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Expanding Best Practice: The Conundrum of Hydraulic Fracturing

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EXPANDING BEST PRACTICE: THE CONUNDRUM OF HYDRAULIC FRACTURING

*Dennis C. Stickley**

INTRODUCTION

An Indian parable recounts the efforts of six blindfolded wise-men to describe an elephant to their King. Each expert feels a different part of the elephant's anatomy, such as the tail, trunk, or tusk. When their findings are reported to the sovereign, it appears they are in complete disagreement regarding the elephant's shape.

This fable illustrates the current state of scientific analysis and policy approaches concerning the hydraulic fracturing (HF) of horizontally drilled wells to stimulate the production of unconventional natural gas.[1] Large accumulations of petroleum resources are considered unconventional when situated in formations with low permeability and can only be produced by application of enhanced recovery techniques.[2] The significance of this technology is highlighted by the fact that HF is used in the completion of approximately 25,000 oil and gas wells in the United States each year.[3]

This article discusses the conflicting and scientific assessments and policy recommendations expressed about HF, or "fracing," as it has come to be known. On one hand, supporters of this technology point out the benefits in terms of

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[1] THE NAT'L ENERGY POLICY DEV. GRP., RELIABLE, AFFORDABLE, AND ENVIRONMENTALLY SOUND ENERGY FOR AMERICA'S FUTURE, at 5–6 (2001), *available at* http://www.netl.doe.gov/publications/press/2001/nep/national_energy_policy.pdf [hereinafter *America's Future*].

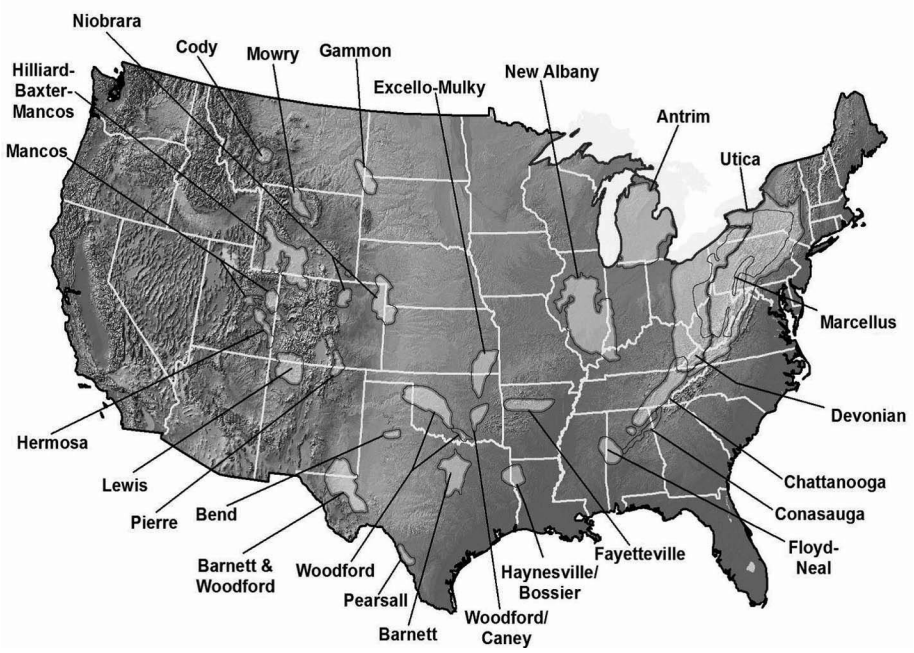
[2] Jennifer L. Miskimins, Jeff Johnson, & Mark Turner, *The Technical Aspects of Hydraulic Fracturing*, ROCKY MTN. MIN. L. FOUND, no. 5, 2011, at 1–9.

[3] *Id.*

allowing an unconventional source of domestic energy to be developed within the context of state oil and gas conservation laws.[4] On the other hand, it is argued with equal force that the technology represents a significant threat to the environment that only federal legislation can address.[5] This article concludes by advocating for the expansion of the current "best practice" approach by operators and regulators, in the context of Wyoming, regarding the use of this technology.

HF TECHNOLOGY

In the United States, substantial quantities of natural gas are located in tight formations, such as shale, that cannot be commercially produced without HF to stimulate production. Deep gas-bearing shales situated in the Great Plains, Rocky Mountain West, Great Lakes, Northeast, and Gulf Coast contain trillions of cubic feet of natural gas. Although each deposit has unique characteristics, gas-bearing shale formations are distributed across the nation as shown in the following map:[6]



[4] *See generally* Wes Deweese, *Fracturing Misconceptions: A History of Effective State Regulation, Groundwater Protection, and the Ill-Conceived Frac Act*, 6 OKLA. J. L. & TECH. 49 (2010), *available at* http://www.okjolt.org/images/pdf/2010okjoltrev49.pdf.

[5] *See generally* Angela C. Cupas, Note, *The Not-So-Safe Drinking Water Act: Why We Must Regulate Hydraulic Fracturing at the Federal Level*, 33 WM. & MARY ENVTL. L. & POL'Y REV. 605 (Winter 2009).

[6] U.S. DEP'T OF ENERGY, MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES: A PRIMER, at ES-2 (Apr. 2009), *available at* http://www.netl.doe.gov/technologies/oil-gas/publications/epreports/shale_gas_primer_2009.pdf.

