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Hydraulic Fracturing: Critical for Energy Production, Jobs, and Economic Growth

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Abstract

Energy production on private lands in the United States has been one of the most promising success stories in recent years. This is especially important now, at a time when the country has struggled to grow economically. A large part of the success behind this tremendous oil and gas production and jobs creation is due to an energy-extraction process known as hydraulic fracturing. Misconceptions about hydraulic fracturing abound. The Heritage Foundation's Nicolas Loris explains how, when regulated effectively, hydraulic fracturing is safe—as well as necessary for energy production and job creation in the United States.

This paper, in its entirety, can be found at **http://report.heritage.org/bg2714**

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While Americans continue to be disappointed by dismal jobs reports and a high unemployment rate, one of the few recent bright spots in the U.S. economy has been energy production, particularly the shale oil and shale gas revolution. In fact, the Yale Graduates Energy Study Group calculated that in 2010 alone, the consumer surplus (the consumer savings or gain from reductions in price) from shale gas production was worth over $100 billion.[1] The technological one-two punch of horizontal drilling and hydraulic fracturing has created a remarkable energy boom and created hundreds of thousands of jobs in the U.S. The possibility of continuously low natural gas prices is turning the United States into a prime destination for chemical companies and other businesses that rely on abundant amounts of natural gas. While the energy development has been substantially positive, the process of hydraulic fracturing has come under scrutiny over concerns about contamination of drinking water, the use of chemicals, wastewater management, and the potential for causing earthquakes.

All 35 of the oil and gas producing states have an impressive and long track record of regulating hydraulic

Key Points

- Hydraulic fracturing—called fracking—has helped tap vast supplies of oil and natural gas in the United States, and will be a critical part of the country's future energy extraction process.
- Fracking has been vital for job creation and helped create affordable natural gas prices that have attracted many energy-intensive industries to the U.S.
- Although there has been much concern over fracking contaminating drinking water through gas migration and through the use of chemical additives, the process has proven to be safe, and has been successfully regulated at the state level for decades.
- Federal attempts to further regulate fracking are both redundant and unnecessary. Congress should act to prevent federal agencies from creating additional layers of red tape that would slow energy production and much-needed economic growth in the United States.

fracturing, yet the federal government is proposing onerous and duplicative regulations. Congress should recognize the states' effectiveness in regulating hydraulic fracturing and prevent federal attempts that would unreasonably slow down the success of oil and gas development.

How Does Hydraulic Fracturing Work?

Hydraulic fracturing, known as "fracking," is a process during which producers inject a fluid consisting of water, sand, and chemical additives deep into the ground in order to free resources, including oil, natural gas, geothermal energy, and even water trapped in deep rock formations.[2] With respect to shale gas (natural gas lodged in shale rock formations), producers drill wells that are on average 7,500 feet below the surface, thousands of feet below drinking water aquifers. After a company completes the well drilling (approximately two to four weeks), it then fracks the rock formation at high pressures that extend for several hundred feet away from the gas well. This process takes between three and five days, at which point the well will produce natural gas for 20 years to 50 years, or longer. After the drilling, the company also restores the land with soil and new vegetation, leaving only the wellhead and collection tanks. Some of the fracking fluid rises to the surface through steel-cased well bores and is temporarily stored in lined pits or steel tanks. Companies then recycle and reuse the wastewater or store it in an injection well deep underground.[3]

Used in over one million wells in the United States for more than 60 years, fracking has been successfully used to retrieve more than 7 billion barrels of oil and over 600 trillion cubic feet of natural gas.[4] Just one trillion cubic feet of natural gas is enough to heat 15 million homes for one year.[5] The development of hydraulic fracturing and horizontal drilling has increased access to proven reserves for oil and natural gas in Alabama, Arkansas, Colorado, Illinois, Louisiana, Michigan, New York, North Dakota, Oklahoma, Pennsylvania, Texas, and Wyoming.

Although geologists and energy companies have long been aware of the shale oil and shale gas reserves, the technological advancements in horizontal drilling and hydraulic fracturing are helping some regions of the country extract those resources and buck the economic downturn. In North Dakota, 4,600 wells produced 7.5 million barrels of crude oil in December 2009. In January 2012, North Dakota had 6,600 wells pumping out 16.9 million barrels of oil.[6] In Pennsylvania, natural gas production more than quadrupled between 2009 and 2011.[7] The oil and gas boom has created work for geologists, engineers, rig workers, truck drivers, and pipe welders. That also means a higher demand for restaurants, repair shops, hardware stores, hotels, and laundromats in those areas. Energy production could be a catalyst of economic revitalization across the country, and the fracking process will be essential for the development of America's future oil and gas production.

Fracking: Critical for Economic Growth

Natural gas is already a critical part of America's energy portfolio and consequently a critical part of the country's economic growth. Not only does natural gas provide over 25 percent of electricity generation, natural gas and other gases extracted from natural gas provide a feedstock for fertilizers, chemicals and pharmaceuticals, waste treatment, food processing, fueling industrial boilers, and much more. Although natural gas prices in the United States have historically been volatile,

1. Robert M. Ames et al., "The Arithmetic of Shale Gas," Social Science Research Network, June 15, 2012, http://dx.doi.org/10.2139/ssrn.2085027 (accessed July 26, 2012).
2. U.S. Department of Energy, "Modern Shale Gas Development in the United States: A Primer," April 2009, http://www.netl.doe.gov/technologies/oil-gas/publications/epreports/shale_gas_primer_2009.pdf (accessed July 26, 2012).
3. U.S. Environmental Protection Agency, "Basic Information About Injection Wells," May 4, 2012, http://water.epa.gov/type/groundwater/uic/basicinformation.cfm (accessed July 26, 2012).
4. Institute for Energy Research, "Hydraulic Fracturing—Is It Safe?" May 3, 2011, http://www.instituteforenergyresearch.org/2011/05/03/hydraulic-fracturing-is-it-safe/ (accessed July 26, 2012).
5. U.S. Department of Energy, "Producing Natural Gas from Shale," January 26, 2012, http://energy.gov/articles/producing-natural-gas-shale (accessed July 26, 2012).
6. Industrial Commission of North Dakota Oil and Gas Division, "2009 Monthly Statistics Update," https://www.dmr.nd.gov/oilgas/stats/2009monthlystats.pdf (accessed July 26, 2012), and "2012 Monthly Statistics Update," https://www.dmr.nd.gov/oilgas/stats/2012monthlystats.pdf (accessed July 26, 2012).
7. U.S. Energy Information Administration, "Horizontal Drilling Boosts Pennsylvania's Natural Gas Production," May 23, 2012, http://www.eia.gov/todayinenergy/detail.cfm?id=6390 (accessed July 26, 2012).

the abundance of shale gas brings the possibility of low, stable prices. North America has approximately 4.2 quadrillion (4,244 trillion) cubic feet of recoverable natural gas that would supply 175 years worth of natural gas at current consumption rates. Further, the National Petroleum Council estimates that fracking will allow 60 percent to 80 percent of all domestically drilled wells during the next 10 years to remain viable.

