sets out the process for developing oil and gas in Santa Fe County. It begins with the submission and approval of an application for an "Oil and Gas Overlay Zoning District Classification that is superimposed over . . . [existing] zoning districts . . . [and] that imposes specific requirements . . . for oil and gas projects."[41] That application must include a detailed description of the proposed development along with a comprehensive assessment of the potential impacts. Among other things, the ordinance requires a detailed description of:

(1) the approximate phases of oil and gas development;
(2) the approximate location of all structures within five miles of the site plan perimeter;
(3) the proposed traffic circulation plan, including number of daily and peak hour trips to and from the site;
(4) the approximate location of emergency services;
(5) the approximate location of sensitive areas such as wetlands and cultural resources.[42]

The ordinance also requires the following reports and assessments:

(1) Environmental Impact Report;
(2) Public Facilities and Services Assessment;
(3) Water Availability Report;
(4) Traffic Impact Assessment Report;
(5) Geohydrologic Report;
(6) Emergency Response and Preparedness Plan

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39. *See* David L. Schwan, *Preemption Update: Local Attempts to Preempt State Regulation of Hydraulic Fracturing*, Envtl., Mass Torts, & Prods. Liab. Litig. Comm. Joint CLE Seminar, ABA (Jan. 29–31, 2015), http://www.americanbar.org/content/dam/aba/administrative/litigation/materials/2015-joint-cle/written_materials/01_fracked_up_preemption_update.authcheckdam.pdf (summarizing recent cases surrounding city and state regulations on oil and gas exploration in Colorado, Pennsylvania, and New York).

40. *See* Staci Matlock, *Bill Limits Local Interference in Oil and Gas Production*, SANTA FE NEW MEXICAN (Feb. 18, 2015, 12:17 PM), http://www.santafenewmexican.com/news/legislature/bill-limits-local-interference-in-oil-and-gas-production/article_c24d8f0c-b7a2-11e4-8514-63e4010a52fc.html (discussing the passage of HB 366 in the State House; the bill did not ultimately become law).

41. Santa Fe, N.M., Ordinance 2008–19, § 7.

42. *Id.* § 9.6(2).

(7) Fiscal Impact Assessment.[43]

To be sure, all of the descriptions and assessments set forth in the ordinance could arguably be consolidated into the environmental impact report (EIR) required by the ordinance, and nothing in the ordinance seems to preclude this option. Perhaps that would make the EIR seem overwhelming, but for the average reviewer, it might be easier to tackle an umbrella EIR, with the other reports either incorporated into the EIR or included as appendices. Separating all of these documents out seems likely to lead to redundant descriptions and analyses.

The Santa Fe ordinance should go a long way toward providing the information necessary to develop the comprehensive planning advocated here. A good ordinance, of course, does not by itself ensure good planning, and it certainly does not ensure that a final plan will actually protect affected communities, or that decisions will be made only after those affected communities are provided a meaningful choice in charting their future. But a good ordinance does at least provide a framework that makes good decisions possible, and that is arguably what the Santa Fe ordinance has accomplished.

2. The Property Rights Challenge

One of the most significant challenges that agencies are likely to face as they push for better planning is the chaotic reality of mineral rights ownership in the United States. In virtually every other country around the world,[44] the state retains ownership of all mineral rights and thereby is in a strong position to dictate the timing and manner of their development. In the context of good planning for unconventional oil and gas development, private ownership of the mineral estate is more common in the United States than not, and those mineral rights, which are most often owned as part of the fee simple estate, encompass relatively small tracts of land. Thus, in order to develop the hydrocarbons found in a shale deposit along a two-mile long shale bed, the developer must acquire the mineral rights from the multiple owners who share in ownership. Now imagine that a state or local agency comes along and demands that the developer acquire the rights to multiple lines for multiple horizontal wells that can be developed from a single well pad. Not

43. *Id.* § 9.6(3).

44. *Mineral Rights Ownership – What Is It and Why Is It So Unique in the USA?,* INT'L ENERGY NETWORK, http://www.ieneurope.com/pdf/Mineral.pdf (last visited Feb. 28, 2016) ("In virtually all countries around the world, the owner of the surface land . . . has absolutely no rights with regards to mineral ownership. Indeed, it is the central governments or monarchs who own such rights . . . . In the USA, however, the owner of the surface land can ALSO have the rights to extract minerals from underneath that land.").

only is this going to be expensive—prohibitively so for many operators—but it is also likely to take a very long time. States with the temerity to impose such restrictions might soon find oil and gas developers pulling up stakes and moving to a jurisdiction with laws friendlier to the industry.[45]

This is a serious problem that cannot be easily dismissed. In some areas, such as where public land resources are proposed for development, the government's ownership of large tracts of lands and minerals will be sufficient to support good planning with minimal concerns about mixed property ownership. But in other parts of the country where land ownership patterns are far less homogeneous, demanding that a single operator acquire the property rights along a dozen or more horizontal lines may be unrealistic or impractical until states have developed creative new regulatory tools that can facilitate efficient and environmentally sound development.

As previously suggested, unitization principles might provide a model that could promote more efficient development of unconventional oil and gas resources. But the critical physical characteristic of conventional oil and gas resources that makes unitization—the ability of a well on one tract to drain the resources from an adjacent tract—a compelling necessity does not apply to unconventional resources. This fact, as well as efforts by states to recognize surface owners' rights in the pore space underlying their property,[46] could complicate efforts to streamline unconventional development.

