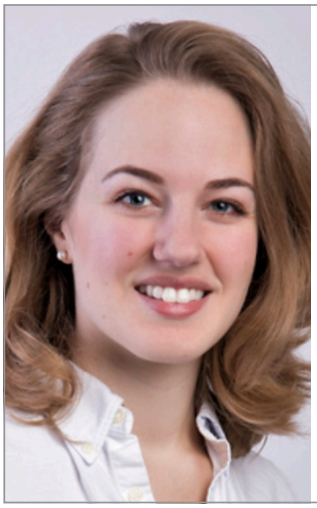
THE HEARTLAND INSTITUTE

POLICY BRIEF

Debunking Four Persistent Myths About Hydraulic Fracturing

By
Timothy Benson
& Linnea Lueken

Timothy Benson is a policy analyst at The Heartland Institute and Heartland Impact. Benson's work has appeared in dozens of national media outlets, including *Investor's Business Daily, National Review Online, The Spectator, The Hill*, *The Washington Times*, *The Washington Examiner, Crain's Chicago Business*, *The Miami Herald*, *The Sun Sentinel*, *The American Spectator*, *Real Clear Policy*, *The Federalist*, and many others, as well as in newspapers throughout the country. He is the author of the Heartland *Policy Brief* "Education Savings Accounts: The Future of School Choice Has Arrived," co-author of the Heartland *Policy Brief* "Saving Chicago Students: Strike Vouchers and SOS Accounts," co-author of the book, Child Safety Accounts: Combating Student Bullying and School Violence by Empowering Parents, and the author of hundreds of Heartland *Research & Commentaries*.



Linnea Lueken is a Research Fellow with the Arthur B. Robinson Center on Climate and Environmental Policy at The Heartland Institute. Lueken graduated from the University of Wyoming in 2018 with a B.S. in Petroleum Engineering, and a minor in geology. Before coming to Heartland, she worked in the Gulf of Mexico on deepwater drillships as a logging geologist. Lueken regularly writes for The Heartland Institute's *Environment & Climate News*, Climate Realism.com, and she has authored opinion articles for the influential climate and environment website WattsUpWithThat.com, along with other outlets.

For more information, please call 312/377-4000 or visit our website at Heartland.org.

3939 N. Wilke Road, Arlington Heights, IL, 60004

POLICY BRIEF

Debunking Four Persistent Myths About Hydraulic Fracturing

CONTENTS

Executive Summary

- The fracking revolution has transformed the American economy and saved consumers billions of dollars.
- The well-documented successes of fracking have largely been unappreciated by the public and attacked by some lawmakers because of numerous false health claims invented by fracking opponents.
- Well-researched studies clearly and consistently show fracking does not pose serious health or safety concerns to the public, and the best-available data do not justify the imposition of unnecessary fracking regulations, moratoria, or bans on fracking.

Hydraulic fracturing, commonly referred to as "fracking," is a process of extracting natural gas and oil from several miles deep beneath the Earth's surface. Over the past decade, fracking has increased the output of these two vital energy sources by 86 percent and 134 percent, respectively, and the fracking industry now supports nearly three million U.S. jobs. Thanks to fracking, energy prices have dropped significantly, saving billions of dollars for consumers and spurring massive economic growth.

The well-documented fracking successes have largely been unnoticed and unappreciated by the public and maligned and attacked by some lawmakers. Fracking opponents, many of whom receive substantial funding from anti-energy activists, feed anti-fracking sentiment by asserting several false claims about fracking. Because of these efforts, policymakers in several states have chosen to impose burdensome and unnecessary restrictions on fracking. Some states have even approved fracking bans, severely limiting economic opportunities for their citizens.

This *Policy Brief* outlines the basic elements of the fracking process and then refutes the four most widespread fracking myths. It provides lawmakers and the public with the research and data they need to make informed decisions about hydraulic fracturing and energy development.

This *Policy Brief* outlines the basic elements of the fracking process and then refutes the four most widespread fracking myths. It provides lawmakers and the public with the research and data they need to make informed decisions about hydraulic fracturing and energy development.

The following is a concise outline of the four most common fracking myths discussed later in this *Policy Brief*:

Myth One: Fracking Pollutes Drinking Water

- Although fracking wells are generally thousands of feet deep, water wells and drinking water sources are no more than hundreds of feet deep. Despite fearmongering to the contrary, there is no evidence that seepage of fracking fluids, oil, or natural gas from fracking wells contaminate water sources.
- Scientific examination has ruled out fracking as the cause of numerous alleged examples of the dangers of fracking, including flammable water flowing from home faucets.
- Multiple studies have found no link between water pollution and fracking.

Myth Two: Fracking Pollutes the Air

- Numerous studies show air pollution found near fracking operations is typically too low to pose a danger to human health.
- The Environmental Protection Agency (EPA) reports the decades-long decline in national air pollution has continued unabated since fracking became frequent and widespread during the middle of the past decade.

Myth Three: Fracking Causes Health Problems

- As fracking has increased over the past 10 years, the prevalence of asthma, birth defects, and cancer have decreased.
- The prevalence of these health problems in major fracking states, such as Pennsylvania and Texas, is lower than in many states that do not have significant fracking operations.
- Studies have found there is no evidence that the miniscule amounts of chemicals in fracking fluids cause cancer.

Myth Four: Fracking Causes Dangerous Earthquakes

- A global database that tracks earthquakes triggered by human activity reveals 44 earthquakes in the database's history, which dates back to the nineteenth century, have been caused by fracking. Only nine of these fracking-induced earthquakes occurred in the United States. Additionally, just three of the earthquakes in the United States were strong enough to be felt and were comparable to the vibrations produced by a passing truck.
- Several studies suggest these small vibrations are associated with water injection and disposal operations in wells of all sorts, not only fracking wells.
- Many scientists believe that after fracking operations conclude, some regions are even less susceptible to seismic activity.

The Basics and Benefits of Fracking

Hydraulic fracturing, commonly referred to as "fracking," is the process of extracting natural gas and oil trapped in layers of shale, which are typically more than a mile deep beneath Earth's surface. To release oil and natural gas, companies drill into the ground and, using explosive charges, puncture tiny holes in the shale. They then inject liquid mixtures, composed primarily of water and sand, into the shale. This process cracks and holds open the shale, allowing oil and natural gas to flow up to the well at the Earth's surface, where it is collected by drillers.

Technological advances and the development of new directional drilling techniques have made it feasible for drillers to tap into these trapped deposits of oil and natural gas. Today, there are about 1.2 million fracking wells in the United States.[1] As the U.S. Energy Information Administration notes, "Hydraulically fractured horizontal wells have accounted for most of the new wells drilled and completed since late 2014. As of 2016, about 670,000 of the 977,000 producing wells were hydraulically fractured and horizontally drilled."[2]

The fracking technological revolution that has occurred in recent years has dramatically increased the availability of affordable and reliable energy, making it more plentiful today than at any other time in U.S. history. From 2007 to 2022, production of natural gas in the United States increased by 86 percent, from 19.26 trillion cubic feet per year to 35.86 trillion cubic feet per year.

The fracking technological revolution that has occurred in recent years has dramatically increased the availability of affordable and reliable energy, making it more plentiful today than at any other time in U.S. history. From 2007 to 2022, production of natural gas in the United States increased by 86 percent, from 19.26 trillion cubic feet per year to 35.86 trillion cubic feet per year.[3] During the same period, oil production increased by a whopping 134 percent, from 5.07 million barrels of oil per day to 11.91 million barrels per day.[4] In July 2018, U.S. crude oil output exceeded 11 million barrels per day for the first time.[5]

As a result of this energy renaissance, the price of natural gas fell from $9.66 per million British thermal units (MMBtu) in January 2007 to $2.18 per MMBtu in June 2023, a price decrease of 77 percent.[6]

A 2015 Harvard Business School/Boston Consulting Group study estimates fracking supported 2.7 million jobs in 2014, with the potential to grow to 3.8 million jobs by 2030.[7] Similarly, PricewaterhouseCoopers prepared a report for the American Petroleum Institute that estimates the oil and natural gas industries supported 11.3 million jobs in 2019, an increase of about one million jobs compared to 2015, comprising a total of 5.6 percent of all U.S. employment.[8] The RAND Corporation projects the industries will support an additional 1.9 million jobs by 2035.[9] By the same year, a 2012 IHS study

estimates fracking will have created an additional 3.5 million jobs.[10]

A 2016 U.S. Chamber of Commerce (COC) study projects that if the fracking revolution of the previous decade had not occurred, 4.3 million jobs would not have been created, the U.S. economy would be $500 billion smaller, and residential natural gas prices would be 28 percent higher.[11] A 2019 COC report concluded a theoretical nationwide ban on fracking beginning in 2021 would eliminate 19 million jobs by 2025, reduce U.S. gross domestic product by $7.1 trillion, and subtract up to $1.9 trillion in local, state, and federal tax revenues.[12]

Despite the apparent economic benefits provided by fracking, many environmentalists remain ardently opposed to hydraulic fracturing. Much of this opposition is based on misinformation and ideological animus, not sound science and well-documented research. To ensure the continuation of the fracking revolution, along with all of its numerous economic benefits, it is crucial those who support reasonable environmental measures and economic growth refute the myths fueling much of the opposition to fracking.

