Facts on Fracking

Addressing concerns over hydraulic fracturing coming to North Carolina

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John Locke Foundation

Policy Report

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Cover Image: Oil worker on the oil pump jack silhouette by zorandim, Stock Photo 45490807, bigstockphoto.com

Executive Summary

In June 2014 the General Assembly passed and Gov. Pat McCrory signed the Energy Modernization Act.[1] The new law solidifies North Carolina's entry into shale gas and oil exploration, a field that has in recent years become a significant contributor to the national economy.

Among other things, the Act extends the rulemaking deadline for gas and oil exploration till January 1, 2015 (formerly it was October 1, 2014) and expedites the rulemaking process for the management of oil and gas. It also authorizes the issuance of permits for oil and gas exploration, development, and production 60 days after the rules become effective. It creates an Oil and Gas Commission and blocks local prohibitions on oil and gas exploration, development, and production. It also reiterates a prohibition against injecting related wastes into the subsurface or groundwater via wells.

Along with hopes for new jobs, a new domestic industry, and a stronger economy, the prospect of hydraulic fracturing ("fracking") in North Carolina has raised several concerns. Some of these are legitimate questions informed by a responsible skepticism. Others are fears fanned by activists and environmentalist pressure groups. The latter include highly questionable advertisements by an environmentalist "dark-money group" calling itself the "North Carolina Environmental Partnership" (NCEP) and comprising several organizations.[2]

This research paper seeks to address questions and concerns about hydraulic fracturing and shale gas and oil exploration in North Carolina.

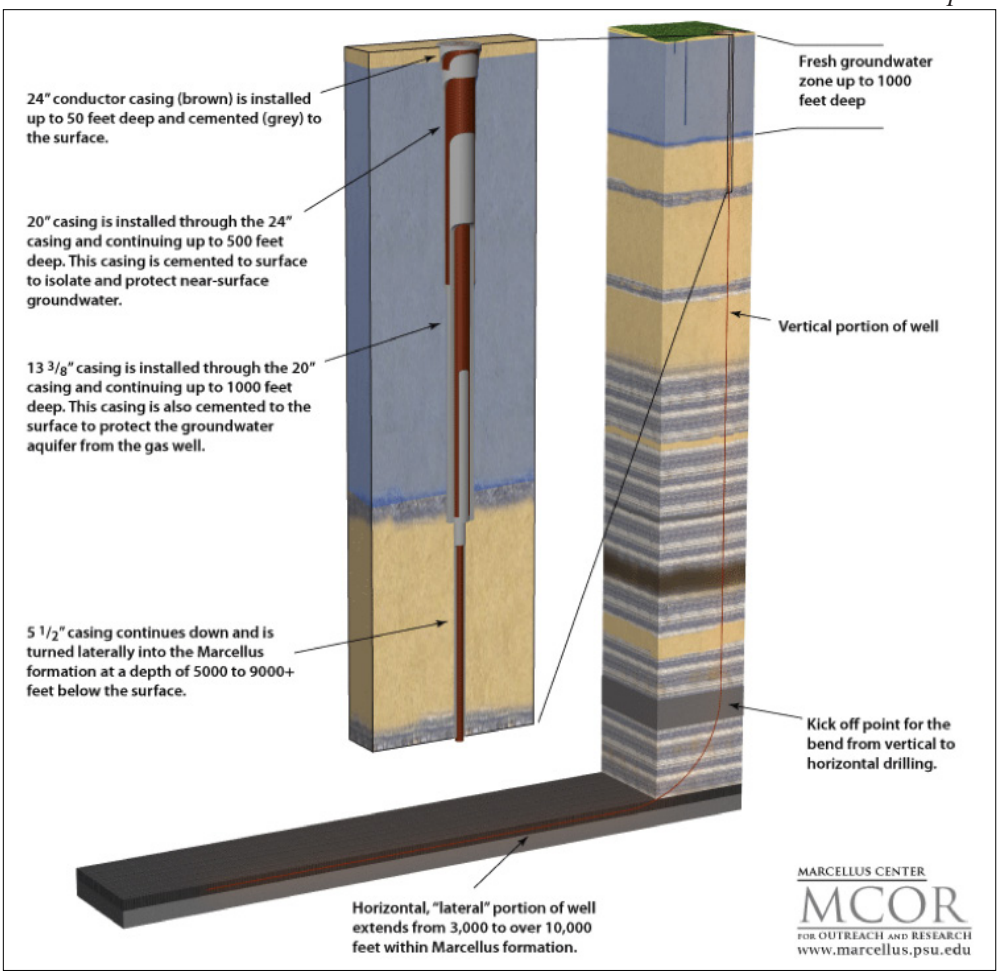
What is fracking?

The technology of hydraulic fracturing was developed in the 1940s. It uses fracturing fluids — chemical mixtures that are nearly all (about 99 percent) water and sand — pumped at high pressure to create and prop open fissures in solid rock formations over a mile underground. The fractures allow trapped resources of natural gas and oil to flow and be recovered.

Fracking is pumping mostly sand and water at high pressure to create and prop open fissures in solid rock over a mile underground to recover trapped gas and oil.

As explained by the Institute for Energy Research:

> *During the initial phase of the fracturing operation, a well is drilled vertically underground to a point past the deepest aquifer containing fresh groundwater. At this stage, the operator inserts steel surface casing down the length of the drilled hole, then pumps in cement to create a barrier of cement and steel between the groundwater and the well bore.*
>
> *The well is then drilled further down into the underground shale formation, where the operator detonates charges in order to create spaces in rock pores to release oil and gas. To create additional fissures, fracturing fluids are injected into the formation at high pressure, which contain additives such as sand to keep the fissures open and the hydrocarbons flowing.*
>
> *Additionally, horizontal drilling provides more exposure within a formation than a vertical well—six to eight horizontal wells drilled from only one well pad can produce the same volume as sixteen vertical wells. This use of multi-well pads significantly reduces the overall infrastructure needed for an operation, such as access roads, pipelines routes, and production facilities, thereby minimizing disturbances to the habitat and impacts to the public.*[3]



Source: "Modern Shale Gas Development in the United States: An Update," National Energy Technology Laboratory, U.S. Department of Energy, 2013, netl.doe.gov/File%20Library/Research/Oil-Gas/shale-gas-primer-update-2013.pdf

How new is fracking?

It isn't new. Hydraulic fracturing has been around for nearly seventy years. The first well in which hydraulic fracturing was used was drilled back in 1947. Since then hydraulic fracturing has been used in over a million wells, and the industry has maintained an excellent safety record.[4]

Since the 1940s, fracking has been used safely in over a million wells.

How dangerous is fracking?

Although fracking has been around for several decades, public debate over fracking has recently become unusually, well, fractious. That makes it hard to separate the facts from the noise. Several notorious examples of "fracking disasters," however, fall far short of the mark upon closer examination.

Lighting tap water on fire

Examples include the famous scene in the 2010 movie "Gasland" where a Colorado man lights his faucet water on fire, a scene in the 2013 sequel "Gasland Part II" where a Texas man sets the end of his garden hose ablaze, and YouTube videos from Pennsylvania and New York residents.