More specifically, hard mandates that provide for compulsory sharing of unconventional resources would likely face legal and perhaps even constitutional objections.[47] Such concerns would not preclude efforts by agencies to work with oil and gas companies and community leaders to identify and allow development only from a limited number of well pad sites

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45. Some scholars have questioned whether the so-called "race to the bottom" fairly explains private behavior. *See, e.g.*, Richard L. Revesz & Robert Stavins, *Environmental Law and Policy* 57–59 (Nat'l Bureau of Econ. Research, Working Paper No. 13575, 2007), http://www.nber.org/papers/w13575. Revesz and Stavins, argue, for example, that "economic analysis of the effects of interstate competition on the choice of environmental standards indicates that rather than a race to the bottom, inter-jurisdictional competition may be expected to lead to the maximization of social welfare . . . ." *Id.* at 57. Still, it is not hard to imagine that local political leaders will resist fundamental changes in the structure of oil and gas regulation at least in part out of concern that it might scare away the industry. Public choice theory might predict corporate behavior that would further make such structural changes difficult to achieve.

46. *See, e.g.*, N.D. CENT. CODE § 47-31-03 (2015) ("Title to pore space in all strata underlying the surface of lands and waters is vested in the owner of the overlying surface estate."); WYO. STAT. ANN. § 34-1-152(a) (2015) ("The ownership of all pore space in all strata below the surface lands and waters of this state is declared to be vested in the several owners of the surface above the strata.").

47. Claims of private property rights in pore space have taken on increasing urgency in the debate over carbon sequestration of CO2; creating many legal issues of pore space ownership. Trae Gray, *A 2015 Analysis and Update on U.S. Pore Space Law—The Necessity of Proceeding Cautiously With Respect to the "Stick" Known as Pore Space*, 1 OIL & GAS, NAT. RESOURCES, & ENERGY J. 277, 280 (2015).

deemed suitable for development, but actual development along multiple horizontal wells will not solve the property-rights issues that developers will have to confront. Perhaps states or local governments could take a softer approach by developing incentives for parties to participate in development when operators share well pads and infrastructure. At a minimum, however, agencies can work with stakeholders and industry representatives through the EIA process to identify a limited number of well pad sites that are far away from people and that also offer the prospects for efficient development of the oil and gas resource. Once the industry understands where they can locate new wells, and that additional process in terms of the siting decision will not be needed, they will have a powerful incentive to acquire the relevant mineral rights and set forth development plans that are best suited to the identified well pad sites.

B. Managing Impacts to Surface and Groundwater Resources

Impacts on water resources from fracking and unconventional oil and gas development have garnered much attention. The issues are wide-ranging and include the impacts of water supplies, management of toxic pits, contamination of groundwater supplies, and the injection of wastewater into deep aquifers. While concerns about these impacts are certainly legitimate, they may be the easiest to address with good management practices. Water supply concerns will be especially important in the more arid parts of the western United States where water supplies are scarcer and where drought is a constant concern.[48] And while the quantities involved in fracking unconventional wells are relatively modest when compared with agricultural and municipal use,[49] the cumulative impacts from hundreds or thousands of wells can be significant.

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48. *See* DRAFT PLAN, *supra* note 4, at 19.

> EPA estimates that approximately 35,000 wells are fractured each year across the United States. Assuming that the majority of these wells are horizontal wells, the annual water requirement may range from 70 to 140 billion gallons. This is equivalent to the total amount of water used each year in roughly 40 to 80 cities with a population of 50,000 or about 1 to 2 cities of 2.5 million people.

Id.

49. *See Water Sources and Demand for the Hydraulic Fracturing of Oil and Gas Wells in Colorado from 2010 through 2015*, COLO. DIV. WATER RES., http://water.state.co.us/DWRIPub/CGWC%20Meetings%20and%20Process%20Documents/Oil%20and%20Gas%20Water%20Sources%20Fact%20Sheet%20-%20Final.pdf (last visited Apr. 7, 2016) (showing past fracturing water usage and usage projection in Colorado). The report found that hydraulic fracturing accounted for 13,900 acre-feet of water in Colorado in 2010, or about 0.08% of the total water demand for that year. *Id.*

Surface water management issues occur at both the drilling and fracking stages of development. The drilling phase produces drilling wastes that include brines and water. These are often stored in lined waste pits near the well site where they can cause ground water contamination (as a result of leaky lines) and wildlife injuries and deaths. "Pitless" or "closed-loop" systems for managing and treating spent drilling muds use closed tanks to hold and manage these wastes until they can be treated and or properly disposed.[50] Such systems may actually save money. One study that looked at several sites in New Mexico found that "eliminating pits is cost-effective and does not add significant cost to the overall operation. Furthermore, when solids must be transported for off-site disposal, eliminating the pit actually reduces costs."[51]

At the fracking stage, the concern relates largely to flowback. One simple solution is to insist that flowback water be treated and recycled for reuse in new frack jobs. Developers will still need to replenish the frack water that remains underground with new water supplies, but by recycling frack water, they can significantly reduce the amount of water needed.[52] Serendipitously, recycling and reusing flowback will also reduce and perhaps eliminate the need for wastewater pits, which pose risks for groundwater contamination and wildlife mortality. Recycling flowback will also conserve water resources, which is an important issue in some of the more arid regions where oil and gas is produced.

