

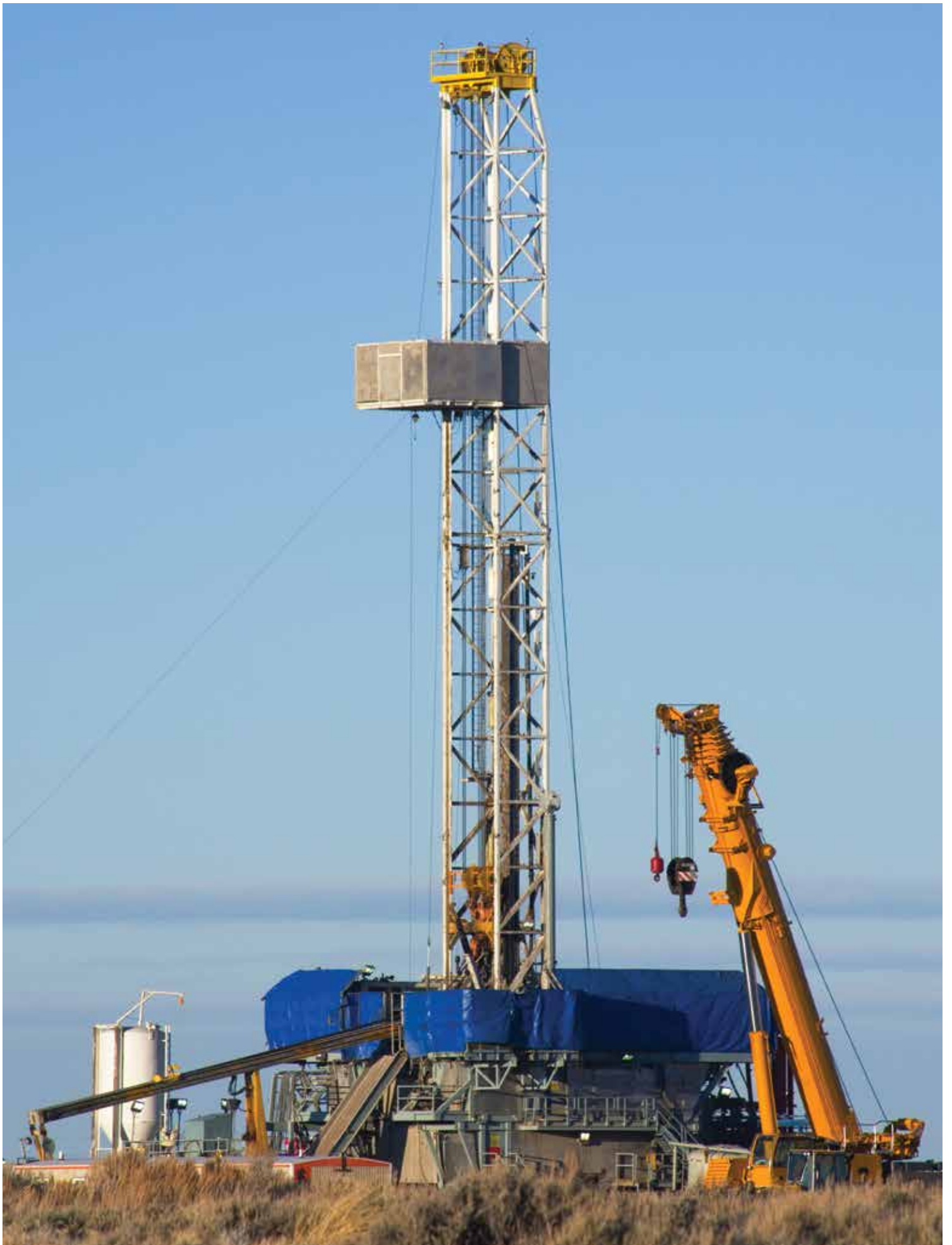
A close-up photograph of a hand holding a small amount of water, with a stream of water falling into a larger body of water below. The background is a blurred body of water with ripples and reflections of light.

Toxic & Dirty Secrets

The truth about fracking
& your family's health



CEH
center for environmental health



All around the country people are finding that hydraulic fracturing, also known as fracking, is dangerous, destructive, and harmful to human health. Contaminated water and harmful air pollution are just a few of the all-too-real side effects associated with unconventional oil and natural gas development.

Pregnant women, mothers, and their babies are at particular risk from toxic chemical exposures that can lead to infertility, miscarriage, impaired learning and intellectual development, birth defects, respiratory problems, heart disease, and cancer.

Our political leaders must make science and health research an integral part of the development of efficient, cleaner and safer energy resources and practices. American families should not have to sacrifice their air, land, drinking water, or health for the benefit of the natural gas industry and the toxic and dirty secrets it is fighting to hide from public view.

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Executive Summary

The chemicals used in the extraction, processing, distribution, transport, and waste disposal of tight oil and shale gas from shale reservoirs can pollute surrounding air and water. One particular phase in the tight oil and shale gas life cycle is known as high-volume horizontal fracturing (fracking). In this process, high volumes of water, sand, and chemicals are pumped under pressure into gas wells to fracture subterranean shale and force natural gas to the surface for capture and distribution. Since fracking enables the process of tight oil and shale gas development, this paper discusses all of the impacts that can affect mothers and their children — from well construction to extraction, operations, transportation, and distribution.

This paper focuses on three ways in which fracking affects the health of mothers, children, and their communities:

- exposure to toxic fracking chemicals and byproducts of the fracking process via air pollution;
- exposure to toxic fracking chemicals and byproducts of the fracking process via water contamination; and
- social stressors associated with the heavy industrial activities that accompany tight oil and shale gas development.

Fracking exposes children and mothers to chemicals and substances such as methane, BTEX (benzene, toluene, ethylbenzene, and xylenes), arsenic, radium, ozone, formaldehyde, radon, nitrogen oxides, methylene chloride, and silica sand. These substances are associated with low birth weight, birth defects, respiratory problems, cancer, and fertility problems.

The oil and gas industry is the only industry in the U.S. that is allowed by the EPA to “inject hazardous materials-unchecked” directly into or adjacent to underground drinking water supplies.

Fracking has also been found to detrimentally impact the immediate and nearby communities. Fracking increases traffic and creates industrial noise, which is correlated with hypertension, sleep disturbance, cardiovascular disease and stroke. Because of the many health problems associated with fracking, the process also strains the communities' health care resources.

The oil and gas industry is the only industry in the U.S. that is allowed by the EPA to “inject hazardous materials-unchecked” directly into or adjacent to underground drinking water supplies², and both current and proposed regulations allow fracking companies to keep their chemical use secret. Fracking has been largely exempted from the major federal environmental laws.