The following are some of the most pervasive and significant falsehoods about fracking, as well as the evidence disproving these fracking myths.

MYTH ONE

Fracking Pollutes Drinking Water

Thanks in large part to the inaccuracies featured in the 2010 "documentary" film *Gasland*, perhaps the most enduring myth about fracking is that it pollutes drinking water. Many have seen the film's clip of a Colorado man lighting water from his home faucet on fire due to the presence of methane in his water. The film's director was quick to point to fracking as the culprit, but after scientific investigation, it turns out that biogenic (naturally occurring) methane was the real source.

The Colorado Oil and Gas Conservation Commission (COGCC) tested the man's water featured in *Gasland*.[13] By analyzing the isotopic composition of the gas, scientists at COGCC determined the source of the methane. The water well did not test positive for chemicals used in the fracking process. Rather, the flames shown in *Gasland* were the result of natural causes, not fracking.

The misconception that fracking is polluting water has also been debunked by numerous other researchers. Since 2010, there have been more than two dozen peer-reviewed studies and assessments from experts determining the fracking process is not a systemic threat to groundwater sources.

The misconception that fracking is polluting water has also been debunked by numerous other researchers. Since 2010, there have been more than two dozen peer-reviewed studies and assessments from experts determining the fracking process is not a systemic threat to groundwater sources. Some of these studies have come from researchers at prestigious institutions, such as Duke University,[14] Massachusetts Institute of Technology,[15] Stanford University,[16] University of Michigan,[17] University of Texas at Austin,[18] and Yale University.[19] Others have come from state and federal agencies, including the U.S. Geological Survey,[20] U.S. Department of Energy,[21] the Wyoming Department of Environmental Quality,[22] the Susquehanna River Basin Commission,[23] and the National Science Foundation.[24] Nonprofit agencies such as the California Council on Science and Technology,[25] National Groundwater Association,[26] and the Academy of Medicine, Engineering, and Science of Texas[27] have also produced numerous studies showing that fracking does not pose a significant threat to drinking water, as has the German Federal Institute for Geosciences and Natural Resources, which examined whether fracking affects groundwater in the North German Basin.[28]

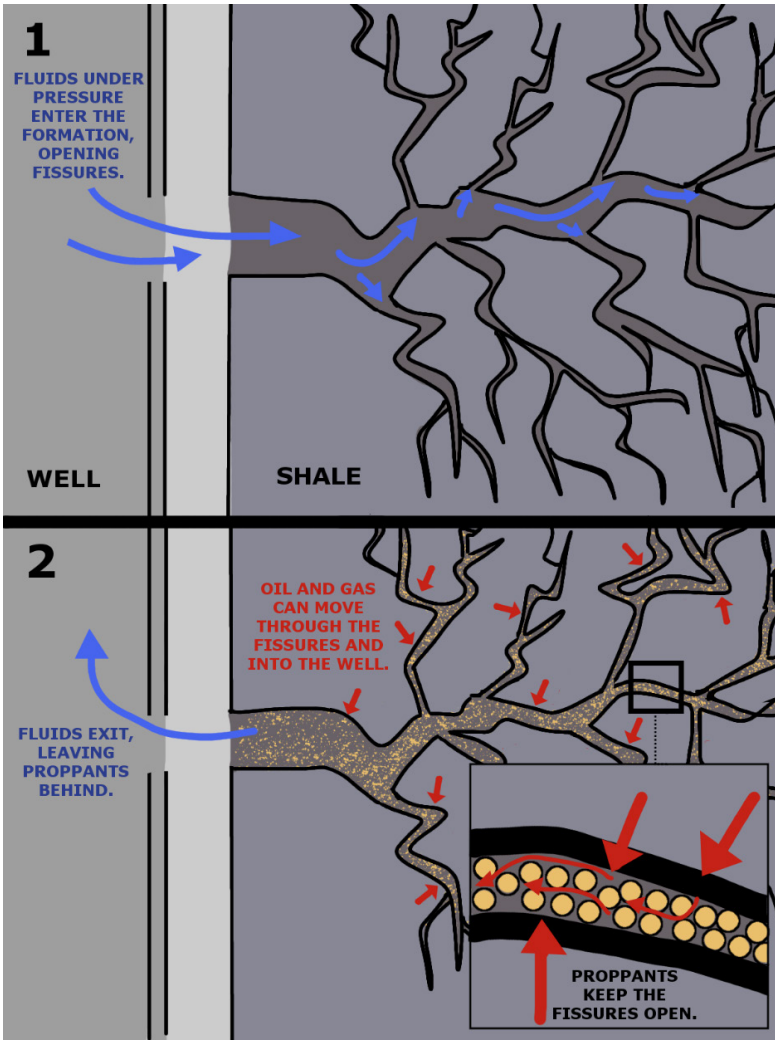
Perhaps most notably, the Obama-era U.S. Environmental Protection Agency (EPA) confirmed these findings in 2016 with its own $29 million, six-year study of the impacts on groundwater located near 110,000 fracked oil and natural gas wells in use across the country since 2011.[29] That report concluded, "Hydraulic fracturing operations are unlikely to generate sufficient pressure to drive fluids into shallow drinking water zones."

Why is fracking contamination of groundwater

so unlikely to occur? Hydraulic fracturing is a "stimulation treatment" in which fissures are opened in rock, such as shale. Shale is a rock with good porosity—meaning it has lots of tiny pores that can hold oil, gas, and water—but it has very low permeability, meaning there are few pathways between the pores that would allow the oil, gas, or water to be extracted.[30]

During the fracking process, fissures are opened by pumping fluid solutions into the chosen shale zone, which is usually thousands of feet deep, at high pressures and rates, forming small fractures in the rock. (See Figure One.) Often, a device called a "perforating gun" is used to assist this process.

Figure One: Simplified diagram of the hydraulic-fracturing process



Source: Linnea Lueken, The Heartland Institute, 2018.

Small particles (mostly sand, commonly referred to as "proppants") are then pumped into the fissures to prevent them from closing, creating "engineered permeability." While the hydraulic pressure is enough to crack the rock, it is not enough to send fluid up through multiple rock formations, where drinking water zones are located.

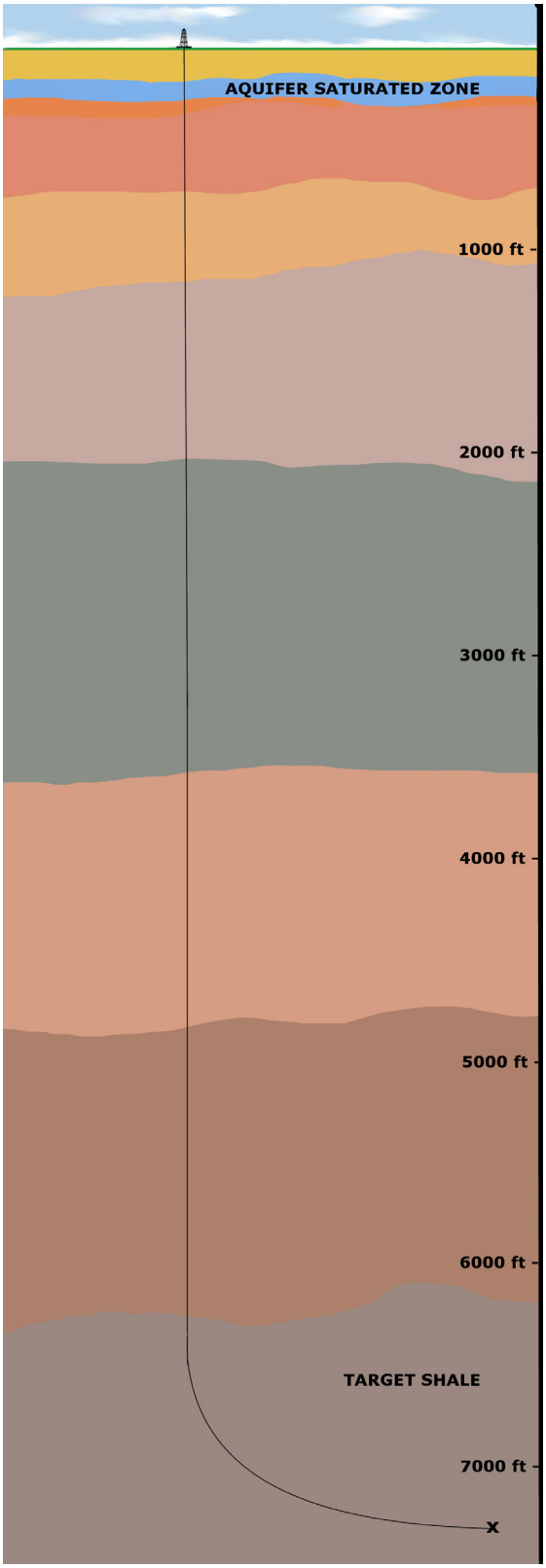
Figure Two shows, to scale, the level of the typical oil well compared to drinking well water aquifers. In Figure Two, tiny marks near the Earth's surface represent drinking water wells. There are thousands of feet of rock between the aquifer and the fracked section of shale. In places such as Wyoming, there are often more than six different rock units, or "layers," to the horizontal portion of a well. Wells for drinking water are usually drilled to a depth of about 100 to 500 feet. Fracking wells are generally 6,000 to 10,000 feet beneath the Earth's surface.