As suggested above, requiring oil and gas developers to drill multiple wells from a single pad can maximize economies of scale for managing wastes, making the process more cost effective. In the limited situations where developers still need surface pits, governments should enforce strict standards, such as double lining pits to prevent leaks into groundwater, rigorous monitoring, and leak detection systems. Strict monitoring and management of air emissions from the pits, and strategies that prevent wildlife access to pits must also be enforced. Indeed, strict standards for waste pits will help incentivize companies to shift to pitless systems to the fullest extent possible, which is plainly the preferable approach.

Pitless systems that promote treatment and reuse of wastewater can also greatly reduce the need to inject wastewater into deep aquifers. While the

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50. Dorsey Rogers et. al., *Closed-Loop Drilling System: A Viable Alternative to Reserve Waste Pits*, WORLD OIL, Dec. 2006, http://www.worldoil.com/magazine/2006/december-2006/features/closed-loop-drilling-system-a-viable-alternative-to-reserve-waste-pits.

51. *Id.*

52. Pam Boschee, *Produced and Flowback Water Recycling and Reuse: Economics, Limitations, and Technology*, OIL & GAS FACILITIES, Feb. 2014, at 16, 17.

Energy Policy Act of 2005 expressly exempts underground injections pursuant to fracking operations from the permit requirements of the Safe Drinking Water Act (SWDA),[53] this exemption does not extend to wastewater injections. Nonetheless, SWDA permits for wastewater injections focus on drinking water contamination,[54] and have not proved successful in addressing the earthquake risk that such injections may cause.[55] The more these injections can be reduced or eliminated the less likely that communities will face human-caused earthquakes and the consequent damage that can result.[56]

C. Managing Air Emissions and Air Quality

While water-related issues seem to draw more attention, air emissions from oil and gas development pose a far more serious threat to public health and the environment. While oil and gas development is responsible for a wide range of air pollutants,[57] most of the focus is on volatile organic compounds (VOCs), methane, and air toxics.

The United States oil and gas sector is the largest industrial source of VOCs in our environment.[58] VOCs mix with nitrous oxides and sunlight in the atmosphere to form ozone, which remains the most challenging criteria[59] air pollutant.[60] Ozone causes serious adverse health effects, especially to lung

53. In the Energy Policy Act of 2005, § 322, Pub. L. No. 109–58 (codified as amended at 42 U.S.C. § 15811–16538 (2012)), Congress amended the definition of "underground injection" in the Safe Drinking Water Act to exclude the injection of fluids or propping agents (other than diesel fuels) for fracking operations related to oil, gas, or geothermal production activities.

54. *See* 42 U.S.C. § 300h(b)(1)(B) (2012) (stating that if a project requires an underground injection permit, the applicant must show that the project will not endanger the underground drinking water supply).

55. Justin L. Rubinstein & Alireza Babaie Mahani, *Myths and Facts on Wastewater Injection, Hydraulic Fracturing, Enhanced Oil Recovery, and Induced Seismicity*, SEISMOLOGICAL RESEARCH LETTERS, July/Aug. 2015, at 2, https://profile.usgs.gov/myscience/upload_folder/ci2015Jun1012005755600Induced_EQs_Review.pdf.

56. *Id.* at 5–6.

57. *See Oil and Natural Gas Air Pollution Standards*, *Basic Information*, ENVT. PROTECTION AGENCY, http://www3.epa.gov/airquality/oilandgas/basic.html (last visited Feb. 29, 2016) (stating that the oil and gas industry is the largest industrial source of VOC emissions and also an emitter of air toxics such as benzene, ethylbenzene, and n-hexane).

58. *Id.*

59. "Criteria" pollutants are those that adversely affect public health or welfare and that result from "numerous or diverse . . . sources." Clean Air Act § 108(a), 42 U.S.C. § 7408(a) (2012). The EPA has listed six criteria pollutants: carbon monoxide, lead, nitrous oxides, ozone, particulate matter, and sulfur dioxide. 40 C.F.R. § 50 (2015).

60. *See* U.S. ENVTL. PROT. AGENCY, SUMMARY NONATTAINMENT AREA POPULATION EXPOSURE REPORT (2015), http://www3.epa.gov/airquality/greenbook/popexp.html (estimating that as of October 1, 2015, more than 122 million people were living in ozone nonattainment areas).

function, and it thus poses a particular risk for those with conditions that compromise breathing such as emphysema and asthma.[61]

The oil and gas sector is also one of the largest sources of methane in our environment, contributing 29% of anthropogenic emissions according to EPA estimates.[62] Methane is an especially potent greenhouse gas. Although it does not remain in the environment as long as carbon, it has approximately 28–36 times the impact of carbon dioxide over 100 years and approximately 84–87 times the impact of CO_2 over 20 years.[63]

Finally, and perhaps most seriously, the oil and gas sector is a significant source of air toxics such as benzene, toluene, ethylbenzene, and xylene (BTEX). These chemicals are byproducts of oil and gas production but they are also used by the industry as solvents during the production process.[64] A growing body of evidence points to serious health consequences for people living near oil and gas operations, most likely because of exposure to these toxic chemicals.[65] Much uncertainty remains and more studies are clearly

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61. *Ground-Level Ozone Health Effects*, ENVTL. PROTECTION AGENCY, http://www3.epa.gov/ozonepollution/health.html (last updated Oct. 1, 2015).

62. Oil and Natural Gas Sector: Emission Standards for New and Modified Sources, 80 Fed. Reg. 56,593, 56,606 (proposed Sept. 18, 2015) (to be codified at 40 C.F.R. pt. 60); ENVTL. PROT. AGENCY, EPA 430-R-15-004, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2013, at ES-9 (2013), http://www3.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2015-Main-Text.pdf.

