Generating the Energy We Need While Protecting the Environment We Treasure: the Regulation of Hydraulic Fracturing in the United States

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Abstract: Hydraulic fracturing provides important benefits, but also raises environmental concerns. In response, federal and state agencies have adopted a variety of regulatory requirements. These requirements reflect several trends that will help shape the approach to this subject by other countries.

Key Words: air, baseline, BLM, chemical, CSSD, Colorado, casing, cementing, community, data, diesel, disclosure, earthquake, economic, emission, energy, environment, EPA, federal, fluid, flowback, FRACFOCUS, fracking, fracturing, gas, greenhouse, health, hydraulic, methane, North Dakota, oil, Ohio, Pennsylvania, pit, recycle, regulation, sampling, sandstone, shale, state, STRONGER, Texas, unconventional, water, well

I. INTRODUCTION

Experts around the world are touting the potential benefits of unconventional oil and gas development, which includes onshore shale, tight sandstone, and coalbed methane formations. According to the International Energy Agency, natural gas is “poised to enter a golden age” which promises “greater energy diversity and more secure supply” as well as “reduced energy costs.”¹ An Advisory Board to the Secretary of Energy has noted the “enormous potential” for “economic and environmental benefits” from shale gas development.² For the European Parliament Committee on Industry, Research and Energy, unconventional gas production promotes energy security and diversity while also providing a “quick, temporary and cost-

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Historically, the low permeability of shale and tight sandstone formations had limited their development.\footnote{See, e.g., GOVERNMENT ACCOUNTING OFFICE, UNCONVENTIONAL OIL AND GAS DEVELOPMENT: KEY ENVIRONMENTAL AND PUBLIC HEALTH REQUIREMENTS 1 (Sept. 2012) (“GAO OIL AND GAS REPORT”), available at http://www.gao.gov/assets/650/647782.pdf; UNITED STATES DEPARTMENT OF ENERGY (“DOE”), MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES: A PRIMER 13-14 (2009) (“DOE SHALE GAS PRIMER”), available at http://energy.gov/fe/downloads/modern-shale-gas-development-united-states-primer.} But recent advances in horizontal drilling combined with multi-stage hydraulic fracturing are allowing operators to develop these resources economically.\footnote{Id.} This is increasing oil and gas production in the United States and expanding it into new regions and areas,\footnote{See, e.g., SEAB 90-DAY REPORT, supra, at 6-8; DOE SHALE GAS PRIMER, supra, at 1.} while creating opportunities for similar production and expansion overseas.\footnote{See, e.g., IEA GOLDEN RULES REPORT, supra, at 9-11 & 68-71.} But the development of these resources is also raising public concern over potential water, air, seismic, and other effects attributed to hydraulic fracturing.\footnote{See, e.g., GAO OIL AND GAS REPORT, supra, at 2; IEA GOLDEN RULES REPORT, supra, at Ch. 2; SEAB 90-DAY REPORT, supra, at 8-9. Some people use “hydraulic fracturing” to refer to all activities associated with unconventional oil and gas development; this paper uses the term to refer only to the hydraulic fracturing process.} In particular, concerns have been raised that spills and faulty well construction could contaminate ground and surface water resources and that emissions of pollutants could adversely affect public health and the environment.\footnote{See, e.g., GAO OIL AND GAS REPORT, supra, at 2; SEAB 90-DAY REPORT, supra, at 15-22.} These are not just American issues but global considerations, which increasingly attract worldwide media attention.\footnote{See, e.g., George Osborne’s Office in Greenpeace Fracking Protest, BBC News Manchester, March 4, 2013, available at \url{http://www.bbc.co.uk/news/uk-england-manchester-2163311}; Fracking Not Yet Shown Harmless, Canberra Times, Feb. 20, 2013, available at \url{http://www.canberratimes.com.au/opinion/editorial/fracking-not-yet-shown-harmless-20130219-2epoj.html}.}
In the United States, these concerns have led to a variety of regulatory actions by federal and state governments, as well as the development of potential new regulatory models and tools by non-governmental organizations. This article summarizes some of the most significant benefits and concerns associated with hydraulic fracturing. It then compares and contrasts the regulatory requirements imposed on this process by the federal government and several states. Using this information, it suggests emerging regulatory trends, which may help shape the approach to these issues by other countries. Responsible regulation of hydraulic fracturing is critical because it can help bridge the widening gap between the pivotal promise and the perceived peril of this process; like Bertram Russell’s description of philosophy, responsible regulation allows us to “live without certainty and yet without being paralyzed by hesitation.”

II. BACKGROUND

The commercial application of hydraulic fracturing to stimulate oil and gas production is more than 60 years old. It is now routinely used to complete oil and gas wells in the United States, particularly those drilled into shale, tight sandstone, and other unconventional formations. More than a million hydraulic fracturing treatments have taken place in the United States, and over 550 technical papers have been written on shale fracturing alone. This process has produced significant public benefits and created a host of “shale plays” across the United States, including the Marcellus and Utica in the Northeast, the Barnett, Haynesville, and Fayetteville in

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13/ Id. at 2-3 (“shale papers in the past three years alone are from over 70 universities, 4 US national labs, over a dozen state, federal and international agencies and more than a hundred energy and service companies”).
the Southeast, the Bakken in the Northern Plains, and the Niobrara in the Rocky Mountains. But it is also stimulating public concern.

A. Hydraulic Fracturing

Hydraulic fracturing occurs after the well is drilled, and is used to increase oil and gas production. The Environmental Protection Agency (“EPA”) has described the process as follows:

Hydraulic fracturing involves the pressurized injection of fluids commonly made up of water and chemical additives into a geologic formation. The pressure exceeds the rock strength and the fluid opens or enlarges fractures in the rock. As the formation is fractured, a ‘propping agent,’ such as sand or ceramic beads, is pumped into the fractures to keep them from closing as the pumping pressure is released. The fracturing fluids (water and chemical additives) are then returned back to the surface. Natural gas will flow from pores and fractures in the rock into the well for subsequent extraction.

In other words, hydraulic fracturing is the injection of a fluid mixture down the wellbore to create small fractures in the hydrocarbon formation in order to increase the rate at which gas and oil are produced.

Water and sand constitute 99% to 99.9% of the hydraulic fracturing fluid, and the volume of water varies by well type and geologic formation. EPA estimates that vertical wells in coalbed methane formations may require 50,000 to 350,000 gallons of water while horizontal wells in shale formations may need two to five million gallons of water. Depending upon the site, 15% to 80% of the injected fluids may return to the surface. These “flowback fluids” may

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16/ See, e.g., King, supra, at 7.

17/ EPA FACT SHEET, supra, at 2.

18/ Id.
be recycled, injected deep underground using a permitted disposal well, treated and discharged to surface water, or applied to land.\textsuperscript{19}

Chemical additives constitute .1% to 1% of the hydraulic fracturing fluid, and they too vary by well and formation.\textsuperscript{20} Each additive serves a specific purpose. For example, friction reducers decrease pumping friction, gels improve sand distribution, and biocides eliminate bacteria that can cause corrosion.\textsuperscript{21} Many of these additives are common chemicals which are encountered in everyday life, but some can be harmful in certain quantities or circumstances.\textsuperscript{22}

To protect ground water, wells are constructed with multiple layers of steel pipe called “casing,” which are surrounded by layers of cement.\textsuperscript{23} The steel casing and surrounding cement isolate the internal portion of the well from the surrounding geologic formations, which may include fresh water aquifers; they thereby help ensure that neither the fracturing fluids injected down the wellbore nor the oil and gas flowing up the wellbore can reach the aquifers.\textsuperscript{24} Measures to prevent surface spills and releases include lined pits, setbacks from surface waters, and “closed loop” fluid handling systems.\textsuperscript{25}

\begin{itemize}
\item \textsuperscript{19} Id.
\item \textsuperscript{20} See, e.g., King, supra, at 8-9 & 34-35.
\item \textsuperscript{21} See, e.g., id.; Fracfocus, Chemical Use In Hydraulic Fracturing: What Chemicals Are Used, http://www.fracfocus.org/chemical-use/why-chemicals-are-used. Fracfocus is a hydraulic fracturing chemical registry managed by the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission, which are national organizations comprised of state regulators. See infra notes 79-81 and accompanying text.
\item \textsuperscript{22} See, e.g., DOE SHALE GAS PRIMER, supra, at 62-63.
\item \textsuperscript{23} See, e.g., King, supra, at 21-24; Fracfocus, Groundwater Protection: Well Construction And Groundwater Protection (“Fracfocus Well Construction”), http://www.fracfocus.org/hydraulic-fracturing-how-it-works/casing.
\item \textsuperscript{24} Id.
\end{itemize}
Trucks are often used to transport water and other supplies to and from the well site, and the hydraulic fracturing of one horizontal well can potentially generate hundreds of truck trips.\textsuperscript{26} In addition, mobile engines are often used to produce the pressure necessary to inject the fluids and fracture the formation.\textsuperscript{27} These trucks and engines can create air emissions and noise, and the trucks can also cause road wear.\textsuperscript{28} Methane may also be released during “flowback,” that is, when the fracturing fluids return to the surface at the conclusion of hydraulic fracturing.\textsuperscript{29} Measures to address these air, noise, and road impacts include reduced emission or “green” completions, gas fired engines, noise barriers, fluid recycling, and temporary pipelines.

