



Governor's Marcellus Shale Advisory Commission

Report

7/22/2011



Edwin Austin Abbey mural, State Capitol, Harrisburg

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Commonwealth of Pennsylvania

July 22, 2011

The Honorable Tom Corbett
Governor
Commonwealth of Pennsylvania
225 Main Capitol Building
Harrisburg, PA 17120

Dear Governor Corbett:

On behalf of the members of the Governor's Marcellus Shale Advisory Commission ("MSAC") and in accordance with Executive Order 2011-01, I am pleased to present you with this unanimously-adopted report containing recommendations to *"develop a comprehensive, strategic proposal for the responsible and environmentally sound development of Marcellus Shale."*

In establishing this commission, you rightly described the Marcellus Shale discovery as a natural resource deposit that rivals coal and oil. Since 2009, Pennsylvania has seen 72,000 new hires reported in natural gas and related industries with an average wage of \$73,000. These industries have paid more than \$1 billion in tax revenue to the state since last year. A Penn State University study estimates that by 2020 there may be 200,000 Pennsylvanians working in this industry.

This report represents the culmination of four months of work by MSAC members, including: five public, full-commission hearings; sixteen public working group meetings; more than 60 presentations; nearly 100 citizens testifying in person; and, over 600 emails and letters from the public. The commission also traveled as a group to Clinton and Lycoming counties to observe natural gas drilling to see first-hand how the industry is creating jobs in our state.

As you have often said, no amount of economic benefit would justify the degradation of our land, air or water. These recommendations contain tough, new measures aimed at protecting the Commonwealth's environment and conserving our precious natural resources. We also detail ways to promote the use of natural gas and its by-products to help maximize the economic potential of this resource. This industry needs workers with particular skills, so we offer ways to train Pennsylvania's workforce to meet these needs. There are also recommendations for training fire and emergency personnel to better respond to public safety issues. Finally, we provide recommendations for addressing the impacts of natural gas development on local communities across the state.

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You asked us to develop recommendations based on science, not emotion or desire for profit. I can tell you that the members took this charge seriously throughout our deliberations and worked hard to separate fact from fiction, understanding full well that the completion of this report represents only the first of many steps in this on-going process.

For decades, our national leaders have called for investing in clean, alternative-energy sources, like natural gas, to reduce our dependence on foreign oil. Pennsylvania has the opportunity to become a national leader in energy independence. As you have said, we must not lose this moment. We must get it right. These recommendations outline a plan to do just that.

Sincerely,

A handwritten signature in black ink that reads "Jim Cawley". The signature is written in a cursive, flowing style.

Jim Cawley
Lieutenant Governor

EXECUTIVE SUMMARY

PURPOSE, SCOPE & NEXT STEPS

Governor Tom Corbett has called the Marcellus Shale natural gas play an “economic cornerstone” of the Commonwealth’s recovery from the recession, which has impacted the nation over the past four years. The development of vast natural gas resources trapped beneath more than half of Pennsylvania has created tens of thousands of new jobs, generated billions of dollars in tax and lease revenues for the Commonwealth and its citizens, infused billions of additional dollars in bonus lease and royalty payments to landowners, and significantly expanded access to clean, affordable energy sources for residential, commercial and industrial customers.

Along with the economic and energy independence and security potential of the Marcellus Shale natural gas reserve comes a heightened awareness of and concern for Pennsylvania’s environment and the activity’s impact on other natural resources and local communities within the shale development regions. While the Commonwealth has an extensive history of oil and natural gas development, particularly in its western region, natural gas development is relatively new to regions such as the Northern Tier and northeastern Pennsylvania. Additionally, the size, scale and accelerated pace of development of the Marcellus Shale natural gas reserve is a new phenomenon for Pennsylvania. Advances in extraction technologies, such as horizontal and directional drilling, along with the refinement of hydraulic fracturing techniques used to stimulate the flow of natural gas from the Marcellus Shale formation, have raised questions among citizens across the Commonwealth and caused the Commonwealth to revisit and refine its current statutory and regulatory framework charged with overseeing this industry.

By assembling experts from within the environmental, conservation, state and local government, academic and natural gas industry communities, Governor Corbett has created the Marcellus Shale Advisory Commission and charged it to identify, prioritize and craft recommendations regarding the safe, efficient and environmentally responsible extraction and use of unconventional natural gas reserves in Pennsylvania.

As outlined in Executive Order 2011-01, the Commission undertook a broad review of a multitude of issues related to Marcellus Shale natural gas development. The review included examining and recommending efforts to mitigate environmental impacts; fostering efforts to promote market development; developing a trained workforce; enhancing emergency response; identifying and mitigating uncompensated local and community impacts; providing for appropriate public health monitoring and analysis; and the responsible and efficient deployment of infrastructure.

In recognition of the tremendous breadth and scope of issues affected by Marcellus Shale natural gas, as well as the significant pace of technology and best management practice advancements occurring within the industry, the Commission strongly encourages Governor Corbett to consider creating a permanent advisory panel or committee to monitor the impacts of this industry, thoroughly investigate advancements in science, public health data and technology, and provide the Commonwealth’s elected officials, policymakers, regulators and members of the public with real-time information, analysis and recommendations regarding the safe, efficient and environmentally responsible extraction and use of unconventional natural gas reserves in Pennsylvania.

ACKNOWLEDGEMENT

The Governor's Marcellus Shale Advisory Commission acknowledges that there are now, and will continue to be into the future, additional shale and other unconventional geologic formations within the Commonwealth that will yield commercial quantities of natural gas. These formations include, but are not limited to, the Utica, Rhinestreet, Geneseo and Burkett. As such, the findings and recommendations of the Commission with respect to the Marcellus Shale should be considered generally applicable to other unconventional natural gas deposits.

1. BACKGROUND ON THE MARCELLUS SHALE ADVISORY COMMISSION

On March 8, 2011 Governor Tom Corbett issued Executive Order 2011-01, which formally created the Governor's Marcellus Shale Advisory Commission ("Commission"). Thirty individuals were appointed by Governor Corbett to serve on the Commission, and Lieutenant Governor Jim Cawley was designated to serve as the Commission's chairman. Under Executive Order 2011-01, a final report on the Commission's activities was to be submitted to the Governor on or before July 22, 2011. The Executive Order, as well as the term of service for each member of the Commission, expired on July 22, 2011. A copy of the Executive Order is located in Appendix A.



Lieutenant Governor Jim Cawley (center) opens a commission meeting.

Members of the Commission were chosen to represent, *inter alia*, interests among the environmental, conservation, industry, and local and state government communities. Each member was administered an oath of office, and received no compensation for their service other than reimbursement for reasonable travel and related expenses consistent with Commonwealth of Pennsylvania (Commonwealth) policy. The Pennsylvania Department of Environmental Protection (DEP) was designated as the lead agency to provide administrative and staff resources to support the activities of the Commission, while all agencies under the jurisdiction of the Governor were directed to cooperate and provide assistance to the Commission as needed.

Governor Corbett established the Commission in light of the following facts:

- Pennsylvania possesses abundant and diverse mineral resource fields, including the Marcellus Shale natural gas reserve, which is regarded as the second largest unconventional natural gas field in the world.¹
- Innovative technological advances in drilling, mining methods, equipment, and water protection and treatment have made it economically feasible to develop the Marcellus Shale and other unconventional natural gas reserves.
- The safe, efficient, and environmentally responsible development of the Marcellus Shale and other unconventional natural gas reserves is in the best economic and energy independence interest of the Commonwealth and its citizens.

¹ Considine, T., Watson, R., Blumsack, S. *The Economic Impacts of the Pennsylvania Marcellus Shale Gas Play: An*

- The Governor and the Commonwealth would benefit from the advice and recommendations of a diverse group of stakeholders committed to the responsible development of this resource.

Executive Order 2011-01 charged the Commission with the following duties:

- Conduct a complete review of existing and proposed statutes, legislation, regulation, and policies that regulate or affect Marcellus Shale natural gas development.
- Provide recommendations on the following:
 - Additional steps necessary to protect, conserve, and enhance the Commonwealth’s environment and natural resources and further mitigate impacts from development on the state’s air, land, and water resources.
 - Efforts necessary to promote the efficient, environmentally sound, and cost-effective development of Marcellus Shale and other unconventional natural gas resources.
 - Policies designed to encourage the end use of natural gas and natural gas byproducts.
 - Workforce development needs and opportunities.
 - Identifying, quantifying and recommending proposals to address the needs and impacts of natural gas development on local communities.

2. OVERVIEW OF THE COMMISSION PROCESS AND DELIBERATIONS

The Commission conducted five full meetings in 2011: March 25, April 27, May 20, June 17, and July 15. In addition, the Commission created four work groups that were charged with examining specific issues related to Marcellus Shale natural gas development. Each work group was comprised of seven members of the Commission, with the Lieutenant Governor and the Governor’s Energy Executive serving as ex-officio members. A chair and vice-chair were appointed to set agendas and guide the deliberations of each work group. Meetings of the Commission and work groups were advertised and open to the public. Agendas, testimony and other material presented at the Commission and work group meetings are posted on the Commission’s website (www.pa.gov, keywords “Marcellus Shale Advisory Commission”).



One of 60 experts who presented testimony to the commission during their four months of meetings.



Commission member Anthony S. Bartolomeo, Chairman of the Pennsylvania Environmental Council, participating in discussion.

Commission and work group meetings included public presentations by various subject matter experts, along with updates from chairs and vice chairs on the activities and deliberations of the respective work groups. The expertise, guidance, and professionalism of these individuals were critical in developing the recommendations presented in this report. The Commission extends great thanks to those individuals listed in Appendix B.

In addition, opportunities for the public to address members were offered at the conclusion of the Commission meetings.

Specifically, the following work groups were created to assist the full Commission in its deliberations:

PUBLIC HEALTH, SAFETY & ENVIRONMENTAL PROTECTION

Consideration of additional measures necessary to ensure the protection of the Commonwealth's environment and natural resources and the enhancement of public health and safety.

Michael Krancer, Secretary of Environmental Protection (chair)

Cynthia Carrow, Western Pennsylvania Conservancy (vice-chair)

Richard J. Allan, Secretary of Conservation and Natural Resources

Nicholas S. Haden, Vice President, Reserved Environmental Services

Ronald L. Ramsey, Senior Policy Advisor, the Nature Conservancy

Anthony S. Bartolomeo, Chairman, Pennsylvania Environmental Council

Jeffrey F. Kupfer, Senior Policy Advisor, Chevron

Ex Officio

** Lt. Governor Jim Cawley*

** Patrick Henderson, Governor's Energy Executive*

LOCAL IMPACTS & EMERGENCY RESPONSE

Identifying and quantifying the impacts on local communities from Marcellus Shale natural gas development, as well as opportunities to mitigate uncompensated impacts affecting county and municipal governments and citizens. In addition, examining and identifying steps necessary to ensure adequate training, resources and equipment are available to emergency first responders.

Glenn Cannon, Director, Pennsylvania Emergency Management Agency (chair)

Jeff Wheeland, Lycoming County Commissioner (vice-chair)

Terry R. Bossert, Vice President, Government & Regulatory Affairs, Chief Oil & Gas

Ray Walker, Chairman, Marcellus Shale Coalition

Clifford "Kip" Allen, President of the PA League of Cities and Municipalities

David Sanko, Executive Director of the PA State Association of Township Supervisors

George Greig, Secretary of Agriculture

Ex Officio

** Lt. Governor Jim Cawley*

** Patrick Henderson, Governor's Energy Executive*

INFRASTRUCTURE

Consideration of challenges and opportunities related to Marcellus Shale natural gas development, including road, bridge, rail, pipeline and other critical infrastructure necessary to the transmission, storage and use of natural gas. In addition, review of measures necessary to ensure the safe and reliable deployment of infrastructure, especially natural gas gathering and transmission pipelines and ensuring the sufficient availability of competent and qualified gas pipeline safety inspectors.

Barry Schoch, Secretary of Transportation (chair)
Christopher Masciantonio, U.S. Steel (vice chair)
Robert Powelson, Chairman, Pennsylvania Public Utility Commission
Gary Slagel, Chairman, PA Independent Oil & Gas Association
Christopher A. Helms, Executive Vice President & Group CEO, NiSource Gas Transmission and Storage
Matthew J. Ehrhart, PA Executive Director, Chesapeake Bay Foundation
Randy Smith, U.S. Government Affairs Manager, Exxon Mobil
Ex Officio
** Lt. Governor Jim Cawley*
** Patrick Henderson, Governor's Energy Executive*

ECONOMIC & WORKFORCE DEVELOPMENT

Identifying and quantifying the economic and labor impacts associated with Marcellus Shale natural gas development, including opportunities to further the end use of natural gas within the Commonwealth and measures necessary to develop and enhance markets in Pennsylvania. In addition, examining the workforce needs of both core and ancillary industries and determining how to deliver curriculum and training necessary to maximize employment opportunities for Pennsylvanians.

C. Alan Walker, Secretary of Community and Economic Development (chair)
Gene Barr, Vice President, Government & Public Affairs, Pennsylvania Chamber of Business and Industry (vice chair)
Vincent J. Matteo, President, Williamsport-Lycoming Chamber of Commerce
Terry Engelder, Professor of Geosciences, Penn State University
David Porges, Chief Executive Officer, EQT
James W. Felmlee, President of the PA State Association of Boroughs
Terry Pegula, Former President/CEO, East Resources
Ex Officio
** Lt. Governor Jim Cawley*
** Patrick Henderson. Governor's Energy Executive*

On May 31st and June 1st the Commission conducted a formal field visit to Lycoming and Clinton counties to visit with local residents, elected officials, business owners and others situated within the Marcellus Shale natural gas field. The field visit included touring an active drilling pad located within the Tiadaghton State Forest. In addition, it should be noted that many members of the Commission have extensive personal field experience regarding the development and impacts of natural gas drilling across the Commonwealth.



Commission Members tour a rig during their field visit

GOVERNOR'S MARCELLUS SHALE ADVISORY COMMISSION

Chair: Lieutenant Governor Jim Cawley

Commission Members:

Richard J. Allan, Secretary of Conservation and Natural Resources

Glenn Cannon, Director of Pennsylvania Emergency Management Agency

George Greig, Secretary of Agriculture

Patrick Henderson, the Governor's Energy Executive

Michael L. Krancer, Secretary of Environmental Protection

Robert Powelson, Chairman of the Pennsylvania Public Utility Commission

Barry Schoch, Secretary of Transportation

C. Alan Walker, Secretary of Community and Economic Development

Clifford "Kip" Allen, President of the PA League of Cities and Municipalities

Gene Barr, Vice President, Government & Public Affairs, Pennsylvania Chamber of Business and Industry

Anthony S. Bartolomeo, Chairman, Pennsylvania Environmental Council

Terry R. Bossert, Vice President, Government & Regulatory Affairs, Chief Oil & Gas

Cynthia Carrow, Vice President of Government & Community Relations, Western Pennsylvania Conservancy

Matthew J. Ehrhart, Executive Director of the Chesapeake Bay Foundation's Pennsylvania Office

Terry Engelder, Professor of Geosciences, Penn State University, Department of Geosciences

James W. Felmler, President of the PA State Association of Boroughs

Nicholas S. Haden, Vice President, Reserved Environmental Services

Christopher A. Helms, Executive Vice President & Group CEO, NiSource Gas Transmission and Storage

Jeffrey F. Kupfer, Senior Policy Advisor, Chevron

Christopher J. Masciantonio, General Manager, State Government Affairs, U.S. Steel

Vincent J. Matteo, President, Williamsport-Lycoming Chamber of Commerce

Terry Pegula, Former President and CEO, East Resources

David Porges, Chief Executive Officer, EQT

Ronald L. Ramsey, Senior Policy Advisor, the Nature Conservancy, Pennsylvania Chapter

David Sanko, Executive Director of the PA State Association of Township Supervisors

Gary Slagel, Chairman, PA Independent Oil & Gas Association

Randy Smith, U.S. Government Affairs Manager, Exxon Mobil

Ray Walker, Chairman, Marcellus Shale Coalition

Jeff Wheeland, Lycoming County Commissioner

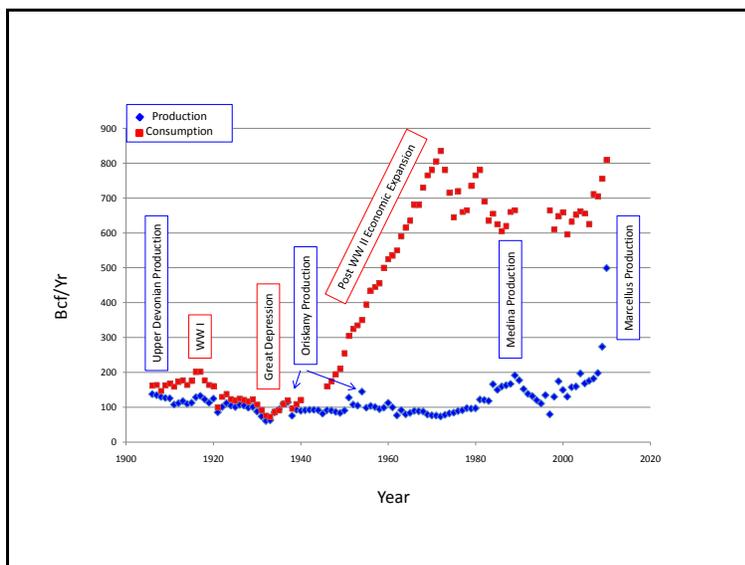
3. GEOLOGIC BACKGROUND ON THE MARCELLUS SHALE NATURAL GAS FIELD

Why the Marcellus Shale is Significant: The Geologic Basis

3.1 A BRIEF HISTORY OF GAS PRODUCTION IN THE COMMONWEALTH

The first natural gas well in North America dates from 1825 when non-associated (without oil) gas was collected from the bubbling Dunkirk/Huron black shale and piped to light street lamps in the village of Fredonia, New York. Pools producing non-associated gas were known in four Pennsylvania counties (Erie, Beaver, McKean, and Greene) within two years of the first North American oil well, drilled by Colonel Drake near Titusville in 1859.² Methane associated with oil production was first piped to market 13 years after the Drake well was drilled. Oil production increased dramatically in the Commonwealth until 1891. Although associated gas was a common byproduct for local delivery, inadequate long haul pipelines engendered drilling for non-associated gas in black shales with gas first produced from the Marcellus black shale near Naples, New York in 1880.³ By 1906 gas production had reached 130 billion cubic feet per year (Bcf/yr), principally from a combination of associated and non-associated gas pools in Upper Devonian strata (Fig. 1).⁴ Pennsylvania gas consumption had exceeded its production before 1906 and with the exception of two years during the Great Depression demand exceeded supply for more than a century.

Figure 1: Pennsylvania's Production vs. Consumption



- (1) Pennsylvania's annual gas production from 1906 to 2010 (blue diamonds) and annual consumption from 1946 to 2010. Units in billions of cubic feet (bcf/yr).
- (2) Sources for production data: Pennsylvania Bureau of Statistics (1944); 1945 to 1954 – Schanz (1957); 1955 to 1966 - DeGolyer and MacNaughton (1993); 1967 to 2009 – EIA (<http://www.eia.gov/dnav/ng/hist/n9010pa2a.htm>); 2010 - PA-DEP.
- (3) Sources of consumption data: 1946 to 1990 - Harper and Cozart (1992); 1997 to 2009 – EIA

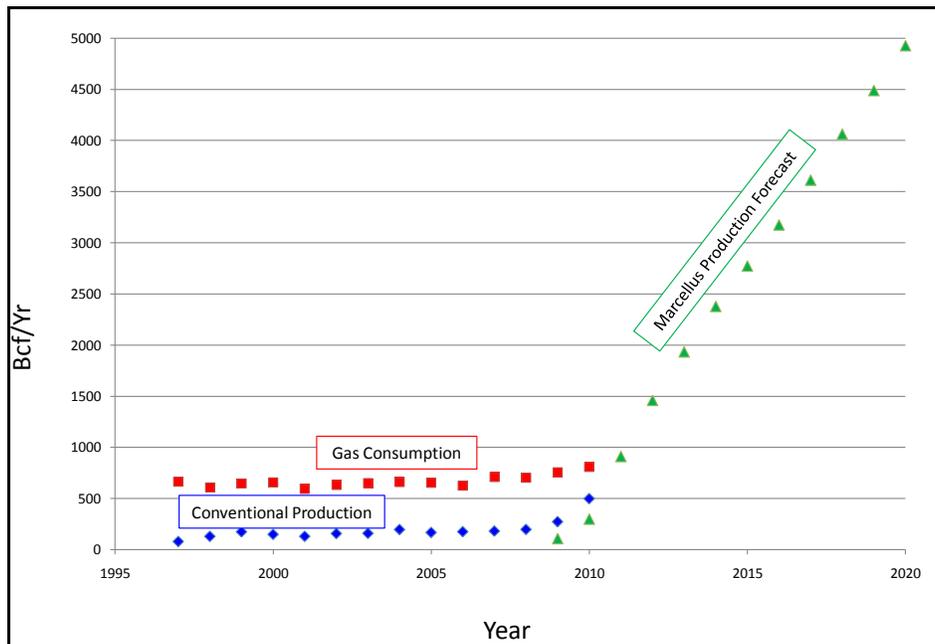
² Sisler, J.D., Ashley, G.H., Moyer, F.T., and Hickok, W.O., 1933, *Contributions to Oil and Gas Geology in western, Pennsylvania: Pennsylvania Geological Survey 4th Series*, Bulletin M 19, 84.

³ Van Tyne, A., 1983, *Natural Gas Potential of the Devonian Black Shales of New York: Northeastern Geology*, v. 5, 9-216.

⁴ Fettke, C.R., 1950, *Summarized Record of Deep Wells in Pennsylvania: Pennsylvania Geological Survey 4th Series*, Bulletin M 31, 148.

Throughout the entire 20th century production of the shallow sands such as the Devonian Vernango, Bradford, and Elk, proved to be a steady, but slowly dwindling supply of natural gas to the Commonwealth. In 1930, it was discovered that a deep sandstone, the Oriskany, was a prolific source for gas. These Oriskany fields possessed a high porosity and permeability with gas trapped below a cap of very low permeability seal rock, which ironically was the Marcellus black shale. The Oriskany gas boom lasted through World War II and into the early 1950s, making up for the dwindling supply of shallow gas (Fig. 1). From the Oriskany boom in the 1950s gas production slipped until production of a lower quality, deep sandstone reservoir, the Silurian Medina, had successfully expanded into northwestern Pennsylvania in the late 1970s (Fig. 1). A third, somewhat more difficult conventional gas reservoir was developed in the Ordovician Trenton-Black River limestones during the 1990s. In the latter part of the 20th century, the Ohio gas shale in Erie County was also of interest although economic production was dependent on identifying prospects of unusually large fracture density. Then, along came production from the Marcellus Shale starting in 2008. After just three years of production, gas from the Marcellus Shale will allow Pennsylvania to supply its entire demand for the first time in more than a century (Fig. 2).

Figure 2: Pennsylvania’s Forecast for Natural Gas Production



- (1) Pennsylvania’s annual gas production in from 1997 to 2010 (blue diamonds), annual consumption from 1997 to 2010 and forecast for natural gas production through 2020 (green triangles). Units in billions of cubic feet (bcf/yr).
- (2) Sources for production data: 1997 to 2009 – EIA (<http://www.eia.gov/dnav/ng/hist/n9010pa2a.htm>); 2010 DEP.
- (3) Sources of consumption data: 1997 to 2009 – EIA (http://www.eia.gov/dnav/ng/hist/na1490_spa_2a.htm). Forecast: Considine et al., 2010.

3.2 HYDRAULIC FRACTURING AND THE PRODUCTION OF GAS IN THE APPALACHIAN BASIN

The most important factor that assures economic production from both low-permeability sandstone reservoirs such as the Medina Formation and gas shales such as the Marcellus is hydraulic fracturing, a technique that arrived in Pennsylvania more than a half century ago (Fig. 3).

Figure 3: Demonstration of Hydraulic Fracturing

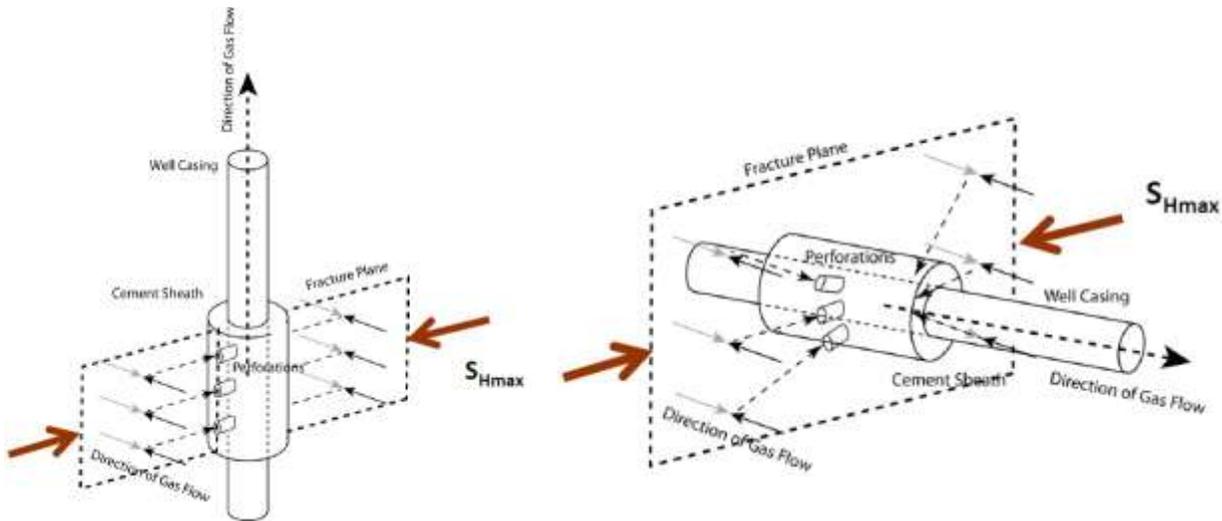
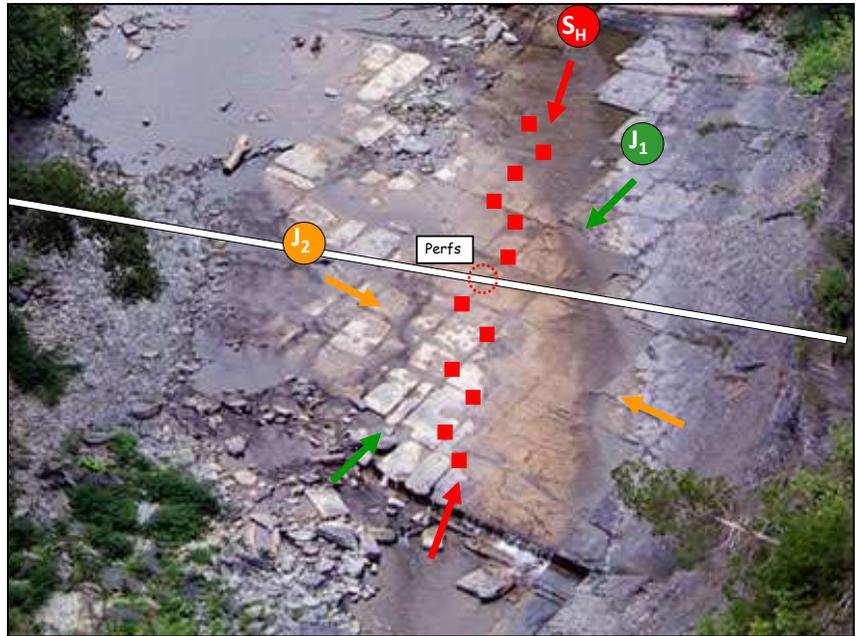


Figure 3 demonstrates hydraulic fracturing. The fracture propagates toward the maximum horizontal stress (S_{Hmax}) and vertical growth of the fracture is often contained between confining layers.

Hydraulic fracturing is a natural process in the earth where high pressure fluids (e.g., methane, water, or magma) split rock because the pressure of the fluid exceeds earth stress. Natural hydraulic fractures in gas shale are common throughout the Appalachian Basin (Fig. 4). Oil and gas producers have mimicked that natural process by pumping a fluid (commonly water or nitrogen) under high pressure to initiate a split at the wellbore which then continues outward into the rock along natural fractures. The direction of the hydraulic fracture, either natural or industrial, is controlled by the minimum horizontal earth stress (S_{hmin}) which is presently oriented NNW-SSE in Pennsylvania. The rock splits and fractures propagate at right angles to the smallest earth stress (S_{hmin}) and runs to the ENE and WSW in Pennsylvania toward the maximum horizontal stress (S_{Hmax}).

Figure 4: Natural Hydraulic Fractures

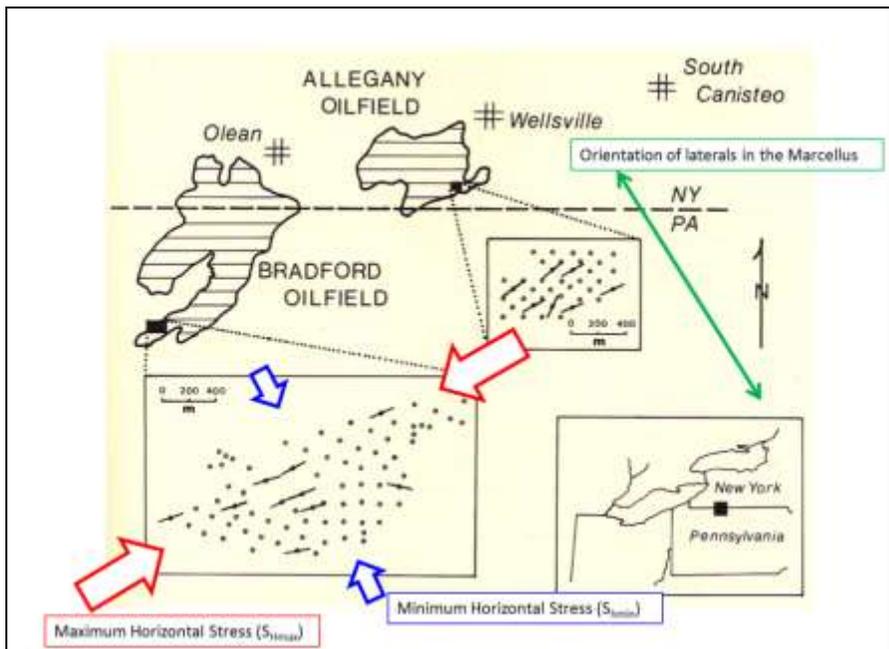
Figure 4 demonstrates that natural hydraulic fractures (J_1 and J_2 joints) have propagated in two directions in an outcrop of gas shale. A horizontal well (white) is shown crossing J_1 joints. Microseismic activity (red squares) indicate the extent to which hydraulic fracturing has opened natural joints. Note the direction of opening of natural joints is toward the maximum contemporary tectonic stress (S_H). Perf = perforations in the casing.



The first application of hydraulic fracturing in the Commonwealth was to promote water floods in the Bradford oil fields of McKean County just after World War II (Fig. 5). Water was used to drive oil between rows of wells that were aligned ENE-WSW and hydraulically fracture to connect those wells. Connection was achieved because hydraulic fractures propagate toward the S_{Hmax} to the ENE and WSW. Oil was then driven in a NNW or SSE direction by water advancing from one row of connected wells to another row of hydraulically fractured wells. The same principle applies to gas production from the Marcellus where wells drilled to take advantage of the orientation of the natural earth stress. From a pad, wells are drilled to either the NNW or SSE to take maximum advantage of hydraulic fractures which grow to either the ENE or WSW (Fig 4).

Figure 5: Orientation of Hydraulic Fractures (Bradford Oil Fields, McKean County)

Source: Engelder, 1992 (adapted).

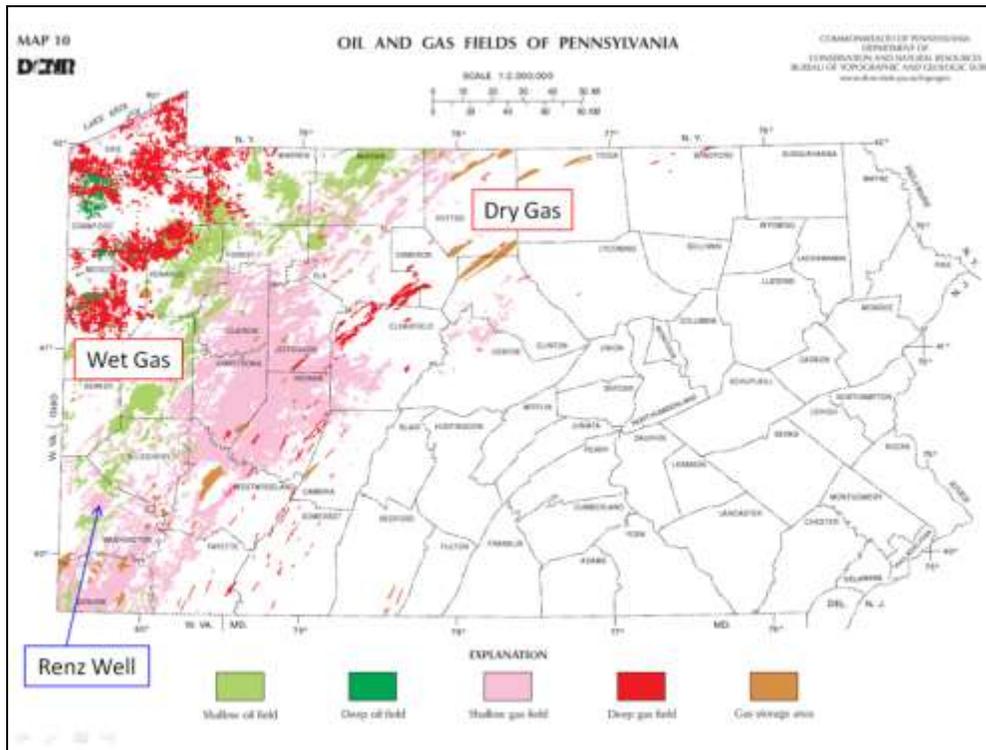


Before the development of the Marcellus gas shale in the 21st century, gas production in Pennsylvania was largely confined to the Appalachian Plateau in the western half of the Commonwealth (Fig. 6). The targets of exploration were conventional traps characterized by a reservoir of higher permeability covered by low permeability shale. Deep gas in the Oriskany gas was trapped

under upfolds, anticlines capped by the Marcellus black shale. Even deeper Trenton-Black River gas was trapped along small faults under the Utica black shale. Both the Oriskany and Trenton-Black River are called structural traps whereas the Medina gas is held in place by a stratigraphic trap consisting of sandstone interlayered with shale.

Figure 6: Distribution of Conventional Oil & Gas Production in Pennsylvania

Source: DCNR Map 10.



Stratigraphic traps tend to extend over larger regions like the shallow gas reservoirs of Indiana, Armstrong, and Jefferson Counties whereas structural traps are found in narrow bands like the gas fields of southeast Elk and Cameron Counties (Fig. 6).

Conventional stratigraphic and structural traps are restricted targets that might be missed if the geological interpretation is incorrect whereas

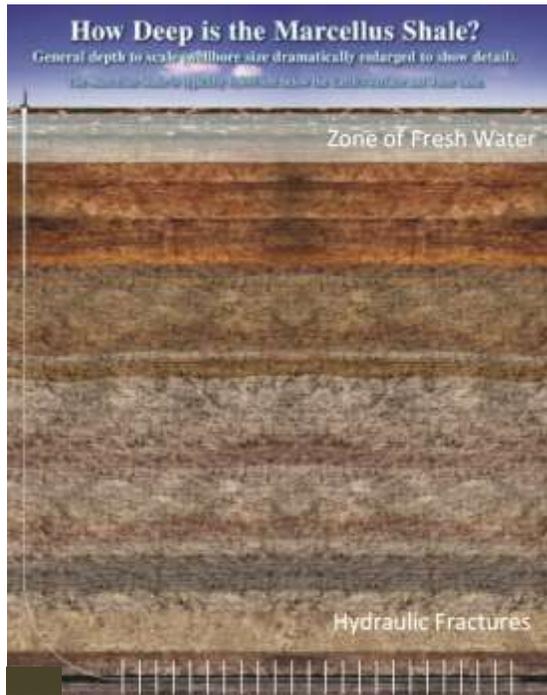
black shale reservoirs are continuous throughout a region and found simply by drilling down. While easy to find by drilling, gas shales are difficult to produce, so the industry labeled these gas deposits as unconventional reservoirs.

Production from the Marcellus in its present form started when a deep, vertical well (the Renz well) in Washington County, failed to show any economic potential in 2004 (Fig. 6). The operator, Range Resources, pulled back to the depth of the Marcellus and tested that interval with a hydraulic fracture stimulation known in industry as a 'massive slickwater frac' (Fig. 3). The difference between the Renz fracture stimulation and the early Bradford treatments is largely the number and height of fractures required for economic payout. In the former case a rock unit is split with many fractures through a thickness 200-300 feet whereas in the latter case only one fracture in a sandstone layer a few feet thick is required. Much larger quantities of water are required for gas shale, hence the term, massive. Slickwater contains an additive similar to common dish soap so that massive quantities of water can rush down wellbores without being impeded by friction between the water and the pipe. This technique was employed by Mitchell Energy in the Fort Worth Basin of Texas to produce gas from vertical wells in another gas shale, the Barnett, which had many of the same characteristics as the Marcellus gas shale.

In 2002, Mitchell Energy was sold to Devon Energy, a company with experience in horizontal drilling. Successful horizontal completions with hydraulic fracturing in the Barnett started about 2003. The only difference between a

hydraulic fracture in a horizontal well and a vertical well is that the plane of the fracture contains the wellbore in the latter whereas the plane of the fracture cuts at right angles to the wellbore in the former. Because the fracture cuts at right angles many fractures are driven from a horizontal well (Fig. 7) whereas just one bi-wing fracture is driven from a vertical well as shown in Figure 3.

Figure 7: Scale Diagram of Horizontal Drilling



Scale diagram of horizontal drilling in the Marcellus at depths of 6000 to 8000 feet in the Commonwealth.
Source: Range Resources

Horizontal drilling was first introduced to Pennsylvania during World War II in the form of slanted wells in the Vernango Formation not too far from where the original Drake Well was drilled in 1859. Drilling from offshore platforms after World War II required reaching out from platforms as much as a mile; therefore, directional drilling was developed to accomplish the task. Horizontal drilling in Appalachian gas shale was first attempted in the late 1970s during the U.S. Department of Energy (DOE) sponsored Eastern Gas Shales Project (EGSP). In developing the Barnett, Mitchell Energy and Devon Energy drew on the experience gained when working gas shales of the Appalachian Basin and in the Michigan Basin (i.e., the Devonian Antrim Formation) to further perfect their horizontal drilling techniques in the Barnett. The modern horizontal well is drilled by a hydraulic motor in the drill head that can be steered while drilling (drill rod does not rotate at the drilling platform). By 2006, horizontal drilling was also successfully used in the Woodford shale of Oklahoma and the Fayetteville of Arkansas. The most extensive use of horizontal drilling in the Appalachian Basin before the development of the Marcellus was in eastern Kentucky, the site of the original EGSP horizontal well.

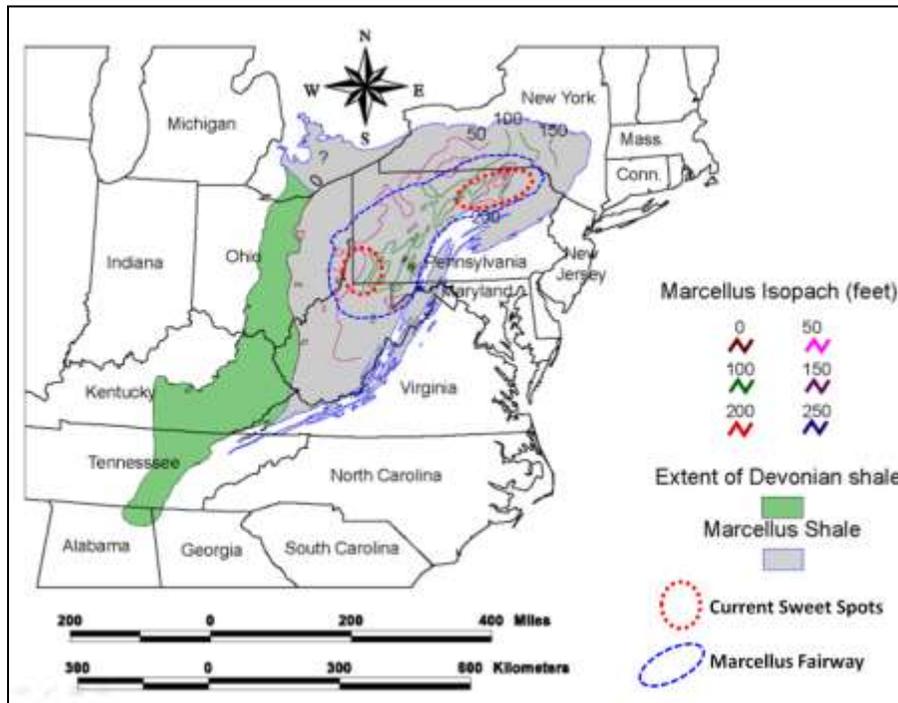
Initial production was so successful following the Marcellus test in the vertical Renz well that Range Resources moved quickly to consolidate its land position in Washington County, Pennsylvania and other places. By 2006, word of the Renz success had leaked out to the point where other players were seeking land positions in Pennsylvania. Following the Devon Energy model of drilling horizontal wells in the Barnett, Range Resources moved to form large enough drainage units in Washington County to experiment with the stimulation of horizontal wells during 2007. Range Resources went public with the results of its first five horizontal wells during an investor and analyst call on December 10, 2007.

The Range Resources announcement was unnoticed outside of industry experts until it was interpreted for the public in a press release issued by the Pennsylvania State University (Penn State) on January 17, 2008. This press release provided information that certified the Marcellus as a bona fide super giant gas field. Calculations in the press release were the outgrowth of over 30 years of research on gas shale.

3.3 THE MARCELLUS AND ITS GEOLOGICAL ORIGINS

The Marcellus formation is a Devonian black shale deposited in an area covering much of Pennsylvania and West Virginia and portions of New York, Ohio, Virginia, and Maryland during approximately 1.5 million years (My) starting at 389.3 Ma (million years ago) (Fig. 8). This radiometric date comes from layers of volcanic ash within the Marcellus. The Marcellus reaches a thickness of over 700 feet in eastern Pennsylvania and the Catskill region of New York and thins to a few feet in central Ohio.

Figure 8: Location of the Marcellus Shale Formation



Source: U.S Geological Survey (adapted).

