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Hydraulic Fracture

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ABSTRACT

Hydraulic fracturing treatments rely heavily on fracturing fluids. Hydraulic fracturing fluid rheology influences proppant movement, suspension, and deposition, as well as flow back after placement. They should also be able to create the crack width required to receive proppants or allow deep acid penetration. It's also important to consider compatibility with formation fluids and materials. When a well is drilled through the reservoir and casing is put and cemented in place, regardless of permeability, the reservoir rock can be damaged. Drilling and/or finishing fluids flow into the reservoir and change the pores and pore throats, causing damage. The permeability is lowered when the pores are clogged, and the fluid flow in this damaged section of the reservoir may be significantly reduced. In naturally broken reservoirs, the damage might be more severe. A brief, conductive hydraulic fracture is frequently used to stimulate damaged reservoirs. If the fracturing fluid is chosen incorrectly, the treatment will fail in terms of reservoir conditions, oil output, and net present value. Hydraulic fracture treatments are commonly employed to boost a producing well's productivity index or an injection well's injectivity index. The productivity index indicates how much oil or gas can be produced at a given pressure differential between the reservoir and the wellbore, whereas the injectivity index indicates how much fluid can be injected into a well at a given pressure differential.

.Keywords: Shale Fracture Propagation, Proppant, Hydraulic Fracturing,Fracturing Fluids

1.Introduction

Oil has been extracted from shallow and hard rock wells since the 1860s. Nitroglycerin or dynamite were employed to boost oil and natural gas output from petroleum-bearing rocks at the time. Petroleum engineers employed fracking to increase well productivity in the late 1940s. Hydraulic fracturing was first used as an experiment by Floyd Farris of Stanolind Oil and Gas Corporation in 1947. In 1950, the procedure was successfully implemented for the first time. Fracking has been used on oil and gas wells all over the world since then.

Domestic oil and natural gas production has expanded dramatically as a result of fracking. According to the Independent Petroleum Association of America, US oil output increased by 75% and natural gas production increased by 39% between 2007 and 2016. And supporters of the extraction process applaud the fact that it has brought natural gas prices down. The recent energy revolution in the United States, fueled by the rapid increase of unconventional gas and oil drilling, has resulted in widespread economic gains as well as considerable reductions in greenhouse gas emissions.

Hydraulic fracturing is one of several processes in the unconventional resource development process. A "conventional" resource, on the other hand, will flow to the wellbore on its own, whereas a "unconventional" resource will not. Oil and gas found in layers of hard rock are referred to as "unconventional" in this context. The technique of hydraulic fracturing involves breaking up the rock to allow trapped oil and gas to flow to the well. Hydraulic fracturing is not a new procedure, despite the fact that modern technologies have made it more common.

Drilling continues vertically and then horizontally once the casing has been cemented in place, sometimes for several kilometers. The casing and the full length of the well bore are lined with inserted pipe, which must then be perforated to allow oil to flow. This is accomplished by dropping explosive charges into oil production zones and setting them off, resulting in holes in the pipe (of predefined size and frequency). Cracks in the reservoir rock around the pipe are also created by the explosions, allowing oil to seep into the wellbore.

Hydraulic fracturing, or "fracking," the formation may further open the fractures. This entails pumping a gelatinous slurry including water, chemicals, and sand down the well at high pressure in order to break open channels in the reservoir rock and open the fissures. The sand (proppant) keeps the channels open so that oil (or natural gas) may flow to the well bore.