**B. Public Benefits**

Hydraulic fracturing has helped create an unconventional oil and gas boom in the United States. This, in turn, has benefited the public by generating needed energy, improving the economy, and reducing greenhouse gas emissions.

1. **Energy Production**

Oil and gas play a vital role in meeting the energy needs of the United States, where they account for almost two-thirds of the energy consumed. During 2011, oil accounted for about 36% and natural gas accounted for about 26% of the energy consumed in the United States;\textsuperscript{30} the

\textsuperscript{26} See, e.g., NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, REVISED DRAFT SUPPLEMENTAL GENERIC ENVIRONMENTAL IMPACT STATEMENT ON THE OIL, GAS, AND SOLUTION MINING REGULATORY PROGRAM: WELL PERMIT ISSUANCE FOR HORIZONTAL DRILLING AND HIGH VOLUME HYDRAULIC FRACTURING TO DEVELOP THE MARCELLUS SHALE AND OTHER LOW-PERMEABILITY GAS RESOURCES Table 6.60 (Sept. 7, 2011), available at www.dec.ny.gov/energy/75370.html.

\textsuperscript{27} See, e.g., GAO OIL AND GAS REPORT, supra, at 15-16.

\textsuperscript{28} Id.; DOE SHALE GAS PRIMER, supra, at 49 & 72.

\textsuperscript{29} See, e.g., EPA, OVERVIEW OF FINAL AMENDMENTS TO AIR REGULATIONS FOR THE OIL AND NATURAL GAS INDUSTRY 3 (“EPA OVERVIEW”), available at http://www.epa.gov/airquality/oilandgas/actions.html.

percentages for other energy sources were coal 21\%, nuclear 8\%, solar, wind, and other non-combustible forms of renewable energy 5\%, and wood and biomass 4\%.\(^{31}\)

Increasingly, this oil and gas comes from unconventional formations. For example, during July 2013 oil production reached its highest volume in 22 years, with much of this increase attributable to production from shale formations.\(^{32}\) Similarly, the percentage of gas production attributable to shale formations has nearly quadrupled from 8\% in 2007 to 30\% in 2011, and total gas withdrawals have increased about 20\% during this period to record highs.\(^{33}\)

Between 2010 and 2011, proved oil reserves increased by more than 15\% and proved gas reserves grew almost 10\% due to increasing unconventional exploration and development, and this marked the largest increase for oil and the second largest increase for gas since 1977.\(^{34}\) As a result, the ratio of energy imports to exports has decreased from eight to one in 2002 to three to one in 2011.\(^{35}\) These trends are projected to continue through the end of this decade, with the United States becoming a net natural gas exporter, oil production increasing by more than 30\%, and the country becoming a net liquid fuel exporter under certain conditions.\(^{36}\)

Beyond meeting more of the nation’s burgeoning energy needs, unconventional oil and gas development also benefits the United States geopolitically. Reducing the nation’s dependence on foreign energy improves our energy security and ultimately our national security.

\(^{31}\) Id.

\(^{32}\) See EIA, SHORT TERM ENERGY OUTLOOK (Aug. 6, 2013), http://www.eia.gov/forecasts/steo/report/.


Reducing energy imports also shrinks the outflow of dollars to foreign interests, making these funds available for domestic investment.

2. Economic Improvement

Unconventional oil and gas development provides significant economic benefits for the United States. Although estimates vary, the development of unconventional resources benefits both workers, through the creation of jobs, and consumers, through lower heating and electrical costs. It also benefits the manufacturing sector through capital investment and lower costs for energy and materials.

For example, a recent study by the global consulting firm IHS calculates that unconventional oil and gas development currently supports more than 1.7 million direct, indirect, and induced jobs and projects this number to grow to almost 3.0 million jobs by 2020.37 The same study estimates that this development is generating $61 billion in annual tax revenues and federal royalties and $237 billion in gross domestic product; by 2020, these numbers are projected to increase to $111 billion, and $416 billion, respectively.38 A similar study by the American Chemistry Council describes shale gas as an economic “game changer,” which is creating “a competitive advantage for US manufacturers, leading to greater investment, industry growth, and jobs.”39 It finds that lower energy costs have led the chemical industry to announce 97 new manufacturing projects as of March 2013, which will involve $71 billion in new investment and create $66 billion in increased output.40 These projects are expected to produce

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38/ Id. at 30-31 & 34-35.
40/ Id. at 22-31.
a total of 1.2 million jobs and $20 billion in tax revenues during construction and 500,000 jobs and $14 billion in annual taxes thereafter.\textsuperscript{41}

\textbf{3. Greenhouse Gas Reduction}

Accumulating evidence indicates that unconventional gas development is also helping to reduce greenhouse gas emissions in the United States. Substantial recent reductions in such emissions have been attributed in large part to low-cost natural gas displacing higher-cost coal, which most authorities believe produces almost twice as much carbon dioxide ("\(\text{CO}_2\)") per energy unit.\textsuperscript{42/}

For example, EIA has reported that \(\text{CO}_2\) emissions from energy use during 2012 decreased by 200 million tons from the prior year and reached their lowest level since 1994.\textsuperscript{43/} EIA attributed much of this reduction to "[l]ower natural gas prices” which “shifted power generation from the most carbon-intensive fossil fuel (coal) to the least carbon-intensive fossil fuel (natural gas).”\textsuperscript{44/} IEA has similarly reported that \(\text{CO}_2\) emissions in the United States have decreased by 430 million tons, or about 8%, since 2006, which is the largest reduction of any country or region.\textsuperscript{45/} This too is attributed largely to utilities switching from coal to gas.\textsuperscript{46/}

\textsuperscript{41} \textit{Id.} at 31-34.


\textsuperscript{44/} \textit{Id.}

\textsuperscript{45/} IEA, GLOBAL CARBON-DIOXIDE EMISSION INCREASE BY 1.0 GT IN 2011 TO RECORD HIGH (May 24, 2012), http://www.iea.org/newsroomandevents/news/2012/may/name,27216,en.html.

\textsuperscript{46/} \textit{Id.}
place this decrease in perspective, it is about double the total effect of the Kyoto Protocols on carbon emissions in the rest of the world.\textsuperscript{47/}

Some researchers have, however, reached contrary conclusions. A 2011 paper by several Cornell University researchers concludes that the greenhouse gas footprint of methane released during shale gas development is potentially greater than that of coal.\textsuperscript{48/} A subsequent study by researchers at the National Oceanic and Atmospheric Administration (“NOAA”) and the University of Boulder reached similar conclusions regarding methane emissions from natural gas development.\textsuperscript{49/} At present, these studies constitute outliers, which have been disputed by researchers at Cornell, the Massachusetts Institute of Technology, and elsewhere.\textsuperscript{50/}

C. Public Concerns

Hydraulic fracturing is also creating environmental and health concerns, particularly as this activity and associated oil and gas development move into new areas and regions. These concerns include potential water contamination and depletion, air emissions, chemical exposure, and seismic and community impacts.

\textsuperscript{47/} See Bjorn Lomborg, \textit{A Fracking Good Story}, SLATE, Sept. 15, 2012, \url{http://www.slate.com/articles/health_and_science/project_syndicate/2012/09/thanks_to_fracking_us_carbon_emissions_are_at_the_lowest_levels_in_20_years_.html}.


1. Water Contamination and Consumption

Concerns have arisen that hydraulic fracturing could adversely impact both the quality and the quantity of water supplies. For example, the acquisition of water for hydraulic fracturing could conceivably diminish the volume of water that is available for other purposes. Similarly, improper handling of hydraulic fracturing fluids at the well site could lead to surface spills and leakage into shallow aquifers, as could improper management and disposal of flowback fluids. Concerns have also been raised over the possibility of fracturing fluid leaking into drinking water through existing or induced fractures or through a poorly constructed well.

These potential water impacts are the subject of proliferating, and sometimes conflicting, studies and commentary. For example, independent analysis of pre- and post-drilling ground water samples in the San Juan Basin of Colorado indicated no statistically significant changes in ground water chemistry. A study conducted for the Pennsylvania General Assembly surveyed similar data from Pennsylvania and reached the same conclusion. The States of Colorado and Texas found that hydraulic fracturing accounts for one percent or less of annual water use.