The Marcellus fairway (i.e., the area of economic gas production) runs under the Appalachian Plateau from the Binghamton area of New York through the Plateau region north of State College, Pennsylvania and on to the northwestern corner of West Virginia (Fig. 8). The fairway for this unconventional resource may be as large as 54,000 square miles with the total subsurface occurrence about twice that size. The Marcellus fairway is defined by a number of geological parameters including suitable thickness, depth of burial, organic richness

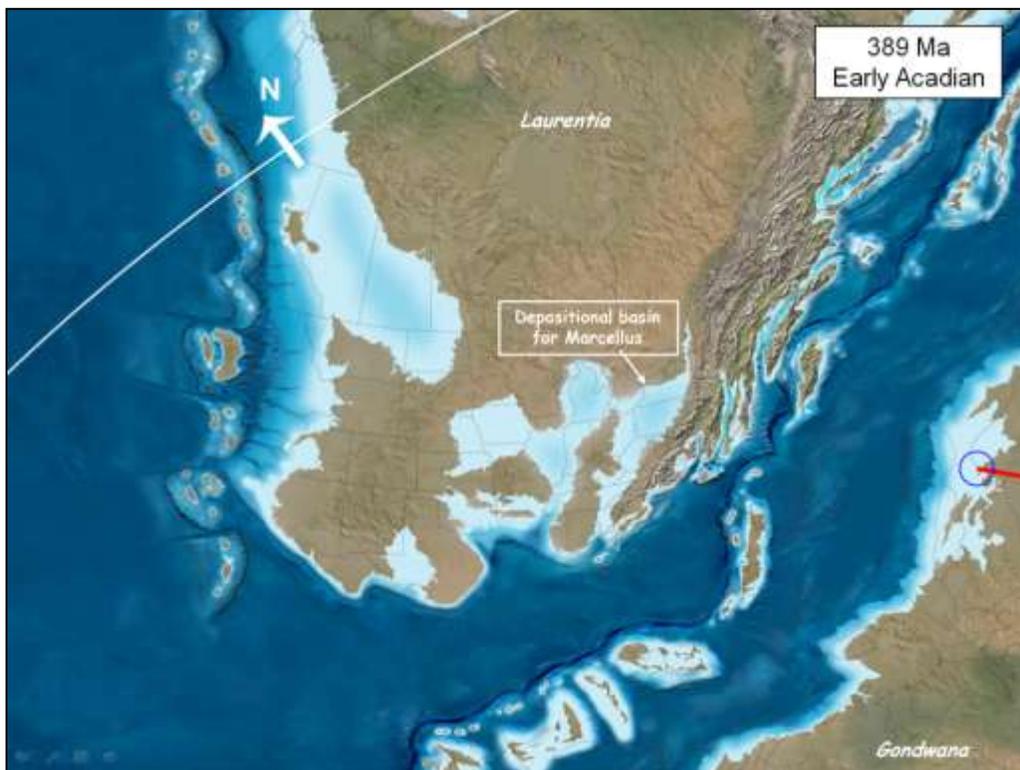
(known as TOC – total organic carbon), thermal maturity, porosity, clay content, and natural fracture density. Current sweet spots of greatest drilling activity include an area of dry gas production in the northeastern tier counties of Pennsylvania (i.e., Susquehanna, Bradford, and Tioga) and an area of wet gas production in the southwestern portion of Pennsylvania (Greene, Washington, and Butler). Wet gas from the Marcellus is found in those portions of the Commonwealth known for oil production whereas dry gas is found in regions of no oil production (Fig. 6). Geologists anticipate that the sweet spots will grow across the central portion of the Appalachian Plateau and eventually merge through Centre, Clearfield, Indiana, and Westmoreland Counties.

The presence of the Marcellus in the subsurface is closely tied to plate tectonics processes. During the past half billion years of earth history, there was a period of about 250 million years when the eastern portion of North America was a vast basin, a depression in which sedimentary rocks accumulated. This vast depression of continental crust was maintained by plate tectonic processes that loaded the edge of present eastern North America and bent it downward like a diving board when a diver stands on it. The Appalachian Basin was the catchment for each of the major sedimentary rocks including limestone, dolomite, sandstone, siltstone, and shale. The Devonian Period from 390 to 365 Megaannum (Ma) was characterized by conditions that favored the preservation of unusually large volumes of organic matter in vast layers of black shale. There was another

comparable interval during the Ordovician Period starting at 454 Ma when the Utica black shale was deposited in the Appalachian Basin. Both the Marcellus and the Utica contain volcanic deposits that came from the tectonic activity responsible for bowing the continental crust.

The Marcellus was deposited in a vast continental interior seaway that was bounded to the east by the Acadia Mountains which included a chain of volcanoes in the area of the present New England states (Fig 9). Continental interior seaways tend to be shallow compared to the deep ocean basins deposited on ocean crust. The Appalachian basin was filled with sediments carried out of the Acadia Mountains by river systems forming deltas on the eastern side of the interior seaway and these vast deltas form the rocks of the present Pocono and Catskill Mountains. Fewer sediments wash out into the center of the basin thus allowing organic source rocks like the Marcellus to accumulate.

Figure 9: Configuration of Earth's Continents (389 Ma)

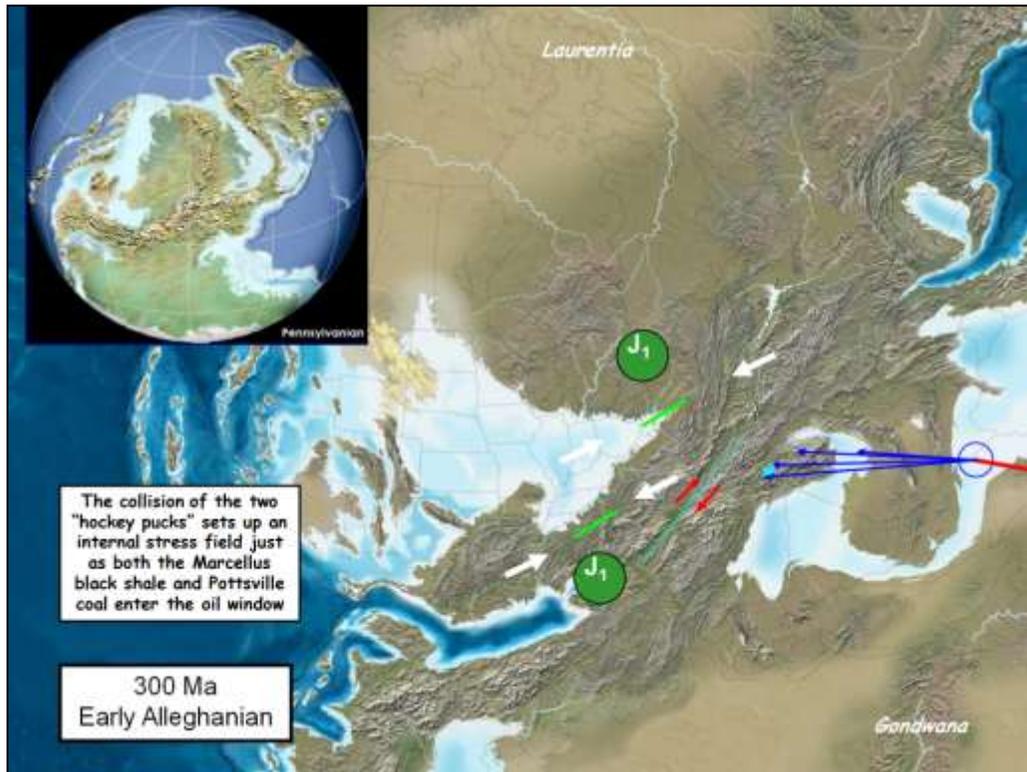


Source: R.C. Blakey (adapted). <http://www2.nau.edu/rcb7/nam.html>

Figure 9 shows the configuration of continents on Earth at about 389 Ma. The Marcellus was deposited in an interior seaway during a period of tectonic deformation within a region from Boston to Philadelphia. This period of deformation was the consequence of the convergence of Gondwana (Africa) toward Laurentia (America) facilitated by a subduction zone off the east coast. Volcanic ash from volcanoes of subduction is found mainly in the Union Springs Member of the Marcellus.

At the time of Marcellus deposition, the ancient continents of Laurentia (present North America) and Gondwana (present Africa and South America) were separated by an ocean basin. By continental drift, Gondwana and Laurentia collided some 70 million years after the Marcellus was deposited (Fig. 10).

Figure 10: Plate Tectonics at the Gondwana and Laurentia Closure

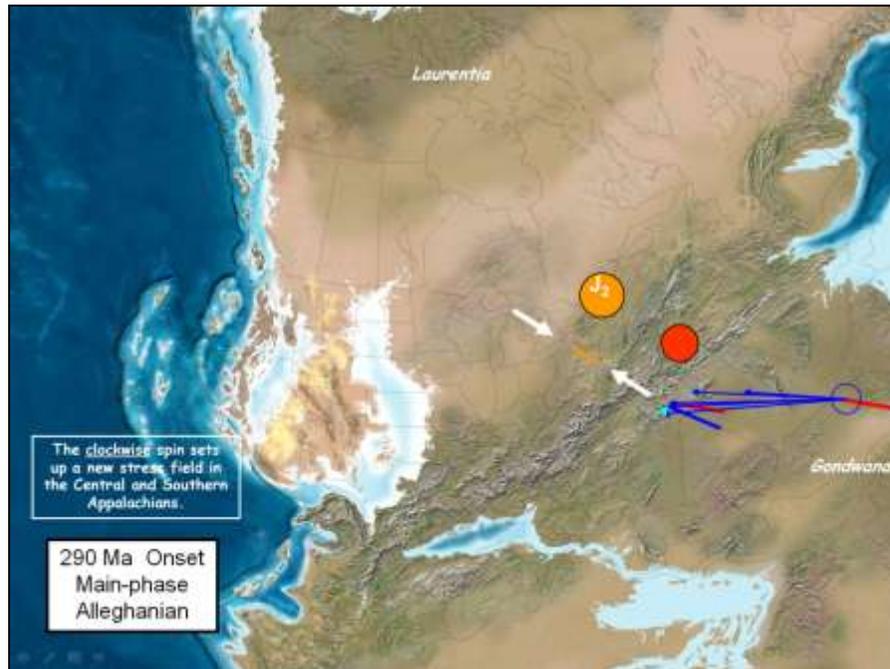


Source: R.C. Blakey (adapted). <http://www2.nau.edu/rcb7/nam.html>.

Figure 10 shows plate tectonics at the time of the closure of Gondwana against Laurentia. The San Andreas-size strike-slip faults in the Appalachian Mountains about 315 Ma indicate that the continents slide past each other (dotted blue line). At this time the tectonic stress field in the Marcellus basin was aligned in the direction of the J1 joint set.

The effect of this continent-continent collision at 315 Ma was the burial of the Marcellus under a thick blanket of sediments shed from the Acadia Mountains. During the initial collision, these large continents responded by sliding past each other like hockey pucks hitting obliquely. By 290 Ma, the continents locked together to form a supercontinent called Pangea. Locking caused Gondwana to pivot clockwise into Laurentia and cause the thrusting and folding of the Appalachian Mountains of Pennsylvania (Fig. 11). It is this folding and faulting, known as the Alleghanian Orogeny, that wrinkles the Marcellus like a rug pushed on a wooden floor.

Figure 11: Faults and Folding of the Appalachian Plateau



Source: R.C. Blakey (adapted). <http://www2.nau.edu/rcb7/nam.html>

As shown in Figure 11, strike slip motion stops when the continents lock near present New York City (red dot). This causes Gondwana to spin clockwise and drive the deformation in the Central and Southern Appalachian Mountains. This new stress field caused the faults and folding of the Appalachian Plateau and controlled the orientation of the J₂ joint set. Plate tectonics sets up a maximum (S_{Hmax}) and minimum (S_{Hmin}) horizontal stress in the crust. When fluid pressure in sedimentary basins is high, rock splits to form natural hydraulic fractures. During the history of sediment accumulation in a basin there are high pressure events and splitting propagates in the direction of S_{Hmax} during each event. Because the orientation of the Earth's stress varies with time as a consequence of changing boundary conditions, splitting during high pressure events propagates in different directions. The two major splitting events in the Marcellus Shale are seen in the form of two joint sets, J₁ and J₂ (Fig. 4). These two splitting events are understood in the context of the plate tectonic stress orientation based on the motion of Gondwana relative to Laurentia. When the continents were sliding past each other, S_{Hmax} was at a small oblique angle to the direction of major fault zones that accommodated slip and this is the orientation of the natural hydraulic fractures called J₁ joints (Fig. 10). Later, continent-continent collision imparted a S_{Hmax} at right angles to the continental boundary. This stress orientation was present when J₂ propagated at a very large acute angles to J₁ (Fig. 11).

3.4 GEOLOGICAL PROPERTIES TO ESTIMATE THE VOLUME OF TECHNICALLY RECOVERABLE GAS

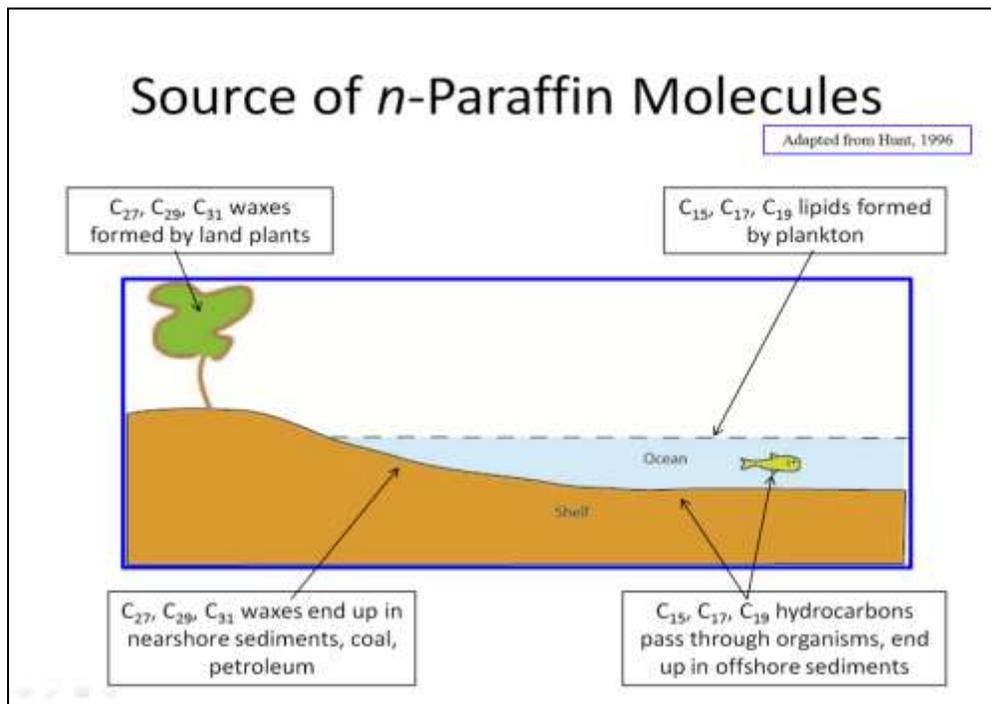
Geologists use a number of properties and parameters to evaluate a gas shale to delineate the Marcellus fairway and estimate the volume of technically recoverable gas. While other parameters play a role in economic value, a gas shale must have five properties that fall within a certain window before industry would consider entering an area for leasing and later drilling. These include a suitable organic richness (known as TOC – total organic carbon), thickness, depth of burial, thermal maturity, and porosity. A sixth property also has a large impact in the economic value of a shale play: a natural fracture density. The Marcellus has one of the finest natural fracture sets among the active gas shale plays in the United States and this property most likely sets the Marcellus aside from the other plays.

3.4.1 ORGANIC RICHNESS (TOC)

The major types of rock in the Appalachian Basin consist of limestone, dolomite, sandstone, siltstone, and shale. Of these only shale is likely to have preserved enough organic matter to allow for the generation of oil and gas. Marine shale is ordinarily a buff to gray color but when more than 2% by volume organic matter is preserved, the shale will turn black during burial. The Marcellus is a black shale with well in excess of 10% by volume organic matter. The volume of organic matter is called the total organic carbon (TOC).

The source of organic matter in the Marcellus is largely algae living in the photic zone of the Devonian interior seaway. Much of these algae passes through organisms and eventually settles to the ocean floor which was oxygen deficient (Fig. 12). The fatty portion of the algae (lipids or n-paraffins) proves more resistive to chemical degradation and is preserved during burial.

Figure 12: Deposition of the Marcellus Shale - Source of Organic Matter



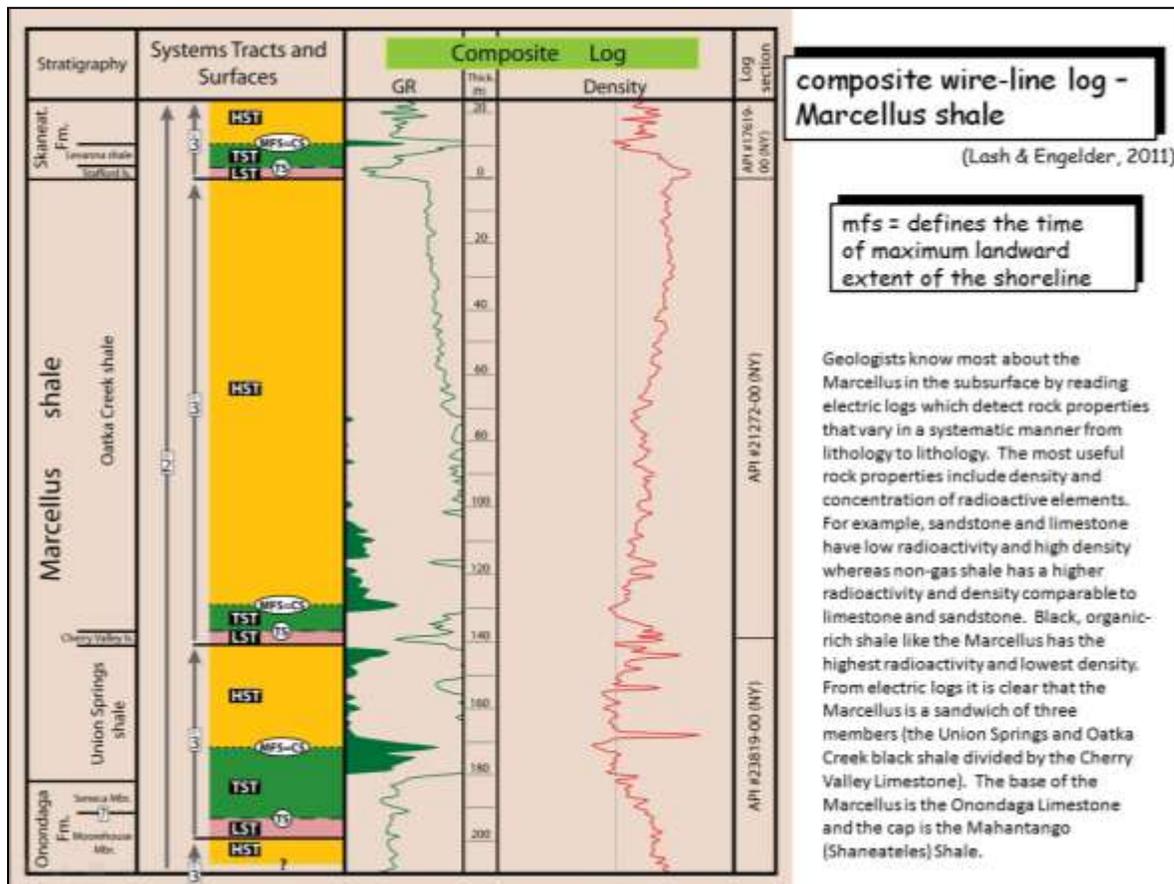
Under elevated temperature these lipids were converted by polymerization to long-chain organic compounds called kerogen. Higher temperatures crack kerogen compounds to both petroleum and natural gas which is the simplest paraffin with one carbon (CH₄). If gas is associated with some longer chain hydrocarbons like ethane, butane,

and propane during production, this product is called wet gas, a characteristic of production in the southwestern corner of Pennsylvania. Additional heat from further burial will eventually crack all longer-chain organic molecules to methane. This is the case in the northeastern sweet spot of the Marcellus where the product is called dry gas.

3.4.2 THICKNESS

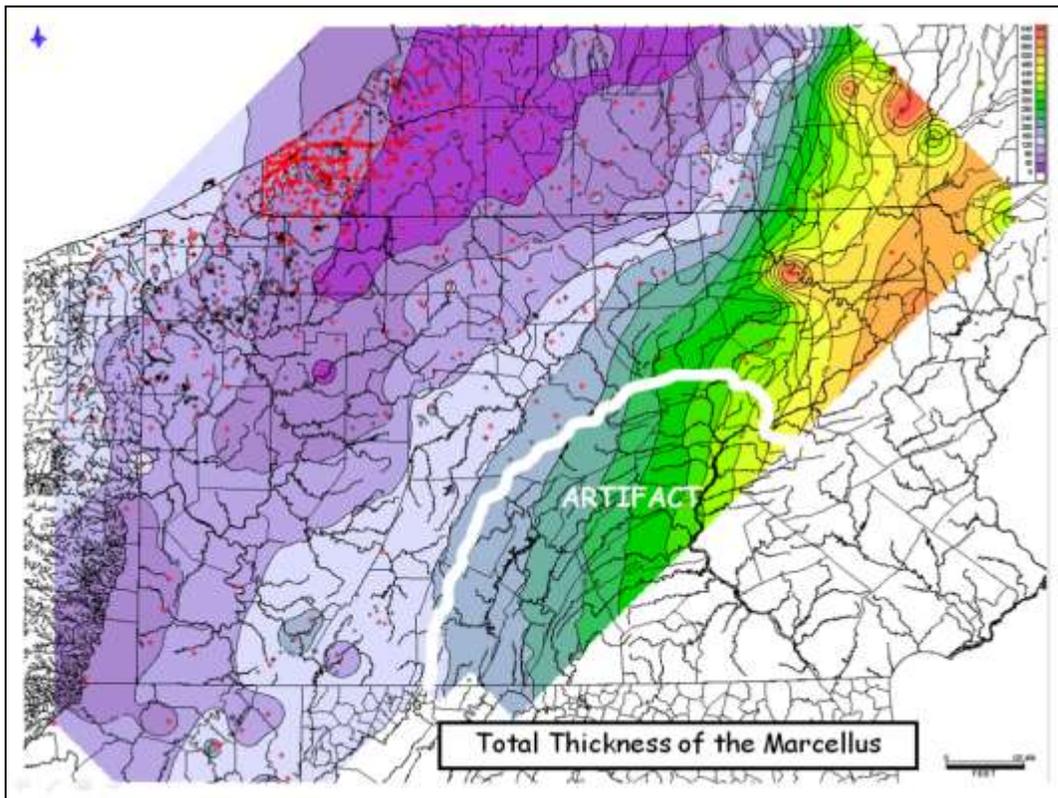
Geologists know most about the Marcellus in the subsurface by reading electric logs which detect rock properties that vary in a systematic manner from lithology to lithology. Before the recent rush to develop the Marcellus, its thickness was known from wells drilled mainly to develop gas in the Oriskany and Trenton-Black River plays. The most useful rock properties include density (measured using a density log) and concentration of radioactive elements (measured using a gamma ray log). For example, sandstone like the Oriskany and limestone like the Onondaga below the Marcellus have a low gamma ray count and high density whereas gray shale has a gamma ray count from clay that adsorbs the radioactive isotopes thorium and potassium and density comparable to limestone and sandstone. Black, organic-rich shale like the Marcellus has the higher gamma ray and a lower density because organic matter is less dense than other common components of sedimentary rock like quartz, calcite, and clay. From electric logs it is clear that the Marcellus is a sandwich of three members (the Union Springs and Oatka Creek black shale divided by the Cherry Valley Limestone) (Fig. 13). The base of the Marcellus is the Onondaga Limestone and the cap is the Mahantango (Shaneteles) Shale. Because of depositional and tectonic nuances in the Marcellus basin, production of dry gas comes mainly from the Union Springs Member whereas the wet gas comes mainly from the Oatka Creek Member.

Figure 13: Marcellus Shale Composite Wire-Line Log



TOC is dictated by the rate of sedimentation from river systems. Consequently, organic richness increases with distance from the ancient shoreline or during periods when the river system was disrupted. Thrust loading in the Acacia Mountains is one mechanism for disruption of the river systems and this happened twice as the Marcellus was being deposited. The Marcellus is much thicker at the southeastern edge of the Appalachian Basin (Fig. 14) largely because sediment supply to the basin came primarily from the Acacia Mountains to the southeast. As organic richness is inversely proportional to sedimentation rate, the thicker portions of the Marcellus are not necessarily the most attractive targets for gas exploration.

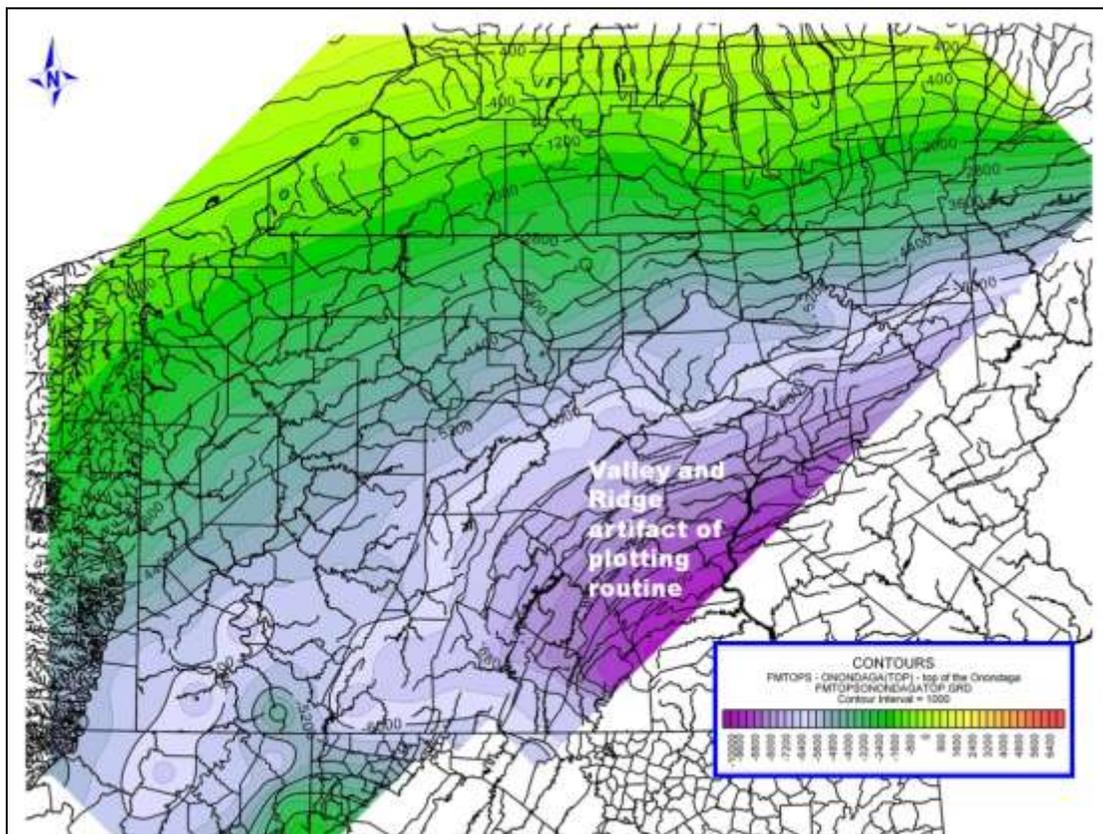
Figure 14: Thickness of the Marcellus Shale



3.4.3 DEPTH OF BURIAL

Although the Marcellus was once more deeply buried, volume of gas held by the Marcellus is proportional to the depth of burial. Burial depth is measured on the gamma ray log at the contact between the Marcellus and Onondaga Limestone, below (Fig. 15). The reason that gas volume increases with depth is that gas is compressible, a property that packs more gas into the same space at higher pressure. The shape of the present Appalachian basin is much like the bottom of a canoe with the keel on a line between the two Marcellus sweet spots, one in Susquehanna County and the other in Washington County. The Marcellus is shallower to the north and northwest which means that New York Marcellus at a shallower depth is not as rich in gas as the Pennsylvania Marcellus in its sweet spots.

Figure 15: Depth to the Base of the Marcellus Shale (Below Sea Level)

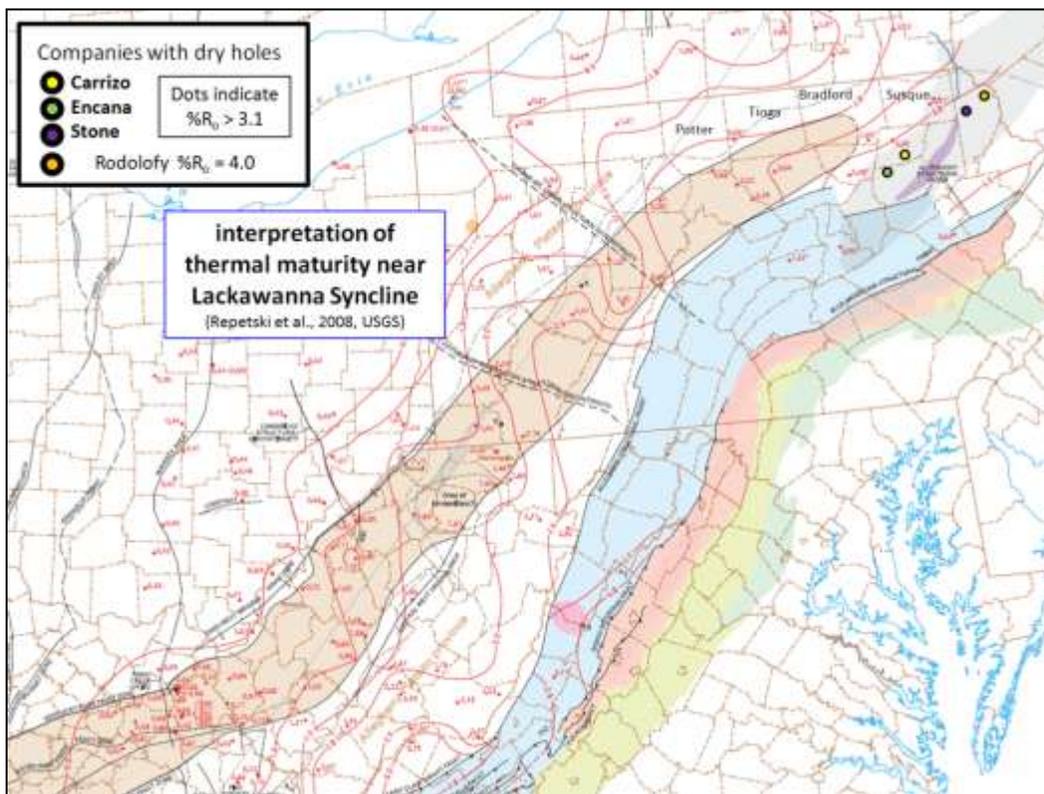


3.4.4 THERMAL MATURITY

Generation of natural gas depends on heat-induced chemical reactions that convert lipids to kerogen to petroleum and then to natural gas. The interior of the Earth is hot relative to its surface with the interior temperature increasing (a geothermal gradient) at the rate of about 57°F/mi. Kerogen is converted to petroleum at a temperature of about 32°F which means that the Marcellus had to reach a depth of about 1.86 miles (mi) before any natural gas was produced. The Marcellus was ultimately buried as much as 2 to 4.5 mi depending on its location relative to the Acadia Mountains to the southeast. Burial was deepest to the east in the area of the anthracite coal district of Pennsylvania. Erosion and exhumation during the past 200 Ma have placed the Marcellus at its present depth of burial, somewhat shy of 1.86 mi at its maximum in Washington County.

Geologists measure the ability of organic matter (mainly woody material) to reflect light. As wood is converted to coal by heat it becomes more reflective. This property is known as vitrinite reflectance ($\%R_o$). A map of vitrinite reflectance for the Marcellus shows the highest $\%R_o$ in the eastern portion of the basin in the anthracite coal district (Fig. 16). This is consistent with ultimate depth of burial of the Marcellus. $\%R_o$ is also used to predict areas of the Marcellus that are capable of producing wet gas ($\%R_o \approx 1.0$ on western Pennsylvania) and dry gas ($\%R_o > 2.5$ in northeastern Pennsylvania).

Figure 16: Thermal Maturity of the Marcellus Shale

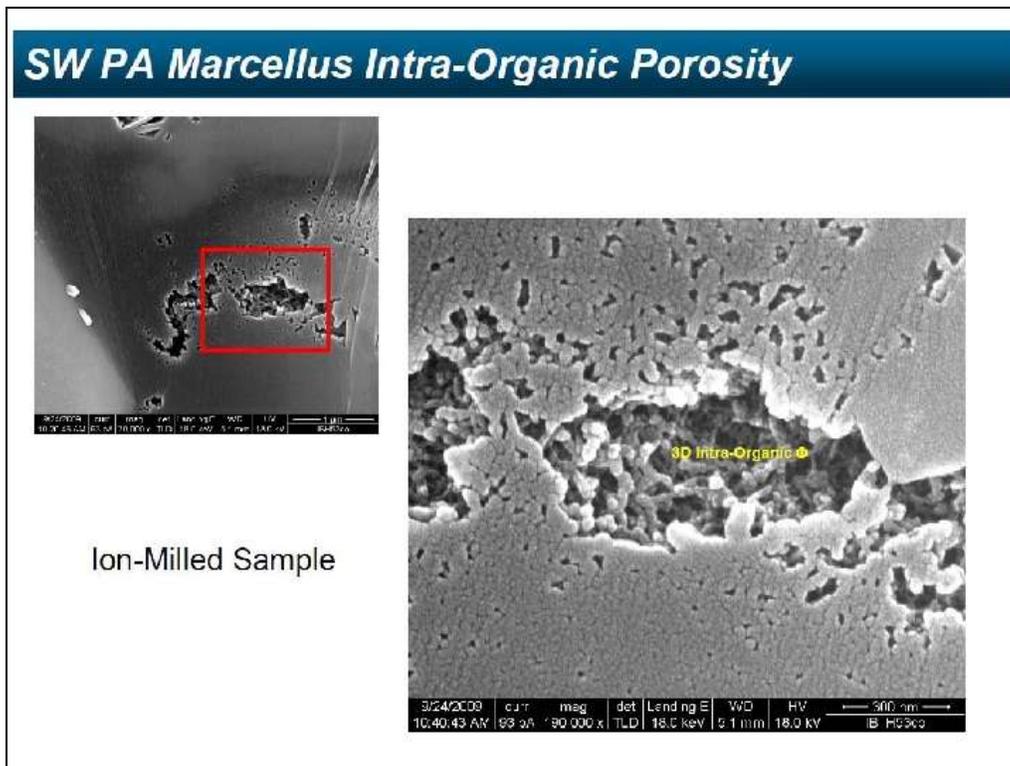


Source: Repetski et al., 2008. Contours given in vitrinite reflectance ($\%R_o$). A number of test wells mark the boundary of the gas basement ($\%R_o > 3.0$).

3.4.5 POROSITY

Pore space in rock is defined as the hole or the 'tank' that holds the gas. When kerogen is converted to petroleum and natural gas, mass is conserved. This means that the kerogen lost mass and that loss is manifested by the development of pore space in kerogen. To represent the concept of porosity, Figure 17 shows gas porosity in the Texas Barnett Shale. Individual pores are often on the order .000019 inches in diameter. The richest portions of the Marcellus Shale have relatively higher porosities, as much as 10%.

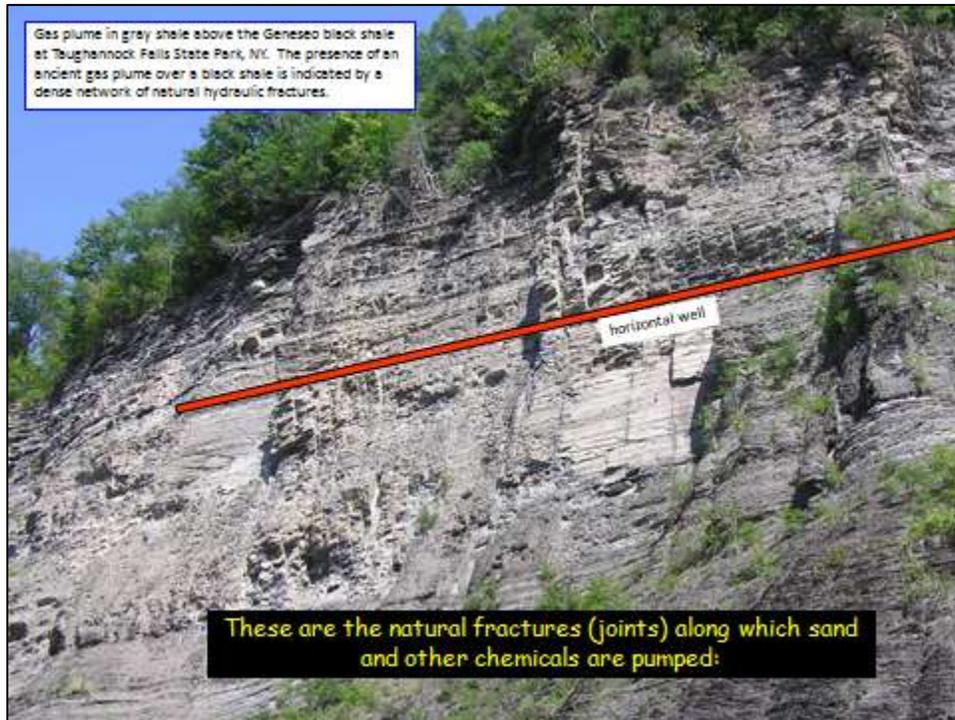
Figure 17: Gas Porosity in the Barnett Shale



3.4.6 NATURAL FRACTURES

The property that may set the Marcellus aside from other gas shales is its abundance of natural fractures (called cracks or joints) (Figs. 4 & 18). If horizontal drilling intersects a dense network of natural fractures in the Marcellus, the energy of hydraulic fracture stimulation is expended opening natural cracks in rocks rather than being lost making fresh cracks. Sand is then pumped into the Marcellus to hold these natural fractures open so that more gas can flow to the production well.

Figure 18: Natural Hydraulic Fractures



3.5 GEOLOGIC CONSIDERATIONS OF SHALE DEVELOPMENT

In 1961, the Pennsylvania General Assembly enacted Act 359, the Oil and Gas Conservation Law. The Act passed in response to advocacy from the Interstate Oil and Gas Compact Commission, previously known as the Interstate Compact to Conserve Oil and Gas. Pennsylvania joined the Compact in 1941. The stated legislative intent of the statute was:

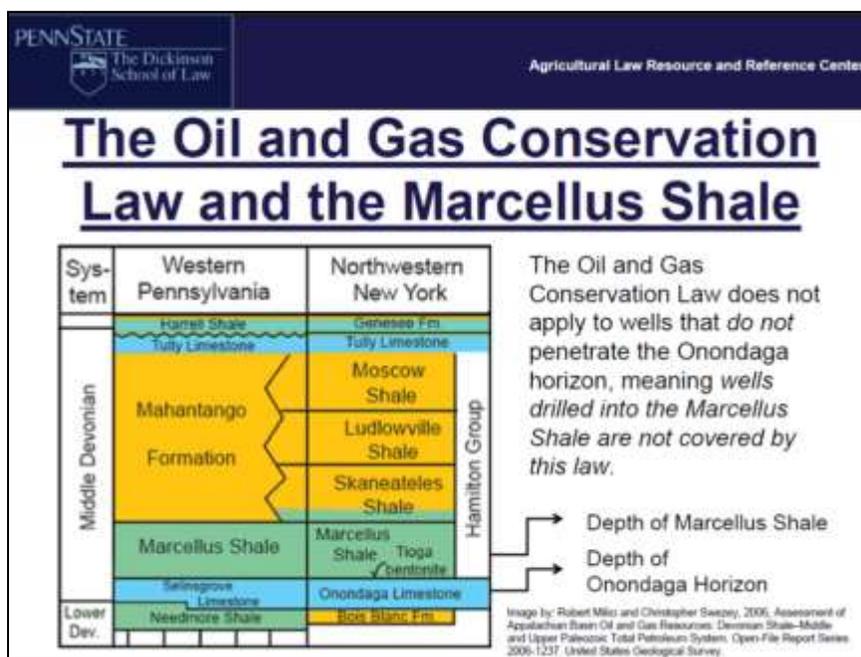
"...to foster, encourage, and promote the development, production, and utilization of the natural oil and gas resources in this Commonwealth...in such manner as will encourage discovery, exploration, and development without waste; and to provide for the drilling, equipping, locating, spacing and operating of oil and gas wells so as to protect correlative rights and prevent waste of oil or gas or loss in the ultimate recovery thereof...and to protect fully the rights of royalty owners..."

The Oil and Gas Conservation Law seeks to minimize the waste of oil and gas resources which may otherwise remain underground due to inefficient development of the resource, and whose future recovery is regarded as economically prohibitive. In addition, the Act is intended to protect the correlative rights of property owners who may either be prevented from participating in a voluntary development unit, or who may receive no compensation for the development of their oil and gas resources due to the development and extraction of the mineral resource

from adjacent property, which is subject to the Rule of Capture. Litigated extensively in Pennsylvania, the Rule of Capture generally recognizes that oil and gas “belong to the owner of the land, and are part of it, and are subject to his control; but when they escape, and go into other land, or come under another’s control, the title of the former owner is gone.”⁵

In an effort to prevent the uninterrupted development and exploration of oil and gas resources of the Pennsylvania and Mississippian Systems and within the Upper and Middle Devonian Geological Series – which had occurred continuously since the successful production of oil at the Drake Well in 1859 – the Oil and Gas Conservation Law was limited to those wells which targeted the Lower Devonian Geological Series. Specifically, the law is only applicable to wells which penetrate the Onondaga Horizon, or 3,800 feet below the surface in areas of the Commonwealth where the Onondaga Horizon is closer to the surface than 3,800 feet (Fig. 19).

Figure 19: Limit of the Oil and Gas Conservation Law



The law authorizes the Commonwealth to integrate, either through voluntary agreement or through involuntary compulsion, interests in oil and gas development, and to provide for the spacing of wells in a manner which maximizes the economic and energy extraction benefits of oil and gas development. This process is commonly referred to as “pooling” or “unitization”. The Commonwealth, after due process and public hearing, is authorized to provide for the spacing and location of wells throughout the unit, and to

provide for fair and just compensation for all mineral rights owners within the unit, including those involuntarily integrated into the unit. According to DEP, this statute has not been utilized for pooling or unitization purposes for several decades.

The Oil and Gas Conservation Law is not applicable to development of natural gas from the Marcellus Shale geographic strata, unless the well bore penetrates the Onondaga Horizon.

The Oil and Gas Conservation Law was enacted at a time when horizontal and directional drilling and modern-scale hydraulic fracturing techniques were not utilized, perfected, or envisioned.