For the latter, research cited above has already shown methane is naturally occurring in the groundwater there and is unrelated to hydraulic fracturing.

With respect to "Gasland," the Colorado Oil and Gas Conservation Commission had investigated the property two years before the movie was released. They found "no indications of oil & gas related impacts to water well."[5] Still, regulators returned after the movie and retested, again finding "biogenic gas that was not related to oil and gas activity" — and furthermore found evidence that the methane had long been present ("a 1976 publication by the Colorado Division of Water Resources states that the aquifer contains 'troublesome amounts of … methane'").[6]

More damning is that "Gasland" director Josh Fox publicly admitted knowledge of those findings and chose to leave them out because he considered them "not relevant." He then furthermore stated that "There were reports in 1936 where people say they could light their water on fire in New York state."[7]

Source: "Gasland Part II" youtube.com/watch?v=s6djv9CCxek

The flaming garden hose of "Gasland Part II," also directed by Fox, was a calculated deception, as well. The hose had been deliberately attached to a gas vent.

The court ruled he had "intentionally attach[ed] a garden hose to a gas vent."

State regulators had already investigated water in the area in 2011 and found that (once again) the source of methane was natural seepage and that natural gas wells were "not causing or contributing to contamination of any Parker County domestic water wells."[8] Going further, in 2012 a Texas District Court ruled that the landowner had conspired with others expressly to "alarm the public" and "alarm the EPA":

> *The Court references with concern the actions of Mr. Steven Lipsky, under the advice or direction of Ms. Alisa Rich, to* intentionally attach a garden hose to a gas vent — *not to a water line — and then light and burn the gas from the end nozzle of the hose. This demonstration was not done for scientific study but* to provide local and national news media a deceptive video, calculated to alarm the public into believing the water was burning. *There is further evidence that Rich knew the regional EPA administration and provided or assisted in providing additional misleading information (including the garden hose video)* to alarm the EPA. *Moreover, the emails in question which refer to this deceptive garden hose demonstration as a "strategy" appear to support that a "meeting of the minds" took place and that a reasonable trier of fact could believe, together with other evidence, that the elements of a conspiracy to defame Range exist." (Emphasis added.)*[9]

Methane has been prevalent in the Susquehanna groundwater for centuries.

In 2008, residents in ***Dimock, Pennsylvania***, on the Marcellus shale formation, began complaining of the quality of drinking water from their wells. Testing revealed heavy concentrations of methane. It was also said that one well exploded, and that toxic chemicals were found in the water.[10] Dimock became "ground zero" in the fight against fracking.[11]

Even as residents reached a financial settlement worth nearly $4.2 million with the mining company, Cabot Oil and Gas, an analysis by the Pennsylvania Department of Environmental Protection (PADEP, to which Cabot also paid over $1 million in penalties) "determined that nearby gas well hydro fracturing activity has not impacted local wells."[12]

Further investigation cast doubt on the allegation that the well explosion had even occurred. According to sworn affidavits, neither the fire chief nor the emergency managing agency director who responded to the call about the well explosion found any evidence on the scene of a fire or explosion in the well pit.[13]

Peer-reviewed research in the May/June 2013 issue of the scientific journal *Groundwater* tested 1,701 wells and concluded that hydraulic fracturing was not responsible for the methane in the wells, that methane (which is not toxic) is and has been prevalent in the groundwater in Susquehanna County, Pennsylvania (which includes Dimock) for hundreds of years, and that the well gases were consistent with upper formation gases, not Marcellus Shale gases.[14]

In 2012, the EPA ruled that there were not levels of contaminants in drinking water in Dimock that warranted additional action by the EPA,[15] and PADEP allowed Cabot to resume drilling there.[16]

Federal documents had discussed Sublette County's poor water quality even back in the 1880s.

In 2008, a water well tested in ***Sublette County, Wyoming***, which has thousands of wells using hydraulic fracturing, found benzene "in a concentration 1,500 times the level safe for people."[17] Supposed to be the "first" federally documented proof of a link between groundwater contamination and fracking, the Sublette study came under fire over several discrepancies as well as lack of acknowledgement of federally documented poor water quality since the 1880s.[18]

In 2013 the U.S. Environmental Protection Agency (EPA) decided to seek neither finalization nor peer review of its report, nor even to rely upon its conclusions, but instead turned its investigation over to Wyoming.[19]

In 2010 the mayor of ***Dish, Texas***, Calvin Tillman, ignited controversy by announcing he and his family were moving from the town, which is located on the Barnett Shale formation and has 60 wells that are hydraulically fractured, because of his concerns over air quality and his family's health. The air in Dish reportedly had elevated levels of many chemicals, including benzene, a known carcinogen. The mayor blamed his younger son's nosebleeds on fracking and suggested it might have also affected his older son's asthma.[20]

Nevertheless, a Texas State Health Department study on Dish residents found that the toxin levels in the blood of the "majority of participants" were "similar to those measured in the general U.S. population suggesting that their exposures to these contaminants were not different than those received by people living in other areas of the U.S."; that for others, the inconsistent pattern suggested the "exposures were most likely due to other factors," including smoking or exposure to disinfectants or home maintenance products; and that the "only residents with elevated levels of benzene in their blood were smokers."[21]

The "only residents with elevated levels of benzene in their blood were smokers."

Meanwhile, energy companies made changes, and state air quality monitoring stations are finding the air pollution levels in Dish to be within compliance.[22]

How safe is fracking?

A 2004 study by the Environmental Protection Agency of hydraulic fracturing of coalbed methane wells found no incident of contamination of drinking water wells from hydraulic fracturing fluid injection.[23] In 2009 state regulators in all member states of the Interstate Oil & Gas Compact Commission stated that they had found no cases where hydraulic fracturing had caused drinking water to be contaminated.[24] The Institute for Energy Research reports that hydraulic fracturing is a safe process well-regulated by the states and that the industry has an excellent safety record.[25]

The "three keys" for safety are "well construction, well construction, and well construction."