The abundance of natural gas makes the United States an attractive place to do business, especially for energy-intensive industries. In what could be a growing trend, Royal Dutch Shell recently announced plans to build a petrochemical plant in western Pennsylvania and cited the proximity to natural gas production as the reason for the location. The $2 billion plant will create 10,000 construction jobs and thousands of permanent jobs for Beaver County, Pennsylvania.[8] A new KPMG analysis of the U.S. chemical industry emphasizes that "[w]ith a new and abundant source of low-cost feedstock, the US market has transformed to become one of the most advantageous markets for chemical production in the world."[9] Shuttered steel towns like Youngstown, Ohio, are seeing a re-emergence of manufacturing employment opportunities. In Youngstown, V&M Star, the pipe and tube producer, is building a factory to manufacture seamless pipes for hydraulic fracturing that will employ 350 people.[10]

Hydraulic Fracturing: Facts and Myths

Despite the length of time that hydraulic fracturing has been used, and despite the fact that fracking has helped create a burst in American energy production and economic growth, fracking has received much negative attention due to misreporting and dramatic exaggerations. Much of the public's concern over hydraulic fracturing has been over the possibility of contaminated drinking water, the chemicals used in fracking, the potential to create earthquakes, and wastewater management. Such concerns do not take into account the federal and state laws and regulations that address these very issues. Following are the four most prevalent myths—followed by the facts:

Myth #1: *Hydraulic fracturing threatens underground water sources and has led to the contamination of drinking water.*

Fact: *Hydraulic fracturing is subject to both federal and state regulations, and there have been no instances of fracking causing contamination of drinking water.*

Groundwater aquifers sit thousands of feet above the level at which fracking takes place, and companies construct wells with steel-surface casings and cement barriers to prevent gas migration. Studies by the Environmental Protection Agency (EPA), the Groundwater Protection Council, and independent agencies have found no evidence of groundwater contamination.[11] In May 2011, EPA Administrator Lisa Jackson stated before the U.S. House Oversight and Government Reform Committee that "I am not aware of any proven case where the fracking process itself affected water although there are investigations

8. Kris Maher, "Pittsburgh Area to Get Shell Plant," *The Wall Street Journal*, March 15, 2012, http://online.wsj.com/article/SB10001424052702304692804577283620419058872.html (accessed July 26, 2012).
9. Mike Shannon, Paul Harnick, and Tom Meike, "The Future of the US Chemical Industry," *Reaction*, 2012, http://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Reaction/Documents/reaction-magazine-seventh-edition.pdf (accessed July 26, 2012).
10. Mark Niquette and Romy Varghese, "Gas Boom Has Youngstown Making Steel Again," Bloomberg, January 10, 2012, http://www.bloomberg.com/news/2012-01-10/youngstown-opens-mills-again-as-states-jockey-for-fracking-jobs.html (accessed July 26, 2012).
11. Environmental Protection Agency, "Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs," June 2004, http://www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_exec_summ.pdf (accessed July 26, 2012), and U.S. Department of Energy, "Modern Shale Gas Development in the United States: A Primer."
12. News release, "EPA Jackson 'Not Aware of Any Proven Case Where the Fracking Process Itself Has Affected Water,'" Committee on Environment and Public Works, U.S. Senate, May 24, 2011, http://epw.senate.gov/public/index.cfm?FuseAction=PressRoom.PressReleases&ContentRecord_id=23EB85DD-802A-23AD-43F9-DA281B2CD287 (accessed July 26, 2012).

ongoing."[12] Three of those investigations are in Texas, Wyoming, and Pennsylvania, and thus far the EPA has found no evidence of contamination; in the case of Wyoming, however, the EPA published faulty data with speculative and heavily contested conclusions. In all three cases the EPA ignored state regulators' management of the alleged problems.[13] Although previous EPA analysis of hydraulic fracturing found the process to be safe, the EPA now plans to publish a full study on hydraulic fracturing and drinking water that ostensibly demonstrates lack of safety. Analysis of the EPA's "Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources" by the nonprofit technology research and development organization Battelle highlighted a number of concerns, including cherry-picking of data, lack of peer review, poor quality control, and a lack of transparency.[14]

Myth #2: *The chemicals used in the fracking process are foreign chemicals that industry hides from the public.*

Fact: *Fracking fluid, made primarily of sand and water, uses a small percentage of chemicals that have common household applications and are regulated by the state.*

The fluid used in hydraulic fracturing is 99.5 percent water and sand. The 0.5 percent of additives (typically between three and 12 different chemicals) depends on the composition of the shale formation that varies by region and by well. The combination of additives function to dissolve minerals, prevent bacteria growth and pipe corrosion, minimize friction, and keep the fractures open or propped up. All chemicals used in the fracking process have common applications from swimming-pool cleaners and laundry detergents to cosmetics, and even ice cream.[15] None of these chemicals is hidden from the public, and federal law stipulates that a company must provide detailed chemical information sheets to emergency personnel in case of an accident. While states that have hydraulic fracturing laws have their own stipulations for chemical disclosure, the U.S. Department of Energy, in collaboration with the Groundwater Protection Council and industry, created the website FracFocus.org. The site provides a full list of chemicals used in the fracking process and companies voluntarily disclose the chemical makeup for specific wells across the country.[16] FracFocus allows users to search wells by operator, state, and county.

Myth #3: *Wastewater from hydraulic fracturing is dangerous and unregulated.*

Fact: *Companies dispose of, and recycle, wastewater using many different methods, all of which are compliant with existing federal and state laws.*

Companies typically use around 4 million gallons of water—what a golf course uses in one week—to fracture a well by using water from lakes, rivers, or municipal supplies. Much of that water remains in the ground; about 15 percent to 20 percent of the water returns to the surface by flowing back through the well.[17] The flowback water contains the chemicals used in the fracking process and can also collect other naturally harmful substances in the ground. This water is never used for drinking and the disposal is subject to federal and state regulations. States have different regulations for disposal, and companies employ a variety of methods including temporary storage of wastewater in steel tanks or

13. Barry Shlachter, "EPA Drops Action Against Range Resources over Parker County Water Wells," *Star-Telegram*, March 31, 2012, http://www.star-telegram.com/2012/03/30/3849362/epa-drops-action-against-range.html#storylink=cpy (accessed July 26, 2012); Tom Tomastik, "Review of U.S. EPA, Office of Research and Development, Investigation of Ground Water Contamination near Pavillion, Wyoming," Ohio Department of Natural Resources, December 2011, http://www.eidohio.org/wp-content/uploads/2011/12/Review-of-U-S-EPA-Groundwater-Investigation-near-Pavillion-Wyoming-_2_.pdf (accessed July 26, 2012); S. S. Papadopulos & Associates, Inc., "Review of U.S. EPA's December 2011 Draft Report: 'Investigation of Ground Water Contamination near Pavillion, Wyoming,'" April 26, 2012, https://images.magnetmail.net/images/clients/IPAA_comm/attach/PavillionReport2012.pdf (accessed July 26, 2012); and U.S. Environmental Protection Agency, "Validated Data Summary Report for 61 Dimock Households that Were Sampled," http://www.epaosc.org/sites/7555/files/Dimock%20W1,2,3,4,5%20Compulation%20Report%202.pdf (accessed July 26, 2012).
14. Battelle, "Review of EPA Hydraulic Fracturing Study Plan, EPA/600/R11/122, November 2011," June 2012, http://www.anga.us/media/251570/final_epa_study_plan_review_061112.pdf (accessed July 26, 2012).
15. FracFocus (Chemical Disclosure Registry), "Chemical Use in Hydraulic Fracturing," http://fracfocus.org/water-protection/drilling-usage (accessed July 26, 2012).
16. In some states, disclosing chemicals on FracFocus satisfies state requirements.
17. Ohio Department of Natural Resources, "Wastewater (Flowback) from Hydraulic Fracturing," http://ohiodnr.com/Portals/11/pdf/wastewater-fact-sheet.pdf (accessed July 26, 2012).