⁵ *Westmoreland & Cambria Natural Gas Co. v. De Witt*, 130 Pa. 235 (1889)

3.6 MARCELLUS ECONOMIC ESTIMATES BASED ON GEOLOGICAL PROPERTIES

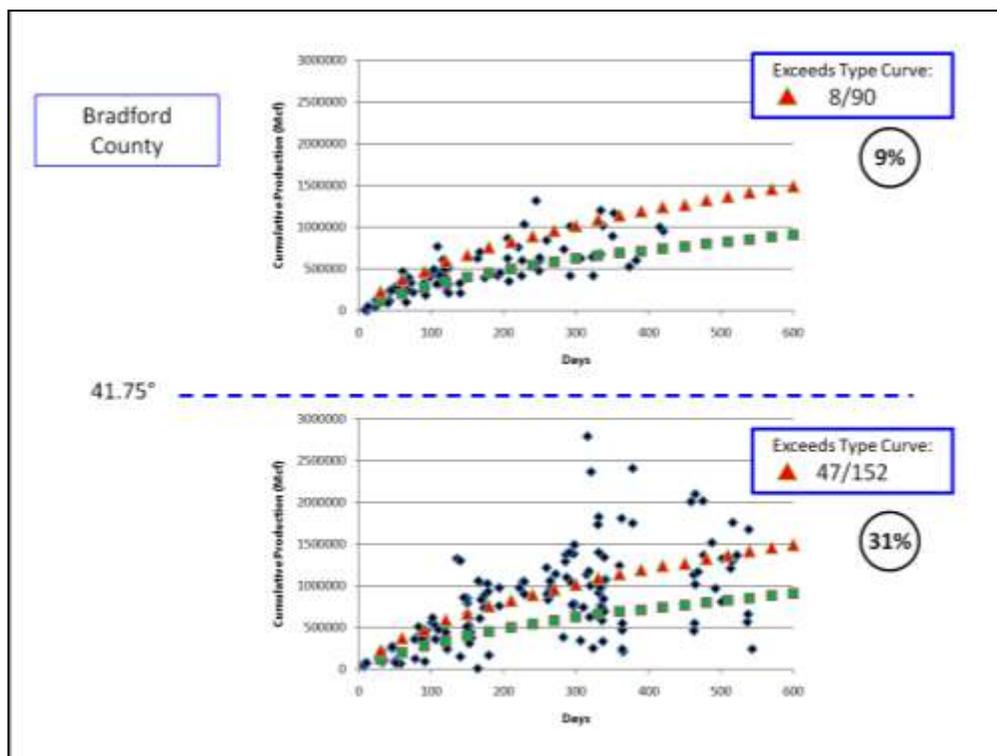
3.6.1 TECHNICALLY RECOVERABLE GAS

An estimated ultimate recovery (EUR) of natural gas from a shale is based on production data. In the absence of production data, geologists use gas shale properties to make an estimate of gas in place and then an estimate of technically recoverable gas. The January 2008 Penn State press release included an estimate of technical recoverable gas of 50 trillion cubic feet (Tcf) based on the five properties mentioned above and recovery factor of 10% of the gas in place. Some operators use a recovery factor of as much as 30%. In fact, conservative numbers were used for all the parameters so with the result that 50 Tcf was a purposely low number. When more liberal values for the five parameters were applied in a November 2008 press release, the figure for technically recoverable gas in the Marcellus climbed to 363 Tcf.

3.6.2 MARCELLUS PRODUCTION

Once gas wells are brought on line, production data is available for an estimate of ultimate recovery (Fig. 20). The first data released to the public is called initial production data (IP). The economic value of the Marcellus was revealed once IP data for about 50 wells was released to the press. These IP data revealed that if the Marcellus were produced under 117 counties in five states the gas field would yield 489 Tcf, thus making it the second largest unconventional gas field in the world under current production.

Figure 20: Bradford County, PA Production Data - North and South Regions



3.6.3 GAS PRICES

Natural gas is marketed in units of 1,000 cubic feet (cf) which is equivalent to one million British Thermal Units (BTUs) of energy. Petroleum is marketed in units of barrels (bbl) which is equivalent to six million BTU of energy. To find the price equivalence between natural gas and petroleum, the price of natural gas is multiplied by six. For a period of about 15 years through the 1980s and 1990s, the wellhead price of natural gas was about half the wellhead price of petroleum when compared on a BTU basis. Through the early 1990s the heating season drove the price of natural gas higher when there were large withdrawals from gas storage fields in Pennsylvania and elsewhere. Starting in 1997 gas started tracking the price petroleum on a BTU per BTU basis until January 2006 when a two to one price differential emerged again but with the price of gas lagging behind price moves in petroleum by a few months. The Penn State calculation for the potential of the Marcellus in Pennsylvania took place in the late fall of 2007 when the price of gas was first being driven upward by a large spike on the price of petroleum. The spot price of petroleum at the Cushing, Oklahoma WTI peaked on July 3, 2008 at \$145.31 with the natural gas peak peaking about the same time. After that both prices collapsed until February 2009 after which a price differential of about four emerged (Fig. 21).

Figure 21: Price of Petroleum vs. Natural Gas

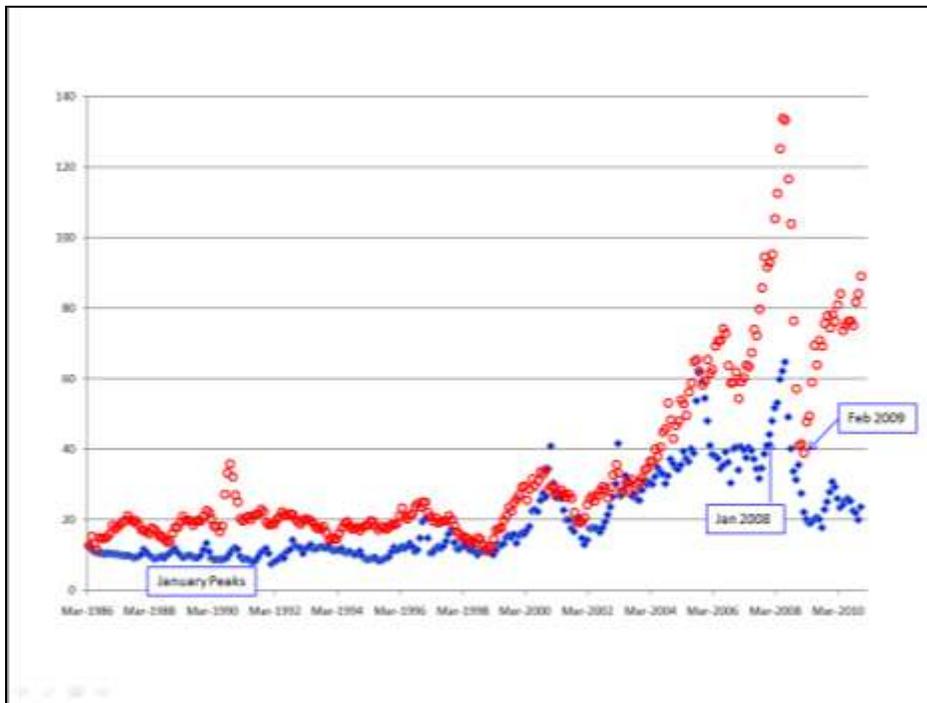


Figure 21 demonstrates the price of petroleum (barrel) versus natural gas (6000 cubic feet) for the past 25 years. The BTU content of a barrel of oil is equivalent to the BTU content of 6000 cubic feet of natural gas.

For all intents and purposes the price of natural gas in North America has decoupled from the international price of petroleum. This decoupling of natural gas from petroleum has yet

to take place in Europe where Russian gas still commands nearly the same price as petroleum in western Europe. The decoupling theory has been tested over the past several months when petroleum has steadily climbed in price with natural gas holding steady around \$4/1,000 Mcf. Despite the price differential between North American and Russian gas the experts think that it is doubtful that United States gas will enter the international spot market. The reason for this is that gas in the Middle East is produced at virtually no cost as a byproduct of petroleum production.

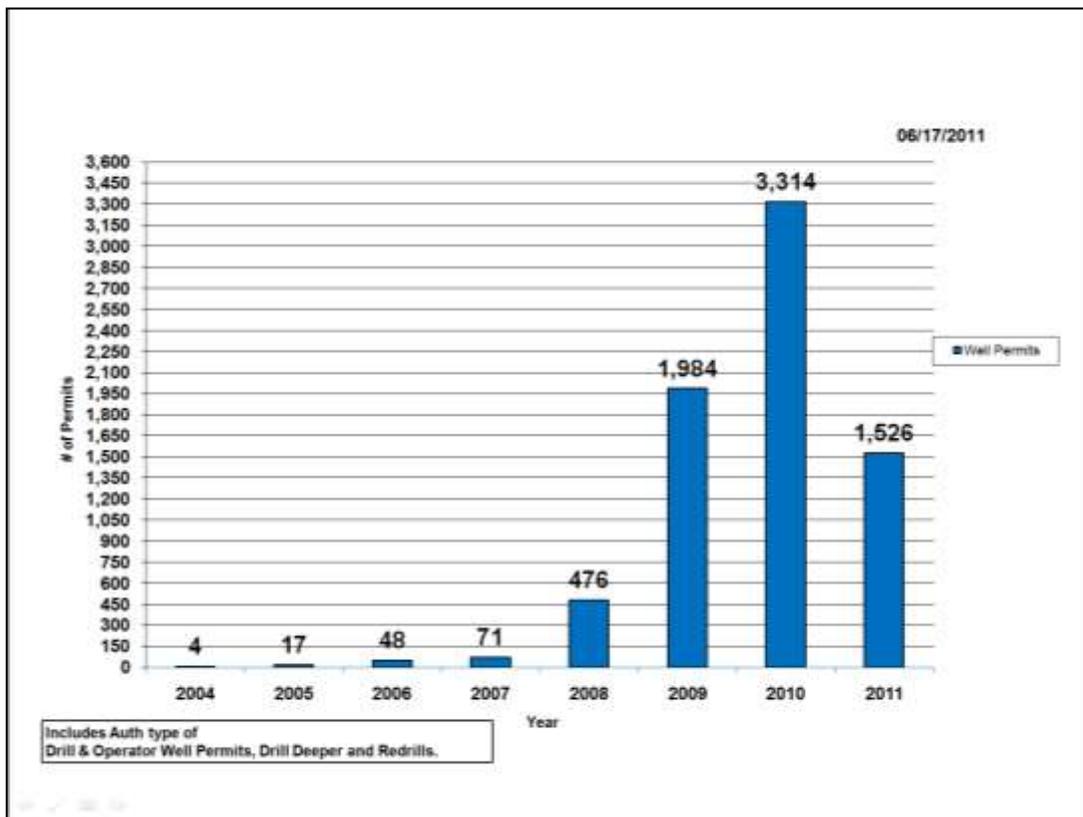
4. MARCELLUS SHALE ACTIVITY IN PENNSYLVANIA

The following section details well and lease activities throughout the Commonwealth of Pennsylvania.

4.1 WELL ACTIVITY

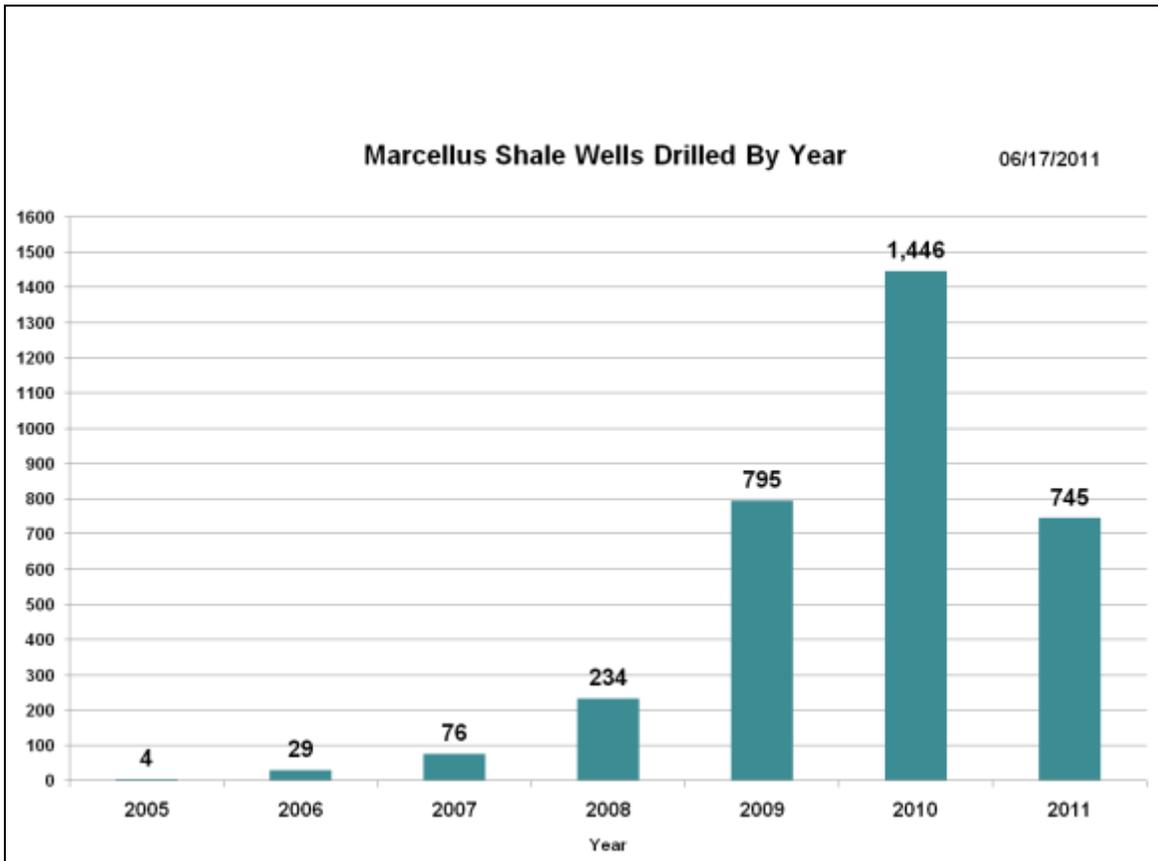
The geologic reasons for why the Marcellus Shale formation is the cause of so much activity in Pennsylvania is substantiated by the sheer volume of permits issued by DEP in recent years. According to records maintained by DEP's Bureau of Oil and Gas Management, the number of Marcellus Shale well permits have increased substantially since 2008 (Fig. 22) . The first Marcellus Shale gas well permits were issued in 2004 with a gradual increase until 2007. Between 2007 and 2008, the number of Marcellus Shale well permits issued increased from 71 to 276. The number of well permits issued between 2009 and 2010 increased from 1,984 to 3,314, a 67% increase. The year 2011 will likely outpace the number of Marcellus Shale well permits issued in 2010. Over 1,500 well permits were issued between January 1 and June 17, 2011, nearly half of the well permits issued in 2010. Figure 23 shows the number of wells drilled per year since 2005.

Figure 22: Marcellus Shale Well Permits Issued (2004 - 2011)



Source: Pennsylvania PA DEP, Bureau of Oil and Gas Management.

Figure 23: Marcellus Shale Wells Drilled by Year (2005 - 2011)



Source: Pennsylvania PA DEP, Bureau of Oil and Gas Management.

The location and number of Marcellus Shale permits issued and wells drilled generally follows the location and sweet spots suggested in Figure 8. The largest number of issued permits has been in Bradford, Susquehanna, and Tioga counties in the Northern Tier region and Washington and Greene counties in the Southwestern region (Fig.24).

A significant portion of the remaining 800,000 acres in the Marcellus gas play includes Wild Areas, Natural Areas, and sensitive ecological and recreation areas that are not offered for leases involving surface disturbance per department policy.

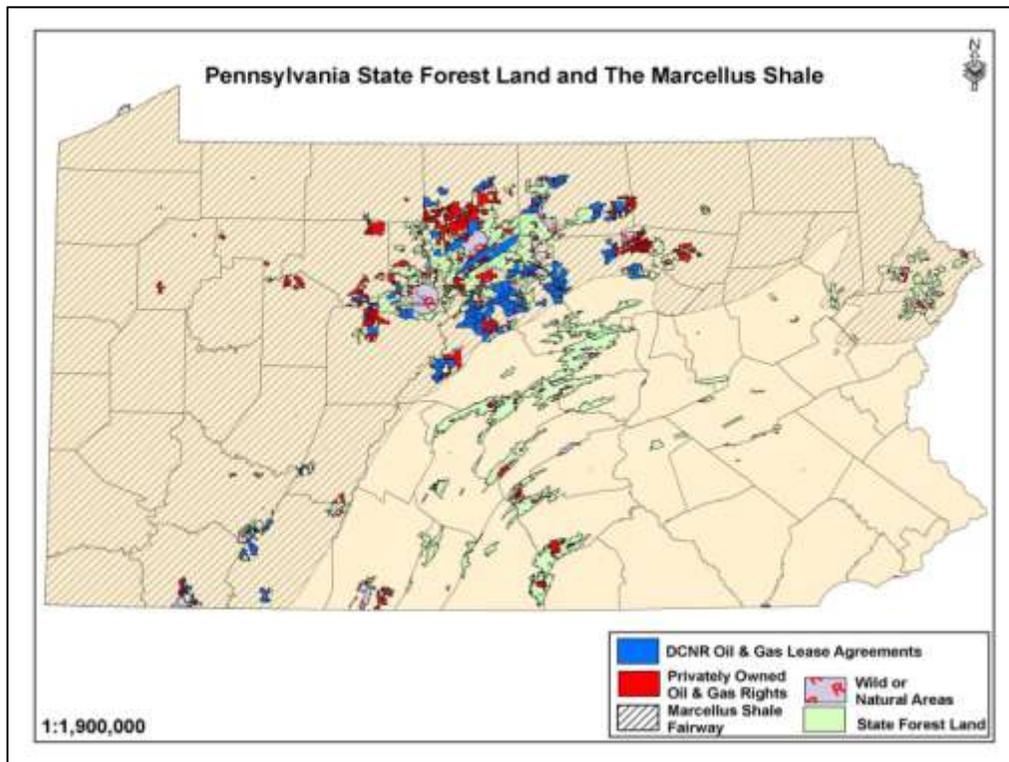
4.2.3 MARCELLUS SHALE LEASING

The first Marcellus lease sale occurred in 2008 and consisted of 74,023 acres and generated \$163 million in bonus bid revenue. The second Marcellus lease sale was held in early 2010, consisted of 31,947 acres, and generated \$130 million in bonus bid revenue. The third Marcellus leasing event took place in 2010 wherein the Commonwealth leased 32,896 acres, generating \$120 million in revenue. These three lease sales totaled 138,866 acres and \$413 million.

State forest lands leased prior to 2008 are not restricted from Marcellus drilling. Marcellus drilling is currently taking place on these acres leased prior to the 2008 and 2010 lease sales mentioned above.

The Bureau of Forestry has approved over 150 well pads and nearly 575 Marcellus well locations since 2008. The Commonwealth does not own the subsurface rights to approximately 290,000 acres within the State Forest System.

FIGURE 25 STATE FOREST LAND & THE MARCELLUS SHALE



Source: PA DCNR

4.2.4 OIL AND GAS DEVELOPMENT ON STATE PARK LANDS

Of the 293,000 acres of Pennsylvania State Park Lands, the Commonwealth owns about 20 percent of the subsurface rights. About 211,000 acres of State Park land (at least a portion of 61 parks) lies within the Marcellus Shale area. Where the Commonwealth owns the subsurface rights it has been DCNR's policy to not lease the land

for oil and gas development. On areas where the Commonwealth does not own the subsurface rights, 1,089 historical wells have been drilled. The DCNR encourages the subsurface owners to practice non-development practices where possible to minimize surface disturbance and public scrutiny. Currently, no Marcellus Shale wells have been drilled on State Park land. However, the southwest part of the system is highly active with Marcellus interest.

The following State Parks contain conventional oil/gas wells:

Presque Isle
Oil Creek
Chapman
Kinzua Bridge
Elk
Sinnemahoning
Kettle Creek
Cook Forest
MK Goddard
Moraine
Hillman
Ryerson Station
Yellow Creek
Keystone
Ohiopyle
Laurel Ridge
Beltzville
Mt. Pisgah

5. REGULATORY FRAMEWORK

Development and production of natural gas resources from the Marcellus Shale is conducted with oversight by the federal government; numerous state agencies and commissions; and affected municipalities. This section provides an overview of the agencies and commissions with regulatory oversight of Marcellus Shale natural gas development. In addition, summaries of the statutes, regulations, and policies at the federal, state, and local levels were prepared by each state agency or commission for the express purpose of due diligence conducted for this report. Federal statutes are discussed in conjunction with the state agency or commission that is responsible for implementing federal statutory intent.

5.1 THE ROLE OF STATE AGENCIES AND COMMISSIONS

While DEP plays a significant role in the regulation of Marcellus Shale natural gas development, several other state agencies and commissions have a responsibility as well.

5.1.1 PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP)

This summary includes many of the existing DEP regulatory programs that that come into play with the extraction of natural gas from the Marcellus Shale formation. The following qualifications are provided:

- DEP administers a large number of regulatory programs affecting Marcellus Shale natural gas development, pursuant to a number of statutes, regulations and policies. Consequently, it is difficult to develop a detailed list for every specific requirement and policy. The summary below contains the vast

majority of the relevant statutes, regulations and policies, in enough detail to be useful for the analysis called for in the Governor's Executive Order.

- Many program areas and their regulations emanate from more than one statute. For example, the Clean Streams Law provides legal authority for many of DEP's regulations.
- The program areas contained in this guidance do not apply separately. There is significant overlap in many circumstances. For instance, legal requirements related to radiation protection laws and regulations may arise in both the waste management and in the wastewater program areas.
- This summary is a snapshot in time. As Marcellus Shale natural gas development and associated activities expand in Pennsylvania, DEP will continually evaluate existing program policies and practices and make modifications accordingly.

5.1.2 PENNSYLVANIA DEPARTMENT OF CONSERVATION & NATURAL RESOURCES

The Pennsylvania Department of Conservation & Natural Resources (DCNR) acts as the leasing agent for natural gas extraction activities on the state lands it manages and has developed extensive guidance to ensure that extraction is accomplished with minimal impacts to human safety or the environment. DCNR does not issue permits for well drilling activities, rather oversight of these activities is performed by DEP. DCNR and DEP coordinate activities with regard to natural gas development on DCNR managed lands and DCNR manages the Pennsylvania Natural Diversity Inventory (PNDI) used in DEP's permitting process. DCNR's guidance and practices regarding Marcellus Shale natural gas development continue to evolve as shale gas extraction expands in Pennsylvania.

5.1.3 PENNSYLVANIA DEPARTMENT OF TRANSPORTATION

The Pennsylvania Department of Transportation (PENNDOT) seeks to deliver safe, efficient transportation services by providing information system policies, procedures, guidelines and regulations. The following tables outline the role of PENNDOT in regards to the Marcellus Shale industry.

5.1.4 PENNSYLVANIA EMERGENCY MANAGEMENT AGENCY

The summary below contains the Pennsylvania Emergency Management Agency (PEMA) and Office of the State Fire Commissioner (OSFC) statutes, regulations, and policies that are activated with the extraction of natural gas from the Marcellus Shale formation.

5.1.5 PENNSYLVANIA PUBLIC UTILITY COMMISSION

The Public Utility Commission (PUC) is the Commonwealth's regulatory agency for oversight of every "public utility" operating in Pennsylvania. The term "public utility" is defined in the Public Utility Code, 66 Pa. C.S. §102. With regard to Marcellus Shale natural gas development, the definition of public utility excludes gas producers except when a producer is "distributing such gas directly to the public for compensation". The definition of public utility includes the transportation of natural gas and hazardous liquids by pipeline "for the public for compensation." However, the factual circumstances when such pipeline public utilities are subject to PUC jurisdiction entails a very fact specific analysis. Presently pending before the PUC are several cases which will help to clarify the circumstances when a pipeline is providing transportation service as a public utility.

The Federal Energy Regulatory Commission (FERC) has exclusive jurisdiction over the interstate gas transportation of natural gas. However, the facilities involved in interstate transportation do not need to cross over state boundaries. Thus, many "interstate" pipelines may be wholly within Pennsylvania, but not subject to PUC jurisdiction because of their status as FERC jurisdictional. Other pipelines, particularly those functioning as

“gathering” pipelines, are not FERC jurisdictional. Such pipelines may be PUC jurisdictional but not all such pipelines are PUC jurisdictional.

The United States Department of Transportation Pipelines and Hazardous Materials Safety Administration (PHMSA), has oversight of all public utility and non-public utility gas and hazardous liquids pipelines regardless of status as FERC, PUC, or non-jurisdictional. The PUC is a state partner with PHMSA and the PUC has the primary role for gas safety over PUC jurisdictional pipelines.

In addition to the PUC’s direct jurisdiction over pipeline public utilities, several areas of Marcellus Shale natural gas reserves affect areas regulated by the PUC. These areas include common carrier transportation, water and wastewater, public utility service, wholesale gas purchases by natural gas distribution utilities, and the effects of gas prices in wholesale electric markets. These areas are not addressed in this summary.

5.1.6 PENNSYLVANIA DEPARTMENT OF AGRICULTURE

The Pennsylvania Department of Agriculture (PDA) encourages, protects and promotes agriculture and related industries throughout the commonwealth. This summary includes PDA regulatory programs that may be activated by the extraction of natural gas from the Marcellus Shale formation.

5.1.7 PENNSYLVANIA DEPARTMENT OF LABOR & INDUSTRY

The Pennsylvania Department of Labor & Industry (PA L&I) administers a large number of employment laws affecting Marcellus Shale natural gas development in their role as employers. The Center for Workforce Information and Analysis has included 23 occupations related to Marcellus Shale in the 2011 High Priority Occupations (HPO) statewide list. The Commonwealth’s workforce development strategy targets education and training dollars to HPOs. HPOs are job categories, within selected industry clusters, that are in demand by employers, have higher skill needs, and are likely to provide family-sustaining wages of at least \$29,574.

5.1.8 PENNSYLVANIA DEPARTMENT OF STATE

The Pennsylvania Department of State oversees the State Board of Landscape Architects and the State Board of Professional Engineers, Land Surveyors and Geologists. Professionals licensed by these boards are vital to natural gas exploration and production in the Commonwealth.

The State Board of Landscape Architects regulates the licensure and registration of landscape architects in order to promote the general welfare and safeguard the life, health and property of citizens of the Commonwealth of Pennsylvania. The functions of the Board include the promulgation of qualifications for a landscape architect license and the granting, revocation or suspension of a license and registration to practice landscape architecture.

The State Registration Board for Professional Engineers, Land Surveyors and Geologists regulates the practice, licensure and registration of engineers, land surveyors and geologists in the Commonwealth of Pennsylvania in order to safeguard life, health and property and promote the general welfare. The Board also certifies engineers-in-training and surveyors-in-training. The functions of the Board include investigating, approving or disapproving engineering, surveying, and geology applications for those desiring to be licensed in Pennsylvania.

5.2 State Statutes⁶

Agency	Statute Name	Citation	Activity	Description
PA DEP	Oil and Gas Act, the act of December 19, 1984	P.L. 1140, No. 223, as amended, 58 P.S. §§ 601.101 <i>et seq.</i>	Oil and Gas Exploration and Production	This statute sets forth the permitting, financial responsibility, drilling, casing, operating, reporting, plugging and site restoration requirements for oil and gas wells.
PA DEP	Oil and Gas Conservation Law, the act of July 25, 1961	P.L. 825, No. 359, as amended, 58 P.S. §§ 401 – 419	Well Spacing	This law establishes the Oil and Gas Conservation Commission, to govern well spacing and drilling units.
PA DEP	Coal and the Gas Resource Coordination Act, the act of December 18, 1984	P.L. 1069, No. 214 58 P.S. §§ 501 – 518	Permitting	This law governs the coordination of drilling permits with respect to workable coal seams, and plugging requirements.
PA DEP	The Clean Streams Law, the act of June 22, 1937	P.L. 1987, as amended, 35 P.S. §§ 691.1 <i>et seq.</i>	Permitting	This statute provides the Department with the basic legal authority to prevent and abate water pollution in Pennsylvania and to reclaim and restore all waters of the Commonwealth. This statute also establishes basic permit requirements for certain activities. The Department issues many different permits under this law, including permits under the National Pollutant Discharge and Elimination System (NPDES) pursuant to Chapter 92a.
PA DEP	Dam Safety and Encroachments Act, the act of November 26, 1978	P.L. 1375, No. 325, as amended, 32 P.S. §§ 693.1 <i>et seq.</i>	Water Obstructions and Encroachments	This statute provides the Department with the authority to regulate construction, operation, maintenance and removal of water obstructions and encroachments. The Department issues various permits under this statute, including those for stream crossings under Chapter 105.
PA DEP	Solid Waste Management Act, the act of July 7, 1980	P.L. 380, No. 97, as amended, 35 P.S. §§ 6018.101 <i>et seq.</i>	Solid Waste	This law establishes requirements for regulation of solid waste storage, collection, transportation, processing, treatment, and disposal. The Department issues various permits pursuant to this statute, including those for beneficial use of residual wastes.
PA DEP	Air Pollution Control Act, the act of Jan. 8, 1960	P.L. 2119, No. 787, 35 P.S. §§ 4001 <i>et seq.</i>	Air Quality	The primary law that governs all air quality issues in Pennsylvania, including the permitting, monitoring, and enforcement of all air contamination sources.
PA DEP	Storage Tank and Spill Prevention Act, the act of July 6, 1989	P.L. 169, No. 32, 35 P.S. §§ 6021.101 <i>et seq.</i>	Storage Tanks	This statute governs use of storage tanks and cleanup of spills.

⁶ The summaries provided in this document are very general and do not contain every element. Most of the statutes provide the Environmental Quality Board with the authority to promulgate regulations implementing the statute.

PA DEP	Water Resources Planning Act, the act of December 16, 2002	P.L. 1776, No. 220, 27 Pa. C.S. §§ 3101 <i>et seq.</i>	Water Withdrawals	This law requires the development of a State Water Plan, establishment of statewide Water Resource Committee, and registration, record keeping and periodic reporting of certain water withdrawals and withdrawal uses. It also provides for designation of critical water planning areas.
PA DEP	Noncoal Surface Mining Reclamation and Control Act, the act of December 19, 1984	P.L. 1093, No. 219, 52 P.S. §§ 3301 <i>et seq.</i>	Non-Coal Mining	This statute authorizes DEP to regulate noncoal surface mining activities and requires persons engaging in noncoal surface mining activities to obtain a noncoal surface mining license and permit prior to commencing such activities.
PA DEP	Act 14 – Section 1905-A of The Administrative Code	71 P.S. § 510-5	Notification of Municipalities	Requires permit applicants for certain permits to give written notice to municipalities in which the proposed activities are located.
PA DEP	Environmental Laboratory Accreditation Act, the act of June 29, 2002	P.L.1559, No. 169, 27 P.S. §§ 4101 <i>et seq.</i>	Laboratory Accreditation	This statute authorizes the Department to issue regulations establishing accreditation program for environmental laboratories.
PA DEP	Delaware River Basin Compact, the act of July 7, 1961	P.L. 518, No. 268, as amended, 32 P.S. §§ 815.101 <i>et seq.</i>	Compact	This statute codifies the Compact entered into by Pennsylvania.
PA DEP	Susquehanna River Basin Compact, the act of July 17, 1968	P.L. 368, No. 181, as amended, 32 P.S. §§ 820.1 <i>et seq.</i>	Compact	This statute codifies the Compact entered into by Pennsylvania.
PA DEP	Great Lakes – St. Lawrence River Basin Water Resources Compact, the act of July 4, 2008	P.L. 526, No. 43, 32 P.S. §§ 817.21 <i>et seq.</i>	Compact	This statute prohibits any diversions of the Great Lakes Basin with limited exceptions and provides the Department with regulatory authority over withdrawals that equal or exceed 100,000 gallons per day and joint authority over consumptive uses exceeding 5 million gallons per day.
PA DEP	Hazardous Material Emergency Planning and Response Act, the act of December 7, 1990	P.L. 639, No. 165, as amended, 35 P.S. §§ 6022.101 <i>et seq.</i>	Emergency Response	This statute governs hazardous material emergency planning and response.
PA DEP	Hazardous Sites Cleanup Act, the act of October 18, 1988	P.L. 756, No. 108, as amended, 35 P.S. §§ 6020.101 <i>et seq.</i>	Emergency Response	This statute governs hazardous sites cleanup.
PA DEP	PA Safe Drinking Water Act, the act of May 1, 1984	P.L. 206, No. 43, as amended, 35 P.S. §§ 721.1 <i>et seq.</i>	Water Supplies	This statute governs public water supplies.
PA DEP	The Radiation Protection Act, the act of July 10, 1984	P.L. 688, No.147, 35 P.S. §§ 7110.101 – 7110.703	Radiation	This statute governs radiation protection.

PA DEP	The Waste Transportation Safety Act, the act of June 29, 2008	P.L. 596, No. 90, 27 Pa. C.S.A. §§ 6201 <i>et seq.</i>	Waste	This statute establishes a waste transportation safety program for the transport of municipal and residual waste, including requirements for authorization from the Department.
PA DEP	Flood Plain Management Act, the act of October 4, 1978	P.L. 851, No. 166, as amended, 32 P.S. §§ 679.101 <i>et seq.</i>	Flood Plains	This statute governs management of flood plains.
PA DCNR	Conservation and Natural Resources Act, the act of June 28, 1995	P.L. 89, No. 18, (Act 18 of 1995), 71 P.S. §§ 1340.101 <i>et seq.</i>	Conservation	This statute declares that Pennsylvania's State forests and parks are a public natural resource and should be conserved and maintained for the use and benefit of all citizens. DCNR is authorized to hold, manage, control, protect, maintain, utilize, develop, and regulate the occupancy and use of State forests.
PA DCNR	Oil and Gas Lease Fund, the act of December 15, 1955	P.L. 865, No. 256, 71 P.S. §§ 1331 – 1333	Leasing	Requires all rentals and royalties from oil and gas leases on lands owned by the Commonwealth (other than PA Game and Fish & Boat Commission) be placed in the Oil and Gas Lease Fund and appropriates funds to be used at the discretion of the Secretary for conservation, recreation, dams, or flood control.
PA DCNR	Wild Resource Conservation Act, the act of June 23, 1982	P.L. 597, No. 170 (Act 170 of 1982), 32 P.S. §§ 5301 <i>et seq.</i>	Conservation	Authorizes DCNR to inventory and protect wild plants. To the extent gas development is planned for areas with protected plant species included in PNDI, DEP's permitting process requires coordination with DCNR to protect these species.
PA DCNR	Project 70 Land Acquisition and Borrowing Act, the act of June 22, 1964.	P.L. 131, No. 8, 72 P.S. §§ 3946.1 <i>et seq.</i>	Conservation	Provides funds to DCNR's grant program that supports the acquisition of land for conservation and recreation purposes. Use of the surface of these lands for gas development facilities is a conversion that requires DCNR approval and may require the purchase of land of equivalent conservation value to replace the disturbed surface area.
PA DCNR	Land and Water Conservation and Reclamation Act, the act of January 19, 1968.	P.L. 425, No. 148; 32 P.S. §§ 5101 <i>et seq.</i>	Conservation	Provides funds to DCNR's grant program that supports the acquisition of land for conservation and recreation purposes. Use of the surface of these lands for gas development facilities is a conversion that requires DCNR approval and may require the purchase of land of equivalent conservation value to replace the disturbed surface area.

PA DCNR	Recreational Improvement and Rehabilitation Act, the act of July 2, 1984	P.L. 527, No. 106; 32 P.S. §§ 5401 <i>et seq.</i>	Conservation	Provides funds to DCNR's grant program that supports the acquisition of land for conservation and recreation purposes. Use of the surface of these lands for gas development facilities is a conversion that requires DCNR approval and may require the purchase of land of equivalent conservation value to replace the disturbed surface area.
PA DCNR	Keystone Recreation, Park and Conservation Fund Act, the Act of July 2, 1993	P.L. 359, No. 50; 32 P.S. §§ 2011 <i>et seq.</i>	Conservation	Provides funds to DCNR's grant program that supports the acquisition of land for conservation and recreation purposes. Use of the surface of these lands for gas development facilities is a conversion that requires DCNR approval and may require the purchase of land of equivalent conservation value to replace the disturbed surface area.
PA DCNR	Environmental Stewardship and Watershed Protection Act, the act of December 15, 1999	P.L. 949, No. 68, as amended 27 Pa.C.S. §§ 6101 <i>et seq.</i>	Conservation	Provides funds to DCNR's grant program that supports the acquisition of land for conservation and recreation purposes. Use of the surface of these lands for gas development facilities is a conversion that requires DCNR approval and may require the purchase of land of equivalent conservation value to replace the disturbed surface area.
PDA	Noxious Weed Control Law	3 P.S. §§ 258.1 <i>et seq.</i>	Conservation	The law governing the control of noxious weeds in the Commonwealth. It sets forth a Noxious Weed Control Committee and Noxious Weed Control List with provisions for sale, transport or propagation of plants found to be injurious to crops, livestock and agricultural land, declaration and treatment of weed control areas, handling of noxious weed complaints, compliance orders and penalties. Movement of contaminated equipment, personnel, vehicles and water that may introduce and/or spread noxious weeds into and throughout the Commonwealth.
PDA	Pesticide Control Act of 1973	3 P.S. §§ 111.21 <i>et seq.</i>	Pesticides	The law relating to the labeling, distribution, storage, transportation, use, application and disposal of pesticides and devices; providing for registration and examination of such materials; the licensing of pesticide dealers and pest management consultants and imposing penalties. Companies involved in the drilling and extraction of natural gas may use pesticides on site to treat water used in the extraction process or vegetation.

PDA	Agricultural Conservation Easement Purchase Program, the act of June 30, 1981	P.L. 128, No. 43, 3 P.S. §§ 901-915	Conservation	Pennsylvania's farmland preservation program is administered at the state level by the Bureau of Farmland Preservation and locally by 57 participating county governments. The program allows preserved farm owners to sign gas leases and to engage in gas activity without limitations on size and location of well pads. The law anticipates appurtenant facilities related to removal of gas. In 2008, the department contacted preserved farm owners by letter, encouraging them to work with gas companies to locate wells and appurtenant structures where there are minimal impacts to viable farmland. There is growing concern among the county farmland preservation program administrators and the public about placement of structures, such as compressor stations, on preserved farmland.
PDA	Farmland and Forestland Assessment Act (Clean and Green Program), the act of December 19, 1974	P.L. 973, No. 319, 72 P.S. §§ 5490.1 - 5490.13	Conservation	The Clean and Green law is administered at the county level by tax assessment offices. The department provides for uniform interpretation of the Act and distributes the use values each year. The law was amended in 2010, as Act 88, to enable for oil and gas leasing activity, with rollback taxes due on those areas permanently devoted to the activity upon the completion of drilling and submission of a well site restoration report to the assessor by DEP.
PDA	The Conservation District Law, the Act of May 15, 1945	P.L. 547, No. 217	Conservation	Provides both county conservation districts and the State Conservation Commission a broad charge and certain legal authorities to provide for the conservation of soil, water and related resources of this Commonwealth, and authorizes any local, state or federal agency to "delegate" duties and authorities to conservation districts. Section 11(2)(a) of the Act specifically allows PA DEP to delegate to a conservation district any of its regulatory programs or duties, such as those provided by the The Clean Streams Law, the act of June 22, 1937 (P.L. 1987), as amended, 35 P.S. §§ 691.1 et seq., which provides DEP with the basic legal authority to prevent and abate water pollution in Pennsylvania.

PDA	Keeping and Handling of Domestic Animals, Ecoterrorism and Criminal Trespass Act, the act of July 11, 1996	P.L. 561, No. 100, 3 Pa.C.S.A. §§ 2301 – 2389	Conservation	Creates a definition of “agricultural biosecurity area,” and gives the Department of Agriculture specific authority to require the establishment of an “agricultural biosecurity area” should that be necessary to control disease. Additionally, the legislation makes it a misdemeanor of the third degree to enter an agricultural biosecurity area without authorization, and a summary offense to enter such an area without first performing the posted biosecurity measures. Trespassing into an agricultural biosecurity area will be considered ecoterrorism if there is intent to release a dangerous transmissible disease or hazardous substance into the environment.
PA Department of State	Architects Licensure Law, the act of December 14, 1982	P.L. 1227, as amended, 63 P.S. §§ 34.1 <i>et seq.</i>	Licensure	The State Board of Landscape Architects regulates the licensure and registration of landscape architects in order to promote the general welfare and safeguard the life, health and property of citizens of the Commonwealth of Pennsylvania. The functions of the Board include the promulgation of qualifications for a landscape architect license and the granting, revocation or suspension of a license and registration to practice landscape architecture.
PA Department of State	Engineer, Land Surveyor and Geologist Registration Law	63 P.S. §§ 148 <i>et seq.</i>	Licensure	The State Registration Board for Professional Engineers, Land Surveyors and Geologists regulates the practice, licensure and registration of engineers, land surveyors and geologists in the Commonwealth of Pennsylvania in order to safeguard life, health and property and promote the general welfare. The Board also certifies engineers-in-training and surveyors-in-training. The functions of the Board include investigating, approving or disapproving engineering, surveying, and geology applications for those desiring to be licensed in Pennsylvania.
PA L&I	Pennsylvania Construction Code Act, the act of November 10, 1999	P.L. 491, No. 45, as amended, 35 P.S. §§ 7210.101 – 7210.1103	Building Construction	Governs construction, alteration and occupancy of buildings and structures in the Commonwealth.
PA L&I	Boiler and Unfired Pressure Vessel Law, the act of June 18, 1998	P.L. 655, No. 85, as amended, 35 P.S. §§ 1331.1 – 1331.19	Safety	Governs the installation and use of boilers and unfired pressure vessels in the Commonwealth.
PA L&I	Liquefied Petroleum Gas Act, the act of June 19, 2002	P.L. 421, No. 61, as amended, 35 P.S. §§ 1329.1 – 1329.19	Safety	Governs the transfer and sale of liquefied petroleum gas and the installation of liquefied petroleum gas facilities in the Commonwealth.

PA L&I	Combustible and Flammable Liquids Act, the act of February 11, 1998	P.L. 450, No. 291, as amended, 35 P.S. §§ 1241 – 1252	Safety	Governs the installation, replacement or relocation of any tank, pump or drawing off device in connection with the possession, use, storage or sale of combustible or flammable liquids.
PA L&I	The Underground Utility Line Protection Law, the act of December 10, 1974	P.L. 852, No. 287, as amended, 73 P.S. §§ 176 <i>et seq.</i>	Safety	The law designed to protect the public health and safety by preventing excavation or demolition work from damaging underground lines by imposing duties on underground facility owners and other persons or entities who prepare drawings or perform excavation and/or demolition work within the Commonwealth.
PA L&I	Section 302(a) of the Workers' Compensation Act	77 P.S. § 461	Workers' Compensation	Provides that persons who contract with another to have work performed consisting of the removal, excavation or drilling of soil, rock or minerals are deemed contractors and hence employers under the Act. Such persons do not have to control or be in possession of the worksite to be considered employers.
PEMA	Emergency Management Services Code	35 Pa. C.S.A. §§ 7101 – 7707	Emergency Response	Title 35 is the main law governing emergency management services in Pennsylvania and includes the structure for state, county and local emergency management programs. Title 35 requires PEMA to establish and assist political subdivisions with training programs for all hazard emergency or disaster events. Under Title 35, PEMA provides emergency direction and control of state/local emergency operations and assists with state/local disaster emergency readiness, response, and recovery. Title 35 also contains the laws regarding the Public Safety Emergency Telephone Act (the "911 Act").
PEMA	Hazardous Material Emergency Planning and Response Act, the act of December 7, 1990	P.L. 639, No. 165, as amended, 35 P.S. §§ 6022.101 <i>et seq.</i>	Emergency Response	This statute governs hazardous material emergency planning and response.
Office of the State Fire Commissioner	Act 118 of 2010	35 PaCS – Health and Safety	Emergency Response	The Office of the State Fire Commissioner provides management responsibility for the State Fire Academy which delivers training to the state's fire and emergency response community.