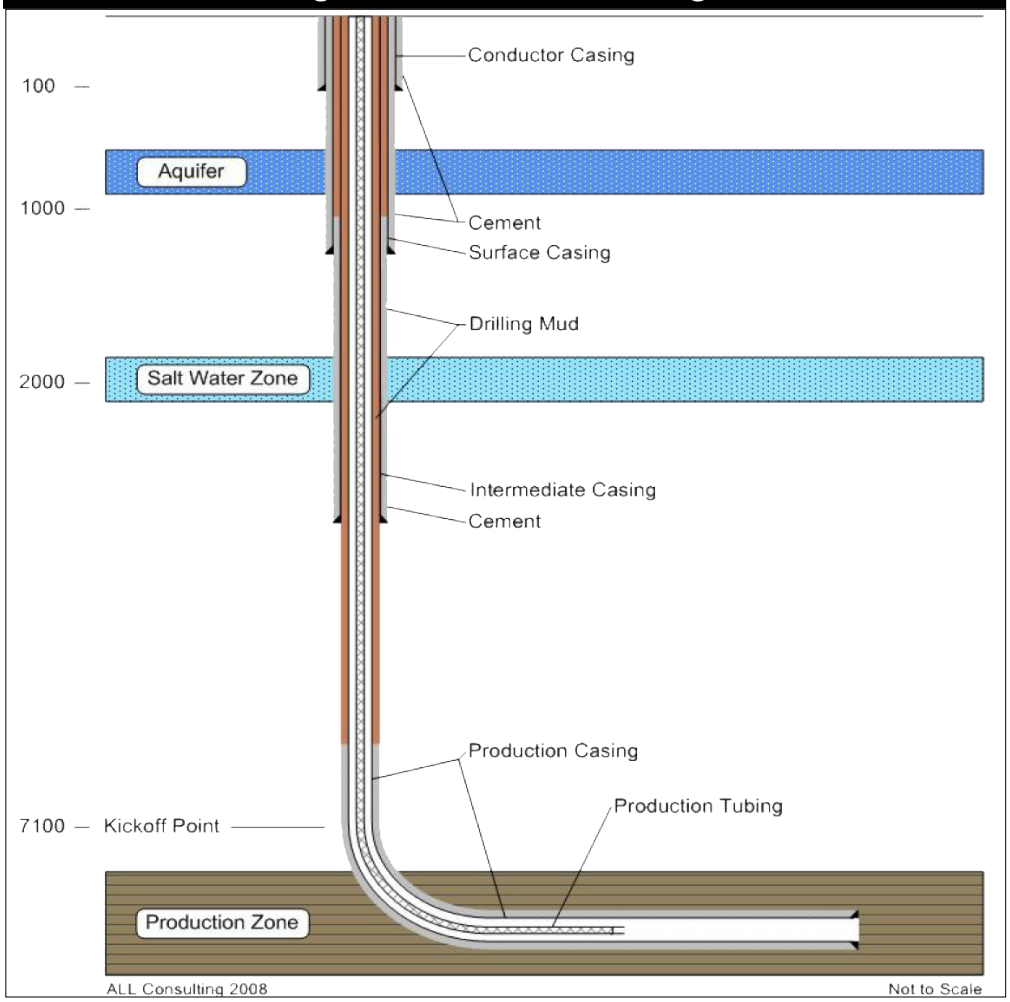
In Pennsylvania, the sudden onslaught of drilling activity — over 2,000 Marcellus wells drilled since 2008 — caught state regulators by surprise, but since then the state has updated its regulatory climate for drilling and fracturing, and energy companies have continued to adjust and refine their practices. A comprehensive review of drilling and hydraulic fracturing in Pennsylvania examined the public records of environmental violations reported to PADEP in 2008–10. Of the 1,924 reports, including administrative violations, 152 were considered serious, with 72 being cement and casing violations, 8 blowouts (uncontrolled fluid flow from a well bore), 56 spills (such as truck accidents or pipeline connection failures), and 16 cases of stray gas (gas moving into freshwater). The report estimated the environmental impact of a typical well to be around $14,000 — compared with an economic impact of about $4 million.[26]

The real issue is well construction

The primary, secondary, and tertiary issue with well safety is not the process of hydraulic fracturing, but well construction. Stanford University geophysicist and Obama administration energy advisor Mark Zoback, who served on the National Academy of Engineering's investigation into the Deepwater Horizon oil spill in the Gulf of Mexico and a study of shale energy production for the U.S. Energy Department, put it: "There are three keys — and those are well construction, well construction, and well construction."[27]

Vikram Rao, executive director of the Research Triangle Energy Consortium, writes that "producing gas wells sometimes leak into freshwater aquifers," but notes that "*In all cases* this is because of some combination of not locating cement in the right places and of a poor cement job" (emphasis added).[28]

Casing Zones and Cement Programs



Source: "Modern Shale Gas Development in the United States: An Update," National Energy Technology Laboratory, U.S. Department of Energy, 2013, netl.doe.gov/File%20Library/Research/Oil-Gas/shale-gas-primer-update-2013.pdf

The Wall Street Journal reported in 2012 on a growing consensus among energy companies, state regulators, academics, and environmentalists that the chief risk isn't hydraulic fracturing, but well construction:

> *Mark Boling, executive vice president and general counsel of Southwestern Energy Co., a major natural-gas producer, said he has examined several incidents in Colorado and Pennsylvania where gas drilling appears to have caused gas to get into drinking water. "*Every one *we identified was caused by a failure of the integrity of the well, and almost always it was the cement job," he said.*
>
> *A. Scott Anderson, a senior policy adviser with the Environmental Defense Fund who is working with Mr. Boling, agreed. "The groundwater pollution incidents that have come to light to date have* all *been caused by well construction problems," he said. ...*
>
> *One of the largest documented instances of water contamination occurred in Bradford County, Pa.—* after wells had been drilled but before any fracking took place*. Chesapeake Energy Corp., the nation's second largest natural-gas company, has conceded that poor well construction may have played a role in high levels of natural gas found in local aquifers, according to letters to state regulators.*[29] *(Emphasis added.)*

How safe is fracking for North Carolina?

Safety of hydraulic fracturing in North Carolina was confirmed by a comprehensive study conducted by the state's Department of Environment and Natural Resources and Department of Commerce under then-Gov. Bev Perdue. Published in April 2012, the study concluded that "information available to date suggests that production of natural gas by means of hydraulic fracturing can be done safely as long as the right protections are in place."[30]

In the Pennsylvania drilling boom, regulators and companies had to adjust on the fly, including regulations and practices concerning well construction. The situation for North Carolina is different. Daniel Fine of the New Mexico Center for Energy Policy has argued that North Carolina, being a latecomer in allowing hydraulic fracturing, is able to adopt best regulatory practices, best technology, and best legal framework from other states' experiences.[31]

Being late in the game means NC can build from other states' experiences and adopt best practices.

The Research Triangle Environmental Health Collaborative reached the same conclusion, stating "North Carolina is thus in a unique position among oil- and gas-producing states. Its new legislative framework can incorporate experiences from other states and include state-of-the-art technologies and best practices."[32]

Does fracking contaminate water?

As discussed above, the process of hydraulic fracturing has been used in over a million wells without a single confirmed incident of drinking water contamination. Numerous studies have found no link between hydraulic fracturing and groundwater contamination.

Fracking fluids are injected over a mile underground. Numerous studies have found no link between fracking and groundwater contamination.

In May 2011, the U.S. Environmental Protection Agency administrator Lisa P. Jackson, testifying under oath before the United States House Committee on Oversight and Government Reform, stated she was "not aware of any proven case where the fracking process itself has affected water."[33]

The U.S. Department of Energy has been conducting a comprehensive, long-term study of hydraulic fracturing in western Pennsylvania. After a year of monitoring, researchers released preliminary findings in July 2013, announcing they had found no evidence of hydraulic fracturing contaminating groundwater.