HF has been said to be of such importance that thirty-five to forty percent of domestic petroleum reserves could not be recovered without the application of HF.[7]

If accurate, these projections indicate there are enough domestic reserves to power the United States for at least another century. The application of HF technology has been credited for oil and gas booms in Pennsylvania's Marcellus gas shale and North Dakota's Bakken oil formation.[8] Both formations are considered to be geologically similar to the Niobrara formation in Wyoming.[9]

HF is not related to the process of drilling a well, rather it is a means of stimulating production of natural gas after a well has been drilled into a tight formation.[10] The application of this technology substantially increases the recovery of natural gas by as much as twenty times.[11] In the United States, HF produces more than 7 billion barrels of oil and 600 trillion cubic feet of natural gas.[12]

HF technology has been used since the 1940's.[13] Early application of HF was used primarily in vertically drilled wells.[14] HF processes are employed after a well has been drilled to the target depth and cased with steel pipe that has been cemented to protect the borehole from collapsing as well as to prevent the contamination of aquifers.[15] The casing is perforated at the interval where hydrocarbons are located.[16] Water, sand, and proprietary chemicals are then injected under high pressure.[17] This process fractures the rock matrix, creating

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[7] Miskimins, Johnson, & Turner, *supra* note 2, at 1–5.

[8] Phil Taylor, *Oil and Gas: Fracking Raises Water Supply Questions in Wyo.*, ENV'T & ENERGY DAILY (Oct. 14, 2010), http://www.eenews.net/Landletter/2010/10/14/archive/2?terms=hydraulic+fracturing+wyoming (subscription required).

[9] *Id.*

[10] L.E. Wilsey & W.G. Bearden, *Reservoir Fracturing—A Method of Oil Recovery From Extremely Low Permeability Formations*, J. OF PETROLEUM TECH., Aug. 1954, at 21–27. Recovery of petroleum from fields situated in tight formations varies from ten to sixty percent depending upon well spacing. *Id.*

[11] *See America's Future*, *supra* note 1.

[12] *Hydraulic Fracturing Well Construction*, AM. PETROLEUM INST., http://www.api.org/oil-and-natural-gas-overview/exploration-and-production/hydraulic-fracturing/hydraulic-fracturing-well-construction.aspx (last visited Apr. 9, 2012).

[13] *Hydraulic Fracturing 101*, HALLIBURTON, http://www.halliburton.com/public/projects/pubsdata/Hydraulic_Fracturing/fracturing_101.html (last visited Apr. 9, 2012).

[14] *Freeing Up Energy*, *Hydraulic Fracturing: Unlocking America's Natural Gas Resources*, AM. PETROLEUM INST. (July 19, 2010), http://api.org/policy/exploration/hydraulicfracturing/upload/hydraulic_fracturing_primer.pdf.

[15] HALLIBURTON, *supra* note 13.

[16] *Id.*

[17] *See Natural Gas Shale Horizontal Drilling Video*, AM. PETROLEUM INST., http://www.api.org/policy-and-issues/policy-items/hf/drilling_video.aspx (last visited Apr. 9, 2012).

fissures that enable natural gas to flow more easily.[18] Operators typically try to maintain fracture width or slow its decline following treatment by introducing a proppant—such as grains of sand, ceramic beads, or other particles—into the injected fluid as a means to prevent the resulting fractures from closing at the conclusion of the injection stage. Formulation of the proppant's composition becomes more important at deeper formations where the pressure is greater.

HF is not an integral part of drilling an oil and gas well. Rather, it is a specialized aspect in completing the well for production once drilling has been concluded. The application of HF technology has largely been developed by oil field service contractors working as independent contractors for the operator of the well.

Recent interest in extracting natural gas from shale formations has resulted in the technology being used in horizontally drilled wells. HF is different in this application as it results in the sequential perforation of the well casing across the formation.[19] Only in the last decade has high-volume, "slick-water" HF technology been applied for stimulating the production of natural gas from shale formations.[20] This innovation in HF technology is the source of the current controversy.

SCIENTIFIC OPINION

The application of HF technology in the completion of horizontally drilled wells has raised a number of concerns among the scientific community. This has included groundwater contamination resulting from fracturing fluids, intrusion of methane gas from the shale formations, disposal of toxic produced water, triggering micro-earthquakes, and worker safety.[21]

Environmental advocates primarily express concerns that injecting chemicals used in HF pose a short-term threat to drinking water quality as well as the possibility that there could be long-term negative consequences for underground

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[18] *Hydraulic Fracturing: The Process*, FRAC FOCUS: CHEMICAL DISCLOSURE REGISTRY, http://fracfocus.org/hydraulic-fracturing-how-it-works/hydraulic-fracturing-process (last visited Apr. 9, 2012).

[19] Miskimins, Johnson, & Turner, *supra* note 2, at 1–17.

[20] *Forum: Just How Safe is 'Fracking' of Natural Gas?*, YALE ENVIRONMENT 360 (Jun. 20, 2011), http://e360.yale.edu/feature/forum_just_how_safe__is_fracking_of_natural_gas/2417/ [hereinafter YALE].

[21] Summary Report, *Hydraulic Fracturing: A Wyoming Energy Forum*, UNIVERSITY OF WYOMING SCHOOL OF ENERGY RESOURCES & HAUB SCHOOL AND RUCKELSHAUS INSTITUTE OF ENVIRONMENT AND NATURAL RESOURCES (Jan. 17, 2011), http://www.uwyo.edu/ser/_files/docs/conferences/hydraulic-fracturing/hydraulic-fracturing-summary-report.pdf [hereinafter *Wyoming Energy Forum*].

drinking water supplies.[22] Industry studies indicate that between twenty to forty percent of the fracturing fluids may be retained in the formation.[23] This raises the potential for contamination of domestic water wells.[24] Industry experts counter with arguments suggesting there has been no documented instance of groundwater contamination of subsurface formations from HF.[25]