contained pits. More companies are recycling or reusing the flowback water because it makes both economic and environmental sense. Other disposal methods include storing wastewater underground in injection wells that states regulate individually, and the EPA regulates under the Safe Water Drinking Act.[18] The demand for wastewater disposal and recycling is creating opportunities for new companies with emerging technologies to treat wastewater.[19]

There have been concerns, in Pennsylvania for instance, that treating wastewater at sewage treatment plants that discharge into rivers supplying drinking water would contaminate drinking water with radioactive material. But Pennsylvania's Department of Environmental Protection found levels of radioactivity well within federal and state standards. Norm Zellers, manager of the Sunbury Generation treatment facility in Synder County, Pennsylvania, emphasized that "[y]ou can have more radioactivity on a bunch of bananas in the store or on a granite countertop."[20] Wastewater management is another aspect of the fracking process that has been well regulated by existing federal and state laws, and the increased demand for wastewater treatment has driven the process to be cleaner and cheaper.

Myth #4: *Fracking causes earthquakes.*

Fact: *The fracking process itself does not cause earthquakes; in rare instances, the use of underground injection wells (for storage) has caused earthquakes. Induced seismic activity from many underground energy activities is not a new phenomenon and has been closely monitored by the Department of Energy.*

After a series of small earthquakes—ranging from 2.1 to 4.0 on the Richter scale—in Ohio and Arkansas near oil and gas sites, many have raised concerns about future tremors resulting from hydraulic fracturing. But the fracking process itself did not cause these earthquakes. The use of injection wells, an efficient and cost-effective way to dispose of briny wastewater, produced the seismic activity. Instances of seismic activity are rare; out of 30,000 injection wells, there have only been eight events of induced seismic activity—none of which caused significant property damage or injury. Induced seismicity does not occur only from oil and gas extraction. A recent National Research Council study highlights the fact that geothermal activities (capturing and using heat stored in the earth's core) have caused relatively small earthquakes (some felt, some not) at more frequent rates from far fewer projects.[21] The study also warns that continuously injecting carbon dioxide at high pressures (carbon capture and sequestration from coal plants) could induce earthquakes of higher magnitudes.[22]

Seismic activity as a result of underground activity is also not a new phenomenon. The U.S. Department of Energy has been observing and monitoring induced seismic activity from energy-related activities since the 1930s. While companies that induce seismic activity should be liable for any damage they cause, calls for bans of hydraulic fracturing or the use of underground injection wells are unfounded.

State Regulation, Federal Redundancy

One of the reasons why hydraulic fracturing has been so successful in promoting oil and gas development, while maintaining a strong environmental record, is the state regulatory regime. States in which fracturing takes place each have comprehensive regulation that ensures that oil and gas companies operate safely and in an environmentally sensible manner, and administer fines and implement punitive measures to correct any wrongdoing. In November 2011, the EPA's Lisa Jackson acknowledged the states' role: "States are stepping up and doing a good job. It doesn't have to be EPA that regulates the 10,000 wells that might go in."[23] But states are not just now stepping up—states have effectively regulated oil and gas

18. U.S. Environmental Protection Agency, "Safe Drinking Water Act Enforcement," http://www.epa.gov/oecaerth/civil/sdwa/index.html (accessed July 26, 2012).
19. Yuliya Chernova, "Fracking's Wake," *The Wall Street Journal*, September 11, 2011, http://online.wsj.com/article/SB10001424053111903918104576502562678793674.html (accessed July 26, 2012).
20. Francis Scarcella and Evamarie Socha, "Is Radioactive Material Flowing into the State's Rivers?" *The Daily Item*, March 1, 2011, http://dailyitem.com/0100_news/x62859065/Is-radioactive-material-flowing-into-the-states-rivers (accessed July 26, 2012).
21. One vapor-dominated geothermal project has induced 300–400 seismic incidents per year since 2005; 23 liquid-dominated geothermal projects produce 10–40 incidents per year, and eight enhanced geothermal pilot projects produce two to 10 incidents per year. National Research Council of the National Academies, "Induced Seismicity Potential in Energy Technologies," 2012, http://www.nap.edu/catalog.php?record_id=13355 (accessed July 26, 2012).
22. Ibid.
23. Interview with Lisa Jackson, "The Rachel Maddow Show," November 22, 2011, http://video.msnbc.msn.com/the-rachel-maddow-show/45395747#45395747 (accessed July 26, 2012).

production and hydraulic fracturing for decades. In Pennsylvania, fracking has been taking place since the 1960s with nearly 100,000 oil and gas wells fracked and no instances of contamination of groundwater. The same clean record is true for Ohio, where over 70,000 oil and gas wells have been fracked since the 1960s. The Interstate Oil and Gas Compact Commission has compiled statistics for all 50 states, each of which has a flawless record when it comes to fracking and groundwater protection.[24] Detailed in the appendix of this paper is an overview of each state's regulations regarding chemical disclosure, groundwater protection, and wastewater management, as well as links to each state's statutes and regulations that pertain to oil and gas operations.

Despite the states' effectiveness in regulating hydraulic fracturing and despite Jackson's comments, the EPA is pursuing onerous and duplicative regulations with weak scientific support. Many activities of oil and gas production are already subject to a number of major federal regulations, including the Clean Air Act (emissions), the Clean Water Act (surface water discharge), the Safe Drinking Water Act (wastewater management), the Emergency Planning and Community Right-to-Know Act (chemical disclosure for emergency responders), and the National Environmental Policy Act (production on federal lands), among others.[25]

While many of these statutes are in need of serious reform,[26] the White House's recently proposed fracking rules are unneeded and duplicative. The Department of the Interior released a draft rule on public disclosure of chemicals on federal lands despite the fact that states have successfully managed chemical disclosure.[27] Congress has also introduced legislation that would regulate fracking fluids under the Safe Drinking Water Act (SDWA) despite the fact that the 2005 Energy Policy Act codified that Congress never intended to regulate fracking (except when using diesel oil in the fracking process under SDWA).[28] Hydraulic fracturing had been safely regulated for a quarter century before Congress even enacted SDWA in 1974.