PENNDOT	The Vehicle Code	75 Pa. C.S. §§ 101 through 9901	Vehicles	Provides vehicle registration requirements, financial responsibility, licensure requirements, restrictions of use, permitting authority, and various other provisions relating to registration, insurance and inspection, and provisions related to the safe operation of vehicles on Commonwealth highways.
PENNDOT	The State Highway Law	36 P.S. §§ 670 – 420	Roads	This law requires that any work performed on Commonwealth highways, including work performed pursuant to an excess maintenance agreement be performed by contractors prequalified by the Department. It also provides the basis for the Department’s highway occupancy program which governs driveway and private road access from property abutting the Commonwealth highways as well as the excavation of the highway surface for placement of drainage and utility pipelines
PUC	Public Utility Code	66 Pa. C.S. §§ 101, <i>et seq.</i>	Utilities	This law establishes the Pennsylvania Public Utility Commission and the framework for the regulation of public utilities.
Fish and Boat Commission	The Fish and Boat Code	30 Pa. C.S.A. §§ 101, <i>et seq.</i>	Conservation	Provides the Fish and Boat Commission with the authority to administer and enforce laws relating to the encouragement, promotion and development of the fishery interests; the protection, propagation and distribution of fish; the management of boating and the operation of boats; and the encouragement, promotion and development of recreational boating.

5.3 FEDERAL STATUTES

Agency	Statute Name	Citation	Activity	Description
PA DEP	The Federal Water Pollution Control Act	33 USC §§ 1251 <i>et seq.</i>	Water Quality	This statute establishes minimum federal standards for protection and restoration of water quality, and the National Pollutant Discharge Elimination System for point source discharges.
PA DEP	The Clean Air Act	42 USC §§ 7401 <i>et seq.</i>	Air Quality	This statute establishes minimum federal standards for protection and restoration of air quality.
PA DEP	The Safe Drinking Water Act	42 U.S.C. §§ 300f – 300j	Drinking Water	This statute establishes minimum federal standards for drinking water supplies, including underground injection.
PA DEP	Resource Conservation and Recovery Act (RCRA)	42 U.S.C. §§ 6901 <i>et seq.</i>	Waste	This statute establishes minimum federal standards for transport, handling, storage and disposal of wastes.

PA DEP	Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	42 U.S.C. §§ 9601 <i>et seq.</i>	Waste	This statute establishes a national cleanup program for hazardous substances.
PA DEP	Surface Mining Conservation and Reclamation Act	30 U.S.C. §§ 1201 <i>et seq.</i>	Non-Coal Mining	This statute establishes minimum federal standards for surface mining.
PA DEP	National Environmental Policy Act (NEPA)	42 U.S.C. § 4321 – 4370b	Multiple	This statute requires federal agencies to evaluate the environmental impact of federal actions significantly affecting the quality of the human environment.
PA DEP	Wild and Scenic Rivers Act	16 U.S.C. §§ 1271 – 1287	Water Quality	This statute protects wild and scenic rivers.
PA DEP	Emergency Planning and Community Right to Know Act	42 U.S.C. §§ 11001 <i>et seq.</i>	Emergency Planning	This law governs Emergency Planning and Community Right to Know.
PA DCNR	Federal Land and Water Conservation Fund Act	16 U.S.C. § 4601 <i>et seq.</i>	Conservation	Provides funds to DCNR's grant program that supports the acquisition of land for conservation and recreation purposes. Use of the surface of these lands for gas development facilities is a conversion that requires DCNR approval and may require the purchase of land of equivalent conservation value to replace the disturbed surface area.
PDA	Noxious Weed Act of 1974	7 U.S.C. §§ 2801 – 2814, <i>et seq.</i>	Conservation	Provides for the control and management of nonindigenous weeds that injure or have the potential to injure the interests of agriculture and commerce, wildlife resources, or the public health; comes into play when industry brings equipment and materials into PA from other states that may be infested with a federal noxious weed not yet established in PA.
PDA	Insecticide, Fungicide and Rodenticide Act of 1947	7 U.S.C. §§ 2801 – 2814, <i>et seq.</i>	Pesticides	The federal law regulating pesticides.
PUC	The Natural Gas Act	15 U.S.C. §§ 717 <i>et seq.</i>	Natural Gas Sale	This law preempts state regulatory authority powers over the transportation and sale of natural gas in interstate commerce.

PUC	Natural Gas Policy Act of 1978 (NGPA)	15 U.S.C. § 3301, <i>et seq.</i>	Pipelines	NGPA section 311, 15 U.S.C. § 3371(c), authorizes FERC to allow intrastate natural gas pipelines to transport natural gas on behalf of interstate pipelines “under such terms and conditions as [FERC] may prescribe.” NPGA section 601 (a)(2) exempts transportation service authorized under NGPA section 311 from FERC’s Natural Gas Act (NGA) jurisdiction.
PUC	FERC Natural Gas Policy	15 U.S.C. Chapter 60	Pipelines	Establishes federal/state “partnership” for pipeline safety overseen by federal Dept. of Transportation with grant funding for state partners.
PUC	Natural Gas Pipeline Safety Act of 1968 and Hazardous Liquid Pipeline Safety Act of 1979 (amended by Pipeline Safety Reauthorization Act of 1988, Pipeline Safety Improvement Act of 2002; Pipeline Inspection, Protection, Enforcement, and Safety Act; of 2006)	Codified with amendments at: 49 U.S.C. Chapters 601, 603, 605	Pipeline Safety	Establishes federal/state “partnership” for pipeline safety overseen by federal Dept. of Transportation with grant funding for state partners.

5.4 State Regulations

Agency	Regulation/Citation	Activity	Description
PA DEP	25 Pa. Code, Chapter 78	Oil and Gas Wells	Chapter 78 implements, <i>inter alia</i> , the Oil and Gas Act; contains basic requirements for natural gas well drilling, including operating standards for drilling, casing, cement, testing, monitoring and plugging of oil and gas wells to minimize gas migration and protect water supplies.
PA DEP	25 Pa. Code, Chapter 79	Oil and Gas Conservation	Chapter 79 implements, <i>inter alia</i> , the Oil and Gas Conservation Law, the Oil and Gas Act and the Gas Resource Coordination Act; addresses well spacing.
PA DEP	25 Pa. Code, Chapter 102	Erosion and Sediment Control	Chapter 102 requires persons proposing earth disturbance activities to develop and maintain best management practices to minimize the potential for accelerated erosion and sedimentation and the manage post construction stormwater.
PA DEP	25 Pa. Code, Chapter 105	Dam Safety and Waterway Management	Chapter 105 implements, <i>inter alia</i> , the Dam Safety and Encroachments Act, and the Flood Plain Management Act; provides for the comprehensive regulation and supervision of dams, reservoirs, water obstructions and encroachments.

PA DEP	25 Pa. Code, Chapter 93	Water Quality Standards	Chapter 93 defines specific water quality criteria and designated water uses to be protected and maintained for all surface waters in Pennsylvania; contains the water quality antidegradation program for protecting and maintaining existing water quality for exceptional value and high quality waters and existing uses of all surface waters.
PA DEP	25 Pa. Code, Chapter 95	Wastewater Treatment Requirements	Chapter 95 sets forth minimum treatment requirements for new and expanding mass loadings of Total Dissolved Solids, all industrial wastes and oil bearing wastes and discharges affected by Acid Mine Drainage.
PA DEP	25 Pa. Code, Chapter 96	Water Quality Standards Implementation	Chapter 96 establishes processes for achieving and maintaining water quality standards; addresses TMDLs.
PA DEP	25 Pa. Code, Chapter 91	Water	Chapter 91 sets forth several general provisions for administration and enforcement of Pennsylvania's water pollution control requirements; establishes specific application requirements, fee schedules, and conditions for the approval and permitting of the construction and operation of waste treatment facilities in Pennsylvania; sets forth requirements for reporting of releases that may cause pollution.
PA DEP	25 Pa. Code, Chapter 92a	NPDES	Chapter 92a implements the federal NPDES program by the Department.
PA DEP	25 Pa. Code, Chapter 106	Floodplain Management	Chapter 106 implements, <i>inter alia</i> , the Floodplain Management Act; contains permitting requirements for construction, modification or removal of obstructions in floodplains; provides for local management of floodplains.
PA DEP	25 Pa. Code, Chapter 110	Water Resources Planning	Chapter 110 implements, <i>inter alia</i> , the Water Resources Planning Act; establishes the requirements for registration of water sources, and record keeping and reporting of water withdrawal and use information.
PA DEP	25 Pa. Code, Chapters 121 – 129 and 131 – 145	Air	This regulation implements, <i>inter alia</i> , the Air Pollution Control Act; contains national standards of performance for new stationary sources, standards for contaminants, national emission standards for hazardous air pollutants, motor vehicle and fuels programs, construction, modification, reactivation and operation of resources, alternative emission reduction limitations, standards for sources, ambient air quality standards, local air pollution agencies, reporting of sources, air pollution episodes, sampling and testing, variances and alternate standards, disbursements from the clean air fund and interstate pollution transport reduction.

PA DEP	25 Pa. Code, Chapters 287 – 299	Waste	This regulation implements, <i>inter alia</i> , the Solid Waste Management Act; contains general provisions, residual waste landfills, residual waste disposal impoundments, beneficial use of coal ash, land application of residual waste, transfer facilities for residual waste, incinerators and other processing facilities, management of waste oil and storage and transportation of residual waste.
PA DEP	25 Pa. Code, Chapters 260 – 270	Waste	This regulation implements, <i>inter alia</i> , the Solid Waste Management Act; contains hazardous waste management system: general, identification and listing of hazardous waste, standards applicable to generators of hazardous waste, transporters of hazardous waste, owners and operators of hazardous waste treatment, storage and disposal facilities, interim status standards for owners and operators of hazardous waste treatment, storage and disposal facilities, management of specific hazardous wastes and specific types of hazardous waste management facilities, universal waste management, land disposal restrictions and hazardous waste permit program.
PA DEP	25 Pa. Code, Chapters 215 – 240	Radiation	This regulation implements, <i>inter alia</i> , implements, <i>inter alia</i> , the Radiation Protection Act; contains general provisions, registration of radiation-producing machines, licensing of radioactive material, fees, standards for protection against radiation, notices, instructions and reports to workers; inspections, x-rays in the healing arts, veterinary medicine, medical use of radioactive material, radiation safety requirements for industrial radiographic operations, radiation safety requirements for wireline service operations and subsurface tracer studies, radiation safety requirements for analytical x-ray equipment, x-ray gauging equipment and electron microscopes, radiation safety requirements for particle accelerators, packaging and transportation of radioactive material, low-level radioactive waste management and disposal, rebuttable presumption of liability of the operator of the regional low-level waste facility and radon certification.
PA DEP	25 Pa. Code, Chapters 803 – 808	Compact	This regulation implements, <i>inter alia</i> , the Delaware River Basin Compact; contains review and approval of projects, water withdrawal registrations and hearings and enforcement actions.
PA DEP	25 Pa. Code, Chapters 901.1 – 901.5	Compact	This regulation implements, <i>inter alia</i> , the Susquehanna River Basin Compact; contains, rules of practice and procedure, comprehensive plan and water quality, water supply charges, flood plains and groundwater protection area, Southeastern Pennsylvania.

PA DEP	25 Pa. Code, Chapter 245	Storage Tanks	Chapter 245 implements, <i>inter alia</i> , the Storage Tank and Spill Prevention Act; contains general provisions, certification program for installers and inspectors of storage tanks and storage tank facilities, permitting of underground and aboveground storage tank systems and facilities, corrective action process for owners and operators of storage tanks and storage tank facilities and other responsible parties, technical standards for underground storage tanks, technical standards for aboveground storage tanks and facilities, simplified program for small aboveground storage tanks and financial responsibility requirements for owners and operators of underground storage tanks and storage tank facilities.
PA DCNR	17 Pa. Code §§ 17.1 et seq.	Conservation	Describes the process for setting aside and protecting areas of State Parks of scenic, historic, geologic or ecological significance.
PA DCNR	17 Pa. Code § 21.21	Motor Vehicles	Requires a road use agreement for the use of State Forest roads for commercial purposes.
PA DCNR	17 Pa. Code §§ 27.1 et seq.	Conservation	Describes process for setting aside and protecting areas of State Forests of scenic, historic, geologic or ecological significance.
PA DCNR	17 Pa. Code §§ 45.1 et seq.	Conservation	Defines classification system for native wild plants in Pennsylvania and lists species within classifications.
PDA	7 Pa. Code Chapter 128	Pesticides	Contains the policies and procedures for labeling, distribution, storage and registration of pesticides; classification of restricted use pesticides; certification of pesticide applicators; licensing of pesticide dealers, commercial and public businesses and pest management consultants; registration of pesticide application technicians and prior notification of proposed pesticide applications.
PDA	7 Pa. Code Chapter 110.1	Conservation	Noxious Weed Control List: 13 plants deemed injurious to crops, livestock, agricultural land, and other property.
PA Department of State	49 Pa. Code §§ 15.1 – 15.63.	Licensure	Regulations of the State Board of Landscape Architects
PA Department of State	49 PA. Code, Chapter 37	Licensure	Regulations of the State Registration Board for Professional Engineers, Land Surveyors and Geologists

PA L&I	34 Pa. Code §§ 401.1 – 405.42	Uniform Construction Code	Contains the requirements needed to do construction, alteration and occupancy of buildings and structures in the Commonwealth.
PA L&I	34 Pa. Code §§ 3a.1 – 3a.171	Boiler and Unfired Pressure Vessels	Governs the installation and use of boilers and unfired pressure vessels in the Commonwealth.
PA L&I	34 Pa. Code §§ 13.1 – 13.54	Propane and Liquefied Petroleum Gas	Contains the requirements to transfer and sale of liquefied petroleum gas and the installation of liquefied petroleum gas facilities in the Commonwealth.
PA L&I	37 Pa. Code §§ 11.1 – 14.8	Flammable and Combustible Liquids	Contains requirements for the installation, replacement or relocation of any tank, pump or drawing off device in connection with the possession, use, storage or sale of combustible or flammable liquids.
PENNDOT	67 Pa. Code Chapter 60	Vehicles	This chapter establishes rules and procedures to implement permanent registration of fleet vehicles. To register under the Fleet Registration Program, an applicant must own or lease 15 or more vehicles for each fleet, with the exception of taxis, buses and limousines.
PENNDOT	67 Pa. Code Chapter 63	Vehicles	This chapter establishes rules and procedures for apportioned registration of vehicles under the International Registration Plan for vehicles which are operated in more than one state during a registration year. Apportioned registration is required for vehicles having a gross weight or registered gross weight in excess of 26,000 pounds, or vehicles having three or more axles, regardless of weight, or combinations with a gross weight in excess of 26,000 pounds.
PENNDOT	67 Pa. Code, Chapter 75	Licensure	This chapter contains regulations governing the licensing of drivers in Pennsylvania. The additional examination requirements for a commercial driver’s license are found in §§75.21 – 75.24.
PENNDOT	67 Pa. Code, Chapter 175	Vehicles	This chapter establishes the vehicle equipment standards and inspection procedures for each category of vehicle subject to a periodic safety inspection.
PENNDOT	67 Pa. Code, Chapter 179	Vehicles	This chapter contains regulations governing movement of mobile homes, modular homes and other vehicles that are over-weight and over-size on all Commonwealth highways because they exceed the statutory maximums prescribed in Chapter 49 of the Vehicle Code. It could have some applicability if the Marcellus Shale industry needs to move large drilling towers or fracking equipment to drilling sites.

PENNDOT	67 Pa. Code, Chapter 189	Roads/Infrastructure	This chapter regulates the use of posted highways by vehicles that exceed the posted weight limit. With certain exceptions, the regulations require the securing of a permit, the posting of a bond and the entry into an excess maintenance agreement for repair of the damage to the roadway caused by the excess posted-weight vehicles. This Chapter is perhaps the Department regulation having the most impact on the Marcellus Shale industry. Proposed emergency amendment to the regulation to clarify some terms and ensure a level playing field for all excess posted-weight haulers.
PENNDOT	67 Pa. Code, Chapter 191	Roads/Infrastructure	This chapter regulates the use of bridges restricted because of weight capacity or size [vertical/horizontal clearance] limitations. The regulation provides for narrow exceptions to weight and size restrictions and the issuance of a permit. Given the catastrophic nature of a potential bridge failure, such permits are not generously issued.
PENNDOT	67 Pa. Code, Chapter 193	Roads/Infrastructure	This chapter, like chapter 189, provides for the permitted use of highways by over-posted-weight or over-posted-size vehicles on roadways so posted, not because of the condition of the roadway, but because the configuration of the roadway or other traffic conditions make use of the posted roadway by such vehicles a hazard to the traveling public. It provides for the issuance of a permit that may require the use of pilot cars, establish maximum speed and other restriction of the movement to limit the hazard created by the movement of the over-posted-weight or over-posted size vehicle.
PENNDOT	67 Pa. Code, Chapter 212	Roads/Infrastructure	This chapter contains regulations governing the placement of active work zones where construction, maintenance or utility workers are on the roadway or on the shoulder of the highway, and workers are adjacent to an active travel lane when pipelines and well pad access driveways are being installed and constructed.
PENNDOT	67 Pa. Code, Chapters 229 and 231	Safety	These chapters contain the regulations governing the Motor Carrier Safety Program. Chapter 229 governs interstate travel; chapter 231 governs intrastate travel. These chapters largely adopt Federal requirements for commercial vehicles and commercial drivers and the Department's ability to deviate from these standards is limited by Federal law.
PENNDOT	67 Pa. Code Chapter 403	Vehicles	This chapter provides for the classification, packaging and placarding requirements relating to vehicles that transport hazardous materials.

PENNDOT	67 Pa. Code, Chapter 441	Roads/Infrastructure	This chapter contains the regulations governing highway occupancy permits (HOPs) generally. These provisions govern occupancy of driveways, private roads and drainage facilities required for Marcellus Shale drill site well pads and other gas industry facilities.
PENNDOT	67 Pa. Code, Chapter 457	Roads/Infrastructure	This chapter contains the regulations governing the prequalification of contractors permitted to perform work on Commonwealth highways, such as contractors performing highway repairs pursuant to an excess maintenance agreement under a permit issued under chapter 189
PENNDOT	67 Pa. Code, Chapter 459	Roads/Infrastructure	This chapter contains the regulations governing occupancy of highways by utilities. These provisions govern the placement of gas, water, and wastewater pipeline under and above the surface of Commonwealth highways by the industry.
PUC	52 Pa. Code § 59.3	Pipelines	Regulates pipeline safety.
PUC	52 Pa. Code, Chapter 60	Pipelines	Regulates natural gas transportation
PUC	52 Pa. Code §§ 69.341 <i>et seq.</i>	Pipelines	Policy statement regarding the least cost purchasing by Pennsylvania natural gas distribution companies following changes in interstate pipeline regulation.
PUC	58 Pa. Code §§ 51.1 <i>et seq.</i>	Conservation/Recreation	Provides for rules and regulations concerning fishing to aid in the better protection, preservation and management of fish; and boating and the management and operation of boats.

5.5 FEDERAL REGULATIONS

Agency	Regulation/Citation	Activity	Description
PA DEP	40 C.F.R. Parts 50 – 87	Air Quality	This regulation implements the Clean Air Act
PA DEP	40 C.F.R. Parts 141 – 147	Drinking Water Quality	This regulation implements the Safe Drinking Water Act
PA DEP	40 C.F.R. Parts 240 – 280	Waste	This regulation implements the Resource Conservation and Recovery Act (RCRA)
PA DEP	40 C.F.R. Parts 122-23, Part 435 and Part 437	General	This regulation covers the NPDES Permit program.

PA DEP	40 C.F.R. Parts 300 and 306	Waste	This regulation implements the Comprehensive Environmental Response, Compensation and Liability Act
PA DEP	30 C.F.R. Parts 761 – 955	Non-Coal Mining	This regulation implements the Surface Mining Conservation and Reclamation Act
PA DEP	18 C.F.R. Part 380	NEPA	This regulation implements the National Environmental Policy Act (NEPA)
PA DEP	18 C.F.R. Part 401 and 410	Compact	Implements the Delaware River Basin Compact
PA DEP	18 C.F.R. Part 801, 806 - 808	Compact	Implements the Susquehanna River Basin Compact
PUC	18 C.F.R. § 375.101 <i>et seq.</i>	General	General rules of the Federal Energy Regulatory Commission
PUC	18 C.F.R. § 284.121 – 126	Pipelines	Open access regulations
PUC	18 C.F.R. PART 152	Pipelines	Certification as a Hinshaw pipeline
PUC	18 CFR § 284.224	Pipelines	Blanket certificates for NGDCs and Hinshaw Pipelines
PUC	18 CFR §§ 284.141 – 142	Pipelines	Certain sales by Intrastate Pipeline
PUC	18 CFR § 281.201, <i>et seq.</i>	Pipelines	Natural gas curtailment, Natural Gas Policy Act
PUC	18 CFR § 225.1, <i>et seq.</i>	Records	Preservation of records, natural gas companies
PUC	18 CFR § 154.1, <i>et seq.</i>	Pipelines	Rate schedules and tariffs
PUC	49 CFR 190–193 and 198 and 199	Pipelines	Federal Pipeline Safety
PUC	49 C.F.R. § 192	Pipelines	Federal Pipeline and Hazardous Materials Safety

5.6 GUIDANCE DOCUMENTS

Agency	Document Name	Document Number	Activity	Description
PA DEP	Oil and Gas Operators Manual	550-0300-001	General	This manual contains guidance for permitting, drilling, BMPs for E&S control, well site environmental controls, waste management practices, well plugging and related activities.
PA DEP	Enforcement Actions by DEP's Oil and Gas Management Program	550-4000-001	Enforcement	The purpose of this document is to provide guidance to DEP's Oil and Gas Management staff in determining what courses of enforcement to pursue to resolve violations and bring about compliance, and to provide advisory information to the regulated industry.
PA DEP	Policy for NPDES Permits for Stormwater Discharges Associated with Construction Activities at Oil and Gas Wells	550-2100-008	Permitting	This guidance provides a framework, consistent with EPA guidelines, for determining when a NPDES stormwater permit is needed that considers the unique nature and business factors of typical oil and gas developments.
PA DEP	Administrative Policy and Procedure Manual	550-2000-001	General	The purpose of this guidance document is to delineate policy and describe office procedures for DEP's field staff in the oil and gas management program.
PA DEP	Approval of Brine Roadspreading Plans	550-2100-007	Waste	This policy applies as guidance for decisions by DEP's oil and gas management program when evaluating plans for spreading brine for dust control and road stabilization.
PA DEP	Civil Penalty Assessments in the Oil and Gas Management Program	550-4180-001	Penalties	The purpose of this document is to provide procedural guidance to DEP's Oil and Gas Management staff in calculating civil penalty amounts to seek in settlements, or to assess in penalty actions for violations, and to provide advisory information to the regulated industry.
PA DEP	Coal Pillars	550-2100-006	Permitting	This policy applies as guidance for decisions by DEP's oil and gas management program when considering coal pillar plans for approval.

PA DEP	Compliance Monitoring of Oil and Gas Wells and Related Facilities and Activities	550-3000-001	Monitoring	The purpose of this guidance document is to provide the Department's interpretation of applicable laws and regulations, and to provide instructional guidance to oil and gas operators as well as DEP staff.
PA DEP	Guidelines for Submitting Oil and Gas Well Bonds	550-2501-101	Bonding	The purpose of this document is to provide instruction to bond applicants and financial guarantors for submitting proper documents and financial instruments for oil and gas well bonds.
PA DEP	Oil and Gas Locational Guidance	550-2100-009	Permitting	This document provides guidance to applicants for authorizations issued by the Oil and Gas Program on how the Program intends to implement the Department's Locational Policy.
PA DEP	Oil and Gas Wastewater Permitting Manual	550-2100-002	Waste	This is a comprehensive manual to provide instructional guidance to oil and gas operators (or others) who would seek a DEP permit or approval to handle, treat and/or dispose of oil and gas wastewaters.
PA DEP	Oil and Gas Well Drilling Permits and Related Approvals	550-2100-003	Permitting	These policies apply as guidance for decisions by DEP's oil and gas management program when reviewing applications for well drilling permits and related approvals.
PA DEP	Pennsylvania's Plan for Addressing Problem Abandoned Wells and Orphaned Wells	550-0800-001	Well Plugging	This guidance document provides the Department's rationale in determining the optimal use of funds, including Growing Greener funding, available for plugging abandoned wells under contract. The strategy is to be incorporated into the state's Reclaim PA initiative.
PA DEP	Redrilling Incidental to Authorized Plugging of an Abandoned Well	550-2100-005	Well Plugging	This policy applies as guidance for decisions by DEP's oil and gas management program when considering an application for an order to plug an abandoned gas well under the authority of Coal and Gas Resource Coordination Act, Section 13(c).

PA DEP	Transfer of Oil and Gas Well Permit or Registration	550-2100-004	Permitting	These policies apply as guidance for decisions by DEP's oil and gas management program when considering applications for transfer of well drilling permits or registrations from one well operator to another.
PA DEP	Erosion and Sediment Pollution Control Program Manual	363-2134-008	Erosion and Sediment Control	This manual contains guidance for the design and implementation of E&S BMPs to achieve the regulatory requirements.
PA DEP	Stormwater Best Management Practices Manual	363-0300-002	Stormwater Management	This manual contains guidance for post construction stormwater management BMPs which may be incorporated as part of the Site Restoration Plan to achieve the regulatory requirements.
PA DEP	Permit Guidelines for Phased NPDES Stormwater Discharges Associated with Construction Activity Permits, Chapter 102 Erosion and Sediment Control Permits, and Chapter 105 Waterway Restoration Project Permits	363-2134-013	Erosion and Sediment Control	This document provides guidance on phased permit projects.
PA DEP	Locational Data Policy	392-0830-001	Permitting	The Department uses locational data generated by Water Use Planning Program staff, or locational data submitted for the Water Allocation Program, Chapter 110 Registration or Water Use Data System (WUDS) to ensure a 10-meter/32.8 feet or better level of accuracy.
PA DEP	Pennsylvania Natural Diversity Inventory (PNDI) Policy	400-0200-001	Permitting	Assists DEP and permittees in meeting legal requirements related to threatened and endangered (T&E) plant and animal species or critical habitat for these species.

PA DEP	Water Quality Antidegradation Implementation	391-0300-002	Water Quality	The Department uses this guidance to ensure protection of the existing uses of all surface waters, and the existing quality of High Quality (HQ) and Exceptional Value (EV) Waters, as required by regulation.
PA DEP	NPDES Permit Writers Manual	362-0400-001	Permitting	The guidance helps permit writers to develop accurate effluent limits and other permit conditions. It also helps the regulated community understand how permits are developed.
PA DEP	Water Quality Toxics Management Strategy	361-0100-003	Permitting	This document provides DEP regional staff and the public guidance for the treatment of toxic pollutants in NPDES permits.
PA DEP	Guidelines for Identifying, Tracking and Resolving Violations for Water Quality	362-4000-006	Water Quality	This internal guidance document is intended to provide guidelines to program staff to implement the provisions of the Standards and Guidelines for Identifying, Tracking and Resolving Violations Policy.
PA DEP	Civil Penalty Assessment Procedure for Pollution Incidents	362-4180-002	Penalties	This penalty assessment procedure is to be used for Clean Streams Law violations that involve: 1. Spills and other pollution incidents which affect surface streams. 2. Readily correctable operation and maintenance problems at permitted facilities that result in discharge violations.
PA DEP	Guidance for Calculation of Civil Penalties for Willfulness	362-4180-003	Penalties	This guidance document provides a consistent and equitable procedure for calculating civil penalties willfulness.
PA DEP	Guidance for Civil Penalties Calculations for Effluent Violations	362-4180-001	Penalties	This guidance document provides a consistent and equitable procedure for calculating civil penalties for effluent violations.
PA DEP	Air Pollution Control Act Compliance History Review and Civil Penalty Assessment Procedures	273-4100-005	Penalties	This guidance document provides the background and justification for the compliance review and civil penalty assessment procedure.

PA DEP	Compliance Docket Procedure	273-4130-004	Compliance	This document provides procedures for Field Staff to use in implementing compliance docket requirements of the Air Pollution Control Act.
PA DEP	Guidance for Application of Regional Civil Assessment Procedure	273-4130-003	Penalties	This document outlines the procedures to be followed for assessing civil penalties for various violations.
PA DEP	Best Available Technology and Other Permitting Criteria	275-2101-007	Permitting	Guides public on Best Available Technology applicability and provides general guidance.
PA DEP	Air Quality Operating Permit Modification/Reactivation	275-2101-004	Permitting	Provides guidance for Regional Personnel in reviewing Plan Approval Applications where source modification/reactivation is involved.
PA DEP	Air Quality Operating Permit Permitting Procedures	275-2101-002	Permitting	Establishes operating permit procedures and provides guidance Regarding source clarification, ownership changes, expired plan approval extensions, permit fees.
PA DEP	Air Quality Operating Permit Protocol	275-2101-001	Permitting	Provides guidance for regional personnel in reviewing plan approval applications and conducting permit inspections.
PA DEP	Air Quality Operating Permit Requirements	275-2101-006	Permitting	Clarifies applicability of state requirements to federal facilities and defines responsibilities and cooperation between the Departments program when these responsibilities overlap.
PA DEP	Air Quality Permit Exemptions	275-2101-003	Permitting	Defines determinations made regarding permitting exemptions as provided in the permitting regulations.
PA DEP	Prevention of Significant Deterioration	275-2101-014	Permitting	Provides guidance for Regional Personnel in reviewing plan approval application for conformance with Prevention of Significant Deterioration requirements.
PA DEP	Public Notification	275-2101-011	Notification	Provides models for preparation of public notices.

PA DEP	Source Testing Manual (Revision 3.3)	274-0300-002	Reporting	The purpose of this document is to provide detailed information on source test methods, procedures and guidance for the reporting of emissions to the Department.
PA DEP	Guidelines for the Development and Implementation of Environmental Emergency Response Plans	4000-2200-001	Emergency Response	To improve and preserve the purity of the Waters of the Commonwealth by prompt adequate response to all emergencies and accidental spills of polluting substances for the protection of public health, animal and aquatic life and for recreation.
PA DCNR	Guidelines for Administering Oil and Gas Activity on State Forest Lands	Version 2011-1, April 26, 2011	State Forests	Describes best management practices, review and approval processes, waivers, field inspections, emergency and pollution incident responses, and guidance on restoration and other issues associated with oil and gas activity on State Forest lands.
PA DCNR	Minimizing the Impact of Oil and Gas Development on State Parks	Bulletin # RM-P-O-15-43	Conservation	Limits impact to State Park natural, historical, cultural, educational, and recreational resources from the extraction of oil and gas resources by prohibiting all oil and gas development when the Commonwealth owns the subsurface mineral rights except in rare instances when (1) significant land and water conservation benefits will result, or (2) some benefit to the State Park exists and no significant impact will occur to park resources.
PA DCNR	DCNR Gas Lease Policy and Process	2010	Leasing	Provides a brief overview of DCNR's natural gas leasing program on State Forest lands.
PA DCNR	Managing the Effects of Natural Gas Development	2010	Conservation	Provides a brief overview of the scope of environmental review, techniques to minimize impacts, and restoration/reclamation of sites on State Forest lands leased for oil and gas extraction.
PA DCNR	Natural Gas Development, Public Access, and Recreation	April 7, 2011	Conservation	Provides summary of the requirements, policies and practices developed for balancing the recreational uses of the State Forest with natural gas development.

PA DCNR	State Forest Assessment	June 2010	Planning	Five-year assessment that provides a holistic, long-term evaluation and strategic planning effort for Pennsylvania's forests.
PA DCNR	Impacts of Leasing Additional State Forest lands	2010	Leasing	DCNR's assessment of how additional leasing will impact the state forest resources.
PA DCNR	Forest Sustainability Certification	March 30, 2011	Conservation	Overview of process to achieve forest sustainability certification based on the principles and criteria developed by the Forest Stewardship Council (FSC), which are the international gold standard for environmentally and socially responsible forestry.
PA DCNR	Bureau of Forestry Strategic Plan	1995	Conservation	Describes the key principles necessary to achieve the long-term health and productivity of the State Forests.
PA DCNR	State Forest Resource Management Plan	Revised in 2007	Conservation	Contains goals, objectives, inventories, procedures, and guidelines for managing the State Forest. Geology/Minerals is one of the fifteen main chapters of the plan.
PDA	Negotiating Oil and Gas Leases on Pennsylvania Farmland	2008	Leasing	Guides farm owners in decisions related to signing leases and consideration of impacts to farmland.
PDA	Pennsylvania Dirt and Gravel Road Program (DGRP)	April 1997	Roads	This program provides training, technical assistance and grant funding to municipalities and other governmental entities that maintain dirt and gravel roads throughout the Commonwealth. This program is administered by the State Conservation Commission, in cooperation with county conservation districts. Technical training and support is provided by the Penn State Center for Dirt and Gravel Road Studies.
PENNDOT	Maintenance Manual	Publication 23, Chapter 15	Roads	This chapter of the Maintenance Manual provides additional guidance in the application of the requirements of Chapter 189 of the regulations.

PENNDOT	Special Hauling Permit Manual	Publication 31	Vehicles	This is the publication that provides guidance to the Department and applicants/permittees regarding oversized and/or overweight (i.e. special hauling) permits for some industry related vehicles.
PENNDOT	Highway Occupancy Permit Manual	Publication 170	Roads	This is the Department's internal manual providing guidance to Department personnel relating to the administration of the Highway Occupancy Permit (HOP) program. There are several recent strike-off letters (SOL's) amending this manual that specifically impact the industry, including guidance on issuance of utility permits to facility owners, who can be an HOP applicant, indemnification and types of security for HOPs.
PENNDOT	Highway Occupancy Permit Manual	Publication 282	Roads	This publication provides utility facility, driveway and private road applicants guidance for the HOP program. This manual and other guidance and information for HOP applicants is available on the PENNDOT website.
PENNDOT	Highway Construction Specifications	Publication 408	Roads	This publication is incorporated as a standard term in the excess maintenance agreements entered into under 67 Pa. Code, Chapter 189.

5.7 EXECUTIVE ORDERS

Agency	Executive Order Number	Activity	Description
PA DCNR	Executive Order 2010 - 05	Moratorium	Prohibits further leasing of Commonwealth lands managed by DCNR for oil and gas development to avoid jeopardizing DCNR's ability to fulfill its duty to conserve and maintain these public natural resources and sustain DCNR's Forest Stewardship Council certification.
PDA	Executive Order 2004 - 1	Conservation	Governor's Invasive Species Council: as chaired by the Secretary of Agriculture, established to "...minimize the harmful ecological, economic and human health impacts of invasive species through the prevention and management of their introduction, expansion and dispersal into, within and from Pennsylvania."

5.8 PENNSYLVANIA MUNICIPALITIES

5.8.1 STATE STATUTES

- Municipalities Planning Code (MPC), act 247 of 1968, (P.L. 805, No. 247), reenacted and amended. The MPC sets forth the provisions for municipalities to individually or jointly plan development by zoning, subdivision and land development ordinances, planned residential development and other ordinances, by official maps, by the reservation of certain land for future public purpose and by the acquisition of such land. Further, the MPC sets forth provisions for municipalities to:
 - Provide for the reasonable development of minerals in each municipality;
 - Provide for the establishment of planning commissions, planning departments, planning committees and zoning hearing boards, authorizing them to charge fees, make inspections and hold public hearings;
 - Provide for further land use related activities as set forth in the act.

The MPC requires land use controls to be consistent with and not exceed the provisions of the Oil and Gas Act.

6. DEP REGULATORY CHANGES PROMPTED BY MARCELLUS SHALE ACTIVITY

Several unique environmental and regulatory challenges are presented by development in unconventional natural gas reserves. DEP has responded quickly to strengthen an already comprehensive regulatory structure to address these challenges. In May 2010, the Pennsylvania Department of Environmental Protection (DEP) volunteered to have its hydraulic fracturing program reviewed by State Review of Oil and Natural Gas Environmental Regulations, Inc. (STRONGER), a non-profit, multi-stakeholder organization. The STRONGER review team consisted of three team members and four official observers. The three team members were: Lori Wrotenbery, Oil and Gas Conservation Division of the Oklahoma Corporation Commission; Wilma Subra, Subra Co., New Iberia, Louisiana; and Jim Collins, Independent Petroleum Association of America. The official observers were: Tom Au, Pennsylvania Chapter of the Sierra Club; Steve Rhoads, East Resources; Brad Field, Division of Mineral Resources of the New York Department of Environmental Conservation; and Dave Rectenwald, U.S. Environmental Protection Agency.

The review team concluded that the Pennsylvania program is, over all, well-managed, professional and meeting its program objectives. The review team also made recommendations for improvements in the program – many of which were incorporated into the new well construction regulations that were finalized in February 2011. A synopsis of state regulatory changes that have been adopted since Marcellus Shale activity increased follows.

6.1 WELL PERMIT FEES AND STAFFING INCREASES

One of the first steps DEP took to ensure that development of the Marcellus Shale is conducted in an environmentally protective manner was to substantially increase the well permit fee in order to increase the staff devoted to the oil and gas program.

The Oil and Gas Act passed in 1984 established a \$100 fee for Oil and Gas well permits. Although the law allowed DEP to increase the fee by regulation, it had not done so until December 16, 2008. At that time, the Pennsylvania Environmental Quality Board (EQB) took the extraordinary step of approving a well permit fee regulation through the expedited omission of notice of proposed rule making process. As a result of the rulemaking, Marcellus well permit fees were increased from \$100 to an average of \$2,850 (the fee increases as the length of the well increases).

With the increased well permit fee, DEP substantially increased the oil and gas program staff. Prior to the staff increase, DEP had fewer than 90 people assigned to the program. Today, 202 staff members are assigned to the program – 84 of whom are devoted exclusively to well site inspection.

The regulation adopted in 2008 requires the EQB to assess the adequacy of the fee at least every three years and make necessary fee adjustments. This will ensure that the oil and gas program maintains staffing levels that are appropriate for the amount of well drilling activity in the Commonwealth.

6.2 WATER USE, WASTEWATER STORAGE, AND WASTEWATER DISPOSAL

6.2.1 WATER USE

While the volume of water to fracture a Marcellus Shale well is greater than the amount required to fracture traditional wells in Pennsylvania, the use of water for Marcellus Shale natural gas development is quite small in comparison with other energy sources and other sources in general. Marcellus Shale natural gas wells use 0.2% of the daily statewide total water withdrawn at 1.9 million gallons per day (MGD). This is in stark contrast to electric generation power plants, especially nuclear generation, which use 6.43 *billion* gallons per day (BGD). Other major uses include public water suppliers (1.42 BGD); industrial users (770 MGD); aquaculture (524 MGD); private water wells (152 MGD); mining (95.7 MGD); livestock (61.8 MGD); and irrigation (24.3 MGD). Of the top 10 water use industries in Pennsylvania, water withdrawn for Marcellus Shale well development ranks 9th.

Still, withdrawing more than 5 million gallons per well from the headwaters of the Commonwealth's most pristine streams has the potential to impair water quality through diminished stream flows. To prevent impacts from occurring, Marcellus operators are only permitted to withdraw water pursuant to an approved water management plan.

There are three entities charged with protecting water quality by managing water withdrawals in Pennsylvania: DEP, the Susquehanna River Basin Commission, and the Delaware River Basin Commission. The two River Basin Commissions were formed by a compact between the federal government, Pennsylvania, and neighboring states within the respective watersheds. If a Marcellus well is drilled within the Susquehanna or Delaware River watershed, DEP and Commission approval of the operator's water management plan must be obtained before construction of the well site can begin. If the well is located outside those two river basins, only DEP approval is necessary.

The water management plan is based on low flow conditions and describes where water will be withdrawn, how much water will be required, and the amount of water that will be withdrawn at any one time. Evaluation of the plan involves looking both upstream and downstream to assess cumulative impacts, taking into account all other withdrawals and discharges and their impact on the resource, particularly during low flow periods.

Once approved, the plan is valid for each location for five years. Although the Commonwealth has ample water resources, operators will be required to cooperate to make sure that access to water is available as additional plans are submitted for headwater streams.

6.2.2 WASTEWATER STORAGE

A new occurrence associated with Marcellus Shale wells is the advent of centralized impoundments. Unlike pits located immediately adjacent to a well, centralized impoundments use dam like structures to hold enough water to service multiple wells over an extended period of time. These impoundments can store freshwater, and more increasingly, flowback from hydraulic fracturing.

Under DEP's dam safety regulations, small freshwater impoundments – similar to a farmer's pond - do not need a permit. However, Marcellus Shale impoundments can hold over 15 million gallons and if wastewater is stored, must be permitted and constructed according to DEP standards. Key standards include embankment construction standards, an impervious clay sub-base, two impervious 40 mil liners with a leak detection zone between, and groundwater monitoring wells around the impoundment. Impoundments located where a breach could threaten public safety require a stringent engineering review.

6.2.3 WASTEWATER TREATMENT AND DISPOSAL

Wastewater treatment and disposal is a significant issue facing Marcellus Shale operators. Operators report that approximately 15% of the 5 plus million gallons of water used to fracture a well is returned to the surface during the initial flowback period.

Flowback from Marcellus Shale hydraulic fracturing contain pollutants of concern – particularly high levels of dissolved salts. Indeed, flowback water is several times saltier than sea water. Thus, Total Dissolved Solids (TDS) represent a growing concern for the Commonwealth's waterways and DEP developed a proactive strategy to address this concern.

A solution for disposing of high TDS wastewater is deep well injection. Unfortunately, the best geology in Pennsylvania for this method of waste disposal is being used for gas storage. Exploration for new injection sites is ongoing but not yet commercially available.

The preferred method of flowback water disposal, prior to April 19, 2011, was through existing DEP approved wastewater treatment plants. These plants typically do not have the technology necessary to remove TDS from the effluent and instead rely on dilution. To address concerns over protecting downstream drinking water supplies, Governor Corbett and Secretary Krancer called on Marcellus Shale drillers to cease taking wastewater to facilities that do not remove dissolved solids such as bromide. The well drilling industry committed to meet this request by the effective date of May 19, 2011. DEP will evaluate treatment plant well driller records to determine compliance with this request.

This is not to say that surface water discharges of treated wastewater is not a viable option. Instead, DEP's recently promulgated Chapter 95 regulations address the remaining treatment facilities and completely eliminate any potential cumulative impact from oil and gas wastewater discharges. Additionally, several operators are utilizing and exploring options related to on-site treatment of the wastewater and its re-use at subsequent well pad sites.

This new rule is the first of its kind in the country and limits the discharge of TDS from new or expanded facilities that take oil and gas wastewater to drinking water standards. The regulations do not allow for new discharges that exceed 250 mg/l for chlorides. Therefore, under the new regulations drinking water supplies would not be impaired due to oil and gas drilling. The process of eliminating TDS will also remove radium. Thus, in addition to reducing the contaminants discharged to our streams, the new Chapter 95 rule will increase the use of recycled water, promote the development of alternative forms of disposal, and perhaps promote the use of alternative sources of fracturing fluid.

6.3 GAS WELL CONSTRUCTION

Drilling any well – even a water well – has the potential to impact fresh groundwater. While this potential may exist, such an impact is not acceptable. Protecting groundwater supplies is of utmost importance and the Oil and Gas Act is particularly strict in this regard. If a well operator impacts a water supply (by pollution or diminution),

the operator *must* restore or replace it and pay for any increased costs of maintaining or operating the replacement supply.⁷

In fact, if an oil or gas well is drilled within 1,000 feet of a water supply and the water supply becomes polluted within 6 months of drilling, the operator is *presumed* to have caused the pollution unless a water sample was taken that demonstrates the pollution was present before the oil or gas well was drilled.⁸ Obtaining a pre-drilling water sample from all supplies within 1,000 feet of a gas well should be a standard business practice.

The goal is to avoid groundwater impacts in the first place; therefore, DEP recently promulgated new regulations that significantly strengthen the well construction standards. These new regulations accomplish five outcomes.

