



ALLEGHENY COLLEGE

Faculty Scholarship Collection

Article Title	Hydraulic Fracturing in Northwestern Pennsylvania
Author(s)	Eric Brandt; Alex Britt; Joshua Haffner; Anna Koebley; Joseph Lampe; Frederico Levy; Elizabeth A. Olsen; J.G. Squires; Jake Szoszorek; Shannon Wade; Anna Zedar
Journal Title	<i>Allegheny College: Department of Environmental Science</i>
Citation	Brandt, E., et al. (2013). Hydraulic Fracturing in Northwestern Pennsylvania. Meadville, PA: Allegheny College.
Version of article in FSC	Published Version
Link to this article through FSC	https://dspace.allegheny.edu/handle/10456/45420
Date article added to FSC	January 15, 2018
Terms of Use	Copyright 2013. Please contact the author or publisher for further use of this material.

INFORMATIONAL BOOKLET

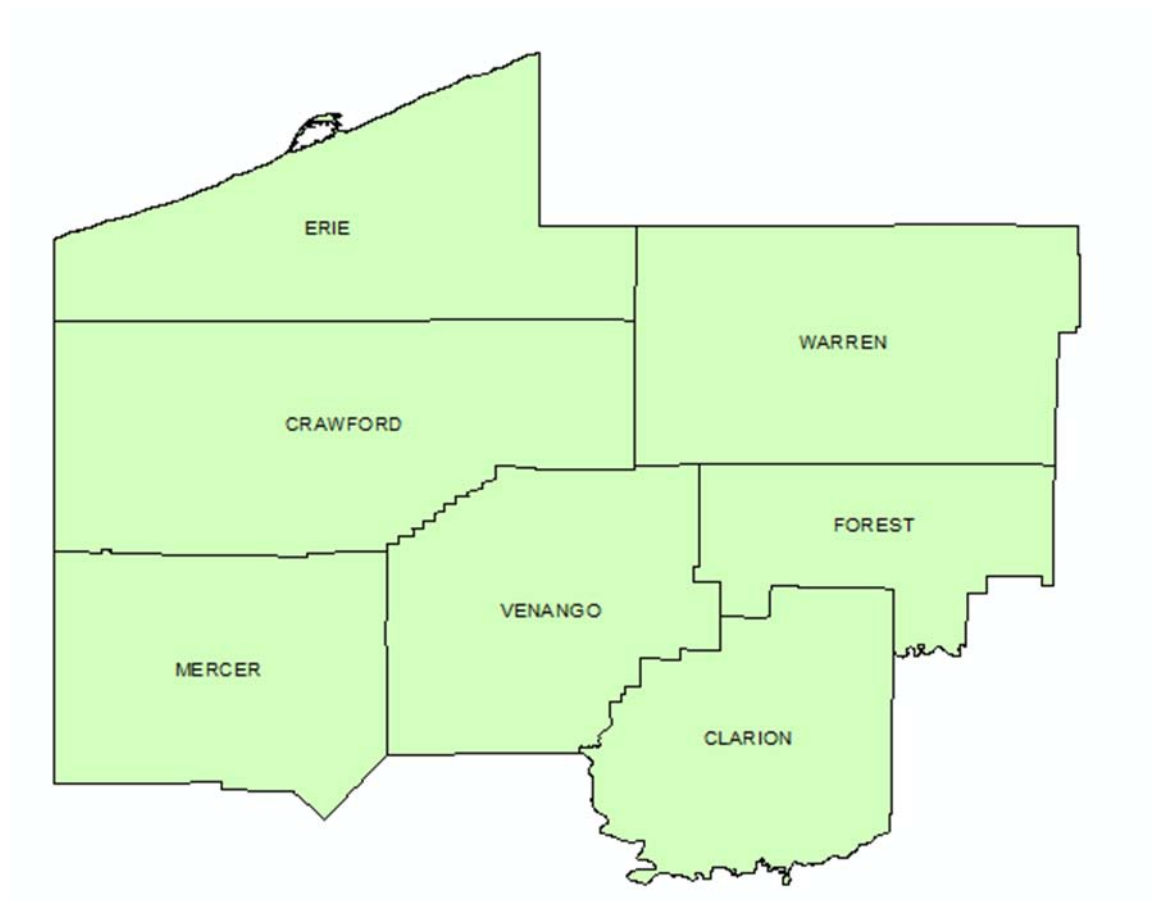
Hydraulic Fracturing in Northwestern Pennsylvania