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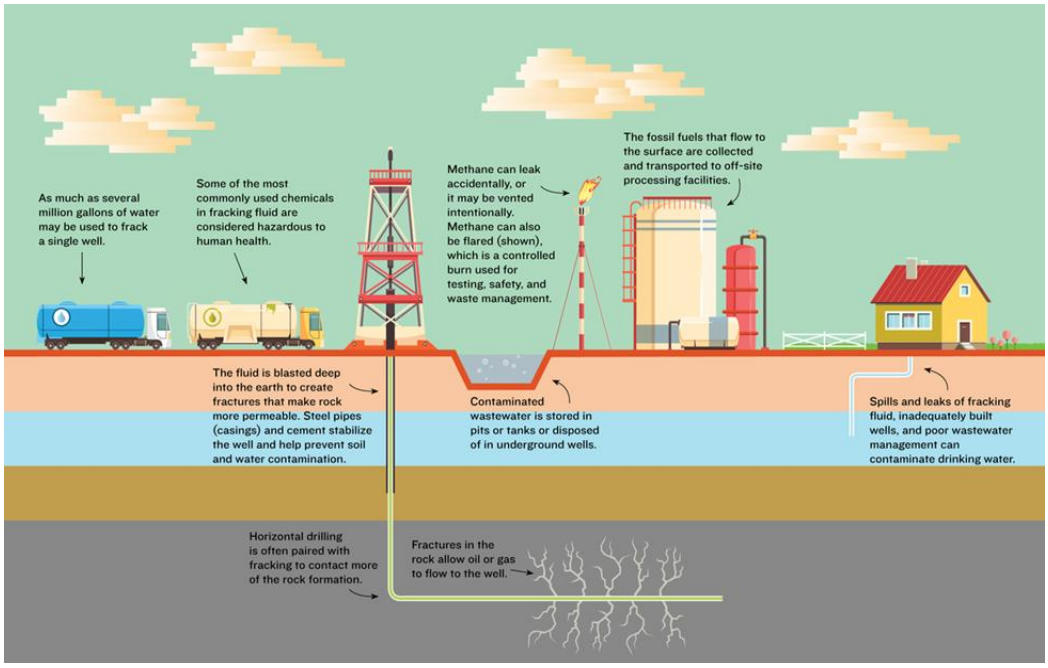

Figure 1 showing the process and technology of hydraulic fracking

A reservoir with a poor permeability has a significant resistance to fluid flow. Chemical and/or physical processes affect reservoir rock over geologic time in numerous formations. These diagenetic processes can sometimes limit the perforations in the rock, limiting the ability of fluids to flow through it. Low-permeability rocks are usually ideal candidates for hydraulic fracturing stimulation.

The well would be uneconomical in many circumstances, particularly for low-permeability formations, damaged reservoirs, or horizontal wells in a layered reservoir, unless an effective hydraulic fracture treatment is planned and pumped. The engineer in charge of the well's economic success must first develop the best fracture treatment and then go to the field to ensure that the best treatment is effectively pumped.

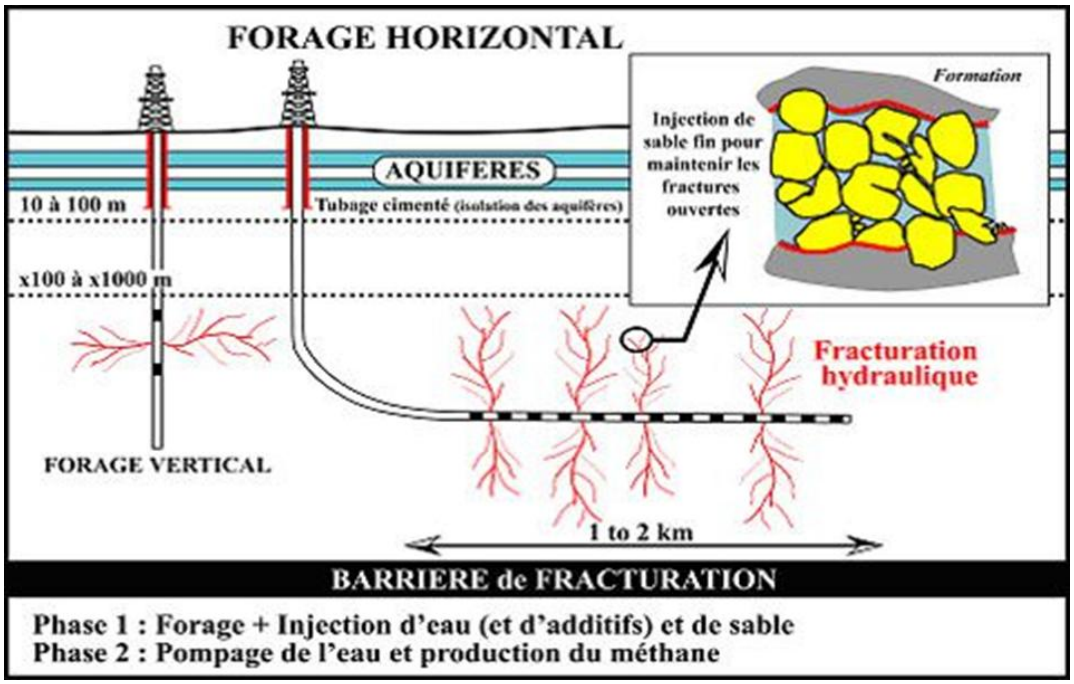

Figure 2 shows two fracking procedures employing a vertical or horizontal well, as depicted by the IFP. These wells are over 1000 meters below the water level. French Institute of Petroleum