The study, being conducted by the National Energy Technology Laboratory in Pittsburgh, was the first to use tracer fluids in the injection fluids to allow researchers to monitor migration of the fluids. The fracturing fluids were injected over 8,000 feet (well over a mile) underground but were undetected at a monitoring zone 3,000 feet (over half a mile) underground.[34] Drinking water supplies are at shallow depths. In general, the deeper the depth, the more brackish the water.

Does it use secret chemicals?

The fluid used in hydraulic fracturing is between 98 and 99.5 percent water and sand.[35] The rest comprises chemical additives used for such purposes as conditioning the water, preventing well casing corrosion, controlling the fluid pH levels, killing bacteria, etc.[36] Most of the additives used are chemicals found in typical household products, including soaps, makeup, hair care, and other personal care products — i.e., chemicals that people already willingly encounter daily and safely and that incidentally also find their way into wastewater from households. (See Appendix.)

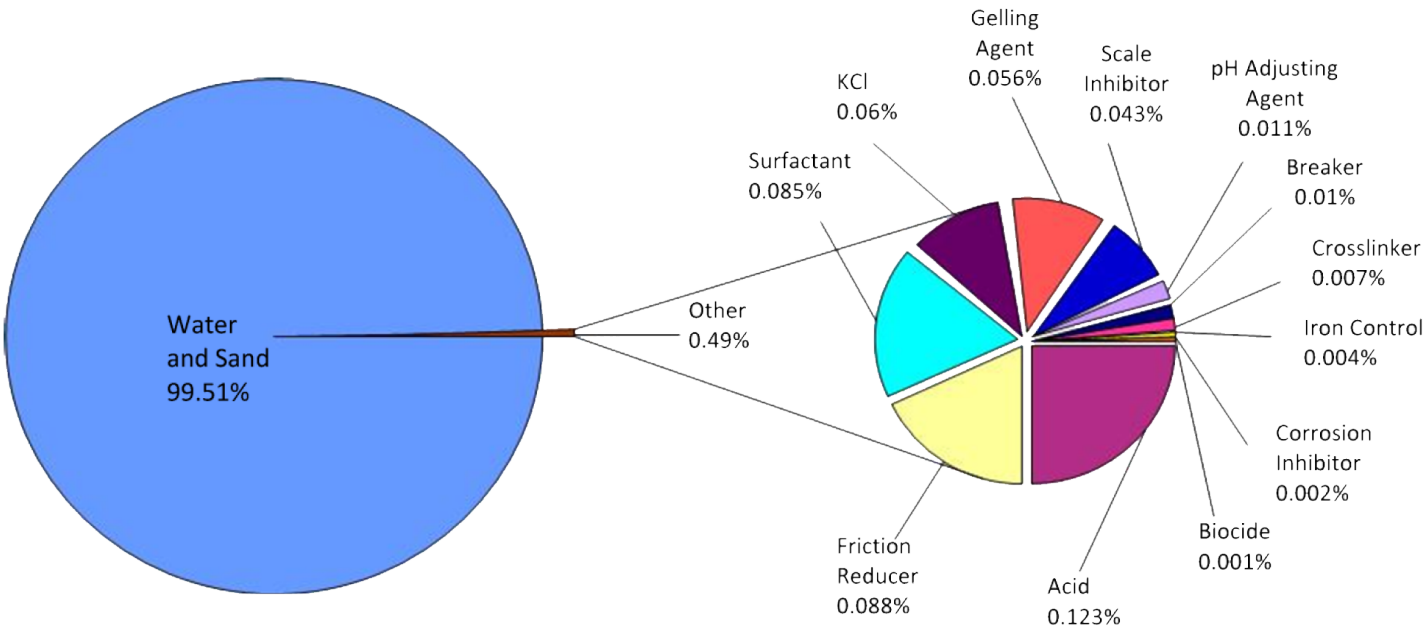
Fracking fluid is 98–99.5% water and sand. The rest is mostly chemicals found in typical household products.

Different companies involved in hydraulic fracturing use proprietary blends of chemicals (not just what chemicals, but what concentrations of each), which they regard as trade secrets not to be shared with competitors. The Energy Modernization Act attempts to balance this concern against public safety concerns.

Counter to misperceptions, the law doesn't mean drilling companies can hide their proprietary fracturing blends from state regulators. That information is shared with the North Carolina Mining and Energy Committee (MEC), the North Carolina Department of Environment and Natural Resources (DENR), the State Geologist, and the State Health Director, and also provided to the Division of Emergency Management. Unlawful disclosure by any state personnel of that information would be a Class 1 misdemeanor. In the event of an emergency, however, that information must be disclosed immediately to first responders and medical personnel.[37]

Draft rules by the MEC would require that the chemicals used in gas and oil exploration and recovery in North Carolina be disclosed to the Chemical Disclosure Registry on the FracFocus website, as is done in many other states.[38] Managed by the Ground Water Protection Council and Interstate Oil and Gas Compact Commission, FracFocus seeks to provide factual information to the public about groundwater protection and also chemicals used in area wells and in hydraulic fracturing operations in general. Colorado, Oklahoma, Louisiana, Texas, North Dakota, Montana, Mississippi, Utah, Ohio, and Pennsylvania use FracFocus as a means of official state chemical disclosure.[39]

Volumetric Composition of a Fracture Fluid

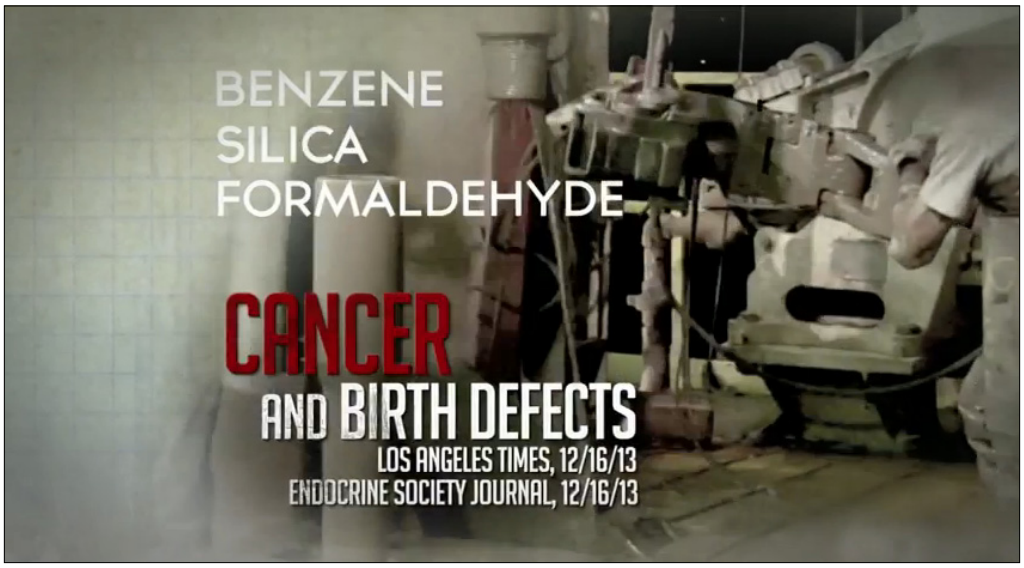


Source: ALL Consulting based on data from a fracture operation in the Fayetteville Shale, 2008

Source: U.S. Department of Energy, *Modern Shale Gas Development in the United States: A Primer.*

Will it cause cancer and birth defects?