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51/ See, e.g., SEAB 90-DAY REPORT, supra, at 19-22.
52/ Id.
53/ Id.
54/ Id.
DOE-funded study reached a similar conclusion regarding water use from potential future hydraulic fracturing in New York, Pennsylvania, and West Virginia. 58/

On the other hand, a peer reviewed study by Duke University researchers found “systemic evidence for methane contamination of drinking water associated with shale-gas extraction” in Pennsylvania, but “no evidence for contamination of drinking water samples with deep saline brines or fracking fluids.” 59/ A subsequent study by some of the same researchers found evidence that deep saline water had migrated into shallower drinking water in Pennsylvania, but determined that such migration was unrelated to oil and gas development. 60/

2. Air Emissions

Hydraulic fracturing can potentially affect air quality in several ways. Diesel trucks transporting equipment, water, and other materials to and from the well site can generate nitrogen oxides, particulates, carbon monoxide, and hazardous air pollutants. 61/ Nitrogen oxides, in turn, can create ozone, which is associated with a number of adverse health effects, while the other pollutants can likewise cause harmful health effects. 62/ Off-road diesel engines used to generate the pressure to fracture the well can produce the same types of pollutants. 63/ Pits that collect flowback fluids can emit volatile organic compounds (“VOCs”), methane, and hazardous

61/ See GAO OIL AND GAS REPORT, supra, at 16.
62/ Id. at 14-15.
63/ Id. at 16.
air pollutants. In addition, methane, a potent greenhouse gas, can be released into the atmosphere during the flowback process.

As with water, these air emissions are the subject of proliferating and sometimes conflicting studies and commentary, much of which addresses oil and gas development generally and not hydraulic fracturing specifically. For example, a study by researchers at the University of Colorado School of Public Health found that residents living within one-half mile of wells in Western Colorado are at greater risk for health effects from natural gas development than residents living further away and that the risks were greatest during the hydraulic fracturing process. But a State of Colorado study involving a different area found no significant concentrations of any air pollutant that could be attributed to the drilling or hydraulic fracturing of a nearby well. Similarly, a Fort Worth study did not reveal any significant health threats extending beyond the City’s 600-foot setback requirement. Pennsylvania emissions data indicates that shale gas development generally accounted for less than 10% of the air pollutants generated by stationary sources during 2011. Assessment of this issue is complicated by the

64/ Id.
65/ See EPA OVERVIEW, supra, at 3.
limited data that is available regarding actual emissions from oil and gas development, by the need to separate such emissions from those of other similar sources, and by the influence of geographic and meteorological conditions.

3. Chemical Exposure

Another source of concern has been the use of chemical additives in hydraulic fracturing fluid. Historically, the identity of these chemicals was unavailable to the public, which diminished public confidence in the safety of hydraulic fracturing. There has also been concern that these chemicals could contaminate ground or surface water or adversely affect the health of nearby residents.

These concerns were underscored by a widely-publicized 2011 congressional report, which summarized the volumes and chemical contents of the hydraulic fracturing products used by a number of oil and gas service companies. According to the report, these companies used more than 780 million gallons of hydraulic fracturing products, not including water, during the period from 2005 and 2009. These products contained 750 chemicals and components, and 29 of these chemicals are known or possible human carcinogens, regulated for their risks to human health under the Safe Drinking Water Act, or listed as hazardous under the Clean Air Act.

On the other hand, wells are cased and cemented to prevent hydraulic fracturing fluid that is injected down the wellbore, and flowback fluids and oil and gas that return up the wellbore,

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70/ SEAB 90-DAY REPORT, supra, at 16.
71/ Id. at 23-24.
73/ Id. at 1.
74/ Id.
from coming into contact with ground water. In addition, the shallowest fractures typically occur thousands of feet below the deepest aquifers that are suitable for drinking water. A 2009 survey of oil and gas producing states found “no known cases of groundwater contamination associated with hydraulic fracturing.” Former USEPA Administrator Jackson has similarly stated that she is “unaware of any proven case” where the hydraulic fracturing process itself affected water.

The issue of chemical identification was partially addressed by the development of a website, www.FracFocus.org, which serves as a registry for oil and gas companies to disclose the chemicals used to hydraulically fracture a well. The publically-available site is currently searchable by area, well, company, date, and chemical. Since the site began operating in April 2011, companies have disclosed information on some 50,000 wells, and during the first year of operation the site received more than 145,000 individual visits.

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75/ See, e.g., King, supra, at 6 & 21-24; FRACFOCUS WELL CONSTRUCTION, supra.
77/ INTERSTATE OIL AND GAS COMPACT COMMISSION, TESTIMONY SUBMITTED TO THE HOUSE COMMITTEE ON NATURAL RESOURCES SUBCOMMITTEE ON ENERGY AND MINERAL RESOURCES 7 (June 11, 2009), available at http://www.iogcc.state.ok.us/hydraulic-fracturing.
4. Other Concerns

Concerns have also been raised about the possibility that hydraulic fracturing could trigger earthquakes or adversely affect communities by increasing truck traffic, noise, dust, and road damage.

The National Research Council has recently addressed the earthquake issue.\textsuperscript{82} Their report acknowledges growing public concern over the potential for various energy technologies that inject or extract fluid from the subsurface, including hydraulic fracturing, to cause induced seismic events.\textsuperscript{83} But they conclude that hydraulic fracturing “does not pose a high risk for inducing felt seismic events” in large part because of the relatively short duration of the injection process and small volume of fluids involved.\textsuperscript{84} DOE has reached similar conclusions, noting that the process “rarely creates unwanted induced seismicity that is large enough to be detected on the surface—even with very sensitive sensors.”\textsuperscript{85}

Community concerns involving truck traffic, noise, dust, and road damage are not limited to hydraulic fracturing, but apply to unconventional oil and gas development generally. These nuisance and infrastructure impacts are usually limited to the initial drilling and hydraulic fracturing period.\textsuperscript{86} Where they are an issue, oil and gas companies can seek to address them in various ways. For example, the use of pipelines to transport fluids to and from the well site can reduce traffic and avoid road damage.\textsuperscript{87} Companies can also adjust the timing of operations and


\textsuperscript{83} Id. at 1.

\textsuperscript{84} Id. at 1, 8.


\textsuperscript{86} See DOE SHALE GAS PRIMER, supra, at 49.

\textsuperscript{87} Id. at 49-50.
install sound barriers to reduce noise and water unpaved roads to decrease dust.\textsuperscript{88} If road damage occurs, companies can maintain or repair the road so that the costs don’t fall on local taxpayers.\textsuperscript{89}

\section*{III. COMPARISON OF FEDERAL AND STATE REGULATIONS}

The development of oil and gas in the United States, including unconventional oil and gas, is regulated by both the federal and state governments.\textsuperscript{90} These federal and state regulations address various exploration and production processes, and a number of these regulatory requirements implicitly encompass hydraulic fracturing. In addition, both federal and state governments have recently adopted or proposed special regulatory requirements to address hydraulic fracturing and its associated risks.

\subsection*{A. Federal Regulation}

Although there is no overarching federal regulatory program for oil and gas development, various federal environmental laws each governs a discrete aspect of this activity.\textsuperscript{91} Even these environmental laws, however, regulate oil and gas development in a nuanced and limited manner. For example, several of them exempt certain exploration and production activities,\textsuperscript{92} while others have provisions for delegating their implementation to the states.\textsuperscript{93}

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\textsuperscript{88} Id. at 49.  \\
\textsuperscript{89} Id. at 50.  \\
\textsuperscript{90} In addition to federal and state regulation, some local governments have adopted requirements for or limitations on oil and gas development. The issue of local regulation is beyond the scope of this paper, but is addressed in Dave Neslin, “Hydraulic Fracturing Litigation: Recent Developments and Current Issues in Cases Involving Alleged Water Supply Impacts,” The Water-Energy Nexus, Paper No. 7, Pages No. 16-20 (Rocky Mt. Min L. Fdn. 2012).  \\
\textsuperscript{91} See, e.g., GAO OIL AND GAS REPORT, supra, at 17-43.  \\
\textsuperscript{92} Id. at 43-45.  \\
\textsuperscript{93} See, e.g., DOE SHALE GAS PRIMER, supra, at 25.
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The most significant federal environmental laws for this purpose are the Safe Drinking Water Act, Clean Water Act, Clean Air Act, Comprehensive Environmental Response, Compensation, and Liability Act, and Emergency Planning and Community Right-to-Know Act. The application of these laws to hydraulic fracturing is summarized below, together with several other recent federal initiatives on this subject.

1. **Safe Drinking Water Act**

The Safe Drinking Water Act ("SDWA") protects drinking water quality. Under SDWA, EPA regulates underground fluid injection through the Underground Injection Control ("UIC") program. The UIC program sets standards for siting, constructing, and operating injection wells, which address casing and cementing and testing and monitoring and require individual well permits. Many states implement the UIC program for oil and gas wells, which typically involve the injection of fluids for enhanced recovery or wastewater disposal.

Historically, EPA did not attempt to regulate hydraulic fracturing under the UIC program. In 1997, however, the United States Court of Appeals for the Eleventh Circuit held that “hydraulic fracturing activities constitute ‘underground injection’ under . . . the SDWA.”