Depth of Hydraulic Fracturing

Extraction of natural gas or crude oil takes place at high depths. A hydraulic fracturing well can be anywhere from 7000 to 10,000 feet deep in the earth. The well extends into a horizontal position at a given depth, which is known as the kick-off point. Hydraulic cracks must be practiced at a sufficient depth to prevent the water body from spoiling. The solid particles added to the water prevent the network of cracks created by the pressured water from closing. Hydraulic Fracture Process, Hydraulic fractures can occur in a variety of ways.

1.Drilling and completions are the first and most important steps. A well is drilled as part of this procedure.

2. Perforation is done at an appropriate depth in the second phase. Pay zones is another name for it.

3. Finally, high-pressure fracking fluid is injected into the reservoir to produce fractures in the rocks, allowing oil or gas to flow freely.

2.THE HEALTH EFFECTS OF FRACKING

2.1. Health Effects

In the United States, holding oil and gas companies responsible for the environmental health effects of unconventional oil and natural gas development (UOGD), also known as "fracking," has proven difficult because current regulations do not require drilling companies to disclose the chemicals they use. Many of the chemicals used in fracking, on the other hand, have been recognized and have substantial health concerns. BTEX chemicals (benzene, toluene, ethylbenzene, and xylene) and related pollutants such as tropospheric ozone and hydrogen sulfide are the main substances of concern. BTEX compounds have been linked to cancer in humans, as well as other major health issues like as harm to the neurological, respiratory, and immune systems. While some of these BTEX chemicals can be found naturally in groundwater, accidents and transportation of these chemicals utilized in fracking can be a major cause of contamination.

Exposure to pollution created by fracking can have a variety of short- and long-term health consequences. Headaches, coughing, nausea, nose bleeds, skin and eye irritation, dizziness, and shortness of breath have all been reported as side effects of short-term exposure to these pollutants. Recent studies have also discovered a link between low birth weights and cardiac abnormalities in pregnant women who live near fracking facilities. Pregnant women living within five kilometers (or about three miles) of fracking operations that regularly engaged in "flaring," or the burning of excess natural gas, were 50 percent more likely to have a preterm birth than those who were not exposed, according to a recent study conducted in the rural area of Eagle Ford, Texas.

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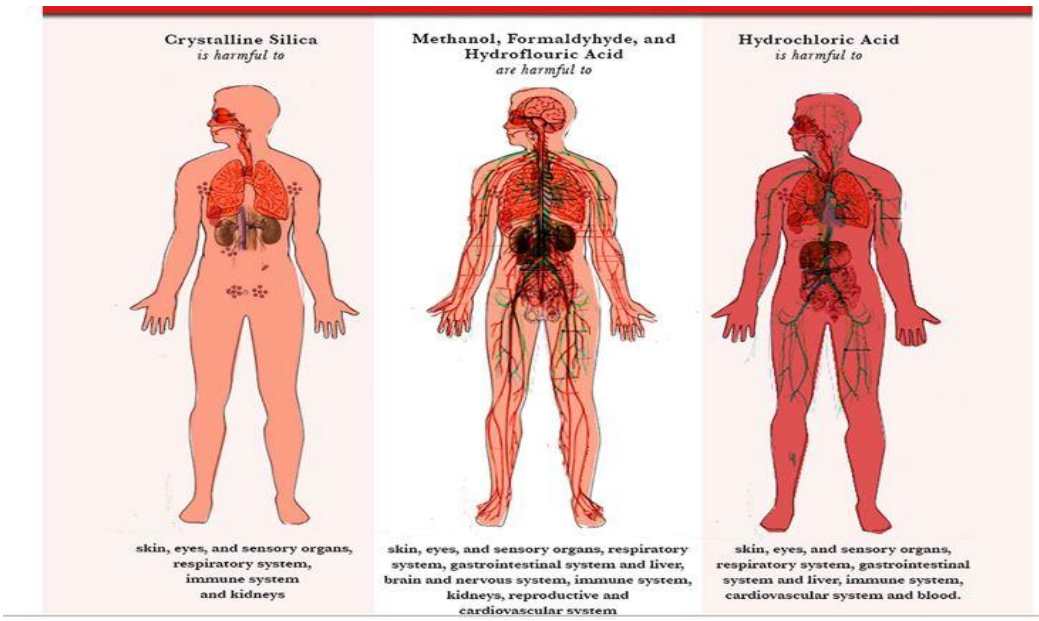