No one wants their well water contaminated by the fluids used in fracking, and it is also important to note drillers do not want well water seeping into their operations, either. Water invasion of an oil or natural gas well could change the drilling "mud weight," which is an essential factor in maintaining safe pressures at the depths drilling operations take place. (See Figure Three.)

Mud weight refers to the density of the drilling mud, which is often a barite clay solution that is similar to the composition of mud masks in beauty stores. It is pumped down and then back up the well during the drilling process. (See the arrows in Figure Three.) Mud helps to maintain stable pressures underground, lubricates the drill bit, and carries the rock bits that are drilled to the surface so that the drill bit doesn't become clogged.

To understand why this process is extremely important for fracking operators, picture the wood shavings that appear when one drills a hole in a plank of wood. With fracking, similar "shavings" develop, but they are much more difficult to clear away because they are thousands of feet underground, made of rock, and significantly larger. Removing these shavings is necessary to ensure the drilling process operates properly.

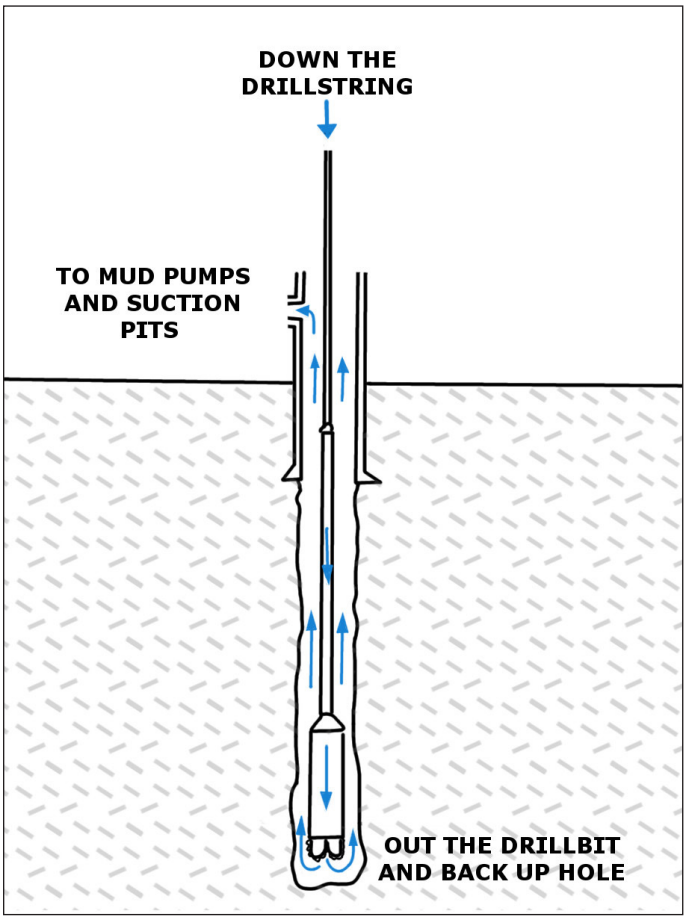
Figure Two: Scale image of a fracked well



Source: Linnea Lueken, The Heartland Institute, 2018.

The rock shavings, known in the fracking industry as "cuttings," do not pop to the surface from the drilling action, rather they are carried to the surface by the drilling mud. If the mud weight is changed because of the presence of unwanted water, the pressure at the bottom of the well will also change, which can lead to a wide range of problems. Insufficient mud weight is the predominant cause of "kicks," which occur when fluid from the rock formation from which drillers are extracting oil and gas rushes up the drilled hole to the surface. If the well is not brought under control, kicks can cause a dangerous blowout. It is in the best interest of every oil and gas worker to ensure well water does not seep into fracking operations.

Figure Three: A simplified diagram of how mud flows in a drilling operation



Source: Linnea Lueken, The Heartland Institute, 2018.

MYTH TWO

Fracking Pollutes the Air

Opponents of fracking often argue poisonous air emissions from fracking create significant and widespread health problems. However, the evidence reveals this claim is erroneous.

A 2017 Colorado Department of Public Health and Environment (CDPHE) study found the levels of air pollution created at active oil and gas drilling operations in or near residential areas are too low to pose serious health problems, even when the data are adjusted to account for people who are more sensitive to air pollution, such as those with asthma.[31]

"All measured air concentrations were below short- and long-term 'safe' levels of exposure for non-cancer health effects, even for sensitive populations," the report concluded.

A 2016 study conducted by the University of Texas at Arlington found air quality surrounding unconventional drilling operations in the Eagle Ford Shale, such as fracking well sites, was well within the acceptable limit.[32] In 2015, a Modern Geosciences study of the Barnett Shale in the Lone Star State found "none of the observed [volatile organic compounds (VOCs)] were noted above [state-mandated public health thresholds.]"[33] These results are supported by a previous study of the Barnett Shale that found "shale gas activities have not resulted in VOC levels that pose a health concern."[34]

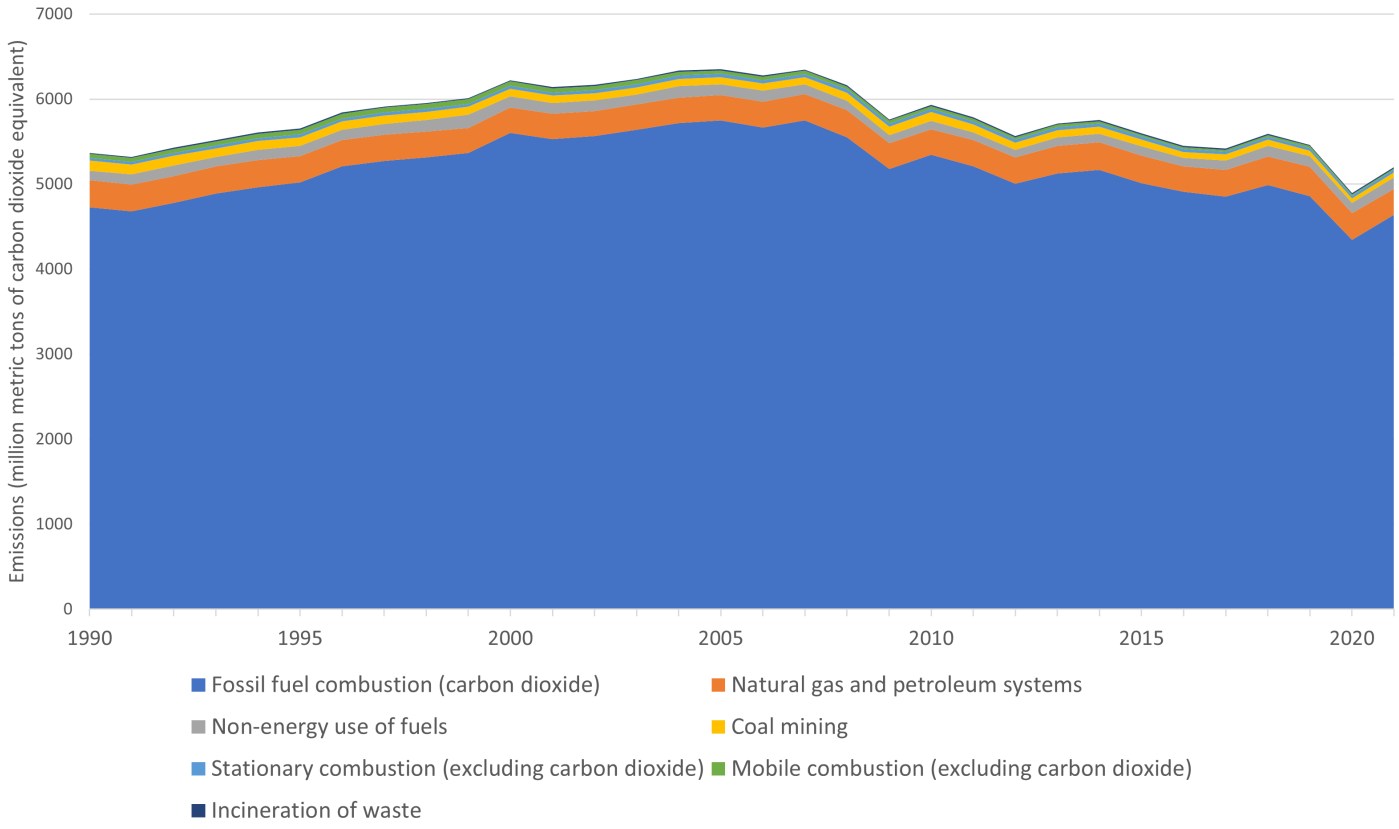
Opponents of fracking often argue poisonous air emissions from fracking create significant and widespread health problems. However, the evidence from shale plays all over the United States reveals this claim is erroneous.