To protect mothers, children, and their communities from the health effects associated with fracking, CEH recommends that citizens, legislators, and regulators demand a regulatory framework that:

- forces oil and natural gas developers to publicly disclose the chemicals that are used and that are byproducts of the fracking process;
- imposes moratoriums or bans that delay fracking until thorough studies show how it can be done safely, including a comprehensive Health Impact Assessment, and establishes a strict regulatory framework that ensures the process is done without contaminating air and water with toxic substances and without undue burden on public health infrastructure;
- calls for better research and scientific oversight of fracking; and
- mandates the use of air quality control technology in fracking communities.

Unfortunately, many of the chemicals of concern we have been working so hard to eliminate from consumer products have also been found in fracking fluids and have been discovered in the air and groundwater and even in household water wells near frack sites.

And the proposed regulations ensure that we may never even know that we have been exposed. ...Companies may hide the fact that they are poisoning us with these chemicals under a claim of “trade secret”. This is unacceptable. If a company is potentially poisoning our air and water, that should not be a secret.

– Ansje Miller, Eastern States Director, CEH¹



Over the past decade, the clean energy debate has been dominated by concerns about global warming. But questions about the health effects of our energy choices have not been adequately addressed.

Background

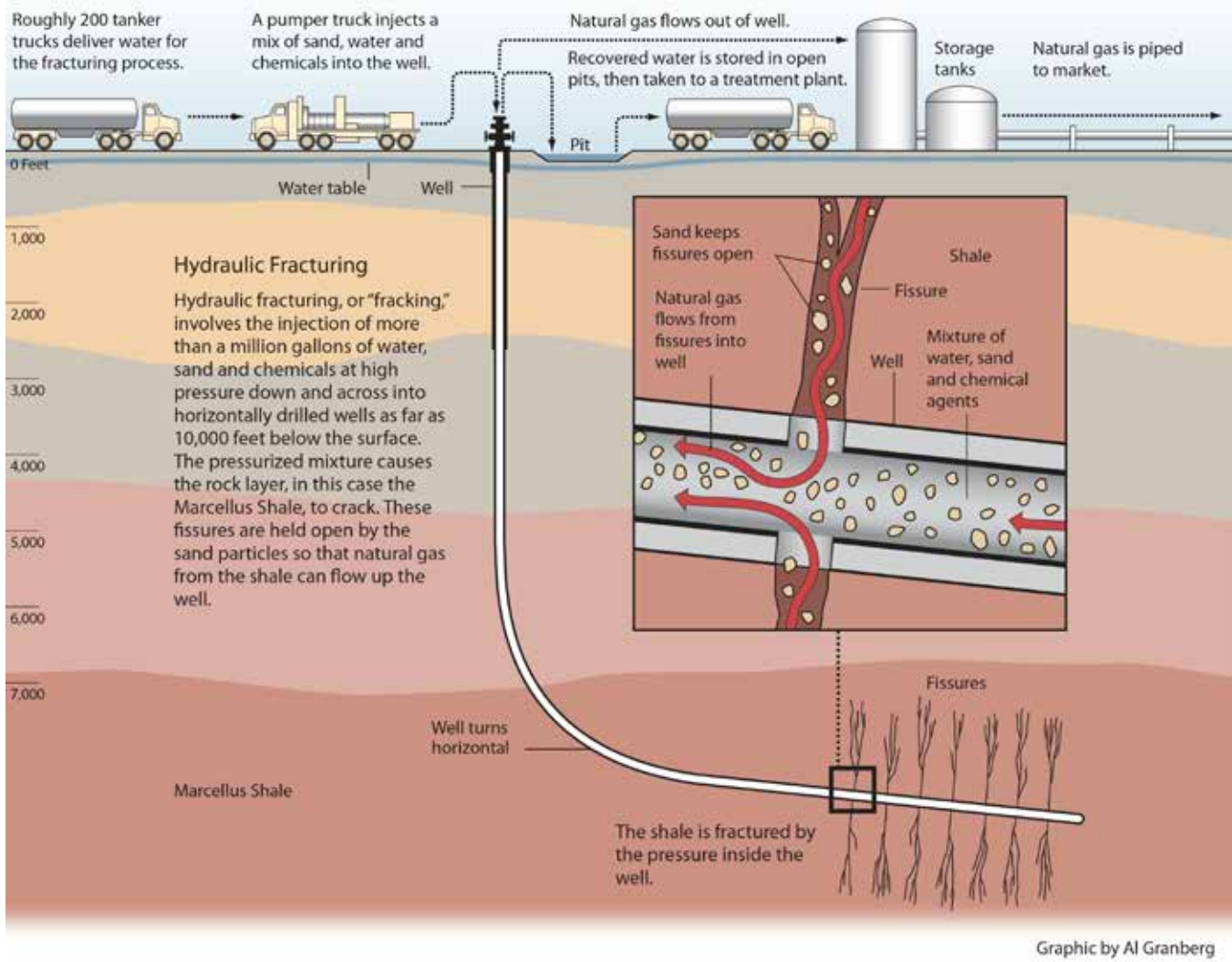
Over the past decade, the clean energy debate has been dominated by concerns about global warming. But questions about the health effects of our energy choices have not been adequately addressed. Major oil and natural gas producers promote fracking as the key to a clean, environmentally friendly, energy-independent future. Many support natural gas as a “bridge fuel” between dirty fossil fuels and a renewable/solar future. However, the largely unregulated expansion of fracking poses serious environmental and health risks to communities throughout the country.

While the term “fracking” refers to one stage in the process of shale development (see below, “What is Hydraulic Fracturing (Fracking)?”), the process of fracking never occurs by itself. When fracking comes to a community, it brings with it the full range of the oil and natural gas development process — from well construction to extraction, operations, transportation, and distribution — that can threaten the health of mothers and children by polluting the air and water and disrupting communities. Since communities are affected by industrial activities in each of these phases, and since the general public considers these individual and collective activities of the industry to be “fracking,” we use the term “fracking” in this paper to describe both the full range and the individual parts and phases of the oil and natural gas development process.

A closer look reveals that fracking for natural gas and oil can have significant health concerns for mothers and their children.

What is Hydraulic Fracturing (Fracking)?

Fracking is short for hydraulic fracturing — an industrial process in which chemicals, sand, and millions of gallons of water are mixed together, creating a ‘fracturing fluid,’ which is pumped under high pressures into natural gas or oil wells. In the process, the fluid fractures and enters subterranean reservoir rock formations called shale and releases natural gas and oil. Larger fissures allow more petroleum,



natural gas, and other substances to flow out of the formation so that they may be more easily extracted.

