CHAPTER II

A BRIEF HISTORY OF NATURAL GAS DRILLING AND THE HYDRAULIC FRACTURING PROCESS

Hydraulic fracturing is the *"propagation of fractures in a rock layer as a result of the action of pressurized fluid*."[1] Gas companies use induced hydraulic fracturing as a technique for releasing natural gas from rocks such as the Marcellus shale. The rock fracturing takes place after a well bore is drilled into a gas bearing formation. Then water, chemicals, and proppants are forced down the well bore, under high pressure, into surrounding rock, which in turn fractures the rock and releases the gas.

The first gas well drilled in NYS was in Fredonia, in 1821. Workers drilled this early, shallow well at a naturally occurring gas seep in the Canadaway Creek bed. This and other wells of the time were drilled vertically.[2]

The concept of fracturing rock to extract oil and gas is a fairly old process dating back to the 1860s. When first introduced as a drilling process for obtaining oil and gas from hard rock formations, workers used nitroglycerin to crack or fracture the rocks to improve production.[3]

The use of vertical hydraulic fracturing to increase production was developed by gas companies around 1947 when Stanolind Oil and Gas Corporation used it as an experimental technique. In 1949, The Halliburton Oil Well Cementing Company received a patent for the "hydrafrac" process which they first used in 1949 on Texas and Oklahoma gas wells.[4] Since taking those first steps with the process, gas companies have used it to drill thousands of wells throughout the United States. From 1949 through 1997, wells were vertically fracked. During the 1980s to 1990s, gel fracturing fluids were developed and used in vertically fracked wells.[5] By 1997, gas companies had developed a new method for extracting larger volumes of gas from shale plays using a combination of vertical and horizontal drilling, huge amounts of water, and a dramatic increase in chemicals. In 1989, the first single pad, horizontal gas well drilled in New York State was in the Black River Herkimer formations.[6]

While the original vertical wells were just a few hundred feet deep, today's horizontally drilled wells are many thousands of feet deep. Gas companies have also moved from using about 750 gallons of fluids and 400 pounds of proppant [7] per well to 4.5 million and more