First, the regulations will establish more stringent well construction standards for all new wells drilled in Pennsylvania. Second, the regulations impose new requirements on operators to inspect existing wells and report findings to DEP. Third, the regulations codify existing case law on water supply replacement requirements and clearly describe an operator's responsibilities if the operator contaminates or diminishes a water supply. Fourth, the regulations impose a duty on operators to investigate complaints of gas migration and to mitigate any hazards found in the course of the investigation. Finally, the regulations require reporting of chemicals used to hydraulically fracture wells.

Below is a brief description of the new requirements in 25 Pa. Code Chapter 78.

6.3.1 NEW WELL DRILLING

Properly cementing and casing a well is critical to preventing gas migration. Prior to drilling a well, operators are required to develop a casing and cementing plan that shows how the well will be drilled and completed. Use of centralizers (which keep the casing centered in the well bore) must be used at prescribed locations to ensure that cement is evenly distributed between the casing and the well bore. Cement meeting ASTM criteria for oil and gas wells must be used. Documentation of the cement quality and cementing practices used at the well must be available for DEP inspection.

When cementing a well, if cement is not returned to the surface the operator must install a second string of casing for an added layer of protection. If cement is returned to the surface and the operator intends to only use surface casing, the operator must demonstrate that any gas, oil and produced fluids cannot leave the well bore.⁹

Used or welded casing must be pressure tested. Casing strings attached to heavy duty blow-out preventers, such as Marcellus intermediate casing, must also be pressure tested.

6.3.2 EXISTING WELLS

Operators must inspect each of their wells quarterly and report the findings of the inspections to DEP annually. If defective casing, evidence of leaks, or excessive pressure within the well bore is discovered, the operator must immediately notify DEP and take corrective action.

6.3.3 WATER SUPPLY REPLACEMENT

The Oil and Gas Act requires any operator who contaminates or diminishes a water supply to restore or replace the supply with one that is adequate in quantity and quality for the purposes served. Case law on these requirements

⁷58 P.S. § 601.208

⁸ 58 P.S. § 601.208(c)

⁹ Marcellus Shale operators typically use surface, intermediate, and production casing.

has defined when an operator must provide compensation for increased operation and maintenance costs (when costs are more than a de minimus amount) and for what duration (in perpetuity). The regulations codify these and other relevant holdings to clearly describe the operator's responsibility.

6.3.4 GAS MIGRATION RESPONSE

The new regulations impose a duty on operators to immediately investigate a gas migration complaint and to notify DEP if such a complaint is received. If natural gas is found at elevated levels (10% of the lower explosive limit) the operator must immediately notify emergency responders and initiate mitigation measures including advisories and controlling access to the area.

6.3.5 REPORTING REQUIREMENTS

The practice of hydraulic fracturing has drawn considerable attention recently. One of the primary concerns involves the chemicals used during the process. DEP's new regulations require operators to disclose the chemical additives and the hazardous constituents of those additives on a well by well basis. DEP has never observed any evidence that hydraulic fracturing has directly contaminated fresh groundwater despite tens of thousands of wells being fractured over the past several decades.

7. PERMITTING OVERVIEW

DEP administers a comprehensive permitting program for oil and gas well development. Pennsylvania regulates oil and gas well operations under several statutes, noted previously, including the Oil and Gas Act, the Clean Streams Law, the Dam Safety and Encroachments Act, the Solid Waste Management Act, and the Air Pollution Control Act.

7.1 WELL PERMIT

No oil, gas, gas storage, or oil and gas wastewater disposal well can be drilled or operated without a well permit from DEP. Permitting is primarily accomplished under the Oil and Gas Act. This law sets forth the permitting, bonding, well construction, site restoration, operating, plugging, reporting, and gas storage requirements, among other aspects of well operation.

Obtaining a well permit is largely a function of obtaining an approved bond and properly locating the well.

7.1.1 BONDING

The Oil and Gas Act requires all oil and gas wells drilled after April 17, 1985 to be bonded. A bond must be approved prior to issuing a permit for a new well. The bond must remain in effect for one year after the date of filing a Certificate of Plugging, until the well is transferred, or the bond is replaced.

The Act establishes bond amounts and allows the requirement to be met through surety, collateral, trust agreement, or in some cases, phased deposits of collateral. Bond amounts are \$2,500 for a single well or \$25,000 for a blanket bond covering all wells.

7.1.2 SITE RESTRICTIONS

Oil and Gas well sites cannot be located within 100 feet of streams and wetlands that are one or more acres in size. DEP may waive these restrictions if additional protective measures are included as conditions to the well permit. Typical conditions include additional erosion and sediment control measures and measures to address additional fresh water encountered while drilling. Also, wells may not be drilled within 200 feet of a water supply or within 200 feet of a home or workplace unless owner permission is obtained or there is no alternative well location.

Additional well location considerations occur under the Oil and Gas Conservation Law and the Coal and Gas Resource Coordination Act described as follows.

The Oil and Gas Conservation Law governs oil and gas wells which are drilled to a depth of at least 3,800 feet and penetrate the Onondaga horizon (these wells are referred to as "conservation wells"). This law provides for resource pooling and requires that conservation wells are spaced 330 feet from the lease boundary.

The Coal and Gas Resource Coordination Act coordinates gas well drilling with coal mining. The Act applies to gas wells which penetrate underground workable coal seams. These wells must be located 1,000 feet apart unless they are part of a "well cluster". Well clusters are part of a multi-well pad and must be located 2,000 feet away from other well clusters unless the coal owner agrees otherwise. Wells subject to the Conservation Law are not subject to these spacing requirements. On May 13, 2011 Governor Corbett signed Act 2 into law, which makes comprehensive changes to this Act to enhance the efficient development of both coal and natural gas resources within the Commonwealth.

7.2 SITE CONSTRUCTION

7.2.1 EARTH MOVING

Stormwater runoff is a leading cause of stream impairment in Pennsylvania. To address this problem, DEP has developed a comprehensive stormwater management program. Pursuant to 25 Pa. Code Chapter 102, all earth disturbance activities must employ best management practices such as silt fences and road side culverts to control erosion and manage stormwater.

Well site construction which disturbs greater than 5,000 square feet or has the potential to discharge sediment to High Quality or Exceptional Value waters classified pursuant to 25 Pa. Code Chapter 93, requires preparation and approval of an erosion and sediment control (E & S) plan. This E&S plan must be kept on site for review by DEP. If development of the well site, access roads, and other related facilities disturb 5 or more acres, the operator must obtain an Erosion and Sediment Control General Permit. This permit is required under Pennsylvania's Clean Streams Law with implementing regulations at 25 Pa. Code Chapter 102. The permits are issued by DEP staff unless the permit is for a FERC or PUC regulated pipeline. Pipeline projects are permitted by County Conservation Districts.

Finally, 25 Pa. Code Chapter 105 (Dam Safety and Encroachment regulations) requires well operators to obtain an encroachment permit if a well site or other support facility such as an access road or water withdrawal pad is located within a Federal Emergency Management Agency (FEMA) designated floodway. If FEMA has not designated a floodway, as can be the case for small streams, the operator must obtain a permit if the facility will be within 50 feet of a stream.

7.2.2 ENCROACHMENTS AND CROSSINGS

If the project requires encroaching or crossing a stream or wetland, additional permits under the Dam Safety and Encroachments Act are required. These encroachments and crossings are typically issued pursuant to one of the general permits listed below.

GP3 - BANK REHABILITATION, BANK PROTECTION AND GRAVEL BAR REMOVAL

This general permit is for the placement of materials along the bank of a stream to prevent erosion or for gravel bar removal.

GP-4 - INTAKE AND OUTFALL STRUCTURES

This general permit is for outfall structures with a diameter less than 36 inches which are in, along, across, or projecting into a watercourse, stream, body of water, or floodway. It also covers intake structures for taking water from streams.

GP-5 - UTILITY LINE STREAM CROSSINGS

This general permit is for utility lines less than 36 inches in diameter which cross streams.

GP-7 - MINOR ROAD CROSSINGS

This general permit is for minor road crossings that disturb less than 0.1 acre of wetlands and/or cross a stream where the drainage area is less than 1 square mile.

GP-8 - TEMPORARY ROAD CROSSINGS

This general permit is for temporary roads installed across a stream (including wetlands) for less than one year.

If the project or activity does not qualify for a waiver of permit requirements or does not meet the criteria of a general permit, an individual permit will be required

If a project involves the placement of dredge or fill material in waters of the United States, a Clean Water Act permit from the United States Army Corps of Engineers is also required. The Pennsylvania State Programmatic General Permit (PASPGP) is a federal Clean Water Act Section 404 Permit issued for Pennsylvania. The PASPGP authorizes the discharge of dredged, excavated, or fill material or structures into waters of the United States and waters of the Commonwealth, including wetlands. The PASPGP places DEP in the lead for processing encroachment permit applications and providing, if appropriate, both state and federal authorizations for the proposed project. If it is determined that the application does not qualify for dual (state and federal) authorization by DEP, the application will be forwarded to the Army Corps of Engineers or Fish and Wildlife Service for a separate federal review.

7.3 AIR QUALITY PERMIT

No person shall construct, assemble, install or modify any air contamination source, air pollution control equipment or device unless the person has received written approval from the DEP. However, not all air contamination sources require a Plan Approval or operating permit. Some contamination sources may be exempt under the regulations and some may be granted an exemption on a case-by-case basis.

7.3.1 AIR QUALITY PERMIT EXEMPTION

The Air Quality Permit Exemption List document (No. 275-2101-003) authorized under the Air Pollution Control Act and implementing regulations specify which sources and activities are exempt from Plan Approval or Operating Permit requirements.

Oil and gas exploration and production facilities and operations, not located at a major source and meeting certain requirements set forth in Air Quality Permit Exemptions Item No. 38, are exempt from the Plan Approval requirements. Although an air contamination source may be exempt from the Plan Approval and Operating Permit requirements of 25 Pa. Code Chapter 127, the source remains subject to all applicable state and federal air quality regulations. The granting of an exemption by DEP does not relieve the owner/operator from the obligation to

comply with the emission limitations, work practice and other applicable requirements contained in the air quality regulations.

If the owner/operator of a facility is claiming an exemption based on emission thresholds or a restriction in operational parameters such as hours or capacity, then the owner/operator must keep adequate records to clearly demonstrate to DEP that the applicable thresholds or restrictions are not exceeded.

7.3.2 REQUEST FOR DETERMINATION (RFD)

If a source is not listed on the exemption list, the owner or operator may submit a Request for Determination (RFD). The RFD is the mechanism by which DEP evaluates a case-by-case exemption request.

If the air contamination sources are covered by an exemption on the Air Quality Permit Exemption List or if DEP determines the sources to be of minor significance, a Plan Approval and/or Operating Permit will not be required. Generally, decisions on RFDs are made by the DEP within 30 days of receipt of a complete application.

BAQ-GPA/GP 11

Emissions released during the drilling phase are largely from truck mounted internal combustion engines which are considered nonroad engines. The nonroad engines are authorized under the DEP Bureau of Air Quality's General Plan Approval and/or General Operating Permit for Nonroad Engine(s) (BAQ-GPA/GP 11) which requires compliance with federal regulation. An applicant may submit an application for the GP-11 if the engines do not qualify under the exemption criteria.

BAQ-GPA/GP 5 - INTERNAL COMBUSTION ENGINE UNDER 1,500 HP

When natural gas leaves a well, it is sent to a gathering station and the gas is then compressed by an internal combustion (IC) engine(s) and conveyed to a processing facility via pipeline. The IC engines typically operate on natural gas and range in size from 1,000 to 4,000 horsepower (HP). An applicant seeking authorization to install and operate engines below 1,500 HP may use Air Quality's General Permit for Natural Gas, Coal Bed Methane or Gob Gas Production or Recovery Facilities (GP-5).

In addition to the state requirements, the engine must comply with the Federal New Source Performance Standards (NSPS) for Stationary Spark Ignition Internal Combustion Engines found at 40 CFR Part 60, Subpart JJJJ, and the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Stationary Spark Ignition Internal Combustion Engines found at 40 CFR Part 63, Subpart ZZZZ.

INTERNAL COMBUSTION ENGINE OVER 1,500 HP

An applicant seeking authorization to install and operate engines above 1,500 HP requires a plan approval from DEP. During the plan approval review, DEP determines that new sources must control the emissions to the maximum extent, consistent with the Best Available Technology (BAT). BAT is an evolving standard and is defined as equipment, devices, methods, or techniques as determined by DEP which will prevent, reduce, or control emissions of air contaminants to the maximum degree possible and which are available or may be made available. Applications are reviewed for BAT requirements on a case-by-case basis.

In addition to the state requirements, the engine must comply with the Federal New Source Performance Standards (NSPS) for Stationary Spark Ignition Internal Combustion Engines found at 40 CFR Part 60, Subpart JJJJ, and the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Stationary Spark Ignition Internal Combustion Engines found at 40 CFR Part 63, Subpart ZZZZ.

SINGLE SOURCE DETERMINATIONS

DEP makes single source determinations on a case-by-case basis to determine the applicability of Prevention of Significant Deterioration, Nonattainment New Source Review and Title V permitting requirements consistent with the Clean Air Act, Air Pollution Control Act and implementing regulations under the acts.

8. WORK GROUP SUMMARIES

Each of the four Marcellus Shale Advisory Work Groups developed a synopsis of the key needs and impacts identified through due diligence conducted between March and July 2011. Five (5) key needs and issues were identified and are detailed in this section with recommendations to address these needs and issues discussed in the Commission Recommendations section.

8.1 ENVIRONMENTAL IMPACT MITIGATION

Developing the Marcellus Shale and other non-conventional shale gas resources requires additional steps to protect, conserve, and enhance Pennsylvania's environmental and natural resources as well as further mitigate impacts from development on water, land, and air resources.

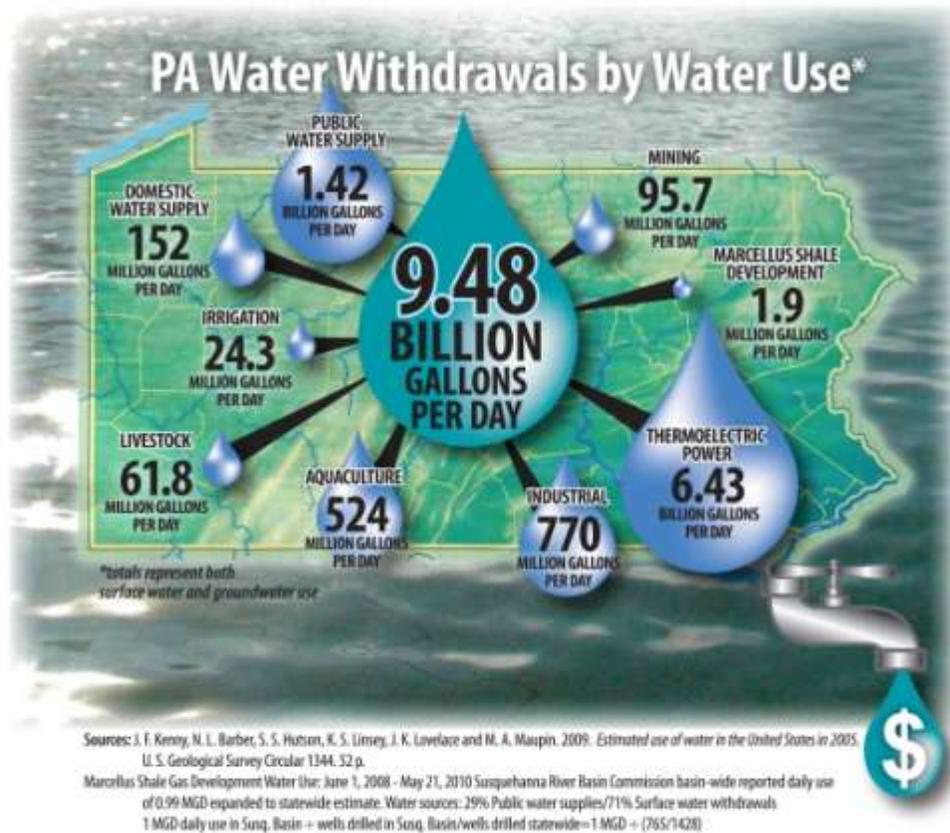
8.1.1 WATER ISSUES

WATER WITHDRAWAL

While hydraulic fracturing is not new to the Commonwealth – it has been standard practice for decades – the size of the natural gas play and the quantity of water used to stimulate a Marcellus Shale or other unconventional natural gas well is new. An average Marcellus Shale well may use more than 5 million gallons of water during the development and stimulation process.

To ensure the protection of other water users, including public drinking water suppliers and aquatic life, it is necessary to ensure that water withdrawals occur in a manner which does not compromise the water quality of the waterway or watershed. Water withdrawals in the eastern portion of the Commonwealth are managed by the Delaware River Basin Commission (DRBC). Water withdrawals in the central portion of the Commonwealth are managed by the Susquehanna River Basin Commission (SRBC). Water withdrawals outside of these two interstate compact commissions are not explicitly governed by state law – with the exception of withdrawals by public drinking water suppliers. However, in order to ensure water quality is not impacted by decreased stream flows, DEP has applied the water withdrawal standards of the SRBC to those areas of the Commonwealth which are not governed by either the DRBC or the SRBC. DEP implements these standards through the application of a water management plan, which is required as a condition of all shale well drilling permits.

FIGURE 26 PA WATER WITHDRAWALS BY WATER USE



GROUNDWATER AND SURFACE WATER PROTECTION (HYDRAULIC FRACTURING AND WELL CONSTRUCTION)

Hydraulic fracturing consists of a large volume of water, mixed with sand and some chemical additives, pumped at significant pressure through the well casing to stimulate gas flow. Despite significant public and media attention concerning the potential for the process of hydraulic fracturing to contaminate fresh water sources, DEP's experience to date indicates no instances where the process itself has negatively impacted a water supply. More than 15 additional large natural gas producing states, including New York State, have made similar certifications to the U.S. Ground Water Protection Council. Additional studies regarding hydraulic fracturing, including by the United States Environmental Protection Agency and the United States Department of Energy, are currently ongoing.

The primary concerns regarding hydraulic fracturing relate to surface spills of fluids, well control and lost containment of production and flowback water on the surface. Proper collection, storage, transportation and maintenance of fluids on the surface are critical to minimizing threats to both surface and ground water resources.

Another potential impact to groundwater is methane migration from poorly constructed gas wells. If a well encounters shallow gas producing formations – which are common in Pennsylvania – and the well does not effectively contain the gas within the producing formation, gas can migrate along the outside of the well and impact water supplies.

Several high-profile incidents underscore the potential for impacts on groundwater and surface water:

- In 2009, poorly constructed wells with defective cement and well casings developed by Cabot Oil and Gas Corporation in Dimock Township, Susquehanna County allowed shallow methane to migrate into water supplies, making 14 water supplies unusable.
- On June 3, 2010 operators lost control of the Punxsutawney Hunting Club 36 well (also referred to as “PHC 36H”). The well is owned by EOG Resources Inc. The company performing the well completion work at the time of the blowout was C.C. Forbes of Washington, Pennsylvania, a division of Forbes Energy of Texas.

Well drilling began in January 2010 and hydraulic fracturing operations began in March. Fracturing was completed on May 28th, and the plug placed after fracturing was being removed in preparation of putting the well into commercial production.

When the operators lost control, natural gas was released uncontrollably and fracturing fluids in the well were discharged onto the ground and 75 feet into the air for approximately 16 hours.

- On April 20, 2011 Chesapeake Energy lost control of the Atgas 2H Marcellus Shale well in Bradford County during hydraulic fracturing, over 10,000 gallons of fracturing flow back fluid escaped the well pad and all containment, flowed down a pasture and into an unnamed tributary to Towanda Creek, and Towanda Creek itself. About seven nearby residences were voluntarily evacuated at Chesapeake's suggestion.

ABANDONED WELLS

New wells drilled through a formation that has previously been drilled and fractured present a potential pathway for groundwater contamination. This potential pathway for contamination must be addressed through the application of well casing and construction standards.

FRESHWATER STORAGE

There are currently no construction standards for freshwater impoundments or what constitutes “freshwater”. The potential for storing degraded freshwater in unlined or poorly lined impoundments should be mitigated. Concerns include ensuring that impoundment sites are reclaimed once no longer necessary and minimizing potential hazards, including for public safety and public health.

WASTEWATER STORAGE

With the advent of multi-well development on a single well pad, single lined pits used to store wastewater may be employed for several months at a time. Prolonged use of these pits has the potential to compromise the liner and result in a leak or seep into freshwater sources.

PIPELINES

The deployment of freshwater or wastewater pipelines to move water above or below ground has the potential to minimize truck traffic. However, improperly constructed pipelines pose the potential to negatively impact both surface and ground water resources.

8.1.2 LAND ISSUES

Developing a Marcellus Shale well site requires considerable land clearing and earth disturbance activity. The need to clear land for support facilities such as access roads, pipe lines, borrow pits (small rock quarries), freshwater and

wastewater impoundments, tank farms, equipment staging areas, water withdrawal locations, and compressor stations greatly expand the footprint of a well site.

According to recent estimates, by 2030, a range of between 38,000 to 90,000 acres of forest cover could be cleared by new Marcellus gas development in the state. Such clearings would create new forest edges where the risk of predation, changes in light and humidity levels, and expanded presence of invasive species could threaten forest interior species in an additional 91,000 to 220,000 forest acres adjacent to Marcellus development¹⁰. In addition, forest impacts will be concentrated in the north central and southwest parts of the state where many of the state's largest and most intact forest patches could be fragmented into smaller patches by well pads, roads, and other infrastructure. Impacts to forest interior species will vary depending on their geographic distribution and density. In general, locating energy infrastructure in open areas or toward the outer edges of large patches can significantly reduce impacts to important forest areas.

A significant percentage of Pennsylvania's globally rare and Pennsylvania threatened species can be found in areas with high potential for Marcellus gas development. These species tend to be associated with riparian areas, streams, and wetlands, while others are concentrated in unusually diverse areas such as the Youghiogheny Gorge. A handful of rare species have most or all of their known locations in high potential areas for Marcellus gas development. More intensive surveys for globally rare and state critically endangered species in high potential Marcellus development areas could help to minimize impacts before development begins.

In addition, best management practices and careful monitoring will be essential to ensure that impacts to forested and other sensitive habitats, including fragmentation, invasive species, loss of wildlife food and cover, erosion and sedimentation, and to recreational uses, are avoided and mitigated, and that monitoring information is used to incorporate management improvements. DCNR has developed a set of best management practices for use on state forestland that are also applicable for private lands.

Minimizing the number of well pads through coordinated planning and consultation, as well as utilization of existing rights of way, can mitigate the cumulative impact on the Commonwealth's landscape. This is especially important as additional shale and unconventional natural gas plays are explored and developed.

8.1.3 AIR QUALITY ISSUES

Marcellus Shale development, including drilling, gas collection and processing, pose challenges with respect to air emissions. Generally, pollutants of concern include nitrogen oxides (NOx), carbon monoxide (CO), particulate matter, hazardous air pollutants (HAP) such as benzene, and toluene, other volatile organic compounds (VOC) and particulate matter. Radionuclides such as radium, thorium, and radon from the wastewater treatment of fluids, malodors and methane are additional sources of air pollution. Methane, the major component of natural gas and a green-house gas pollutant, is released into the atmosphere as fugitive emissions through leaks from processing equipment and pneumatic devices. Fugitive emissions including dust from truck traffic and fugitive VOC emissions from leaking valves and pipes are also pollutants of concern.

Volatile Organic Compounds which are also hazardous air pollutants e.g., benzene, toluene, ethyl benzene, and xylenes (BTEX) are emitted in low quantities. Formaldehyde is emitted from the compressor engines burning natural gas. Typically the engines are controlled by oxidizers to minimize organic emissions including formaldehyde. A small quantity of ethylene glycol is also emitted from gas dehydration operations at compressor stations. VOC and BTEX emissions may also be released from the condensate tanks which are typically controlled

¹⁰ Pennsylvania Energy Impacts Assessment, Executive Summary: Marcellus Shale Natural Gas and Wind Energy Nels Johnson, The Nature Conservancy, Pennsylvania Chapter. February, 2011 (updated)

by vapor recovery units. However, very low concentrations of BTEX compounds have been detected during Marcellus Shale activities.

Generally, the emissions of NO_x and VOCs during the drilling phase are largely from truck-mounted internal combustion engines, which are considered non-road engines.

Natural gas compressor stations mainly emit pollutants such as NO_x, VOCs, and CO—the formaldehyde emissions are controlled by oxidation catalysts. Compressor stations include compressor engines, gas dehydration units and condensate tanks. To date DEP has issued approximately 370 authorizations to use General Plan Approval and General Operating Permit for Natural Gas, Coal Bed Methane or Gob Gas Production or Recovery Facilities (GP-5); compressor stations operating in the Commonwealth including the Marcellus Shale Region.

Hazardous air pollutants including formaldehyde, ethylene glycol, mixed xylenes, n-hexane, benzene, toluene and ethyl benzene, may be emitted from certain sources at natural gas production facilities. Facilities which emit at least 10 tons per year of a single HAP or 25 tons per major sources of HAP emissions are considered “major” sources, which are subject to maximum achievable control technology requirements.

The utilization of natural gas, particularly as a transportation fuel, contains the potential for significant air quality benefits as well. For example, Compressed Natural Gas (CNG) for vehicles emit significantly less CO, CO₂, NO_x, VOC, SO₂ and Particulate Matter than conventional fuel sources and can assist in addressing air quality non-attainment obligations, especially in larger, urban locales.

AMBIENT AIR MONITORING PROJECTS

In response to the proliferation of Marcellus Shale natural gas development, in April 2010 DEP launched a short-term, screening-level air quality sampling initiative in the southwest, northeast and northcentral regions of the Commonwealth. The scope of the short-term sampling effort focused on natural gas extraction stages including drilling operations, hydraulic fracturing operations where wastewater was being produced, the flaring (use of natural gas which cannot yet be shipped to market) of gas for production and gas compression facilities. Reports for the Southwest, Northeast and Northcentral regions have been issued. The key findings to date are similar and can be summarized as follows:

- Concentrations of certain natural gas constituents including methane, ethane, propane and butane, and associated compounds, in the air near Marcellus Shale drilling operations were detected during sampling.
- Elevated methane levels were detected in the ambient air during short-term sampling at most sampling locations.
- Certain compounds, mainly methyl mercaptan, were detected at levels which generally produce odors.
- Results of the ambient air sampling initiative did not identify concentrations of any compound that would likely trigger air-related health issues associated with Marcellus Shale drilling activities.
- Sampling for carbon monoxide, nitrogen dioxide, sulfur dioxide and ozone, did not detect concentrations above National Ambient Air Quality Standards (NAAQS) at any of the sampling sites. Continued monitoring and sampling will assist DEP in determining whether the potential cumulative emissions of criteria pollutants may exceed NAAQS.

AIR QUALITY PERMIT EXEMPTION LIST REVISIONS

Pursuant to 25 Pa. Code § 127.14 (relating to Exemptions), a plan approval is not required for certain air contamination sources. This section authorizes DEP to establish a list of sources and physical changes meeting the requirements of this section. Currently, the Air Quality Permit Exemption List (Document No. 275-2101-003) includes an “automatic” exemption from plan approval and operating permit requirements for drilling operations including the Marcellus Shale drilling operations. This exemption does not apply to compressor station engines equal to or greater than 100 HP. The revised federal ozone standards and the recently promulgated short-term SO₂ and NO₂ federal standards may necessitate changes to the Exemption List.

DEVELOPMENT OF AN EMISSIONS INVENTORY FOR NATURAL GAS OPERATIONS

DEP must submit a complete emissions inventory for all sectors (point, area, mobile, and biogenic sources) to EPA every three years pursuant to 40 CFR Part 51, Subpart A. The next emissions inventory is due to EPA by December 31, 2012 for emissions occurring in 2011. The emission inventories, which have not previously provided an estimate of NO_x and VOC emissions for natural gas development activities, must include emissions from natural gas operations.

Marcellus Shale Impacts on Attainment and Maintenance of NAAQS (for Ozone and Fine Particulate Matter)

OZONE

- Pennsylvania has made progress in reducing contributions to ground-level ozone concentrations. For the 37 counties designated as nonattainment for the previous (1997) 8-hour ozone NAAQS of 0.08 parts per million (ppm), EPA re-designated 25 counties to attainment after DEP demonstrated not only that the areas attain the standard but would be able to maintain that standard through 2018. Between 2007 and 2009, EPA re-designated the following counties as attainment for the 1997 ozone standard: Adams, Berks, Blair, Cambria, Carbon, Centre, Clearfield, Cumberland, Dauphin, Erie, Franklin, Greene, Indiana, Lackawanna, Lancaster, Lebanon, Lehigh, Luzerne, Mercer, Monroe, Northampton, Perry, Tioga, Wyoming, and York. While the seven-county Pittsburgh area (Allegheny, Armstrong, Beaver, Butler, Fayette, Washington, and Westmoreland counties) has not been re-designated to attainment, air quality monitoring data from 2007-2009 indicates that the 1997 ozone standard has been attained.
- In 2008, EPA lowered the 8-hour ozone standard to 0.075 (75 parts per billion). Most of the counties that previously met the 1997 standard did not meet this standard. Furthermore, the EPA agreed to reconsider the 8-hour ozone standard and in January 2010, proposed to lower the health-based standard and set a new secondary standard to protect the environment; the proposed standard ranged from 70 to 60 parts per billion. EPA will issue final revised 8-hour ozone standards by July 29, 2011. The revised ozone NAAQS will pose significant attainment and maintenance challenges requiring additional reductions of NO_x and VOC emissions across Pennsylvania. The use of natural gas, particularly as an alternative transportation fuel, contains significant advantages to achieving and maintain federal ozone NAAQS.

FINE PARTICULATE MATTER (PM_{2.5})

- EPA has found that the following counties met the 1997 annual (PM_{2.5}) standard of 15ug/m³ for fine particulate matter based on 2007-2009 data: Berks, Cambria, Cumberland, Dauphin, Indiana, Lebanon, Lancaster, and York. State Implementation Plan (SIP) revisions projecting attainment in 2010 have been submitted to EPA for the remaining areas: the Pittsburgh-Beaver Valley area (Allegheny, Armstrong, Beaver, Butler, Fayette, Washington, Westmoreland and portions of Indiana, Cambria, Lawrence and Greene counties)

and the Philadelphia area (Bucks, Chester, Delaware, Montgomery and Philadelphia counties). The Liberty/Clairton SIP revision submitted to EPA will be revised to project attainment by December 2013.

- In 2006, EPA established a more stringent 24-hour particulate standard and in December 2009 designated the following counties or portions thereof as nonattainment. Allegheny (and the Liberty/Clairton area separately), Armstrong, Beaver, Bucks, Butler, Cambria, Chester, Cumberland, Dauphin, Delaware, Fayette, Greene, Indiana, Lebanon, Lancaster, Lawrence Lehigh, Montgomery, Northampton, Philadelphia, Washington, Westmoreland, and York. SIP revisions are due to EPA in December 2012.
- In order to achieve and maintain the PM 2.5 NAAQS across Pennsylvania, additional reductions of fine particulates and precursors of PM 2.5 including NOx and SO2 may be needed.

8.2 INFRASTRUCTURE DEVELOPMENT CHALLENGES & OPPORTUNITIES

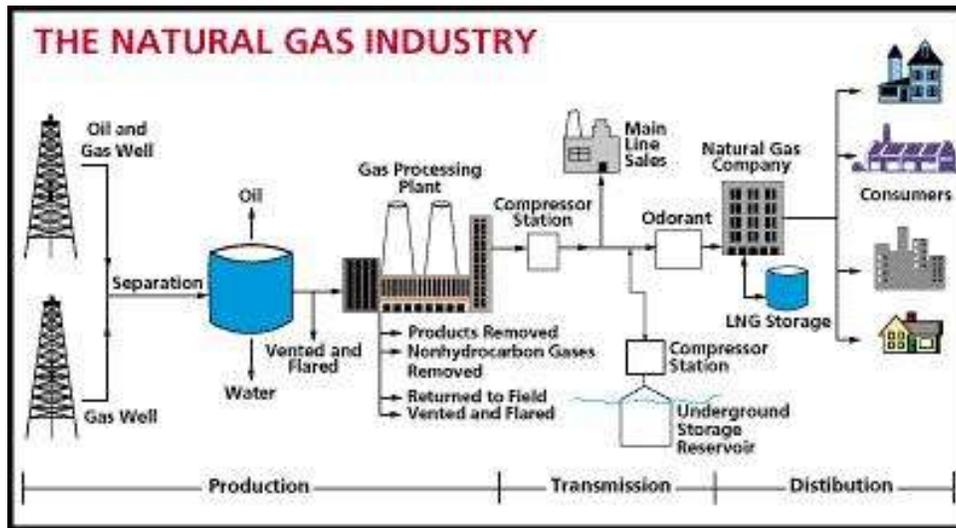
8.2.1 OVERVIEW OF INFRASTRUCTURE DEVELOPMENT ISSUES

After a natural gas deposit is located, the process of drilling and extraction begins. However, because natural gas is not utilized at the point of extraction, an infrastructure is needed to process, compress, store, and transport the natural gas to market. When natural gas is mostly methane, it requires little or no processing before transportation. This gas is referred to as dry natural gas as discussed previously. As the levels of corrosive contaminants in natural gas (water, carbon dioxide, sulfur, etc.) and liquefiable hydrocarbons in natural gas (known as natural gas liquids or NGLs) increase, natural gas must be processed to remove the contaminants and/or NGLs. Removal of the contaminants is primarily for operational concerns. Removal of the NGLs is both for operational concerns and to produce saleable NGL products such as ethane and propane. This gas is called wet natural gas. In general, Marcellus Shale gas from southwestern Pennsylvania is wetter than Marcellus Shale gas from northeastern Pennsylvania. Processing plants used to separate NGLs from gas and pipelines used for NGLs are inherently part of the infrastructure related to Marcellus Shale.

There are two main types of infrastructure needed to develop natural gas from the Marcellus Shale formation. The direct infrastructure consists of the wells and related physical facilities to extract, move and sometime store, the gas and related by-products as it goes to markets and end-users. These facilities include, but are not limited to, pipelines, compressor stations and processing plants. Indirect infrastructure consists of road and bridge improvements, water and wastewater facilities and other ancillary services such as housing. This section focuses on direct infrastructure issues related to pipelines and related facilities. A discussion of indirect infrastructure costs is included in the Mitigation of Adverse Local Impacts section.

The natural gas industry is divided into three parts, upstream, downstream and midstream. Exploration, extraction and production are upstream activities. Gathering gas from multiple wells, storage and the treatment and processing of gas are midstream activities. Transportation and marketing are downstream activities. These three parts frequently overlap, with treatment and processing often occurring at both production facilities and transportation pipelines.

Figure 27: The Natural Gas Industry Infrastructure



Source: U.S. Department of Energy, Energy Information Agency.

Regulation of natural gas occurs at both the federal and state levels. Laws and regulations include the general governmental supervision applicable to any industry (environmental protection, occupational safety and health, etc.) and those which are directed to energy or utility industries in general or to the natural gas industry alone. The latter vary considerably by industry segment and also by the source of the laws. Some areas are exclusively federal, some are exclusively state, and some areas overlap.

8.2.2 REGULATION OF NATURAL GAS

The Federal Energy Regulatory Commission (FERC) oversees the economic regulation and infrastructure regulation of natural gas in interstate commerce. FERC's economic regulation includes the transmission and sale for resale of natural gas in interstate commerce. FERC's infrastructure regulation includes approval of the siting and abandonment of interstate natural gas facilities such as pipelines, storage facilities and liquefied natural gas facilities.¹¹ However, FERC does not regulate the "gathering" of natural gas.¹² Similarly, FERC does not regulate retail sales of natural gas and other intrastate functions. FERC's economic regulation and siting of gas facilities is exclusive and pre-empts state and local regulation of such facilities.

¹¹ Facilities which export LNG from the United States also require approval from the Department of Energy.

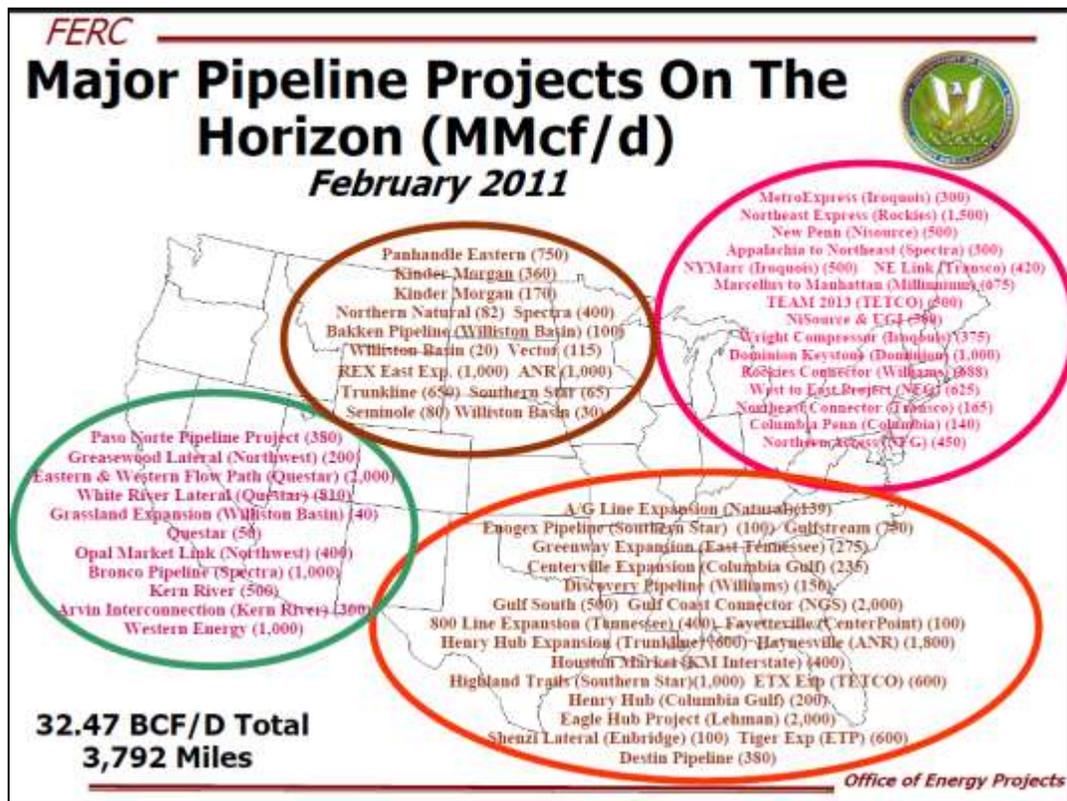
¹² FERC uses a "primary function test" to determine which facilities are non-jurisdictional gathering facilities. See *Laser Marcellus Gathering Co., LLC*, 130 F.E.R.C. P61,162 (2010).

Intrastate Transmission Pipelines within the Commonwealth:

Operator Business Name	Operator ID	Inter / Intra	Number of Miles
PEOPLES NATURAL GAS COMPANY LLC	15350	INTRASTATE	427.63
UGI CENTRAL PENN GAS, INC	31467	INTRASTATE	122.81
UGI UTILITIES, INC	20010	INTRASTATE	117.86
EQUITABLE RESOURCES (A.K.A EQUITABLE GAS CO)	4510	INTRASTATE	117.33
COLUMBIA GAS OF PENNSYLVANIA	2600	INTRASTATE	67.01
PECO ENERGY CO	15462	INTRASTATE	30.59
HANLEY & BIRD	7009	INTRASTATE	29.57
UGI PENN NATURAL GAS	15259	INTRASTATE	28.12
SERGEANT GAS CO	18184	INTRASTATE	25.8
PEI POWER CORP	31453	INTRASTATE	23.46
UNITED STATES GYPSUM CO	20236	INTRASTATE	17.85
PEOPLES TWP LLC	15476	INTRASTATE	12.89
APPALACHIA MIDSTREAM SERVICES, L.L.C.	32465	INTRASTATE	5.02
NFG MIDSTREAM COVINGTON, LLC	32506	INTRASTATE	3.14
DELMARVA POWER & LIGHT COMPANY	3240	INTRASTATE	0.03

FERC has identified several interstate pipeline projects as being “on the horizon” (Fig 28).

Figure 28: Major Pipeline Projects on the Horizon



Source: Federal Energy Regulatory Commission, Office of Energy Projects.

<http://www.ferc.gov/industries/gas/gen-info/horizon-pipe.pdf>

The United States Department of Transportation Pipelines and Hazardous Materials Safety Administration (“PHMSA”) regulates the safety of intrastate and interstate natural gas and hazardous liquids facilities. PHMSA’s regulations are minimum federal safety standards. As such, they are not exclusive and states can establish safety regulations for natural gas and hazardous liquids facilities. PHMSA uses state utility commissions as “state partners” to enforce the federal safety standards over entities within state’s jurisdiction.

The PUC is PHMSA’s state partner overseeing gas safety for natural gas public utilities in Pennsylvania. The PUC fully regulates (economic and safety) most Pennsylvania entities which distribute natural gas to the public as public utilities. The PUC regulates some, but not all, pipelines providing intrastate transportation service as public utilities. However, the PUC does not require natural gas public utilities (distribution or pipeline) to obtain its preapproval in order to site or construct new facilities. PUC approval is required before a gas utility may abandon service to customers.

Many pipeline projects are underway or have been proposed to further development of Marcellus Shale.¹³ Many of the projects are classified as part of the interstate pipeline system and are subject to FERC jurisdiction as shown in the preceding figure. Other projects are not FERC jurisdictional. These include the following three projects which are seeking status as public utilities from the PUC.

1. Laser Marcellus Gathering Company LLC, Northeast Pennsylvania
2. Peregrine Keystone Gas Pipeline Company, Southwest Pennsylvania
3. Pentex Pipeline Company, Northeast Pennsylvania

Additional Marcellus Shale related pipeline projects have been publicly announced. The FERC/PUC jurisdictional status of the following projects is not known at this time.

1. PVR Midstream (2 projects), Wyoming and Lycoming counties¹⁴
2. Williams, Northeast Pennsylvania¹⁵
3. Momentum (M3 Midstream), Southwest Pennsylvania¹⁶
4. Laurel Mountain Midstream, Southwest Pennsylvania¹⁷

8.3 PENNSYLVANIA MARKET DEVELOPMENT

8.3.1 ECONOMIC IMPACT OF MARCELLUS SHALE NATURAL GAS DEVELOPMENT

Pennsylvania has been presented with a tremendous economic opportunity to create thousands of jobs and generate billions in revenue for the state by fostering the development of the Marcellus Shale natural gas play. Even greater economic gains could be realized when the industry begins to drill other potentially viable formations in Pennsylvania.