The Difference Between Horizontal Versus Vertical Fracking

There are millions of fracking wells drilled across the country every year. The hydraulic fracturing ("fracking" or "hydrofracking") commonly performed is "conventional" (low-volume) vertical fracking, which has been used for more than 50 years by the oil and gas industry. The vertical method bores a vertical well in single gas reservoirs close

to the surface. Technological advances in the use of the high-volume, horizontal, fracking (HVHF or “unconventional” hydraulic fracturing) have allowed oil and gas to be extracted from tight formations in shale reservoirs as well. In this paper, we focus on this newer method for tight oil and shale natural gas extraction, otherwise known as high-volume, horizontal fracking (HVHF).

Tight Oil and Shale Gas Development in the U.S.

The largely unregulated expansion of fracking poses serious environmental and health risks to communities throughout the country.

Like crude oil, natural gas is extracted from a variety of rock formations including sands, coal beds, and a layer of subterranean rock called shale. The natural gas and tight oil in these layers (called “shale plays”) is largely untapped and has been made profitable only recently by technological advances such as the combination of HVHF and horizontal/directional drilling. After the exploration process, in which the geology of a natural gas reservoir location is evaluated and assessed, the gas and oil is extracted. Pipelines then transport the gas and oil from the extraction/drilling site to processing facilities and power plants.

The map below shows major gas shale reserves across the U.S.

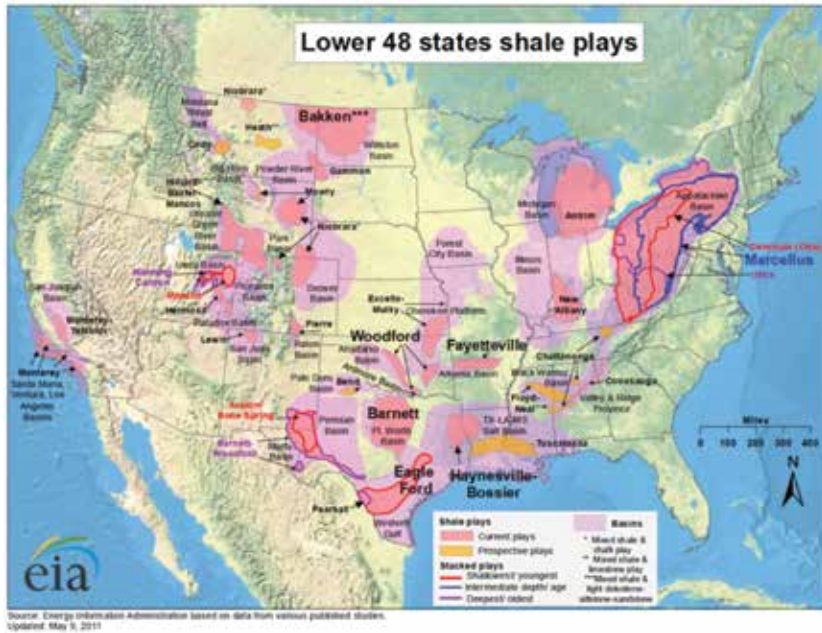


Figure 1 - Natural Gas Shale Plays in the Continental US³



The quantity of a well's fracking fluid mixture is massive, often millions of gallons, so even a small percentage of chemicals can mean a large amount (80-330 tons) of toxic chemicals to potentially contaminate drinking water sources.

Water and Air Pollution

Every part of the fracking process — from well construction to operations to transportation — can threaten the health of mothers and children by polluting the air and water. Pollution can come from the production and transportation of material to and from well development activities (such as sand mining and trucking of wastewater), emissions from fuel consumption for the drilling and fracturing equipment, transportation and equipment used in gas production, processing, transmission, and distribution.

Water Pollution from fracking, drilling, gas processing, and leaks can make water dangerous for mothers and their families. Some toxic chemicals found in water from tight oil and shale gas development sites include:

- **Methane**^{4,5}
- **BTEX** (Benzene, Toluene, Ethylbenzene, Xylenes)⁶
- **Arsenic**⁷
- **Radium**⁸

The oil and gas industry claims that fracturing fluid injection mixture is typically 98-99.5% water and that chemicals constitute only a small percentage of the mixture.⁹ But the amounts of fracturing fluid typically used in the fracking process are staggering. Tracking on a percentage basis obscures the massive raw quantities of toxic chemicals often pumped underground — chemicals that can potentially contaminate drinking water sources. In fact, in an assessment carried out by the New York Department of Environmental Protection in 2009, this “small fraction of chemicals” actually translated to anywhere from 80 to as many as 330 tons of chemicals per well.¹⁰



Communities residing near hydraulic fracturing sites have seen elevated levels of air pollution from benzene, toluene, ethylbenzene, and xylene (BTEX), as well as methane, radon and other gases.

It is also important to note that as much as half of the fracturing fluid returns to the surface as wastewater (“flowback”), which typically includes more chemicals and radioactive particles brought up from underground.¹¹

There have been documented incidents of drinking water contamination from shale gas and tight oil operations.¹² Chemicals in drilling and fracturing fluids can make their way into surface water; and water supplies from vehicle accidents, leaks, and spills can threaten the water supply as well.¹³ Also, when fracking chemicals at storage sites are not handled properly, they can migrate into water supplies.¹⁴

Air Pollution from fracking, drilling, gas processing, gas leaks, and diesel exhaust make air dangerous for mothers and their families. Hazardous air emissions include:

- **Ozone**^{15, 16}
- **Methane**^{17, 18}
- **Formaldehyde**¹⁹
- **BTEX** (Benzene, Toluene, Ethylbenzene, Xylenes)²⁰
- **Radon**²¹
- **Nitrogen Oxides**²²
- **Methylene Chloride**²³
- **Silica sand**²⁴
- **Hydrogen sulfide**^{25, 26}
- **Particulate matter**²⁷

Communities near hydraulic fracturing sites have seen elevated levels of air pollution from benzene, toluene, ethylbenzene, and xylenes (BTEX), as well as methane, radon, and other gases that are released into the air by the process of shale gas and tight oil development.^{28, 29, 30} Vented methane releases occur during fracking operations. Toxic emissions can also occur from the stations where fracked natural gas is compressed, during the production of fracturing fluid, and in releases from flaring (burning off excess gas).³¹



Some reports suggest that 25% of chemicals used in fracking have been linked to cancer. Furthermore, 35% of chemicals used in fracking disrupt the normal functioning of our hormones. The EPA has identified that hormone-disrupting chemicals may be linked to breast cancer.³²

Effects on Maternal and Children's Health

The chemicals and substances that are used in or are byproducts of tight oil and shale gas development have been linked to cancer and other serious health problems, including issues of particular concern to pregnant women, women who may become pregnant, and children.