Closer to home, regional EPA officials are concerned that drinking water and oil and gas resources are co-located in western states.[26] In Wyoming, EPA Region 8 informed rural families in Fremont County that there were several potential sources for the contamination including "natural gas production activities such as abandoned pits improperly plugged and abandoned wells, improper well construction, improper well completion techniques, well stimulation, and workover activities."[27]

The long-term toxicity of the fracturing fluids and proppants is concerning. Although HF has been part of oilfield operations for decades, the precise formulation of the fluids used in a "frac-job" are regarded as proprietary information—so much so that the EPA has subpoenaed this information from one of the major well service companies offering this service.[28] Some commentators have argued that the "public currently lacks the information necessary to determine which chemicals are present" in HF fluids.[29]

Researchers from the Center for Global Change at Duke University concluded that methane concentrations in drinking water wells had increased in active gas-extraction areas in a study area of Pennsylvania's Marcellus shale.[30] However, a

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[22] *Hydraulic Fracturing 101*, EARTHWORKS, http://www.earthworksaction.org/issues/detail/hydraulic_fracturing_101 (last visited Apr. 9, 2012).

[23] *Id.*

[24] *See Hydraulic Fracturing Well Construction*, *supra* note 12.

[25] *See* YALE, *supra* note 20.

[26] *Wyoming Energy Forum*, *supra* note 21, at 16.

[27] U.S. ENVTL. PROT. AGENCY, EXPANDED SITE INVESTIGATION ANALYTICAL RESULTS REPORT: PAVILLION AREA GROUNDWATER INVESTIGATION § 4.1 (Aug. 30, 2010), *available at* http://www.epa.gov/region8/superfund/wy/pavillion/PavillionAnalyticalResultsReport.pdf.

[28] On November 10, 2010, the EPA issued a subpoena to Halliburton requiring submission of requested information after it failed to respond to a voluntary information request sent to it and eight other hydraulic fracturing companies.

[29] Hannah Wiseman, *Trade Secrets, Disclosure and Dissent in a Fracturing Revolution*, COLUM. L. REV. (Jan. 27, 2011), http://www.columbialawreview.org/articles/trade-secrets-disclosure-and-dissent-in-a-fracturing-energy-revolution.

[30] Stephen G. Osborn et al., *Methane Contamination of Drinking Water Accompanying Gas-Well Drilling and Hydraulic Fracturing*, 108 PROC. OF THE NAT'L. ACAD. OF SCI. OF THE U.S. 37, E665–66 (Sept. 13, 2011), http://www.pnas.org/content/108/37/E665.full.pdf.

later study by other investigators challenged this analysis and concluded that HF was not responsible for methane migration.[31]

A similar state of disagreement surrounds the claim that HF is responsible for causing micro-earthquakes. There are documented examples of situations where the injection of hazardous waste is linked to destabilizing geologic faults.[32] The Oklahoma Geologic Survey recently studied forty-three small earthquakes occurring on January 18, 2011 and noted the data correlation suggested the possibility that the seismic events were HF induced.[33] The study, however, concluded it was impossible to be certain that HF had caused the earthquakes.[34]

The increase of production from non-conventional sources has resulted in an increase of water produced from shale formations.[35] HF applications involve additional disposal of fluids that flow-back from the process. Depending upon the location, options have included land disposal, discharge into surface waters, injection wells, and recycling.[36] Treatment is required prior to HF flow-back being discharged into surface water.[37] Treatment is typically performed by wastewater treatment facilities. Underground injection of flow-back involves the use of injection wells that must be properly designed to preclude contamination of aquifers.[38] In localities where injection well disposal is not an option, HF flow-back has been discharged into municipal waste water treatment facilities that are not designed to deal with such fluids.[39]

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[31] Samuel C. Schon, *Hydraulic Fracturing Not Responsible for Methane Migration*, 108 PROC. OF THE NAT'L ACAD. OF SCI. OF THE U.S. 37, E664 (Sept. 13, 2011), http://www.pnas.org/content/108/37/E664.full?sid=1272cc85-75fb-4e94-82b5-96b4cb8d15bb.

[32] U.S. ENVTL. PROT. AGENCY, EPA 816-R-02-025, TECHNICAL PROGRAM OVERVIEW: UNDERGROUND INJECTION CONTROL REGULATIONS 1, 3 (July 2001), *available at* http://www.epa.gov/safewater/uic/pdfs/uic_techovrview.pdf (stating "in 1967, the U.S. Army Corps of Engineers and the U.S. Geological Survey (USGS) reported that a deep, hazardous waste disposal well at the Rocky Mountain Arsenal was causing significant seismic events in the vicinity of Denver, Colorado").

[33] AUSTIN HOLLAND, OKLAHOMA GEOLOGICAL SURVEY, EXAMINATION OF POSSIBLY INDUCED SEISMICITY FROM HYDRAULIC FRACTURING IN THE EOLA FIELD, GARVIN COUNTY, OKLAHOMA 25 (Aug. 2011), *available at* http://www.ogs.ou.edu/pubsscanned/openfile/OF1_2011.pdf.

[34] *Id.*

[35] *A Guide to Practical Management of Produced Water from Onshore Oil and Gas Operations in the United States*, INTERSTATE OIL AND GAS COMPACT COMM'N AND ALL CONSULTING, at 20 (Oct. 2006), http://www.gwpc.org/e-library/documents/general/A%20Guide%20to%20Practical%20Management%20of%20Produced%20Water%20from%20Onshore%20Oil%20and%20Gas%20Operations%20in%20the%20United%20States.pdf.

[36] *See generally* M.E. Blauch, *Developing Effective and Environmentally Suitable Fracturing Fluids Using Hydraulic Fracturing Flowback Waters*, *in SPE Unconventional Gas Conference*, Pittsburgh, Pa., Feb. 23–25, 2010.