One of the dark-money ads airing in North Carolina asserts that hydraulic fracturing "uses toxic chemicals including benzene, silica, formaldehyde — chemicals that can cause cancer and birth defects."[40] According to MEC Chairman Jim Womack, however, benzene "is an EPA banned substance at the federal and state levels — its use for hydraulic fracturing anywhere in the country is illegal"; concentrations of formaldehyde "are so small that the fluid is diluted well below toxicity levels considered harmful"; and furthermore, silica "is sand … [i]t is no more harmful in this industry than it is to quarry workers." By "simple precautionary measures silica can be safely and effectively managed during the well stimulation process."[41]



Source: North Carolina Environmental Partnership (NCEP), "Fracking NC," political advertisement, March 2014

While breathing in great quantities of silica can be harmful, all concern about airborne silica from hydraulic fracturing is over workers' exposure. It is not even remotely a threat to the general population.

Furthermore, occupational exposure to silica is neither a new concern nor is it in any way unique to hydraulic fracturing. It is an occupational hazard faced by nearly 2 million U.S. workers. Affected industries include several kinds of construction work (sandblasting, jack hammering, rock drilling, concrete mixing, concrete drilling, brick and concrete block cutting and sawing, tuck pointing, tunneling operations, drywall finishing, sand and gravel screening, etc.), any other kind of abrasive blasting (such as mold or jewelry cleaning, foundry casting, tombstone finishing, glass etching, maritime offshore rust removal, etc.), quarry work, highway construction and repair, bridge construction and repair, asphalt pavement manufacturing, brick and cement manufacturing and replacement, china and ceramic manufacturing, pottery work, the tool and die industry, and steel and foundry industries, shipbuilding, surface and underground mining, glass manufacturing, railroad work, abrasives manufacturing, boiler scaling, welding, and soap and detergent manufacturing.[42]

The NCEP's choice of "silica" for sand is a topical example of chemical names devoid of their familiar context tending to sound extremely dangerous to the general public. Conscientious researchers must be aware of this tendency. Unprincipled polling firms, special-interest outfits, and demagogues not only know it, they exploit it.

Researchers have demonstrated how easy it is to generate significant public support for an absurd ban of an unfamiliar-sounding chemical with certain dangers. The chemical, identified as "dihydrogen monoxide" to interviewees, is said to be "routinely used" by the chemical industry "in significant quantities," "often leads to spillages and other leaks," and worse, "regularly finds its way into rivers and into our food supply." Furthermore, this chemical's listed effects include being a major component of acid rain, a contributor to erosion, a major greenhouse gas in its vapor state, a presence in the tumors of terminal cancer patients, and often fatal if accidentally inhaled. Given that information, over three-fourths of respondents favored banning the substance.[43]

"Dihydrogen monoxide," or H20, is more commonly known as water.

Benzene use is illegal, formaldehyde is diluted below toxic levels, and silica is sand.

What about flowback from the wells?

Estimates are that from 9 to 35 percent of fracturing fluid pumped into a well returns back to the surface of the well, which is called flowback and is recaptured by the energy companies.[44] Less than 10 percent of the chemicals injected return as flowback, however, in large part because those chemicals perform the various tasks they are injected to perform. The flowback also contains greater salinity and some mineral content from the reservoir.[45]

Many states allow flowback to be disposed of via injection wells, which is an EPA-approved method of disposing of fluid deep underground into a porous (or previously depleted) rock formation. Rao considers deepwater injection to be the least costly method of disposal.[46] North Carolina law, however, currently precludes this option.[47]

Disposal via injection well risks spills from well overflow or, more likely, from equipment failure and accidents in truck transport of the collected flowback to the injection wells.[48] Disposal in North Carolina under present law could involve disposal in municipal solid waste landfills or municipal water treatment plants, though neither are optimal choices to handle the salinity and chemical content of the flowback.[49] Both would also risk spillage during collection and transport.

Another option would be for the energy company to recycle and reuse flowback for hydraulic fracturing. This option would require the company's injection fluid to tolerate a greater salinity — which dovetails with the industry's interest in expanding the use of brackish water in fracturing, because saline aquifers are more pervasive than freshwater aquifers.[50] A 2012 report from the University of Texas at Austin on water usage in hydraulic fracturing in Texas anticipated "rapid development of technological advances, resulting in more common reuse and in the ability to use more brackish water."[51]

Less than 10% of chemicals return in flowback, and flowback is recaptured by the energy companies.

Does it use too much water?

Given that so much of fracking fluid *is* water, a related concern is whether the water used in well drilling and hydraulic fracturing would consume too much of the available water supplies. Water is used in drilling the initial well, also. Fracturing operations in Colorado and Texas have, for example, come under criticism for using too much water. A 2012 joint report by the Colorado Division of Water Resources, the Colorado Water Conservation Board, and the Colorado Oil and Gas Conservation Commission estimated that hydraulic fracturing required just 0.08 percent of the state's water resources.[52] The UT-Austin study estimated that in 2010 hydraulic fracturing used 0.5 percent of water use in the state and furthermore found that "the industry has been decreasing its fresh-water consumption despite the increase in water use."[53]

Even under worst-case assumptions, fracking would not affect surface water supplies in N.C.

In 2014, the American Journal of Engineering and Applied Sciences published estimates on water consumption by hydraulic fracturing in North Carolina. Researchers from North Carolina A&T State University found that, even by using worst-case assumptions (highest-volume water use and lowest lifespan per well), water demand would be "significantly lower" than water availability. They concluded: "It is very clear that the surface water supplies of North Carolina will not be affected at all by the fracking activities."[54]

Does it contaminate our air?

Concern over hydraulic fracturing and air quality was heightened by a 2011 research finding by Robert Howarth and colleagues at Cornell University, who estimated that from 3.6 percent to 7.9 percent of the methane from shale-gas production escapes to the atmosphere through venting and leaks over the lifetime of a well.[55] The study was heavily criticized and countered by numerous subsequent studies,[56] and its finding were even contradicted by a peer review by Howarth's own colleagues at Cornell.[57] A study led by David T. Allen of the University of Texas at Austin took emissions measurements at 190 different natural gas sites and found less than one-half of one percent (0.42 percent) of methane escaped into the atmosphere.[58]

The concern with methane in the atmosphere is its role as a greenhouse gas, one estimated to be many times over more potent than carbon dioxide. The Howarth study assumed 100 percent of methane is vented into the atmosphere, but in actual practice over 93 percent of the gas is recovered and sold, and the remainder is either flared (which converts it to carbon dioxide) or vented.[59] Beginning in 2015, flaring and venting are prohibited by the EPA, while recapturing emissions at the completion of the well, like recapturing flowback, has already become the industry standard. [60]

Other possible sources of air pollution from hydraulic fracturing activities include diesel and dust emissions from trucks used to transport water, sand, cement, equipment, and wastewater; diesel emissions from pumps on the job; fugitive emissions; and combustion emission from compressor stations powered by natural gas.