Residents living close to unconventional natural gas wells were found to have higher estimated risks for cancer, breathing problems, and effects on the nervous system based on their exposure to air pollutants than residents who live farther from wells.³³

Low Birth Weight & Birth Defects

Birth weight is an indicator of infant health and long-term health outcomes and has become an important but often overlooked focus in health policy. Low birth weight puts babies at risk for developing serious health problems, including newborn illnesses, delayed motor skills, delayed social development, and learning disabilities.³⁴

Benzene, Toluene, Ethylbenzene, and Xylene (BTEX)

A well-known quartet of chemicals, usually abbreviated as BTEX, is used in millions of gallons of fracking fluids every year — 11.4 million gallons between 2005 and 2009.³⁵ BTEX was found in 60 hydraulic fracturing products between 2005 and 2009.³⁶

Benzene (the B in BTEX), along with the other BTEX chemicals, is known to cause low birth weight, decreased head size, and birth defects such as spina bifida.^{37, 38, 39}

When developing children are exposed to toxic, airborne chemicals, including the heavy use of diesel-powered equipment and transportation associated with fracking, they are more likely to become susceptible to health problems, including asthma, allergies, bronchitis, and other respiratory problems.

FACT: More than

632

chemicals are used in natural gas fracking fluids.

As many as 353 of these chemicals are often cited in scientific literature, and more than:

- 75% could affect skin, eyes, respiratory, and gastrointestinal systems
- Roughly 40-50% could affect the brain and nervous, immune, and cardiovascular systems and the kidneys
- 37% could affect the endocrine system
- 25% were carcinogens and mutagens³²

Nitrogen Oxides, Particulate Matter & Ozone

Shale gas and tight oil development rely heavily on the use of diesel-powered equipment and transportation, including 18-wheelers to transport large quantities of water, sand, chemicals, and equipment. The pollutants found in diesel exhaust also contribute to rising levels of ozone in the air.

Both fine particulate matter (PM_{2.5})⁴⁰ and nitrogen oxide gases (NO_x) are responsible for a range of health problems, including low birth weight.^{41, 42, 43} Low birth weight can also be caused by exposure to diesel exhaust,⁴⁴ which is composed of many pollutants, including fine particulate matter and nitrogen oxides. Mothers' exposure to ozone levels in the second and third trimesters of pregnancy is associated with lower birth weight.⁴⁵

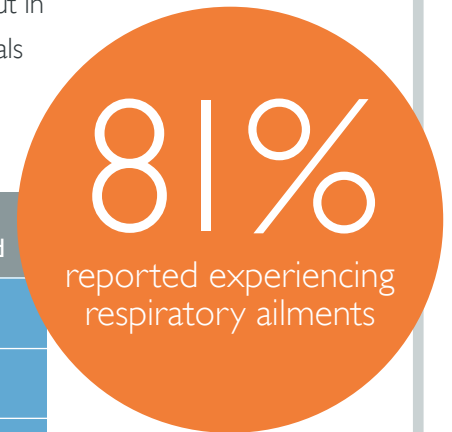
Respiratory Problems

The metabolisms of infants and children differ from those of adults. Infants and children eat more, drink more, and breathe more per unit of body weight than adults do.⁴⁶ Respiratory problems are particularly problematic for babies and children, because their lungs continue to develop throughout childhood.⁴⁷ Children's unique physiology makes them more susceptible to health problems.⁴⁸ When developing

Contaminated Wells and Air Quality Health Impacts

In August 2009, the Environmental Protection Agency (EPA) publicly released data from an investigation of 39 wells in Pavilion, Wyoming, where the development of oil and gas resources had been going on for some time. Eleven of these wells were found to be contaminated. In response to ongoing reports of air and water contamination and health impacts, a community health survey was carried out in March 2010. The community survey was completed by a total of 16 individuals between the ages of 37 and 82. Thirteen of the 16 individuals surveyed (81%) reported experiencing respiratory ailments (see table below).⁵⁶

Health Problem	Number of Individuals Reporting Ailments	Percentage of Individuals Surveyed
Throat irritation	8/16	50%
Sinus problems	7/16	44%
Breathing difficulties	6/16	38%
Nasal irritation	4/16	25%
Wheezing	2/16	12%
Bronchitis	1/16	6%
TOTAL	13/16	81%



children are exposed to toxic, airborne chemicals, including traffic pollution, they are more likely to become susceptible to health problems, including asthma, allergies, bronchitis, and other respiratory problems.⁴⁹ Infants exposed to high levels of traffic-related air pollution are at higher risk of death from respiratory causes.⁵⁰

BTEX & Volatile Organic Compounds (VOCs)

Volatile organic compounds, including the BTEX compounds described above, are substances that easily vaporize and become airborne. BTEX compounds have been found in the air near fracking sites and in diesel exhaust.



Studies show that living in areas with high levels of particulate air pollution is associated with higher death rates in the first year of life.⁶⁶

In addition to birth defects and low birth weight, these compounds can cause respiratory problems, such as asthma.⁵¹ A comprehensive risk assessment suggests that residents living within a half mile from tight oil and gas wells are at greater risk for health problems from hydrocarbons, such as benzene and xylenes.⁵²

Methane

In a study of 68 drinking water wells in Pennsylvania and New York, methane contamination rose significantly with increasing proximity of the wells to the hydraulic fracturing sites.⁵³

Methane can be flammable and explosive,⁵⁴ and when trapped in confined spaces, like a home or garage, can cause suffocation.⁵⁵

Ozone

Ozone is produced not only by the release of pollutants from diesel exhaust, but also when chemicals are released into the air from natural gas wells. When VOCs escape from wells, they can combine with nitrogen oxides in the surrounding atmosphere and produce ozone. Nitrogen oxide can also interact with sunlight and produce ground-level ozone.⁵⁷

Ground-level ozone (commonly known as smog) is different from stratospheric ozone, which protects us from the sun's harmful rays. Ground-level ozone is made through the mixture of man-made and natural emissions, and can be harmful to humans.⁵⁸ Ground-level ozone is reactive and damaging to lung tissue. It is particularly harmful to children and active young adults who spend time outdoors.⁵⁹ Exposure to ozone is associated with reduced lung function, and chronic exposure can lead to asthma, chronic obstructive pulmonary disease (COPD), and can worsen pre-existing asthma and emphysema.^{60, 61, 62}

Hydrogen Sulfide

This gas has been found near gas wells in Colorado and has an odor of rotten eggs, noticeable at low levels.