63. *Climate Change: Understanding Global Warming Potentials*, ENVTL. PROTECTION AGENCY, http://www3.epa.gov/climatechange/ghgemissions/gwps.html (last visited Feb. 29, 2016).

64. Kevin Fisher, *Terpenes Replacing BTEX In Oil Field*, AM. OIL & GAS REP., Sept. 2013, http://www.aogr.com/magazine/editors-choice/terpenes-replacing-btex-in-oil-field (pointing out that "BTEX solvents . . . are being used in operations, including cleaning out oil-based drilling mud prior to completions, dissolving and dispersing paraffin and asphaltene in older wells, and as preflushing in acidizing and cementing procedures"; describing the use of bio-based terpenes solvents that are "both green and great" and thus can replace the BTEX solvents.)

65. *See, e.g.*, JHON ARBELAEZ & BRUCE BAIZEL, CALIFORNIANS AT RISK: AN ANALYSIS OF HEALTH THREATS FROM OIL AND GAS POLLUTION IN TWO COMMUNITIES 31, 34 (2005), https://www.earthworksaction.org/files/publications/CaliforniansAtRiskFINAL.pdf (concluding that regular exposure to air contaminants typically associated with oil and gas production may be negatively effecting the health of local residents); Gregg P. Macey et al., *Air Concentrations of Volatile Compounds Near Oil and Gas Production: A Community-Based Exploratory Study*, ENVTL. HEALTH, Oct. 30, 2014, at 15, http://www.ehjournal.net/content/13/1/82 (noting that high concentrations of toxic compounds are present at many oil and gas production areas; recommending community-based research to improve policymaking); Lisa M. McKenzie et al., *Birth Outcomes and Maternal Residential Proximity to Natural Gas Development in Rural Colorado*, 122 ENVTL. HEALTH PERSP. 412, 416 (2014), http://dx.doi.org/10.1289/ehp.1306722 (finding a higher frequency in heart and brain birth defects within a 10-mile radius of natural gas wells); Peter M. Rabinowitz et al., *Proximity to Natural Gas Wells and Reported Health Status: Results of a Household Survey in Washington County, Pennsylvania*, 123 ENVTL. HEALTH PERP. 21, 26 (2015), http://dx.doi.org/10.1289/ehp.1307732 (concluding that natural gas drilling activities may be associated with increased risk of respiratory problems in nearby communities); John L. Adgate et al., *Potential Public Health Hazards, Exposures and Health Effects from Unconventional*

needed, but anyone familiar with the existing literature would be justifiably concerned about living in close proximity to oil and gas development.

Oil and gas related air pollution comes from a range of sources including flowback from wells, compressor stations, gathering lines and pipelines, waste pits, storage tanks, gas processing facilities, drill rigs, and trucks. Emissions from these sources are sometimes flared or vented and venting in particular can contribute significant quantities of methane and toxic air pollutants to the environment.[66]

Regulators have begun to recognize the significant risks posed by air emissions from oil and gas development, and substantial progress has been made in setting standards for oil and gas operations and related facilities. In 2012, the EPA published rules requiring, among other things, "green completions" or "reduced emission completions" (RECs) for natural gas wells.[67] These rules do not apply to oil wells or to existing wells, although the EPA has proposed rules for the oil and gas sector that would encompass all new oil and gas wells,[68] and some believe that existing wells may be regulated in the near future.[69] The State of Colorado has also promulgated rules that go beyond the federal standards, and many view these standards as

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Natural Gas Development, 48 ENVTL. SCI. & TECH. 8307 (2014) (stressing the lack of research on the health risks posed by unconventional natural gas development); Trevor M. Penning et al., *Environmental Health Research Recommendations from the Inter-Environmental Health Sciences Core Center Working Group on Unconventional Natural Gas Drilling Operations*, 122 ENVTL. HEALTH PERSP. 1155, 1158 (2014), http://dx.doi.org/10.1289/ehp.1408207 (advocating for community engagement in order to understand the health risks related to unconventional natural gas); Seth B.C. Shonkoff et al., *Environmental Public Health Dimensions of Shale and Tight Gas Development*, 122 ENVTL. HEALTH PERSP. 787, 793 (2014), http://dx.doi.org/10.1289/ehp.1307866 (suggesting that further epidemiological studies can assess health risk factors for communities living near shale gas operations); Angela K. Werner et al., *Environmental Health Impacts of Unconventional Natural Gas Development: A Review of the Current Strength of Evidence*, 505 SCI. TOTAL ENV'T 1127, 1139 (2015) (emphasizing the difficulty of credibly assessing the environmental health impacts of unconventional natural gas development).

66. *See* ARBELAEZ & BAIZEL, *supra* note 65, at 14 (noting that flaring effectively burns the methane and other organic compounds, thereby emitting carbon dioxide, but such emissions are generally preferable to venting).

67. Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews, 77 Fed. Reg. 49,490, 49,492 (Aug. 16, 2012) (to be codified at 40 C.F.R. pt. 60 & 63). The purpose of a "green completion" is to capture excess natural gas that is released during the development of the well. *Id.* In the past, excess gas was vented or flared, which obviously has significant adverse environmental impacts. *Id.*

68. Oil and Natural Gas Sector: Emission Standards for New and Modified Sources, 80 Fed. Reg. 56,593, 56,594 (proposed Sept. 18, 2015) (to be codified at 40 C.F.R. pt. 60).