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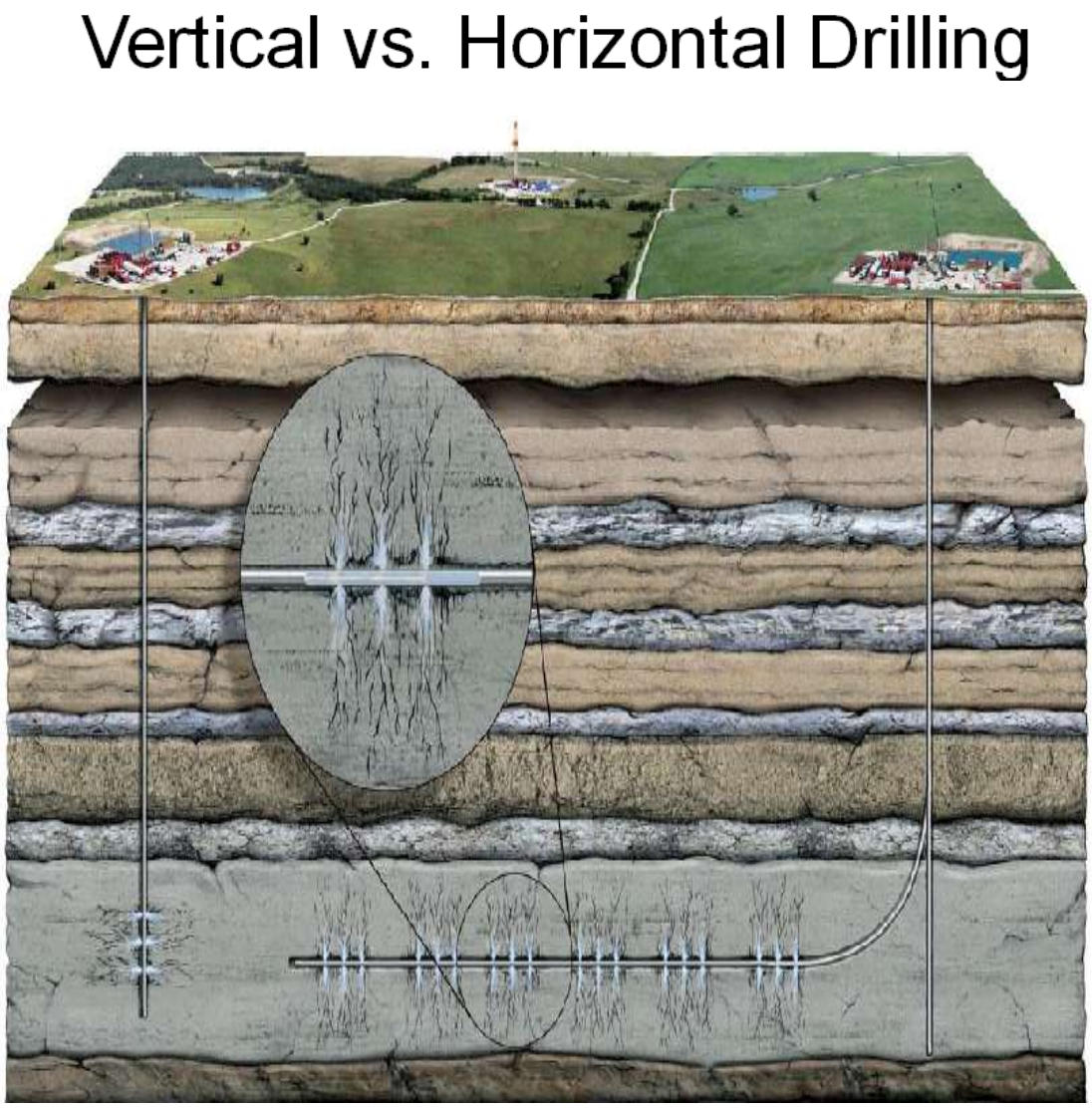
[1] "Hydraulic Fracturing," Wikipedia.com.
[2] GEIS, 1992, Chapter 5.
[3] Hines, D., "How Long has Hydraulic Fracturing Been Practiced?" Institute for Energy and Environmental Research of Northeastern Pennsylvania Clearinghouse website, March 15, 2011.
[4] Hines, D., "How Long Has Hydraulic Fracturing Been Practiced?"
[5] dSGEIS, September, 2011, Chapter 5, p. 5-5.
[6] dSGEIS, September 2011, Chapter 5, pp. 5-52.
[7] A *"proppant"* is defined as grains of sand, ceramic or other particulates that prevent fractures from closing when the pressure of the fluid is stopped. (WIKIPEDIA, "Hydraulic Fracturing")

gallons of fluids (water and chemicals) and hundreds of thousands of pounds of sand or other proppant per well.[8]

The newer process, high volume hydraulic fracturing, (HVHF) has been employed as a commercial drilling technique just since 1997. It was initially used in the Barnett shale, in Texas, and then first used in the Marcellus shale in 2004, West Virginia. High volume hydraulic fracturing, then, is still very new.

The figure below graphically demonstrates differences between vertical and horizontal drilling and hydraulic fracturing.



(Drilling and Developing the Marcellus Shale, Independent Oil & Gas Association of Pennsylvania, Pennsylvania State Association of Township Supervisors Annual Meeting, Hershey, Pa, May 12, 2008.)

[8] Chesapeake Energy Company, 2011. "Hydraulic Fracturing," Chesapeake Energy website. http://www.chk.com/Media/Marcellus/Media KitsMarcellus_Hydraulic Fracturing Fact Sheet.pdf.

The chart directly below explains differences between vertical hydraulic fracturing and high volume hydraulic fracturing.