ALLEGHENY
COLLEGE

E. Brandt, A. Britt, J. Haffner, A. Koebley, J. Lampe, F.
Levy, J. G. Squires, Szoszorek, S. Wade, A. Zedar

Supervised by Professor E. A. Olson, PhD



April 2013

DEPARTMENT OF ENVIRONMENTAL SCIENCE
ALLEGHENY COLLEGE

Table of Contents

Foreword.....	7
Introduction.....	8
Technology	13
Legislative & Legal Dimensions	18
Citizen Science	22
References.....	23
Scorecard.....	24

Foreword

About us

One of the requirements for each student majoring in Environmental Science/Studies at Allegheny College is to participate in a Junior Seminar project-based class prior to the senior year. During the Spring 2013, Professor Liz Olson (PhD, Anthropology) led a course on the very relevant topic of hydraulic fracturing for natural gas. As a group of ten optimistic and eager students, we ventured out to learn all that we could about the significance of hydraulic fracturing for our local community.

This booklet is a product of nearly three months of rigorous research conducted by our class. We read books, critiqued controversial films, hosted various guest speakers, attended advisory committee meetings held on Allegheny's campus, and surveyed the vast array of information that the public is exposed to via news media and the Internet. These research activities have allowed us to create a comprehensive guide for community members in northwestern Pennsylvania (NW PA) about hydraulic fracturing. We want this informational booklet to answer the question "What should I do if I am approached by a gas company?"

Please enjoy this resource!



Introduction

What is Natural Gas, and where does it come from?

Natural gas is a relatively recent energy innovation in the United States. The term “natural gas” refers to methane (CH₄) that exists underground as a result of a natural compaction process. While there is not one definitive answer as to how natural gas was created, the most commonly accepted theory is that as organic matter was compacted and compressed underground and under high pressure for millions of years, it formed hydrocarbons, some of came together to form natural gas. The deeper (and therefore hotter) the area underground, the more natural gas is found. This type of natural gas is formed through a thermogenic process. There is also a biogenic process, when methane emitted from organic matter close to the surface is harnessed in small quantities (King, 2012).

Much of the natural gas produced in Pennsylvania comes from an expansive shale formation that stretches across the mid-Atlantic seaboard. The Marcellus shale formation located 5,000 – 9,000 feet underground is one of the most well-known shale formations in the country and currently one of the world's largest producing natural gas fields (King 2012). However, the Utica shale, a lesser-known and explored but thicker and more expansive shale formation, lies two to three thousand feet below the Marcellus shale and has the potential to produce commercial quantities of natural gas (King 2012; Gushard 2012; Yost 2011). The Utica shale, which also lies below Crawford County, is proving to be a rich resource for financially struggling rural communities in economic terms as well as in terms of domestic energy generation.

Oil and gas leases in Crawford County, including one existing on the Utica shale well outside Cochranton, have been valued at more than \$3,000 an acre (Gushard 2012). In Ohio, the “Department of Natural Resources estimates a recoverable Utica Shale potential between... 3.8 and 15.7 trillion cubic feet of natural gas” (King 2012).

When harnessed, natural gas can be used as an efficient source of heating, cooking, and the formation of electricity in homes, businesses, schools, and other places. Compared to other fuel sources such as coal-powered heating, natural gas is a cleaner

source of energy. The U.S. Environmental Protection Agency's website states that “compared to the average air emissions from coal-fired generation, natural gas produces half as much carbon dioxide, less than a third as much nitrogen oxides, and one percent as much sulfur oxides at the power plant,” (EPA 2007). However, it has also been found that “in its unburned state, [natural gas] is itself a more potent greenhouse gas than carbon dioxide” (Schmidt 2011). The EPA recently “passed new rules to force drillers to limit releases of methane from wells and pumping stations,” but experts still debate whether or not the benefits of burning cleaner natural gas outweigh its costs to the overall climate (AP 2012; Schmidt 2011).

Our Community

Our community of northwestern Pennsylvania consists of seven rural counties with each county having a unique identity (Figure 1). The main urban center is the city of Erie with 101,000 people. There are many small towns in our region and all have a small town feel. Neighbors are friendly and it's common to know people in the supermarket. The average household size is 2.42 (U.S. Census, 2010). Populations by county vary, but many are under 60,000. Counties in our study area have relatively low population densities, and median household incomes of approximately \$40,000. Poverty levels vary between 16%-18%, and many people have high school degrees, but college degree rates are below 20%.

Our region is known for the wide variety of outdoor activities available: hiking, hunting, fishing, biking, boating, and more. A portion of the Allegheny National Forest is located in Warren and Forest counties. Many environmental natural resources are present like lakes, wetlands, small creeks, forests, and many historical sites. The average household median income is \$40,000 and the most common occupation is farming and goods-production industry (U.S. Census, 2010 and P.A. Department of Labor, 2013). Based off the recent election it can be noted that the majority of our region identifies themselves as Republican.