Studies of air pollutants at productive shale formations across the country have found, for example, that on the Marcellus Shale in Pennsylvania, emissions from natural gas production "may not differ substantially from any other large-scale industrial emissions that impact regional air quality" and that "Compared to total emissions from all industries reporting, the shale extraction industry in 2011 was producing relatively little conventional air pollution. Only NOx [nitrogen oxides] emissions are equivalent to more than 1% of statewide emissions across the entire estimated range."[61]

On the Barnett Shale, which underlies a highly populated urban area, the city of Fort Worth, Texas, commissioned an air quality study to evaluate the effects of natural gas exploration and production there. The study found emissions of "[p]ollutants with relatively low toxicities (e.g., methane, ethane, propane, and butane) accounted for the overwhelming majority — approximately 98% — of the city-wide emissions. However, several pollutants with relatively high toxicities (e.g., benzene) were also emitted from these sites, though in considerably lower quantities." Nevertheless, "measured and estimated air pollution levels did not reach levels that have been observed to cause adverse health effects" such that "this study did not reveal any significant health threats beyond setback distances."[62]

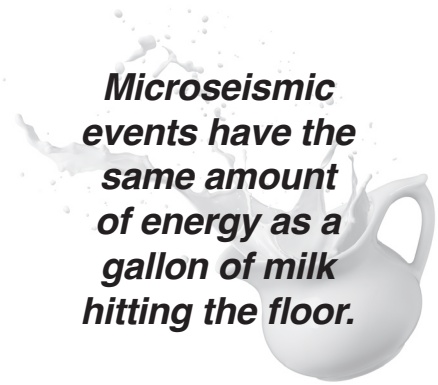
Numerous studies of have not found air pollution to be at levels that would impact health. And recapturing emissions is already the industry standard.

On the Niobrara Shale, the Colorado Department of Public Health and Environment (CDPHE) "conducted air sampling adjacent to natural gas well completion activities in Erie, Colorado … to measure air emissions that may be associated with the well completion activities." Even with monitors placed in such proximity to the wells, the various compounds observed — ethane, propane, methane, toluene, and benzene — were found to be "comparatively low and are not likely to raise significant health issues of concern."[63]

As a side note, Erie, Colorado, had earlier that year been declared by a coalition of environmental activists and special-interest groups as the new "ground zero" in the fight against hydraulic fracturing.[64]

Does fracking cause earthquakes?

Research into whether hydraulic fracturing contributes to a rise in seismic activity is ongoing, but it seems that any earthquakes possibly attributable to hydraulic fracturing[65] are more likely associated with related deepwater injection wells and regardless are very low-magnitude quakes of 3.0 or below on the Richter scale.[66]



Andrew Miall, a Univerity of Toronto geologist who has studied the link between hydraulic fracturing and earthquakes, said quakes caused by fracking were "rare" and explained why the fear was "exaggerated":

> *The fracking process of course itself is explosive and does trigger tiny earthquakes. And when I say tiny, they are about strength one or two, and* even if you were standing right on top of the well as they were doing it, you wouldn't feel it. *(Emphasis added.)*[67]

For comparison's sake, the U.S. Geological Survey defines quakes of the magnitude of 1.0 to 3.0 as "Not felt except by a very few under especially favorable conditions."[68]

Rao explained that fracking-induced earthquakes should not be an item of public worry. "The magnitudes have always been small, so the technique is described as 'microseismic.' … It will be by and large below the threshold for human detection except in unusual situations."[69]

Mark Zoback, the Stanford geophysicist and Obama administration energy advisor, recently showed that "roughly 150,000 wastewater injection wells have been safely operating in the U.S. for many decades with no earthquakes being triggered."[70] Zoback also discussed the "extremely small microseismic events" of hydraulic fracturing:

> *A typical hydraulic fracturing operation involves pressurizing a relatively small volume of rock for a short period of time, typically about two hours, which generates extremely small microseismic events. "The energy released by one of these tiny microseismic events is* equivalent to the energy of a gallon of milk hitting the floor after falling off a kitchen counter*," Zoback says. "Needless to say, these events pose no danger to the public."*
>
> *In several cases, however, larger, but still very small earthquakes have been associated with hydraulic fracturing operations. Out of the hundreds of thousands of hydraulic fracturing operations carried out over the past few years, there have been* only a few reports of triggered earthquakes that might have been large enough to be felt by people *living in the region and none were reported to have caused significant damage. (Emphasis added.)*[71]

Conclusion: A well-tested source of new jobs and revenue

Exploration for and recovery of natural gas in North Carolina holds promise of job creation, wealth creation, revenue generation, and a new domestic industry in the state.

Nevertheless, a common misperception that the method of extraction — hydraulic fracturing — is "new" and insufficiently tested, a natural and reasonable disposition to be skeptical of new methods until proven, combined with a public campaign based on instilling fear through imbalanced reporting, sensationalized half-truths, and even outright lies has made this late development more controversial than it ought to be. Those concerns are addressed here.

North Carolina's late entry to shale gas extraction offers the advantage of state regulators and drilling companies adopting the best standards, legal framework, technological innovations, and practices learned through the experiences of leading shale states.

The promise of job creation, wealth creation, revenue generation, and a new domestic industry in the state.

Appendix: Chemicals routinely used in hydraulic fracturing and other consumer uses

Between 98 percent and 99.5 percent of the fluid used in hydraulic fracturing is water and sand. The rest comprises chemical additives used to condition the water, prevent well casing corrosion, control the fluid pH levels, kill bacteria, and so forth.

According to FracFocus, while "there are dozens to hundreds of chemicals which could be used as additives, there are a limited number which are routinely used in hydraulic fracturing" (emphasis added). This table contains the chemicals listed by FracFocus as the chemicals "most often used" in hydraulic fracturing and what function they serve in fracturing.

If a chemical is known by a common or trade name, the table includes that. It then looks at whether the chemical is something that is either found in or derived from food or is something that is used as a chemical additive in food. Most of that information is taken from NutritionData.com, which supplements data from the U.S. Department of Agriculture with information provided by restaurants and food manufacturers.

In its final columns, this table examines the chemicals' use in consumer products. It counts how many consumer products in the U.S. Department of Health and Human Services' Household Products Database use the chemicals, including examples. The counts are derived from the following categories in the database: Home Maintenance, Home Office, Inside the Home, Landscape/Yard, Personal Care, and Pet Care. It does not include the categories of Arts & Crafts, Auto Care, or Pesticides. The database does not include products for human or animal consumption.

