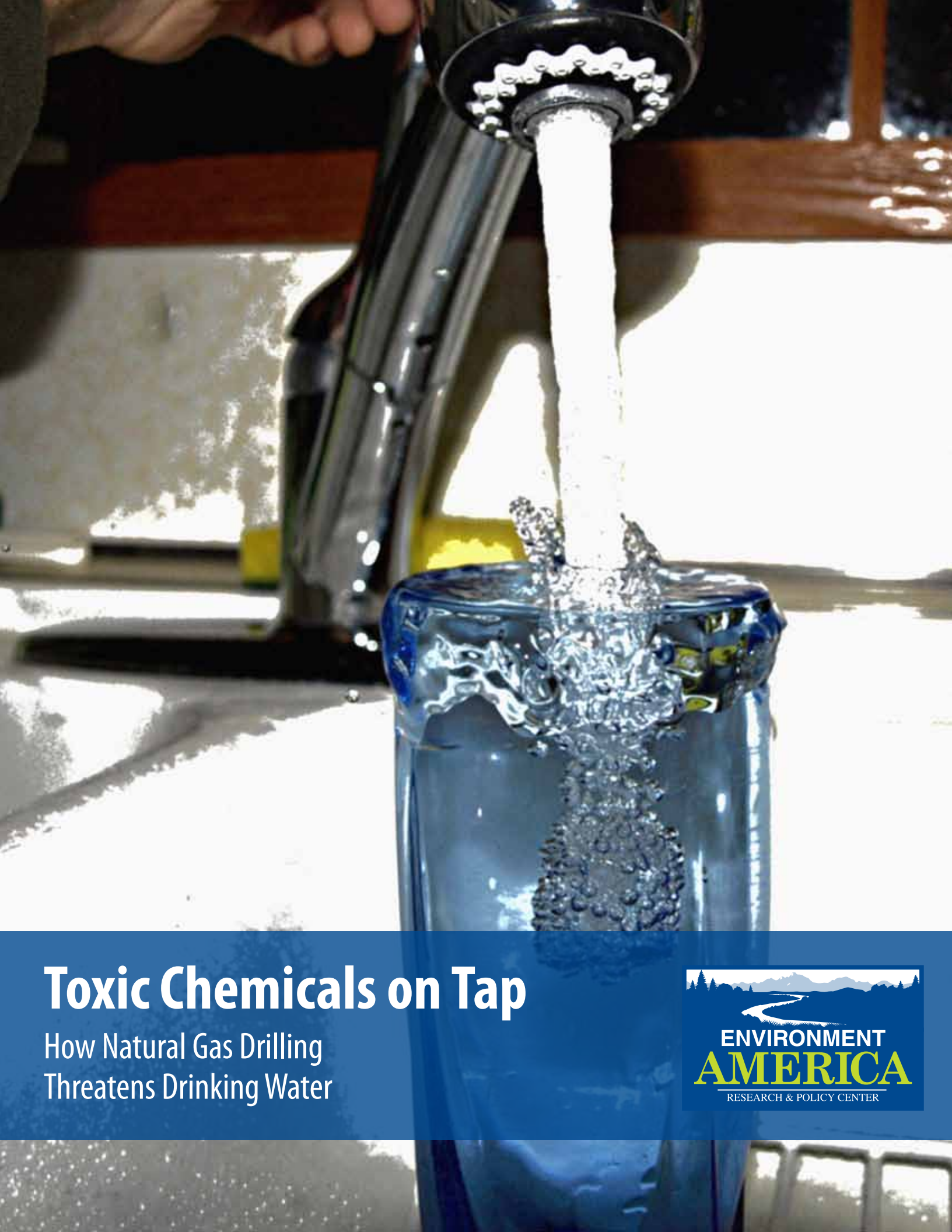

Toxic Chemicals on Tap

How Natural Gas Drilling Threatens Drinking Water

ENVIRONMENT AMERICA
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Executive Summary

Humans need very few things to survive: air, shelter, food, and water. Fossil fuels (oil, coal and natural gas) pollute the air with smog, soot and global warming pollution, but their effect on water is often overlooked. Natural gas, which the industry touts as the "cleanest of all fossil fuels," threatens to dirty drinking water with toxic chemicals used in drilling.[1] Rivers, lakes and groundwater already face threats from industrial pollution, agricultural runoff, and overdevelopment. Adding an unnecessary threat to one of the most valuable resources is dangerous. The government must act to safeguard drinking water.

In light of the increased pressure to drill for more natural gas in states across the country, this report focuses on the dangers to drinking water from gas drilling. In particular, we examined hydraulic fracturing (often called "fracking"), a commonly used process gas companies employ to extract natural gas or oil reserves. Natural gas exists in bubbles underground, much like bubbles in carbonated soda. Getting to these pockets of gas requires injecting millions of gallons of water, sand and chemicals into the ground in order to crack open these bubbles in the rock to allow natural gas to flow to the surface.

Because manufacturers are often not required to disclose the make-up of fluids used in fracturing, we cannot present a truly comprehensive portrait of the toxic chemicals used in drilling. However, the available information from state-required or voluntary disclosures paints a very troubling picture of the toxicity of these chemicals. We find that many of the chemicals used in fracking pose serious health threats. They harm the nervous system, cause respiratory problems and create reproductive issues.

While the chemicals used in drilling near water certainly require monitoring and regulation, drilling also threatens water in other ways. The huge amounts of water required for drilling each site may drain local watersheds. Drilling sites can use up to 7.5 million gallons of water per well.[2] Other problems with the process include inadequate standards for waste disposal, the ability of drilling to force naturally occurring toxics substances as well as the natural gas itself into the groundwater, and a lack of appropriate monitoring of drilling sites.