Natural Gas in Our Community

Southwestern and northeastern parts of Pennsylvania have been fracking “hotspots”, with the most wells drilled and gas production in PA by far. In total, PA currently has 74 Operators, 8,982 wells drilled, and 3,025 violations resulting in \$3.5 million in fines.

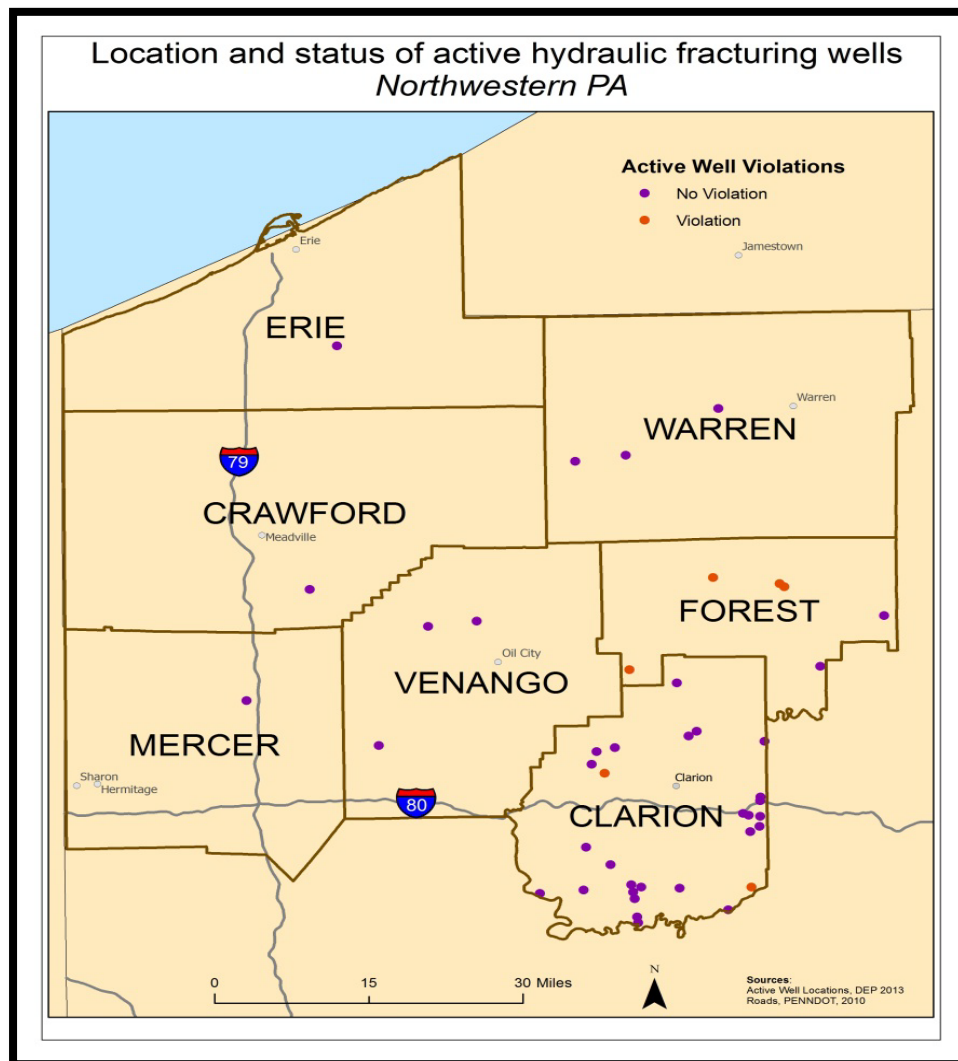


Figure 1. Displays NW PA counties with the location and status of the active wells. Data was accessed 4/14/13 (Koebley, 2013).

Three Most Active Operators in Pennsylvania

Company	Number of Active Wells	Number of Violations
Chesapeake	1,355	380
Range Resources	885	129
Talisman Energy	793	304

Severe Violations

Catalyst Energy paid 185,000 for contaminating 14 residential drinking supplies in Forest County. DEP inspections found that Catalyst did not install controls to prevent sediment runoff. State regulators say the company also caused oil and fluid leaks at sites in Forest, Warren and McKean counties.

There has been natural gas development and hydraulic fracturing in each county in our study area. Clarion, Crawford, Mercer, Venango, Erie and Warren Counties have relatively few wells and can be described as experimenting with the process. Forest County has been the most active in terms of wells drilled, it is also leads these counties in violations. These have largely been related to water resource contamination. Catalyst Energy Company is associated with these problems, and counties in the study area have responded to this groundwater contamination with skepticism towards gas development. In 2012, local citizens in Warren County combated a proposal to allow deep-water disposal injection wells, which the EPA has denied pending further investigation (State Impact, 2013).