In April 2012, the EPA announced its first air-emission rules for hydraulic fracturing. Rather than being aimed at fracking itself, this is a backdoor global warming regulation: The rule highlights the supposed environmental benefits of reducing emission of methane, a greenhouse gas. The EPA's rule miserably fails the cost-benefit test; the agency's own analysis projects $745 million in annual costs and just $11 million to $19 million in environmental benefits. Moreover, the EPA has grossly overestimated methane emissions from the wells.[29] The rule also fails to quantify any benefits from reducing volatile organic compounds (VOC) and hazardous air pollutants (HAP).[30] While the rule asserts that benefits exist, the draft also says that "with the data available, we [the EPA] are not able to provide credible health benefit estimates for the reduction in exposure to [hazardous air pollutants], ozone and [particulate matter] (2.5 microns and less) (PM2.5) for these rules."[31]

Congress: Prevent Federal Overreach on Fracking

The states' effective regulation underscores the need for Members of Congress to prevent federal intervention that would unnecessarily stall the oil and gas boom and drive up costs for producers (and thus consumers). The states with tremendous oil and natural gas reserves have the

24. Interstate Oil and Gas Compact Commission, "Hydraulic Fracturing: State Progress," http://groundwork.iogcc.org/topics-index/hydraulic-fracturing/state-progress (accessed July 26, 2012).
25. Advanced Resources International, Inc., "Bringing Real Information on Energy Forward: Environmental and Regulatory Considerations Associated with the American Oil and Natural Gas Industry," April 24, 2009, http://www.energyindepth.org/PDF/Brief/BRIEF-State_Fed-Partnership.pdf (accessed July 26, 2012).
26. The Heritage Foundation, *Environmental Conservation: Eight Principles of the American Conservation Ethic*, July 28, 2012, http://www.heritage.org/research/projects/environmental-conservation (accessed July 30, 2012).
27. U.S. Department of the Interior, "Oil and Gas: Well Stimulation, Including Hydraulic Fracturing, on Federal and Indian Lands," Draft Rule, May 4, 2012, http://www.doi.gov/news/pressreleases/loader.cfm?csModule=security/getfile&pageid=293916 (accessed July 26, 2012).
28. Energy Policy Act of 2005, Public Law 109–58.
29. Terri Shires and Miriam Lev-On, "Characterizing Pivotal Sources of Methane Emissions from Unconventional Natural Gas Production," American Petroleum Institute and America's Natural Gas Alliance, June 1, 2012, http://www.anga.us/media/249160/anga%20api%20survey%20report%201%20june%20final.pdf (accessed July 26, 2012).
30. U.S. Environmental Protection Agency, "Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews," April 17, 2012, http://www.epa.gov/airquality/oilandgas/pdfs/20120417finalrule.pdf (accessed July 12, 2012).
31. Ibid.

most to gain economically, and have the greatest incentive to protect their environments. States have qualified experts to handle the regulatory requirements surrounding hydraulic fracturing. To that end, Congress should:

- **Prevent any federal agency from adding new regulations to hydraulic fracturing.** The proposed federal regulations are unnecessary and duplicative.
- **Prohibit federal regulators from using any statute to regulate greenhouse gas emissions.** Greenhouse gas regulations would drive up the cost of energy for no meaningful change in the Earth's temperature.
- **Reaffirm the states' authority and effectiveness in regulating hydraulic fracturing.** The states have effectively handled the disclosure of chemicals used in the fracking process and have effectively protected drinking water for decades.

Fracking: It's Important

Hydraulic fracturing and horizontal drilling should be celebrated as important technological progress that has opened new opportunities for the safe development of affordable, reliable energy. The facts and history of hydraulic fracturing indicate that many of the fears associated with the process are exaggerated or unsubstantiated. Entrepreneurs created an energy boom and state regulators have been ensuring that energy production occurs in an environmentally sensible way. Congress should keep it that way.

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Appendix

The following is a snapshot of state regulatory approaches for oil and gas extraction. While the state permitting process and regulatory code is much more thorough than this, the following provides an overview for how each state handles issues of public concern.

1. Alabama

Chemical Disclosure: Within 30 days of operations, the well operator must provide the State Oil and Gas Board with a detailed report of the well treatment method used. A monthly report of fluids injected is required.

Groundwater Protection: Each well must be treated or fractured so that it will not cause damage to the rock formation, result in water encroachment into the oil-bearing or gas-bearing formation, or endanger freshwater-bearing strata. Each well must also be protected by adequate casing and cementing that meets American Petroleum Institute standards and at least the minimum amounts of each to withstand pressure.

Wastewater Management: Waste fluids must be recycled or disposed of in a permitted well within 30 days. Within 90 days after the well is drilled, the pits must be properly filled and compacted.

For More Information: "State Oil and Gas Board of Alabama Administrative Code," http://www.ogb.state.al.us/documents/misc_ogb/goldbook.pdf.

2. Alaska

Chemical Disclosure: A drilling-fluid program with a diagram and description of the drilling-fluid system is required in permit applications. Material Safety Data Sheets must be kept on-site.

Groundwater Protection: Disposal into freshwater is prohibited except in strictly defined circumstances. Wells must demonstrate mechanical integrity and a casing program to protect groundwater. Operators must cement waste wells to ensure zone isolation below permafrost and freshwater aquifers.

Wastewater Management: Permit applications require a plan to dispose of mud and cuttings. There are extensive regulations requiring operators to report how waste is to be stored, how much, the fluid's makeup, where it comes from and is going to, and how long the process will take.

For More Information: Alaska Oil and Gas Conservation Commission, http://doa.alaska.gov/ogc/Regulations/RegIndex.html, and "Alaska State Review," December 1992, http://67.20.79.30/sites/all/themes/stronger02/downloads/Alaska%20Initial%20Review%2012-1992.pdf.

3. Arkansas

Chemical Disclosure: Operator must report to the director of the Oil and Gas Commission the types and volumes of the hydraulic fracturing fluid and proppant (a material that keeps a hydraulic fracture open) used in each stage, and provide a list of all additives and their rates of concentration.

Groundwater Protection: Surface casing requirements are in place to protect freshwater. Any leaks or chemical spills require notification of the director of the Department of Environmental Quality within 24 hours.

Wastewater Management: Wastewater must be disposed of in a state-approved well, and quarterly status reports of injecting intervals, rates, and volumes are required.

For More Information: Arkansas Oil and Gas Commission, http://www.aogc.state.ar.us/OnlineData/Forms/Rules%20and%20Regulations.pdf, and "Arkansas Hydraulic Fracturing State Review," February 2012, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Arkansas%20HF%20Review%202-2012.pdf.

4. California

Chemical Disclosure: Drilling permits require an injection plan detailing water treatment, as well as the source of water and analysis of injection fluid. Injection methods and equipment must be recorded and kept by the operator. Monthly production reports must include the amount of fluid injected.

Groundwater Protection: Permits require a report on wells and freshwater aquifers below the producing zone. Proper casing and cement plugging must be done to protect freshwater and is inspected for environmental regulations adherence. The state Oil and Well Supervisor must approve the abandonment of a well, which includes proper sealing and protection of freshwater nearby. If a violation is found, the supervisor may require a "life of well" bond to pay for the costs of cleanup and decommissioning.