While natural gas may be better in some aspects than its fossil fuel brethren, drilling for natural gas must not put drinking water at risk. In order to assure water safety, we should:

Avoid Toxic Contamination

- Replace dangerous chemicals in fracturing fluids with safer alternatives; and
- Send wastewater to facilities capable of dealing with the issues presented by fracturing fluids.

Plan for Safety

- Prevent gas drillers from using water for fracturing where it depletes local watersheds;
- Drill only in areas safely distant from drinking water;
- Require a fee for drilling sufficient to pay for cleanup of abandoned sites and to pay for monitoring, permitting, and enforcement of active sites; and
- Create a bonding requirement to make sure that companies have the ability to cover the above costs before drilling begins.

Hold Drillers Accountable

- Make the composition of fracturing fluids public;
- Make sure citizens know the quantity and location of fluids injected nearby;
- Make polluters pay for any contamination they cause; and
- Clean up sites when done and replace lost water supplies.

Employ Best Practices

- Construct drilling sites in a way that prevents the spread of contaminants, such as using steel tanks rather than open pits for wastewater; and
- Be prepared for problems by using rubber pools to catch spills and frequently monitoring for the possibility of escaped fluids or gases.

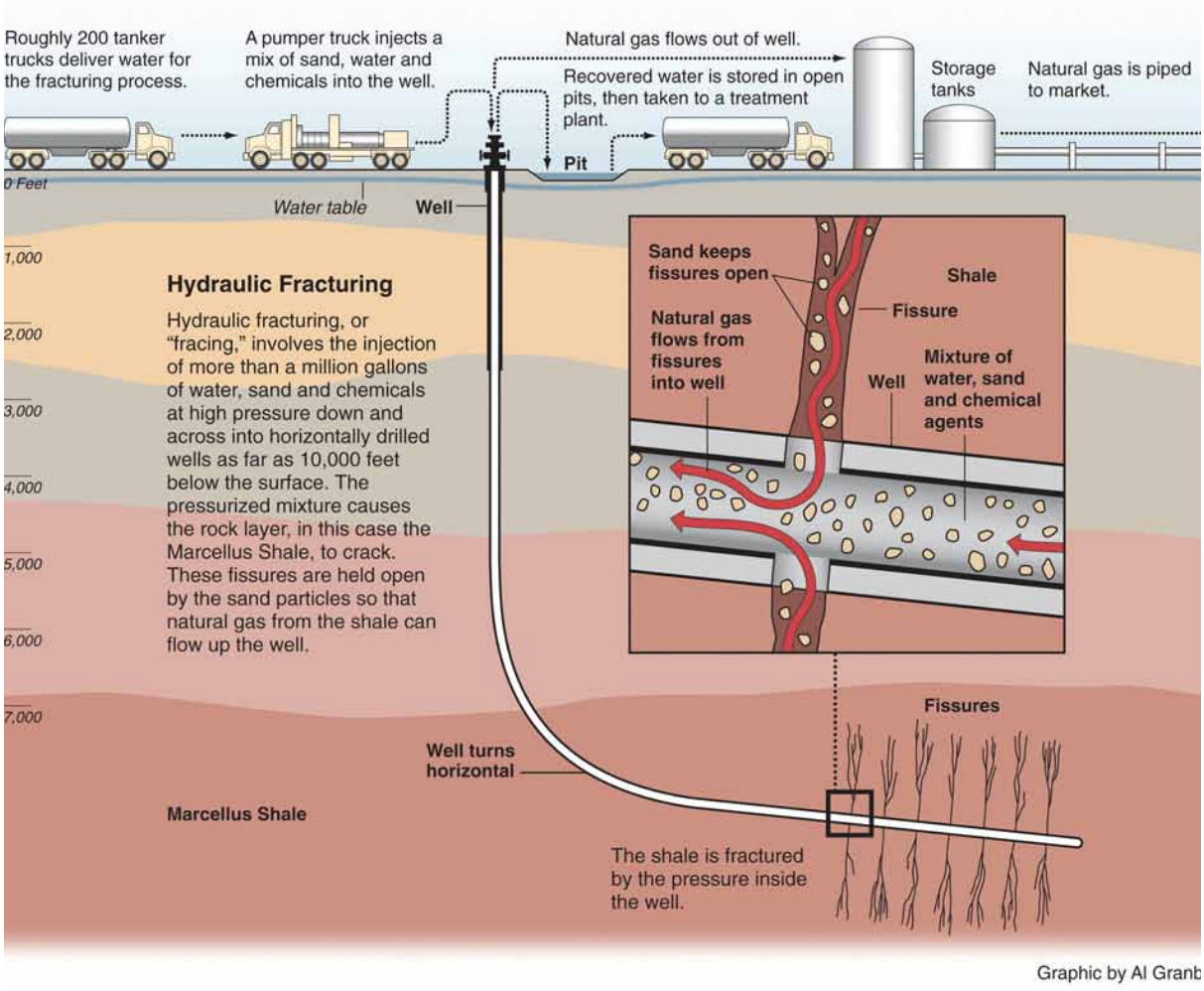
An Introduction to the Threat of Gas Drilling

Clean, drinkable water usually comes from freshwater sources such as streams, lakes, or groundwater. Water above and below the ground faces the threat of contamination by the natural gas drilling technique of hydraulic fracturing. Although some are calling for increased natural gas use in the United States, shifting from one fossil fuel to another must not come at the expense of clean drinking water.