The Complexity of Hydraulic Fracking

Fracking has drawn the ire of many people in northwestern Pennsylvania. In addition, many residents are making the choice whether or not to lease their land. Where many residents and key decision-makers find themselves is caught in that uncomfortable region in the middle of a cost-benefit analysis. There are potential risks and benefits that must be considered carefully by each individual and family.

BENEFITS

- Abundant energy source
- Lower energy costs
- USA energy source
- Financial gain
- Stimulates economy (local and global)
- Employment opportunities
- Emits less greenhouse gases than other fossil fuels

RISKS

- Methane leaks
- Water contamination
- Weakens community structure
- Distraction from pursuing renewable energies
- Uses vast amounts of water laced with toxic chemicals
- Negative environmental impacts
- Negative human health impacts

Technology

Hydraulic fracturing is a technology used to stimulate oil and gas wells and maximize the amount of gas collected from any one well. It is done through the use of water and various chemicals to create cracks in the rock near a drilled well deep under the earth, allowing the gas in the shale to escape to the surface through the well, where it is collected. Precautions are taken to ensure the drilling process is safe for the both humans and the environment. The entire process can be broken-down into three phases, explained below.

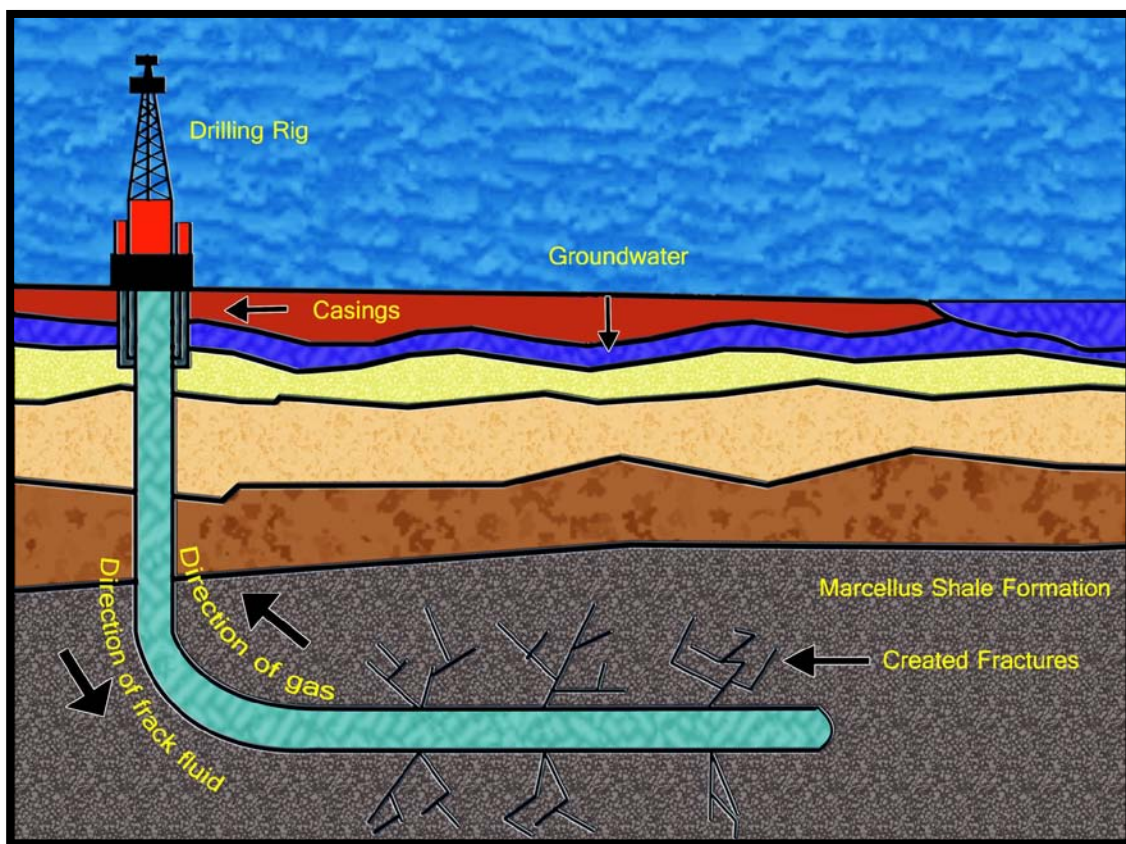


Figure 2. Underground View of Fracking (Britt, 2013)