69. *See, e.g.*, Carlos R. Romo & Nicholas Graham, *EPA Regulation of Existing Oil & Gas Sources: Immediate and Long-Term Challenges*, BLOOMBERG BNA: DAILY ENV'T REP. (Sept. 25, 2015), http://www.bakerbotts.com/ideas/publications/2015/09/epa-regulation-of-existing-oil-gas (noting that EPA can regulate emissions from existing sources under the Clean Air Act).

a model for the industry.[70] These rules are designed to promote good air pollution control practices to minimize hydrocarbon emissions from hydrocarbon liquid collection, storage, processing, and handling. They include standards for storage tanks, natural gas dehydrators, well operation and maintenance and liquids unloading. They also include standards for leak detection and repair (LDAR).[71]

The technical details of the federal rules and their state counterparts are beyond the scope of this Article but several observations about controlling air emissions from oil and gas facilities can nonetheless be made. First, oil and gas facilities are a major source of greenhouse gas emissions, VOCs, and toxic air pollution. Individually and collectively, these emissions impose significant costs on society that are not captured by the market. Capturing some of those costs in the form of impact fees or other charges might be a sensible policy choice, but at a minimum these costs should be accounted for in the decisionmaking process.

Second, while enough is known about air emissions from the oil and gas sector to label them significant, much uncertainty remains. Research that can help reveal the environmental and health costs is ongoing and more will be needed. But if ever there was a case for exercising the precautionary principle,[72] this may be it. Too many people living too close to oil and gas development are exhibiting adverse health consequences and the response must be to minimize exposure, especially to toxic pollutants, to the greatest extent possible.

Third, state and federal regulators should require the oil and gas industry to use best practices throughout the development, processing, storage, and transporting of oil and gas. Best practices should include green completions for all oil and gas wells, sealing lines as well as valves, employing LDAR

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70. COLO. CODE REGS. § 1001-9: XVII (2015).

71. *See* COLO. DEP'T OF PUB. HEALTH & ENV'T, REVISIONS TO COLORADO AIR QUALITY CONTROL COMMISSION'S REGULATION NUMBERS 3, 6, & 7 FACT SHEET (2014), https://www.colorado.gov/pacific/sites/default/files/AP_Regulation-3-6-7-FactSheet.pdf (identifying standards that rules should address).

72. *See generally* David Kriebel et al., *The Precautionary Principle in Environmental Science*, 109 ENVTL. HEALTH PERSP. 871, 871–76 (2001), http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240435/pdf/ehp0109-000871.pdf (discussing the four central components to the "precautionary principle" in environmental decision making: "[1] taking preventive action in the face of uncertainty; [2] shifting the burden of proof to the proponents of an activity; [3] exploring a wide range of alternatives to possibly harmful actions; and [4] increasing public participation in decision making").

standards,[73] operating storage tanks without venting,[74] and using the flexibility that horizontal drilling affords to site wells and other facilities away from people.

Finally, the highest responsibility of regulatory agencies is to protect public health, and it is fair to say that regulatory agencies have sometimes failed the public when it comes to regulating air emissions from oil and gas development.[75] Arguably, a significant aspect of the problem has been the lack of solid scientific evidence showing a clear causal link between air emissions from oil and gas facilities and health problems. While the information gap has been closing for some time now, this will be an issue fraught with uncertainty for the foreseeable future. In this situation, regulators have a higher responsibility to step up monitoring of both emissions and public health to help ensure that the impacts of emissions are better understood going forward. Agencies must also maintain aggressive enforcement programs that signal to the industry and the public that violations will not be tolerated. Beyond monitoring and enforcement, agencies must be committed to adapting regulatory programs to address newly identified risks once they are discovered. This should include, for example, flexible standards in permits that can be tightened if new information indicates that stronger standards are necessary to protect public health.

D. Managing Noise and Community Impacts

It might seem easy to dismiss the impacts from the dust, noise, and truck traffic as minor or secondary when compared to the air-quality and land-based impacts from oil and gas development. But for many people living in communities affected by significant oil and gas development, these community impacts hardly seem minor. On the contrary, dust, noise, and truck trafficking impacts can fundamentally alter the quality of life in these communities. Imagine, for example, a constant stream of heavy trucks driving on local roads not built to handle them, or compressor stations running around the clock without adequate sound insulation located too close

73. *See* COLO. CODE REGS. § 1001-9: XVII.F (2015) (establishing a mandatory leak detection and repair program for well production facilities and natural gas compressor stations).

74. *See id.* § 1001-9: XVII.C.2 (mandating owners or operators of storage tanks to route all emissions through air pollutant control equipment without venting).

75. In proposing new regulations for the oil and natural gas sector on September 18, 2015, the EPA offered details supporting its conclusion that air emissions from the oil and gas sector threaten the public health and welfare. Oil and Natural Gas Sector: Emission Standards for New and Modified Sources, 80 Fed. Reg. 56,593 (proposed Sept. 18, 2015) (to be codified at 40 C.F.R. pt. 60).

to occupied buildings. The web of roads, power lines, and other infrastructure needed to support the industry can turn a bucolic, rural community into an industrial zone that may seem unfit for residential living.[76]

Given the nature of unconventional oil and gas development, some degree of negative impacts to the community is inevitable. For instance, a single fracking job might require five million gallons of water or more. That is enough water to serve about 60,000 people per day. If that water has to be transported to the fracking site by trucks, then approximately 800 truckloads of water will be needed. Additional pump trucks will also have to be brought to the site to generate the pressure needed to frack the shale rock. Other trucks to transport workers and service the mine and the infrastructure add to the industrial feel. Trucks cause significant road damage, dust, noise, and congestion at high volumes and can destroy the very fabric of a community.