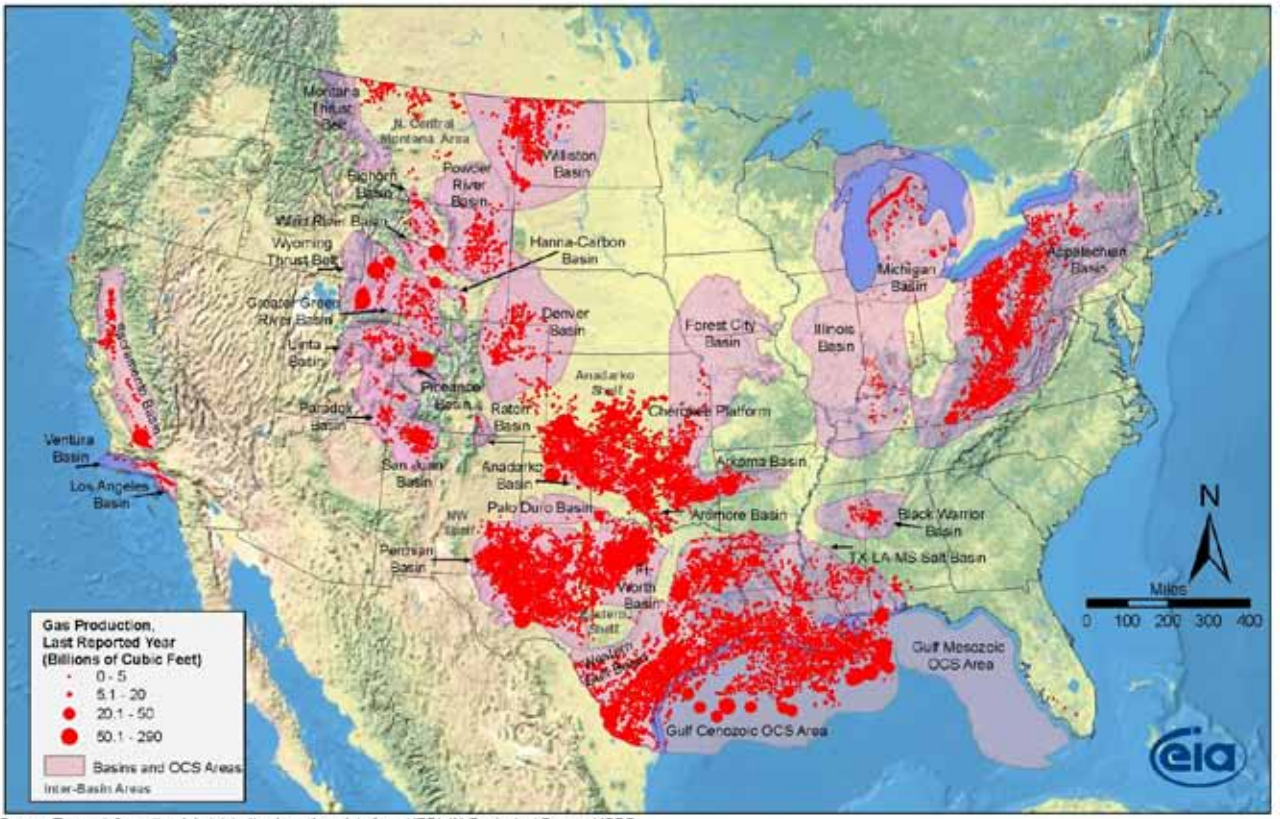
Hydraulic fracturing, or "fracking," is a process used by oil and gas companies to extract hard-to-get natural gas or oil reserves. Natural gas exists in bubbles underground much like bubbles in carbonated soda. Getting to these pockets of gas involves the injection of millions of gallons of water, sand and chemicals into the ground in order to crack open these bubbles in the rock to allow natural gas or oil to flow to the surface.

First put into commercial use in the 1940s, hydraulic fracturing has recently become a crucial part of the oil and gas industry. Today, 90 percent of United States oil and gas wells employ some form of hydraulic fracturing.[4] The number of gas wells that will require the procedure is expected to increase as drillers focus on shale gas deposits as well as coal-bed methane.[5] Gas wells currently operate across the nation with the states of Texas, Pennsylvania, and West Virginia leading the nation in the number of gas wells. Figure 2 shows the current production levels, as well as natural gas reserves in the continental U.S. (Appendix B lists the number of gas wells in each state).

▼ *Figure 1. How Fracking Works*[3]



Graphic by Al Granb



Source: Energy Information Administration based on data from HPDI, IN Geological Survey, USGS
Updated: April 8, 2009

▲ *Figure 2. Gas Production in Conventional Fields, Lower 48 States.*

Methods of fracturing vary based on the location of the gas, but no baseline regulations exist for all practices. The result is an amalgam of state regulations that don't sufficiently protect the public's health from threats to drinking water from drilling.

Gas drilling can ruin clean water sources by enabling drilling chemicals, natural gas itself or other naturally-occurring toxic pollutants to use the paths created in drilling to find their way into water. In addition drilling can contaminate water with chemical spills. It uses large amounts of water, and it threatens water by employing inadequate safety precautions.

Companies are not required to monitor the amount of fracturing fluid injected that is actually recovered, but some estimates report that as much as 91 percent of injected fluid never returns to the surface.[6] Fluid that is left behind after the fracturing process could find its way to drinking water, though no conclusive studies have demonstrated this yet. Naturally occurring pollutants can be disturbed by the fracturing process, and forced into water. Finally, drilling into these formations can create pathways by which fluids or natural gas itself can find its way into water supplies-see "Case Studies".[7]

The wastewater that is recovered from drilling operations may also end up in waterways that supply downstream communities' tap water because no safe standard is enforced for its storage and treatment. Often, drillers store that waste in open pits which may leak, or send it to waste management facilities incapable of properly treating it.[8] Errors in gas well construction or spills during transportation can also lead to water contamination.