Figure 3 showing the different organs affected by chemicals used for fracking

What effects can chemicals from fracking, acidification, and gravel packing have on the human body?

a. The skin, eyes, and sensory organs, as well as the respiratory and immunological systems, the immune system, and the kidneys

b. The respiratory system, gastrointestinal system, and liver, the brain and nerve system, the immunological system, and the kidneys, as well as the reproductive and cardiovascular systems.

c. Skin, eyes, and sensory organs, respiratory, gastrointestinal, and liver systems, immune system, cardiovascular, and blood circulation systems

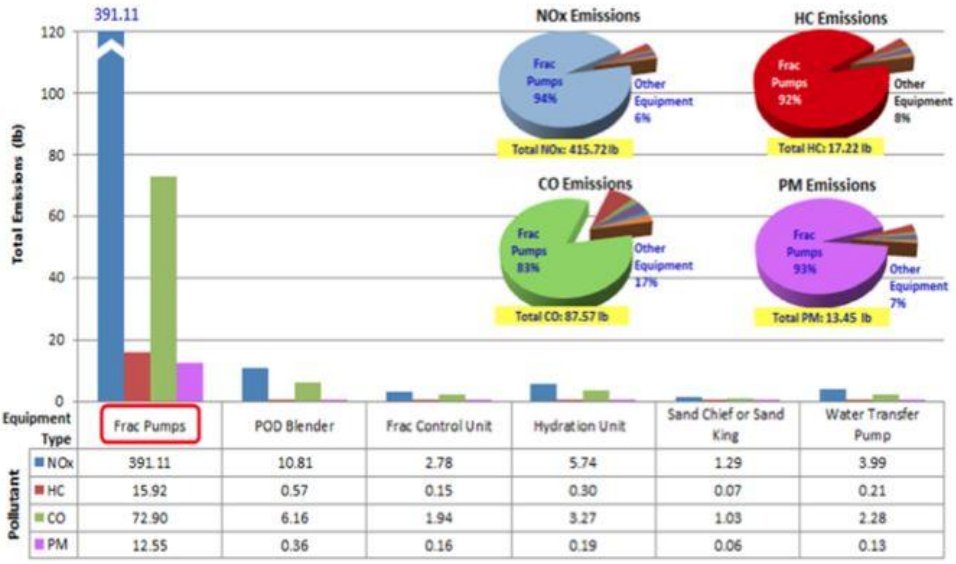
3.Environment impacts of fracking

3.1 Air Quality and pollution

Methane is a major component of natural gas and is twenty-five times more effective than carbon dioxide at trapping heat in the atmosphere. Natural gas wells leak roughly 4% of methane into the atmosphere, raising concerns about global warming. Various drilling activities, such as the building and operation of the well site, the transfer of supplies and equipment, and the disposal of trash, produce a variety of additional air contaminants. Drilling releases pollutants such as benzene, toluene, xylene, and ethyl benzene, as well as smog, nitrogen oxides, carbon monoxide, formaldehyde, and metals from diesel fuel burning. The fracking pumps are responsible for more than 83 percent of the overall pollutant emissions from hydraulic fracturing in the Marcellus Shale, with nitrogen oxides being the most prevalent pollutant discharged, according to researchers from the University of Michigan. The graph below depicts the pollution emissions found in the Marcellus Shale, as well as their percentages:

Figure 4. Showing a fracking station

Because of the potent greenhouse gas emitted during the fracking process, oil and natural gas extraction, particularly fracking activities, is a severe concern that endangers the health of nearby populations. Domestic methane pollution is primarily caused by the oil and gas industry.
Many harmful air pollutants, including xylene, are known to be produced by oil and gas operations. Scientists in rural Utah calculated that the amount of smog-causing compounds created each year was equivalent to the emissions of 100 million cars.