A 2015 study of the Marcellus region in Pennsylvania by researchers at Drexel University "did not observe elevated levels of any … light aromatic compounds (benzene, toluene, etc.)" at well sites, and it noted there were "few emissions of non-alkane VOCs … from Marcellus Shale development."[35] A 2019 analysis conducted by Gradient Corp. found shale development at three sites in Pennsylvania's Washington County "do not pose any acute or chronic health concerns" nor have they had a deleterious impact on the air quality of the surrounding area. "Our air quality and public health evaluation of December 2016 to October 2018 ambient air quality data collected at three sites in proximity to the Yonker well pad in Mount Pleasant Township showed that measured PM2.5 and VOC concentrations were consistently below health-based air comparison values and thus are not expected to pose acute or chronic health concerns."[36]

In Utah, a multi-year collaborative report from the Utah Division of Air Quality, Region 8 of the Environmental Protection Agency, and the Ute Indian Tribe, released in 2016, found VOC emissions levels in the Uinta Basin were far lower than had previously been estimated.[37]

"The emissions inventory shows basin-wide emissions of VOCs, thought by scientists to be the main drivers of ozone formation in the

Figure Four: U.S. Greenhouse Gas Emissions from Energy Production and Use, by Category, 1990-2021



Source: Data and chart from U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021," accessed October 06, 2023, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks.

basin, are 49% lower than previous inventory estimates," a contemporaneous press release noted. "Like in other oil and natural gas basins, the new inventory revealed primary VOCs have lower potency for driving ozone. That's especially important because the oil and natural gas industry is the largest contributor of VOC emissions in the Uinta Basin. However, this downward revision of VOC emissions is yet another example of how industry has been able to reduce emissions while maintaining strong growth in oil and natural gas production."[38]

In West Virginia, the state's Department of Environmental Protection found in 2013 that "there are no indications of a public health emergency or threat" from fracking activity there.[39] This led the department to conclude, "based on a review of completed air studies to date, including the results from the well pad development monitoring conducted in West Virginia's Brooke, Marion, and Wetzel Counties, no additional legislative rules establishing special requirements [for drilling activity] need to be promulgated at this time."[40]

A 2020 CDPHE investigation into the air quality near a school 1,200 feet from a drilling site in the town of Greeley in Weld County, the hub of the state's oil production, found "no health risk for students or nearby residents."[41] "The consultation evaluated both long-term and short-term health risk, using data from the Colorado Air Monitoring Mobile Lab (CAMML), which measured 25 VOCs in the air for more than 1,900 hours in 2019," a CDPHE press release read.[42] "The consultation concluded that VOC levels were below those known to result in either short-term or long-term non-cancer health impacts, including harmful effects on blood cells and the immune system. Additionally, cancer risks due to VOC levels were below EPA's limit of unacceptable risk for excess cancer from environmental exposures."[43]

As seen by these highlighted examples, fracking does not pose a significant threat to air quality. EPA reports the decades-long decline in national air pollution has continued unabated since fracking became frequent and widespread, during the middle of the past decade.

These U.S.-based studies are not outliers. To take just one example from abroad, in 2013, the United Kingdom's Department of Health issued a report concluding "that the potential risks to public health from exposure to the emissions associated with shale gas extraction are low if the operations are properly run and regulated."[44]

As seen by these highlighted examples, fracking does not pose a significant threat to air quality. EPA reports the decades-long decline in national air pollution has continued unabated since fracking became frequent and widespread, during the middle of the past decade.[45]

MYTH THREE

Fracking Causes Health Problems

Some environmental activists have claimed the fracking process causes a multitude of health problems, including increased asthma hospitalizations, lower birth weights, higher infant mortality, and increased rates of cancer.[46] However, there is no evidence showing that fracking causes such health problems. The following is a brief summary of the research examining these important concerns, grouped by health problem.

The following is a brief summary of the research examining these important concerns, grouped by health problem.

Asthma

If fracking causes asthma, one would expect asthma to have become more common and severe during the past decade, because fracking has become much more prevalent. However, this has not occurred.

According to the Centers for Disease Control and Prevention (CDC), the number of asthma sufferers reporting an attack has fallen from 52.5 percent in the 2006 to 2010 period to 39.4 percent in 2021.[47,48] The CDC also notes asthma prevalence rates have decreased over the same period, from 8.4 percent to 7.7 percent.[49] Meanwhile, asthma mortality rates are stagnant at 1.1 per 100,000 over that same time period.[50]

Texas—a major center of fracking operations and a state that is on pace to become the world's third-largest oil producer—has among U.S. states the second-lowest adult asthma prevalence rate and the tenth-lowest asthma mortality rate.[51,52]

Pennsylvania, which ranks second nationally in natural gas and total energy production, has the sixteenth-lowest asthma mortality rate.[53] Pennsylvania's asthma mortality rate is even lower than neighboring New York's, which banned hydraulic fracturing in 2014.[54]

Further, age-adjusted asthma hospitalization rates in Pennsylvania decreased by 58 percent from 2010 to 2019, the most recent year for which data are available.[55] All age groups saw a decline in asthma hospitalization rates over that time period, decreasing the amount spent on hospitalization costs from $492 million in 2010 to $296 million in 2019. This decrease in asthma hospitalization rates occurred during the same period the number of active hydraulically fracked shale wells in the commonwealth increased from around 1,400 to more than 12,900.[56] Pennsylvania's six largest shale-producing counties—Bradford (12.7 per 10,000), Greene (22.3 per 10,000), Lycoming (37.8 per 10,000), Susquehanna (13.6 per 10,000), Tioga (24.5 per 10,000), and Washington (28.2 per 10,000)—have experienced lower asthma hospitalization rates during the same period, and all six counties have lower rates than the state average (56 per 10,000) in 2021.[57]

Birth Defects, Low Birthweight, and Infant Mortality

If fracking has been causing various birth anomalies, one would also expect the prevalence of these health problems to have massively increased in the United States over the past decade, but this has not occured.

The low birthweight rate in the United States was 8.52 percent in 2021, the most recent year for which data are available, up from 8.26 percent in 2006, a small 3 percent increase.[58] Meanwhile, infant mortality in the United States has declined. From 2005 to 2020, the latest year for which data are available, infant mortality fell by 21 percent, reaching a historic low.[59] In Pennsylvania, the infant mortality rate declined 8.8 percent from 2014 (5.89 per 1,000 live births) to 2021 (5.37 per 1,000 live births) and over 26 percent from 2005 (7.29 per 1,000 live births) when there was no fracking happening in Pennsylvania at all.[60] Pennsylvania's 2021 infant mortality rate was also 1 percent lower than the national average of 5.42 per 1,000 live births,[61] while the commonwealth's rate for various other birth defects fell or remained stable over the same period.[62]

Other large oil- and natural gas-producing states—such as Louisiana, Oklahoma, Texas, and Wyoming—have experienced similar decreases in their infant mortality rates.[63]

Further, a review of 25 studies published from 2000 to 2018, published in September 2019 by the Health Research Institute's Energy Research Committee, could not find a definitive link between fracking and low birth weights, birth defects, pre-term births, and fetal and infant mortality. "Results of studies with the same exposure-outcome pairs were inconsistent and the studies employed limited control of potential confounders, in particular strong measures of [socioeconomic status] and lifestyle factors. The limitations of these studies prevent the committee from concluding whether environmental exposures originating directly from [unconventional oil and natural gas development] did or did not contribute to the assessed perinatal outcomes."[64]

Cancer

Research overwhelmingly shows fracking does not cause cancer. Fracking chemicals remain locked deep underground, well below groundwater and water reservoirs. Moreover, fracking fluids are almost entirely made of water and sand. As noted by the EPA, less than 1 percent, by mass, of fracking fluids is composed of chemical additives.[65] These chemical additives are used to control numerous aspects of the process, from the gel-quality of the fluid (thicker fluid will suspend sand better than water) to the fluid's density.