Wastewater Management: Disposal of wastewater must protect public health, natural resources, public and private property, and freshwater aquifers and surface

waters. Disposal must meet State Water Resources Control Board regulations. Surveillance of wastewater disposal is conducted by the state Oil and Well Supervisor.

For More Information: State of California Department of Conservation, http://www.consrv.ca.gov/dog/pubs_stats/Pages/law_regulations.aspx, and "California Follow-Up and Supplemental Review," December 2002, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/California%20Follow-up%20Review%2012-2002.pdf.

5. Colorado

Chemical Disclosure: Operators must complete a chemical disclosure registry form and maintain a chemical inventory of fracturing treatments used during drilling.

Groundwater Protection: Before a well is completed, water strata above and below the well must be sealed. Operators must routinely complete a compliance checklist that includes protection of surface water and drinking-water-supplies requirements.

Wastewater Management: Permits must include a plan for waste management with a water analysis of the injection formation, which may be rejected if deemed insufficient to protect the environment and public health. Use of a commercial disposal facility must be accompanied by a Certificate of Designation from the corresponding county. Disposal can also be accomplished by land treatment or application at a waste management facility.

For More Information: "Colorado Oil and Gas Conservation Commission Rules," http://cogcc.state.co.us/RR_Docs_new/Rules_new2.html, and "Colorado Hydraulic Fracturing State Review," October 2011, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Colorado%20HF%20Review%202011.pdf.

6. Florida

Chemical Disclosure: There are no regulations for chemical disclosure yet.

Groundwater Protection: Well owners must provide a chemical analysis of water samples from the zone proposed for brine injection. Well logs of the proposed injection zone must be kept once drilling begins, ensuring that chlorides are no less than 5,000 parts per million (ppm).

Wastewater Management: A plan showing the casing and cement construction of a disposal well insuring the protection of freshwater aquifers is required for a permit. Approval of a wastewater disposal zone requires that fluids meet or exceed dissolved solids of 10,000 ppm and that chloride content not equal or exceed 5,000 ppm. Regulations exist for plugs and casing of abandoned wells to protect drinking water.

For More Information: "Florida Department of Environmental Protection Water Resource Management Rules by Program," http://www.dep.state.fl.us/water/rulesprog.htm#oil_gas.

7. Idaho

Chemical Disclosure: Trade name and content of fluids must be included in the permit application. Operators must provide the Oil and Gas Conservation Commission with detailed information on the additive types for each stage of the well stimulation program.

Groundwater Protection: A groundwater protection plan showing how groundwater resources will be protected must accompany the permit to drill. The commission may conduct inspections throughout the well life.

Wastewater Management: Disposal method, size, and design of storage pits must be included in the permit application. Storage within the Idaho Department of Environmental Quality public drinking water system is not permitted. Conditions apply for underground disposal of wastewater, disposal wells, and evaporation in earthen pits.

For More Information: The Oil and Gas Conservation Commission, "Conservation of Crude Oil and Natural Gas in the State of Idaho," 2011, http://www.idl.idaho.gov/adminrule/20-07-02/20-07-02-Temporary-Rule.pdf.

8. Illinois

Chemical Disclosure: Injection fluid sample is required with the permit for a standard laboratory analysis. Operators may not change injection fluids without permit approval.

Groundwater Protection: The permit must include water samples from two freshwater wells within one-quarter mile for lab analysis. It must also show that all wells within one-quarter mile are securely cemented.

Wastewater Management: Discharge into surface or drainage water is prohibited. Temporary storage of fluid waste must be in a pit or ground container and lined if appropriate. Waste must be disposed of in an Illinois Environmental Protection Agency (IEPA) certified Class II commercial well.

For More Information: "Illinois Department of Natural Resources Administrative Rules (Adopted)," http://www.dnr.illinois.gov/adrules/Pages/default.aspx, and "Illinois

State Review," August 1996, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Illinois%20Initial%20Review%208-1996.pdf.

9. Indiana

Chemical Disclosure: The owner of the well must send a standard lab analysis of an injected water sample with the well permit application. He must also monitor injection fluids to include in quarterly reports.

Groundwater Protection: The permit application must include the locations and descriptions of each underground source of drinking water that the well would cross, and list all wells within one-quarter mile. Operators must not exceed maximum injection pressures to avoid creating new fractures that may endanger underground drinking water.

Wastewater Management: Evaporation pits are prohibited to prevent surface or underground pollution. A lined pit may be permitted for temporary use. Disposal wells must be completed and maintained to prevent pollution, protect oil and gas sources, and properly confine injected fluid. Mechanical integrity must be proved.

For More Information: Natural Resources Commission, "Article 16 of the Indiana Administrative Code: Oil and Gas," http://www.in.gov/legislative/iac/T03120/A00160.PDF, and "Indiana State Review," April 2005, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Indiana%20Initial%20Review%204-2005.pdf.

10. Iowa

Chemical Disclosure: Well completion reports require data on acidizing and fracturing.

Groundwater Protection: During drilling, water strata above and below the producing horizon must be sealed off or separated. All water with potential value for domestic use must be protected. Wells must have sufficient casing.

Wastewater Management: All waste must be disposed of as the Iowa Environmental Protection Commission requires.

For More Information: The Iowa Legislature, "Iowa Code Title XI Natural Resources Chapter 458A Oil, Gas, and Other Minerals," http://search.legis.state.ia.us/nxt/gateway.dll/ic?f=templates&fn=default.htm.

11. Kansas

Chemical Disclosure: Records of the amount and kind of fluid in injection wells must be recorded.

Groundwater Protection: Encountered freshwater must be sealed off. Minimum surface casing requirements must be met and certain injection pressures may not be exceeded.

Wastewater Management: Injection well permit requires design approval and description of the fluids injected. Pits must be approved by the State Corporation Commission. Chloride concentrations are monitored by a state lab or according to American Petroleum Institute recommendations. The appropriate district office must be notified 24 hours in advance if waste is to be transported.

For More Information: State Corporation Commission of the State of Kansas, "General Rules and Regulations for the Conservation of Crude Oil and Natural Gas," http://www.kcc.state.ks.us/conservation/cons_rr_010711.pdf, and "Kansas State Review," August 1993, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Kansas%20Initial%20Review%208-1993.pdf.

12. Kentucky

Chemical Disclosure: Report of fluid types and volumes and a standard lab analysis must be included in a Class II injection well permit application.

Groundwater Protection: Freshwater wells and streams within a one-quarter mile radius must be noted in a Class II well permit application, which must also demonstrate that it does not endanger underground sources of drinking water. Specific methods for casing and cementing are established to prevent leaking.

Wastewater Management: Operators may not inject fluids in Class II wells without a permit.

For More Information: Kentucky Legislature, "Kentucky Administrative Regulations: Title 805 Energy and Environment Cabinet," http://www.lrc.ky.gov/kar/TITLE805.htm, and "Kentucky State Review," August 2006, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Kentucky%20Follow-up%20Review%208-2006.pdf.

13. Louisiana

Chemical Disclosure: Inspectors and engineers of the Department of Conservation have access to drilling fluid records except in regard to patentable rights and may require the company to correct objectionable conditions.