¹³ See generally, *From ‘Colonel’ Drake to the Marcellus Gas Play – Transmission Developments*, Pipeline and Gas Journal, June 2011, Vol. 238, No. 6. <http://www.pipelineandgasjournal.com/%E2%80%9Ccolonel%E2%80%9D-drake-marcellus-shale-gas-play-transmission-developments?page=show>

¹⁴ <http://www.pvresource.com/News/Press-Release-Details/2011/Penn-Virginia-Resource-Partners-LP-Announces-Start-of-Service-on-Second-Marcellus-Shale-Natural-Gas-Gathering-System1124329/default.aspx>

¹⁵ <http://williamsinthemarcellus.files.wordpress.com/2011/03/springvillegatheringfactsheet032311.pdf>

¹⁶ <http://www.m2midstream.com/assets/docs/AGS-Press%20Release2.25.2011.pdf>

¹⁷ http://www.pittsburghlive.com/x/pittsburghtrib/news/fayette/s_741244.html

On a national level, IHS Global Insights reports that in 2008 alone, the natural gas industry supported nearly 3 million American jobs, with 622,000 in direct employment. The industry also created “\$385 billion in economic activity, including \$181 billion in labor income, and more than 10,000 direct, indirect and induced jobs in 31 U.S. states.”¹⁸

Pennsylvania has already witnessed some of the positive economic impacts that the natural gas industry brings about. According to the Pennsylvania Department of Labor & Industry, from the 4th Quarter of 2009 to the 1st Quarter of 2011, there were 72,000 new hires in the Marcellus Shale core and ancillary industries.^{19 20} Moreover, 71% of new hires were Pennsylvanian’s according to L & I. This data helps to substantiate Penn State’s projections that “by 2020, the industry could create more than \$18 billion in value added, generate more than \$1.8 billion in state and local tax revenues, and support more than 211,000 jobs”.²¹

8.3.2 MULTIPLYING EFFECT OF THE MARCELLUS SHALE NATURAL GAS PLAY

Generally, when the public thinks of jobs that are associated with the Marcellus Shale natural gas play, the perception is drilling work. However, the natural gas industry employs individuals from many other trades and sectors. From site selection and preparation to pre-drilling work, to production stages and finally, delivery of the natural gas, each stage engages many other industries. A study published by Penn State provides the following example: “*Exploration crews purchase supplies, stay at hotels, and dine at local restaurants. Site preparation requires engineering studies, heavy equipment and aggregates. Drilling activity generates considerable business for trucking firms and well-support companies now based in Pennsylvania that, in turn, buy supplies, such as fuel, pipe, drilling materials and other goods and services. Likewise, construction of pipelines requires steel, aggregates, and the services of engineering construction firms.*”²² The Penn State study goes on to state that for every \$1.00 that Marcellus producers spend in the state, \$1.90 of total economic output is generated.

The ripple effect that the natural gas industry causes enables businesses to hire additional workers, which ultimately leads to higher income taxes. This business-to-business activity has already generated increased sales and sales tax revenues and has the potential to produce even greater returns in the future (Fig. 27).

¹⁸ IHS Global Insight, *The Contributions of the Natural Gas Industry to the U.S. National and State Economies*. (September 2009),

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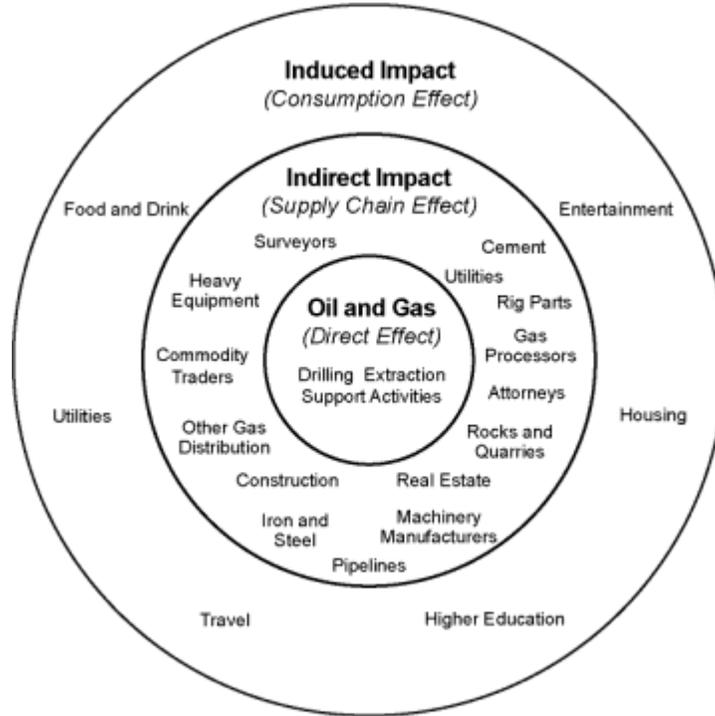
¹⁹ Pennsylvania PA L&I defines Marcellus Shale as a group of six core and 30 ancillary (or indirect) industries.

²⁰ New hires provides an indication of hiring activity in an industry or region.

²¹ Considine, T., Watson, R., Blumsack, S. *The Economic Impacts of the Pennsylvania Marcellus Shale Gas Play: An Update*. (Penn State, 2010), 3.

²² *Ibid*, 1.

Figure 29: Marcellus Shale Related Industries



Source: Marcellus Shale Education and Training Center

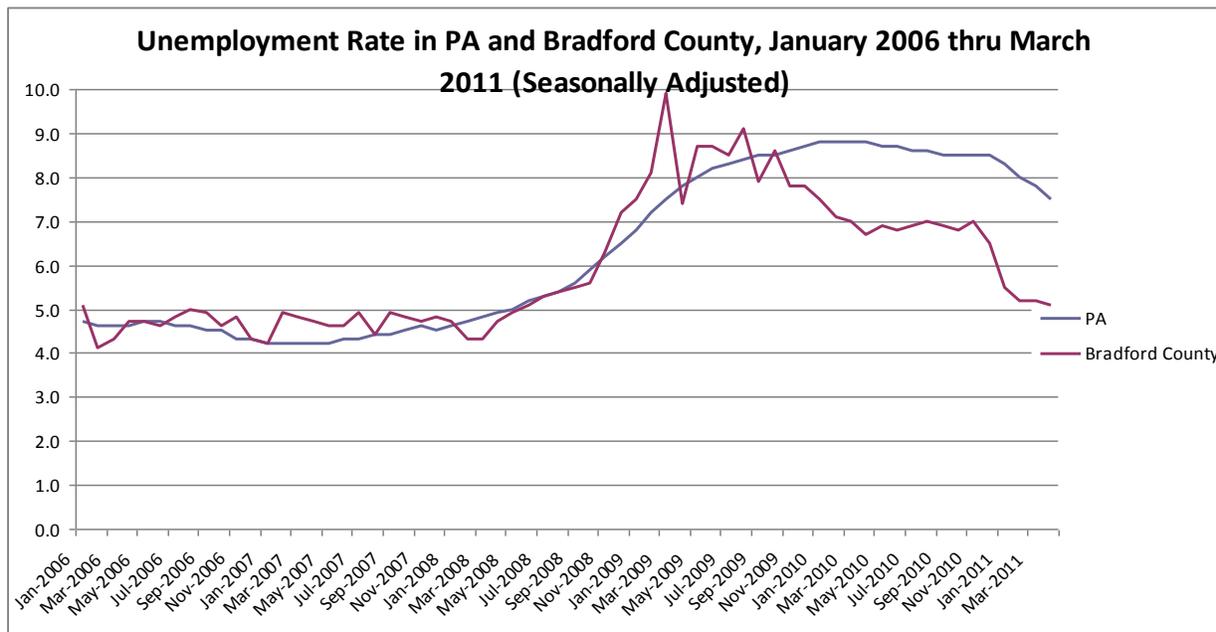
Total employment in Marcellus Shale core and ancillary industries was 218,000 in the 4th Quarter of 2010; the six core industries made up 19,000 of the employment and the 30 ancillary industries accounted for 199,000.²³ This represents almost 4% of Pennsylvania’s total employment. While 4% may seem to represent a small portion of employment in Pennsylvania, this is quite substantial considering that Marcellus Shale gas development began to substantially increase in 2008. Refer to the well permitting and drilling statistics noted earlier in this report.

Also, areas with substantial Marcellus Shale drilling activity have seen notable decreases in unemployment rates. From March 2009 to March 2011, the overall unemployment rate for counties with 10 or more wells drilled in 2010 dropped from 7.7% to 7.1%, while the overall unemployment rate for counties with no wells remained relatively constant. This suggests that an inverse relationship exists between the number of wells and unemployment rates. This relationship is further evidenced by trends in the Northern Tier region which is home to a majority of Pennsylvania’s Marcellus Shale wells (Fig. 24). One example is Bradford County, which in April 2011 had the lowest unemployment rate in the state at 5.1%, much lower than the state average of 7.6% (Fig. 28).²⁴

²³ L & I, Center for Workforce Information & Analysis, Marcellus Shale Fast Facts, June 2011 Edition, <http://www.paworkstats.state.pa.us/gsipub/index.asp?docid=775>

²⁴ Seasonally adjusted unemployment rate.

Figure 30: Unemployment Rate in Pennsylvania and Bradford County



Although some areas in the Northern Tier region are actually reaching full employment, continued demand for these jobs is evidenced both in the Northern Tier and statewide. According to L & I, in April 2011 there were over 2,700 online job postings in Marcellus Shale related industries statewide.

8.3.3 STATE TAX REVENUE GENERATED BY MARCELLUS SHALE ACTIVITY

Marcellus Shale natural gas development has generated significant new tax revenues in the Commonwealth. A recent study by the Department of Revenue estimates that since 2006, the industry has paid \$1.1 billion in taxes. This amount includes an array of taxes, from corporate and sales taxes to employee withholding taxes. The Department of Revenue’s analysis breaks out tax payments from oil and gas companies and their affiliates through April 2011 and indicates that 857 of these companies have paid \$238.4 million in capital stock/foreign franchise tax, corporate net income tax, sales/use tax, and employer withholding. These figures from the 1st Quarter of 2011 already exceed, by nearly \$20 million, the total tax payments made in all of 2010. The Department of Revenue’s analysis also identified \$214.2 million in personal income taxes paid since 2006 attributable to Marcellus Shale lease payments to individuals, royalty income and sales of assets.²⁵

An additional revenue source is the state well permit fee which totaled \$12.5 million in state fiscal year 2010 – 2011. In state appropriations testimony DEP anticipated collecting \$15.4 million in fees for the current fiscal year. These funds are used to pay for well inspections. DEP estimates approximately 7,000 Marcellus Shale well inspections in 2011, up from 5,000 well inspections in 2010.

In addition, Pennsylvania has received revenue for state forest land leases associated with Marcellus Shale natural gas production. From 1947 to 2008, the revenue received from Marcellus Shale related drilling on state forest lands was between \$4 million and \$5 million according to DCNR. Since 2008, the lease of 138,866 acres generated

²⁵ Pennsylvania Department of Revenue, press release, May 2, 2011.

\$413 million in revenue. The state has also received an additional \$12.7 million in royalty revenue and estimates that these revenues will exceed \$63 million for fiscal year 2011 - 2012. This represents an increase of 396%.

An analysis of Department of Revenue data by Penn State in March 2011 found that in comparison with other Pennsylvania counties, major Marcellus Shale producing counties have realized an 11.36% increase in state sales tax receipts since 2007 and a 7% increase in individual taxable income.

8.3.4 MARKETS FOR NATURAL GAS

Due to its versatile nature natural gas can be used for many purposes. The United States currently spends \$1 billion per day purchasing foreign oil. Natural gas provides a more cost-effective, domestic energy option. Pennsylvania currently ranks 10th in its use of natural gas vehicles (NGV's) according to the U.S. Energy Information Administration.²⁶ While Pennsylvania is among the top 10 in terms of utilizing natural gas, the Commonwealth is behind New York and California which use 10% and 36% more gas, respectively. Natural gas is a clean-burning resource which provides a unique opportunity for the Commonwealth to utilize a lower-cost, lower-emission resource to meet its transportation needs. In the short term, the conversion of public transit systems and vehicle fleets, including school buses and state, county and municipally-owned vehicles, will create new jobs as well as help to build out Pennsylvania's CNG infrastructure. Upon build-out of the infrastructure, citizens across Pennsylvania can begin to use natural gas for their personal use.

Natural gas is now also commonly used in Combined Heat and Power (CHP) systems. Today, many industrial companies are using natural gas to generate electricity which can be used for a variety of applications including space heating, water heating, and powering industrial boilers. In addition to creating new supplier, construction and engineering jobs, CHP offers a low marginal cost of electric power and reduces greenhouse emissions.

A market where natural gas use can expand is residential heating. According to the U.S. Census Bureau, the percentage of new homes constructed in the northeast United States which use natural gas as their heat source increased from 45% in 1980 to 78% in 2010.²⁷ Only 11% of new homes were constructed with electric heat and 9% with oil heat in 2010. Additional markets also exist for natural gas furnaces, appliances and residential air conditioning units.

Natural gas also has many industrial uses. It is generally used as the base ingredient for products such as plastic, fertilizer, anti-freeze, and fabrics. In fact, industrial users are the largest consumer of natural gas and account for 43% of natural gas use across all sectors. Natural gas is the second most used energy source in industry, trailing only electricity. It is consumed primarily in the pulp and paper, metals, chemicals, petroleum refining, stone, clay and glass, plastic, and food processing industries. These types of manufacturers account for over 84% of all industrial natural gas use.

8.4 WORKFORCE, EDUCATION, AND TRAINING

8.4.1 WORKFORCE DEVELOPMENT FOR PENNSYLVANIA'S MARCELLUS SHALE INDUSTRY SECTOR

In the Marcellus Shale region, there are significant numbers of unemployed, underemployed, and military veteran populations for whom natural gas jobs are a unique opportunity to enter the workforce, earn family sustaining wages, and build strong career paths. Additionally, many entry level jobs do not require a postsecondary degree,

²⁶ U.S. Energy Information Administration, *Alternatives to Traditional Transportation Fuels 2009* (April 2011), 11.

²⁷ U.S. Department of Commerce, Census Bureau, *2010 Characteristics of New Housing* (2010), 304.

but can create pathways that can lead to a two- or four-year college degree. A 2009 study conducted by the Marcellus Shale Education & Training Center revealed that the drilling of a single well requires over 400 people working in nearly 150 occupations.²⁸

The Marcellus Shale industries require certain numbers of high-skilled workers. Many of the jobs are ideally suited to Pennsylvania's workforce. Across regions with Marcellus Shale activity, the skilled worker requirements of most industries are reasonably compatible with the skills found in the local workforce. In many cases, one in four or one in five workers in the regional workforce are highly compatible with the skill needs of the Marcellus Shale industries. However, skill gaps can be found in most regions in the following industries: fossil fuel electric power generation; natural gas distribution; engineering services; geophysical surveying and mapping services; testing laboratories; industrial gas manufacturing; and commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance.

Recent statistics from the Pennsylvania Department of Labor & Industry (L & I) reveal that unemployment rates are dropping rapidly in counties that have a high concentration of natural gas drilling activity. This recent set of statistics further validates the industry's claim that they are hiring a substantial number of Pennsylvania residents, with two recent studies putting the average at 70% of the natural gas workforce.

In the development of the Marcellus it is important to note that many of the drilling phase jobs will be geographically temporary, meaning a drilling rig does move from location to location, but the drilling phase jobs will continue to be stable jobs across much of the Appalachian Basin for an estimated 30 to 50 years. In contrast to drilling phase jobs, jobs associated with the production phase are well defined, generally serve a fixed geographic area, and are predictable in that many will last the lifetime of a producing Marcellus well. Even if drilling were to cease completely, the "production phase" jobs necessary to manage and maintain Marcellus wells would still be required for decades. In fact, many people believe the wells created as part of the Marcellus Shale development will likely produce commercial quantities of natural gas for 30 years or more.

8.4.2 MEASURABLE IMPACTS OF MARCELLUS SHALE ON PENNSYLVANIA'S LABOR MARKET

L & I used North American Industry Classification System (NAICS) codes to define the Marcellus Shale industry sector. Defining the sector with a group of six industries identified as "core," and a group of 30 identified as "ancillary", L & I produced several reports documenting the employment, wages, number of establishments, and new hires in these industries.

²⁸ Marcellus Shale Education & Training Center, *Marcellus Shale Workforce Needs Assessment*, <http://www.msetc.org/docs/NeedsAssessmentwithcover.pdf#zoom=75>.

UNEMPLOYMENT RATES

Table 1: Preliminary Seasonally Adjusted Unemployment Rate (April 2011)

April 2011 Preliminary Seasonally Adjusted Unemployment Rate	
Central WIA	7.0%
Northern Tier WIA	6.5%
North Central WIA	8.2%
Southwest Corner WIA	6.8%
Tri-County WIA	6.8%
Westmoreland & Fayette WIA	7.5%
Pennsylvania	7.5%
United States	9.0%

Source: Pennsylvania PA L&I, Local Area Unemployment Statistics.

The six Workforce Investment Areas (WIAs) most closely involved in Marcellus Shale activities in Pennsylvania were identified as Central, North Central, Northern Tier, Tri-County, Southwest Corner, and Westmoreland-Fayette. In April 2011, all six WIAs had a lower unemployment rate than the nation, and five had rates lower than or equal to the state of Pennsylvania. For the most part, inverse correlation is found between Marcellus Shale well drilling activity and regional unemployment rates.

EMPLOYMENT

Table 2: Change in Employment (2007 Q4 - 2010 Q4)

Marcellus Shale industries have added a total of 7,176 jobs (4,621 core; 2,555 ancillary) across the six WIAs in a three year period. The Northern Tier experienced the largest employment gains in the Marcellus Shale core industries in terms of both volume and percentage, with 2010 Q4 employment standing at more than 15 times the level of 2007 Q4. Marcellus Shale wells drilled in Northern Tier account for more than half of all Marcellus Shale wells drilled in Pennsylvania in 2010. The North Central region has had the smallest growth, but still grew at a robust 16.8% in core industries.

From 2007 Q4 to 2010 Q4, Pennsylvania statewide employment in the Marcellus Shale core industries increased from 9,549 to 18,837, accounting for an employment increase in these NAICS of more than 97 percent. Over the same time period, employment in the ancillary industries decreased by approximately 2%, while total employment across all industries declined by approximately 3%. However, in the six WIAs most closely involved in Marcellus Shale activities, employment in the ancillary industries grew by 5.7%.

	2007 Q4	2010 Q4	Change	% Change
Northern Tier				
Core	87	1,422	1,335	1534.5%
Ancillary	1,728	2,668	940	54.4%
Southwest Corner				
Core	627	1,425	798	127.3%
Ancillary	10,372	10,633	261	2.5%
North Central				
Core	1,988	2,321	333	16.8%
Ancillary	4,039	4,198	159	3.9%
Westmoreland & Fayette				
Core	415	1,059	644	155.2%
Ancillary	10,262	10,352	90	0.9%
Tri-County				
Core	2,190	2,835	645	29.5%
Ancillary	8,530	8,761	231	2.7%
Central				
Core	117	1,283	1,166	996.6%
Ancillary	9,602	10,476	874	9.1%
Pennsylvania				
Core	9,549	18,837	9,288	97.3%
Ancillary	202,996	199,377	-3,619	-1.8%

Source: Pennsylvania PA L&I, Quarterly Census of Employment & Wages

WAGES

In 2010 Q4, the statewide average wage was \$45,747. By comparison, in 2010 Q4, average wages for the core Marcellus Shale industries was \$73,150, and average wages in ancillary industries was \$61,871.²⁹

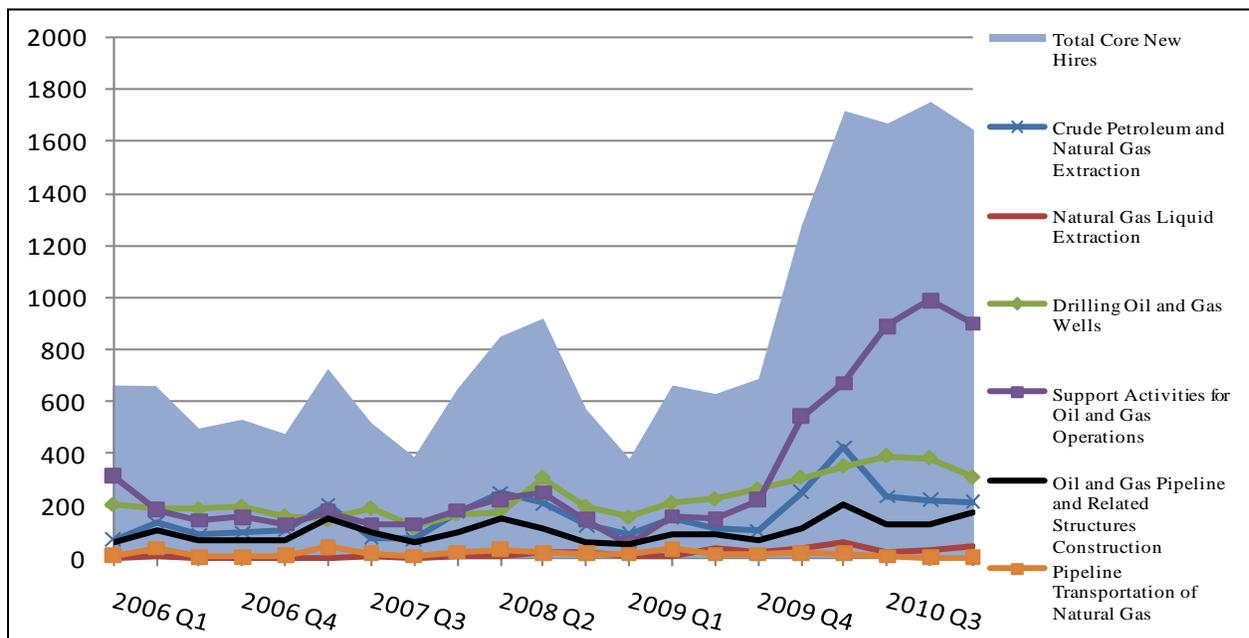
ESTABLISHMENTS

From 2007 Q4 to 2010 Q4, over 500 establishments (or business types) were added in Marcellus Shale related industries in Pennsylvania (319 core; 206 ancillary). This represented 59% growth in core industries and 2% growth in ancillary industries. Over the same time period, Pennsylvania experienced 1% growth for all industries.

NEW HIRES

New hires provide a strong indication of where employment is trending. From 2009 Q4 to 2011 Q1, there were approximately 72,000 new hires (9,000 core; 63,000 ancillary) in Marcellus Shale related industries. New hire activity in core Marcellus Shale industries picked up significantly in 2010 Q2, increasing by 140 percent from 2009 Q2 (Fig. 29).

Figure 31: New Hires by Marcellus Shale Core Industries (2006 Q1 to 2010 Q3)



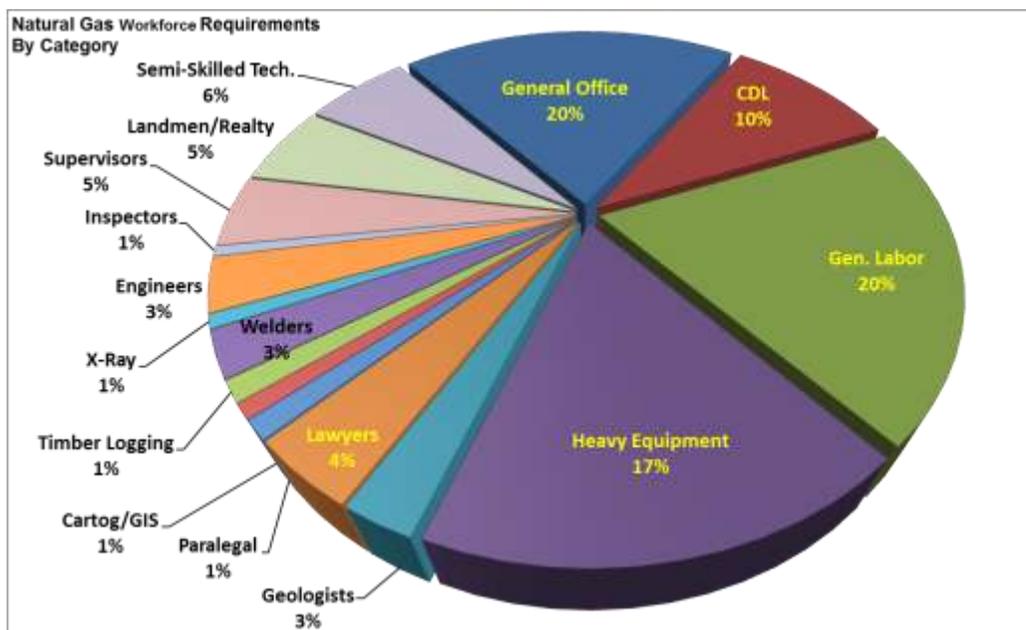
Source: Pennsylvania PA L&I (April 2011).

²⁹ Pennsylvania PA L&I, *Quarterly Census of Employment & Wages* (April 2011).

8.4.3 MARCELLUS SHALE TRAINING OPPORTUNITIES

Marcellus Shale careers are classified into three categories: traditional; drilling phase; and production phase occupations. Traditional careers found within the industry include law, finance, computer technology, accounting, business management, administration, and natural resource management. Drilling phase careers training is more labor intensive and requires more time to acquire appropriate skills. The drilling phase occupations include down hand welding, engineering, natural resource and environmental technologies, and diesel engine technologies. During the production phase a small number of jobs are associated with monitoring the long-term production of natural gas throughout the life of the well. These careers include compression technicians, petroleum engineers, well tenders, production engineers, and CDL drivers. Figure 32 depicts specific jobs required to meet industry needs.

Figure 32: Marcellus Shale Job Types



Source: Marcellus Shale Education & Training Center, Workforce Needs Assessment, 2009.

Pennsylvania College of Technology's Marcellus Shale Education and Training Center provides curriculum and various certificates including a 10-hour OSHA certificate, First-Aid/CPR Certificate, Defensive Driving Certificate, OSHA forklift operation training, and oil field heavy equipment operation. Lackawanna College, Mansfield University, and Keystone College offer training courses for a wide range of "white collar" jobs such as computer technology, information technology, office staff, administrative assistant, accounting, financial and business management, and security. Penn State University and Pennsylvania College of Technology collaborate to offer advanced degrees in the geological and engineering sciences.

The Northern Tier Workforce Development Corporation has a series of four types of training and the Fit 4 Natural Gas training is a pre-employment program for individuals looking to begin a career in the natural gas industry. Other trainings available through the two Marcellus Shale Industry Partnerships include: PEC Safeland Certification, Landman/Land Agent, GIS Software Training, Effective Leadership Levels 1 – 3, Gas Drilling Processes and Principles, Driving in Winter Weather Conditions, Safeland Training, Fire Prevention, H2S Awareness, High Pressures, Reservoirs, and Oilfield Introduction, among others.

PENNSYLVANIA CAREERLINK GOALS AND OBJECTIVES

The main objectives of the Pennsylvania CareerLinks are to connect employers to potential employees and create employment opportunities for the residents of Pennsylvania. The services offered by the PA CareerLink offices include assessment and soft skills training, resume development, interviewing techniques, and the opportunity to earn a WorkKeys Career Readiness Certificate. The Pennsylvania CareerLinks also identify potential candidates that meet Marcellus Shale company qualifications for open positions and inform these employers of Workforce Investment Act funded programs like Individual Training Accounts and On-the-Job Training funding. In addition, The Pennsylvania CareerLinks also provide job posting and client prescreening services for companies.

DIRECT JOB TRAINING NEEDS IN MARCELLUS SHALE

1. On-site jobs: Helpers; Extraction Workers; Earth Drillers; Pipe Layers; and Construction Laborers
2. Pipeline jobs: Water & Sewer Line and Related Structure Construction; Pipeline Transportation
3. Well control: Wellhead Pumpers; Welders, Cutters, Solderers, and Brazers

INDIRECT JOB TRAINING NEEDS IN MARCELLUS SHALE

1. Supply chain businesses: Highway, Street, & Bridge Construction; General Freight Trucking (Local); and Leasers of Other Real Estate Property
2. Natural gas sourced product manufacturing: Industrial Gas Manufacturing; Mining Machinery & Equipment Manufacturing; and Petrochemical Manufacturing
3. Gas pipeline safety training: Regulation and Administration of Communications, Electric, Gas, and other Utilities; Administration of Air & Water, Residential & Solid Waste Management Programs; and Administration of Conservation Programs
4. Emergency responders: Hospitals, Doctor Offices

8.5 MITIGATION OF ADVERSE LOCAL IMPACTS

The communities where Marcellus Shale natural gas activity is occurring serve as the foundation for future natural gas opportunities that will have substantial, positive impacts on both Pennsylvania and our nation from an energy perspective. Therefore, development of shale gas should account for and mitigate, to the maximum extent possible, any adverse impacts on these communities. A brief overview of the impacts identified through due diligence conducted by the Local Impact & Emergency Response Work Group follows.

8.5.1 EMERGENCY MANAGEMENT AND EMERGENCY RESPONSE

Municipalities have a legal responsibility for planning for and responding to all types of emergencies. Drilling activity leads to the potential for many types of incidents for which response may be necessary including: fires, well blowouts, chemical and fuel spills, and traffic accidents attributed to an overall increase in vehicular traffic. Emergencies at drilling locations have occurred and until emergency specialists retained by drilling companies arrive on site, volunteer fire companies and other local first responders must secure a site and take appropriate

action. Quite often local emergency responders in Marcellus Shale communities are unpaid volunteer fire fighters and paramedics who face increasing demands on their services.

The Office of the State Fire Commissioner (OSFC) has provided the majority of Marcellus Shale related training for first responders through a contract with the Marcellus Shale Coalition (Coalition). The Coalition and the Pennsylvania Independent Oil and Gas Association (PIOGA) have provided \$241,000 for the training which began in September 2010. As of April 1, 2011 OSFC has delivered 43 Phase 1 training classes with 2,416 first responders having been trained. After Phase 1 training was complete, additional and extensive training (Phase 2 and Phase 3) for first responders was considered but has not yet been conducted.

Responding to natural gas incidents requires additional emergency management planning at the local, county, and regional levels and appropriate equipment and training, particularly with respect to natural gas well operations. Planning and training is both time intensive and expensive and local volunteer fire companies often lack the financial resources, as well as the volunteer staff, required to keep pace with the increased call volume.

Many natural gas companies have site emergency operations response plans in place which address areas such as: medical, property damage, law enforcement, and fire. Emergency exercising has been and will continue to be routinely conducted through a partnership between industry, regional emergency response taskforces, and local emergency responders. While emergency operations response plans are critical to effectively plan for emergency contingencies, it has been reported that some communities have experienced difficulties in obtaining such plans for well sites.

Finally, owners of gathering lines and compressor stations are not currently required to join Pennsylvania One Call as facility owners.³⁰ Therefore, there is no requirement to communicate with emergency response or local government officials regarding locations. Federal regulations are in place for gathering lines, but there is no state or federal enforcement mechanism established to ensure that the federal regulations are followed.

Since all disasters are local, the need to plan, prepare, and exercise is critical for effective emergency response.

8.5.2 STATE AND LOCAL ROADS

Pennsylvania's highway system consists of nearly 122,000 miles of roadway, of which almost 44,000 miles are state owned (primarily by PENNDOT and the Pennsylvania Turnpike Commission), and just over 78,000 are non-state owned (mostly municipalities). It is estimated that over 283 million miles are travelled over PA roads each day, with increases of 1 to 2 percent each year. PENNDOT owns approximately 40,000 miles of the 44,000 state owned miles, which carry over 213 million daily vehicle miles. Municipalities own almost all of the 78,000 non-state owned miles, and carry just less than 49 million daily vehicle miles. Truck traffic accounts for about 27% of all miles travelled, or just over 75 million daily vehicle miles. On the 122,000 miles of roadway, there are over 31,600 bridges, with 127 million sq. ft. of deck surface (Msf); 25,321 are state owned, and 6,334 are locally owned.

- Posting. If a roadway is showing signs of deterioration due to truck traffic, or if a large influx of truck traffic is expected, a posting authority (PENNDOT or municipality) can conduct a traffic and engineering study to determine if a road needs to be posted. Posting takes into consideration not only the weight of the vehicles, but also the volume of vehicles expected to use a particular road. Postings have increased 56% (over 4,000 miles) since 2008. Bridges are also posted based on its structural capacity; however,

³⁰ Pennsylvania One Call is a communication network which receives and processes underground line location requests from excavators, contractors, builders, and the general public to prevent damage to underground facilities. <http://www.pa1call.org/>

bridges are reanalyzed frequently to determine if postings are required, regardless of the volume of trucks. All bridges in PA are designed to the same standard, so the posted bridges are typically older, or have specific deterioration issues. Table 4 demonstrates the increase in posting activity in PENNDOT districts experiencing increased Marcellus Shale related activity as well as the counties that have experienced the greatest bonding activity.

Table 3: Increase in Posting and Bonding Activity related to Marcellus Shale

<u>Marcellus Posted & Bonded Data</u>							
District	Posted Data			Bonded Data			
	Total Miles Posted	Miles Posted for Marcellus ('08-'11)	% of Total from Marcellus	Miles Bonded by Marcellus	Marcellus miles with Minor Damage	Marcellus miles with Significant Damage	% Bonded Miles Damaged
1	1,775	542	30.5%	5.9	0	0	0.0%
2	1,267	498	39.3%	288.1	81.5	40.5	42.3%
3	1,623	1,504	92.7%	1031.7	349.5	79.6	41.6%
4	1,457	1,131	77.6%	329.1	4.2	0	1.3%
5	24	0	0.0%	0	0	0	0.0%
6	13	0	0.0%	0	0	0	0.0%
8	0	0	0.0%	0	0	0	0.0%
9	1,167	58	5.0%	22.7	0	0.9	4.0%
10	1,923	19	1.0%	101.3	1.8	0	1.8%
11	429	14	3.2%	6.2	0.3	0	4.8%
12	1,589	290	18.3%	674.5	451	0	66.9%
Totals	11,267	4,057	36.0%	2,459.5	888.3	121.0	41.0%

Most affected Counties		
Counties	Miles bonded	Traffic Route miles (mostly unposted)
Bradford	557	249
Tioga	252	302
Greene	237	150
Susquehanna	216	282
Fayette	189	284
Washington	178	381
Lycoming	153	379

- **Bonding / Permitting.** Once a road is posted, Chapter 189 of Title 67 - *Hauling in Excess of Posted Weight Limit* governs the method of permitting vehicles over the posted weight limit. In order to obtain a permit to exceed the weight restriction, three items need to be in place, 1) an Excess Maintenance Agreement, 2) Security, and 3) an inspection of the roadway. The Excess Maintenance Agreement requires the hauler to take responsibility for any damages that are in excess of normal use. The security, typically a performance bond, is needed to provide assurance that there are funds available if a hauler is unable or unwilling to pay for damages. Finally, the inspection is necessary to document the condition of the road before hauling starts. Once hauling is completed, a final inspection is conducted, and any excess damage will need to be repaired at the haulers expense. The attached charts give an overview of the number of state miles posted because of the Marcellus Shale industry, and the number of state miles permitted/bonded by the Marcellus Shale industry. Permits can also be obtained for posted bridges, which are governed by Chapter 191 of Title 67. These permits are only given if an analysis of the bridge shows that it has enough capacity to handle the specific type and weight of truck(s) seeking the permit.

The increase in posting activity over the past two years is shown in Figure 33. This increase is clearly demonstrated by reviewing mapping from 2010 (Fig. 32) and 2011 (Fig. 33).

Figure 33: Increase in Posting Activity (2010 - 2011)

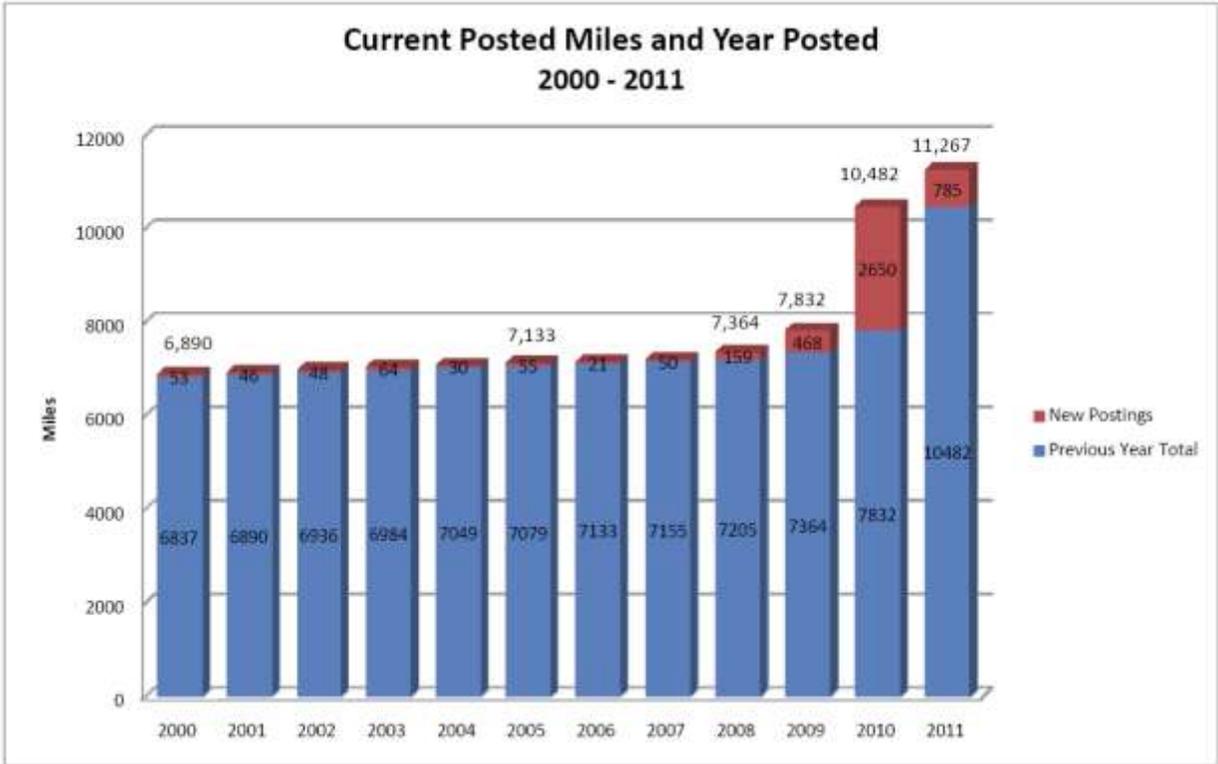


Figure 34: Posted State Roads Before 2010

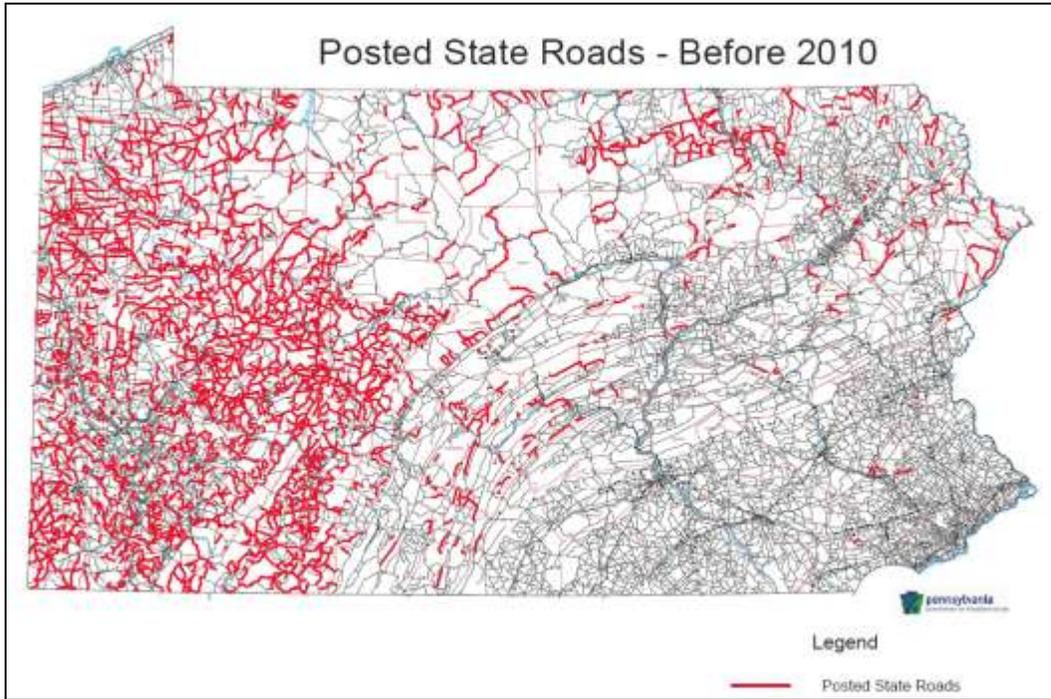
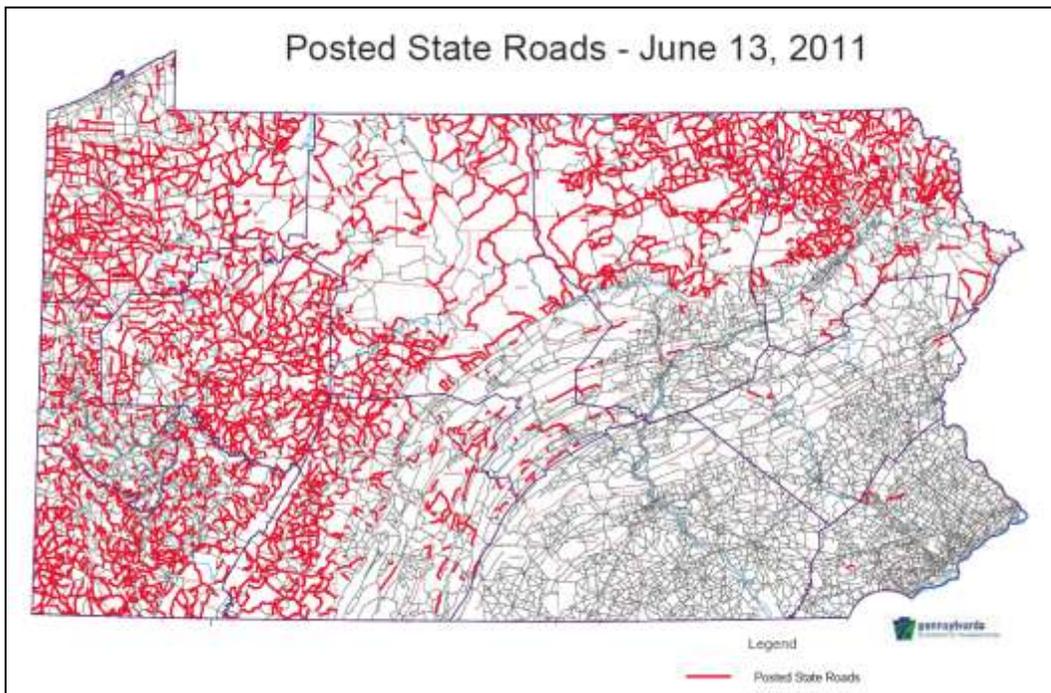


Figure 35: Posted State Roads (June 13, 2011)



- Excess Maintenance Agreement. An Excess Maintenance Agreement needs to be in place before a permit can be given on a weight restricted roadway. The agreement lays out several stipulations, including, the responsibility of the user to maintain the roadway to its existing state of repair, the geographic area wherein permits can be issued, as well as the type of permit to be issued (1, 2, or 3). It also establishes who will be responsible to do repair work, PENNDOT, the municipality, or the User's contractor, with the User reimbursing PENNDOT or municipality for any work they complete. Also, the agreement indicates the type of security that will be provided and a list of remedies if the User is not in compliance, from a warning letter to termination of the agreement. Once an agreement is in place for a specific geographic area, the local District offices can add or subtract permits for specific roads, as long as enough security is in place.
- Spring Thaw. Spring thaw also presents heightened maintenance issues, since water from thawing ice near the surface becomes trapped because it is unable to percolate downward through the soils that remain frozen. Subgrade soils directly below the pavement structure become saturated and weakened. The decreased subgrade support leads to increased deflection of the pavement layers which leads to fatigue cracking and/or rutting. With the large number of heavy vehicles (30 to 40 tons) involved with Marcellus operations (average 1,500/well), a roadway can quickly deteriorate to mud as the pavement is unable to hold up under the repeated loads.