VERTICAL HYDRAULIC FRACTURING vs. HIGH VOLUME HYDRAULIC FRACTURING

COMPARISONS	VERTICAL HYDRAULIC FRACTURING	HIGH VOLUME[9] HYDRAULIC FRACTURING
When Developed	Late 1940s (one vertical shaft per well)[10]	HVHF (a vertical and a horizontal shaft) developed in the late 1990s with slickwater fracturing fluids introduced in 1997[11]
Technology first developed	Late 1940s	1991- first horizontal well, Barnett Shale, Texas 2002 – multi stage slickwater fracturing of horizontal wells[12]
Agents Used	1980s to 90s: Cross-linked gel fracturing fluids developed and used.[13]	1996: "slickwater"[14] fracking fluids introduced.[15].
Gallons of Water Used in Each Well	20,000 – 80,000[16]	2,400,000 to 7,800,000[17]
Amount of Chemicals Used for Each Well Fracking	About 700 – 2,800 pounds[18]	About 205,000 to 935,000 pounds[19]
Land Area Used and acreage Disturbed	One well per 40 acres; 4.8 acres disturbed	One multi-well pad per 640 acres; 7.4 acres disturbed per well pad[20]

[9] dSGEIS, September, 2009, Chapter 5, p. 33.
[10] Halliburton.com
[11] dSGEIS, September, 2011, Chapter 5, p. 5.
[12] Ibid.
[13] Ibid.
[14] *"Slickwater"* refers to a water based fracturing fluid with chemicals (friction reducing agents) added to increase the fluid flow in a well. http://waytogo.com/wiki/index.php/Slickwater.
[15] dSGEIS, 2011, Chapter 5, p.5.
[16] GEIS, 1992, Chapter 9, p. 26.
[17] dSGEIS, September, 2011, Executive Summary, p.8.
[18] GIES, 1992, Chapter 9, pp.26-27.
[19] dSGEIS, September, 2011, Section 5.4.3, p.44.
[20] dSGEIS, September, 2011, Chapter 5, p.5.

One-Way Truck Trips Per Well	225 - 387	1979[21]
Cuttings For Disposal Produced Per Well	A 7,000 foot well produces about 125 cubic yards[22]	A 7,000 foot vertical and 4,000 foot horizontal shaft produce about 217 cubic yards[23]
Well Density	16 wells per sq. mile. Current most dense area in NYS: Chautauqua County at 3 wells per sq. mile	In the Marcellus shale, 1 well pad per sq. mile with 6 -10 wells per pad, and may be up to 16 wells per pad[24]
Volume of Chemicals in Well Shaft After Drilling	Estimated in one vertical shaft: 280 – 1,120 gallons	Estimated in one vertical shaft with a 4000 foot bore: about 43,680 – 102,000 gallons[25]
Casing Deterioration from Age and Exposure	Identified in wells[26]	There was no cumulative impact study included in dSGEIS.
Height of Drilling Rigs Height of Drilling Rigs (cont.)	40 – 45 feet high for singles and 70 – to 80 feet high for doubles[27]	100 – 170 feet high, with multiple rigs present at a well pad at one time[28]

The differences demonstrated in the above chart between vertical hydraulic fracturing and high volume hydraulic fracturing are numerous. As drilling in the United States has moved from west to east, questions have been raised about the impact such industrial activities have on the environment and people.

While gas companies claim the processes are safe, opponents point to the need for studies regarding both vertical and high volume drilling. Some of the major issues include the amount of water used, the number and kinds of chemicals used, truck traffic on local roads, waste disposal of cuttings, flowback, and brine, and impacts on drinking water, air quality, human health, the local economy, community character and the quality of life.

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[21] dSGEIS, September, 2011, Chapter 6, pp.302-303. NOTE: DEC Commissioner, Martens, admitted at a NYS Assembly hearing, October 6, 2011, that truck traffic figures had been underestimated by 300%.
[22] dSGEIS, September, 2009, Chapter 5, p.29.
[23] dSGEIS, September, 2009, Chapter 5, pp. 29-30.
[24] dSGEIS, September, 2011, Chapter 3, p. 3.
[25] dSGEIS, Figures from Executive Summary, p.8, Section 5.11.1.
[26] GEIS, 1992, Chapter 6. p.17.
[27] dSGEIS, Chapter 5, p 25.
[28] "Impacts on Community Character of Horizontal Drilling and High Volume Hydraulic Fracturing in the Marcellus Shale and Other Low Permeability Gas Reservoirs," NYSERDA General Reports, September 16, 2009, updated February 18, 2011, Chapter 5, p.18.