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101/ Id. § 300h(b).
103/ See, e.g., GAO OIL AND GAS REPORT, supra, at 18.
104/ Id. at 20.
105/ Legal Envt’l Assistance Found. v. EPA, 118 F.3d 1467, 1478 (11th Cir. 1997).
In 2005, Congress amended the SDWA to specifically exempt hydraulic fracturing not involving diesel fuel from the UIC program.\textsuperscript{106} Therefore, EPA currently construes the SDWA to require a UIC permit for hydraulic fracturing if diesel fuel is used.\textsuperscript{107}

In May 2012, EPA issued draft permitting guidance under the SDWA for hydraulic fracturing using diesel fuel.\textsuperscript{108} The draft guidance defines the key term “diesel fuel” for this purpose,\textsuperscript{109} and it makes a number of recommendations regarding permit applications, well construction, financial responsibility, and well closure.\textsuperscript{110} By its terms, the guidance is directed to EPA permitting staff in those states that do not implement the UIC program for oil and gas development,\textsuperscript{111} including Pennsylvania and New York. In practice, however, it may influence all states with respect to both hydraulic fracturing involving diesel fuel and the broader topic of hydraulic fracturing generally. EPA has not yet finalized the draft guidance.

2. Clean Water Act

The Clean Water Act (“CWA”) protects general water quality by regulating discharges into waters of the United States.\textsuperscript{112} Under the National Pollutant Discharge Elimination System (“NPDES”), a permit is required to discharge pollutants to surface waters.\textsuperscript{113} Such discharge permits can impose conditions pursuant to technology-based and water-quality based effluent

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\textsuperscript{107} EPA, REGULATION OF HYDRAULIC FRACTURING UNDER THE SAFE DRINKING WATER ACT, \url{http://water.epa.gov/type/groundwater/USC/class2/hydraulicfracturing/wells-hydoreg.cfm}.
\textsuperscript{108} EPA, PERMITTING GUIDANCE FOR OIL AND GAS HYDRAULIC FRACTURING ACTIVITIES USING DIESEL FUELS – DRAFT: UNDERGROUND INJECTION CONTROL PROGRAM GUIDANCE #84 (May 4, 2012), available at \url{http://water.epa.gov/type/groundwater/vic/class2/hydraulicfracturing/upload/hfdieselfuelsguidance508.ndf}.
\textsuperscript{109} Id. at 6-11.
\textsuperscript{110} Id. at 12-31.
\textsuperscript{111} Id. at 32-34.
\textsuperscript{112} See EPA, SUMMARY OF THE CLEAN WATER ACT, \url{http://www.epa.gov/lawsregs/laws/cwa.html}.
\textsuperscript{113} 33 U.S.C. §§ 1311(a) & 1342 (2012).
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limitations. These permitting requirements would apply to discharges of fracturing fluid flowback or produced water to rivers, streams, and other surface waters. EPA has generally prohibited such discharges except that facilities located west of the 98th meridian, which extends from the eastern border of North Dakota through central Texas, may discharge produced water that meets water quality standards and is used for designated purposes.

Under the CWA, EPA also requires certain facilities to obtain NPDES permits for discharges of stormwater associated with industrial and construction activities and undertake certain oil spill prevention and response planning measures. As currently crafted, however, these stormwater and spill prevention requirements have limited application to hydraulic fracturing.

EPA plans to develop effluent limitations to address wastewater discharges associated with certain types of unconventional oil and gas development. In 2013, EPA plans to propose effluent limitations for produced water discharges from coalbed methane development. In 2014, EPA plans to propose such limitations for produced water discharges from shale gas development into wastewater treatment plants. When finalized, these limitations will apply to hydraulic fracturing flowback that comes from coalbed methane formations or is discharged to wastewater treatment plants.

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114/ Id. §§ 1311-1317.
115/ See, e.g., GAO OIL AND GAS REPORT, supra, at 24-25.
118/ See, e.g., GAO OIL AND GAS REPORT, supra, at 26-28.
120/ Id. at 66,295-98.
3. **Clean Air Act**

The Clean Air Act (“CAA”) protects air quality by regulating emissions from mobile and stationary sources.\(^{121}\) Among other things, the CAA authorizes EPA to set air quality standards for six criteria pollutants, including ozone, carbon monoxide, particulates, and nitrogen oxide, and to regulate emissions of 187 hazardous air pollutants, including benzene.\(^{122}\)

Mobile sources associated with hydraulic fracturing may include trucks emitting nitrogen oxides, particulates, carbon monoxide, and hazardous air pollutants when they bring equipment, water, and supplies to and from the well site and truck-mounted pumps and engines which may emit such pollutants when they provide the necessary pressure for fluid injection.\(^{123}\) This type of equipment is not specific to hydraulic fracturing and is subject to generally-applicable EPA emission regulations.\(^{124}\)

Stationary sources associated with hydraulic fracturing include wells emitting VOCs, methane, and hazardous air pollutants during flowback.\(^{125}\) In 2012, EPA adopted new emission standards to reduce the venting of VOCs (and, implicitly, methane and hazardous air pollutants) during the flowback process.\(^{126}\) This will be accomplished by requiring most hydraulic fracturing treatments to use “green completion” techniques to capture and treat flowback emissions.

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\(^{123}\) See, e.g., GAO OIL AND GAS REPORT, supra, at 16.

\(^{124}\) Id. at 29-30.

\(^{125}\) Id. at 16.

emissions so that the captured natural gas can be sold or otherwise used and the remaining hydraulic fracturing treatments to combust the emissions.\textsuperscript{127/}

Under the CAA, EPA also requires various industrial facilities, including many oil and gas wells, to report their greenhouse gas emissions annually.\textsuperscript{128/} This requirement became effective for oil and gas wells in 2012,\textsuperscript{129/} and EPA estimates that it will apply to approximately 467,000 onshore wells.\textsuperscript{130/} It requires operators to report greenhouse gas emissions associated with hydraulic fracturing and other operations.

4. **Comprehensive Emergency Response, Compensation, and Liability Act**

The Comprehensive Emergency Response, Compensation, and Liability Act ("CERCLA") addresses the cleanup of hazardous substances, pollutants, and contaminates.\textsuperscript{131/} CERCLA defines "hazardous substance" to exempt petroleum, crude oil, natural gas, natural gas liquids, and associates substances.\textsuperscript{132/} But it does apply to releases of other hazardous substances, which could include spills of hydraulic fracturing chemicals. Such releases are subject to reporting requirements,\textsuperscript{133/} and EPA has authority to undertake investigations, obtain information, and pursue potentially responsible parties.\textsuperscript{134/} Indeed, EPA has recently used this

\begin{itemize}
\item \textsuperscript{127/} Id.
\item \textsuperscript{128/} 40 C.F.R. pt. 98, subpt. W (2012).
\item \textsuperscript{129/} Id.
\item \textsuperscript{130/} Mandatory Reporting of Greenhouse Gases: Petroleum and Natural Gas Systems; Final Rule, 75 Fed. Reg. 74,458, 74,479 (Nov. 30, 2010).
\item \textsuperscript{131/} See EPA, SUMMARY OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT, \url{http://www.epa.gov/lawregs/laws/cercla.html}.
\item \textsuperscript{132/} 42 U.S.C. § 9601(14) (2012).
\item \textsuperscript{133/} Id. § 9603(a).
\item \textsuperscript{134/} Id. §§ 9604(a), (b), & (c) & 9606(a).
\end{itemize}
authority with respect to alleged hazardous substance releases from several oil and gas well sites, though it is unclear what, if any, role hydraulic fracturing played.135/

5. **Emergency Planning and Community Right-to-Know Act**

The Emergency Planning and Community Right-to-Know Act (“EPCRA”) helps communities plan for emergencies and obtain information on chemical hazards.136/ Among other things, it requires facilities to notify state and local emergency planning authorities if certain hazardous or extremely hazardous substances are released in specified amounts.137/ It also requires facilities to meet inventory reporting requirements if they store or use more than 500 pounds of an extremely hazardous substance or 10,000 pounds of other hazardous chemicals.138/ These requirements would apply to hydraulic fracturing operations if such operations trigger the release, storage, and use substance and quantity thresholds; this may be more likely at service company facilities than individual well sites.