Chemical name	Common or trade name	Function(s) and chemical purpose(s) in hydraulic fracturing	Derived from food or used as a food additive	Use in personal, house, lawn, and pet products	Examples of use in consumer products
2-Butoxyethanol		*Surfactant:* Product stabilizer	Yes	211 household, 2 personal care, and 13 lawn products listed	Simple Green Hand Cleaner Gel Windex Aerosol Glass Plus Mirror & Glass Cleaner
Acetaldehyde		*Corrosion Inhibitor:* Prevents the corrosion of the pipe	Yes	6 household products and 1 lawn product listed	Aleenes School Glue Sakrete Concrete Glue DAP Kwik Seal Tub & Tile Adhesive Caulk
Acetic Acid	Vinegar	*Iron Control:* Prevents precipitation of metal oxides *pH Adjusting Agent:* Adjusts the pH of fluid to maintains the effectiveness of other components, such as crosslinkers	Yes	16 household products and 1 personal care product listed	Earth Friendly Window Kleener, Grecian Formula 16 Liquid with Conditioner Pledge Clean & Dust Spray
Ammonium Persulfate		*Breaker:* Allows a delayed breakdown of the gel	Yes	8 personal care and 3 household products listed	Clairol Maxi Blonde Clairol Kaleidicolors Glidden Brilliance Collection Exterior Latex Paint, Semi-Gloss, Accent Base, 9403G
Borate Salts		*Crosslinker:* Maintains fluid viscosity as temperature increases	No	2 household products and 1 pet care product listed	Method Laundry Detergent for Baby Method Laundry Detergent High-Efficiency Fresh Air Kordon Nov Aqua Water Conditioner and Fish Protector
Boric Acid	Boric acid	*Crosslinker:* Maintains fluid viscosity as temperature increases	No	1 personal care product listed	Efferdent Denture Cleaner
Calcium Chloride	Ice bite	*Breaker:* Product stabilizer	Yes	47 household, 16 personal care, 11 lawn, and 3 pet care products listed	Downy Fabric Softener, Ultra, Free & Sensitive, Unscented Sunlight Liquid Dish Soap, Lemon Scent Gain Liquid Fabric Softener, Apple Mango Tango

Chemical name	Common or trade name	Function(s) and chemical purpose(s) in hydraulic fracturing	Derived from food or used as a food additive	Use in personal, house, lawn, and pet products	Examples of use in consumer products
Choline Chloride		*Clay Stabilizer:* Prevents clays from swelling or shifting	Yes	None listed	
Citric Acid	Lemon juice, lime juice	*Iron Control:* Prevents precipitation of metal oxides	Yes	849 personal care, 225 household, 4 lawn, and 24 pet care products listed	Pampers Sensitive Wipes Pantene Pro-V Color Revival Shampoo Lever 2000 Family Body Wash, Pure Rain
Copolymer of Acrylamide and Sodium Acrylate		*Scale Inhibitor:* Prevents scale deposits in the pipe	Indeterminate	4 personal care, 5 household, and 3 pet care products listed	Olay Purely Pristine Body Bissell Deepclean, Spring Breeze Gillette Fusion ProSeries UV Moisturizer, Instant Hydration, SPF Plus 15
Ethanol	Grain alcohol, ethyl alcohol	*Surfactant:* Product stabilizer and/or winterizing agent	Yes	539 personal care, 548 household, 12 lawn, and 16 pet care products listed	Aveeno Baby Soothing Relief Moisture Cream, Fragrance Free Lanacane First Aid Spray Earth Friendly Products Pet Stain & Odor Remover, Pump Spray
Ethylene Glycol	Antifreeze	*Breaker:* Product stabilizer and/or winterizing agent *Friction Reducer:* Product stabilizer and/or winterizing agent *Gelling Agent:* Product stabilizer and/or winterizing agent *Non-Emulsifier:* Product stabilizer and/or winterizing agent	No	689 household, 2 personal care, and 13 lawn products listed	Burt's Bees, Baby Bee, Diaper Ointment with Vitamin A and Vitamin E Kiwi Scuff Magic, Black Epson Ink Cartridges
Formic Acid	Formic acid	*Corrosion Inhibitor:* Prevents the corrosion of the pipe	Yes	6 personal care and 20 household products listed	Downy Fabric Softener, Ultra, Free & Sensitive, Unscented Softsoap Body Wash, Pure Cashmere Pantene Pro-V Fine Hair Style Mousse, Maximum Hold
Glutaraldehyde	Diswart	*Biocide:* Eliminates bacteria in the water that produces corrosive by-products	No	2 household products listed	Sunlight Liquid Dish Soap Lemon Scented Snuggle Ultra Blue Sparkle Fabric Softener
Guar Gum	Cluster bean	*Gelling Agent:* Thickens the water in order to suspend the sand	Yes	1 pet care product listed	Arm & Hammer Essentials Natural Clumping Litter
Hydrochloric Acid	Stomach acid, muriatic acid, spirit of salt	*Acid:* Helps dissolve minerals and initiate cracks in the rock	Yes	46 household, 1 personal, 1 pet care, and 16 lawn products listed	Lysol Power Toilet Bowl Cleaner Febreze Air Fresheners Herbal Essences Hello Hydration 2 In 1
Hydrotreated Light Petroleum Distillate		*Crosslinker:* Carrier fluid for borate or zirconate crosslinker *Friction Reducer:* Carrier fluid for polyacrylamide friction reducer *Gelling Agent:* Carrier fluid for guar gum in liquid gels	No	145 household, 3 personal care, 11 lawn, and 9 pet care products listed	Spray N Wash Prewash Stain Remover Lysol Neutra Air Freshmatic Automatic Spray Goo Gone Aerosol
Isopropanol (Isopropyl Alcohol)	Rubbing alcohol	*Corrosion Inhibitor:* Product stabilizer and/or winterizing agent *Non-Emulsifier:* Product stabilizer and/or winterizing agent *Surfactant:* Product stabilizer and/or winterizing agent	Yes	202 personal care, 339 household, 8 lawn, and 27 pet care products listed	Purell Instant Hand Sanitizer New-Skin Liquid Bandage L'Oreal Preference Haircolors