In such small proportions, it is an absurd exaggeration to say exposure to fracking fluids causes cancer. The very small amounts of chemical additives in fracking fluid are too miniscule to impact human health. If that were the case, oil and gas workers who mix fracking fluids and drilling mud would have higher rates of cancer, but according to a Norwegian study, they do not. The Norwegian researchers found the only fracking-worker-related elevated cancer rates are associated with asbestos exposure, both on-site and off-site, particularly before 1980 (when asbestos was commonly used on fracking sites).[66]

A 2015 study purporting to show elevated cancer risks near fracked natural gas wells had to be retracted after the authors admitted they included "honest calculation errors" in their assessment.[67] When those errors were corrected, the observed hydrocarbon emissions were reduced by 7,250 percent, leaving them well below any cancer risk threshold.[68]

There have also been numerous other studies showing fracking does not pose a significant public health risk.[69] For instance, a 2017 analysis by Resources for the Future, titled "Health Impacts of Unconventional Oil and Gas Development," concluded many of the studies linking severe health issues to unconventional oil and gas operations had "weaknesses and many had significant shortcomings."[70] Furthermore, the study's authors concluded, "Overall, we find that the literature does not provide strong evidence regarding specific health impacts and is largely unable to establish mechanisms for any potential health effects."[71]

A four-year, $2.5 million study from the University of Pittsburgh published in August 2023 found "no associations between unconventional natural gas development activities and childhood leukemia, brain and bone cancers, including Ewing's family of tumors."[72]

MYTH FOUR

Fracking Causes Dangerous Earthquakes

Numerous studies show fracking does not cause dangerous, widespread earthquakes. As the U.S. Geological Survey notes on its "Myths and Misconceptions" webpage, fracking is not the primary cause of induced (human-caused) earthquakes. The page directly states, "Fracking is not directly causing most of the induced earthquakes. Disposal of waste fluids that are a byproduct of oil production is the primary cause of the recent increase in earthquakes in the central United States."[73]

A database administered by researchers at the United Kingdom's University of Durham and University of Newcastle upon Tyne is the largest and most up-to-date catalog of earthquake sequences purported to have been induced or triggered by human activity worldwide since the 1800s. According to this important database, as of July 2018, fracking has been conclusively linked to only 6 percent of all human-caused earthquakes, 44 earthquakes overall. Considering there are around 1.2 million active fracking wells in the United States, this number is miniscule.[74]

Furthermore, in the United States, only nine earthquakes have been conclusively linked to fracking, and of those nine, just three have reached M3 on the moment magnitude scale, which is roughly the threshold needed for an earthquake to be felt on the surface.[75] SM3 earthquakes produce "vibrations similar to the passing of a truck."[76]

Numerous studies show fracking does not cause dangerous, widespread earthquakes. As the U.S. Geological Survey notes on its "Myths and Misconceptions" webpage, fracking is not the primary cause of induced (human-caused) earthquakes. The page directly states, "Fracking is not directly causing most of the induced earthquakes."

Researchers have noted that there is a correlation to the presence of a fracking site and a higher likelihood of earthquakes. In light of the information presented above, what is causing earthquakes near these sites? Analysts say the culprit is wastewater disposal processes.[77]

Wastewater injection and disposal wells are those in which brine (salt water) and other fluids are re-injected so drillers can dispose of them. While wastewater is produced by fracking operations, it is also produced in almost all other traditional oil and gas drilling and production processes. It is not the drilling itself that is potentially causing tremors, nor is this a problem that is exclusive to fracking. Wastewater disposal involves much higher injection pressures and volumes of fluid than fracking, because the aim of drillers is to keep those fluids in well reservoirs. The practice, by law, is overseen by local or regional EPA offices.[78]

Extrapolating that fracking is the cause of these earthquakes because frack wastewater is occasionally injected is comparable to saying turning on the ignition of a car causes traffic accidents.

Interestingly, some researchers say that once fracking operations conclude, earthquakes may be *less likely* to occur than in similar areas where no fracking processes have been conducted. At The Heartland Institute's 2017 America First Energy Conference, Joe Leimkuhler, vice president for drilling at LLOG Exploration, observed, "Long-term, once a well produces enough volume of fluid that exceeds the volume of water and sand that you've put in the fractal well, once you've taken more material out than you've in, you've lowered the overall stress state of the system, and you can make an argument that on a regional basis you've actually decreased the tendency for earthquakes and not increased it long term."[79]

The researchers concluded that in all but one studied region there was no correlation between increased seismic activity and the presence of increased oil and gas production.

Researchers at the University of Alberta recently conducted a two-year study to determine just how much of the seismic activity experienced from 1965 to 2014 could be correlated with increased oil and gas production. The examined regions were in the states of North Dakota, Ohio, Oklahoma, Pennsylvania, Texas, and West Virginia and the Canadian provinces of Alberta, British Columbia, and Saskatchewan.[80]

The researchers concluded that in all but one studied region there was no correlation between increased seismic activity and the presence of increased oil and gas production: "Analysis of oil and gas production versus seismicity rates in six other States in the USA and three provinces in Canada finds no State/Province-wide correlation between increased seismicity and hydrocarbon production."[81]

One of the researchers even went so far as to say: "It's not as simple as saying 'we do a hydraulic fracturing treatment, and therefore we are going to cause felt seismicity.' It's actually the opposite. Most of it is perfectly safe."[82]

Even the relationship between wastewater injection wells and seismicity stands on shaky ground. The Institute for Geophysics at the University of Texas at Austin conducted a study attempting to determine if the earthquakes in the Barnett Shale region of Texas are a danger to the public and whether they could be connected to Texas' many wastewater injection wells.[83] According to the study, the presence of injection wells increases the likelihood of small earthquakes, but the study also shows there are a significant number of wells with similar injection rates as those linked to small earthquakes that did not experience earthquakes in the area.

The EPA found similar results in its study of 30,000 wastewater disposal wells: "EPA is unaware of any … [underground drinking water] contamination resulting from seismic events related to injection-induced seismicity," the report concludes.[84] "Very few of these disposal well sites have produced seismic events with magnitudes greater than M 4.0. For example, at the time of EPA's report, there were approximately 2,700 active disposal wells in Louisiana, with no recent significant seismic events occurring as a result of the disposal activities."[85]

Conclusion

Well-researched studies clearly and consistently show fracking does not pose serious health or safety concerns to the public, and the best-available data do not justify the imposition of unnecessary fracking regulations, moratoria, or bans. In light of the immense number of studies showing fracking is relatively safe and that it provides substantial economic benefits, lawmakers in Maryland, New York, and Vermont, who have responded to environmentalists' fear-mongering and spurious claims by banning fracking, should reconsider their decision to unnecessarily stifle economic growth.

As this paper has made evident, fracking does not pollute water or air, nor does it cause public health problems or dangerous earthquakes. Of course, this does not mean energy companies shouldn't continue to develop technologies that make the fracking process safer or more efficient.

Nothing in this *Policy Brief* is meant to suggest there are zero risks associated with fracking or other drilling operations. However, those risks are quite small compared to the enormous benefits fracking continues to provide to the United States.

Endnotes

1 Sam Rubright, "34 states have active oil & gas activity in U.S. based on 2016 analysis," FracTracker Alliance, March 23, 2017, https://www.fractracker.org/2017/03/34-states-active-drilling-2016/.

2 U.S. Energy Information Administration, "Hydraulically fractured horizontal wells account for most new oil and natural gas wells," January 30, 2018, https://www.eia.gov/todayinenergy/detail.php?id=34732.

3 U.S. Energy Information Administration, "U.S. Dry Natural Gas Production," Accessed August 31, 2023, https://www.eia.gov/dnav/ng/hist/n9070us2A.htm.

4 U.S. Energy Information Administration, "U.S. Field Production of Crude Oil," Accessed August 31, 2023, https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=mcrfpus2&f=a.

5 David Gaffen and Ayenat Mersie, "U.S. crude oil output hits 11 million barrels per day for the first time ever," Reuters, July 18, 2018, https://www.reuters.com/article/us-usa-oil-eia/us-crude-oil-output-hits-11-million-barrels-per-day-for-first-time-ever-idUSKBN1K81XT.