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Breathing air heavily contaminated with silica crystals has long been known to cause respiratory problems. Breathing silica can cause silicosis, a disease that reduces the lungs' ability to take in oxygen and can lead to disability and premature death.

It irritates the nose and throat and causes difficulty breathing for people with asthma. Even brief exposures to high concentrations can be life-threatening.⁶³

Particulate Matter

The heavy use of diesel-powered equipment and transportation, including 18-wheelers to transport large quantities of water, sand, chemicals, and equipment, can significantly increase levels of fine particulate matter released into the environment.

Particulates are responsible for increased incidence of asthma, chronic obstructive pulmonary disease, and lung cancer;⁶⁴ People with preexisting respiratory conditions, children, and pregnant women are at greatest risk from particulates.⁶⁵

Silica

Silica sand is commonly used in fracking to prop open fissures in the shale to allow the gas to flow.^{67, 68}

Breathing air heavily contaminated with silica crystals has long been known to cause respiratory problems.⁶⁹ Breathing silica can cause silicosis, a disease that reduces the lungs' ability to take in oxygen and can lead to disability and premature death.^{70, 71} Silica is also a possible contributor to other diseases, such as kidney and autoimmune diseases.⁷² The National Institute for Occupational Safety and Health has found that worker exposure to crystalline silica during fracking operations is hazardous.⁷³

A wide range of health problems are associated with arsenic exposure, including thickening and discoloration of the skin, stomach pain, nausea, vomiting, diarrhea, numbness in hands and feet, partial paralysis, and blindness.

Arsenic Poisoning

Marcellus shale flowback samples submitted to the New York Department of Environmental Conservation by well operators detected trace levels of arsenic.⁷⁴ Independent studies have also found arsenic in flowback wastewater from fracking sites on the Marcellus Shale.⁷⁵

A wide range of health problems are associated with arsenic exposure, including thickening and discoloration of the skin, stomach pain, nausea, vomiting, diarrhea, numbness in hands and feet, partial paralysis, and blindness.⁷⁶

There is also a risk that elevated methane migrating into private water wells increases the leaching of arsenic and other heavy metals from underground rock formations into flowback water. This depends on regional hydrogeology characteristics and varies from place to place.⁷⁷

Cancer

Radium

The gas/chemical fracking process brings radium, a naturally occurring radioactive material often found underground, above ground.⁷⁹

Radioactive materials, including radium, are carcinogenic.^{80, 81} Marcellus Shale is rich with radium.

CASE STUDY: Arsenic Poisoning

Researchers Oswald and Bamberger interviewed a family living in rural Pennsylvania who had a child who suffered arsenic poisoning as a result of living near fracking wells. Very soon after drilling and hydraulic fracturing began, the child began showing signs of fatigue, severe abdominal pain, sore throat, and backache. Six months later, the child was hospitalized with confusion and delirium and was given morphine for abdominal pain. When the family's animals started to die, the child's physician suspected poisoning. A toxicology test revealed arsenic poisoning as the cause of the child's sickness. The family stopped using their well water and the child gradually recovered after missing one year of school.⁷⁸

Radium 226 emits gamma radiation; these particles can travel long distances in the air and potentially increase the risk for cancer in surrounding areas.

Radium 226 emits gamma radiation; these particles can travel long distances in the air and potentially increase the risk for cancer in surrounding areas. The New York Department of Environmental Conservation analyzed flowback water samples and found that radium levels therein were as high as 267 times the regulatory limit for discharge into the environment.⁸²

Radon

According to the U.S. Geological Survey, radon levels in gas samples from the Marcellus region in Pennsylvania are an average of eight times higher than the U.S. Environmental Protection Agency (EPA) threshold for radon in indoor air.⁸⁴

According to the EPA, radon is the leading cause of lung cancer among non-smokers and is the second leading cause of lung cancer overall. Radon is responsible for about 21,000 lung cancer deaths every year, and 2,900 of these deaths occur among people who have never smoked.⁸⁵

Benzene

Between 2005 and 2009, BTEX was found in 60 hydraulic fracturing products.⁸⁶

This is a concern because benzene (the B in BTEX) is a known human carcinogen,⁸⁷ linked with several types of leukemia in exposed adults and also may be linked to childhood leukemia.^{88, 89} Studies have found higher rates of leukemia among children living in areas where higher benzene concentrations are detected in the air and water.^{90, 91}

Methylene Chloride

Methylene chloride (also known as dichloromethane) has been detected in high levels in air samples collected in areas near gas wells.⁹² It has been identified as a carcinogen by many government agencies.^{93, 94}

Silica

Silica sand is commonly used in fracking to prop open fissures in the shale to allow the gas to flow.^{95, 96}



A recent study found that if men were exposed to formaldehyde at work, their partners took longer to become pregnant and were more likely to have miscarriages when they did become pregnant.

In addition to the respiratory problems listed above, excessive air exposure to silica crystal dust has been known to cause lung cancer.^{97, 98}

Arsenic

Arsenic has been found, among many other contaminants, in drilling reserve pits (where drilling fluid is stored.)⁹⁹

Not only is arsenic connected to gastrointestinal problems, nervous system problems, and other adverse health impacts,¹⁰⁰ it is also linked to cancer of the bladder, lungs, skin, kidney, nasal passages, liver, and prostate.^{101, 102} According to the National Toxicology Program, arsenic is known to cause cancer in people.¹⁰³

Formaldehyde

Formaldehyde has been found in fracking fluid. According to the National Toxicology Program, formaldehyde is carcinogenic.¹⁰⁴

Fertility

One important concern for women in fracking areas who are pregnant or who are planning to become pregnant is the possibility of fracking chemicals causing infertility or miscarriages. Certain compounds found in fracking fluids can increase the risks for these health problems. (They can also affect the fertility of their male partners.)

Formaldehyde

Since formaldehyde has also been found in fracking fluids, this is also a concern for women and men of childbearing age.