Phase 1: Pre-Site Selection & Preparation

- o Permission is obtained from the owner of the mineral rights in the testing area, and permits for the use of seismic equipment are acquired.
- o Site is examined by geophysicists, who ensure proper placement of the equipment and use flags to mark the designated spots.
- o Placement of seismic equipment: geophones are placed approximately 165 feet apart, and remote seismic recorders are placed on the ground, connected to the geophones, to monitor signals given by the geophones (geophones read vibrations in the earth to determine what is underground).
- o During seismic testing, “thumper” trucks drive through the area and periodically place a vibrating device on the ground, sending sound waves through the earth. This is detected by the geophones once the vibration is reflected back to the surface, and the information is gathered by the remote seismic recorders. The information is then transferred to the recorder vehicle, which converts the data into a three-dimensional map.
- o The testing equipment is removed.

Phase 2: Drilling

As gas companies drill the well, they install a series of steel and cement layers to protect surrounding formations. In the upper part of the well, layers of steel and cement are also installed. This creates a barrier between the well and groundwater. Most casings are put even deeper in the well to isolate natural gas formations.

Drilling Steps

1. Casing (metal tubing) for the well is inserted to depths between 1,000 and 4,000 feet before continuing to drill deeper.
2. Cement is used to fill the space between the parts of the well casing and the well to prevent any leakage of fracking fluid or oil/gas.

3. Drilling continues after the cement solidifies to avoid further problems and prevent the risk of the casing being damaged.
4. Drilling is stopped at subsequent depth points, and more casing is added further down.
5. The process is repeated until the well reaches the oil or gas reservoir underground.
6. After these precautions are taken and the well is properly constructed, high volumes of fracturing fluids called *slickwater* are pumped into the well at pressures great enough to create or expand small fractures in the rock to release the oil or gas. However, all of the methods are similar, with the greatest differences being the exact order of actions as well as the chemicals used.

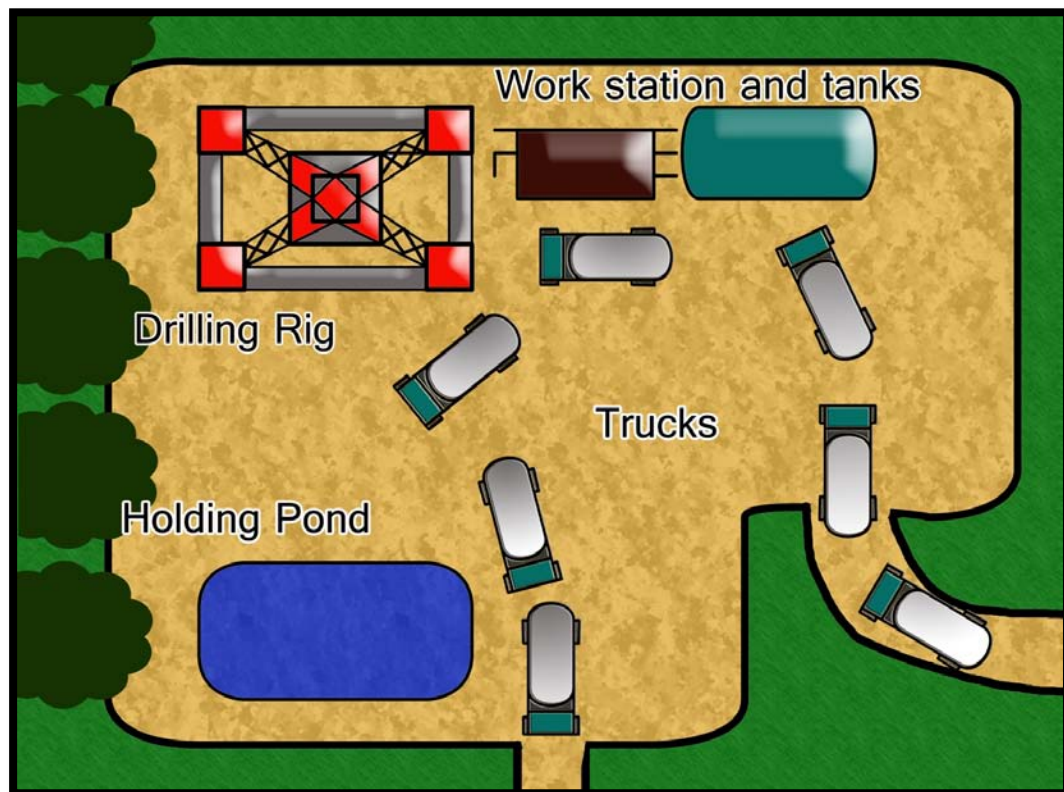


Figure 3. Aerial View of Drilling Site (Britt, 2013)