6 Statista.com, "Monthly prices for natural gas in the United States and Europe from January 2014 to June 2023," Accessed September 14, 2023, https://www.statista.com/statistics/673333/monthly-prices-for-natural-gas-in-the-united-states-and-europe/#:~:text=The%20average%20monthly%20price%20for,(Btu)%20in%20June%202023.

7 Michael E. Porter, *et al.*, *America's Unconventional Energy Opportunity: A Win-Win Plan for the Economy, the Environment, and a Lower-Carbon, Cleaner-Energy Future*, Harvard Business School and the Boston Consulting Group, June 2015, p. 19, https://www.hbs.edu/competitiveness/Documents/america-unconventional-energy-opportunity.pdf.

8 American Petroleum Institute, *Impacts of the Oil and Natural Gas Industry on the U.S. Economy in 2019*, July 2021, p. E-1, https://www.api.org/-/media/Files/Policy/American-Energy/PwC/API-PWC-Economic-Impact-Report.pdf.

9 Matthew D. Baird, Robert Bozick, and Mark Harris, *Postsecondary STEM Education and Employment in the United States*, RAND Corporation, November 29, 2017, https://www.api.org/~/media/Files/Policy/Jobs/STEM-Employment/RAND-Education-Report.pdf.

10 IHS Markit, *America's New Energy Future: The Unconventional Oil and Gas Revolution and the U.S. Economy: Volume 1: National Economic Contributions*, October 2012, p. 2, https://www.westernenergyalliance.org/wp-content/uploads/2009/05/AmericasNewEnergyFuture-Volume-12.pdf.

11 Institute for 21st Century Energy, *What If … America's Energy Renaissance Never Actually Happened?* U.S. Chamber of Commerce, September 22, 2016, p. 2, https://www.globalenergyinstitute.org/sites/default/themes/bricktheme/pdfs/er-fullreport-16.pdf.

12 Institute for 21st Century Energy, *What If … Hydraulic Fracturing Was Banned? (2020 Edition)*, U.S. Chamber of Commerce, December 18, 2019, https://www.globalenergyinstitute.org/sites/default/files/2019-12/hf_ban_report_final.pdf.

13 Colorado Oil and Gas Conservation Commission, "COGCC *Gasland* Correction Document," October 29, 2010, https://cogcc.state.co.us/documents/library/Technical/Public_Health_Safety_and_Welfare/Hydraulic_Fracturing/GASLAND%20DOC.pdf.

14 Jennifer S. Harkness *et al.*, "The geochemistry of naturally occurring methane and saline groundwater in an area of unconventional shale gas development," *Geochimica et Cosmochimica Acta*, Volume 208, Issue 1, pp. 302–334, July 2017, https://www.sciencedirect.com/science/article/pii/S0016703717302004; Timothy M. Kresse *et al.*, "Shallow Groundwater Quality and Geochemistry in the Fayetteville Shale Gas-Production Area, North-Central Arkansas, 2011," *Scientific Investigations Report 2012-5273*, U.S. Geological Survey, U.S. Department of Interior, January 9, 2013, https://pubs.usgs.gov/sir/2012/5273/sir2012-5273.pdf.

15 Massachusetts Institute of Technology Energy Initiative, *The Future of Natural Gas: An Interdisciplinary MIT Study*, June 2011, pp. 39–41. http://energy.mit.edu/wp-content/uploads/2011/06/MITEI-The-Future-of-Natural-Gas.pdf.

16 Robert B. Jackson *et al*., "The Depths of Hydraulic Fracturing and Accompanying Water Use Across the United States," *Environmental Science & Technology*, Volume 49, Issue 15, pp. 8,969–8,976, July 21, 2015, https://pubs.acs.org/doi/abs/10.1021/acs.est.5b01228?journalCode=esthag.

17 John R. Wilson *et al*., "The Application of Hydraulic Fracturing Technologies to Michigan Oil and Gas Recovery," *Graham Sustainability Institute Integrated Assessment Report Series Volume II, Report 2*, University of Michigan, September 3, 2013, http://graham.umich.edu/media/files/HF-02-Technology.pdf.

18 Toti E. Larson *et al*., "Monitoring Stray Natural Gas in Groundwater With Dissolved Nitrogen. An Example From Parker County, Texas," *Water Resources Research*, August 15, 2018, https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2018WR022612.

19 E. Barth-Naftilan, *et al*., "Methane in groundwater before, during, and after hydraulic fracturing of the Marcellus Shale," *Proceedings of the National Academy of Sciences*, June 18, 2018, http://www.pnas.org/content/pnas/early/2018/06/12/1720898115.full.pdf; Brian D. Drollette *et al*., "Elevated levels of diesel range organic compounds in groundwater near Marcellus gas operations are derived from surface activities," *Proceedings of the National Academy of Sciences*, October 12, 2015, http://www.pnas.org/content/pnas/early/2015/10/07/1511474112.full.pdf.

20 Peter B. McMahon *et al*., "Methane and Benzene in Drinking-Water Wells Overlying the Eagle Ford, Fayetteville, and Haynesville Shale Hydrocarbon Production Areas," *Environmental Science & Technology*, Volume 51, Issue 12, pp. 6,727–6,734, https://pubs.acs.org/doi/full/10.1021/acs.est.7b00746.

21 R. Hammack *et al*., "An Evaluation of Fracture Growth and Gas/Fluid Migration as Horizontal Marcellus Shale Gas Wells are Hydraulically Fractured in Greene County, Pennsylvania," National Energy Technology Laboratory, U.S. Department of Energy, September 15, 2014, https://www.netl.doe.gov/File%20Library/Research/onsite%20research/publications/NETL-TRS-3-2014_Greene-County-Site_20140915_1_1.pdf.

22 The Pavillion, Wyoming case is an enlightening example. The small town became a locus of the hydraulic fracturing debate in 2011 when the Environmental Protection Agency (EPA) hinted at a link between drilling and water contamination in the area around the small Wyoming town. After EPA's handling of the testing was criticized by the Bureau of Land Management and the U.S. Geological Survey, among others, EPA turned the investigation over to the Wyoming Department of Environmental Quality (WDEQ) in 2013. In 2016, WDEQ released an 80,000-page report which concluded drilling activity did not contaminate well water there and that any contaminants found in those wells were likely to be naturally occurring, but recommended the area deserved further testing. WDEQ updated this study in 2019, which "confirmed the conclusions" of its predecessor, but went further by noting the "investigation into palatability issues [around Pavillion] is complete and no additional investigations are warranted at this time."

The two reports, which combined included more than 14,650 water samples, concluded that methane gas "in the upper Wind River Formation [near Pavillion] appears to have originated mainly from upward migration from deeper commercial gas-bearing zones and evidence suggests that upward gas seepage (or gas charging of shallow sands) was happening naturally before gas well development."

Further, WDEQ found "inorganic compounds that were found over applicable drinking water standards are generally associated with naturally occurring salts, metals and radionuclides," and that "evidence does not indicate that hydraulic fracturing fluids have risen to shallow depths utilized by water-supply wells. Also, based on an evaluation of hydraulic fracturing history, and methods used in the Pavillion Gas Field, it is unlikely that hydraulic fracturing has caused any impacts to the water-supply wells."

To examine the full 2019 study, see: Wyoming Department of Environmental Quality, *Final Pavillion, Wyoming Gas Field Domestic Water Wells Report on Recommendations for Further Investigation*, December 23, 2019, https://deq.wyoming.gov/water-quality/groundwater/investigations/pavillion-area-investigation/.

23 Joanna Berry, "Remote Water Quality Monitoring Network/ PA Department of Conservation & Natural Resources Technical Summary," *Publication No. 316*, Susquehanna River Basin Commission, June 2019, https://www.srbc.net/our-work/reports-library/technical-reports/316-rwqmn-padcnr-tech-summary-2019/docs/RWQMN-PADCNR-technical-summary-2019.PDF.

24 Tao Wen *et al*., "Exploring How to Use Groundwater Chemistry to Identify Migration of Methane near Shale Gas Wells in the Appalachian Basin," *Environmental Science & Technology*, July 12, 2019, https://naturalgasnow.org/wp-content/uploads/2019/08/acs.est_.9b02290.pdf.

25 Jean C.S. Long *et al*., "An Independent Scientific Assessment of Well Stimulation in California, California Council on Science and Technology," July 9, 2015, p. 1, https://ccst.us/publications/2015/2015SB4summary.pdf.

26 Lisa J. Molofsky *et al*., "Evaluation of Methane Sources in Groundwater in Northeastern Pennsylvania," *Groundwater*, Volume 51, Issue 3, May/June 2013, https://onlinelibrary.wiley.com/doi/full/10.1111/gwat.12056.

27 The Academy of Medicine, Engineering and Science of Texas, *Environmental and Community Impacts of Shale Development in Texas*, June 19, 2017, p. 21, http://tamest.org/wp-content/uploads/2017/07/Final-Shale-Task-Force-Report.pdf.