A recent study found that if men were exposed to formaldehyde at work, their partners took longer to become pregnant and were more likely to have miscarriages when they did become pregnant.¹⁰⁵

Benzene & Toluene (the B and T in BTEX)

As mentioned previously, BTEX is used in millions of gallons of fracking fluids every year.¹⁰⁶ BTEX levels in groundwater contamination spills at drilling sites studied in Colorado exceeded the National Drinking Water standards.¹⁰⁷



Studies have shown that men exposed at work to the BTEX quartet of chemicals produced more abnormal sperm than their unexposed co-workers.¹⁰⁸

In Dish, Texas, blood and urine samples were taken from individuals living near Barnett Shale gas wells, and results showed that 65% of people had toluene in their bodies.¹⁰⁹

Studies have found that women exposed to organic solvents during pregnancy, such as benzene and toluene, are at greater risk for miscarriages.¹¹⁰ Studies have also found that women exposed to toluene at work had more difficulty becoming pregnant than did their unexposed co-workers.

CASE STUDIES: Birth & Reproduction Problems

Researchers Oswald and Bamberger conducted interviews with two families that lived within two miles of approximately 25 shale gas wells. Both families had farm animals or pets residing with them on their land. One family had a three-year-old goat that aborted two kids in the second trimester. The other family had a five-year-old boxer that produced a stillborn pup and a pup with a cleft palate, which died shortly after. The boxer gave birth to another litter of 15 pups – seven of the pups were stillborn and eight died within 24 hours. Eight of the pups were also born with no hair.¹¹¹

In another case, these same researchers interviewed a beef cattle farmer who lived on a farm that was about five miles from 190 gas wells.¹¹² The area had been experiencing intense ongoing drilling. The farmer had 60 cows that had access to a creek in his pasture that they used as their main source of drinking water. In the pasture nearby, 20 cows had access to water from a runoff. In a third pasture 14 cows and two bulls had access to a pond. Of 60 cows drinking from the creek, 21 died. Of the 34 cows drinking from water sources at higher elevations, where no or fewer fracking chemicals would likely be found, none were injured. Finally, in two cases where fracking accidents led to chemical releases, fracking fluid directly flowed into pastures inhabited by cows and goats, resulting in stillborn calves with congenital defects and reproductive problems.¹¹³



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Increased levels of noise from traffic and equipment can cause stress, difficulty sleeping, and psychological problems that can exacerbate physical outcomes or existing health conditions.

Effects on Social & Community Health

Beyond chemical exposure, there are a number of other ways that fracking can affect the health of families. For example, increased traffic volume can increase the likelihood of injuries and fatalities in a community. Other aspects of the fracking process, such as increased levels of noise from traffic and equipment, can cause stress, difficulty sleeping, and psychological problems that can exacerbate physical outcomes or existing health conditions.

A strong and healthy community improves the likelihood that children will thrive as they develop. Shale development typically industrializes a community (usually one that is residential or rural), opening its doors to convoys of tractor-trailers, “man camps” for temporary workers not committed to or invested in the community, and noise pollution from the constant hum of operating equipment and increased traffic.

Traffic

An increase in accidents, injuries, and fatalities related to transportation can result from a rise in traffic volume in communities.¹¹⁴ Studies have shown that there is a significant relationship between traffic volume and the number of vehicle accidents involving pedestrians,¹¹⁵ with injury risk estimates up to 14 times greater for child pedestrians in busy traffic areas, compared to areas where there was less traffic.^{116, 117} In addition to injuries and fatalities, increased traffic congestion can also increase stress levels and adverse psychosocial impacts.

Noise

Natural gas rig construction, equipment, and transportation can all increase noise levels in communities.

The increased health care costs resulting from fracking create a financial burden, placing professional health care beyond the reach of many families.

Health outcomes related to noise pollution include hypertension, sleep disturbance, cardiovascular disease, stroke, increased aggression, depression, and cognitive impairment (such as problems with attention and recognition). Noise from road traffic has been linked with a higher risk for heart attack and heart disease.^{118, 119}

Social Disruption

Hydraulic fracturing can change the social fabric of a community. Community members have reported changes in social norms and behaviors and a perceived loss of social cohesion where ongoing natural gas development has taken place.

These effects can be caused by increased traffic congestion, economic changes, and shifts in demographics. For example, Garfield County, Colorado, noticed that the natural gas industry boom of 2003-2009 coincided with significant changes to the community's demographics, social structures, and community wellness.¹²⁰ In this case, as temporary workers moved in and out of communities, demographic and socioeconomic changes led to social disruption. These changes also brought about a rise in crime and stress levels and a sense of general discontent and dissatisfaction in the surrounding community.¹²¹

Residents reported an increase in sexually transmitted diseases (STDs), drug and alcohol abuse, and violent crime.¹²² These stressors can increase the demand on health and emergency services and can cause new challenges, particularly for children's development, in areas in which infrastructure is weakened and resources are already limited.

Increased Health Costs

The number of American families living near fracking sites, including expectant mothers and those with children, is expected to increase substantially over the next 10 years. Many of those women and children are expected to be at or below poverty-income levels.

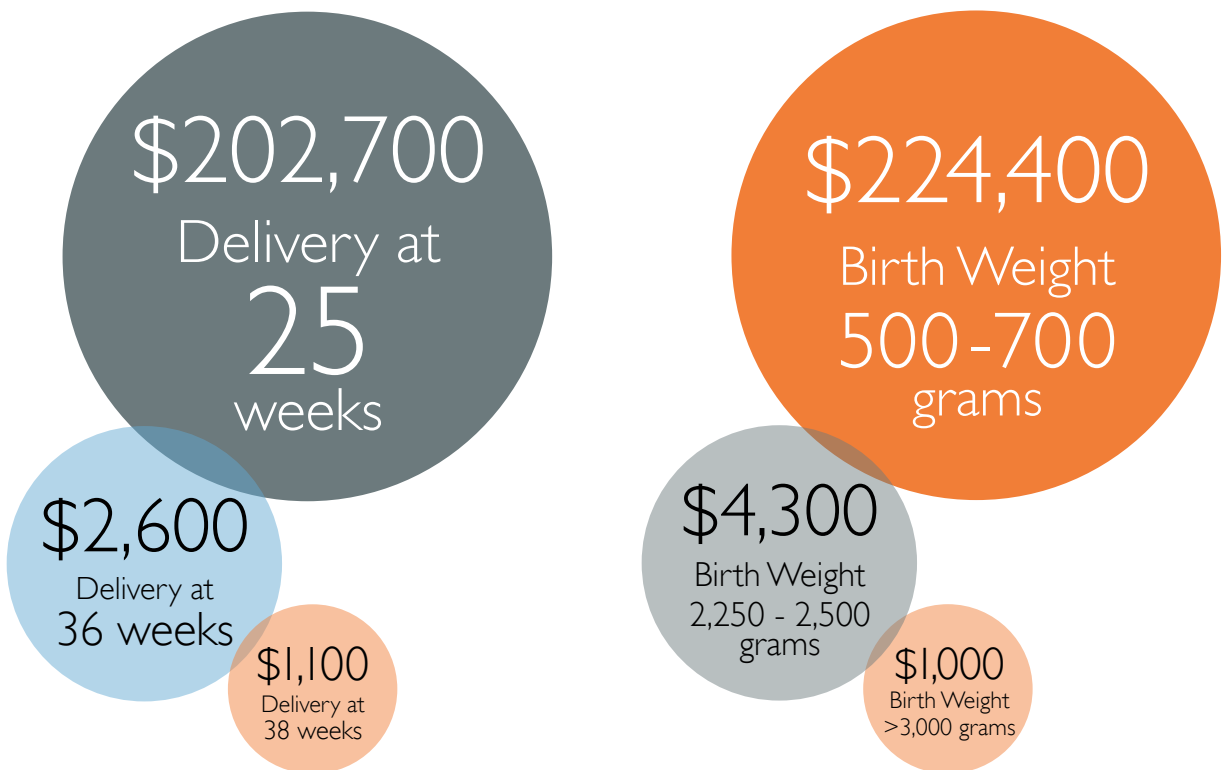
The increased health care costs resulting from fracking create a financial burden, placing professional health care beyond the reach of many families. For example, a recent report from the Institute of