[37] *Hydraulic Fracturing Background Information*, U.S. ENVTL. PROT. AGENCY, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydrowhat.cfm (last visited Apr. 9, 2012).

[38] *Id.*

[39] *See* YALE, *supra* note 20.

Like the venerable wise men in the folk tale, the EPA has attempted to assess the scope of the environmental impact posed by HF before adopting regulations. In 2004, the agency initially concluded that "the injection of hydraulic fracturing fluids into coal-bed methane wells pose little or no threat to underground drinking water."[40] However, not all members of the scientific community accepted this determination. As a result, the EPA established a twenty-two-member Scientific Advisory Board (SAB), referred to as the "Panel for Review of Hydraulic Fracturing Study Plan for Assessment of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources."[41] The SAB initiated its study in 2011, expecting to make available the initial results by late 2012 and issuing a final report in 2014.[42]

However, the site investigation of sources of groundwater contamination in Pavillion, Wyoming could be influential on the SAB's finding. The EPA's Draft Report on the situation in Pavillion cast doubt on the contention that there has never been a documented case of water contamination from fracturing.[43] The investigation followed a "lines of reasoning" approach to conclude that the explanation for the presence of inorganic and organic compounds contamination was associated with hydraulic fracturing at or below the depths used for domestic water supply.[44] The EPA further stated that its approach indicated that gas production activities have likely enhanced the migration of natural gas in the aquifer and the migration of gas to domestic wells in the area.[45] Following the release of the Draft Report, the U.S. Senate Environment and Public Works Committee requested the Congressional Research Service (CRS) to review the EPA's findings.[46] The CRS assessment concluded ". . . the only pathways for fluid

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[40] U.S. ENVTL. PROT. AGENCY, EPA 816-R-04-003, EVALUATION OF IMPACTS TO UNDERGROUND SOURCES OF DRINKING WATER BY HYDRAULIC FRACTURING OF COALBED METHANE RESERVOIR (June 2004), *available at* http://nepis.epa.gov/Adobe/PDF/P100A99N.pdf.

[41] U.S. ENVTL. PROT. AGENCY, EPA 600/D-11/001, DRAFT PLAN TO STUDY THE POTENTIAL IMPACTS OF HYDRAULIC FRACTURING ON DRINKING WATER RESOURCES (2011).

[42] *Id.*

[43] U.S. ENVTL. PROT. AGENCY OFFICE OF RESEARCH AND DEV., NATIONAL RISK MANAGEMENT RESEARCH LABORATORY, DRAFT REPORT: INVESTIGATION OF GROUNDWATER CONTAMINATION NEAR PAVILLION, WYOMING 33–37 (Dec. 8, 2011), *available at* http://www.epa.gov/region8/superfund/wy/pavillion/EPA_ReportOnPavillion_Dec-8-2011.pdf.

[44] *Id.* The Draft Report considered the correlation between seven sets of data including high pH values, elevated potassium and chloride concentrations, detection of synthetic organic compounds, detection of petroleum hydrocarbons, breakdown products of organic compounds, no cement or sporadic bonding outside of the production casing, hydraulic fracturing of thin, discontinuous sandstone units.

[45] *Id.* at 37–39.

[46] *See generally* PETER FOLGER ET AL., CONG. RESEARCH SERV., R42327, THE EPA DRAFT REPORT OF GROUNDWATER CONTAMINATION NEAR PAVILLION, WYOMING: MAIN FINDINGS AND STAKEHOLDER RESPONSES (Jan. 25, 2012), *available at* http://www.eenews.net/assets/2012/01/27/document_gw_02.pdf.

migration from a deep shale gas reservoir would be along leaky old wells or poorly constructed production wells."[47] The EPA has convened a panel to undertake a peer review and the agency intends to issue a final report in 2012.[48]

HF POLICY

The opportunities and threats of HF are the subject of debate and litigation, domestically as well as internationally. The Report of the National Energy Policy Development Group stated that HF would "face added controls, and costs" for protection of the environment.[49] This assessment is shared by other commentators. In a forum on HF, hosted in 2011 by the on-line journal *Yale Environment 360*, experts from both sides of the controversy shared a consensus that the technology will be facing tougher federal and state environmental controls.[50]

The application of HF in shale formations has met growing opposition in the United States as new allegations of adverse effects surface.[51] At the federal level, environmental campaigners sought to make HF subject to the scheme for permitting underground injection wells. In 1997, the Eleventh Circuit Court of Appeals held hydraulic fracturing came within the definition of an "underground injection" that could be regulated under EPA's underground injection control (UIC) program.[52]

Following this ruling, in 2001 the report to Congress by the National Energy Policy Development Group recommended the promotion of new technologies that would enhance the recovery of oil and gas.[53] Congress subsequently adopted Section 322 of the Energy Policy Act of 2005, unaffectionately referred to as the "the Halliburton loophole," which expressly exempts HF from regulation by the EPA under the Safe Drinking Water Act.[54]

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[47] *Id.* at 16.

[48] *Id.* at 15.

[49] *See America's Future*, *supra* note 1, at 5–6.

[50] *See* YALE, *supra* note 20.

[51] A critical view of hydraulic fracturing is presented in the movie *Gasland*. *See* GASLAND (2010).

[52] *See generally* Legal Envtl. Assistance Found. v. U.S. Envtl. Prot. Agency, 118 F.3d 1475 (11th Cir. 1997).

[53] *See America's Future*, *supra* note 1, at 5–6.