7. **The acid stage**, where several thousand gallons of water, mixed with dilute acid (hydrochloric or muriatic) is pumped into the well to clear cement debris in the well, provide an open conduit for other fracturing fluids, and opens fractures near the central well.
8. **A “pad” stage**. The well-pad is most commonly 5 acres consisting of a flat area where the well is located surrounded by the equipment and supplies needed to drill using approximately 100,000 gallons of *slickwater* with no proppant material, opening the fractured formation and helping to increase the flow of the oil or gas and fracturing fluids. **Slickwater** is fracturing fluid comprised mostly of water and sand (99.5% water/sand), and is also known as slurry. Additional chemicals are added to the slickwater to reduce friction, corrosion, bacterial growth, or provide other benefits.
9. **A “prop sequence” stage**, possibly consisting of several substages of adding water and proppant material, which are substances used to maintain, create, or expand fractures, such as fine mesh sand or ceramic, in order to keep the created fractures open or to expand them after the initial pressures used to create the fractures subside. This stage may end up using several hundred thousand gallons of water.
10. **A flushing stage**, where fresh water is injected into the well in order to flush any excess proppant from the well.

Phase 3: Extraction

- o Following the drilling, a wellhead is put at the top of the piping. This wellhead is called a *Christmas tree*. The **Christmas tree** is often six feet tall. It contains tubes and valves that monitor the flow of the natural gas and other well fluids into the pipeline. It gets its name from the many branches of piping that are similar to branches of a Christmas tree.
- o The **wellhead** is at the surface of the wellbore that manages the flow of the natural gas extraction. It is also what the Christmas tree mounts to for flow control and to help prevent blowouts. The upper casing head provides a heavy seal between the casing and the surface, and it also provides support for the entire length of casing that is present in the well. The tubing head provides a heavy seal, but between the tubing running inside the casing and the surface.
- o Natural gas flows from the fractures in the shale into the pipe and to the surface. When the slickwater comes back to the surface, sand grains or ceramic pellets remain in the fractures, which holds them open so that pressurized gas can escape and rise to the surface of the well.
- o Produced water, the water which is collected during the flowback process and throughout the life of the well, is properly disposed of or treated and re-used in the next hydraulic fracturing operation.
- o **Wastewaters** from the hydraulic fracturing process may be disposed in several ways. For example, the flowback water following fracturing may be returned underground using a permitted underground injection well (which disposes of the water underground), discharged to surface waters after treatment to remove contaminants (such as in waste water reservoirs), or applied to land surfaces (which involves simply placing the water on the ground).
- o Not all fracturing fluids injected into the shale during hydraulic fracturing are recovered. Estimates of the fluids recovered range from 15-80% of the volume injected depending on the site. Some companies reuse flowback to hydraulically fracture more than one well as a way of conserving water and recycling the fluids.

Legislative & Legal Dimensions

Negotiating A Lease

You have a say in what goes into the lease. You do not have to simply accept what the gas company is offering you - you can negotiate with them to ensure the most safety for your land and your family. For example, you can:

- Tell the company to not drill within a specific proximity to your water well.
- State that the company must clean up any damage to your property and/or pay you back for these damages.
- Indicate that the company cannot have free access water sources on your property.

These are just a few examples of what you can include in your lease. It is your land, so it is your right to tell the drilling company what they can and cannot do. Their default is to do everything that is best for them, so it is important that you counter their proposals with what is best for you.

If you are offered a lease for drilling on your land, it will contain a lot of legal words and phrases that are unfamiliar to most people who have not studied law. If you can afford it, it is ideal to hire a lawyer to read through the lease with you and tell you exactly how the terms of the lease would impact you.

Attorneys vary in cost, so it is best to contact different lawyers and inquire about price. Some may agree to help you for less if you will definitely sign a lease in the end. Additionally, there may be lawyers at your local bar association willing to help you at a reduced price or even for free.

Below is a list written by Voss Law Firm (2013) of the eight tips that they give to landowners who are considering a lease:

1. You don't have to accept a lease right away.
2. Don't be quick to sign.
3. Avoid saying "I'm not interested."
4. Don't spend your money too soon.
5. Don't warrant.
6. Don't lease multiple non-contiguous tracts.
7. There's time to be silent while you figure out your opinion.
8. Beware "unrestricted use of fresh water."

Your Land and Your Rights

The land you own has different kinds of rights attached to it, and how much say you have over certain parts of your property are different depending on which rights you possess.