Equipment Type	Frac Pumps	POD Blender	Frac Control Unit	Hydration Unit	Sand Chief or Sand King	Water Transfer Pump
Pollutant: NOx	391.11	10.81	2.78	5.74	1.29	3.99
HC	15.92	0.57	0.15	0.30	0.07	0.21
CO	72.90	6.16	1.94	3.27	1.03	2.28
PM	12.55	0.36	0.16	0.19	0.06	0.13

Figure 5. Emissions from fleet equipment during a fracking job in the Marcellus Shale

State	Particulate Matter	NO_x	Carbon Monoxide	VOCs	Sulphur Dioxide
Arkansas	400	5,300	8,100	700	20
Colorado	1,100	14,000	21,000	2,000	50
Kansas	100	1,700	2,700	200	6
Louisiana	80	1,000	1,600	100	3
Mississippi	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable
Montana	100	1,300	2,000	200	4
New Mexico	300	3,600	5,400	500	10
North Dakota	1,000	13,000	19,000	2,000	40
Ohio	100	1,700	2,600	200	6
Oklahoma	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable
Pennsylvania	800	10,000	15,000	1,000	30
Tennessee	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable
Texas	7,800	100,000	153,000	14,000	300
Utah	400	5,700	9,000	1,000	20
Virginia	1	7	11	1	0
West Virginia	400	4,500	6,900	600	20
Wyoming	270	3,500	5,300	500	12
TOTAL	**13,000**	**170,000**	**250,000**	**23,000**	**600**

Table 6. Estimated Air Pollution from Fracking in the Early Stages (Drilling and Well Completion in 2012) (tons)

3.2Fracking and the total environment

The anthroposphere has been altered by fracking. It usually necessitates a significantly larger concreate fracking pad (120m x 150m = 1.8 hectare, Fig. 1), as well as a frac pit (90m*200m = 1.8 hectare, Fig. 1) for storage waste and injection wells near fracking sites. Fracking pads, frac pits, and fracking transportation networks are forming a new environment in shale gas regions, known as the fracking landscape (e.g., Fig. 1). The original forest, wetlands, rural, and urban landscapes are intruded upon by these fracking sites. Fracking employees usually live in a neighboring town or city, and they move around from time to time as drilling and fracking are completed and new fracking is necessary.

Fracking has drastically disrupted the original biosphere system. Fracking sites, for example, frequently intrude on forest, grassland, and agricultural terrain. Deforestation caused by fracking or the conversion of grassland into fracking pads results in the loss of wildlife habitat and a reduction in species variety. After clear-cutting, soils quickly dry out and become barren earth, where the land surface is easily heated during the day and swiftly cools down at night, putting microorganisms and wildlife at risk.

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Figure 7. The geography of fracking in shale gas locations

3.3 Earthquakes

According to the USGS, there were 704 earthquakes in central and southwest Alaska in 2015. Sewage disposal wells are thought to be to blame for the recent increase in earthquakes. Structures have been damaged and people have been injured as a result of large natural earthquakes.
Due to the rarity of natural earthquakes, many states are unprepared to deal with the resulting seismic activity. As a result of fracking sewage disposal, numerous residents in Arkansas experienced a series of tiny earthquakes in 2010 and 2011. As a result of their expanding oil and gas sectors, Oklahoma and Ohio have seen significant increases in seismic activity.
Although earthquakes can be caused by fracking, they are smaller and less common than earthquakes caused by subterranean injection control wells. Fracking was revealed to be the likely cause of hundreds of minor tremors in Ohio in 2013, according to a study published in Seismological Research Letters; another Ohio-based study published in 2015 identified fracking as the origin of a 3.0 magnitude earthquake near Poland Township. Fracking was related to a 3.8 magnitude earthquake in British Columbia, Canada, in 2011, and two earthquakes were directly linked to fracking operations in Blackpool, England, in the same year. Fracking has also been linked to an earthquake in Garvin County, Oklahoma that occurred in 2011.
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3.4 Land use

The conversion of land from one type of biome/management to another is known as land use. Shale gas exploration and extraction necessitates a variety of construction activities in the chosen area. Well pad construction necessitates the removal of soil and vegetation, as well as the transport, handling, and storage of chemicals and other materials for the construction of gas pipelines, water extraction structures, and other operational facilities, following the successful identification of potential areas using various methodologies. These operations have the potential to alter land use, disturb habitat, create erosion, and increase noise pollution