Groundwater Protection: Injection or contamination of waste into groundwater aquifers of underground sources of drinking water is prohibited. A minimum of surface casing is required and must be tested

before drilling to prevent leaks. Intermediate casing may be required by the district manager to prevent underground waste.

Wastewater Management: Discharge of wastewater into man-made or natural drainage or directly into state waters is allowed only in accordance with the extensive regulatory program. Use of closed storage systems is encouraged.

For More Information: Louisiana Office of Conservation, "Title 43: Natural Resources, Part XIX Office of Conservation—General Operations," http://dnr.louisiana.gov/assets/OC/43XIX_June2010.pdf, and "Louisiana Hydraulic Fracturing State Review," March 2011, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Final%20Louisiana%20HF%20Review%203-2011.pdf.

14. Michigan

Chemical Disclosure: A chemical analysis of each type of fluid to be injected must be included in the permit application; volumes of each must be reported as well.

Groundwater Protection: Drilling under the Great Lakes or under connecting waterways is prohibited. Surface water may not be used for drilling. A water source must be approved by the supervisor.

Wastewater Management: Waste cannot be stored in earthen reservoirs or open receptacles. Waste should be stored in underground wells isolated from freshwater strata. Casing and sealing must be approved by the project supervisor. Spills must be reported within eight hours.

For More Information: Department of Oil and Gas Regulations, "Michigan's Oil and Gas Regulations," http://www.michigan.gov/deq/0,1607,7-135-3311_4111_4231-9245--,00.html, and "Michigan State Review," July 2003, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Michigan%20Initial%20Review%207-2003.pdf.

15. Mississippi

Chemical Disclosure: Within 30 days of the chemical treatment of a well, the operator must file a report to the Mississippi State Oil and Gas Board. A sample and analysis of formation fluid must be supplied to the board upon completion of a fluid disposal well.

Groundwater Protection: All fresh waters of present or probable future for domestic or commercial purposes must be confined and properly protected. A minimum amount of surface casing is required to prevent leaks. Pollution damages are at the expense of the operator.

Wastewater Management: Earthen evaporation pits are prohibited except under temporary permits. Applications to drill injection wells require a fluid sample and must follow regulations for casing, and monthly reports must be made to the board once in operation. Injection into underground reservoirs is only permitted when proved underground drinking water sources are not endangered, and must be reported on monthly.

For More Information: Mississippi State Oil and Gas Board, "Statutes, Rules of Procedure, and Statewide Rules and Regulations," November 2011, http://www.ogb.state.ms.us/docs/MSOGB_Rulebook_20111214.pdf.

16. Missouri

Chemical Disclosure: For injection disposal wells, the permit application must include the proposed average daily injection, the source of the injection fluid, and an analysis of the injection fluid.

Groundwater Protection: In reviewing a permit application, the state geologist may deny a permit if the drilling project seems unnecessarily risky to the surface or subsurface environment. Surface casing must meet regulation standards to prevent water contamination and adequately manage injected fluids. Before any well is abandoned it must be plugged with "mud-laden fluid, cement and plugs" as determined by the state geologist, so that all strata of oil, gas, and water will be permanently contained in the strata.

Wastewater Management: Operators must provide a monthly report of injection fluids and the disposal method to the state geologist. Injection wells must demonstrate mechanical integrity before operations begin, and at least every five years after that. The state geologist will set a maximum injection pressure for a well to prevent additional fracturing and may sample injected fluids during operations.

For More Information: "Code of State Regulations: Division 50–Oil and Gas Council," http://www.sos.mo.gov/adrules/csr/current/10csr/10csr.asp#10-50.

17. Montana

Chemical Disclosure: Upon completing the well, an owner must provide the Board of Oil and Gas Conservation with the type and amount of additive fluid.

Groundwater Protection: Well owners must show throughout the permitting and construction process that surface and ground waters will not be degraded during any part of production and waste disposal.

Wastewater Management: Wastewater with 15,000 ppm or less of total dissolved solids may be disposed of in any way that does not degrade surface or ground waters. Water with greater total dissolved solids must be disposed of in an approved Class II injection well or into an approved earthen pit at the rate of no more than five barrels per day and with proof that groundwater will not be degraded.

For More Information: "Administrative Rules of the State of Montana, Rule Chapter 36.22: Oil and Gas Conservation," http://www.mtrules.org/gateway/ChapterHome.asp?Chapter=36.22.

18. Nebraska

Chemical Disclosure: Water analysis may be submitted in a driller's log at the operator's option. An analysis of injection fluids must be included in permit applications for enhanced recovery wells. Well completion forms require a stimulation summary of fluid types and volumes.

Groundwater Protection: Special caution must be taken to protect artesian water. Water strata above and below the producing horizon must be sealed or separated. Casing must prevent leaks and withstand pressure of up to 300 pounds per square inch, or 125 percent of maximum authorized injection pressure. Any spill or leak over 20 barrels must be reported within two days, after which there are standards for cleanup that must be followed.

Wastewater Management: Disposal plans must be included in a permit application and show, in the case of injection wells, that fluids will not initiate new fractures or enter freshwater strata. Off-site disposal must be transported to an authorized disposal site. There are minimum criteria for reserve pits, and unlined evaporation pits are permitted for 72 hours for waters containing less than 10,000 milligrams per liter of total dissolved solids. Lined pits must meet specifications and have an approved monitoring system.

For More Information: Nebraska Oil and Gas Conservation Commission, "Rules and Statutes Index," http://www.nogcc.ne.gov/NOGCCrulesstatutesindex.aspx.

19. Nevada

Chemical Disclosure: Permit applications require a statement of the sources and estimated amounts of injection fluids.

Groundwater Protection: Freshwater must be protected during all stages of the drilling process. Permit applications require a description of the proposed casing program that demonstrates that adequate casing will prevent leakage and damage to fresh water.

Wastewater Management: Waste may not be stored in unlined pits or open receptacles without approval. Underground disposal must be approved by the administrator of the Division of Minerals of the Nevada Commission on Mineral Resources, locations must be recorded, and certain casing standards must be met.

For More Information: "Nevada Administrative Code: Chapter 522–Oil and Gas,"

http://www.leg.state.nv.us/NAC/NAC-522.html#NAC522Sec185.

20. New Mexico

Chemical Disclosure: The operator must complete and file the Oil Conservation Division's hydraulic fracturing disclosure form within 45 days after well completion. Volume of fluid, description of the fluid's composition and concentration, and maximum ingredient concentration must be included.

Groundwater Protection: The operator must seal off all oil, gas, and water strata above the injection horizon. Special precaution must be taken with artesian water. The operator must use sufficient cement to ensure that casing protects prevent water contamination. If fracturing or treating a well creates underground waste or water contamination, the operator must notify the division within 24 hours, file a full report to the division within 15 days, and may have to plug and abandon the well.

Wastewater Management: Transporters of produced water must first apply to transport wastewater. Operators must keep a monthly water disposal report. Pits, closed-loop systems, below-grade tanks, sumps, and waste management facilities are permitted, but only under certain siting and design requirements.