6. **Other Regulatory Actions**

A number of other federal regulatory actions regarding hydraulic fracturing deserve brief mention. In early 2011, the Secretary of Energy created a blue ribbon panel to identify “immediate steps that can be taken to improve the safety and environmental performance of fracking.”139/ The resulting “90-Day Report” recommends 20 actions, including improving

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135/ See, e.g., GAO OIL AND GAS REPORT, supra, at 177-78.
138/ Id. §§ 11021 & 11022.
139/ See SEAB 90-DAY REPORT, supra, at Annex A.
public information, reducing air emissions, adopting best practices for well construction, requiring background water quality measurements, and disclosing fracturing fluid chemicals.\textsuperscript{140}

In November 2011, EPA released its plans for a comprehensive, multi-year study on the potential effects of hydraulic fracturing on drinking water.\textsuperscript{141} This study will address the full range of such effects, from water acquisition through chemical mixing and fluid injection, to flowback management and disposal.\textsuperscript{142} The research will include data analysis, case studies, scenario evaluations, laboratory studies, and toxicity assessments.\textsuperscript{143} In December 2012, EPA issued an interim progress report, which drew no conclusions but summarized the study’s progress.\textsuperscript{144} A draft final report is expected to be released in 2014 for public comment and peer review.\textsuperscript{145}

Also in November 2011, EPA granted part of a petition submitted by several environmental organizations requesting that it conduct rulemaking under Section 8 of the Toxic Substances Control Act\textsuperscript{146} to develop rules for obtaining data on chemical substances and mixtures used in hydraulic fracturing.\textsuperscript{147} In granting the petition, EPA stated that it expects to

\textsuperscript{140} SEAB 90-DAY REPORT, supra.
\textsuperscript{141} EPA, PLAN TO STUDY THE POTENTIAL IMPACTS OF HYDRAULIC FRACTURING ON DRINKING WATER RESOURCES (Nov. 2011), available at http://www2.epa.gov/hfstudy/plan-study-potential-impacts-hydraulic-fracturing-drinking-water-resources-epa600r-11122.
\textsuperscript{142} Id.
\textsuperscript{143} Id.
\textsuperscript{146} 33 U.S.C. § 2607 (2012).
focus on “providing aggregate pictures of the chemical substances and mixtures used.” EPA has not yet indicated from whom it will seek this information, nor has it initiated rulemaking on this subject.

In April 2012, President Obama issued an executive order on unconventional natural gas development. The order states that it is “vital that we take full advantage of natural gas resources,” while protecting “air and water quality, and public health and safety.” In describing the federal government’s role, it includes supporting research and development and seeking sensible, cost-effective standards to implement federal law and augment state regulation. It also establishes a working group to coordinate the ongoing efforts of 13 federal agencies that have some involvement with unconventional gas development. Although the order does not address hydraulic fracturing specifically, the guidance it provides applies to this topic too.

Finally, in May 2012, the Bureau of Land Management (“BLM”) proposed new rules to regulate hydraulic fracturing on federal and Indian land. Following significant opposition, the proposed rules were withdrawn and reissued in revised form in May 2013. Both as originally proposed and as revised, the new rules would impose three general types of new requirements on such activity: wellbore integrity requirements; water management requirements; and chemical disclosure requirements. For wellbore integrity, operators would have to submit mechanical

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148/ Id.
150/ Id.
151/ Id.
152/ Id.
153/ Oil and Gas; Well Stimulation, Including Hydraulic Fracturing, on Federal and Indian Lands, 77 Fed. Reg. 27,691 (proposed May 11, 2012) (to be codified at 43 C.F.R. § 3162.3-3).
integrity test results, cement evaluation logs, and various other information.\textsuperscript{155} For water management, operators would have to submit plans for managing flowback fluids and store all fluids in tanks or lined pits.\textsuperscript{156} For disclosure, operators would have to report fluid composition on FracFocus, another BLM-designated database, or a BLM sundry notice.\textsuperscript{157} States and Indian Tribes could seek variances from these requirements for all wells within their jurisdiction where their regulations provide equivalent protection.\textsuperscript{158} BLM has not yet adopted final rules.

B. State Regulation

States have traditionally taken the laboring oar in regulating oil and gas development.\textsuperscript{159} State leadership is appropriate given that highly diverse regional and local conditions are best understood at the state level and states can tailor their requirements to fit the needs of their basins, environments, and communities.\textsuperscript{160} In addition, states are generally faster acting and more nimble than the federal government, attributes which are critical in regulating a dynamic and technically innovative activity like unconventional oil and gas development. For example, since September 2010, at least 19 states, which collectively account for about 95% of oil and gas development in the United States, have adopted mandatory disclosure requirements for hydraulic fracturing chemicals, while no comparable federal legislation or regulations have yet been

\textsuperscript{155} Id. at 31,765-66 (to be codified at 43 C.F.R. §§ 3162.3-3(d)(4), (e), & (f)).
\textsuperscript{156} Id. (to be codified at 43 C.F.R. §§ 3162.3-3(d)(5) & (h)).
\textsuperscript{157} Id. at 31,766 (to be codified at 43 C.F.R. § 3162.3-3(i)(1)).
\textsuperscript{158} Id. at 31,767 (to be codified at 43 C.F.R. § 3162.3-3(k)).
\textsuperscript{160} Id.
Numerous states have also updated various other aspects of their oil and gas regulations during the past few years. Most states have relatively sophisticated, cradle-to-grave regulations that govern both conventional and unconventional oil and gas development. These regulations typically address:

• well site selection and preparation;
• drilling, casing, and cementing;
• hydraulic fracturing;
• well plugging;
• site reclamation;
• waste management and disposal; and
• air emissions.

Many of these requirements are set forth in regulations, while others are added to permits on an ad-hoc basis based upon environmental review, site visits, public comments, or agency hearings. All states require operators to obtain a permit before drilling an oil or gas well, and multiple agencies often oversee different facets of oil and gas operations.

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162/ See, e.g., GAO OIL AND GAS REPORT, supra, at 47 (referencing Colorado, North Dakota, Ohio, Pennsylvania, Texas, and Wyoming).

163/ See, e.g., DOE SHALE GAS PRIMER, supra, at 26; GAO OIL AND GAS REPORT, supra, at 47.

164/ See, e.g., GAO OIL AND GAS REPORT, supra, at 50-65.

165/ See, e.g., DOE SHALE GAS PRIMER, supra, at 26.
In recent years, a number of states have adopted specific regulatory requirements to address concerns associated with hydraulic fracturing. The following are representative examples of these requirements.

1. **Colorado**

Colorado comprehensively updated and amended its regulations in 2008 to better address increasing unconventional oil and gas development, including development of both tight sandstone and coalbed methane formations. \[168\] As part of that process, Colorado adopted a number of requirements to address concerns associated with hydraulic fracturing, including requiring operators to:

- submit cement bond logs to confirm the sufficiency of cement coverage; \[169\]
- monitor well pressures during hydraulic fracturing and report any pressure increases that might indicate a release of fracturing fluids; \[170\]
- comply with additional setback requirements and operating standards to protect public drinking water systems; \[171\]
- install secondary containment at the well site and comply with more stringent pit requirements to protect ground water; \[172\]
- sample ground water and survey nearby oil and gas wells when developing coalbed methane formations; \[173\]
- in designated areas, use green completion techniques where feasible and comply with other operating requirements to reduce air emissions; \[174\] and

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166 Id.
167 Id. at 27.
170 Id. § 404-1:341.
171 Id. § 404-1:317B.
172 Id. §§ 404-1:603.e.(12), 604.a.(4), & 904.
173 Id. § 404-1:608.
174 Id. § 404-1:805.b.
• inventory chemicals stored at well sites in specified amounts and share this information with the State and health professionals.\textsuperscript{175}  

In 2011, Colorado adopted new regulations mandating the public disclosure of hydraulic fracturing fluid constituents.\textsuperscript{176}  These regulations impose tiered requirements on chemical vendors, service companies, and operators, with vendors and service companies providing chemical information to operators and operators posting such information on www.FracFocus.org.\textsuperscript{177}  All chemicals and chemical concentrations must be reported unless they constitute trade secrets,\textsuperscript{178}  but product information may be separated from chemical information to reduce the need for trade secret claims.\textsuperscript{179}  If a trade secret is claimed, the claimant must justify the claim and certify its legitimacy.\textsuperscript{180}  Such claims are subject to challenge,\textsuperscript{181}  and trade secret information must be provided to the State and health professionals under certain circumstances.\textsuperscript{182}  Operators must also provide landowners with information on hydraulic fracturing\textsuperscript{183}  and notify the State 48 hours before the treatment begins.\textsuperscript{184}  

In 2012, the State began requiring operators to provide the State with additional information on hydraulic fracturing.\textsuperscript{185}  The additional information includes the total volumes of

\textsuperscript{175}  Id. § 404-1:205.  
\textsuperscript{176}  35 COLO. REG. No. 1 (Jan. 10, 2012).  
\textsuperscript{177}  2 COLO. CODE REGS. § 404-1:205A.b.(1) & (2) (2012).  
\textsuperscript{178}  Id. § 404-1:205A.b.(2).  
\textsuperscript{179}  Id. § 404-1:205A.b.(2)(A).  
\textsuperscript{180}  Id. § 404-1:205A.b.(2)(C).  
\textsuperscript{181}  Id. § 404-1:522.a.(1) & C.R.S. § 34-60-114 (2012).  
\textsuperscript{182}  2 COLO. CODE REGS. § 404-1:205A.b.(5) & d.(2) (2012).  
\textsuperscript{183}  Id. § 404-1:305.e.(1)(A).  
\textsuperscript{184}  Id. § 404-1:316C.  
\textsuperscript{185}  COLORADO OIL & GAS CONSERVATION COMMISSION, FORM 5A, COMPLETED INTERVAL REPORT, available at http://cogcc.state.co.us.
fluid and sand used, together with the amount of recycled and fresh water utilized.\textsuperscript{186} Information is also required on the volume and disposition of flowback as well as whether green completion techniques were used.\textsuperscript{187} The State also began requiring the operators in the Greater Wattenberg Area north of Denver to notify the operators of certain offset wells before conducting hydraulic fracturing treatments, and for such offset well operators to monitor their well pressure during the treatment and notify the State of significant increases.\textsuperscript{188}