[54] Paragraph (1) of section 1421(d) of the Safe Drinking Water Act (42 U.S.C. 300h(d)) is amended to read as follows:

(1) UNDERGROUND INJECTION. The term 'underground injection'

(A) means the subsurface emplacement of fluids by well injection; and

On public lands, HF is generally recognized as a standard completion practice that requires no prior approval unless additional surface disturbance is required.[55] Among the states, issues have ranged from potential threats to the quality of water from domestic wells, interference with correlative rights from oil and gas wells, consumption of scarce water resources, and micro-earthquakes. Many states where shale formations are located have little experience with oil and gas exploration and production and are consequently hesitant to support HF.[56] For example, New York has adopted legislation that imposed a moratorium on the practice until July 1, 2011.[57]

Other states have gone further. Legislation adopted in New Jersey states that HF "has been found to use a variety of contaminating chemicals and materials that can suddenly and in an uncontrolled manner be introduced into the surface waters and ground water of the State."[58] Considering that the Marcellus shale in New Jersey is not located deep enough to drill, the ban is more symbolic than economic.

In Texas, the Regional EPA Office is not only at odds with oil and gas operators, but with the Railroad Commission as well. On March 22, 2011, the Texas Railroad Commission reached a unanimous decision that the EPA wrongly concluded a gas driller contaminated domestic water wells in the northern part of the state. A dispute over an environmental issue has the potential to evolve into a fierce debate about states' rights.[59]

Service companies have been reluctant to disclose their formulation of the fluids used for HF because they believe it is part of their competitive edge.[60] Significant amounts of capital and effort go into developing high-performance

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(B) excludes

(i) the underground injection of natural gas for purposes of storage; and

(ii) the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities.

42 U.S.C. § 300h(d) (2012).

[55] Larry Claypool, *Wyoming Energy Forum*, *supra* note 21, at 9. Larry Claypool is the Deputy State Director of the Division of Minerals and Lands for the Bureau of Land Management.

[56] Joseph A. Dammel, *Notes from Underground: Hydraulic Fracturing in the Marcellus Shale*, 12 MINN. J.L. SCI. & TECH. 773, 775 (Spring 2011).

[57] Keith B. Hall, *New York DEC Recommends Lifting Moratorium on Hydraulic Fracturing*, OIL & GAS LAW BRIEF (July 9, 2011), http://www.oilgaslawbrief.com/hydraulic-fracturing/new-york-dec-recommends-lifting-moratorium-on-hydraulic-fracturing/.

[58] Assembly No. 3313, 214th Leg., at 2 (N.J. 2010).

[59] Mike Soraghan, *Texas EPA Official's Emails Show Federal-State Tension Over Drilling Sanctions*, GREENWIRE (Feb. 11, 2011, 3:15 PM), http://www.eenews.net/public/Greenwire/2011/02/11/3.

[60] *What are Hydraulic Fracturing Regulations*, WHAT IS FRACKING (Feb. 2, 2012), http://www.what-is-fracking.com/what-are-hydraulic-fracturing-regulations.

stimulation chemistry.[61] Naturally, the owners of HF technology seek a certain measure of protection for their intellectual property. Nevertheless, some disclosure is necessary for effective regulations of petroleum resources and protection of public welfare.

In June 2011, the Wyoming Oil & Gas Conservation Commission (WOGCC) voted unanimously to adopt rules relating to the disclosure of the constituents in HF fluids.[62] The new rules state in pertinent part:

> (d) The Owner or Operator shall provide detailed information to the Supervisor as to the base stimulation fluid source. The Owner or Operator or service company shall provide to the Supervisor, for each stage of the well stimulation program, the chemical additives, compounds and concentrations or rates proposed to be mixed and injected, including:
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> > (i) Stimulation fluid identified by additive type (such as but not limited to acid, biocide, breaker, brine, corrosion inhibitor, crosslinker, demulsifier, friction reducer, gel, iron control, oxygen scavenger, pH adjusting agent, proppant, scale inhibitor, surfactant);
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> > (ii) The chemical compound name and Chemical Abstracts Service (CAS) number shall be identified (such as the additive biocide is glutaraldehyde, or the additive breaker is aluminum persulfate, or the proppant is silica or quartz sand, and so on for each additive used);
> >
> > (iii) The proposed rate or concentration for each additive shall be provided (such as gel as pounds per thousand gallons, or biocide at gallons per thousand gallons, or proppant at pounds per gallon, or expressed as percent by weight or percent by volume, or parts per million, or parts per billion);
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> > (iv) The Owner or Operator or service company may also provide a copy of the contractor's proposed well stimulation program design including the above detail;

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[61] *See generally* Patrick Schorn, *Hydraulic Fracturing Technology and Reporting Continue to Evolve*, J. OF PETROLEUM TECH., Sept. 2011, at 46–48, *available at* http://www.spe.org/jpt/print/archives/2011/09/12Management.pdf.

[62] WYOMING OIL AND GAS CONSERVATION COMM'N, RULES AND REGULATIONS CH. 3 § 45, *available at* http://soswy.state.wy.us/Rules/RULES/7928.pdf [hereinafter *WOGCC Rules*].

> (v) The Supervisor may request additional information under this subsection prior to the approval of the Application for Permit to Drill (Form 1) or of the Sundry Notice (Form 4);
>
> (vi) The Supervisor retains discretion to request from the Owner or Operator and/or the service company, the formulary disclosure for the chemical compounds used in the well stimulation(s).[63]

The WOGCC's rules allow operators to withhold the chemical contents of hydraulic fracturing fluids as a trade secret under the Wyoming Open Records Act, but only with permission of the Commission's supervisor.[64] Since the adoption of these regulations, the supervisor has granted the trade secret exemption to eleven companies.[65] However, getting permission to withhold proprietary information is not a foregone conclusion.