SUMMARY OF ROAD INFRASTRUCTURE NEEDS AND IMPACTS

Although posting and bonding effectively requires haulers to pay for road damages, there are hundreds of miles of traffic routes (main thoroughfares used regularly for local commercial and residential traffic), which are typically un-posted. Given the volume and diversity of users traveling on traffic routes, it is often not practical to bond these roadways, as doing so may be a prohibitive barrier to commerce in general. These roadways, therefore, are likely to see an accelerated need for repair and maintenance.

While many municipalities are working cooperatively with the natural gas industry to post, bond, and monitor impacted roads, the increased demand burdens many municipalities that do not have sufficient staff capacity to keep pace with industry timeframes. In addition, the maximum bond is limited to \$12,500 for a paved road and \$6,000 for an unpaved road which has been reported as inadequate as reconstruction costs can approach several hundred thousand dollars.

Many gas companies and municipalities have entered into excess maintenance agreements in accordance with PENNDOT regulations as part of posting and bonding, resulting in a cost and time savings for both parties. However, there are concerns that non-state certified materials are being used and it is unknown how these materials will respond to wear. Additionally, the speed at which the work is performed has not allowed for adequate storm water planning.

The additional traffic in Marcellus Shale natural gas production areas has resulted in reports of: increased accidents from heavy haulers rolling on damaged roads which can block emergency response in limited access areas; increased traffic accidents in all heavily impacted areas; and an increase in all reported incidents in these areas.

8.5.3 RAIL INFRASTRUCTURE

The natural gas industry faces significant logistical challenges associated with transporting and storing the tremendous volumes of sand, pipe, water, and other materials required to drill a well. The maximum distance to effectively serve a well head in Pennsylvania is 75 miles, particularly due to the steep terrain found in many of

Pennsylvania's drilling locations. The closer a drilling company can get to areas to effectively store the vast quantities required for drilling a well, the better the efficiency of the drilling operation—the better the likelihood of achieving just-in-time delivery. Pennsylvania's railroads, already in place and operational, provide a location to effectively and efficiently receive, store, and trans-load commodities to well heads. The railroads provide the added benefit of reducing the need to develop a staging area from forest land or other vacant land within a 50 to 75-mile radius. Nevertheless, even with the benefit of rail transportation, there still exists a need for trucks to move material and equipment from the rail terminal to the well pads.

Companies providing support services (Well Service Companies) to Marcellus Shale drilling firms are actively and aggressively seeking locations to receive, store, and trans-load materials along the existing railroads. The SEDA--COG Joint Rail Authority (JRA), located in eight counties in Central Pennsylvania, has seen an increase in the number of Marcellus Shale-related carloads, focusing in the Williamsport area in Lycoming County. A total of 80 carloads related to Marcellus were handled on the JRA's Lycoming Valley Railroad in 2008, increasing to 1,600 in 2009. Since 2008, a total of eight Well Service Companies have located along SEDA-COG JRA rail lines, with five companies currently considering locations. Industry experts have told the railroads to expect an explosion of traffic between 2012 and 2013, making the current projections seem small.

The demand is such that SEDA-COG JRA and the railroad operator, North Shore Railroad Company, cannot keep up with the demand for rail-served sites. Currently, Well Service Companies are looking for rail-served sites along SEDA-COG JRA track to accomplish the following:

- **Trans-loading Frac Sand** – Trans-loading frac sand typically requires a long and narrow site with sufficient room to accommodate railcars (typically 60 track feet per railcar), unload sand into a pit, and pump sand to waiting trucks for transport. Well Service Companies handling sand are locating within 75 miles of drilling locations. Most proppants, such as frac sand, are sourced in the Midwestern states.
- **Pipe Lay-Down Yards** - Well Service Companies seeking rail-served locations for pipe lay-down yards in general require a site 25 acres or more in size. A 10,500-foot well (typical for current Marcellus Shale drilling activity) requires 87 tons of pipe; approximately 350 pieces in 30-foot sections, each weighing 495 pounds.
- **Cement Manufacturing** - Manufacturing cement or “mud” is also an increasing need for Well Service Companies. Rail-served sites must be sufficiently sized to accommodate carloads of commodities used in production, production equipment, and sufficient room to handle truck traffic. Each Marcellus Shale well requires 125 tons of locally produced specialty cements.
- **Road Construction/Maintenance/Well Pad Preparation** - A significant local issue associated with Marcellus Shale development is the need to access well sites by road. Existing roads need to be reinforced to handle increased truck travel and travel weights. Roads need consistent repair and maintenance, and new access roads must be constructed to well sites. A total of 5,000 tons of aggregate are required for each well pad location. This does not include aggregate required for road construction, repair, and maintenance.
- **Water Transport** - The waste brine water from a well pad is typically brought to a rail head to ship to a Pennsylvania Department of Environmental Protection-approved treatment facility. Increased water transport via rail is anticipated once well production increases.

Short lines in the Marcellus area are ramping up unused sidings and terminal areas. In some cases new sidings are being constructed. The new facilities are being constructed privately or using Commonwealth grants; the most common source being PENNDOT's Rail Freight Assistance Program (RFAP). In the case of larger projects, the Rail

Transportation Assistance Program is being used for those projects that have been included in a PA Capital Budget.

8.5.4 WATER AND SEWER INFRASTRUCTURE

Extracting Marcellus Shale natural gas requires modern drilling techniques which consume large quantities of water treated with industrial chemicals through hydraulic fracturing. Loss of access to potable water from both a water quality and water quantity perspective is a concern for both private well owners and drinking water providers.

Many residents in most rural areas of Pennsylvania depend on wells supplied by groundwater as their primary source of potable water and residents have reported concerns that chemicals used in hydraulic fracturing may contaminate local water supplies. Similarly, public water providers have concerns about the potential for negative impacts on both water quality and water quantity.

The Pennsylvania Department of Environmental Protection and natural gas companies have been working cooperatively to ensure that hydraulic fracturing water is recycled to reduce the amount of ground water withdrawals and wastewater treatment. Currently, only pre-treated hydraulic fracturing water may be discharged to sewage treatment plants for final processing. Only a handful of wastewater treatment plants are permitted to accommodate this activity.

Several areas in the Marcellus Shale region are fortunate to experience an increase in economic development due to Marcellus Shale natural gas companies and well service companies. Many areas require new and expanded public water and sewer infrastructure to accommodate increased development activity at industrial and Brownfield sites. The costs associated with constructing new facilities, as noted above, is expensive with local governments and economic development agencies not always in a financial position to fund the public improvements.

8.5.5 PLANNING AND LAND USE

The substantial and swift growth of natural gas activity was not an activity that communities could have reasonably anticipated. Even those communities with the most up-to-date and progressive comprehensive plans have not been totally prepared for the rapid growth and development in their communities. It is incumbent upon municipalities to balance the rights of the natural gas industry to access their property, while mitigating community impacts through land use controls.

As noted previously, the Oil and Gas Act regulates the development of oil and gas drilling in Pennsylvania and requires DEP, landowners, and the natural gas industry to follow statutes and regulations. Pennsylvania's Municipalities Planning Code (MPC) requires land use controls to be consistent with and not exceed the provisions of the Oil and Gas Act. The Pennsylvania Supreme Court upheld this authority.

Land use tools such as comprehensive plans, zoning ordinances, and subdivision and land development ordinances can be adopted by municipalities to make certain that development is located where and at an intensity that meets both industry and community needs. However, many municipalities in Pennsylvania's rural areas, where the majority of Marcellus Shale natural gas production is occurring, have not faced significant development activity in the past and subsequently have not adopted sufficient land use controls to protect citizen interests.

Pennsylvania's local government associations have taken action by developing a model zoning ordinance to assist municipalities with adopting regulations to allow Marcellus Shale natural gas production while maintaining reasonable local controls. This model ordinance has been promoted and used in several municipalities.

Maintaining effective land use control in Pennsylvania requires that municipalities retain their authority to enact reasonable regulations and be afforded the opportunity to plan for the impact of such activity on their communities. According to testimony presented to the Commission, more than 800 counties and municipalities in the Marcellus Shale region have adopted zoning regulations or ordinances. The zoning regulations and ordinances may be inconsistent in substance and application, and include various restrictions on noise, setbacks, and road use. Some zoning regulations and ordinances provide for disparate treatment of the natural gas industry.

Beyond well sites, the natural gas industry is creating significant demands for housing, lodging, support business activity, and transportation. Land use planning is also required to help identify and address municipal needs resulting from increased economic development.

Finally, community and economic growth resulting from natural gas development will decline sometime in the future. It will also be necessary to conduct strategic economic planning to avoid stagnant economic conditions in the future. Often overlooked, this type of post-development planning can help communities prepare for and help mitigate potential decline after industry growth slows.

8.5.6 GOVERNMENT OPERATIONS

Staffing in both local governments and counties has been a significant impact associated with the burgeoning shale gas industry. According to PSATS, areas with heavy natural gas extraction activity have reported a rapid increase in labor costs, particularly for skilled employees. This corresponds to Pennsylvania Department of Labor & Industry data which indicates that the average wage in core natural gas industries is \$73,150, nearly \$27,400 higher than the statewide average wage of \$45,747.³¹

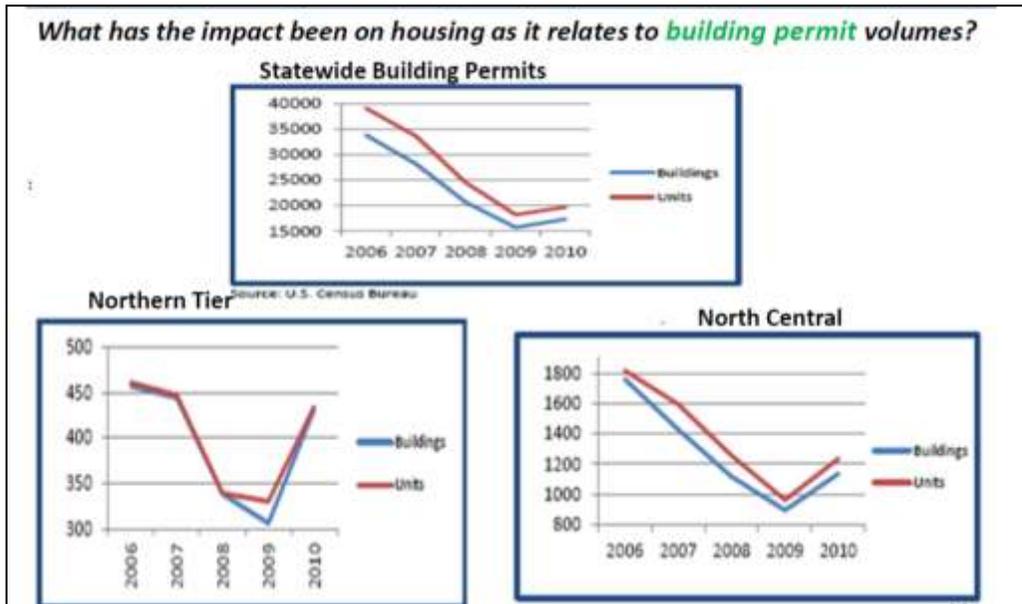
Municipalities have reported to local government organizations the need to increase hours or hire additional staff to keep up with the pace of development associated with road inspections and rebuilding, zoning and building code administration and enforcement, and police services. While the increase can be confirmed, it is not as large as expected. According to the findings of a survey conducted of 494 municipal governments in the Marcellus region, while 28% of survey respondents reported an increase in services and 26% reported an increase in service costs; 67% of respondents reported no change in services and 70% reported no change in costs.³²

The increase in building permits demonstrates the major impact the natural gas industry is having on local governments and their ability to provide efficient services with limited resources. According to U.S. Census Bureau data provided by Pennsylvania Department of Labor & Industry, while the number of building permits issued statewide between 2009 and 2010 rose slightly, the number of building permits issued in the Northern Tier and North Central regions increased rather dramatically during the same time period (Fig. 34). Keeping pace with the need to issue permits and inspect new structures may require an increase in staff time or new staff resources.

³¹ Pennsylvania PA L&I, Center for Workforce Information and Analysis. June 2011.

³² Marcellus Shale Education and Training Center, Economic Impact Study, to be released July 2011.

Figure 36: Building Permits Issued in North Central and Northern Tier Regions (2006 - 2010)



Source: Pennsylvania PA L&I, Center for Workforce Information and Analysis. June 2011.

There has been a reported rise in certain offenses, specifically DUI citations and minor altercations prompting some communities to contract for police service or expand existing departments.

County governments have reported the need to augment County government functions such as: title searches; deed recording; planning expertise; social services such as housing, food, clothing, schools, and drug and alcohol rehabilitation; 911 dispatch; and domestic services. It has been noted that the increase in the number of legal actions in both local and county court systems requires additional court system staffing and training.

8.5.7 AFFORDABLE HOUSING AND QUALITY OF LIFE

While Marcellus Shale natural gas production has had significant, positive impacts on Pennsylvania’s overall economic outlook, the impacts on quality of life should not be overlooked. While in some instances difficult to quantify, there have been substantial impacts reported in and near communities where well drilling is occurring. From an overall increase in traffic, noise impacts near well drilling sites, and disturbance of view sheds, to rising school district enrollments, there are marked community changes pre- and post-development.

Affordable housing has been an impact in many communities and an impact that has been and will continue to be assessed and monitored. As the natural gas industry is expanding into communities, housing costs have risen to meet demand such that local residents can no longer afford housing. While a few natural gas companies are constructing company man camps for workers, many residents particularly renters, have relocated further away from their job and communities to find an affordable place to live.

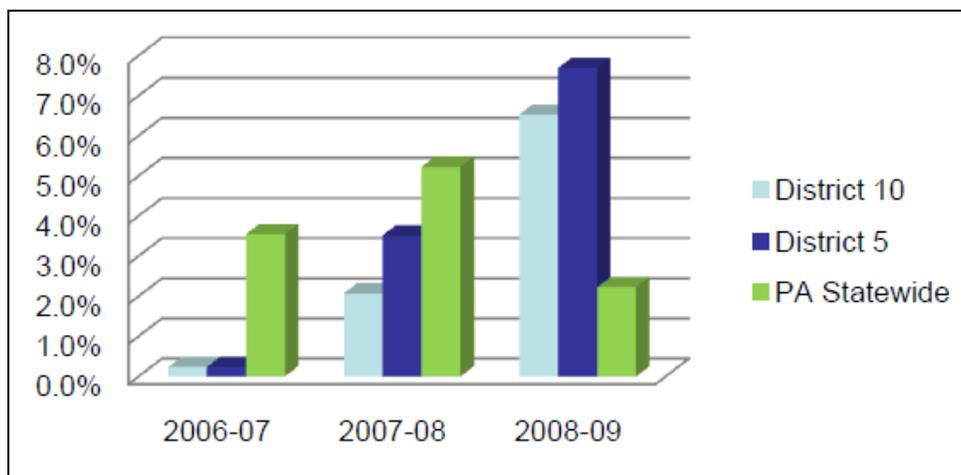
To substantiate this impact, the Pennsylvania Department of Labor & Industry analyzed the increase in rental prices statewide and in two Pennsylvania Congressional Districts (District 5 and District 10) that are experiencing significant amounts of Marcellus Shale natural gas activity. Figure 37 shows the locations of Districts 5 and 10 and Figure 38 shows average rental price increases for these districts compared to the statewide average rental price

increases for 2006 to 2009. From 2006 to 2007 and from 2007 to 2008, Pennsylvania experienced increases in average rental prices above both Congressional Districts 5 and 10. From 2008 to 2009, rental price increases in Congressional Districts 5 and 10 substantially outpaced rental prices for Pennsylvania as a whole.

Figure 37: Congressional Districts 5 & 10



Figure 38: Rental Price Increases Congressional Districts 5 & 10



Source: U.S. Department of Commerce, Census Bureau, *American Community Survey* (2006 – 2009).

Opportunities to address affordable housing issues are well underway with three (3) affordable housing studies near completion or planned.³³ In addition, the Pennsylvania Housing Finance Agency (PHFA) makes rental housing programs available. Current applications are being reviewed for rental properties seeking to develop affordable housing through the federal Low Income Housing Tax Credit Program. Four (4) applications for affordable housing in Marcellus Shale communities are currently being reviewed by PHFA. Additional Low Income Housing Tax Credit Program allocations will be available in the next round of program funding in fall 2011.

³³ Affordable housing studies are being conducted by: Institute for Public Policy & Economic Development at Wilkes University, *due July 2011*; Center for the Study of Community and the Economy at Lycoming College, *due fall 2011*; and The Reinvestment Fund, *due date to be determined*.

9. COMMISSION RECOMMENDATIONS

Following are the recommendations adopted by the Governor’s Marcellus Shale Advisory Commission at the Commission’s July 15, 2011 public meeting. Roll call votes of the recommendations can be found in Appendix C.

9.1 INFRASTRUCTURE

9.1.1

Currently, there is only one gas safety inspector training center (Oklahoma) in the nation. Pennsylvania, in partnership with industry, the federal Pipeline and Hazardous Materials Safety Administration and educational institutions, should pursue existing opportunities which seek to locate a gas safety inspector training facility within the Commonwealth.

The Pennsylvania Public Utility Commission (PUC) must currently send its gas safety inspectors out-of-state to obtain needed training related to pipeline safety. The PUC has stated that its need for pipeline inspectors will grow in coming years as additional pipeline infrastructure is deployed throughout the natural gas producing regions.

9.1.2

To address the lack of coordinated permitting processes for pipeline deployment, the Commonwealth should designate a state agency to create a “One-Stop” permitting process while expanding the use of General Permits to authorize routine development activities, as well as maintain jurisdiction over multi-county linear pipeline projects and ensure appropriate notifications have been made to local jurisdictions. It is not the purpose of this proposal to encourage the expansion of statutory jurisdiction of the Public Utility Commission beyond gas safety oversight in so far as non-jurisdictional gathering lines are concerned.

9.1.3

To relieve the burden imposed upon roads and bridges from the transportation of sand, water, pipe and other commodities associated with natural gas development, the Commonwealth should prioritize the utilization of its financial resources to evaluate and potentially expand its rail freight facilities and capabilities, and partner with rail authorities to seek federal rail assistance funding, such as the Transportation Investment Generating Economic Recovery (TIGER) program.

On April 21, 2011 Governor Corbett issue Executive Order 2011-02, which established the Governor’s Transportation Funding Advisory Commission. Among its charges, the Commission will “Study and prepare a comprehensive listing of potential revenue sources available for current and future funding of transportation in the Commonwealth for all modes of transportation.”

9.1.4

PENNDOT should identify a mechanism to properly invoice natural gas operators for costs incurred for inspections and improvements on non-posted roadways. Invoices must reflect actual costs apportioned to the industry utilizing engineering calculations based on traffic counts.

9.1.5

Prioritize and encourage the beneficial re-use of steel and blast furnace slag a byproduct of the electric arc and integrated steelmaking process for aggregate applications, such as well pad and access road construction, thus preserving limited landfill capacity.

9.1.6

As PENNDOT and municipalities expand the use of posting roadways for heavy truck traffic, both the Commonwealth and municipalities should evaluate the impacts this imposes upon other users of the roadway, including timber, wood product, quarry and other mine operators and others, and work to provide flexibility for all users whenever possible.

See 8.5.2 for an overview of increased posting and bonding activity related to Marcellus Shale development.

9.1.7

The Public Utility Commission should be given statutory gas safety oversight of non-jurisdictional intra-state gathering systems, including mechanisms to establish safety standards regarding the design, construction and installation of such lines within Class 1 areas.

Pipelines are generally classified based on location to building density. Class I pipelines are generally defined as having 10 or fewer buildings intended for human occupancy within the "Class Location Unit" (220 yards from the centerline on either side of the pipeline).

9.1.8

The Commonwealth, through the Bureau of Aviation, should undertake a detailed assessment of air service and infrastructure needs among regional airports within the Shale area so that targeted improvements can assist in capitalizing on gas-industry generated economic opportunities.

9.1.9

Counties and municipalities should undertake an inventory and structural evaluation of locally-owned bridges currently exempt from federally mandated inspections (typically 8' to 20').

9.1.10

PENNDOT should calculate and evaluate increased traffic volume to continuously calculate impacts, particularly as natural gas development activities expand into currently undeveloped regions of the Commonwealth.

9.1.11

To ensure the safety, integrity and use of high quality steel (such as steel which meets API standards) annual well production reports submitted to DEP should specify the country of origin and manufacture of any steel products used in the maintenance or construction of a well during the reporting period.

9.1.12

To ensure the safety, integrity and use of high quality steel (such as steel which meets API standards) in the exploration, gathering and transmission of natural gas, operators required to register with the Public Utility Commission shall report the country of origin and manufacture of any steel products used for a PUC regulated activity during the reporting period.

9.1.13

A lead state agency should be designated to alleviate delays in linear pipeline project development and approval; to identify redundant (state and federal) natural and cultural resource reviews which should be eliminated; to properly tailor the scope of agency reviews; and the PA Natural Resource Inventory on-line tool should be expanded to accommodate linear projects longer than 15,000 feet.

9.1.14

State agencies should offer accelerated permit reviews within guaranteed time frames, provided any incremental costs associated with the accelerated review shall be paid by the permit applicant.

9.1.15

State law should be amended to authorize PENNDOT to negotiate leases which permit the location of energy and utility infrastructure within PENNDOT's right-of-way.

9.1.16

PENNDOT shall look to add language to either the Excess Maintenance Agreement or the Road Maintenance Plan that directs the industry to evaluate the Erosion and Sediment controls already in place on a roadway to determine if interim erosion and sediment control measures are necessary while the road is in use but before road reconstruction begins.

See 8.5.2 for an overview of Excess Maintenance Agreements and challenges posed to local and state road and bridge infrastructure.

9.1.17

Develop and provide planning tools and educational opportunities relating to unconventional natural gas development to counties; require proper notice of permit applications with an opportunity to comment (similar to notice for host and adjoining municipalities); and, under DEP guidance and consistent with applicable permit conditions, allow for County Conservation Districts to engage in inspections of erosion and sedimentation controls at unconventional well sites, if they choose to do so.

9.1.18

DEP should ensure that natural gas construction activities are required to meet the same standards as general construction activities. Modifications to current construction standards as they are applied to unconventional natural gas drilling activities may be necessary.

9.2 PUBLIC HEALTH, SAFETY & ENVIRONMENTAL PROTECTION

9.2.1

Civil penalties for violations of the Oil and Gas Act should be increased from \$25,000 to \$50,000 and the daily penalty should be increased from \$1000/day to \$2,000/day. Current criminal penalties for summary and misdemeanor offenses should be reviewed to ensure they are consistent with penalties of comparable environmental statutes.

9.2.2

Consistent with other environmental statutes, DEP should be able to assess civil penalties, rather than the Environmental Hearing Board.

Section 506 of the Oil and Gas Act authorizes the Environmental Hearing Board to impose civil penalties.

9.2.3

Authorize the Environmental Quality Board to develop, by regulation, criteria for conditioning a well permit based on its impact to public resources.

Section 205 (c) of the Oil and Gas Act directs DEP to consider an oil or gas well's impact on public resources, such as parks, forests, scenic rivers, national natural resources, habitat for critical communities and historical and archeological sites.

9.2.4

Amend the Oil and Gas Act to authorize DEP to suspend, revoke or deny permits in a more timely manner than current law allows when an operator has failed to comply with the Oil and Gas Act or other applicable environmental statutes and is not correcting the violation to the satisfaction of the department.

9.2.5

Pre-drilling notification should be extended from 1,000 feet to 2,500 feet of the proposed well, and include all landowners and water purveyors. In addition, notification shall be made to host municipality or adjacent municipalities within 2,500 feet.

9.2.6

Expand an operator's presumed liability for impaired water quality from within 1,000 feet of a well to within 2,500 feet of a well, and from 6 months to 12 months of completion or alteration of the well. In addition, the presumed liability should be applied to well stimulation.

Under the Oil and Gas Act, any well operator who affects a water supply is responsible for repairing or replacing the water supply. An oil or gas well operator is presumed responsible for the pollution of a water supply which occurs within 1,000 feet and within 6 months of completing or altering the oil and gas well. The current "rebuttable presumption" does not include stimulation of the well, such as hydraulic fracturing.

9.2.7

Well operators should be required to track and report on the transporting, processing and treatment or disposal of wastewater from high-volume wells (ie 80,000 gallons or more of water used).

9.2.8

Authorize DEP to develop a well operation permit so that entities can "adopt" orphaned or abandoned wells.

The "adoption" of abandoned and orphaned oil and gas wells through the registration process by present-day operators can return wells to useful production; eliminate a potential environmental or safety hazard; and relieve the Commonwealth of a potential liability. DEP's authority to authorize this practice was struck down by the Environmental Hearing Board in Emerald Coal Resources, LP v. Department of Environmental Protection and Samuel R. Barclay on the grounds that DEP's statutory authority to register wells had expired.

9.2.9

Current well bonding amounts are \$2,500/well or a \$25,000 blanket bond. Well bonding amounts should be significantly increased (\$10,000/ deep well) in a manner which provides for bond amounts in two tiers based on total wellbore length (up to and including 6,000 feet and greater than 6,000 feet) and authorizes blanket bonds based on the number of wells per operator, up to \$250,000. Well bond amounts and options for alternative financial assurances should be re-examined within three years.

Oil and gas permit applicants are required to file a bond with DEP to ensure that the operator complies with the requirements of the Oil and Gas Act, including provisions related to drilling, water supply replacement, restoration and plugging requirements. Bond amounts have not been increased since the Act's passage in 1984.

9.2.10

Amend the Oil and Gas Act to authorize DEP to enter into contracts with well control specialists; hold well control specialists free from damages which may arise from emergency response actions; and permit DEP to recover costs from well operators should a contracted well control specialist need to be deployed.

9.2.11

Increase the minimum setback distance from a private water well from 200 feet to 500 feet and establish a minimum setback distance from a public water supply (water well, surface water intake or reservoir) to 1,000 feet unless waived in writing by the owner or public water supply operator.

9.2.12

Provide DEP with additional authority to establish further protective measures for the storage of hazardous chemicals or materials on a well site located within a floodplain.

9.2.13

Impose additional conditions for locating well sites in floodplains, including prohibiting where appropriate.

9.2.14

Amend well stimulation and completion reporting requirements to include, at a minimum, the following:

- Pump rate, pressure and total volume used for Hydraulic Fracturing;
- List of all hazardous chemicals used for Hydraulic Fracturing;
- Identification of all water sources used for hydraulic fracturing, consistent with the DEP-approved water management plan (if applicable).
- Depth of potable aquifers encountered during drilling.
- Whether methane was encountered at other than target formation during drilling.
- Radioactive or other industry standard logs, if appropriate.
- Other information as required by DEP
 - Well stimulation and completion reports should be posted on DEP's website and be accessible to the public

9.2.15

Require enhanced inspection and notice of activity on well sites, including:

- The timely inspection of each well site upon completion of erosion and sedimentation control measures, prior to the commencement of drilling activity;

- Notice by the well operator to DEP, at least 24 hours in advance, before commencing the following activities at the well site:
 - Cementing of casing strings;
 - Pressure testing of production casing strings;
 - Well stimulation, including hydraulic fracturing;
 - Plugging or abandoning of a well.

9.2.16

Require DEP to post, and regularly update, well inspection reports online. Reports shall include:

- Nature and description of any violations, if any;
- Operator’s written response to violations, if available;
- Status of violation;
- Any remedial steps taken by the well operator or DEP to address the violation.

9.2.17

The Commonwealth should enact legislation establishing construction standards for new private water wells to ensure the delivery of safe drinking water to its residents.

According to the Penn State Cooperative Extension, more than 1 million water wells serve over 3.5 million residents in Pennsylvania (second only to Michigan), with approximately 20,000 new water wells drilled each year. According to a study financed by the Center for Rural Pennsylvania, approximately 41% of private water wells in Pennsylvania failed to meet at least one of the health-based drinking water standards. Poorly or improperly constructed water wells can result in pathways for bacteria and other contaminants, such as naturally occurring shallow methane, to migrate into the potable water supply. Pennsylvania remains one of only a handful of states without statewide private water well construction standards.

9.2.18

Over the next six months DEP should evaluate all of its regulatory programs to determine if obstacles exist or changes could be made to facilitate the increase in proper recycling of flow back and produced water from gas wells and to facilitate and encourage the increased use of non-fresh water for hydraulic fracturing.

9.2.19

The Commonwealth should encourage the establishment of voluntary ecological initiatives which incentivize extraction-oriented industries to finance improvement projects within critical watersheds, streams and forest habitat and which generate mitigation credits which are eligible for use to offset future development.

9.2.20

The Oil and Gas Act's well site remediation provisions should be amended to authorize the Department to extend the nine-month well-site restoration requirement when the Department determines that an extension would ultimately result in less surface disturbance, increased water reuse, or more efficient development of the resource. Such an extension would be for a defined period of time and could include interim restoration/stabilization measures, as specified by DEP.

Under the Oil and Gas Act, within 9 months of completing a well, the site must be restored, all pits must be removed or filled, and all non-production equipment and supplies must be removed. The nine-month period may be extended by DEP for up to 6 months due to adverse weather conditions or lack of essential fuel, equipment or labor.

9.2.21

The Oil & Gas Act should be amended to clarify that DEP has authority pursuant to the Clean Streams Law to require a Water Management Plan (Plan) as part of the Section 201 permitting process to protect the ecological health of water resources. Approval of a Plan shall authorize the removal and use of such water away from the riparian lands, provided the use is conducted in accordance with the Plan. An operator must still obtain legal permission from the riparian rights owner for access. Such program should not duplicate the authority of any interstate river basin commissions.

Water withdrawals in the Commonwealth are regulated within the Delaware and Susquehanna river basins by two interstate compact commissions: the Susquehanna River Basin Commission (SRBC), and the Delaware River Basin Commission (DRBC).

9.2.22

The Commonwealth should encourage the use of non-freshwater sources where technically feasible and environmentally beneficial. For example, legislation that would provide operators with immunity from environmental liability for the use of acid mine drainage water from abandoned mine pools would encourage operators to reduce their use of freshwater sources for water utilization as well as reduce the amount of acid mine water draining into local streams.

9.2.23

DEP and DCNR – along with industry – should continually review and examine the range of best management practices utilized during construction and operation of the well site, and consider incorporating these types of practices into regulatory and operator guidance. The practices, some of which DCNR already requires for its leases, could include:

- Minimizing the size and disturbance of well sites and related facilities;
- Stockpiling of topsoil; utilizing rocks, stumps and slash for wildlife enhancement;
- Use of closed-loop drilling systems;
- Increased use of flow-back water;
- Use of surface water withdrawals rather than groundwater withdrawals;
- Utilization of “tank in tank” systems with secondary containment for storage flow-back water;
- Use of high-density polyethylene pipe for flow-back water transportation;
- Noise abatement strategies for gas processing and compressor stations;
- Minimize, avoid or buffer against conflicts with resources such as critical waterways, public parks, endangered or threatened plants, species and habitats, historic and cultural areas;
- Avoid or minimize forest loss and fragmentation;
- Cement all casing strings to surface to provide multiple protective barriers for aquifer;
- Pressure-test each casing to ensure integrity of casing design and cement;
- Perform a combination of pressure tests and electric logging to verify the mechanical integrity of the casing and cement over the life of the well;
- Enhanced safety procedures for wet gas testing, flowback and production;
- Ensure the integrity of well control systems at all times, with a particular focus during completion operations (such as “isolation tools” or “tree savers”);
- Avoidance of construction activities during adverse weather conditions which may impact public safety;
- Use of marking systems to indicate presence of below-ground gas, water, electric and flow-back pipelines;
- Minimize conflicts with recreational activities during holidays and high visitor-use periods.

9.2.24

The setback standard for an unconventional well shall be increased to 300' from the wellbore to a stream or water body as provided in section 205(b) of the Oil and Gas Act. A 100' setback from the stream or water body to the edge of disturbance shall also be implemented. DEP's current waiver authority would be retained for both setbacks. For High Quality and Exceptional Value streams, however, additional setbacks or BMPs may be required by DEP. Additional discussion of the appropriate definition of water body for the purpose of these setbacks is necessary.

Section 205(b) of the Oil and Gas Act states that no well site may be prepared or well drilled within 100' feet of a stream, spring or body of water.

9.2.25

DEP should continue to participate in non-profit, multi-stakeholder organizations such as the State Review of Oil and Natural Gas Environmental Recommendations, Inc. (STRONGER), that provide periodic peer review of the Commonwealth's regulatory structure and enforcement efforts.

9.2.26

Using publicly available data (e.g., PA Natural Diversity Inventory, County Natural Heritage/Natural Area Inventories, and other relevant sources), DEP, DCNR, PGC and PFBC will jointly identify and make accessible for public review information (but not including location information on species) on areas of high ecological value in Pennsylvania (e.g., high conservation value forests, concentrations of biological diversity, sensitive aquatic communities, etc.). When submitting a permit application for an unconventional shale gas well that would be located in such an area, the applicant will be required to provide DEP with a description of its efforts to avoid, minimize or mitigate for impacts to the area. (e.g., co-location and centralization of infrastructure, use of specialized BMPs, well pad spacing and density adjustments, working with other companies holding leases in this area to reduce cumulative impacts, etc.). DEP could establish specific conditions on well permits proposed in such areas.

9.2.27

Conduct an engineering analysis of spill containment systems at unconventional shale gas well sites, including wells, well pads, storage tanks/impoundments and other equipment/facilities. This analysis will evaluate the design and structure of containment systems and determine adequacy and effectiveness in relation to the volumes and types of materials present at these sites at different stages of the production process. The analysis also will review past performance of containment systems used at well sites. Recommendations for new or improved containment practices, structures, and procedures –including, but not limited to, liners and berms on well sites, will be developed as needed.

9.2.28

Strengthen and improve effectiveness of the permit review process in protecting rare, threatened and endangered species. State agencies should consider, but not be limited to, the following options: increasing staff capacity and program resources, enhancing quality and presentation of data on wildlife and critical habitats; identifying appropriate opportunities to improve and manage access to such data, upgrading computer systems, providing additional technical and planning assistance, increasing acquisition of current field data, and other options as identified.

9.2.29

DEP should develop an environmental assessment checklist as part of the permit application process to locate and construct a drilling site. The checklist should be used to identify all the features to which setbacks are applicable; identify all natural features that DEP is authorized to consider; and to identify those additional Areas of High Ecological Value.

9.2.30

Invasive Plant Species introductions should be avoided by utilizing techniques such as:

- Thorough cleaning of construction equipment;
- Minimization of soil disturbances;
- Timely re-vegetation of sites using native, non-invasive species;
- Annual surveillance to detect and control early infestations.

9.2.31

Recognize and utilize the expertise of DCNR to advise other Commonwealth agencies which host natural gas development on their land.

9.2.32

DCNR should monitor and document effects, both positive and negative, of natural gas development on plants and forests, wildlife, habitat, water, soil and recreational resources.

9.2.33

The Commonwealth and its agencies should work together to promote, encourage and establish regular communications and information sharing among local communities, operators, environmental and conservation groups and other stakeholders.

9.2.34

DCNR should establish a Natural Gas Advisory Committee to enhance communications among stakeholders regarding natural gas development on state forest and park land.

9.2.35

Identify legislative/regulatory changes needed to:

- Effect the sharing of pipeline capacity and reduce surface disturbance and associated environmental impacts;
- Encourage the use of existing pipeline infrastructure and co-location with other rights-of-way;
- Achieve coordination and consistency of infrastructure planning and siting decisions by State, county and local governments;
- Provide sufficient authority and resources for appropriate government agencies to ensure that ecological and natural resource data are used in the review and siting of proposed pipelines, in order to avoid or minimize impacts to these resources.

9.2.36

Any future leasing of state forest land should be limited to agreements which result in no or minimal surface impact to Commonwealth-owned land, and prohibits surface disturbance in high conservation value forests and other ecologically important areas.

Section 302 of the Conservation and Natural Resources Act (Act 18 of 1995) authorizes DCNR to enter into leases for the development of oil, gas and other mineral resources. Executive Order 2010-05 prohibits the leasing of additional lands owned and managed by DCNR for oil and gas development.

9.2.37

The Department of Health should work in partnership with the Commonwealth's graduate schools of public health and other appropriate medical institutions to better protect and enhance the public health interests of citizens, such as through the establishment of the population-based health registry and curriculum development.

9.2.38

The Department of Health should collect and evaluate clinical data provided by health care providers.

9.2.39

The Department of Health should routinely evaluate and assess Marcellus Shale-related environmental data, such as air, water, solid waste, and fish and other food samples, that is collected from a variety of entities, such as PA DEP, US EPA, the US Geologic Survey, water works or treatment facilities, industry and academic partners.

9.2.40

The Department of Health should create, or oversee the creation of, a population-based health registry with the purpose of characterizing and following over time individuals who live in close proximity (ie one mile radius) to gas drilling and production sites.

9.2.41

The Department of Health should establish a system to provide for the timely and thorough investigation of and response to concerns and complaints raised by citizens, health care providers or public officials.

9.2.42

The Department of Health should educate health care providers on the presentation and assessment of human illness that may be caused by material in drilling constituents.

9.2.43

The Department of Health should establish public education programs regarding the constituents used in the drilling process, potential pathways to humans, and at what level, if any, they have the potential to cause human illness.

9.3 LOCAL IMPACT & EMERGENCY RESPONSE

9.3.1

Oil and gas well pads and related facilities should be assigned a 9-1-1 address for emergency response purposes, and oil and gas operators should be required to provide GPS coordinates for access roads and well pad sites, and post this information, along with appropriate emergency response contact information, in a conspicuous manner

at the well pad site or related facilities, including but not limited to: compressor stations, launching equipment sites, impoundments and tank batteries.

Accurate locational information is critical to ensuring a timely response during an emergency. Many well pads and related facilities are located in rural areas. Several counties, including Lycoming and Bradford, have begun assigning addresses to well pad sites and related facilities.

9.3.2

In coordination with PEMA and DEP, emergency plans for responding to incidents on well development sites should be standardized across the Commonwealth to ensure an acceptable level of expectation for safety and response coordination. The emergency plan should be distributed to the county emergency management coordinator.

9.3.3

Establish and provide for a Specialized Team of Emergency Responders to enhance incident management and unified command practices capable of immediate response to an incident anywhere in the Commonwealth. The Specialized Team will focus on ensuring public safety, isolating and securing the incident site while leaving well control of blow outs, fires or releases to professional, trained experts utilizing equipment staged in a manner to provide a timely response to emergencies.

9.3.4

Establish county/regional safety task forces utilizing public/private partnerships comprised of public officials, local emergency responders, industry representatives and other experts to facilitate coordination, knowledge sharing and emergency response protocols. Task forces should be overseen by a state emergency response work group to ensure consistency and uniformity across the Commonwealth.

9.3.5

Provide comprehensive training to local fire and emergency responders, focused on the unique situations presented from natural gas-related emergencies, and assist in the identification and acquisition of appropriate materials, through a program overseen and administered by the Office of the State Fire Commissioner.

The Office of the State Fire Commissioner oversees the training, operational and informational purposes of the Commonwealth's fire and emergency services community. The number of volunteer fire and emergency service providers in Pennsylvania has decreased substantially in recent years, from over 300,000 in the 1970s to approximately 60,000 today.

9.3.6

Establish a statewide Commodity Flow Study to assess the need for additional Hazardous Material training, personnel and preparation related to the transport of chemicals, fluids and other materials of concern.

Act 165 of 1990, as amended, known as the Hazardous Material Emergency Response and Planning Act, governs the emergency response to releases of hazardous materials from facilities and transportation-related accidents.

9.3.7

Design and implementation of a Unified Command System at well pad incidents involving multi-agency responses. Federal Emergency Management Agency ICS 300 and ICS 400 level programs may serve as appropriate models for state use.

FEMA ICS 300/ICS 400 courses are aimed at ensuring a sufficient number of adequately trained and qualified emergency management/response personnel.

9.3.8

PENNDOT, in cooperation with the Pennsylvania State Police, should establish a protocol for the emergency movement of heavy equipment during off-hours (evening, night and weekends) which must be dispatched to a location in immediate need of the equipment.

9.3.9

Based upon the testimony presented, research conducted, and first-hand personal experiences, the Commission recommends the enactment of – or authorization to impose a fee for – the purpose of mitigating and offsetting the uncompensated portion of demonstrated impacts borne by the citizens and local governments of the Commonwealth attributable to unconventional natural gas development.

The imposition of any fee should be accompanied by appropriate statutory changes to ensure fair and consistent municipal regulation which does not unreasonably impede the development of natural gas. Any fee should include a correlation between the amount of the fee and costs incurred; should recognize the ongoing nature of certain impacts; and should be done in a manner that does not discourage maintaining or expanding partnerships between well operators and local communities.

Impacts identified by the Commission as appropriate for compensation include, but are not necessarily limited to:

- Local emergency response, planning, coordination, training, equipment acquisition, communication and implementation;
- Public safety, including police and fire protection;
- Public water and sewer infrastructure extension;
- Costs associated with inspection and long-term maintenance of road and bridge improvements;
- Increased demand on social services, such as housing, domestic relations, drug and alcohol assistance and education;
- County and municipal general land use planning;
- Increased judicial system (Court of Common Pleas and Magisterial District Judges) demands, including training, defendant processing and associated needs;
- Environmental remediation associated with natural gas development;
- Community-based projects to protect and restore land, wildlife, water resources and outdoor recreation opportunities;
- Local conservation agency oversight;
- State-administered emergency response training, planning and coordination;
- Public health evaluation, citizen and health care provider education, data collection and investigation;
- State natural resource agency oversight, permit review and enforcement.

See Appendix D for examples of local impact costs.

9.4 ECONOMIC & WORKFORCE DEVELOPMENT

9.4.1

The Commonwealth should carefully evaluate and strategically target the investment of revenues generated from natural gas development on state owned land; including the enhancement of bridges and other infrastructure.

9.4.2

The Commonwealth should identify strategic locations to construct regional business parks capable of tapping into existing infrastructure, partnering with local economic development agencies seeking the development, and utilize available financial incentives, such as the proposed Liberty Financing Authority.

9.4.3

PENNDOT, or an independent consultant, should evaluate the future rail needs necessary for maximizing shale development to facilitate the efficient targeting of financial assistance programs and remove additional truck traffic from roadways.

9.4.4

A comprehensive evaluation of Pennsylvania's competitive business climate should be conducted to ensure that the Commonwealth is best positioned to attract private investment capital and maximize downstream natural gas use, such as in chemical manufacturing, plastics and other uses.

9.4.5

Pennsylvania should develop "Green Corridors" for natural gas fueled vehicles, including Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG) fueling stations, located at least every 50 miles and within 2 miles of designated highways.

9.4.6

The Pennsylvania Clean Vehicles Program, which incorporates by reference regulations promulgated by the California Air Resources Board related to Low Emission Vehicles, should be modified to repeal those provisions which prohibit the conversion to bi-fuel (diesel and natural gas) vehicles.

Under federal law, states must choose to utilize either the federal low emission vehicle standards, or those adopted by the state of California. In December 2006, the Environmental Quality Board adopted the standards promulgated by the state of California (see 25 Pa Code §126).

9.4.7

Create financial incentives for the conversion of mass transit and school bus fleets to natural gas, as well as for the manufacture of engines and other component parts, utilizing funding sources such as the Alternative Fuels Incentive Grant fund.

9.4.8

The Commonwealth should promote the use of cogeneration technology (Combined Heat & Power (CHP)) through the use of Permit-by-Rule, standardized utility power grid interconnection rules and direct financial incentives.