For More Information: "New Mexico Administrative Code: Chapter 15 Oil and Gas," http://www.emnrd.state.nm.us/ocd/documents-SearchablePDFofOCDTitle19Chapter15created3-2-2012.pdf.

21. New York

Chemical Disclosure: Operators must keep records of injected fluid volumes and report them to the Department of Environmental Conservation annually.

Groundwater Protection: No well can be located closer than 50 feet to a public stream, river, or body of water. The drilling, casing, and completion program for a well must prevent pollution of the surface or groundwater.

Wastewater Management: In order to apply for a well drilling permit, an operator must first

submit an approved plan for environmentally safe disposal of wastewater. Water may be temporarily stored in a tank or lined earthen pit. Operators must submit an application to inject wastewater into underground strata, which the Department of Environmental Conservation will hold for 10 days for any objections from regulators or the general public. If there are objections, a public hearing will be held.

For More Information: New York Department of Environmental Conservation, "Rules and Regulations for Oil, Gas, and Solution Mining," http://www.dec.ny.gov/energy/1630.html.

22. North Carolina

Chemical Disclosure: Fracking is effectively prohibited in North Carolina where drilling is limited to vertical drilling, and pressure limits preclude hydraulic fracturing.

Groundwater Protection: Freshwater strata must be protected by sufficient casing and cement, which must meet certain standards.

Wastewater Management: Except in the case of "extreme emergencies" wastewater may not be stored in earthen reservoirs.

For More Information: Division of Land Resources, "Subchapter 5D–Oil and Gas Conservation," http://ncrules.state.nc.us/ncac/title%2015a%20-%20environment%20and%20natural%20resources/chapter%2005%20-%20mining%20-%20mineral%20resources/subchapter%20d/subchapter%20d%20rules.html, and "North Carolina State Review," February 2012, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/North%20Carolina%20Initial%20Review%202-2012.pdf.

23. North Dakota

Chemical Disclosure: Operators must post all elements used within 60 days after the hydraulic fracturing stimulation is performed on FracFocus.org.

Groundwater Protection: Cement and casing evaluations must be done to ensure that operations meet American Petroleum Institute standards of structural integrity. All water strata above the drilling horizon must be sealed with cement or landing casing that meet construction standards.

Wastewater Management: All waste must be reported and disposed of in an authorized facility or disposal well. A lined earthen pit may only be used temporarily.

For More Information: "North Dakota Oil and Gas Division Rules and Regulations," https://www.dmr.nd.gov/oilgas/rules/rulebook.pdf, and "North Dakota Review," June 1997, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/North%20Dakota%20Initial%20Review%206-1997.pdf.

24. Ohio

Chemical Disclosure: Permits must include the proposed stimulation program, including the average and maximum amounts of injection fluid proposed. The Division of Mineral Resources Management has authority to sample injection fluids at any time.

Groundwater Protection: Permits must include the proposed casing and cementing programs and proposed unloading, surface-storage, and spill-containment facilities. Casing will be pressure tested before drilling commences. Operations must not contaminate the surface or water above or below ground. Surface casing must effectively separate underground sources of water from operations.

Wastewater Management: All fluid storage requires a permit and must be constructed to prevent pollution of surrounding surface and subsurface soil and water. Area review of saltwater injection wells is between a one-quarter-mile and one-half-mile radius; construction, operation, and monitoring must follow division guidelines. Operators must report the amount and destination of disposed water annually to the division.

For More Information: Division of Mineral Resources Management—Oil and Gas, http://codes.ohio.gov/oac/1501:9, and "Ohio Hydraulic Fracturing State Review," January 2011, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Final%20Report%20of%202011%20OH%20HF%20Review.pdf.

25. Oklahoma

Chemical Disclosure: The Conservation Division may access hydraulic fracturing and chemical treatment records upon request. Permit applications for enhanced recovery projects must include a description of the injection medium to be used, its source, and the estimated amounts to be injected daily.

Groundwater Protection: In the permit application, the operator must include the minimum amount of surface casing to be used.

Wastewater Management: Wastewater must be disposed of in one of the options listed in the disposal reference guide that will not pollute surface or underground freshwater. Temporary pit storage and disposal or injection into wells requires an application. Waste sites must be monitored for one year before closure by the Conservation

Division. Prior to disposal, produced water will be tested by a laboratory.

For More Information: Oklahoma Corporation Commission, "Oil and Gas Conservation," http://www.occeweb.com/rules/rulestxt.htm, and "Oklahoma Hydraulic Fracturing State Review," January 2011, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Final%20Report%20of%20OK%20HF%20Review%201-19-2011.pdf.

26. Oregon

Chemical Disclosure: Operators must keep well logs that include chemical treatment records to be submitted to the state geologist after the completion or abandonment of any well.

Groundwater Protection: Sufficient surface casing must run below all potable water levels. Casing and sealing must be tested to ensure there will be no leakage.

Wastewater Management: Disposal is allowed in lined earthen pits with a permit from the Department of Environmental Quality. Disposal into proved saltwater strata is permitted. Ocean disposal may be permitted depending on wastewater quality and approval by the Department of Environmental Quality.

For More Information: State of Oregon Department of Geology and Mineral Industries, "Mineral Land Regulation and Reclamation: Oil and Gas Rules," http://www.oregongeology.org/mlrr/regulations.htm#oil.

27. Pennsylvania

Chemical Disclosure: Operators must keep a drillers log to be submitted to the Department of Environmental Protection at the altering or cessation of a well. The log must include a "stimulation record" that lists the chemical additives and their percent by volume and Chemical Abstracts Service (CAS) registry number.

Groundwater Protection: A water source harmed by drilling must be restored or replaced by the well operator. Operators must report a release of brine no later than two hours after discovery. Operators must report the total volume of the base fluid, a list of water sources used, and the total volume of recycled water.

Wastewater Management: Before waste is produced the operator must prepare a plan for the control and disposal of wastewater. Lined pits and tanks are acceptable for temporary holding.

For More Information: Office of Oil and Gas Management, "Laws, Regulations, and Guidelines," http://www.portal.state.pa.us/portal/server.pt/community/laws%2C_regulations___guidelines/20306, and "Pennsylvania Hydraulic Fracturing State Review," September 2010, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/PA%20HF%20Review%20Print%20Version.pdf.

28. South Dakota

Chemical Disclosure: For disposal injection wells, the source and nature of injected fluids must be reported in a permit application. A water quality analysis must also be submitted with total dissolved solids, chlorides, sodium, sulfates, nitrates, and hydrocarbons.

Groundwater Protection: During construction, all freshwater resources must be sealed. Freshwater resources not being currently used must be protected with sufficient casing. The secretary of the South Dakota Department of Environment and Natural Resources may inspect all operations for pollution, among other things.

Wastewater Management: All wastewater must be disposed of by injection in a permitted disposal or enhanced recovery well, by evaporation in an approved pit, or by discharge into a surface water source through a permitted outfall. Records of the amount, volumes, major changes, and average and maximum injection pressure of fluids must be kept. These records must be monitored at least once in the first year and every time changes are made to fluid.

For More Information: South Dakota Legislature, "Administrative Rules–Oil and Gas Conservation," http://legis.state.sd.us/rules/DisplayRule.aspx?Rule=74:12.