Figure 8 View of fracking from the air at Jonah field, Wyoming.
Source: https://ecoflight.zenfolio.com/p648196342/h32638d19#h32638d19

4.Wastewater from Fracking: Growing Disposal Challenge or Untapped Resource

According to a new report from the Natural Resources Defense Council, all currently available options for dealing with contaminated wastewater from fracking are insufficient to protect human health and the environment, but stronger federal and state protections can better safeguard against the threats posed by this byproduct. The research examines how Pennsylvania gas companies disposed of almost 1.3 billion gallons of wastewater last year, as well as the risks posed by the disposal methods.
Recycling for additional fracking, treatment and discharge to surface waterways, underground injection, storage in open air pits, and spreading on roadways for ice or dust control are the five most prevalent fracking wastewater disposal strategies now in use. All of these alternatives pose major dangers to public health and the environment. And there aren't enough regulations in place to ensure that none of them hurt people or ecosystems.
Some of these practices are so dangerous that they should be outlawed right now. Treatment at municipal sewage treatment plants and subsequent discharge into surface waters, storage in open air pits, and road spreading are examples of these procedures. Meanwhile, if strong safety standards are instituted for these methods, recycling for reuse in fracking operations and underground injection into properly designed and sited disposal wells (that better protect against groundwater contamination and seismic activity) hold the most potential for improvement.
Significant barriers to treatment exist in industrial facilities, which could be overcome with better protections. However, it would still be a less ideal disposal technique for a variety of reasons, the most serious of which is the risk to people's health in the event of a misstep, as treated wastewater would be deposited into streams that provide drinking water.

Using a mixture of hydraulic-fracturing fluids that can contain hundreds of chemicals, the fracking industry extracts natural gas from deep under the ground. Drilling can go as deep as two miles, releasing gas from the rock below with high pressure, water, and sand.

What is the issue? Earthquake-like vibrations, contaminated drinking water, and severely contaminated air are all genuine consequences. For example, fracking fluid chemicals, as well as poisonous compounds and radioactive materials from the bedrock it shatters, are present in considerable effluent that runs back to the surface. The Yale team discovered that 157 of the chemicals used in fracking were harmful. Arsenic, benzene, cadmium, lead, formaldehyde, chlorine, and mercury were among them, all of which are known to be developmental or reproductive toxins. According to Yale researchers, 781 chemicals used in fracking need to be investigated to see if they pose any additional health risks to humans. This is alarming, given that non-conventional hydraulic fracturing has been used in the United States for a few years. (2)

This is just the latest example of how the United States enables dangerous chemicals to enter the market before they've been thoroughly studied for long-term human health effects. Synthetic smells, chemicals in the food system, and other personal care goods are all examples of this. Let's take a closer look at the primary risks of fracking.

5.Conclusion

Exploration of shale oil reserves has increased dramatically in recent decades as a result of technological advancements, and it continues to cause public worry. Fracking has both favorable and unfavorable outcomes. Oil and natural gas can now be used instead of coal as a more cost-effective and greener energy source.

The potentially destructive effects of unconventional gas development on water resources, air quality, and global climate need to be studied and scrutinized far more thoroughly. Scientists undertaking study into unconventional gas dangers have raised red flags of alarm, indicating that a preventive approach is required. Regardless of the uncertainty, one thing is certain: the unconventional gas business in the United States is now free from many of the necessary transparency, oversight, monitoring, and enforcement regulations required to protect public health and safety. This has to change.

So, after reviewing the evidence and discussing the issue, we have concluded that fracking is not a sustainable method of obtaining natural gas and oil, despite the fact that it reduces our reliance on foreign oil and gas. Not only do the disadvantages exceed the benefits, but the fracking technique also violates sustainability rules. Even though fracking generates cash, creates jobs, and reduces the United States' reliance on foreign oil, it is not worth endangering the environment and making people sick by exposing them to unknown chemical mixes in their water and air pollutants. Consider it this way as well. If the ecosystem dies or finite resources employed in the fracking process are depleted as a result of fracking at its current rate, hydraulic fracturing will have to be phased out over time since these resources will be severely depleted. Depleted to the point where the fracking industry could no longer operate as it does now.

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