This column is presented weekly by the Public Education sub-committee of the Clinton County Natural Gas Task Force in an effort to provide accurate, up-to-date information on activities surrounding the Marcellus Shale formation and the natural gas exploration industry.

Welcome to the new "GasFacts: Understanding the Marcellus Shale Play" column. The Marcellus Shale is a rock formation 5,000-8,000 feet below surface of roughly 70% of Clinton County. Overall, the Marcellus Shale Play covers 95,000 square miles in portions of Pennsylvania, Maryland, West Virginia, Ohio, and New York and is estimated to contain up to 489 trillion cubic feet of natural gas making the Marcellus the largest natural gas field in the continental United States and one of the largest fields in the world (Engelder, 2009).

With the development of such a vast natural resource there will be opportunities for entrepreneurship, business development, family sustaining jobs, and substantial mineral leasing agreements. However, given the incredible scale of natural gas extraction techniques needed to develop unconventional shale, like the Marcellus, there are many concerns that have surfaced about a process called hydraulic fracturing or fracking, water quantity and quality, air quality, community impacts, and transportation.

Barring a radical shift in Pennsylvania state law or Federal policy, Marcellus Shale development will continue at an accelerated pace over the coming years. With the pace of development increasing, we as a community need to begin to raise the level of discussion about how we can take advantage of the opportunities, care for our communities, protect our values, and preserve our environment. To help facilitate quality discussion about Marcellus Shale opportunities and challenges the "Understanding the Marcellus Shale Play" column will strive to provide accurate, timely, and fact-based information about a variety of natural gas development topics.

As we begin, it is important to understand how the Marcellus development occurs and where development stands today. Drilling for natural gas in the Marcellus Shale is very complex and requires several steps. Actually to complete a single well will require 20-40 different contractors and portions of time from more than 410+ different people across 150+ occupations equaling between 11.53 and nearly 14 full time equivalent jobs per well (MSETC, 2009). A much abbreviated version of the steps to develop a well includes leasing, permitting, well pad construction, drilling, hydraulic fracturing, and production.

Roughly two-thirds of Pennsylvania contains some Marcellus Shale; however, portions of 30 counties are located in what is known as the Marcellus Fairway or the prime area of interest for Marcellus development. Currently the highest interest areas on the fairway are in the northern tier and southwestern PA where the shale is believed to be the most productive. Leasing activity in these areas has brought some mineral owner group's agreements in excess of $5,000 per acre and 18¾% royalty stake in future wells. Lease rates in Clinton County have varied greatly but in general seem to hover between $1,000 and $2,500 per acre for bonus payments and 15% royalty rates. It is never a good idea to base your lease agreement on general assumptions; mineral owners should always consult an attorney to help craft a good lease that will represent the owner's best interest.

After leasing, a variety of permits for erosion and sedimentation, water impoundments, drilling, etc… are required to drill a Marcellus Well. All natural gas drilling in Pennsylvania is regulated by the Pennsylvania Oil and Gas Law. All Pennsylvania drilling activity requires a permit, which is issued by the Pennsylvania Department of Environmental Protection (DEP). The number of Marcellus drilling permits issued in the state as of August 20, 2010 topped 1,977, only eight fewer than all of 2009. Clinton County is on a slightly higher permit pace than 2009 with 34 permits being issued so far in 2010, or just seven fewer than all of 2009.

Once all the appropriate permits have been secured, well pad construction begins. Well pads are about five acres in size or about the size of 2½ to 3½ football fields. A well pad generally serves a drilling block of 500 to 1,000 acres. The predominant practice in Pennsylvania has been for energy companies to drill more than one well per pad, which greatly reduces the footprint of drilling operations. Reports from the field indicate the current practice of energy companies is to drill four to 10 wells per pad. Early rough estimates for Clinton County are for 464-580 well pads containing 2,782-4,636 wells.

After construction of the well pad, a drilling rig will move in. The modern drilling rig is very large and very powerful. A single drilling rig can take 50-65 tractor trailers to move and will stand well over 100 feet tall. Most Marcellus Shale wells are drilled down vertically 5,000 to 8,000 feet and then horizontally between 3,000 to 5,000 feet on average. To drill vertically then horizontally, the drilling rigs use a special bit to gradually turn the drilling pipe over about 1,000 vertical feet. Currently in Pennsylvania there are 89 drilling rigs operating, up more than 71% from the same time last year. One drilling rig will drill between 8-12 wells per year. At the peak in June and July, Clinton County had three rigs operating. So far this year 827 Marcellus wells have been drilled in Pennsylvania, up more than 14% over all of 2009. Bradford County has the most wells drilled in 2010 with 225. Clinton County has 17 wells drilled so far in 2010, up more than 41% from last year.

After drilling, the energy companies will use a process called hydraulic fracturing or fracking to stimulate natural gas production. Fracking involves the use of 3-6 million gallons of water and roughly five groups of chemicals are used to fracture the shale and release the natural gas. Water withdrawals in much of Pennsylvania are permitted by the Susquehanna River Basin Commission (SRBC). During the well stimulation phase people generally notice a large increase in truck traffic hauling equipment, water, sand, and chemicals. Convoys of more than 35+ trucks have been reported on several local roads. Fracking generally takes just a few days per well. Immediately following fracking, the first signs of a successful well appear with a natural gas fire called a flare. A flare is normal and is used to determine the initial daily flow of a well and to provide for the safety of the production crew while the well is brought on-line. After fracking roughly 25% of the water used will come out of the well in what is called flow-back water. Over the life of the well perhaps 40-50% of the water used in fracking will come back out of the well in the form of flow-back or production water. Much of the current debate about fracking stems from the treatment/disposal of flow-back and production water and the level of risk for ground water. To help find where the facts are about fracking, the Federal Environmental Protection Agency (EPA) is currently undertaking a study to review unconventional shale fracking practices and the current fracking exemptions in the Safe Drinking Water Act.

Finally, after all the equipment is removed and a permanent well head or Christmas tree is installed, the focus turns to natural gas production. Although official production data is not yet available, early reports suggest initial daily flow from most Marcellus wells is in excess of several million cubic feet per day or enough natural gas produced in one day to provide the energy needs of more than 20+ homes for one year.

In order to bring natural gas to a home from the well, significant production infrastructure needs to be constructed. Natural gas infrastructure construction includes pipelines, compressor stations, natural gas storage areas, and in southwestern PA, processing facilities to remove other valuable energy sources including oil, heavy gasoline, propane, butane, ethane and more.

As I hope you can see from the outline above, there are several potential opportunities and potential challenges facing Pennsylvania around the issue of natural gas development. The goal of this column is to offer timely, accurate, and fact-based information to help form a positive discussion and constructive debate. In future articles we hope to explore the technical aspects of drilling and fracking, economic and workforce development opportunities, environmental concerns, potential community impact and opportunities, local initiatives, current legislation, and much more. For more information on Marcellus Shale point your web browser to naturalgas.psu.edu or marcellus.psu.edu.

Multi Well Marcellus Shale Pad

Marcellus Shale Drilling Rig

Well Fracking in the Barnett Shale, Texas

Jim Ladlee, Penn State Cooperative Extension