In a notice to the WOGCC an operator simply stated the HF fluid was proprietary and listed it as "petroleum distillate blend" without giving the Chemical Abstract Service (CAS) registry number.[66] The supervisor determined that under the new rules it was not acceptable to insert "proprietary" in place of a CAS number.[67] The question of whether a designation by CAS number should be accorded the status of a trade secret is currently the subject of a petition for review of the WOGCC's administrative action.[68]

HF also raises a question for state oil and gas regulators regarding the protection of correlative rights. Arguably, well stimulation by HF can extend across lease boundaries and result in oil and gas being drained from adjacent lands. The occurrence of such a situation could raise the possibility of administrative and judicial proceedings to determine whether injunctive relief or damages could be awarded for subsurface trespass against the fracing party. Lessors where the

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[63] *Id.*

[64] WYO. STAT. ANN. § 16-4-203(d)(v) (2011). This section of the Wyoming Public Records Act exempts the following records from public disclosure: "trade secrets, privileged information and confidential commercial, financial, geological or geophysical data furnished by or obtained from any person." *Id.*

[65] Telephone Interview with Mr. Gary Strong, Geologist, Wyo. Oil and Gas Conservation Comm'n (Mar. 9, 2012).

[66] *Id.*

[67] *Id.* In addition to the CAS registry number, the applicant is required to provide information regarding the quantities, and pressure and disposal data. *Id.*

[68] *Powder River Basin Resource Council, Wyoming Outdoor Council, Earthworks, OMB Watch v. Wyoming Oil and Gas Conservation Commission*, Petition for Review of Administrative Action; Complaint for Declaratory Relief, Seventh Judicial District Court of the State of Wyoming (Mar. 22, 2012).

drainage occurred could sue their lessee for breaching the implied covenant to protect against drainage.

The Texas Supreme Court recently addressed this issue in the context of the "rule of capture." In *Coastal Oil & Gas Corp. v. Garza Energy Trust*, the court held the rule of capture precluded any recovery of damages based on drainage resulting from a fracture stimulation that crossed property lines.[69] While the decision did not address the trespass issue, earlier decisions by the Texas Supreme Court have suggested cross-lease fracture stimulation constitutes a trespass.[70]

Wyoming has not adopted the rule of capture. As such, the liability for cross-lease drainage resulting from HF remains to be litigated in the context of correlative rights, and the prevention of waste which allows each lessee "to produce or to receive its just and equitable share" of petroleum.[71]

WATER AND HF

In Wyoming, the scarcity of water is regarded as a major limitation to economic development.[72] Water is the primary component for slick water HF used for shale gas development.[73] Availability of water is a distinguishing factor between various shale gas plays across the country.

The Wyoming State Engineer is quoted as saying drillers are "going to have to pursue a number of different sources to get" the water needed for the scale of exploration and development of the Niobrara Formation.[74] The alternatives have included striking deals with farmers and ranchers for temporary use permits for irrigation water, purchasing municipal water from cities like Cheyenne, and using deep wells to access new water sources.

HF INTERNATIONALLY

HF has also been met with opposition overseas.[75] Countries with promising shale oil and gas reserves have adopted legislation to ban HF. The French House of Delegates adopted a measure giving oil and gas companies two months to declare

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[69] 268 S.W.3d 1, 14 (Tex. 2008).

[70] Caleb A. Fielder, *I Drink Your Milkshake: The Status of Hydraulic Fracture Stimulation in the Wake of Coastal v. Garza*, 46 ROCKY MTN. MIN. L. INST. 17, 31 (2009).

[71] WYO. STAT. ANN. § 30-5-102(b) (2011).

[72] Edward Barbier, *Water Scarcity and Economic Growth in Wyoming*, ECONOMIC RECORD, no. 80, Mar. 2004, at 1–16.

[73] *See* HOLLAND, *supra* note 33.

[74] *See* Taylor, *supra* note 8.

[75] The author has seen television newscasts in New Zealand and the United Kingdom discussing the environmental threat of HF.

the type of drilling techniques they will use.[76] If a company does not respond or states it will use HF, regulators will revoke the drilling permit.[77] Earlier this year, Bulgaria became the second European Union country to ban HF and cancelled a shale gas exploration permit previously awarded to a Chevron subsidiary.[78]

EXPANDING BEST PRACTICE

The oil and gas industry recognizes it is in its interest, from the standpoint of cost and potential liability, to exercise control over HF operations. Generally, the focus of industry best practice for HF has been on improving the recovery of petroleum.[79] In the face of mounting public concern, the oil and gas industry is giving greater attention to HF practices that reduce environmental impacts. One of the leading initiatives is to recycle HF fluids.[80] Other best practice measures being addressed by the petroleum industry include improvements in well integrity assurance, reducing water volume requirements, capturing and treating flow-back, and disclosing and reporting downhole fluid mixtures.[81] Furthermore, there are ways the petroleum industry can achieve disclosure and transparency while addressing industry concerns about intellectual property.

The American Petroleum Institute (API) prepared a series of guidance documents that address cradle-to-grave water handling practices for HF operations and surface environmental considerations.[82] The API initially proposed a three-step approach towards best practice for HF that focuses on well construction to both achieve the proper drilling, completion and production of a well, and protection for shallower ground water aquifers.[83]

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[76] Tara Patel, *France Vote Outlaws 'Fracking' Shale for Natural Gas, Oil Extraction*, BLOOMBERG (July 1, 2011, 4:22 AM), http://www.bloomberg.com/news/2011-07-01/france-vote-outlaws-fracking-shale-for-natural-gas-oil-extraction.html.