Finally, in early 2013, the State adopted new regulations to expand the ground water sampling program\textsuperscript{189} and provide additional protection for nearby homes and neighborhoods.\textsuperscript{190} Although not specific to hydraulic fracturing, these regulations address some of the water quality and community impact concerns associated with that practice. The water sampling rule generally requires operators to sample four water sources before, six to twelve months after, and again five to six years after an oil and gas well is drilled and hydraulically fractured.\textsuperscript{191} This information must be provided to the landowner and the State\textsuperscript{192} and can be used to evaluate allegations of water contamination. The neighborhood protection rule expands the setbacks for oil and gas wells to 500 feet and imposes new notice, meeting, and mitigation requirements.\textsuperscript{193} The new

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\textsuperscript{186} Id.
\textsuperscript{187} Id.
\textsuperscript{188} COLORADO OIL & GAS CONSERVATION COMMISSION, COGCC POLICY FOR MONITORING DURING HYDRAULIC FRACTURING TREATMENTS IN THE GREATER WATTENBERG AREA (May 29, 2012), available at http://cogcc.state.co.us.
\textsuperscript{189} 36 COLO. REG. No. 3 (Feb. 10, 2013) (to be codified at 2 COLO. CODE REGS. § 404:609).
\textsuperscript{190} 36 COLO. REG. No. 5 (March 10, 2013) (to be codified at 2 COLO. CODE REGS. §§ 404:100, 303, 305, 306, 602-605, & 802-805).
\textsuperscript{191} 36 COLO. REG. No. 3 (to be codified at 2 COLO. CODE REGS. §§ 404:609.b, .d, & .e).
\textsuperscript{192} Id. (to be codified at 2 COLO. CODE REGS. § 404-1:609f).
\textsuperscript{193} 36 COLO. REG. No. 5 (to be codified at 2 COLO. CODE REGS. §§ 404-1:305, 306, 604, & 802).
mitigation includes tougher noise restrictions, closed loop fluid system requirements and pit limitations, expanded green completion obligations, and traffic plans.194/

2. North Dakota

North Dakota adopted extensive amendments to its oil and gas regulations in 2012.195/ The amendment involved 26 sections of rules, and were termed “the most significant changes” made in “31 years.”196/ As amended, the regulations require operators to:

- obtain special permits for horizontal wells;197/
- site new wells at least 500 feet from occupied buildings and away from bodies of water and natural drainages;198/
- install dikes and ensure that spills and leaks do not come to rest on the land surface or infiltrate the soil;199/ and
- run cement bond logs to confirm the sufficiency of cement coverage.200/

The amendments specifically address hydraulic fracturing and pits. A new hydraulic fracturing rule sets forth specific technical requirements for hydraulic fracturing treatments, including casing, pressure monitoring, and relief valve requirements.201/ It also requires the owner, operator, or service company to post chemical constituent information on www.FracFocus.org within 60 days after the fracturing treatment is performed.202/ A new pit rule generally prohibits storing salt water, drilling mud, crude oil, waste oil, or other waste in

[194/ Id. (to be codified at 2 COLO. CODE REGS. §§ 404-1:604.c.(2)(A)-(D)).
196/ Id.
198/ Id. §§ 43-02-03-19 & -28.
199/ Id. § 43-02-03-30.1.
200/ Id. § 43-02-03-31.
201/ Id. § 43-02-03-27.1.
202/ Id.]
earthen pits or open receptacles except in an emergency or with State approval.\textsuperscript{203} Lined earthen pits may be temporarily used for fluids generated during hydraulic fracturing, provided that such pits are impermeable and the contents are removed within 72 hours after operations cease.\textsuperscript{204}

3. Ohio

In 2010, the Ohio legislature enacted Senate Bill 165, which extensively amended Ohio’s oil and gas laws to update environmental and other requirements.\textsuperscript{205} Although the legislation covered a wide array of issues, a number of provisions address hydraulic fracturing either directly or indirectly. These provisions require operators to:

- maintain setbacks of 200 feet from occupied dwellings in urban areas and 150 feet from occupied dwellings in other areas;\textsuperscript{206}
- notify landowners within 500 feet and local governments of drilling permit applications;\textsuperscript{207}
- comply with various well construction requirements;\textsuperscript{208}
- notify the State 24 hours before beginning hydraulic fracturing;\textsuperscript{209} and
- use pits or steel tanks as specified by the State to contain hydraulic fracturing flowback.\textsuperscript{210}

The State adopted regulations to implement those provisions in 2012.\textsuperscript{211}

\textsuperscript{203} Id. § 43-02-03-19.3.
\textsuperscript{204} Id.
\textsuperscript{205} See Ohio Department Natural Resources, Division Oil & Gas Resources, Laws & Regulations, Senate Bill 165, http://oilandgas.ohiodnr.gov/Laws-Regulations/Senate-Bill-165.aspx/.
\textsuperscript{206} Ohio Rev. Code Ann. § 1509.021(A) & (C), (West 2012).
\textsuperscript{207} Id. § 1509.06(A).
\textsuperscript{208} Id. § 1509.17.
\textsuperscript{209} Id. § 1509.19.
\textsuperscript{210} Id. § 1509.22.
\textsuperscript{211} See Ohio Department Natural Resources, Division of Oil & Gas Resources, Well Construction Rule Package to JCARR, http://oilandgas.ohiodnr.gov/Laws-Regulations/Well-Construction-Rule-Package-to-JCARR.aspx/.
Subsequently, in 2012, the Ohio legislature enacted Senate Bill 315, which further amended Ohio’s oil and gas laws in response to increasing Utica Shale development. The amendments relevant to hydraulic fracturing require applicants for horizontal well permits to provide information on their anticipated water sources and volumes and any recycled water to be used and to attempt to reach agreement with the local government regarding road maintenance and use. Such applicants must also sample existing water wells within 1,500 feet of their proposed well prior to commencing drilling.

Senate Bill 315 also requires operators to disclose the chemical composition of all fluids used to drill, hydraulically fracture, or refracture a well. This information must be either disclosed as prescribed by the State or posted on www.FracFocus.org. Trade secrets are protected, but certain property owners and anyone else who could be adversely affected by the fluids may challenge trade secret claims in court. Trade secrets also must be shared with health professionals and the State.

4. Pennsylvania

Pennsylvania extensively amended its oil and gas regulations in 2011 to respond to the increasing development of natural gas from the Marcellus Shale and several incidents of

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213/ OHIO REV. CODE ANN. § 1509.06(C).
214/ Id.
215/ Id. § 1509.10(9), (10)(b), & (11)(B)(3).
216/ Id. § 1509.10(11)(F).
217/ Id. § 1509.10(11)(I)(1).
218/ Id. § 1509.10(11)(I)(2).
219/ Id. § 1509.10(11)(H) & (J).
contaminated drinking water attributed to such development. The amendments address hydraulic fracturing both directly, through new chemical recordkeeping requirements, and indirectly, through new water replacement, casing and cementing, and gas migration response requirements.

Subsequently, in 2012, the Pennsylvania legislature enacted Act No. 13, which comprehensively updates and amends the Commonwealth’s Oil and Gas Act. Much of Act 13 targets unconventional natural gas development that utilizes hydraulic fracturing, and it further addresses many of the concerns associated with that practice. For example, the Act expands the setbacks for unconventional wells to 300 feet from streams, wetlands, and other water bodies, 500 feet from buildings and private water wells, and 1,000 feet from facilities for water purveyors. It also requires: applicants for permits to drill unconventional wells to notify surface landowners and water purveyors within 3,000 feet, and to submit spill containment and water management plans; and operators of such wells to maintain wastewater fluid records and report certain air emissions.