28 Stefan Ladage *et al*., *Schieferöl und Schiefergas in Deutschland - Potenziale und Umweltaspekte*, Bundesanstalt für Geowissenschaften und Rohstoffe, January 2016, (English translation is *Shale Oil and Shale Gas in Germany – Potentials and Environmental Aspects,* Federal Institute for Geosciences and Natural Resources.) https://www.bgr.bund.de/DE/Themen/Energie/Downloads/Abschlussbericht_13MB_Schieferoelgaspotenzial_Deutschland_2016.pdf;jsessionid=AE516F348D916FE8F09972F6CADEF3B2.1_cid284?__blob=publicationFile&v=5.

29 U.S. Environmental Protection Agency, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (Final Report)*, December 2016, Chapter 6, p. 52, https://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=332990.

30 Geomore.com, "Porosity and Permeability," *Oil On My Shoes: Introduction to Petroleum Geology*, Accessed September 15, 2023, http://www.geomore.com/porosity-and-permeability-2/.

31 Colorado Department of Public Health & Environment, *Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado*, February 21, 2017, https://naturalgassolution.org/wp-content/uploads/2017/08/Assessment-Potential-Public-Health-Effects-Oil-Gas-Operations-Colorado.pdf.

32 Zacariah L. Hildenbrand *et al*., "Point source attribution of ambient contamination events near unconventional oil and gas development," *Science of the Total Environment*, Volume 573, pp. 382–388, December 15, 2016, https://www.sciencedirect.com/science/article/pii/S0048969716318150.

33 Modern Geosciences, "Air Monitoring Report, SE Mansfield Padsite, Mansfield, Tarrant County, Texas," December 12, 2014, https://d3n8a8pro7vhmx.cloudfront.net/northtexansfornaturalgas/pages/365/attachments/original/1434572237/14217-_SEM_Air_Monitoring_Report_Frac_Pumping_2014_12_12.pdf?1434572237; Modern Geosciences, "Air Monitoring Report, SE Mansfield Padsite, Mansfield, Tarrant County, Texas," December 29, 2014, https://d3n8a8pro7vhmx.cloudfront.net/northtexansfornaturalgas/pages/365/attachments/original/1434572243/14217-SEM_Flowback_AIR_Monitoring_Report.pdf?1434572243.

34 A.G. Bunch *et al.,* "Evaluation of impact of shale gas operations in the Barnett Shale region on volatile organic compounds in air and potential human health risks," *Science of the Total Environment*, Volumes 468–469, pp. 832–842, January 15, 2014, https://ac.els-cdn.com/S0048969713010073/1-s2.0-S0048969713010073-main.pdf?_tid=87b69d50-235f-4d50-947b-25a648ace3a0&acdnat=1538426690_ac553340a8b828235a9fdf079c3715fb.

35 J. Douglas Goetz *et al*., "Atmospheric Emission Characterization of Marcellus Shale Natural Gas Development Sites," *Environmental Science & Technology*, Volume 49, Issue 11, pp. 7,012–7,020, April 21, 2015, https://pubs.acs.org/doi/abs/10.1021/acs.est.5b00452.

36 Gradient Corp., *Public Health Evaluation of Ambient Air Near a Shale Gas Well Site and School Campus: Results from Long-term Air Monitoring at the Yonker Well Site Nearby the Fort Cherry School Campus in Washington County, PA*, May 10, 2019, https://www.rangeresources.com/wp-content/uploads/2020/12/Public-Health-Evaluation-of-Ambient-Air-Near-a-Shale-Gas-Well-Site-and-School-Campus.pdf.

37 Utah Department of Environmental Quality, *2014 Utah Air Agencies O&G Emissions Inventory*, June 6, 2016, https://cdn.westernenergyalliance.org/sites/default/files/2014%20Utah%20Air%20Agencies%20O_G%20Emissions%20Inventory_v3.pdf.

38 Ryan Streams, "Uinta Basin VOC Emissions Half of Previous Estimates," *The Source Rock Blog*, Western Energy Alliance, June 28, 2016, https://www.westernenergyalliance.org/blog/uinta-basin-voc-emissions-half-previous-estimates.

39 West Virginia Department of Environmental Protection, "Noise, Light, Dust, and Other Volatile Organic Compounds Generated by the Drilling of Horizontal Wells Related to the Well Location Restriction Regarding Occupied Dwelling

Structures," May 28, 2013, p. 4, https://dep.wv.gov/oil-and-gas/Horizontal-Permits/legislativestudies/Documents/FINAL%20OOG%20Noise%20Light%20Dust%20and%20VOCs%20Report%205-28-2013.pdf.

40 West Virginia Department of Environmental Protection, "Air Quality Impacts Occurring from Horizontal Well Drilling and Related Activities," June 28, 2013, p. 8, http://dep.wv.gov/oil-and-gas/Horizontal-Permits/Documents/Final%20Air%20Quality%20Report%20June%2028%2c%202013.pdf.

41 Kieran Nicholson, "Air quality near Greeley school found to be in compliance with health standards," *The Denver Post*, June 3, 2020, https://www.denverpost.com/2020/06/03/air-quality-greeley-school-health-standards/.

42 Colorado Department of Public Health and Environment, "State releases health consultation on air quality near Bella Romero Academy 4-8 Campus," June 3, 2020, https://cdphe.colorado.gov/press-release/state-releases-health-consultation-on-air-quality-near-bella-romero-academy-4-8-campu.

43 *Ibid*.

44 Public Health England, "Review of the potential public health impacts of exposures to chemical and radioactive pollutants as a result of shale gas extraction," October 30, 2013, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/329744/PHE-CRCE-002_for_website_protected.pdf.

45 U.S. Environmental Protection Agency, "Our Nation's Air," Accessed September 28, 2023, https://gispub.epa.gov/air/trendsreport/2021/#home. U.S. Environmental Protection Agency, "Air Quality Improves as America Grows," *Our Nation's Air*, Accessed September 28, 2023, https://gispub.epa.gov/air/trendsreport/2021/documentation/AirTrends_Flyer.pdf.

46 Concerned Health Professionals of New York & Physicians for Social Responsibility, *Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking (Unconventional Gas and Oil Extraction)* (Fifth Edition), March 13, 2018, https://www.psr.org/wp-content/uploads/2018/04/Fracking_Science_Compendium_5.pdf; Sara G. Rasmussen *et al.*, "Association Between Unconventional Natural Gas Development in the Marcellus Shale and Asthma Exacerbations," *JAMA Internal Medicine*, Volume 176, Issue 9, pp. 1334–343, September 2016, https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2534153; Joan A. Casey *et al*., "Predictors of Indoor Radon Concentrations in Pennsylvania, 1989–2013," *Environmental Health Perspectives*, Volume 123, Issue 11, pp. 1,130–1,137, November 2015, https://ehp.niehs.nih.gov/wp-content/uploads/123/11/ehp.1409014.alt.pdf; Shaina L. Stacy *et al*., "Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania," *PLOS ONE*, June 3, 2015, http://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0126425&type=printable.

47 Jeanne E. Moorman *et al.*, "Asthma Attacks Among Persons with Current Asthma — United States, 2001–2010," Centers for Disease Control and Prevention, November 22, 2013, https://www.cdc.gov/mmwr/preview/mmwrhtml/su6203a16.htm?s_cid=su6203a16_e#Tab1.

48 Centers for Disease Control and Prevention, "Most Recent Asthma Data," May 10, 2023, https://www.cdc.gov/asthma/most_recent_national_asthma_data.htm.

49 *Ibid*.

50 Centers for Disease Control and Prevention, "Asthma," June 30, 2023, https://www.cdc.gov/nchs/fastats/asthma.htm.

51 Matt Egan, "Texas to pass Iraq and Iran as world's No. 3 oil powerhouse," *CNN Money*, July 17, 2018, https://money.cnn.com/2018/07/17/investing/texas-oil-iran-iraq-permian-basin/index.html.

52 Centers for Disease Control and Prevention, "Most Recent Asthma State or Territory Data," May 10, 2023, https://www.cdc.gov/asthma/most_recent_data_states.htm.

53 *Ibid.*

54 *Ibid.*

55 Pennsylvania Department of Health, "Pennsylvania Asthma Fact Sheet 2021," May 26, 2021, https://www.health.pa.gov/topics/Documents/Programs/Asthma%20Hospitalization%20Fact%20Sheet.pdf.

56 Pennsylvania Department of Environmental Protection, "Oil and Gas Operator Well Inventory Report," Accessed September 20, 2023, https://greenport.pa.gov/ReportExtracts/OG/OilGasWellInventoryReport.