*It is **important to know** that when you sign a lease with a gas company, you turn over some or all of these rights for the length of the lease to the gas company itself.*

A **split estate** is when you own one or more of the following rights but another party owns the third. For example, if you have land rights to the land where your house is and water rights to use the stream that runs through your property, but not mineral rights. Then, if a gas company acquires your mineral rights, they may be able to drill under your property even if you don't want them to.

The different kinds of rights include:

- **Land rights:** the rights you have to own your land and use it, allow others to use it, or exclude others from using it.
- **Water rights:** rights to a body of water.
 - o 4 Classifications: surface water (streams and lakes), diffused surface water, ground water in subterranean streams, and percolating ground waters.

- o The Department of Environmental Protection (DEP) regulates all water used for drilling in Pennsylvania. Drilling companies must identify the water sources from which they will obtain the water their process requires.
- o In Pennsylvania, gas wells cannot be drilled within 200 feet of structures, water wells and/or freshwater springs. Wells also cannot be drilled within 100 feet of streams or wetlands. In some circumstances, waivers can allow companies to drill inside of these limits with protective measures.
- o The DEP states that flowback liquid from hydraulic fracturing must be treated at a plant until there are only 500 parts per million of substances other than water (sand, chemicals, etc.) in the fluid. There is currently one facility in Pennsylvania that is capable of meeting this standard (DEP).
- **Mineral rights:** the right to extract a mineral from the earth or to receive payment in the form of royalty from the extraction of minerals (such as metals, coal, natural gas, gemstones, dimension stone and salt).
 - o Some citizens own the right to only one kind of mineral (such as oil or gas) and to only one geological formation or depth, and some landowners have the rights to everything underground; it varies on a case to case basis.

Glossary of Common Lease Terms

Delay Rental Free	Annual payment to landowner (usually on a per acre basis) prior to a well being drilled
Free Gas	Annual allocation of gas to landowner for domestic heating purposes
Initial Term Lease Length	Length of lease in years (typically 2-4 years)
Locating Equipment	Property owner must approve, in advance, the location of the well pad and related equipment, access roads and pipelines. Additionally, the lease should prohibit the installation of a compressor facility on the property
Loss of timber or crops	Lessee is responsible to pay property owner for value of any timber cut or crops destroyed by the drilling operations. An alternative is to provide that the property owner may retain the cut timber and then seek to sell it; however, the lessee should be responsible for assembling and stacking the cut timber
Paid-up Lease Payment	Advance rental payment securing energy companies initial lease term
Real Estate Taxation	For tax exempt property, the lease should provide that the lessee is responsible for any real estate taxes in the event that the property loses its tax exempt status due to the oil and gas lease
Royalty	Amount of production received by the landowner (usually 12.5% of sales from the well)
Secondary Term Lease Length	Length of lease after the well is drilled (usually as long as the well is in production)
Shut-in Royalty	Payment received in lieu of a production royalty when a well can't be produced due to production problems
Spilt Estate	Own the land on the surface but not the resources underneath
Storage	Lease should provide that the lessee has no rights to use the property for storage (Whether underground or on the surface) , except for temporary storage of brine water at the time the well is installed
Termination	End of lease due to expiration of primary term or when production ceases and well is plugged
Unitization	Provision that allows property owner's land to be combined with adjoining land to form a drilling unit
Upfront Cash Bonus	Compensation for allowing the well to be located on the owner's land

Citizen Science

Citizen science is a way in which curious or concerned citizens are able to conduct their own data collection and are able to make their own scientific observations about the world around them. Some examples of citizen science projects include: helping professional scientific projects collect data, noticing and recording seasonal changes in deer population, or simply observing changes that occur to the land by or near your home. Citizen science is meant to be interactive, family-oriented, and a way for local people to make their own scientific judgments instead of having to be told what is happening by outsiders.

The Pennsylvania state offices do not have enough field agents to directly monitor all of the land in water in fracked regions. Citizens can be active in monitoring the impacts of fracking in their neighborhoods. Everyone can be a citizen scientist regardless of their educational background. All you need is to be aware of the changes occurring in your local surroundings.

We have included two easy worksheets on pages 23—24 that can help you monitor those changes. They are fun and anyone can participate!!

References

American Petroleum Institute. (10, 21 11). Overview of industry guidance/ best practices on hydraulic fracturing(hf).

Associated Press (2012) "Experts: Some fracking critics use bad science". Associated Press.

Brzycki, Elaine. "Explore Shale." ExploreShale.org. Penn State Public Broadcasting, 2011. Web 17 Apr. 2013.

Eichler, A. (April, 19 2013). Pennsylvania fracking: A history of shale gas drilling, as told by the people who live there.