Because it is so water intensive, drilling can deplete watersheds and interfere with the local supply of water. In western Pennsylvania, for example, streams have run dry as gas drilling is becoming more common in the region and companies remove excessive quantities of water from nearby streams.[9]

The myriad problems associated with hydraulic fracturing reveal only part of the overall danger the practice poses. Since the Emergency Planning and Community Right-to-Know Act does not cover natural gas drilling, companies do not need to report the chemicals they use.[10] In almost two-thirds of states with drilling, companies do not have to report which chemicals they use, local agencies don't know which chemicals to test for and can't confirm the source of contaminations. If workers or neighbors become exposed, lack of disclosure makes it difficult for health workers to treat the resulting illnesses.[11]

The industry's frequent refrains about why the fluids pose no threat are: chemicals make up a small percentage of fracturing fluids, and some of the chemicals are also found in common household products such as glass cleaners or paints. Yet, years of scientific data show that even very small amounts of certain chemicals cause serious harm. Also, no one would recommend drinking glass cleaners.

The federal government, meanwhile, has done a poor job regulating gas drilling to protect clean water. Instead of taking a tough stand against toxic chemical use, the EPA has historically turned a blind eye to dangerous drilling practices. In 2005, Congress chose to exempt hydraulic fracturing from regulation under the Safe Drinking Water Act (with the exception of the use of diesel fuel as a fracturing fluid-see "Diesel Use in Natural Gas Drilling") rather than to protect the public.[12]

Current drilling operations threaten to poison drinking water, and there is increased pressure to drill for more natural gas around the country. There has never been a more urgent time for the government to better protect drinking water from these increasing threats.

Chemicals Used in Drilling and Their Impacts

General knowledge of chemicals is incomplete, and there is no stringent health standard applied before chemicals are brought to market. Not only that, but the gas industry does not have to disclose the specific chemicals it uses in fracturing. As a result, it is likely that many of the fracturing fluids injected underground contain chemicals untested for their impacts on human health and the environment.

However, with even incomplete information from disclosure laws in several states and partial information supplied by some companies, we know that the chemicals injected in fracturing operations are dangerous, and belong nowhere near drinking water.

Table 1 includes these chemicals, along with some of their more dangerous health effects. It highlights some of the most hazardous chemicals including 2-butoxyethanol (2-BE), naphthalene, formaldehyde, ethylbenzene, and xylene.

Methodology

The table included in this report, as well as Appendix A, is based on the work of The Endocrine Disruption Exchange (TEDX) which compiled the available information on fracturing fluids and their health effects.[20] The data was gathered from a variety of sources including state Right-to-Know acts, Material Safety Data Sheets (MSDSs), accident and spill reports, and Environmental Impact Statements. However, TEDX notes, "the quantity and quality of information varied among these data sources. TEDX makes no claim that [the information] is complete either in the scope of the products used during fracturing operations, or in the chemical composition of the products."[21]

Some additional chemicals have been included due to their use in diesel fuel, a known fracking fluid. We have also added formaldehyde which, though not included in the primary chart of fracturing fluids by TEDX, is listed on the page for fluids used in Pennsylvania. Its use has been documented by the

Diesel Use in Natural Gas Drilling

Prior to 2004, drilling companies frequently used diesel fuel as a fracturing fluid in their operations. Diesel poses a tremendous threat to human health if ingested. Diesel includes a group of chemicals known as BTEX (benzene, toluene, ethylbenzene, and xylene which are listed in Table 1). These are notoriously harmful: the EPA calls anything above five parts per billion an unacceptable level of benzene in drinking water.[13]

The EPA addressed the hazard posed by the use of diesel in fracturing by asking companies to stop using the product. In December 2003, Halliburton Energy Services Inc., Schlumberger Technology Corporation and BJ Services Company voluntarily signed a "Memorandum of Agreement" with EPA in which they voluntarily pledged not to use diesel in limited situations where they were fracturing in coal bed methane deposits in underground sources of drinking water. These deposits presently account for only a small percentage of United States natural gas production.[14] The agreement also included provisions that would allow the three companies to resume using diesel as long as they notified the EPA.[15] This agreement is voluntary, does not include the entire industry, is only limited to one type of geological formation and is virtually unenforceable. Again, because of the lack of mandatory reporting there is no way to know whether companies still use diesel in their fracturing operations.

Chemical	EPA limit parts per million	Cancer	Mutagen	Cardiovascular and Blood Effects	Developmental Toxicant	Endocrine Disruptors	Gastrointestinal and Liver Effects	Immune Effects	Kidney Effects	Brain and Nervous System Effects	Reproductive Effects
(2-BE) 2-Butoxyethanol		S		S	S	S	S	S	S	S	S
Benzene[16]	0.005	S	S	S	S	S	S	S	S	S	S
Crystalline silica, quartz		S	S			S		S	S		
Ethanol (Acetylenic alcohol)		S	S	S	S	S	S	S	S	S	S
Ethylbenzene	0.7	S	S	S	S	S	S		S	S	S
Ethylene glycol				S	S	S	S	S	S	S	S
Formaldehyde[17]		S	S	S	S	S	S	S	S	S	S
Formic acid			S	S	S		S	S	S	S	
Glutaraldehyde			S	S	S	S	S	S	S	S	S
Hydrochloric acid (HCl)				S			S	S			
Isopropanol (Propan-2-OL)				S	S		S	S		S	
Methanol			S	S	S	S	S	S	S	S	S
Naphthalene		S	S	S	S	S	S	S	S	S	S
Toluene[18]	1			S	S		S	S	S	S	S
Xylene	10			S	S	S	S	S	S	S	S

▲ Table 1: Dangerous Chemicals Associated with Gas Drilling and Selected Health Effects

The categories for harms represent a sampling of the potential health risks posed by the chemicals. 'S' indicates that the chemical is suspected of causing the effect. The number of endocrine disruptors involved in fracturing is particularly disconcerting since those chemicals act like hormones and may be harmful at extremely low doses. Mutagens, which cause genetic mutations, are also prevalent in fracturing fluids. The EPA monitors water supplies for only a few of these chemicals. The amounts listed here are the "Maximum Contaminant Levels" for the given chemical. The EPA may take action where the chemical in question exceeds the listed concentration.[19]

Pennsylvania Department of Environmental Protection.[22]

The chemicals included here represent a small portion of the total chemicals used in fracturing. They were selected based on a combination of factors including the number of times they appear in fracturing products from available information sources (as found by TEDX) and the severity and quantity of the health effects they cause.[23] These lists are far from exhaustive, but are meant to be illustrative of the dangers of hydraulic fracturing.