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221/ 25 PA. CODE § 78.122 (2012).
222/ Id. § 78.51.
223/ Id. §§ 78.82-.85.
224/ Id. § 78.89.
227/ Id. § 3211(b)(2).
228/ Id. §§ 3211(m) & 3218.2.
229/ Id. § 3218.3.
230/ Id. § 3227.
The Act also creates a public disclosure process for hydraulic fracturing fluid chemicals that is modeled after the Colorado requirement.\textsuperscript{231} As in Colorado, the Act imposes tiered reporting requirements on chemical vendors, service companies, and operators,\textsuperscript{232} and requires chemical identities and concentrations to be posted on www.FracFocus.org.\textsuperscript{233} Trade secrets are protected,\textsuperscript{234} but they must be certified\textsuperscript{235} and the information must be shared with the State and health professionals under certain circumstances.\textsuperscript{236}

The Act also encourages operators of unconventional wells to undertake baseline ground water monitoring by extending a rebuttable presumption of responsibility for ground water pollution to 2,500 feet from the wellbore and 12 months from the later of completion, drilling, stimulation, or alteration.\textsuperscript{237} If such pollution occurs, an operator can use baseline ground water samples to prove that the pollution occurred prior to its work.\textsuperscript{238} If the operator has chosen not to collect such samples, then it is legally presumed to be responsible for the pollution and it must provide alternative water under certain circumstances.\textsuperscript{239}

\begin{itemize}
\item \textsuperscript{231} Id. § 3222.1.
\item \textsuperscript{232} Id. §§ 3222.1(b)(1) & (2).
\item \textsuperscript{233} Id. §§ 3203 & 3222.1(b)(2).
\item \textsuperscript{234} Id. §§ 3222.1(b)(3), (d)(1), & (e).
\item \textsuperscript{235} Id. § 3222.1(b)(4).
\item \textsuperscript{236} Id. §§ 3222.1(b)(10), (11), & (d)(2)(ii).
\item \textsuperscript{237} Id. § 3218(c).
\item \textsuperscript{238} Id. § 3218(d).
\item \textsuperscript{239} Id. §§ 3218(c) & (c.1).
\end{itemize}
5. Texas

Texas is the Babe Ruth of oil and gas producing states, with approximately 270,000 currently producing wells.\textsuperscript{240} In 2011, it became one of the first states to require public disclosure of hydraulic fracturing fluid chemicals.\textsuperscript{241} Like several other states, Texas imposes tiered disclosure requirements on chemical vendors (referred to as suppliers), service companies, and operators\textsuperscript{242} and requires chemical identities and concentrations to be posted on www.FracFocus.org.\textsuperscript{243} Trade secrets are protected,\textsuperscript{244} but they may be challenged by the State and certain landowners.\textsuperscript{245} Trade secret challenges are decided by the Office of the Attorney General with appeal to the courts.\textsuperscript{246} Trade secrets also must be shared with health professionals and emergency responders under certain circumstances.\textsuperscript{247}

In 2013, Texas adopted two regulatory amendments that relate to hydraulic fracturing. First, the State overhauled its well construction regulations.\textsuperscript{248} This process was intended to update the requirements for drilling, casing, cementing, and hydraulic fracturing,\textsuperscript{249} most of which predated the current boom in unconventional development. With respect to hydraulic fracturing, the amendment requires operators to:

\textsuperscript{242} 16 Tex. Admin. Code § 3.29(c)(1) & (2) (2012).
\textsuperscript{243} Id. § 3.29(c)(2)(A).
\textsuperscript{244} Id. §§ 3.29(c)(2)(C), (d)(4), & (e)(1).
\textsuperscript{245} Id. § 3.29(f)(1).
\textsuperscript{246} Id. § 3.29(f)(6)-(10).
\textsuperscript{247} Id. § 3.29(e) & (g).
\textsuperscript{248} 38 Tex. Reg. 3447 (June 7, 2013) (to be codified at 16 Tex. Admin Code § 3.13).
\textsuperscript{249} Id.
• test wells that will be hydraulically fractured to ensure that the casing will withstand the anticipated pressure;\textsuperscript{250/}

• monitor well pressures during hydraulic fracturing and report significant pressure increases;\textsuperscript{251/} and

• meet additional cementing, casing, and testing requirements on wells where there is “minimum separation” between ground water and the formation to be fractured.\textsuperscript{252/}

Second, the State amended certain regulations to encourage the recycling of hydraulic fracturing fluid flowback and produced water.\textsuperscript{253/} This amendment authorizes the on-lease, non-commercial recycling of such fluids, and clarifies the permitting requirements for off-lease, commercial recycling.\textsuperscript{254/}

6. NON-GOVERNMENTAL ORGANIZATIONS

The efforts of non-governmental organizations to ensure that hydraulic fracturing is undertaken responsibly are illustrated by two organizations: State Review of Oil and Natural Gas Environmental Regulations (“STRONGER”); and the Center for Sustainable Shale Development (“CSSD”).

a. STRONGER

STRONGER is a non-profit, multi-stakeholder organization that audits state programs regulating the environmental effects of oil and gas development.\textsuperscript{255/} One-third of its board members and regulatory review teams are state oil and gas regulators, one-third are industry representatives, and one-third are environmental representatives.\textsuperscript{256/} Audits are voluntary and

\textsuperscript{250/} Id. (to be codified at 16 TEX. ADMIN. CODE § 3.13(a)(7)(B)).

\textsuperscript{251/} Id. (to be codified at 16 TEX. ADMIN. CODE § 3.13(a)(7)(C)).

\textsuperscript{252/} Id. (to be codified at 16 TEX. ADMIN. CODE § 3.13(a)(7)(D)).

\textsuperscript{253/} 38 TEX. REG. 2275 (Apr. 12, 2013) (to be codified at 16 TEX. ADMIN. CODE §§ 3.8 & 4.201-04).

\textsuperscript{254/} Id.

\textsuperscript{255/} See STRONGER, WHO WE ARE, www.strongerinc.org/who-we-are.

public.\textsuperscript{257} They evaluate state programs against STRONGER guidelines and result in written reports setting forth findings and recommendations for improvement.\textsuperscript{258/}

In 2010, STRONGER issued hydraulic fracturing guidelines, which address the following issues: standards; reporting; staffing and training; public information; and water and waste management.\textsuperscript{259/} These guidelines have been used to review hydraulic fracturing regulations in Arkansas, Colorado, Louisiana, Ohio, Oklahoma, and Pennsylvania.\textsuperscript{260/} STRONGER assists states in sharing their best practices, harmonizing their approach, and improving their environmental programs.

b. CSSD

Like STRONGER, CSSD is a non-profit, multi-stakeholder organization, which seeks to improve environmental performance through standards and certifications.\textsuperscript{261} Also, like STRONGER, CSSD’s board members reflect equal representation of environmental groups, industry, and government, academic, and other unaligned sectors.\textsuperscript{262} Unlike STRONGER, CSSD’s standards and certifications apply to the oil and gas operators rather than state regulators, and they focus on shale development in the Appalachian Basin rather than oil and gas development nationally.\textsuperscript{263}

\begin{thebibliography}{9}
\bibitem{258/} \textit{Id.}
\bibitem{260/} See STRONGER, PAST REVIEWS, www.strongerinc.org/past-reviews. STRONGER has reviewed a total of 22 state programs, and these 22 states account for more than 94% of onshore oil and gas production. \textit{Id.} For an example of a hydraulic fracturing review, see STRONGER, COLORADO HYDRAULIC FRACTURING STATE REVIEW (Oct. 2011), available at \textit{id}.
\bibitem{261} See CSSD, ABOUT THE CENTER FOR SUSTAINABLE SHALE DEVELOPMENT, https://www.sustainable shale.org/about/.
\bibitem{262} \textit{Id.}
\bibitem{263} \textit{Id.}
\end{thebibliography}
In 2013, CSSD issued 15 performance standards for addressing water and air issues associated with unconventional development in the Appalachian Basin.\textsuperscript{264} These standards focus on water recycling, wellbore integrity, groundwater monitoring, chemical disclosure, green completions, and reduced engine emissions, among other issues.\textsuperscript{265} The certification process is voluntary and will compare an operator’s performance against the CSSD standards.\textsuperscript{266} CSSD can assist operators in identifying best practices and improving their environmental performance.

IV. REGULATORY TRENDS

As the preceding section indicates, both federal and state agencies are currently devoting significant attention to hydraulic fracturing in the United States. These regulatory efforts suggest several trends which may help shape the approach to this subject in other countries.

A. Frequent Improvement

As reflected by the experience of diverse states like Colorado, Ohio, Pennsylvania, and Texas, hydraulic fracturing requirements are being adopted and updated with greater frequency. For example, Colorado addressed hydraulic fracturing in 2008, 2011, 2012, and 2013, Ohio in 2010 and 2012, Pennsylvania in 2011 and 2012, and Texas in 2011 and 2013.\textsuperscript{267} Some of these regulatory initiatives have been part of broader efforts to address unconventional oil and gas development generally, while others have focused on hydraulic fracturing specifically. Some have addressed well construction, while others have addressed chemical safety, flowback management, or data collection. This same trend is apparent at the federal level, where EPA has adopted, proposed, or contemplated a host of new regulatory initiatives under SDWA, CWA,

\begin{itemize}
\item \textsuperscript{264} CSSD, PERFORMANCE STANDARDS, https://www.sustainableslease.org/performance-standards/.
\item \textsuperscript{265} Id.
\item \textsuperscript{266} CSSD, CERTIFICATION, https://www.sustainableslease.org/certification/.
\item \textsuperscript{267} See supra notes 168-254 and accompanying text.
\end{itemize}
CAA, and TSCA.\textsuperscript{268} Taken together, these initiatives illustrate how the frequency of regulatory activity is increasing across the United States in response to hydraulic fracturing and unconventional oil and gas development, and they suggest that other countries may need to take more frequent action on these issues as well.