29. Tennessee

Chemical Disclosure: Any fluid or chemicals injected into or above an underground source of drinking water are regulated. Permits require a report of the "nature of injected fluid," its volume, and its maximum injection pressure.

Groundwater Protection: Permits must include an action plan for erosion control, prevention of surface water pollution, and reclamation of land. A casing program must be submitted that builds a cement barrier between all freshwater strata.

Wastewater Management: No waste may be discharged into any body of water or drainage leading to a body of water except by a Department of Environment and Conservation permit. Wastewater may also be sent to an authorized disposal facility with department approval. Temporary pits must be

lined. Regulations include spacing and basic plans of containment pits.

For More Information: "Rules of the Tennessee State Oil and Gas Board," http://tn.gov/sos/rules/1040/1040.htm, and "Tennessee State Review," September 2007, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Tennessee%20Initial%20Review%207-2007.pdf, and Tennessee Department of Environment and Conservation, Rules, May 2010, http://tn.gov/sos/rules/1200/1200-04/1200-04-06.20100518.pdf.

30. Texas

Chemical Disclosure: Within 15 days of fracturing treatment of a well, the supplier or service company must provide to the operator each additive used in the fracturing fluid, its trade name, supplier, and function; the actual or maximum concentration of each chemical; and the CAS registry number of each. The operator must complete the FracFocus Chemical Disclosure Registry. Suppliers and operators may not withhold information from health and emergency professionals.

Groundwater Protection: Fluids must be confined to their strata and protected from contamination with casing.

Wastewater Management: Low-chloride drilling fluid may be disposed of through underground injection into a nonproducing zone where water is unfit for general use. Wastewater may be disposed of upon application by underground injection in a nonproducing zone where water is unfit for general use. Disposal wells must be properly cased and equipped. Mechanical integrity will be tested periodically.

For More Information: Rail Road Commission of Texas, "Rules," http://www.rrc.state.tx.us/rules/rule.php, and "Texas State Review," August 2003, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Texas%20Follow-up%20Review%208-2003.pdf.

31. Utah

Chemical Disclosure: Operators must keep well logs that include formation-water data.

Groundwater Protection: Drilling permit applications must include a plan of drilling, water resources expected to be encountered, and a plan for properly protecting water and other mineral resources. Casing must be pressure-tested before well completion to ensure structural integrity. There are minimum requirements that well owners must meet to prevent pollution and surface damage.

Wastewater Management: The director of the Department of Natural Resources' Division of Oil, Gas and Mining may require that wastewater be tested for quantity, casing, and pressure. Operators may inject wastewater in wells with a permit on a case-by-case basis. The permit must include a plat map[32] of all wells within a one-half-mile radius and a statement of the source, amounts, and daily injection amounts of waste fluids. Class II wells must also include a standard laboratory analysis of injected fluids in a permit application and supply data to support a finding that injection will not cause fractures or water strata contamination.

For More Information: Department of Natural Resources, "Utah Oil and Gas Conservation General Rules," http://oilgas.ogm.utah.gov/Rules/Rules.htm.

32. Virginia

Chemical Disclosure: Operation plans for drilling permits must include a general description of additives. No drilling fluid that has adverse health effects on living organisms is allowed except if specially approved along with proof of environmental protection.

Groundwater Protection: Permit applicants must choose from a listing of several approved sources of water for drilling that protect groundwater.

Wastewater Management: The director of the Department of Mines, Minerals and Energy must approve a disposal plan with maps and narrative of method, or the operator must provide a validated permit of a commercial waste disposal accepting the waste. Operators must record movements of fluid to final destinations. Tanks must be tested at least annually for structural integrity.

For More Information: Virginia General Assembly, "Virginia Gas and Oil Regulation," http://leg1.state.va.us/000/reg/TOC04025.HTM#C0150, and "Virginia State Review," April 2004, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Virginia%20Initial%20Review%204-2004.pdf.

33. Washington

Groundwater Protection: Exploratory drilling through or under state waters requires an environmental impact statement. The Department of Natural Resources will require safeguards to prevent pollution of surface or ground waters.

32. A plat map displays acreage and property lines.

For More Information: Washington State Legislature, "Oil and Gas Conservation," http://apps.leg.wa.gov/RCW/default.aspx?cite=78.52&full=true.

34. West Virginia

Chemical Disclosure: Permit applications must include a description of means used to stimulate a well. Before drilling a well for wastewater disposal, the operator must supply a plat map of the well's location to the Secretary of Environmental Protection, and include a general description of the liquids. After the completion of drilling, the operator must file a report with the Secretary including additives used.

Groundwater Protection: Permits will not be given to projects that fail to protect freshwater sources or supplies. Freshwater strata must be permanently cemented. The Secretary or a state inspector may without notice or hearing stop a fracturing operation that is polluting private or public waters and causing a clear and immediate threat to public health. It is illegal unless in possession of a water pollution control permit to discharge or allow pollutants into state waters.

Wastewater Management: Pits may not be used for permanent storage of waste fluid. Before disposing of waste in wells, the operator must supply the casing records, the maximum pressure to be introduced, a general description of the fluids to be injected, and the location of all water-bearing horizons. Unless allowed by permit, waste cannot be disposed of in state waters. Well permits must include a plan of abandonment. Disposal wells must receive a permit by the state.

For More Information: West Virginia Legislature, "West Virginia Code: Department of Environmental Protection," http://www.legis.state.wv.us/WVCODE/ChapterEntire.cfm?chap=22, and

"West Virginia Follow-Up and Supplemental Review," January 2003, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/West%20Virginia%20Follow-up%20Review%201-2003.pdf.

35. Wyoming

Chemical Disclosure: The source of water and trade name of chemicals, type of proppants, and estimated pump pressures must be reported in a permit application. The well operator must report to the project supervisor the base stimulation fluid, the stimulation program, chemical additives, as well as compounds and concentrations or rates proposed to be mixed and injected. The application must also include the chemical compound name and CAS registry number. The supervisor has access to all confidential well records. Upon completion of a well, the operator must report to the supervisor the quantity of sand and chemicals used.

Groundwater Protection: A permit application must include a report of all water supply wells within one-quarter mile of the proposed well, and data on useable groundwater underlying the drilling unit. Permits must show a proposed casing program. The injection of volatile organic compounds known as BTEX compounds or any petroleum distillates into groundwater is prohibited.

Wastewater Management: Tanks or lined pits may be used for temporary storage with a permit. A report to the supervisor of waste fluids to be disposed must include, at a minimum, estimated volume, pH value, and level of chlorides. Underground disposal of water may be allowed with a permit and after a mechanical integrity test to ensure the casing will not leak. The Wyoming Oil and Gas Conservation Commission encourages recycling drilling fluids.

For More Information: Wyoming Oil and Gas Conservation Commission, http://wogcc.state.wy.us/wogcchelp/commission.html, and "Wyoming State Review: Follow-Up," May 1994, http://www.strongerinc.org/sites/all/themes/stronger02/downloads/Wyoming%20Follow-up%20Review%205-1994.pdf.