Medicine estimates that the cost to society for preterm birth (which can result in low birth-weight babies) is \$51,600 per infant.¹²³

Researchers have examined a variety of indicators and found that ventilation, length of hospital stay, and hospital costs all decreased exponentially with increasing gestational age and birth weight.¹²⁴

Neonatal Hospital Costs by Week & Birth Weight



SOURCE: <http://www.ncbi.nlm.nih.gov/pubmed/12962929>



Recommendations

What Legislators and Community Members Can Do

Despite the widespread risks that hydraulic fracturing poses to health, the environment, and public drinking water, fracking is largely exempt from the major federal environmental laws. These include the Safe Drinking Water Act, the Clean Water Act, the Clean Air Act, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, better known as the Superfund Act), the Resource Conservation and Recovery Act (RCRA), the Toxic Release Inventory under the Emergency Planning and Community Right-to-Know Act (EPCRA), and the National Environmental Policy Act (NEPA) (Oil and Gas Accountability Project 2007).

The oil and gas industry is the only industry in the U.S. that is allowed by the EPA to “inject hazardous materials-unchecked” directly into or adjacent to underground drinking water supplies.¹²⁵ Moreover, current and proposed regulations allow fracking companies to keep their chemical use secret. That is to say, companies are allowed to keep secret the chemicals they are putting into the air, water, and indirectly the bodies of American mothers and children.

Policy makers and the public must act today to protect mothers and children from health problems caused by fracking. To meaningfully protect American mothers and children from toxic chemicals, legislators and regulators must require far more rigorous oversight of fracking. The loopholes that allow natural gas developers to sidestep vital federal environmental regulations must be shut so that fracking is regulated no differently from any other energy development.

Complete evidence regarding health impacts of gas drilling cannot be obtained due to incomplete testing and disclosure of chemicals and nondisclosure agreements. Without rigorous scientific studies, the gas drilling boom sweeping the world will remain an uncontrolled health experiment on an enormous scale.

- M. Bamberger and R.E. Oswald. Impacts of gas drilling on human and animal health.



We call on federal legislators and regulators to protect mothers and the next generation from the numerous illnesses and other adverse health effects associated with fracking.

The health of mothers and children depends on the revival and passage of previously unsuccessful legislation to close the environmental and public health loopholes that give the fracking industry a virtual carte blanche to expose families to toxic chemicals. Just as importantly, the public should have ready access to complete and accurate information about *all* of the chemicals being used in the hydraulic fracturing process.

Studies show that past regulatory reforms have significantly reduced many adverse health outcomes for infants and children. One study evaluated air improvement standards mandated by the Clean Air Act (CAA) of 1979 to estimate the effects of particulate matter on infant mortality and determined that a 1% decline in total suspended particles (TSP) resulted in a 0.5% decline in infant mortality. Prudent, commonsense environmental regulations can improve the health of American children, mothers, families, and communities.

With that in mind, we call on federal legislators and regulators to protect mothers and the next generation from the numerous illnesses and other adverse health effects associated with fracking.

Many communities have decided that the health risks posed by fracking outweigh the potential economic benefit promised by the natural gas industry. Legislators can support their constituents by supporting moratoria that delay fracking until thorough studies show how it can be done safely and establish a solid regulatory framework that ensures the process is conducted without contaminating air and water with toxic substances. They can also honor the conservative, precautionary will of constituents who support an outright ban on the process.

What did mothers do in Erie, Colorado?

When families in Erie, Colorado, found out that Encana Corporation was planning to drill near Red Hawk Elementary School, they started a campaign to stop it. Parents delivered more than 21,000 petitions to Encana. Several moratoriums have been passed because of community action. The community is now meeting with school and district officials to discuss concerns.

Both legislators and community members can protect the health of mothers and children by supporting stronger federal and state regulations on flowback (fracking wastewater), protections for private well water, and air quality. By demanding that industry disclose which chemicals it is using, legislators and individuals can also protect the health of families who live where fracking is already occurring or is pending.

To summarize, legislators, regulators, and families have at their disposal several opportunities to protect mothers and children from fracking. These include:

- Supporting efforts to **increase the public's access to specific information** on the chemicals used during drilling and fracking (i.e., abolishing drilling and fracking trade secrets);
- **Voting for a moratorium or bans** that delay fracking until thorough studies show how it can be done safely, including a comprehensive Health Impact Assessment, and establishing a strict regulatory framework that ensures the process is done without contaminating air and water.
- **Advocating for better research** and scientific oversight;
- **Spreading information** about the dangers of the currently unregulated process; and
- Supporting efforts to make the **use of air quality control technology mandatory** in fracking communities.

Because children cannot vote or make public policy, because children are more vulnerable than adults to toxic exposures, and because parents are charged with keeping children safe and providing for their future, we, the undersigned mothers, have joined with scientists, pediatricians, and public health officials in calling for a moratorium on fracking until the potential effects on children's health and the environment can be carefully studied. Right now, demonstration of safety does not exist.

-Angela Monti Fox, Mom and Founder of The Mother's Project



What Can Mothers and Their Families in Drilling Communities Do?

Watch for “sputtering” or “spitting” from your faucet or a gurgling noise from your well. Also note if your tap water is clear with bubbles, milky, frothy, or has a bluish tint.