[77] *Id.*

[78] Elizabeth Konstantinova, *Bulgaria Bans Chevron From Using Hydraulic Fracturing*, BLOOMBERG (Jan. 17, 2012, 5:18 AM), http://www.bloomberg.com/news/2012-01-17/bulgaria-bans-chevron-from-using-hydraulic-fracturing.html.

[79] S.D. Mohaghegh et al., *Identifying Best Practices in Hydraulic Fracturing Using Virtual Intelligence Techniques*, SPE Eastern Regional Meeting, Canton, Ohio, Oct. 17–19, 2001.

[80] *See* Fielder, *supra* note 70, at 19.

[81] *See* Schorn, *supra* note 61, at 1–2.

[82] *See Overview of Industry Guidance/Best Practice on Hydraulic Fracturing (HF)*, AM. PETROLEUM INST. (2011), http://www.api.org/~/media/Files/Policy/Exploration/Hydraulic_Fracturing_InfoSheet.ashx [hereinafter *Overview*].

[83] *See Hydraulic Fracturing Operations—Well Construction and Integrity Guidelines*, AM. PETROLEUM INST. (Oct. 2009), http://www.shalegas.energy.gov/resources/HF1.pdf [hereinafter *Guidelines*].

The design of the well stimulation plan is the first step. In particular, the completion, perforation, and fluid injection should be designed to avoid out-of-zone complications.[84] The second step involves insuring the integrity of the well by sealing, perforating, and cementing the casing in a manner that isolates the fractured formation from other zones, including aquifers.[85] The API has also revised its standards for cementing to include new processes for isolating the fractured zone and maintaining well integrity.[86] The third step is to preclude the use of compounds, such as petroleum distillates, that contain benzene, toluene, ethylebenzene, and xylene (BTEX).[87]

The API has published additional guidance on the best practice for the disposal of fracing fluids and waste water.[88] These recommendations focus on the application of hydraulic fracturing technology to deep shale gas formations. More recently, the industry has developed best practice for dealing with surface impacts from HF.[89]

All of API's best practice documents are consistent with WOGCC regulations.[90] Most importantly, the requirement that if any formation containing fresh water or potable water was not sealed or separated when the production casing was cemented, the casing must be perforated at the base of the fresh water or potable water zone and squeeze cemented utilizing a mechanical cement retainer with a volume of cement sufficient to cover the formation.[91] The supervisor may also require the production casing to be perforated at a depth of the float shoe of the surface casing and that cement be squeezed or circulated through the perforations through the uncemented zone.[92] In addition, BTEX is prohibited by regulation in Wyoming.

The options for disposing of water produced in conjunction with oil and gas include: reuse, surface discharge, on-site evaporation, deep well injection, or transportation to a waste water treatment plant. In the case of fracing fluids, the selection of the method of disposal raises concern about the contamination of soil

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[84] *Id.*

[85] *Id.*

[86] *Isolating Potential Flow Zones During Well Construction*, *API Standard 65—Part 2*, AM. PETROLEUM INST. (2d ed., Dec. 2010), http://www.shalegas.energy.gov/resources/65-2_e2.pdf.

[87] *See Overview*, *supra* note 82.

[88] *See Guidelines*, *supra* note 83.

[89] *Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing*, AM. PETROLEUM INST. (Jan. 2011), http://www.api.org/~/media/Files/Policy/Exploration/HF3_e7.ashx.

[90] *See generally* Tom Doll, *Wyoming Energy Forum*, *supra* note 21.

[91] *WOGCC Rules* Ch. 3 § 22(d)(iii), (d)(iii), (v) (eff. Apr. 2, 2008), *available at* http://soswy.state.wy.us/RULES/rules/6913.pdf.

[92] *See Hydraulic Fracturing Well Construction*, *supra* note 12.

and water due to the chemical constituents in the fluid, particularly where the produced water contains petrochemicals or BTEX.[93]

The WOGCC has specific rules on the disposal of stimulation fluids by disposal pits or well injection.[94] In addition, the new rules on well stimulation expressly prohibit the use of BTEX for hydraulic fracturing without prior approval of the supervisor.[95]

Best practice is a process of continuous improvement. It is incumbent upon the oil and gas industry, as well as state oil and gas agencies who oversee its regulation, to demonstrate that despite the exemption from federal regulation under 42 U.S.C. § 1421(d)(1), HF best practice will continue to evolve.[96] One example is the new website that hosts a hydraulic fracturing chemical registry.[97] The website allows a search for nearby well sites that have been hydraulically fractured to see what chemicals were used in the process.

Best practice should be expanded to include a process to verify whether an HF operation is affecting groundwater quality. This is the standard before-and-after approach that is common to other injection-recovery operations, such as *in situ* mining. Under this approach, baseline groundwater quality is assessed, and a system of monitoring is implemented to determine whether the fracing fluids migrate from the formation into which they were injected.[98]

Another element involves establishing a baseline groundwater quality prior to HF operations. This practice applies equally to landowners in an area where HF is to be conducted. One of the key lessons from the situation in Pavillion is that water quality monitoring is critical for the scientific assessment of impacts.[99] Some operators in the southern part of the state have experimented with the use of monitoring wells.[100]

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[93] Benzene, toluene, ethylbenzene, xylene, and naphthalene.

[94] *WOGCC Rules*, *supra* note 62, at Ch. 3 § 45(j), CH. 4 § 5.

[95] *Id.* at Ch. 3 § 45(g).

[96] A list of best management practices for hydraulic fracturing can be found on the website for the Intermountain Oil and Gas BMP Project. *See Intermountian Oil and Gas BMP Project,* NATURAL RESOURCE LAW CENTER UNIV. OF COL. LAW SCH., http://www.oilandgasbmps.org/bmpsearch.php?mode=1&kw=hydraulic+fracturing&cat=0&loc=0 (last visited Apr. 9, 2012).