Addressing community impacts should be a top priority for the industry. Some of the more progressive companies have begun to embrace "good neighbor" policies that encourage them to work with local communities and other stakeholders to set parameters for oil and gas development that protect the public health and the environment.[77] But too often these policies focus on ways to minimize impacts from development rather than considering structural changes to the development itself.[78]

A better approach, and one that might truly signal a desire to be a "good neighbor," would look first at the appropriate scale of development, as was earlier discussed. Under this approach, one might consider: (1) how many well pads will be located in a community and over what period of time; (2) what infrastructure will be needed to support those facilities; (3) whether the scale of development is appropriate for the size of the community and acceptable to the community members; (4) whether the scale of development has been set in a manner that will minimize the risk of boom and bust cycles; (5) whether the community fully appreciates how the development will impact them, especially in terms of their quality of life; and (6) whether community members are comfortable with those projected impacts.

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76. A short video clip from the documentary *Groundswell* offers a compelling personal story about community impacts in the Marcellus Shale from truck traffic. Repix,*"Heavy Fraffic" from the Documentary GROUNDSWELL: Protecting Our Children's Water,* YOUTUBE (Aug. 04, 2011), https://www.youtube.com/watch?v=KZZQxe6FiGA.

77. *See Considering Good Neighbor Practices*, AM. PETROLEUM INST. (2008), http://www.api.org/~/media/Files/Policy/Exploration/environment/Good_Neighbor_Guidelines.pdf (describing "good neighbor" policies for the oil and gas industry).

78. *Id.* The API's *Good Neighbor Practices Guidelines* are similar to the API's *Community Engagement Guidelines*, described *infra* Part III, in that they both focus entirely on ways to minimize impacts to communities from oil and gas development and give no hint that developers might engage the public on whether and to what extent development should be allowed to proceed. *Id.*

Once an appropriate scale has been determined, oil and gas developers must still make decisions about where to locate well pads, compressor stations, and other infrastructure. As previously suggested, good planning takes advantage of the flexibility that comes with horizontal drilling and is essential for minimizing community disruption and maximizing efficient development. Good planning will likely require coordination among developers and the regulatory agency. While good planning will almost certainly take more time upfront, the advantages to the community should make any delay well worthwhile. In the end, a happy community serves the best interests of the oil and gas industry.

While good planning that allows development at an appropriate scale should minimize truck traffic, more specific transportation management plans can afford additional assurances to affected communities. Such plans can help make clear which roads trucks will use and what limits will be placed on truck traffic. While managing these limits among multiple developers might seem complicated, there are simple, well-understood technologies and strategies available that can make this management fairly easy. For example, a community might set a maximum limit on the total number of truck trips allowed on certain roads per day, per week, and per month and perhaps have further restrictions on nighttime truck traffic. Moreover, company trucks could be fitted with recording tags that record the passage of a truck through a portal, much as modern toll roads operate today. Communities might assess fees for each trip sufficient to discourage traffic. These fees could generate substantial revenues to help communities address impacts and cover regulatory costs. Alternatively, or perhaps in addition to a toll program, communities might adopt a cap and trade program whereby the total number of truck trips would be capped and then allocated to the oil and gas developers (perhaps for a fee), allowing developers to buy or sell truck trip credits as necessary to meet their needs.

As previously described, well-planned oil and gas development can also minimize community impacts by monitoring and controlling air pollution. Good neighbor practices for air pollution might, for example, emphasize the precautionary principle, given the high levels of uncertainty and serious public health concerns raised by air emissions from oil and gas facilities. Likewise, well-planned developments can ensure the efficient movement of fluids with gathering lines and pipelines, and the efficient deployment of electricity, perhaps on-site with small natural gas generators. All of this should decrease the likelihood of adverse community impacts from water pollution and vehicle traffic.

III. DESIGNING A REGULATORY APPROACH AS IF COMMUNITIES MATTER

The foregoing has offered a range of proposals for protecting air, water, and community resources from the adverse impacts associated with oil and gas development. Most importantly, this Article has also emphasized the important role of good planning to avoid, minimize, and manage adverse impacts. Beyond these specific ideas, however, regulators and developers alike must also recognize the importance of designing an approach toward managing oil and gas that will give local communities and the general public confidence that they are prepared to do whatever is necessary to keep impacts below a level that is acceptable to the vast majority of those in the affected community. Such an approach must include an understanding that the industry and local regulators are willing to walk away from a development proposal that imposes unacceptable adverse impacts.

Too often the response of the industry has been to push a slick marketing campaign to convince people that oil and gas development is safe.[79] That money might be better spent on developing and adhering to policies that respect the rights of local communities to decide for themselves whether and how development will proceed. As previously noted, the American Petroleum Institute (API) has established guidelines for oil and gas companies to behave as "good neighbors."[80] In similar fashion, the API has adopted "Community Engagement Guidelines" that promote transparency and meaningful community engagement.[81] If followed, these Guidelines could help ensure that impacted communities better understand the consequences of oil and gas development. They should also help promote better relations between community leaders and industry officials.