The Threats to Underground Water

For some types of wells, it is estimated that 65 to 91 percent of the fluids remain underground.[26] These chemicals may migrate through underground aquifers and find their way up to drinking wells.

The EPA, in its 2004 report on hydraulic fracturing for coal bed methane, said that, "The literature also indicates that hydraulic fracturing may have increased or have the potential to increase the communication between coal seams and adjacent aquifers…"[27]

Though the EPA has failed to conclusively connect hydraulic fracturing with the contamination of a particular well, its current investigation of the wells in Pavillion, Wyoming may change that. Pavillion, a small town of 172 people, may become the center of the battle over this controversial drilling practice.[28] The EPA recently studied water wells in the area and found nearly a third of the wells to be contaminated. Three of the wells sampled by the EPA contained 2-BE. The EPA is planning to release a report on the cause of the contamination in the spring of 2010.[29]

Also, fracturing may disturb underground formations and cause

naturally occurring toxic substances, such as arsenic or mercury to enter aquifers. Finally, the natural gas itself can migrate into drinking water if drillers are not careful.[30]

Contaminating Above Ground Water

Even without underground leaking of fluids, drilling threatens water. Fluids can spill before they are injected and fluids recovered from fracturing can contaminate surface waters. When it comes back to the surface after drilling, the contaminated water is frequently stored in open-air storage pits. The lack of a clear standard for waste disposal allows unsafe practices to continue while better practices are available such as using steel tanks for storing wastewater on site.

Wastewater from fracturing, as mentioned previously, is sometimes sent to sewage treatment plants which are unequipped to deal with gas drilling pollutants leading to high levels of total dissolved solids and potentially other contaminants in rivers, lakes and streams.[31]

Refuting the Gas Industry's Arguments

In their stated desire to protect secret fracturing formulas from industry rivals, drilling companies endanger the public by preventing citizens from holding faulty operators accountable. This secrecy hampers the tracing of contamination back to its source.

Gas production companies vigorously defend their secrecy about chemicals used in drilling while trying to assure regulators and the public about their safety. Two common industry arguments in defense of their practices are that the same chemicals they drill with are used in common household products, and that they are used in relatively dilute concentrations.

For example, Chesapeake Energy includes on its website a chart of some of its fracturing fluid ingredients and their common uses.[32] Table 1 includes some of those chemicals such as isopropanol, ethylene glycol, and glutaraldehyde.

While Chesapeake notes that isopropanol is "used in glass cleaner, multi-surface cleansers, antiperspirant, deodorants and hair color," it fails to note that, according to The Endocrine Disruption Exchange, the chemical might affect development, the cardiovascular system, or the immune system.[33] Ethylene glycol, the company says, is "used in household cleansers, de-icer, paints and caulk." De-icer, also commonly called anti-freeze, has been linked to a host of adverse health effects.[34]

Chesapeake also says that glutaraldehyde is used as a "disinfectant; sterilizer for medical and dental equipment." The chemical has been associated with problems ranging from mutagenic effects to endocrine disruption and immune disorders.[35]

While toxic chemicals may be found in commonly-used household products, they should not be in a home's drinking water.

Case Studies

Not knowing what chemicals are used in nearby drilling often hampers the ability of local agencies to directly implicate gas producers in contamination cases. Still, the following cases show some recent examples of contamination caused by drilling.

A spill on September 16th, 2009 in Dimock, Pennsylvania highlights the perils of using hazardous chemicals. Fracturing fluids from the spill reached a stream and killed fish near the drilling site, according to the Pennsylvania department of Environmental Protection. Reuters reported that nearly 8,000 gallons of fracturing fluids were spilled in total.[24]

• • •

Natural gas is mostly methane. Methane has been finding its way into homes near drilling sites (sometimes due to faulty drilling). In Weld County, Colorado, the local ABC station aired a segment on the McClure family's tap water. When a lighter was used next to the family's faucet, the water ignited.[25]

The Danger of Small Doses

When not comparing drilling fluids to common household products, the gas industry tries to downplay their hazardous chemical use by highlighting the dilution of the chemicals used. For example, the gas industry estimates that water accounts for 99.5 percent of fracturing fluids, with chemicals making up the rest, or five parts per thousand.[36] Although this sounds small, it means that a well using two million gallons of water would require 10,000 gallons of chemicals.

In addition, water containing five parts per thousand of toxic chemicals could easily endanger human health. Benzene is banned from drinking water by the EPA at levels above 5 parts per billion.

Industry's Slow Progress

Regulating the gas industry now will help ensure that the push for expanded drilling does not come at the cost of safe drinking water. Some in the drilling industry are beginning to acknowledge the need to be more open about their practices.

Schlumberger, for one, is pushing for more transparency. Company spokesman Stephen Harris said recently, "Our suppliers do understand the need for a level of disclosure and are working to address that need."[37]

Vello Kuuskraa of Southwestern Energy Co. said, "I think the industry and the forward thinkers realize that, 'let's just put it out there, we're better off. There's nothing here that should be scary.'"[38] Federally required full disclosure would help the public and regulators protect against drilling operations which could endanger public health.

Some fracturing companies, Schlumberger, for instance, have also moved to develop "green" fracturing fluids.[39] The search for safe substitutes to hazardous chemicals should drive innovation.