The EPA recommends that families in communities where the industry is fracking test their well water annually. The American Academy of Pediatrics (AAP) recommends that prior to drilling, and on a regular basis during drilling, families in fracking communities test their wells for barium, sodium, chloride, strontium, and VOCs. Guidelines on testing can be found here: <http://water.epa.gov/drink/info/well/faq.cfm>

Watch for “sputtering” or “spitting” from your faucet or a gurgling noise from your well. Also note if your tap water is clear with bubbles, milky, frothy, or has a bluish tint. If your tap produces water that exhibits any of these warning signs, have your water tested for methane and other dissolved gases. If you find methane in your well or water source, it should be well vented outside of enclosed spaces and away from heavy traffic, control switches, or other sources of ignition. For tips, see <http://www.health.state.mn.us/divs/eh/wells/waterquality/methane.html>.

Families living in fracking areas can try to lower concentrations of air pollution by keeping indoor areas well-ventilated and clean.

Other Ways to Stay Safe

Prevention

Keep floors clean. Vacuum with a HEPA filter to reduce fracking chemicals in your home. In high-traffic areas, vacuum the same spot several times. Don't forget walls, carpet corners, and upholstered furniture, where dust accumulates. For best results, vacuum two or



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more times each week and wash out your vacuum's filter regularly. After vacuuming, mop to pick up any lingering dust.

Place a floor mat at your home's entrances to reduce the amount of chemicals and pollutants that make their way into your home.

Purchase air cleaners and water purifiers. There are many types and sizes of air cleaners on the market, ranging from relatively inexpensive to expensive. Information on testing and types of cleaners can be found at: <http://www.epa.gov/iaq/is-imprv.html>

Monitor Symptoms

Families should monitor respiratory symptoms and report to their doctor if they are short of breath, fatigued, and/or asthmatic. Other symptoms of exposure to fracking chemicals include eye and nosebleeds, skin rashes, throat irritation, dizziness, headaches, and difficulty moving.

Get Active

Get active and join local groups and organize together to keep toxins out of your community. If there isn't a group in your area already, start your own. In New York, contact Ansje Miller at the Center for Environmental Health (CEH), Ansje@ceh.org for resources or more information.

Be Heard

Support legislation to ban or place a moratorium on fracking and natural gas development until it is determined through formal scientific and health studies that it can be done safely.

Educate

Share with your family, friends, and neighbors what you know about reducing exposure to the toxic chemicals released into the air and water from natural gas development. Host a get-together for local families and speak at social and community events.

For a complete list of resources, including access to other educational materials, peer-reviewed references, and more, go to www.ceh.org

APPENDIX: A Toxicological Endpoints and Health Impacts Summary

- **Arsenic** can cause both cancer and irritation of the stomach and intestines with symptoms such as stomachache, nausea, vomiting, and diarrhea. Other effects include decreased production of red and white blood cells, fatigue, nerve damage, and impaired heart rhythm.¹²⁶
- **BTEX** (Benzene, Toluene, Ethylbenzene, and Xylenes)
 - **Benzene** exposure may cause irritation of the skin, eyes, and upper respiratory tract as well as blisters on the skin. Exposure to benzene over a long period of time may cause blood disorders, reproductive and developmental disorders, and cancer.¹²⁷
 - **Toluene** exposure over a long time may cause nervous system effects, irritation of the skin, eyes, and respiratory tract, dizziness, headaches, difficulty with sleep, or birth defects.¹²⁸
 - **Ethylbenzene** may cause throat and eye irritation, chest constriction, and dizziness. Long-term exposure may cause blood disorders.¹²⁹
 - **Xylenes** exposure may cause irritation of the nose and throat, nausea, vomiting, gastric irritation, mild transient eye irritation, and neurological effects. Long-term exposure to high levels of xylene may severely affect the nervous system, and death may occur due to the failure of automatic neurological processes.¹³⁰
- **Carbon Monoxide** health effects can include headache, nausea, dizziness and blurred vision, confusion, chest pain, cardiac arrest, pulmonary edema, seizures, and coma.¹³¹
- **Fine Particulate Matter** (PM_{2.5}) can lead to respiratory and cardiac problems such as asthma, decreased lung function, and heart attacks.¹³²
- **Formaldehyde** is a very toxic, recognized carcinogen. Ingestion can cause severe damage to the upper gastrointestinal tract. Inhalation can cause irritation and burning of the eyes and mucous membranes. Symptoms of inhalation include headache, difficulty breathing (especially in asthmatics), and damage to the lining of the nose and throat. Nasal and eye irritation, neurological effects, and increased risk of asthma and/or cancer of the nose and throat have been observed in humans. Decreased body weight and liver damage were also observed.¹³³
- **Hydrogen Sulfide** can cause irritation to the eyes, nose, and throat. It can also cause breathing difficulty for asthmatics. Acute exposure to hydrogen sulfide at concentrations above 500 ppm can cause a loss of consciousness. Long-term effects include headaches, poor attention span, memory damage, and poor motor skills.¹³⁴
- **Methane** can be flammable and explosive and when trapped in confined spaces, like a home or garage, can cause unconsciousness and death.¹³⁵
- **Methylene Chloride** exposure occurs mostly from breathing contaminated air but may also occur through skin contact or by drinking contaminated water. Contact of eyes or skin with methylene chloride can result in burns. Inhalation of methylene chloride can damage the central nervous system, and at concentrations above 8,000 ppm, unconsciousness and death may occur.¹³⁶
- **Nitrogen Oxide** can irritate eye, skin, and respiratory tracts. Exposure can result in damage to the pulmonary system, including bronchitis, pneumonitis, pulmonary edema, and emphysema. Inhalation of very high concentrations can lead to burns, spasms, swelling of the throat tissues, and death.¹³⁷
- **Ozone** can cause lung and breathing problems. Chest pain, coughing, emphysema, bronchitis, and asthma attacks may occur. Long-term exposure to nitrogen oxides, combined with fine particles and ozone, increases bronchial hyper-responsiveness in asthmatics and in individuals with chronic lung disease.¹³⁸
- **Radon** is known to cause cancer according to the National Toxicology Program, and has been found as a leading cause of lung cancer in non-smokers.¹³⁹
- **Radium** has been shown to cause anemia, fractured teeth, and cancer.¹⁴⁰
- **Silica** particles can cause silicosis, a non-reversible, and sometimes fatal, lung disease. Respirable crystalline silica is a known human carcinogen, and can cause lung cancer.¹⁴¹

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