Chemical name	Common or trade name	Function(s) and chemical purpose(s) in hydraulic fracturing	Derived from food or used as a food additive	Use in personal, house, lawn, and pet products	Examples of use in consumer products
Lauryl Sulfate		*Non-Emulsifier:* Used to prevent the formation of emulsions in the fracture fluid *Surfactant:* Used to increase the viscosity of the fracture fluid	Yes	383 personal care, 79 household, and 21 pet care products listed	Pantene Pro-V Ice Shine Shampoo Colgate Toothpaste Nature's Miracle Ultra-Cleanse Gentle Dog Shampoo
Magnesium Oxide	Magnesia	*Breaker:* Allows a delayed breakdown of the gel	Yes	8 household and 8 lawn products listed	Ajax Cleanser with Bleach Master Collection All Purpose Plant Food 15-13-13 Sakrete Anchor Cement
Magnesium Peroxide	Magnesium dioxide	*Breaker:* Allows a delayed breakdown of the gel	No	4 personal care products listed	Garnier Nutrisse Level 3 Permanent Creme Haircolors
Methanol	Wood alcohol, wood spirits	*Corrosion Inhibitor:* Product stabilizer and/or winterizing agent *Crosslinker:* Product stabilizer and/or winterizing agent *Friction Reducer:* Product stabilizer and/or winterizing agent *Gelling Agent:* Product stabilizer and/or winterizing agent *Surfactant:* Product stabilizer and/or winterizing agent	Yes	83 household, 4 personal care, and 3 lawn products listed	Murphy Wet Disposable Soft Wipes Palmolive Dishwashing Detergent Softsoap Body Wash, Pure Cashmere
Naphthalene	Mothballs	*Surfactant:* Carrier fluid for the active surfactant ingredients	No	8 household and 4 lawn products listed	Enoz Old Fashioned Moth Balls Spectracide Brush Killer Concentrate Sherwin-Williams All Surface Enamel Oil Base Primer, White
Petroleum Distillate		*Crosslinker:* Carrier fluid for borate or zirconate crosslinker *Friction Reducer:* Carrier fluid for polyacrylamide friction reducer *Gelling Agent:* Carrier fluid for guar gum in liquid gels	No	1 household product listed	Klean-Strip Brush Cleaner
Phosphonic Acid Salt		*Scale Inhibitor:* Prevents scale deposits in the pipe	Indeterminate	Indeterminate	
Polyacrylamide	PAM soil conditioner	*Friction Reducer:* "Slicks" the water to minimize friction	No	36 personal care and 2 household products listed	Oil of Olay Active Hydrating Beauty Fluid–Sensitive Skin Dove Men+Care Body & Face Wash Aveeno Positively Radiant Moisturizing Lotion
Polysaccharide Blend		*Gelling Agent:* Thickens the water in order to suspend the sand	Indeterminate	None listed	
Potassium Carbonate	Potash	*pH Adjusting Agent:* Adjusts the pH of fluid to maintains the effectiveness of other components, such as crosslinkers	Yes	8 household and 3 lawn products listed	Clorox Green Works Natural Dilutable Cleaner Simple Green Naturals Dilutable Concentrated Cleaner Miracle Gro Instant Action Houseplant Food Tablets 15-20-15
Potassium Hydroxide	Caustic potash	*pH Adjusting Agent:* Adjusts the pH of fluid to maintains the effectiveness of other components, such as crosslinkers	Yes	36 personal care and 2 household products listed	Aveeno Baby Soothing Relief Diaper Rash Cream, Fragrance Free Vaseline Petroleum Jelly Cream, Deep Moisture Mop & Glo Triple Action Floor Shine
Potassium Metaborate*		*Crosslinker:* Maintains fluid viscosity as temperature increases	Indeterminate	1 personal care product listed	Efferdent Denture Cleaner

Chemical name	Common or trade name	Function(s) and chemical purpose(s) in hydraulic fracturing	Derived from food or used as a food additive	Use in personal, house, lawn, and pet products	Examples of use in consumer products
Quaternary Ammonium Chloride		*Biocide:* Eliminates bacteria in the water that produces corrosive by-products	Indeterminate	92 personal care and 32 household products listed	Suave for Kids 2-in-1 Shampoo, Wild Watermelon Suave Herbal Care Shampoo AXE Shower Gel, Apollo
Sodium Carbonate	Soda ash, washing soda	*pH Adjusting Agent:* Adjusts the pH of fluid to maintains the effectiveness of other components, such as crosslinkers	Yes	285 household, 39 personal care, 11 lawn, and 4 pet care products listed	Sensodyne Extra Whitening Toothpaste Clairol Mens Choice Haircolor Purex Ultra Laundry Detergent
Sodium Chloride	Table salt	*Breaker:* Product Stabilizer *Clay Stabilizer:* Prevents clays from swelling or shifting	Yes	583 personal care, 131 household, 14 lawn, and 23 pet care products listed	Snuggle Ultra Blue Sparkle Fabric Softener Aussie Moist Shampoo Drano Crystal Clog Remover
Sodium Erythorbate*	Sodium isoascorbate, erythorbic acid	*Iron Control:* Prevents precipitation of metal oxides	Yes	180 personal care products and 1 household product listed	Clairol Natural Instincts for Men Haircolors Revlon Colorist Expert Color and Glaze Systems Spray N Wash Prewash Stain Remover
Sodium Hydroxide	Lye	*pH Adjusting Agent:* Adjusts the pH of fluid to maintains the effectiveness of other components, such as crosslinkers	Yes	276 personal care, 290 household, 7 lawn, and 3 pet care products listed	Aveeno Baby Calming Comfort Bath Dove Ultra Moisturizing Body Wash Colgate Total Toothpaste
Sodium Polycarboxylate		*Scale Inhibitor:* Prevents scale deposits in the pipe	Indeterminate	Indeterminate	
Sodium Tetraborate	Borax	Crosslinker: Maintains fluid viscosity as temperature increases	No	21 personal care, 87 household, 13 lawn, and 4 pet care products listed	Burt's Bees, Baby Bee Buttermilk Lotion for Sensitive Skin Cheer Liquid Laundry Detergent Four Paws Pet Dental Liquid Tartar Remover for Dogs
Tetrakis Hydroxymethyl-Phosphonium Sulfate		*Biocide:* Eliminates bacteria in the water that produces corrosive by-products	No	None listed	
Tetramethyl ammonium chloride*		*Clay Stabilizer:* Prevents clays from swelling or shifting	No	21 personal care products and 1 pet care product listed	Avon Perfect Wear Extralasting Lipstick Infusium 23 Shampoo 1 Frizz Controller Olay Regenerist Night Recovery Moisturizing Treatment
Thioglycolic Acid*	Mercaptoacetic acid	*Iron Control:* Prevents precipitation of metal oxides	No	8 personal care products listed	Veet Bikini Hair Removal Cream for Sensitive Skin Nair Lotion Hair Remover with Aloe & Lanolin Veet Underarm Kit
Triethanolamine Zirconate		*Crosslinker:* Maintains fluid viscosity as temperature increases	Indeterminate	None listed	
Zirconium Complex*		*Crosslinker:* Maintains fluid viscosity as temperature increases	Indeterminate	49 personal care products listed	Dial Roll-On Antiperspirant Lady Speed Stick by Mennen Right Guard Xtreme Clear Antiperspirant and Deodorant

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About the Author

Jon Sanders is Director of Regulatory Studies at the John Locke Foundation. Before assuming his current responsibilities, Sanders served as JLF's Associate Director of Research. He also researched issues in higher education for the John William Pope Center for Higher Education Policy and has been an adjunct instructor in economics at North Carolina State University. Sanders has been widely published, appearing in The Wall Street Journal, National Review, ABC News online, Washington Examiner, Townhall.com, FrontPage Magazine, the San Francisco Chronicle, The Freeman: Ideas on Liberty, the Philadelphia Inquirer as well as numerous newspapers across North Carolina. A native of Garner, N.C., Sanders holds a masters degree in economics with a minor in statistics and a bachelors degree in English literature and language from N.C. State.

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"To prejudge other men's notions
before we have looked into them
is not to show their darkness
but to put out our own eyes."

JOHN LOCKE (1632–1704)

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