Additionally certain field studies, including one done by Amoco, found that hydraulic fracturing done solely with water can be more effective and cheaper than using toxic gels in some cases.[40]

A History of Poorly Safeguarding Drinking Water

Hydraulic fracturing has been around for decades, but regulators at both the state and federal level have been slow to regulate the process to ensure the protection of water. With increasing use of this process, this error threatens to contaminate more sources of drinking water.

The EPA has a history of poor oversight regarding hydraulic fracturing. In 1997, the Legal Environmental Assistance Foundation (LEAF) sued the EPA in the state of Alabama after two of its members alleged that the quality of water in their well had changed due to gas drilling. LEAF claimed that the EPA needed to regulate hydraulic fracturing under the Underground Injection Control (UIC) program of the Safe Drinking Water Act. The EPA responded by stating that "[UIC] regulations [cover] only those wells whose 'principal function' is the injection of fluids into the ground," and excluded fracturing which has a "principal function" of stimulating gas production.[41]

The 11th Circuit Court of Appeals ruled against the EPA, stating that, "EPA's argument that a methane gas production well is not an 'injection well' because it is used primarily for gas extraction is spurious. Congress directed EPA to regulate 'underground injection' activities, not 'injection wells.'"[42]

Following the court mandate to regulate fracking, the EPA undertook a study on the issue which it released in 2004. The EPA's website says, "Based on the information collected and reviewed at the time, EPA concluded that the injection of hydraulic fracturing fluids … posed little or no threat to [Underground Sources of Drinking Water] (USDWs) and additional studies were not justified."[43]

Following the final report an EPA scientist not affiliated with the report, Weston Wilson, wrote a letter to Congress describing the EPA's conclusion as "unsupportable" and listing the many ways in which the study was dubious in nature. He noted that the final study failed to look into migration of gas through fractures and that the study used a biased peer review panel.[44] That peer review panel included three oil and gas industry employees and two former oil and gas industry employees (out of seven total reviewers).[45]

In spite of its flaws, the report bolstered oil and gas industry lobbying to help them win what is known as the "Halliburton Loophole" - an exemption from the Safe Drinking Water Act - in the 2005 Energy Policy Act. Halliburton Company, in addition to having former Vice President Dick Cheney as its one-time CEO, is one of the leaders in energy services. This loophole prevented any new EPA administration from regulating fracturing under the Safe Drinking Water Act with the exception of diesel use.

Without federal standards for drilling and no protection of drinking water from gas operations, the regulation of fracturing falls to the states. While most states have some guidelines for drilling, there is a clear unevenness in the quality of regulations. For instance, only 13 states have some form of specific regulation on the practice of hydraulic fracturing (as noted in Appendix B).

Eleven of the thirty-plus states with drilling require some form of disclosure of chemicals, and even those can be vague. The disclosures often include phrases such as "no hazardous chemicals" or do not list specific chemicals with their identifying number.[46] Without knowing what exactly makes up a fracturing fluid, how much fluid is used, and where precisely the fluid is being used, it becomes incredibly difficult to tie together a drilling operation and a case of water contamination.

Table 2 shows the top 10 gas producing states and whether they require disclosure of fracturing chemicals. The same information is available for every state in Appendix B. Please note that states that require disclosure generally do so only in their permitting process, and not as part of law.[47]

Protecting Drinking Water

With increased natural gas production in several parts of the country, the lack of regulation of hydraulic fracturing increases the risk to drinking water. To protect drinking water, we recommend:

Avoiding Toxic Contamination

- Replacing dangerous chemicals in fracturing fluids with safer alternatives; and
- Sending wastewater to facilities capable of dealing with the issues presented by fracturing fluids.

Planning for Safety

- Preventing gas drillers from using water for fracturing where it depletes local watersheds;
- Drilling only in areas safely distant from drinking water;
- Requiring a fee for drilling sufficient to pay for cleanup of abandoned sites and to pay for monitoring, permitting, and enforcement of active sites; and
- Creating a bonding requirement to make sure that companies have the ability to cover the above costs before drilling begins.

Holding Drillers Accountable

- Making the composition of fracturing fluids public;
- Making sure citizens know the quantity and location of fluids injected nearby;
- Making polluters pay for any contamination they cause; and
- Cleaning up sites when done and replacing lost water supplies.

Employing Best Practices

- Constructing drilling sites in a way that prevents the spread of contaminants, such as using steel tanks rather than open pits for wastewater; and
- Preparing for problems by using rubber pools to catch spills and frequently monitoring for the possibility of escaped fluids or gases.

It's clear that gas drilling poses a threat to drinking water. We need better regulation of drilling to protect clean water.

▼ *Table 2. Disclosure Regulations in States with Most Gas Wells*

State	# of Wells[48]	Some disdisclosure[49]	Public Disclosure?	Specific Hydraulic Fracturing Regulation?[50]
Colorado	40,234[51]	Yes	No	Yes
Kansas	30,232	Yes	Yes	No
Louisiana	19,441	No		Yes
New Mexico	28,417	No		Yes
Ohio	34,817	No		No
Oklahoma	41,921	No		Yes
Pennsylvania	52,700[52]	Yes	No	No
Texas	95,814[53]	No		No
West Virginia	46,123[54]	No		No
Wyoming	29,125	No		Yes

Appendices

▼ *Appendix A. Dangerous Chemicals Associated with Gas Drilling and Selected Health Effects. 'S' indicates that the chemical is suspected of causing the effect. The number of endocrine disruptors involved in fracturing is particularly disconcerting since those chemicals act like hormones and may be harmful at extremely low doses. Mutagens, which cause genetic mutations, are also prevalent in fracturing fluids.*