B. Incremental Action

A corollary to the increasing pace of regulatory activity is that much of this action is focused on incremental improvement and discrete issues, rather than comprehensive solutions. For example, Colorado followed the comprehensive updating of its regulations with further regulatory actions addressing chemical disclosure, data collection, ground water sampling, and community impacts.\textsuperscript{269} Ohio passed wide-ranging legislation followed by further legislation to address chemical disclosure, water protection, and road maintenance.\textsuperscript{270} Pennsylvania followed extensive regulatory amendments with legislation addressing setbacks, water protection, chemical disclosure, and data collection.\textsuperscript{271} Texas has separately addressed chemical disclosure, well construction, and recycling.\textsuperscript{272} And EPA has separately addressed or is addressing well construction, effluent discharges, air emissions, and chemical manufacturing.\textsuperscript{273}

This incremental approach allows the government to fine tune and adjust its requirements to respond to new concerns, information, and experience. It reflects the complexity and range of issues associated with hydraulic fracturing, as well as the variation in geographic, environmental, and social settings in which this activity occurs. This complexity and variation make

\textsuperscript{268} See supra notes 99-158 and accompanying text.  
\textsuperscript{269} See supra notes 168-194 and accompanying text.  
\textsuperscript{270} See supra notes 205-19 and accompanying text.  
\textsuperscript{271} See supra notes 220-39 and accompanying text.  
\textsuperscript{272} See supra notes 240-54 and accompanying text.  
\textsuperscript{273} See supra notes 108-11, 119-20, 126-30, & 146-48 and accompanying text.
comprehensive solutions more difficult to attain and less effective in practice. Incremental action can also help avoid regulatory paralysis, where the government becomes seemingly stymied by the complexity of the task or the controversial nature of the issue. In this way, it can help prevent the search for perfection from becoming an impediment to concrete improvements that can provide meaningful benefits.

C. Diverse Issues

Recent state and federal action also illustrates the diverse regulatory issues that are being addressed in connection with hydraulic fracturing. For example, Colorado, North Dakota, Ohio, Pennsylvania, Texas, EPA, and BLM have all addressed or are addressing well construction. Regulatory attention to this issue is appropriate because well bore integrity is the first line of environmental defense during both hydraulic fracturing and oil and gas development generally. Proper casing and cementing, coupled with typically-extensive geologic separation, keep hydraulic fracturing fluids, as well as oil and gas, from reaching ground water.

But recent regulatory action has gone beyond well construction. Colorado has addressed surface water protection, air emissions, chemical disclosure, data collection, ground water sampling, and community impacts. Ohio and Pennsylvania have likewise addressed chemical disclosure, data collection, ground water sampling, and community impacts, albeit in different ways. North Dakota and Texas too have addressed chemical disclosure, and Texas


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275/ See supra notes 23-24 and accompanying text.
276/ See supra notes 75-78 and accompanying text.
277/ See supra notes 171-72, 174-87, & 189-94 and accompanying text.
278/ See supra notes 206-07 & 213-19 and accompanying text.
279/ See supra notes 226-39 and accompanying text.
280/ See supra note 202 and accompanying text.
is addressing recycling. 282/ At the federal level, EPA has addressed or is addressing fracturing fluid disposal, air emissions, and chemical manufacturing. 283/ These additional issues all respond to environmental, health, and community concerns associated with hydraulic fracturing. Responsible attention to them will help maintain the “social contract” for unconventional oil and gas development and facilitate the expansion of such development into new areas and countries.

D. Prescription and Performance

State and federal regulation of hydraulic fracturing includes both prescriptive and performance-oriented requirements. Prescriptive regulations set forth detailed and specific requirements; they specify what, where, when, and how something must be done. In contrast, performance-oriented regulations set forth goals and objectives; they specify what must be accomplished. A regulation setting forth specific depth, compressive strength, and other cementing requirements is prescriptive; 284/ a regulation specifying that the casing program must prevent the migration of hydrocarbons or fluids from one geologic horizon to another is performance-oriented. 285/ Prescriptive requirements, coupled with performance-oriented exceptions are methods of combining the two approaches. 286/ In practice, many regulations do not fit exclusively into one approach or the other, but incorporate elements of both.

Both prescriptive and performance-oriented requirements are beneficial. Generally, prescriptive requirements provide greater uniformity, are more predictable, and are easier to enforce. By comparison, performance-oriented requirements can better encourage efficiency and

281 See supra notes 241-47 and accompanying text.
282 See supra notes 253-54 and accompanying text.
283 See supra notes 119-20, 125-30, 146-48 and accompanying text.
284 See, e.g., 2 COLO CODE REGS. §§ 404-1:317.h & .i (2012).
285 See, e.g., id. § 404-1:317.d.
286 See, e.g., id. §§ 404-1:904.c & .d (setting forth detailed specifications for pit liners, but allowing operators to use different specifications upon a satisfactory demonstration that they will provide equivalent protection).
creativity and generate more win-win solutions. Responsible regulation requires regulators to strike an appropriate balance between the two approaches and thereby seek to maximize the benefits of each. This, in turn, will require careful consideration of various factors, including the range of potential solutions, need for uniformity, opportunity for innovation, anticipated cost, and historical experience. Regulators will need to ensure that operators can take efficient and cost-effective action while appropriately protecting the environment and public health and that requirements allow for evolving approaches while still promoting public confidence.

E. Interagency Coordination

Proliferating state and federal hydraulic fracturing regulations make interagency coordination vital. As previously noted, hydraulic fracturing treatments may be regulated by multiple state agencies as well as EPA and BLM.\(^\text{287/}\) Local governments too may seek to regulate this activity. Conflicting or duplicative federal, state, and local requirements can create unnecessary confusion, reduce regulatory effectiveness, and increase compliance costs. To avoid such results, agencies need to coordinate, integrate, and harmonize their regulatory programs where possible. Otherwise, they risk killing the proverbial golden goose of unconventional development and needlessly forgoing the potential energy, economic, and climate benefits.

Federal and state oil and gas regulation provides several models for such coordination. For example, EPA has delegated implementation of the UIC program under SDWA to a number of states, which allows those states to permit and regulate UIC wells under EPA oversight.\(^\text{288/}\) Similarly, BLM has entered into memoranda of agreement with several states, which specify how BLM and the state coordinate their regulation of oil and gas development on federal land.

\(^{287/}\) See supra notes 90 & 174 and accompanying text.
\(^{288/}\) See supra note 103 and accompanying text.
and clarify their respective roles and responsibilities. At the state level, Colorado’s 2008 updating of its oil and gas regulations involved joint work by multiple state agencies, including the Colorado Oil and Gas Conservation Commission, the Colorado Department of Public Health and Environment, and the Colorado Division of Wildlife. Colorado and Ohio have also sought to integrate local governments into the State regulatory program by providing them with notice of permit applications, opportunity to raise issues and recommend requirements, and other special rights. And Colorado has entered into a memorandum of agreement with a local government to allow the local government to undertake State inspections under certain circumstances. Other countries interested in regulating hydraulic fracturing will need to consider similar measures for coordinating their regulatory efforts.

F. New Tools

There are a variety of new and improved tools available to facilitate the process of developing hydraulic fracturing regulations. These tools include comparative information on state regulatory approaches, regulatory compilations, recommended guidelines, model


290/ See COGCC Statement of Basis and Purpose, supra, at 2-5.

291/ See 2 COLO. CODE REGS. § 404-1:214, 305, 306(b) & (d), 503.b.(7).(C), & 508 (2012); OHIO REV. CODE ANN. § 1509.06(A) (West 2012).

292/ Memorandum of Understanding Between the Colorado Oil and Gas Conservation Commission and Gunnison County (Dec. 2011), http://cogcc.state.co.us/.


statutes and regulations,296/ and reports and position papers.297/ Within the United States, STRONGER is available to review existing regulatory programs with respect to hydraulic fracturing and recommend improvements, and CSSD can perform the same function for operators.298/ By utilizing these resources, governments can consider alternative approaches, identify best practices, and expedite the rulemaking process.

V. CONCLUSION

Hydraulic fracturing is a key to unlocking unconventional oil and gas development in the United States and other countries. This development promises a brighter future, with additional energy supplies, improved economic performance, and reduced greenhouse gas emissions. But it also raises the specter of potential water, air, and other impacts, which generate public controversy. Responsible regulation can help to prevent such impacts and allay public concern.

Too often, oil and gas development and environmental protection are portrayed as incompatible alternatives. One can either develop the resource and despoil the environment or protect the environment and forgo energy and economic benefit. But Colorado’s recent regulatory activity has demonstrated that energy development and environmental protection are compatible; that it’s not either or, but both and. From an energy standpoint, oil and gas production increased annually after Colorado comprehensively updated its regulations in 2008, despite the economic downturn and continued low natural gas prices. In the first three years after the new rules were implemented, natural gas production increased by about 10%, oil


298/ See supra notes 255-66 and accompanying text.
production increased by about 30%, and Colorado remained the regional leader in well starts.\textsuperscript{299/}

From an environmental standpoint, the use of closed loop drilling systems more than doubled, the number of wells sited at least 1,000 feet from the nearest building increased by almost 10%, and operators increasingly employed green completions and fluid recycling.\textsuperscript{300/} Thus, we can generate the energy we need while protecting the environment we treasure.

\textsuperscript{299/} Neslin Overview, supra, at 22.

\textsuperscript{300/} Id.