57 Pennsylvania Department of Health, "Pennsylvania Asthma Emergency Department Visits Factsheet," January 20, 2023, https://www.health.pa.gov/topics/Documents/Programs/Asthma%20ED%20Visit%20Fact%20Sheet.pdf.

58 Michelle J.K. Osterman *et al*., "Births: Final Data for 2021," *National Vital Statistics Reports*, Volume 72, Number 1, Centers for Disease Control and Prevention, January 31, 2023, https://www.cdc.gov/nchs/data/nvsr/nvsr72/nvsr72-01.pdf; Joyce A. Martin *et al*., "Births: Final Data for 2006," *National Vital Statistics Reports*, Volume 57, Number 7, Centers for Disease Control and Prevention, January 7, 2009, https://www.cdc.gov/nchs/data/nvsr/nvsr57/nvsr57_07.pdf.

59 Danielle M. Ely & Anne K. Driscoll, "Infant Mortality in the United States, 2020: Date From the Period Linked Birth/Infant Death File," *National Vital Statistics Reports*, Volume 71, Number 5, Centers for Disease Control and Prevention, September 29, 2022, https://www.cdc.gov/nchs/data/nvsr/nvsr71/nvsr71-05.pdf.

60 Centers for Disease Control and Prevention, "Infant Mortality Rates by State," September 12, 2023, https://www.cdc.gov/nchs/pressroom/sosmap/infant_mortality_rates/infant_mortality.htm.

61 *Ibid*.

62 Enterprise Data Dissemination Informatics Exchange, Pennsylvania Department of Health, Accessed September 20, 2023, https://www.phaim1.health.pa.gov/EDD/WebForms/BirthDefect.aspx.

63 Centers for Disease Control and Prevention, "Infant Mortality Rates by State."

64 Health Effects Institute—Energy, "Potential Human Health Effects Associated with Unconventional Oil and Gas Development: A Systematic Review of the Epidemiology Literature," *Special Report 1*, September 2019, https://www.heienergy.org/system/files/hei-energy-epi-lit-review.pdf.

65 U.S. Environmental Protection Agency, *Analysis of Hydraulic Fracturing Fluid Data from the FracFocus Chemical Disclosure Registry 1.0*, March 2015, p. 74, https://www.epa.gov/sites/default/files/2015-03/documents/fracfocus_analysis_report_and_appendices_final_032015_508_0.pdf.

66 J.S. Stenehjem *et al*., "Cancer incidence among 41,000 offshore oil industry workers," Occupational Medicine, Volume 64, Issue 7, pp. 539–545, July 30, 2014, https://academic.oup.com/occmed/article/64/7/539/2750752.

67 L. Blair Paulik *et al*., "Impact of Natural Gas Extraction on PAH Levels in Ambient Air," *Environmental Science & Technology*, Volume 49, Issue 8, pp. 5,203–5,210, March 26, 2015, https://pubs.acs.org/doi/ipdf/10.1021/es506095e; L. Blair Paulik *et al*., "Retraction of 'Impact of Natural Gas Extraction on PAH Levels in Ambient Air,'" *Environmental Science & Technology*, Volume 50, Issue 14, p. 7,936, June 29, 2016, https://pubs.acs.org/doi/pdf/10.1021/acs.est.6b02342.

68 L. Blair Paulik *et al*., "Emissions of Polycyclic Aromatic Hydrocarbons from Natural Gas Extraction into Air," *Environmental Science & Technology*, Volume 50, Issue 14, pp. 7,921–7,929, July 11, 2016, https://pubs.acs.org/doi/abs/10.1021/acs.est.6b02762.

69 Colorado Department of Public Health & Environment, Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado, February 21, 2017, https://naturalgassolution.org/wp-content/uploads/2017/08/Assessment-Potential-Public-Health-Effects-Oil-Gas-Operations-Colorado.pdf; British Columbia Ministry of Health, *Detailed Human Health Risk Assessment of Oil and Gas Activities in Northeastern British Columbia*, August 2014, http://www.health.gov.bc.ca/library/publications/year/2014/detailed-health-risk-assessment.pdf; Texas Department of State Health Services, "Updated Summary Report: Occurrence of Cancer In Zip Codes 75022 & 75028 in Flower Mound, Denton County, Texas," July 30, 2014, https://www.scribd.com/document/235472973/Texas-2014-Flower-Mound-Cancer-Study; Jon Fryzek *et al*., "Childhood Cancer Incidence in Pennsylvania Counties in Relation to Living in Counties With Hydraulic Fracturing Sites," *Journal of Occupational and Environmental Medicine*, Volume 55, Issue 7, pp. 796–801, July 2013, https://journals.lww.com/joem/Abstract/2013/07000/Childhood_Cancer_Incidence_in_Pennsylvania.12.aspx; Cardno Entrix, *Hydraulic Fracturing Study: PXP Inglewood Oil Field*, October 10, 2012, https://www.eenews.net/assets/2012/10/11/document_ew_01.pdf.

70 Alan J. Krupnick and Isabel Echarte, *Health Impacts of Unconventional Oil and Gas Development*, Resources for the Future, June 23, 2017, http://www.rff.org/files/document/file/RFF-Rpt-ShaleReviews_Health_0.pdf.

71 *Ibid*., p. 20.

72 University of Pennsylvania School of Public Health, *Hydraulic Fracturing Epidemiology Research Studies:*

Childhood Cancer Case-Control Study, August 3, 2023, https://www.health.pa.gov/topics/Documents/Environmental%20Health/Report_Cancer_outcomes_2023.pdf.

73 U.S. Geological Survey, "Induced Earthquakes: Myths and Misconceptions," Accessed September 28, 2023, https://www.usgs.gov/programs/earthquake-hazards/myths-and-misconceptions-about-induced-earthquakes

74 The Human-Induced Earthquake Database, Accessed July 20, 2018, http://inducedearthquakes.org/.

Note: When this database was first cited in 2018, it only included earthquake instances in which fracking was scientifically "proven" to be the cause. Now, the database lists all industrial projects "claimed" to have caused the earthquakes. Further, the database states that "the database does not filter, rank or discriminate on the basis of the strength of the claims." As a result, any claim that an earthquake instance was caused by fracking—including by potentially unreputable and/or unscientific sources—is included in the recent data. As such, it may be worth approaching any recent updates to the database with skepticism.

75 *Ibid*.

76 U.S. Geological Survey, "Magnitude/Intensity Comparison," Accessed September 28, 2023, https://www.nrc.gov/docs/ML1821/ML18214A882.pdf.

77 Justin L. Rubenstein and Alireza Babaie Mahani, "Myths and Facts on Wastewater Injection, Hydraulic Fracturing, Enhanced Oil Recovery, and Induced Seismicity," *Seismological Research Letters*, Volume 86, Number 4, June 10, 2015, https://pubs.geoscienceworld.org/ssa/srl/article-abstract/86/4/1060/315450/Myths-and-Facts-on-Wastewater-Injection-Hydraulic?redirectedFrom=fulltext.

78 U.S. Environmental Protection Agency, "Primary Enforcement Authority for the Underground Injection Control Program," August 16, 2023, https://www.epa.gov/uic/primary-enforcement-authority-underground-injection-control-program-0.

79 Joe Leimkuhler, "Fracking Safety and Economics," Presentation at The Heartland Institute's *America First Energy Conference,* November 9, 2017, http://americafirstenergy.org/Speaker/joe-leimkuhler.

80 Mirko van der Baan and Frank J. Calixto, "Human-induced seismicity and large-scale hydrocarbon production in the USA and Canada," *Geochemistry, Geophysics, Geosystems*, Volume 18, Issue 7, pp. 2,467–2,485, July 2017, https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017GC006915.

81 *Ibid*.

82 "Hydraulic fracturing rarely linked to felt seismic tremors," *EurekAlert!*, June 26, 2017, https://www.eurekalert.org/pub_releases/2017-06/uoa-hfr062617.php.

83 Wei Gan & Cliff Frohlich, "Gas injection may have triggered earthquakes in the Cogdell oil field, Texas," *Proceedings of the National Academy of Sciences*, Volume 110, Issue 47, pp. 18, 786–18, 791, November 19, 2013, http://www.pnas.org/content/pnas/110/47/18786.full.pdf.

84 U.S. Environmental Protection Agency, "Minimizing and Managing Potential Impacts of Injection-Induced Seismicity from Class II Disposal Wells: Practical Approaches," November 12, 2014, https://www.epa.gov/sites/production/files/2015-08/documents/induced-seismicity-201502.pdf.

85 *Ibid*.

THE HEARTLAND INSTITUTE

3939 North Wilke Road
Arlington Heights, IL 60004

Heartland.org

For more information on this topic, visit Heartland.org, email Think@heartland.org, or call (312) 377-4000.