Chemical	Cancer	Mutagen	Cardiovascular and Blood Effects	Developmental Toxicant	Endocrine Disruptors	Gastrointestinal and Liver Effects	Immune Effects	Kidney Effects	Brain and Nervous System Effects	Reproductive Effects
(2-BE) 2-Butoxyethanol	S		S	S	S	S	S	S	S	S
1,2-Bromo-2-nitropropane-1,3-Diol (2-Bromo-2-nitro-1,3-propanediol or Bronopol)						S	S	S		
2-(2-Methoxyethoxy)ethanol	S		S	S	S	S		S	S	S
2,2',2"-Nitrilotriethanol	S	S	S		S	S	S	S	S	S
2,2-Dibromo-3-nitrilopropionamide (DBNPA)			S	S		S	S		S	
2-ethylhexanol		S	S	S	S	S	S	S	S	S
5-chloro-2-methyl-4-isothiazolin-3-one	S	S	S	S		S	S		S	
Acetic anhydride	S		S	S	S	S		S		S
Acrolein	S	S	S	S	S	S	S	S	S	S
Acrylamide (2-Propenamide)	S	S	S	S	S	S	S	S	S	S
Adipic acid						S	S	S	S	
Ammonia		S	S			S	S	S	S	S
Ammonium nitrate			S			S	S	S	S	S
Benzene	S	S	S	S	S	S	S	S	S	S
Boric acid			S	S	S	S	S	S	S	S
Chromium III				S		S	S	S	S	S
Crystalline silica, quartz	S	S			S		S	S		
Diesel 2	S	S	S			S		S	S	
Ethanol (Acetylenic alcohol)	S	S	S	S	S	S	S	S	S	S
Ethylbenzene	S	S	S	S	S	S		S	S	S
Ethylene glycol			S	S	S	S	S	S	S	S
Formaldehyde	S	S	S	S	S	S	S	S	S	S
Formic acid		S	S	S		S	S	S	S	
Glutaraldehyde		S	S	S	S	S	S	S	S	S
Hydrochloric acid (HCl)			S			S	S			
Hydrofluoric acid			S	S	S	S	S	S	S	S
Isopropanol (Propan-2-OL)			S	S		S	S		S	
Kerosene	S	S	S		S	S	S	S	S	

Chemical	Cancer	Mutagen	Cardiovascular and Blood Effects	Developmental Toxicant	Endocrine Disruptors	Gastrointestinal and Liver Effects	Immune Effects	Kidney Effects	Brain and Nervous System Effects	Reproductive Effects
Methanol		S	S	S	S	S	S	S	S	S
Monoethanolamine		S	S	S	S	S	S	S	S	S
Naphthalene	S	S	S	S	S	S	S	S	S	S
Phosphonium, tetrakis(hydroxymethly)-sulfate	S	S	S		S	S	S	S	S	S
Propane-1,2-diol			S	S	S	S	S	S	S	S
Sodium tetraborate			S			S		S	S	
Thiourea	S	S	S	S	S	S	S			S
Toluene			S	S		S	S	S	S	S
Xylene			S	S	S	S	S	S	S	S

▼ *Appendix B. State Gas Wells and Regulations*

State	Gas Wells[55]	Some Disclosure	Public Disclosure?[56]	Specific Hydraulic Fracturing Regulation?[57]
Alabama	5,958	Yes	No	Yes
Alaska	140	Yes	No	Yes
Arizona	6	Yes	No	Yes[58]
Arkansas	6,554	No		No
California	1,361	No		No
Colorado	40,234[59]	Yes	No	Yes
Connecticut	0	No		
Delaware	0	No		
Florida	0	No		No
Georgia	0	No		
Hawaii	0	No		
Idaho	0	No		
Illinois	733	No		No
Indiana	1,011	No		No
Iowa	0	No		
Kansas	30,232	Yes	Yes	No
Kentucky	16,290	Yes	Yes	No
Louisiana	19,441	No		Yes
Maine	0	No		
Maryland	8	No		No

State	Gas Wells[55]	Some Disclosure	Public Disclosure?[56]	Specific Hydraulic Fracturing Regulation?[57]
Massachusetts	0	No		
Michigan	10,327	No		Yes
Minnesota	0	No		
Mississippi	1,685	No		Yes
Missouri	12	No		Yes[60]
Montana	6,544	No		No
Nebraska	322	No		No
Nevada[61]	100	Yes		Yes
New Hampshire	0	No		
New Jersey	0	No		
New Mexico	28,417	No		Yes
New York	6,683	Yes	Yes	Yes
North Carolina	0	No		
North Dakota	202	Yes	Yes	Yes
Ohio	34,817	No		No
Oklahoma	41,921	No		Yes
Oregon	20	No		Yes[62]
Pennsylvania	52,700[63]	Yes	No	No
Rhode Island	0	No		
South Carolina	0	No		
South Dakota	81	No		No
Tennessee	285	No		No
Texas	95,814[64]	No		No
Utah	5,575	No		No
Vermont	0	No		
Virginia	6,426	Yes	Yes	No
Washington	0	No		
West Virginia	46,123[65]	No		No
Wisconsin	0	No		
Wyoming	29,125	No		Yes