But while transparency and a meaningful process that engages the community are important, the Community Engagement Guidelines, like the Good Neighbor Policy Guidelines, are insufficient because they focus entirely on process. To show that communities matter, these policies must also respect the substantive choices that a community makes for itself. The oil and gas industry will likely have far more success developing resources in the long run if they pay close attention to local concerns and develop a

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79. *See* Susan Krashinsky, *Oil Companies Seek to Rebrand with Friendly Campaigns,* GLOBE & MAIL (July 16, 2015), http://www.theglobeandmail.com/report-on-business/industry-news/marketing/oil-companies-seek-to-rebrand-with-friendly-campaigns/article25541810/ (discussing how oil and gas companies are launching campaigns in an attempt to present their brands differently and in a more favorable light).

80. AM. PETROLEUM INST., COMMUNITY ENGAGEMENT GUIDELINES 1 (2014), http://www.api.org/~/media/Files/Policy/Exploration/100-3_e1.pdf.

81. *Id.*

reputation as an honest partner that respects community choices. If developers are allowed to proceed they should commit themselves to following "best management practices"[82] to protect communities and to avoid, minimize, and mitigate adverse impacts whenever they occur.

The oil and gas industry is understandably concerned about local ordinances that seek to ban all oil and gas from a community. But rather than fighting these ordinances in court, the industry might be better advised to work with communities to find common ground. For example, when a city bans fracking it might nonetheless be amenable to some amount of drilling underneath that city's land. If so, an agreement might be reached to allow horizontal drilling underneath some portion of the city, even while requiring that all surface facilities be sited outside city boundaries.

In order to protect communities from the adverse impacts associated with oil and gas development regulatory agencies must have sufficient resources to hire expert staff to review applications, monitor activities, and otherwise manage the program. One appropriate way to help ensure sufficient resources is to develop a system of permit fees that covers the cost of the agency's regulatory program. While there may be some disagreement about the scope of regulatory oversight, few would deny that government has an important role to play in regulating oil and gas development. This is an external cost associated with oil and gas development and should therefore be paid by the industry.

As previously suggested, a fee program might also be used to recover some or all of the external costs associated with greenhouse gas emissions. The federal government's Interagency Working Group (IWG) has developed a useful protocol for quantifying the social costs of carbon.[83] While much uncertainty remains, the IWG has worked hard to update its assessment regularly,[84] and courts have begun to insist that these costs at least be taken into account when making decisions that implicate such costs.[85]

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82. *See Intermountain Oil and Gas BMP Project*, UNIV. COLO. BOULDER, http://www.oilandgasbmps.org/ (last visited Apr. 11, 2016) (helping parties better understand how to manage oil and gas development to address adverse impacts).

83. *See EPA Fact Sheet: Social Cost of Carbon*, ENVTL. PROT. AGENCY, http://www3.epa.gov/climatechange/Downloads/EPAactivities/social-cost-carbon.pdf (last visited May 15, 2016) (providing guidance on how to incorporate the social cost of carbon in rulemaking).

84. INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866, at 4 (2015), https://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf.

85. *See* Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1198 (9th Cir. 2008) (holding that the government cannot "put a thumb on the scale" and undervalue other

EIAs have already been touted as an essential tool that should be used before oil and gas development is allowed to move forward. EIAs are important not only for addressing the site impacts associated with development, but also because of the critical role that EIAs play in understanding the cumulative impacts associated with other mineral and non-mineral development in the affected community, and most importantly, because EIAs demand consideration of all reasonable alternative development scenarios.[86] If development is going to take place, how many wells should be drilled, where should those wells be sited, what are the alternative locations for well pads and what are the relative advantages of each possible site? This, of course, is part of planning, but the EIA process is uniquely designed to tease out these issues not only for the decisionmaker but also to allow for more meaningful public engagement.

While cash-strapped local governments may be tempted to ask prospective developers to prepare EIA documents, this approach will inevitably limit the scope of the proposed alternatives to only those favored by the developer.[87] To be sure, few agencies at the state and local level will have sufficient resources or expertise to prepare their own environmental documents but they can hire an independent consultant to prepare the EIA, and they can and should demand that the cost of an EIA be paid for by the developer, as Santa Fe has done in its 2008 ordinance.[88] One concern with outside consultants is that most have longstanding business ties to industry clients that may make it difficult to reach conclusions that are unfavorable to the industry. But agencies can establish clear standards for their consultants and demand procedures that will ensure that their reports receive critical review both from the agency and the public.

Finally and perhaps most importantly, agencies must establish a program for monitoring land, air, and water resources as well as biotic communities to ensure that the impacts predicted during the EIA process are within the acceptable range. When unanticipated adverse impacts occur, agencies must

qualitative and quantitative costs); High Country Conservation Advocates v. U.S. Forest Serv. 52 F. Supp. 3d 1174, 1196 (D. Colo. 2014) (finding that the United States Forest Service "did not act arbitrarily" by deferring to lacking research on the human health impacts of volatile organic compounds).

86. While the Council on Environmental Quality (CEQ) rules bind only federal agencies, the CEQ rules are universally respected for the standards they set for things like "cumulative impacts" and "alternative" analysis. *See* 40 C.F.R. § 1502.14 (2015) (alternatives including the proposed action); *id.* § 1508.7 (definition of "cumulative impact"); *id.* § 1508.8 (definition of "effects"); *id.* § 1508.25 (definition of "scope") (2015).