Environmental Protection Agency (2007) "Natural Gas". EPA.

Gushard, K. (2012). "States gas boom comes to town with first Utica Shale well in county". Meadville Tribune.

"How Is Natural Gas Formed?" Baftechnologies.com. BAF: A Clean Energy Company, 2012. Web. 17 Apr. 2013.

King, H. (2012). Utica Shale – The Natural Gas Giant Below the Marcellus?" Geology.com.

Roberts, G. (February, 26 2011). Extracting natural gas from rock.

Schmidt CW, (2011). Blind Rush? Shale Gas Boom Proceeds Amid Human Health Questions. Environmental Health Perspectives 119(8).

State Impact Pennsylvania. Ed. Lynette Clemetson. NPR, Web.

U.S. Census Bureau. 2010. American Fact Finder. Income, Poverty Data, and Household size.

Voss Law Firm. 2013. Top Ten Mineral Lease Mistakes: Negotiating Oil and Gas Leases.

Yost, A. (2011). "Research Plan for Utica Shale Characterization and Development". National Energy echnology Laboratory. Accessed from: <http://www.pttc.org/>

Scorecard

Included on the next two pages is a checklist/score card for observations of potential disturbances due to hydraulic fracturing. It is intended for use by the general public and you do not need to be a scientist to use this form.

- *Scorecard* for observations related to hydraulic fracturing
 - Visual observations
 - Any disturbance with the access road drainage
 - Water observations
 - Gas bubbling from a pool, puddle, or stream
 - Observed changes in health
- Additional tips
 - Keep notes
 - Stay organized
 - Take pictures
 - Reach out to local councilmen or news outlets.
 - Talk to your neighbors
- Where to report findings:
 - For severe cases, report the violation to the EPA (<http://www.epa.gov/tips/>).
 - For slight difference in observations, refer to FracTracker (<http://www.fractracker.org/>) and Trout Unlimited to report results online.

Property with a stream or other moving water source:

If you are concerned about water contamination and would like to monitor your own stream, contact Creek Connections, located on Allegheny's campus in Meadville, PA at 814-332-5351. Additionally, the Dickinson College Department of Environmental Studies created the ALLARM program in which results can be directed to. This program provides a more in depth scorecard and description in which communities can monitor, protect and restore local waterway.

Score Card- Please fill out this form bi-monthly

Name: _____

Phone Number: _____

Date: _____

Location: _____

Address: _____

City, Zip Code: _____

Checklist for Visual Observations: Check all that apply

Earth Disturbance Access Road:

- ☐ Mud/sediment on Township / State Road that access road enters
- ☐ Mud/sediment entering public road ditch from site
- ☐ Access road to site not stabilized with clean gravel
- ☐ Access road crosses stream with access road drainage directly emptying into stream
- ☐ Access road carrying drainage from site directly to road ditch or stream
- ☐ Road banks not stabilized with mulch, seeding, vegetation, etc.
- ☐ Additional Comments:

Pad/Storage Pond/Staging Areas:

- ☐ Earth disturbance to edge of water body with no controls to stop or filter
- ☐ Clean water entering site from uphill (no diversion ditch)
- ☐ Outlets of sediment control structures go directly to water body without filtering/cleaning
- ☐ Diversion ditch
- ☐ Sediment pond
- ☐ Road drainage
- ☐ Silt barrier (fence, hay bales, tubes, etc.)
- ☐ Soil stockpile areas not stabilized if open longer than 20 days
- ☐ Outlets of ditches, sediment control structures, etc. are not stabilized and are causing erosion
- ☐ Additional Comments:

Receiving Streams:

- ☐ Visual evidence of sediment entering stream, pond, wetland or other body of water
 - ☐ Sediment plume
 - ☐ Discolored water
 - ☐ Increased sediment deposition on the stream bottom spills and Discharges
 - ☐ Unusual odor in water
 - ☐ Persistent foam or bubbles in absence of high level of agitation
 - ☐ Dead fish or other organisms in the water or along the bank
 - ☐ Discolored water, especially an oily film on the water surface
 - ☐ Increased bank erosion (may indicate a high water event)
 - ☐ Additional Comments:
-
-
-
-

Water Withdrawal

- ☐ Water hoses in or adjacent to stream
 - ☐ Unusually low flow in the stream not related to drought conditions
 - ☐ Trucks parked beside streams where there are no signs posted that it is a withdrawal area.
- Gas Migration or Leakage
- ☐ Gas bubbling from a pool, puddle, or stream
 - ☐ Odor due to mercaptan compounds
 - ☐ Additional Comments:
-
-
-
-
-