Endnotes

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9. ABC News, "Pa. Streams Drained Dry by Drillers," 13 November 2008, downloaded from www.thepittsburghchannel.com/news/17973811/detail.html, 8 October 2009.
10. United States Environmental Protection Agency. The Emergency Planning and Community Right to Know Act, Section 313. Available at www.epa.gov/TRI/guide_docs/pdf/2000/brochure2000.pdf, 10, October 2009.
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Available at www.newsweek.com/id/154394, 15 October 2009.
12. Energy Policy Act of 2005, Public Law 109–58, Section 322, 8 August 2005.
13. United States Environmental Protection Agency, Drinking Water Contaminants, downloaded from www.epa.gov/safewater/contaminants/index.html#1, 3 October 2009.
14. This procedure comprised only 7 percent of national production in 1996 according to the 2004 EPA study Environmental Protection Agency, Study to Evaluate the Impacts to USDWs by Hydraulic Fracturing of Coalbed Methane Reservoirs, 2004. Available at www.epa.gov/ogwdw000/uic/wells_coalbedmethanestudy.html, 26 September 2009.
15. Though they may still be using diesel fuel based on the Memorandum of Agreement, its use is not exempted from the Safe Drinking Water Act.
A Memorandum of Agreement Between The United States Environmental Protection Agency and BJ Services Company, Halliburton Energy Services, Inc., and Schlumberger Technology Corporation, 12 December 2003. Available at www.epa.gov/OGWDW/uic/pdfs/moa_uic_hyd-fract.pdf, 14 October 2009.
16. Benzene and Toluene were not included in the spreadsheet on fracturing fluid chemicals used, but are found in the New Mexico drilling reserve pit chemical spreadsheet.
17. Found from Pennsylvania Department of Environmental Protection; formaldehyde is included in The Endocrine Disruption Exchange's Pennsylvania fracturing chemicals page.
18. See note 16.
19. United States Environmental Protection Agency, Drinking Water Contaminants, found at www.epa.gov/safewater/contaminants/index.html#1, 10 October 2009.
20. Founded by Dr. Theo Colborn, The Endocrine Disruption Exchange (TEDX) is a non-profit organization, "dedicated to compiling and disseminating the scientific evidence on the health and environmental problems caused by low-dose exposure to chemicals that interfere with development and function, called endocrine disruptors."
The Endocrine Disruption Exchange, TEDX Analysis of Chemicals Used in Fracturing, downloaded from www.endocrinedisruption.com/chemicals.fracturing.php, 27 September 2009.
21. Ibid.
22. Pennsylvania Department of Environmental Protection via River Reporter, List of Pennsylvania Fracking Liquids. Available at www.riverreporter.com/issues/08-12-18/news-fracking.html, 7 October 2009.
23. The health effects listed here were compiled by TEDX from numerous sources including the EPA, Scorecard, the MSDSs, and scientific studies.
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25. Lance Hernandez, 7NEWS, "Flammable Tap Water Ignites Concern Near Hudson," 23 March 2009.
26. See note 6.
27. Environmental Protection Agency, Study to Evaluate the Impacts to USDWs by Hydraulic Fracturing of Coalbed Methane Reservoirs, 2004. Available at www.epa.gov/ogwdw000/uic/wells_coalbedmethanestudy.html, 28 September 2009.
28. Pavillion Wyoming, July 2007, downloaded from www.city-data.com/city/Pavillion-Wyoming.html, 20 October 2009
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30. See note 7.
31. See note 8.
32. Chesapeake Energy, Hydraulic Fracturing Fact Sheet, downloaded from www.chk.com/Media/CorpMediaKits/Hydraulic_Frac_Fact_Sheet_July_2009.pdf, 20 October 2009.
33. See note 20.
34. Ibid.
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37. David Wethe, Bloomberg News, "Schlumberger Presses for Shale-Gas Openness as Regulation Looms," 29 September 2009.
38. Ibid.
39. Schlumberger, Green Chemistry: Earth-friendly GreenSlurry System for Uniform Marine Performance, downloaded from www.slb.com/content/services/stimulation/execution/greenslurry.asp 10 October 2009.
40. See note 4.
41. 11th Circuit United States, Court of Appeals, Legal Environmental Assistance Foundation Inc. vs United States Environmental Protection Agency, Case No. 95-6501.1997.
42. Ibid.
43. United States Environmental Protection Agency, Hydraulic Fracturing, part of the Underground Injection Control program, downloaded from www.epa.gov/ogwdw000/uic/wells_hydrofrac.html 11 October 2009.
44. Weston Wilson, EPA Allows Injection of Hazardous Fluids into Ground Water, 7 October 2004. Available at latimes.image2.trb.com/lanews/media/acrobat/2004-10/14647025.pdf, 29 September 2009.
45. Ibid.
46. The Endocrine Disruption Exchange, Products and Chemicals Used in Fracturing, February 2009.
47. Bruce Baizel, Oil and Gas Accountability project, phone conversation 21 October 2009.
Mr. Baizel noted that his experience with regulations was that most states (with the only exception he could think of being Colorado) require disclosure only as part of the permitting process.
48. Gas well numbers provided by the Natural Resources Defense Council. Some numbers may be approximate.
49. Not all disclosures are equal. Colorado, for instance, does not require public disclosure, and some states only require general descriptions of fluids used. Public disclosure means that the permit submitted, or the fracturing fluids must be available to the general public.
50. Ground Water Protection Council, U.S. Department of Energy, Office of Fossil Energy, National Energy Technology Laboratory, "State Oil and Gas Regulations Designed to Protect Water," May 2009.
51. This figure includes both oil and gas wells.
52. Based on 2007 numbers.
53. Numbers are for "regular producing wells."
54. May include duplicates.
55. See note 48.
56. See note 49.
57. See note 50.
58. Arizona Secretary of State, Arizona Administrative Code, Title 12. Natural Resources Section 7: Oil and Gas Conservation Commission, downloaded from www.azsos.gov/public_services/Title_12/12-07.htm, 12 October 2009.
59. This figure includes both oil and gas wells.
60. Missouri Department of Natural Resources, Fluid Injection Projects, 10 CSR 50-2.100, downloaded from www.sos.mo.gov/adrules/csr/current/10csr/10c50-2.pdf, 11 October 2009.
61. Nevada Department of Environmental Protection, Underground Injection Controls, NAC 445A.867, downloaded from ndep.nv.gov/nac/445a-810.pdf, 11 October 2009.
62. Oregon Department of Geology and Mineral Resources, Division 1-: Oil and Gas Rules, 632-010-0002, downloaded from arcweb.sos.state.or.us/rules/OARS_600/OAR_632/632_010.html, 11 October 2009.
63. Based on 2007 numbers.
64. Numbers are for "regular producing wells."
65. May include duplicates.