87. *See* Mark Squillace, *An American Perspective on Environmental Impact Assessment in Australia*, 20 COLUM. J. ENVTL. L. 43, 89 (1995) (discussing the importance of considering a range of viable alternatives).

88. Santa Fe, N.M., Ordinance 2008–19, § 9.6.1(e) (Oct. 12, 2008).

have an adaptive management plan built into their permits to ensure that developers can and will address those impacts.

Adaptive management is relatively easy to describe. In its simplest form, it is a process that aims to learn from actual experience. "Learning while doing" is the mantra frequently invoked.[89] In practice, however, implementing an adaptive management protocol has proved more challenging.[90] The key failure seems to be in developing adequate metrics. A useful model for thinking about metrics is the so-called "SMART" model, which promotes criteria that are "specific, measurable, achievable, realistic (or results-oriented), and time-bound."[91] The Fish and Wildlife Service employs this model for its comprehensive conservation plans.[92]

Establishing clear metrics and monitoring the effects of oil and gas development against those metrics would be a good start; however, the regulatory agency will have to go further and demand corrective action whenever an approved development fails to achieve the metrics established for that project. While it is possible that agencies will have to revise the metrics over time, corrective action should generally mean changing the development project to meet those metrics in the future and taking any necessary action to mitigate and remediate any unanticipated adverse impacts.

While it might not seem so at first blush, if agencies can figure out how to employ efficient adaptive management strategies, the industry could significantly benefit. A major problem inherent in most environmental decisionmaking is the substantial uncertainty concerning the consequences of a proposed action. This can greatly complicate the EIA process and lead to legitimate calls for decisions to reflect the precautionary principle. If, however, agreement can be achieved in advance on the ultimate metrics that

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89. *See* J.B. Ruhl & Robert L. Fischman, *Adaptive Management in the Courts,* 95 MINN. L. REV. 424, 424–484 (2010) (describing in detail how the mantra, "learning while doing," works in adaptive management); Holly Doremus, *Precaution, Science, and Learning While Doing in Natural Resource Management*, 82 WASH. L. REV. 547, 550 (2007) (explaining what is meant by "learning while doing, and how it differs from common understandings of adaptive management and 'learning *by* doing'").

90. Ruhl & Fischman, *supra* note 89, at 426 n.8 (describing current practice as largely involving "a/m-lite", which is defined as a "stripped-down version of adaptive management that often fails due to management, implementation, and planning problems").

91. George T. Duran et al., *There's a S.M.A.R.T. Way to Write Management's Goals and Objectives*, 70 MANAGEMENT REV. 35 (1981).

92. U.S. FISH & WILDLIFE SERV., DEP'T OF THE INTERIOR, OUTLINE & GUIDANCE FOR DEVELOPING HABITAT MANAGEMENT PLANS § II.C(1) (2002), http://www.fws.gov/policy/e1620fw1.html; s*ee* Richard L. Schroeder, *Evaluating the Quality of Biological Objectives for Conservation Planning in the National Wildlife Refuge System,* 26 GEORGE WRIGHT FORUM 22, 22–23, 27–28 (2009), http://www.georgewright.org/262schroeder.pdf (discussing the FWS approach to comprehensive conservation planning and the use of the SMART model).

must be met, and a program is put in place to carefully monitor those metrics and ensure that they are achieved, then the public has far less reason to call for additional analysis of the potential impacts of a proposed action.[93]

CONCLUSION

Oil and gas development has engendered considerable controversy in recent years largely due to the dramatic growth in the development of unconventional resources. In many cases, that development has pitted local communities against oil and gas companies, and these conflicts invariably engage federal, state, and local agencies, political leaders, the oil and gas industry, and the environmental community. Too often the controversy is described in all or nothing terms. We can either have our health and a clean environment or we can have oil and gas development. The industry has made considerable efforts to persuade the public that developing oil and gas resources can occur without harm to communities. But while many companies have made significant efforts toward protecting communities, their track record and the ongoing conflicts playing out in many communities throughout the country suggest that much more can still be done.

The current slump in oil and gas prices offers an opportunity to step back and look at our regulatory programs and ask how we can do better. This Article offers a framework for thinking about oil and gas regulation as if communities mattered. It promotes good planning that is orchestrated and directed proactively by regulatory agencies, with special attention to protecting the air, water, and community resources that too often suffer when oil and gas resources are developed.

Until communities gain some modicum of control over the scope and scale of oil and gas development, conflict and controversy between the industry and communities will continue. It will not be easy to persuade the industry to relinquish any aspect of the control that they currently enjoy over where and how they plan to develop oil and gas resources. Litigation over local versus state versus federal control and over different aspects of development will likely continue. But in the long run, the industry will benefit from working with communities, and respecting their choices about whether and how development of oil and gas should go forward. Companies

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93. *See* U.S. FISH & WILDLIFE SERV., DEP'T OF THE INTERIOR, *supra* note 92, at 4. Precautionary principles can and perhaps should be built into the metrics themselves, of course, but employing adaptive management can help avoid decisions that unnecessarily constrain activities due to concerns about potential impacts that ultimately turn out to be unwarranted. *Id.* Because adaptive management proceeds by constantly assessing and reassessing the actual impacts and by ensuring that those impacts stay below the established threshold, the uncertainties that lead to exercising extreme caution become less important. *Id.*

that figure out how to develop oil and gas resources in harmony with community values will find themselves in great demand. And they will be in demand because they will have learned that communities really do matter.