[97] *See generally* FRAC FOCUS: CHEMICAL DISCLOSURE REGISTRY, http://fracfocus.org (last visited Apr. 9, 2012).

[98] WYO. DEPT. OF ENVTL. QUALITY LAND QUALITY DIV., GUIDELINE NO. 4 IN-SITU MINING (Dec. 2009), http://deq.state.wy.us/lqd/guidelns/Guide4=3-00.pdf.

[99] *See supra* notes 43–47 and accompanying text.

[100] Telephone Interview with Rick Marvel, WOGCC (Apr. 4, 2011).

Arrangements establishing baseline groundwater quality as well as monitoring and testing of domestic wells could be incorporated into the surface use agreements provided for in the Surface Owner Protection Act.[101] Other commentators have suggested that operators pay for testing the landowner's wells.[102]

It is questionable whether the Surface Owner Protection Act provides all landowners with the means to protect the quality of their well water from impacts related to oil and gas operations from horizontally drilled HF wells. The scope of the legislation appears to be limited to the "surface disturbing activities" that affect the "land surface on which oil and gas operations occur."[103] Similarly, the level of bonding set by the WOGCC is limited to an "amount covering oil and gas operations on the surface owner's land."[104] These provisions appear to preclude the owners of lands whose subsurface is traversed by horizontal wells from the protection of this remedial legislation. This gap is significant in locations where wells are horizontally deviated.

In the case of landowners whose surface is disturbed by oil and gas operations, the ability to protect their domestic and stock wells is equally uncertain on the basis of the above definitions. However, the provisions regarding the scope of the surface use agreement as well as the right of recovery for damages is less restricted. The legislation refers to the terms of a surface use agreement as providing "compensation for all damages" and is not restricted to surface disturbance.[105] Furthermore, the surface owner is able to claim damages due to the loss of production and income, land value, and improvements.[106] The surface owner is obliged to bring a claim within "two (2) years after the damage has been discovered, or should have been discovered through due diligence."[107]

The statute of limitation behooves a surface owner to monitor the quality of their well water. According to the Wyoming Department of Environmental Quality, well water should be sampled on at least an annual basis.[108] The State

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[101] WYO. STAT. ANN. §§ 30-5-401 to -410 (2011).

[102] *See generally* MICHELE STRAUD & MELINDA HOLLAND, U.S. INST. FOR ENVTL. CONFLICT RESOLUTION, A CONFLICT ASSESSMENT OF SPLIT ESTATE ISSUES AND A MODEL AGREEMENT APPROACH TO RESOLVING CONFLICTS OVER COALBED METHANE DEVELOPMENT IN THE POWDER RIVER BASIN (Mar. 14, 2003).

[103] WYO. STAT. ANN. § 30-5-401(a)(iv), (vii).

[104] *Id.* § 30-5-404.

[105] *Id.* § 30-5-406.

[106] *Id.* § 30-5-405.

[107] *Id.* § 30-5-406(a).

[108] *Rural Well Protection Fact Sheet: Well Maintenance*, WYO. DEP'T ENVTL. QUALITY (June 1998), http://deq.state.wy.us/wqd/groundwater/downloads/Private%20Wells/wellheadmaintenance.asp.

of Wyoming has two state laboratories in Cheyenne and Laramie that will analyze samples.[109]

The WOGCC has adopted rules for other forms of specialized production.[110] Several aspects of the General Drilling Rules regarding Special Sodium Drilling Areas seem suited to HF; particularly, the express obligations to prevent fluid migration and to prevent freshwater contamination could be adapted to HF.[111]

As a final suggestion, disclosure and reporting should include the establishment of a register of service companies who conduct HF operations and the location of wells where they have applied their techniques. This will allow regulators and the public to determine whether the service companies have a satisfactory operating history. One of the major HF service companies has established an on-line database for its domestic and international operations.[112]

CONCLUSION

It is increasingly difficult to predict where the HF debate will lead or how it will be resolved. The significance of the discussion is highlighted by weighing the economic benefits against the potential impacts on individuals and the environment. Currently, these issues are being heard in the court-of-public-opinion.[113]

There is no question that unconventional resources will play a vital role in supplying energy for the future. None of the suggested expansion of best practice is novel as to be discounted by prudent operators.[114] The industry can go further in terms of best practice in order to maintain credibility. The adoption of so-called "green" HF practices to reformulate additives and reduce water requirements has shown that the industry is responsive to public concern.[115]

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[109] Wyo. Dep't of Agric. Analytical Services Lab., 1174 Snowy Range Road, Laramie, Wyo. 82070, (307) 742-2984. Wyo. Dep't of Health, Preventative Medicine Div., Pub. Health Lab. Hathaway Bldg., 5th Floor, Cheyenne, Wyo. 82001, (307)-777-7431.

[110] *WOGCC Rules*, *supra* note 62, at Ch. 4 § 5.

[111] *Id.* at Ch. 3 § 22(a)(i).

[112] Press Release, Halliburton, Halliburton Introduces Cleanstim™ Fracture Formulation Launches New Microsite On Hydraulic Fracturing Fluids Disclosure (Nov. 15, 2010), http://www.halliburton.com/public/news/pubsdata/press_release/2010/corpnws_111510.html.

[113] In addition to the states and countries mentioned in the citations, the author has seen HF discussed as a potential environmental threat on television news broadcasts in the United Kingdom and New Zealand.

[114] Briana Mordick, *Wyoming Energy Forum*, *supra* note 21, at 19.

[115] HYDRAULIC FRACTURING FACTS, http://www.hydraulicfracturing.com/Green-Frac/Pages/information.aspx (last visited Apr. 9, 2012).