9.4.9

The Alternative Energy Portfolio Standards Act should be amended to include natural gas as an eligible Tier 2 fuel source.

Act 213 of 2004, as amended, enacted the Alternative Energy Portfolio Standards Act. The Act establishes certain requirements for electric distribution and supply companies to purchase an increasing amount of electricity from alternative and renewable energy sources.

9.4.10

The development and utilization of Marcellus Shale and other unconventional gas resources should be a critical and prominent component of an established state energy plan for the Commonwealth.

9.4.11

Academic research efforts across the Commonwealth, including initiatives such as SAFER (Shale Alliance for Energy Research), the Ben Franklin Technology Partners' Shale Gas Innovation and Commercialization Center and others, should be marshaled to focus academic-supported efforts on needs such as research and development, business start-up incubation and seed-capital start-up assistance.

9.4.12

The Department of Conservation and Natural Resources and other public resource agencies should be tasked with ensuring access to mixed land uses within the Marcellus Shale region to highlight and ensure the viability of recreational activities, such as hiking, canoeing, snowmobiling, ATV and other uses.

9.4.13

The Commonwealth should incentivize the development of intra-state natural gas pipelines to ensure the in-state use of Marcellus Shale and to lower costs to consumers through the avoidance of interstate pipeline transmission costs.

9.4.14

The Commonwealth should seek to attract and encourage the siting of facilities such as ethylene processing plants for the development of value-added gas byproducts.

Ethylene is produced from components of "wet" natural gas, and has numerous commercial purposes, particularly within the petrochemical industries.

9.4.15

The Department of Community & Economic Development should work closely with its regional economic development partners and gas producers to grow the number of existing manufacturing firms participating in the shale gas industry in Pennsylvania by helping suppliers adapt their products, meet industry standards, market their services and resources and identify qualified suppliers.

9.4.16

The Commonwealth should work with the natural gas industry to identify future employment opportunities, and partner with academic institutions, including trade and technical schools, to develop and disseminate curriculum and training needed to educate and provide employment opportunities for Pennsylvania workers.

9.4.17

As is done with nursing, education and other high-demand professions, consideration should be given to providing additional job training assistance and certification programs, such as those developed by the Pennsylvania College of Technology, Westmoreland County Community College and others, to individuals seeking employment in the natural gas industry.

9.4.18

Provide assistance to rural regions unaccustomed to rapid economic growth, through state programs administered by the Department of Labor and Industry and the federal Shale-NET program.

Shale-NET is a coalition between Westmoreland County Community College (lead agency) and Pennsylvania College of Technology, West Virginia Northern Community College, Eastern Gateway Community College in Ohio, and Broome Community College in New York. Its mission is to design a comprehensive recruitment, training, placement, and retention program for high priority occupations in the natural gas drilling and production industry. See www.shalenet.org.

9.4.19

The Commonwealth should work with potential partners, such as the U.S. Chamber of Commerce, the PA Chamber of Business and Industry, individual gas development companies and others to sponsor programs (such as Hiring Our Heroes & Troops to Roughnecks) geared toward providing employment opportunities for veterans of the United States Armed Forces.

9.4.20

Enhance the utilization of the PA CareerLink program to better align and match the state's unemployed with job opportunities available across the Commonwealth, especially jobs available in regions of the state where unemployed workers may not be familiar.

See www.pacareerlink.com for additional information on PA CareerLink and the Commonwealth Workforce Development System.

9.4.21

Enhance efforts to train, certify and employ individuals seeking work with Commercial Drivers' Licenses, through the deployment of standardized curriculum developed by Shale-NET and educational seminars like the "Marcellus Transportation Safety Day" sponsored by the Marcellus Shale Coalition.

9.4.22

Pennsylvania should undertake a comprehensive effort to develop and disseminate education material and curriculum for use in primary and secondary education institutions regarding the development, extraction and uses of natural gas within the Commonwealth, drawing upon expertise from within industry, environmental, public health, academic, government and other sectors.

9.4.23

The Commonwealth should partner with public health agencies, as well as industry, to disseminate drug and alcohol awareness programs for the benefit of prospective employees, especially school-age students.

9.4.24

The Department of Labor and Industry should prepare and disseminate a Marcellus Shale Labor Market Information Report, which is updated regularly, to inform the public, policymakers and job-seekers on the employment-related impacts of the natural gas industry.

9.4.25

The Department of Labor and Industry should prepare and disseminate a “High Priority Occupation (HPO)” list to help job-seekers identify the best potential employment opportunities.

9.4.26

Pennsylvania’s statutes should be modernized in a timely manner to:

- Include the Marcellus Shale and other deep unconventional geologic formations currently excluded from existing conservation statutes;
- Conform with the best practices for shale gas development in the great majority of states with said production;
- Ensure the protection of property rights for both surface and mineral rights owners;
- Account for the opportunities afforded by advances in technology of natural gas extraction practices, including horizontal and directional drilling and well stimulation;
- Ensure the minimization of surface impact through the proper placement and spacing of well pads;
- Prevent the waste or stranding of natural gas so as to maximize job and revenue-generating opportunities for the Commonwealth and its citizens.

See 3.5 for an overview of Pennsylvania’s statutes related to oil and gas conservation.

10. PUBLIC COMMENT AND RESPONSE

A critical component of the Commission’s deliberations included the consideration of comments received from the public. At the conclusion of each full Commission meeting, members of the public were encouraged to address the Commission. In addition, written and electronic mail comments were accepted throughout the entirety of the Commission’s work. Lieutenant Governor Jim Cawley frequently reminded those present at Commission meetings, as well as those viewing the televised proceedings on PCN-TV, of opportunities to provide public comments. Electronic mail comments were submitted to MarcellusCommission@state.pa.us and were made available to all Commission members via a secure online website. Approximately 120 members of the public addressed the Commission in person, while more than 650 electronic mail and other written comments were received throughout the duration of the Commission’s work.

Comments received covered a variety of issues related to the development of Marcellus Shale natural gas in the Commonwealth and urged the Commission to make recommendations, which addressed these issues. The following represents an overview of several prominent and consistent themes identified in the comments submitted to the Commission, along with steps taken by the Commission to address these concerns.

10.1 ENVIRONMENTAL PROTECTION & OVERSIGHT

Comment: Citizens expressed concern about the adequacy of the Commonwealth’s environmental protection laws and regulations, as well as, the sufficiency of personnel and resources available to DEP. Some commentators urged a moratorium on the issuance of additional permits or the drilling and hydraulic fracturing of new wells. Others supported an enhanced role for local regulatory agencies, such as county conservation districts.

Response: The Commission has included several recommendations to better enhance its oversight of natural gas development, including added protections for water supply owners, notification of drilling activity, coordination and training of emergency responders, increased well bonding, enhanced penalties for violations of environmental standards and many others. The Commission has also included a comprehensive overview, found in Chapter 6 – DEP Regulatory Changes Prompted by Marcellus Shale Activity, Page 65 of the Report, of the regulatory and statutory changes, which have been adopted since the advent of the Marcellus Shale development. These include increased permitting fees for operators, which has doubled the number of personnel within the DEP Bureau of Oil and Gas Management; stricter wastewater treatment and discharge standards; new well production reporting and disclosure requirements; adoption of a water management plan requirement, and significantly enhanced well construction, casing and cementing standards. In addition, the Commission recognizes the need to continuously revisit many of these standards to ensure they are sufficiently protecting the public health, safety and environment of Pennsylvania, while ensuring that DEP and other regulatory agencies have sufficient resources to fulfill their obligations.

10.2 PUBLIC HEALTH

Comment: Numerous citizens expressed concern about the potential public health risks associated with natural gas development, including methane migration, cumulative air quality impacts and exposure to chemicals. Several commentators expressed concern that chemicals and other ingredients used in the hydraulic fracturing were not disclosed.

Response: Both the Public Health, Safety and Environmental Protection work group, as well as the full Commission, heard from a wide array of public health experts, including the state Department of Health, academic schools of public health, and local health care providers. As a result, several recommendations are included in this report to better protect and enhance public health. With respect to hydraulic fracturing, the Commission notes that disclosure of chemicals and other ingredients utilized in the hydraulic fracturing process are, in fact, required to be disclosed as part of the well completion report filed with the PA DEP (DEP). In addition, DEP maintains information regarding the components used in hydraulic fracturing by companies operating within Pennsylvania on its publicly accessible website.

10.3 WATER USE AND POLLUTION

Comment: Several comments expressed concern regarding the impact of the hydraulic fracturing process on water supplies, as well as the impact of withdrawing large quantities of fresh water on other users, including aquatic life. In addition, comments reiterated the belief among many members of the public that natural gas drilling is exempt from the Clean Water Act, Safe Drinking Water Act and other environmental protection federal statutes.

Response: According to DEP, to date, no groundwater supplies have been negatively impacted from the hydraulic fracturing process, which generally occurs a mile or more below the fresh water aquifer. However, due diligence, including aggressive regulatory oversight, is critical to guard against surface spills or leaks, as well as migration of methane and other potential contaminants, due to inadequately constructed and cased wells. Earlier this year, comprehensive new regulations, found in 25 Pa Code Chapter 78, took effect and now govern the construction, cementing and casing of oil and natural gas wells in the Commonwealth.

In addition, the Commission notes that natural gas development, including hydraulic fracturing, is subject to the provisions of numerous federal and state laws, including the federal Water Pollution Control Act, Safe Drinking Water Act, Clean Air Act and the state Clean Streams Law, Oil and Gas Act, Air Pollution Control Act, and many others. A comprehensive overview of the federal and state governing statutes is found in Chapter 5 – Regulatory Framework, of this report.

10.4 MUNICIPAL ZONING

Comment: Many members of the public expressed support for local municipal authority to regulate the oil and gas industry. Others expressed concern over the lack of consistency and uniformity of zoning across the Commonwealth related to the oil and gas industry.

Response: The Commission recognizes the importance of reaching the proper balance between appropriate local oversight of land use and planning, while not unfairly impeding the responsible growth of the natural gas industry. The Commission has adopted recommendations concerning the streamlining of permits and enhanced notifications to municipalities affected by natural gas development activities.

10.5 ECONOMIC IMPACTS

Comment: Several citizens expressed support for maximizing the economic opportunities presented by the Marcellus Shale and urged the Commission to craft recommendations designed to achieve this objective. In addition, citizens expressed concern over potential negative economic impacts on other industries, particularly tourism and affordable housing.

Response: The Commission's Economic and Workforce Development work group spent considerable time focused on end-use development of natural gas. In addition, particular attention was paid to recognizing the effects of the Marcellus Shale development on other industries and expanding opportunities for affordable housing.

10.6 LOCAL GOVERNMENT & COMMUNITY IMPACTS

Comment: Many comments discussed the impacts upon roads, bridges and other local infrastructure, social services, emergency response and public safety associated with natural gas development. Comments also recognized the impact of new industrial activity in regions of the Commonwealth upon citizen's quality of life. Pennsylvania citizens have encouraged the assessment of a severance tax or impact fee to compensate for these impacts.

Response: The Commission spent considerable time during its deliberations examining the impacts associated with natural gas development, identifying the uncompensated portion of these impacts, and crafting a recommendation on how to structure an appropriate local impact fee.

10.7 SAFETY

Comment: The availability of both the necessary equipment and trained personnel to respond to emergencies associated with natural gas development was a concern expressed by several members of the public. Additionally, oversight of infrastructure deployment, especially Class 1 pipelines, was raised by several members of the public.

Response: The Commission's Local Impact and Emergency Response work group spent considerable time focused on enhancing and coordinating emergency response procedures, while ensuring that first responders have access to the training and equipment they need. The Commission also recognizes the concerns expressed by citizens over the deployment of pipelines and related facilities and recommends the adoption of legislation that would enhance the Public Utility Commission's oversight of non-jurisdictional intra-state gathering lines.

10.8 DELAWARE RIVER BASIN COMMISSION

Comment: The lack of natural gas development within the Delaware River Basin, due to an effective moratorium on water withdrawal and development permits within the watershed, has greatly frustrated residents interested in exercising their private property rights. While many comments expressed support for ensuring sufficient environmental oversight and protection, they also expressed opposition to the apparent duplication over regulatory oversight given the state DEP natural gas drilling regulatory framework.

Response: The Commonwealth is one of five members of the Delaware River Basin Commission, an interstate compact, and therefore is not able to directly control or alter its oversight of the natural gas industry. However, the Commission notes that the Commonwealth has been an active participant and partner in working with other members of the DRBC and is hopeful that the current regulatory process will be finalized by September 2011.

10.9 ENERGY EDUCATION

Comment: Several people expressed an interest in creating or expanding energy education programs to teach students about the process of natural gas development, environmental risks, and potential job opportunities. Several potential models were identified, including "Energy in the Classroom."

Response: The Commission is recommending the development and dissemination of a wide array of educational material. Communities of particular focus include K-12 students, public health providers and landowners within the Shale regions.

10.10 COMPOSITION OF THE GOVERNOR'S MARCELLUS SHALE ADVISORY COMMISSION

Comment: Many of the comments received expressed dissatisfaction with the composition of the Governor's Marcellus Shale Advisory Commission. In addition to comments expressed at full Commission meetings, nearly two-thirds of all electronic mail comments received were form letters expressing their belief that the Commission contained too many members of the natural gas industry and of the Governor's Administration.

Response: In appointing members of the Governor's Marcellus Shale Advisory Commission, Governor Corbett sought to ensure a broad representation of diverse interests, including the environmental and conservation, natural gas, academic, local government and economic development communities. In addition, members of the Governor's Administration with key roles in overseeing the Marcellus Shale industry, including those responsible for the environment, conservation of natural resources, energy, agriculture, transportation, public safety, emergency response and economic development within the Commonwealth, served on the Commission.

Recognizing the numerous and diverse aspects associated with such a broad scope of issues related to the Marcellus Shale, Lieutenant Governor Jim Cawley, chairman of the Commission, sought to ensure that those appearing before the Commission were representative of the wide array of issues under the Commission's review and deliberation. Four work groups were created, with members selected based on their expertise in specific areas related to the Marcellus Shale. In addition, both full Commission and work group agendas were structured to respond to expressed areas of interest from Commission members and the public.

APPENDICES

APPENDIX A

Executive Order Commonwealth of Pennsylvania Governor's Office	
Subject: Creation of Governor's Marcellus Shale Advisory Commission	Number: 2011-01
 By Direction of: Tom Corbett, Governor	Date: March 8, 2011

WHEREAS, The Commonwealth of Pennsylvania is fortunate to have one of the most abundant and diverse mineral resource fields in the world, including the Marcellus Shale natural gas reserves; and

WHEREAS, innovative technological advances in drilling, mining methods, equipment and water protection and treatment have made development of gas in the Marcellus Shale and other unconventional natural gas reserves possible; and

WHEREAS, in 2010, Commonwealth taxpayers and communities received more than \$600 million in state and local tax revenue from Marcellus Shale; and

WHEREAS, Marcellus Shale offers tremendous economic and energy independence opportunities for the Commonwealth; and

WHEREAS, the Commonwealth takes seriously its responsibility to ensure the development of natural gas in a manner that protects the environment and safeguards the health and welfare of its citizens; and

WHEREAS, the responsible development of natural gas resources will position the Commonwealth in the global marketplace as a world leader in energy supply and reduce our dependence on foreign oil; and

WHEREAS, it has been determined that the Governor and the Commonwealth would benefit from the advice and counsel of an official advisory commission comprised of key stakeholders, including experts from the environmental community, natural gas industry, local government representatives and state government officials.

NOW, THEREFORE, I, Tom Corbett, Governor of the Commonwealth of Pennsylvania, by virtue of the authority vested in me by the Constitution of the Commonwealth of Pennsylvania and other laws, do hereby establish the **Governor's Marcellus Shale Advisory Commission** (hereinafter referred to as the "Commission") as hereinafter set forth.

- 1. Purpose.** The Commission shall develop a comprehensive, strategic proposal for the responsible and environmentally sound development of Marcellus Shale.
- 2. Responsibilities.** The Commission shall:
 - a.** Complete a review of existing and proposed statutes, legislation, regulation and policies that regulate or affect Marcellus Shale natural gas development in the Commonwealth and provide analysis and recommendations regarding the following:
 - (1)** Additional steps necessary to protect, conserve and enhance the Commonwealth's environment and natural resources and further mitigate impacts from development on the state's air, land, and water resources.
 - (2)** Efforts necessary to promote the efficient, environmentally sound and cost-effective development of Marcellus Shale and other unconventional natural gas resources.
 - (3)** Policies designed to encourage the end use of natural gas and natural gas byproducts.
 - (4)** Workforce development needs and opportunities.
 - (5)** Identifying, quantifying and recommending proposals to address the needs and impacts of natural gas development on local communities.
 - b.** Provide interim reporting to the Governor, as determined as appropriate by the Commission chair, as well as a Final Report due on or before July 22, 2011.
 - c.** Convene its first meeting no later than March 31, 2011, with subsequent meetings as determined by members of the Commission. A simple majority of the members shall constitute a quorum; and
 - d.** Adopt rules of procedure consistent with the provisions of this order.
- 3. Composition of the Commission.** The Commission shall consist of the following members:
 - a.** The Lieutenant Governor, who shall serve as Chair of the Commission; and
 - b.** A minimum of 25 and a maximum of 35 appointees, representing, *inter alia*, the interests of environmental, conservation, industry, local and state government, who shall be chosen by and serve at the pleasure of the Governor.

- 4. Terms of Membership.** The members of the Commission shall serve from the date of their appointment by the Governor until July 22, 2011 or their removal from the Commission by the Governor, whichever occurs first. The Governor may fill vacancies that may occur and may remove any member from the Commission at his discretion.
- 5. Compensation.** Members of the Commission will receive no compensation for their service as Commission members. Non-government members will be reimbursed for travel and related expenses in accordance with the Commonwealth policy.
- 6. Staffing.** The Department of Environmental Protection shall provide administrative staff resources to support the Commission.
- 7. Cooperation by State Agencies.** All agencies under the Governor's jurisdiction shall cooperate with and provide assistance and support as needed by the Commission to carry out its functions effectively.
- 8. Reports.** In addition to the interim recommendations described above, the Commission shall submit to the Governor a final report on the Commission's activities on or before July 22, 2011.
- 9. Effective Date.** This Executive Order shall take effect immediately.
- 10. Termination Date.** This Executive Order shall remain in effect until July 22, 2011.

APPENDIX B

The Governor's Marcellus Shale Advisory Commission would like to extend thanks to the following individuals for participating in Commission proceedings by taking the time to attending or testify at meetings. Lt. Governor Cawley would like to extend his personal gratitude to Mr. T. Boone Pickens for his time, counsel and helpful information. The expertise, guidance, and professionalism of many were critical in developing the recommendations presented in this report.

FULL COMMISSION MEETINGS

Richard J. Allan	Secretary, DCNR
Dr. Eli Avila, MD, JD, MPH, FCLM	Pennsylvania Secretary of Health
Glenn Cannon	Pennsylvania Emergency Management Agency Director
Nicholas DeBenedictis	Chairman and CEO, Aqua America, Inc.
Dan Devlin	Pennsylvania Director of Forestry
Terry Engelder, Ph.D.	Pennsylvania State University
Steve Frobouck	Chairman, Frobouck Group, LLC
Elam Herr	Asst. Executive Director, Pennsylvania State Association of Township Supervisors
Doug Hill	Executive Director, County Commissioners Association of Pennsylvania
Aaron Horn	President, Ecosphere Energy Services
Nels Johnson	Pennsylvania Deputy State Director, The Nature Conservancy
Kathryn Klaber	President & Executive Director, Marcellus Shale Coalition
Dr. Jerry V. Mead	Patrick Center for Environmental Research, The Academy of Natural Sciences
Tom Murphy	Co-Director, Penn State Marcellus Center for Outreach and Research
Teri Ooms	Executive Director, The Institute for Public Policy & Economic Development
Scott Perry	Director, DEP Bureau of Oil & Gas Management
Hon. Stan Saylor	Majority Whip, PA House of Representatives
Ed Troxell	Director of Government Affairs, Pennsylvania Association of Boroughs

INFRASTRUCTURE WORK GROUP

Scott Christie	Deputy Secretary for Highway Administration, PENNDOT
Heath Deneke	Tennessee Pipeline
Scott Dorn	General Manager, Marketing United States Steel Tubular Products
Hank Foley	Vice President for Research, Pennsylvania State University
Christopher Helms	Chief Executive Officer, NiSource Gas Transmission & Storage
Elam Herr	Asst. Executive Director, Pennsylvania State Association of Township Supervisors
Norman Holmes	Tennessee Pipeline
Aron J. Lantz, PE	Innovation Engineer, Larson Design Group
Daniel LeFevers	Executive Director, Gas Technology Institute
Charlie McLaughlin	Director of Government Relations, University of Pittsburgh
Commissioner Robert Powelson	Chair, PUC Commission
Jeff Stover	Executive Director, SEDA-COG Joint Rail Authority

PUBLIC HEALTH, SAFETY, & ENVIRONMENTAL PROTECTION WORK GROUP

John A. Arway	Executive Director, PA Fish & Boat Commission
Dr. Eli Avila, MD, JD, MPH, FCLM	Pennsylvania Secretary of Health
Anthony Bartolomeo	Chair, Pennsylvania Environmental Council
Pat Canavan	Superintendent, Clairton Municipal Authority

Staci Covey
Bernard Goldstein

Dave Miller
Walt Nicholson
Dr. Ostroff, MD
Bob Sokolove
Dr. Radisav Vidic Ph.D., P.E
Ephraim Zimmerman

CEO, Troy Community Hospital
Interim Director, Center for Healthy Environments &
Communities, University of Pittsburgh Graduate
School of Public Health
Director of Standards, American Petroleum Institute
Acting Executive Director, Williamsport Municipal Authority
Acting Physician General
President, Womble Carlyle Ecology Innovation
University of Pittsburgh
Forest Ecologist, The Western Pennsylvania Conservancy

LOCAL IMPACT AND EMERGENCY RESPONSE WORK GROUP

Bill Fogarty
Holly Glauser
Tom Helmacy
Elam Herr
Doug Hill
Edward Mann
Jacqueline Root
David Sanko
Ralph Tijerina
Edward Troxell
Jim VanBlarcom
Barb Warburton
MaryAnn Warren

Director of Government Affairs, Pennsylvania Housing Finance Agency
Director of Development, Pennsylvania Housing Finance Agency
Pennsylvania Farm Bureau
Assistant Executive Director, PA State Association of Township Supervisors
Executive Director, County Commissioners Association of PA
Fire Commissioner
CMM, Pennsylvania Royalty Owners Association
Executive Director, PA State Association of Township Supervisors
Director, Range Resources
Pennsylvania State Association of Boroughs
Pennsylvania Farm Bureau
Pennsylvania Farm Bureau
President, Pennsylvania Conservation Districts & Susquehanna County Commissioner

ECONOMIC & WORKFORCE DEVELOPMENT WORK GROUP

Stephen Brawley
David E. Callahan
Terry Engelder, Ph.D.
Gearoid Foley
Dennis Hawley
Larry L. Michael
Hugh Mose
Sue Mukherjee
Robert Pistor
Dave Ross
Frank Thompson

Ben Franklin Technology Partners
Vice President, Marcellus Shale Coalition
Pennsylvania State University
Senior Advisor, US DOE's Mid-Atlantic Clean Energy Applications Center
Associate Vice President for Facilities, Bucknell University
Director, Marcellus Shale Education & Training Center
General Manager, Centre Area Transportation Authority
Director, Center for Workforce Information Analysis PA L&I
Vice President, UGI HVAC Enterprises, Inc.
Technical, Marketing & Business Development Director, EQT Corporation
Deputy Director, Northern Tier Workforce Investment Board

APPENDIX C

Roll Call Votes

A – Aye, N – Nay, Ab - Abstention

Infrastructure Recommendations

- 9.1.1 A – 27 N – 0 Ab – 0
- 9.1.2 A – 24 N – 0 Ab – 3
Ab - Bartolomeo, Ramsey, Carrow
- 9.1.3 A – 27 N – 0 Ab – 0
- 9.1.4 A – 27 N – 0 Ab – 0
- 9.1.5 A – 27 N – 0 Ab – 0
- 9.1.6 A – 27 N – 0 Ab – 0
- 9.1.7 A – 27 N – 0 Ab – 0
- 9.1.8 A – 27 N – 0 Ab – 0
- 9.1.9 A – 27 N – 0 Ab – 0
- 9.1.10 A – 27 N – 0 Ab – 0
- 9.1.11 A – 23 N – 0 Ab – 4
Ab - Gardner (for Porges), Kupfer, Bossert, Smith
- 9.1.12 A – 23 N – 0 Ab – 4
Ab - Gardner (for Porges), Kupfer, Bossert, Smith
- 9.1.13 A – 24 N – 0 Ab – 3
Ab - Bartolomeo, Ramsey, Carrow
- 9.1.14 A – 24 N – 0 Ab – 3
Ab - Bartolomeo, Ramsey, Carrow
- 9.1.15 A – 27 N – 0 Ab – 0
- 9.1.16 A – 27 N – 0 Ab – 0
- 9.1.17 A – 27 N – 0 Ab – 0
- 9.1.18 A – 27 N – 0 Ab – 0

Public Health, Safety, and Environmental Protection Recommendations

- 9.2.1 A – 27 N – 0 Ab – 0
- 9.2.2 A – 27 N – 0 Ab – 0
- 9.2.3 A – 27 N – 0 Ab – 0
- 9.2.4 A – 27 N – 0 Ab – 0
- 9.2.5 A – 27 N – 0 Ab – 0
- 9.2.6 A – 27 N – 0 Ab – 0
- 9.2.7 A – 27 N – 0 Ab – 0
- 9.2.8 A – 27 N – 0 Ab – 0
- 9.2.9 A – 27 N – 0 Ab – 0
- 9.2.10 A – 27 N – 0 Ab – 0
- 9.2.11 A – 27 N – 0 Ab – 0
- 9.2.12 A – 27 N – 0 Ab – 0
- 9.2.13 A – 27 N – 0 Ab – 0
- 9.2.14 A – 27 N – 0 Ab – 0
- 9.2.15 A – 27 N – 0 Ab – 0
- 9.2.16 A – 27 N – 0 Ab – 0
- 9.2.17 A – 27 N – 1 Ab – 0
N – Sanko
- 9.2.18 A – 27 N – 0 Ab – 0
- 9.2.19 A – 27 N – 0 Ab – 0
- 9.2.20 A – 27 N – 0 Ab – 0

- 9.2.21 A-27 N-0 Ab-0
- 9.2.22 A-27 N-0 Ab-0
- 9.2.23 A-27 N-0 Ab-0
- 9.2.24 A-27 N-0 Ab-0
- 9.2.25 A-27 N-0 Ab-0
- 9.2.26 A-27 N-0 Ab-0
- 9.2.27 A-27 N-0 Ab-0
- 9.2.28 A-26 N-0 Ab-1
Ab - Carrow
- 9.2.29 A-27 N-0 Ab-0
- 9.2.30 A-27 N-0 Ab-0
- 9.2.31 A-27 N-0 Ab-0
- 9.2.32 A-27 N-0 Ab-0
- 9.2.33 A-27 N-0 Ab-0
- 9.2.34 A-27 N-0 Ab-0
- 9.2.35 A-27 N-0 Ab-0
- 9.2.36 A-18 N-4 Ab-5
N - Ehrhart, Bartolomeo, Ramsey, Carrow, Ab - Walker, Helms, Bossert, Gardner (for Porges), Slagel
- 9.2.37 A-27 N-0 Ab-0
- 9.2.38 A-27 N-0 Ab-0
- 9.2.39 A-27 N-0 Ab-0
- 9.2.40 A-27 N-0 Ab-0
- 9.2.41 A-27 N-0 Ab-0
- 9.2.42 A-27 N-0 Ab-0
- 9.2.43 A-27 N-0 Ab-0

Recommendations not approved

A) Offered by Anthony Bartolomeo

To appropriately protect sensitive public and natural resources, amend Section 205(c) of the Oil and Gas Act as follows:

1. Add the following as additional listed resources:
 - (6) Sources used for public drinking water supplies
 - (7) Whether the proposed well is within a floodplain
 - (8) Wild and Wilderness Trout Streams
 - (9) High Quality or Exceptional Value Waters
 - (10) Exceptional Value Wetlands
2. Expressly state in Section 205(c) that DEP may, in making a determination on a well permit, condition the permit based upon impacts to the resources listed in Section 205(c).
3. Require DEP to consult with County Conservation Districts regarding impacts to any resources listed in Section 205(c).
4. Require DEP to consult with the Pennsylvania Fish and Boat Commission regarding impacts to (8) Wild and Wilderness Trout Streams; (9) High Quality or Exceptional Value Waters; or (10) Exceptional Value Wetlands.

A-4 N-23 Ab-0

A - Ehrhart, Bartolomeo, Ramsey, Carrow

B) Offered by Ronald Ramsey

No future leasing of State Forest land for surface gas development.

A-4 N-18 Ab-5

A - Ehrhart, Bartolomeo, Ramsey, Carrow, Ab - Walker, Gardner (for Porges), Bossert, Helms, Smith

Local Impacts & Emergency Response Recommendations

- 9.3.1 A-27 N-0 Ab-0
- 9.3.2 A-27 N-0 Ab-0
- 9.3.3 A-27 N-0 Ab-0
- 9.3.4 A-27 N-0 Ab-0
- 9.3.5 A-27 N-0 Ab-0
- 9.3.6 A-27 N-0 Ab-0
- 9.3.7 A-27 N-0 Ab-0
- 9.3.8 A-27 N-0 Ab-0
- 9.3.9 A-27 N-0 Ab-0

Economic & Workforce Development Recommendations

- 9.4.1 A-23 N-4 Ab-0
N - Carrow, Ehrhart, Bartolomeo, Ramsey
- 9.4.2 A-27 N-0 Ab-0
- 9.4.3 A-27 N-0 Ab-0
- 9.4.4 A-27 N-0 Ab-0
- 9.4.5 A-27 N-0 Ab-0
- 9.4.6 A-24 N-0 Ab-3
Ab - Carrow, Ramsey, Kupfer
- 9.4.7 A-27 N-0 Ab-0
- 9.4.8 A-27 N-0 Ab-0
- 9.4.9 A-23 N-1 Ab-3
N - Ehrhart, Ab - Bartolomeo, Ramsey, Carrow
- 9.4.10 A-27 N-0 Ab-0
- 9.4.11 A-27 N-0 Ab-0
- 9.4.12 A-27 N-0 Ab-0
- 9.4.13 A-23 N-0 Ab-4
Ab - Ehrhart, Bartolomeo, Ramsey, Carrow
- 9.4.14 A-26 N-0 Ab-1
Ab - Bartolomeo
- 9.4.15 A-27 N-0 Ab-0
- 9.4.16 A-27 N-0 Ab-0
- 9.4.17 A-27 N-0 Ab-0
- 9.4.18 A-27 N-0 Ab-0
- 9.4.19 A-27 N-0 Ab-0
- 9.4.20 A-27 N-0 Ab-0
- 9.4.21 A-27 N-0 Ab-0
- 9.4.22 A-27 N-0 Ab-0
- 9.4.23 A-27 N-0 Ab-0
- 9.4.24 A-27 N-0 Ab-0
- 9.4.25 A-27 N-0 Ab-0
- 9.4.26 A-26 N-2 Ab-0
N - Carrow, Ramsey

Motion to Approve Final Report

- A-27 N-0 Ab-0

APPENDIX D

A Sampling of Estimated Marcellus Shale Drilling Impacts

General Statements:

The following was submitted by the Pennsylvania State Association of Township Supervisors, Pennsylvania State Association of Boroughs, County Commissioners Association of Pennsylvania and the Pennsylvania League of Cities and Municipalities. It represents a sampling of potentially unmet local government impacts and associated costs experienced by their members, and should not be considered to represent all related costs. Additional discussion of impacts occurred at meetings of the full Governor's Marcellus Shale Advisory Commission and its work groups.

Growth and Planning Components:

- Amendments to zoning ordinance, subdivision and land development ordinance to plan for drilling activity, compression stations, pipelines, and related activities;
 - Mandatory planning commission and board of supervisors meetings and hearings;
 - Legal fees for drafting and reviewing ordinance (average statewide hourly rate is \$117.56);
 - Advertisements for all meetings and hearings, as well as for ordinance amendments (hundreds to thousands, depending on length of ad);
 - Staff time for coordinating meetings, attending meetings, research and reviewing amendments;
 - Estimated Cost: \$10,000 to \$30,000;
- Administering and enforcing land use regulations;
 - Staff time (average zoning officer makes \$26/hour) and related expenses (use of vehicle, fuel, cameras, time away from other responsibilities, overtime, need to add additional staff);
 - Legal fees and court expenses;
 - Hearing expenses (conditional use or special exception);
 - Meeting pay, legal advertisements, legal fees, and court stenographer;
- Related issues;
 - Act 537 plan amendments to accommodate requests for holding tanks at drilling sites, with related enforcement issues;
 - Amendment to ordinance and Act 537 plan requires legal review, legal advertising expense, and staff time;
 - Uniform Construction Code enforcement for facilities at sites, housing issues;
 - Staff time (\$24-32/hour) and related expenses (use of vehicle, fuel, cameras, overtime, need to add additional staff, legal fees and court costs).

Transportation components:

- Expenses for properly bonding roads;
 - Engineering studies for each road (varies significantly by firm);
 - Adoption of ordinance, including legal advertisement and legal review expenses;
 - Purchase and posting of required signs and detour routes;
 - Administering bonding requirements;
 - Staff expense (\$18/ hour and up) for applications and meeting with companies;
 - Legal expense for review of excess maintenance agreements and enforcement advice and action;

- Staff expense for road inspections, often daily, to monitor damage;
 - Staff expense for road inspections during repairs;
 - Staff and legal expense for enforcing bonding limits;
- Future expenses for maintaining upgraded roads;
 - Dirt roads now paved;
 - Wider roads;
 - Possibility of subpar materials and methods used in road reconstruction by subcontractors;
 - Expenses for rebuilding and maintaining roads depending on level of damage, ranges from \$80,000 to \$300,000 per mile.

Emergency response/public safety components, 911:

- Municipal police;
 - Contract or department. Includes cost for officer, training, car, equipment, and administrative support. (Officer salary is \$23/hour and up);
- Volunteer fire departments;
 - Potential need for additional equipment and vehicles;
 - Increased volume of response or call outs due to increase activity;
 - Additional cost for normal and specialized training;
 - Additional demand may result in need for paid personnel;
- Emergency management planning;
 - Retain and hire more emergency management personnel due to increased training and use;
 - Need to update emergency management plan, including staff time, legal review, training needs;
- Ambulance;
 - Additional equipment, need for paid drivers as calls increase;
- Pipelines;
- Hazmat.

Operating costs:

- Increased salaries and benefits to maintain and attract employees (particularly CDL drivers and mechanics). Not unusual for salaries to increase by 20 to 25 percent. (In 2010, \$20/hour and up for mechanic, \$16.77/hour and up for heavy equipment operator);
- Need for overtime and/or additional employees to deal with general administration, administration and enforcement of road bonds, zoning and building permits, frequent inspections of roads, administration of rebuilding of roads, etc.

Environmental issues:

- Water treatment plants, upgrades, and/or lines to rural communities;
- Sewer treatment plants, upgrades, and/or lines to rural communities;
 - Estimated Cost: Varies significantly on design of plant, population served, length of lines, availability of water, and terrain. Both water and sewer treatment plants can cost a minimum of \$1.5 million and up to construct, not including significant expenses for engineering and permit acquisition. There are also continuing operating costs for both facilities, which includes the operators plus the administrative staff to take care of billing and paperwork.

Human services:

- Impacted in unique ways;
 - Higher percentage of individuals with behavioral issues;
 - Most frequent incidence is drug and alcohol, mental health, children and youth and domestic issues;
 - More likely to fall into county programs rather than being supported by families, etc.;
 - Being transience, counties do not have easy access to any existing case files.

Housing:

- Traditional housing market has become extremely tight;
 - Rents have doubled, tripled or more;
 - Low-income renters are accordingly facing particular hardships as they are being priced out of the market;
 - HUD housing is being converted back to regular housing by landlords to take advantage of market's higher rents;
 - Seen rise in homeless rate;
 - Unfortunate consequence is having victims of domestic violence return to abusive homes.

Courts, criminal justice, and probation supervision:

- Interstate compacts;
 - Out of state workers on probation or domestic relations actions in their home states are placed directly into the county probation system;
 - Requires additional time and resources by the district attorney, public defenders office and support staff.

Tourism:

- Displacement of traditional tourist;
 - Renting of motel rooms for long periods of time have resulted in limited if any rooms for traditional tourist that would come to the area for local attractions;
 - Loss of local hotel tax.

Specific Examples:**Wyalusing Township, Bradford County**

Township has been forced to increase road workers wages by 20 percent to stay competitive with wages of industry workers. Township lost one employee to the industry because employee was able to receive a higher wage. Township has 2 full-time road crew employees, 1 part-time road crew employee, and 1 as needed part-time employee.

Natural gas drilling activity has cost township more time with employees constantly dealing with industry contractors when they are repairing township roads as well as zoning matters. A recently held conditional use hearing cost the township over \$8,000. This included legal, administration, advertising, and staff cost.

Township has seen an influx in what they refer to as “support businesses.” (pipe yards, compressor stations, RV parks, etc.) These businesses cause additional staff time and funds, as they require conditional use hearings. These are businesses that were not anticipated 5 years ago when they drafted their current zoning ordinance.

Township is in the process of amending zoning ordinance and anticipates it being adopted in August.

Increased their property taxes last year to compensate for increased wages and expenses.

Endless Mountains

From just two hotels in the Endless Mountains region it has been determined that the counties lost approximately \$142,000 in the past 18 months from the state law requirement that if someone stays in a motel over 30 days they are not subject to the hotel tax.

Damascus Township, Wayne County

Township has been sued twice over provisions of zoning ordinance regarding mineral extraction as industry stated that mineral extraction provision in the ordinance did not apply to them. Both suits were dismissed. Legal costs for these suits are around \$5,000. (Company unofficially said they would reimburse the township for legal costs. They have not done so and have since left town.)

Township has revised ordinance and has drilling as conditional use.

Natural gas activity has “hidden costs” to the township. Example: Township spent two weeks gathering files for cases before they were dropped, time on maintenance agreements with companies, advertised and paid for two lengthy public hearings when they were revising ordinance, spent nearly six months getting from draft ordinance to adoption and have spent funds on a consultant.

Note: Township is located in Delaware River Basin and the DRBC has issued a moratorium on drilling.

Municipality of Murrysville, Westmorland County

To date the municipality has incurred approximately \$50,000 in cost to bond and post their roads. This figure takes into account the legal expense, advertising and related cost, staff time and actual signage of the roads. Since drilling has not commenced they have not incurred additional cost, but anticipate expenditures within their planning and codes department, police and highway maintenance.

Upper Burrell Township, Westmoreland County

Township does not currently have drilling activity, but DEP has granted permits for wells in their township.

In anticipation of the activity they have conducted a yearlong study and are currently in the process of drafting amendments to their zoning ordinance.

They have also conducted a traffic and engineering study of all township roads, posted new weight limits, and adopted a weight limit ordinance.

Morgan Township, Greene County

Township staff has had to switch their attention from their typical duties to monitoring the activities of the contractors and the condition of their roads. Staff is also spending time answering an overwhelming number of complaints regarding the drilling activities.

Costs directly resulting from drilling activities were for the previous year was approximately \$70,000, which included wages, legal and administrated expenses and winter maintenance activities. The cost for snow removal has risen due to the increased traffic on township roads, requiring them to maintain them to a different standard than before.

Lycoming County

Lycoming County planning department estimates that it cost \$30,000 to develop their county zoning ordinance revisions to address oil and gas drilling issues including their consultant and staff time, and approximately \$160,000 to update their emergency management plan. They estimate that it will cost \$80,000 per year for natural gas facility regulation and permitting.

Roulette Township, Potter County

Township is undergoing extensive engineering study of all of their major roads to accommodate an updated and comprehensive road bonding and excess maintenance ordinance. The proposed costs of this study are nearly \$9,000. (This number does not include staff time, legal fees, or CBR testing.)

Township recently spent \$1800 on base line water testing for both of their public water systems. Township is worried about their public water sources as they do not have the funds to find alternate ones should the need arise. Township is also worried about damage to township roads, as they do not have the funds to rebuild them.

BIBLIOGRAPHY

Administration, U.S. Energy Information. "Alternatives to Traditional Transportation Fuels 2009." April 2011.

Considine, T. J.; Watson, R.; Blumsack, S. *The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play: An Update*. State College: Pennsylvania State University, 2010.

DeGoyler and MacNaughton. *Twentieth Century Petroleum Statistics*. 49th Edition, Dallas: One Energy Square, 1993.

Engelder, T. *Stress Regimes in the Lithosphere*. Princeton: Princeton Press, 1993.

Federal Energy Regulatory Commission. "Major Pipeline Projects on the Horizon." February 2011. <http://www.ferc.gov/industries/gas/gen-info/horizon-pipe.pdf> (accessed June 2011).

Fettke, C.R. "Summarized record of deep wells in Pennsylvania." *Pennsylvania Geological Survey 4th Series, Bulletin M 31*, 1950: 148.

"From 'Colonel' Drake to the Marcellus Gas Play - Transmission Developments." *Pipeline and Gas Journal, Vol. 238, No. 6*, June 2011.

Harper, J.A., and C.L. Cozart. "Oil and gas development in Pennsylvania in 1990 with ten-year review and forecast." *Pennsylvania Geological Survey 4th Series, Progress Report 204*, 1992: 83.

IHS Global Insight. *The Contributions of the Natural Gas Industry to the U.S. National and State Economies*. America's Natural Gas Alliance, 2009.

Johnson, Nels. *Pennsylvania Energy Impacts Assessment, Executive Summary: Marcellus Shale Natural Gas and Wind Energy*. The Nature Conservancy, Pennsylvania Chapter, 2011.

Marcellus Shale Education & Training Center. "Marcellus Shale Workforce Needs Assessment." June 2009. <http://www.msetc.org/docs/NeedsAssessmentwithcover.pdf#zoom=75>.

Penn State, The Dickinson School of Law. "The Rule of Capture in Pennsylvania Oil and Gas Law." PowerPoint. http://law.psu.edu/_file/aglaw/Rule_of_Capture_in_Pennsylvania_Oil_and_Gas_Law.pdf (accessed June 2011).

Pennsylvania Bureau of Statistics. *Pennsylvania's Mineral Heritage: The Commonwealth at the Economic Crossroads of Her Industrial Development*. Statistics of the mineral industries, Commonwealth of Pennsylvania Department of Internal Affairs, 1944.

Pennsylvania Department of Labor & Industry, Center for Workforce Information & Analysis. "Local Area Unemployment Statistics." April 2011.

—. "Marcellus Shale Fast Facts." June 2011 Edition. <http://www.paworkstats.state.pa.us/gsipub/index.asp?docid=775>.

Pennsylvania Department of Labor & Industry, Center for Workforce Information & Analysis. "Quarterly Census of Employment & Wages." 2007 Q4 - 2010 Q4.

Schanz, J.J. "Historical statistics of Pennsylvania's Mineral Industries, 1759-1955." *Bulletin of the Mineral Industries Experiment Station*, Number 69, 1957: 94.

Sisler, J.D., G.H. Ashley, F.T. Moyer, and W.O. Hickok. "Contributions to Oil and Gas Geology in western Pennsylvania." *Pennsylvania Geological Survey 4th Series, Bulletin M 19*, 1933: 84.

U.S. Department of Commerce, Census Bureau. "American Community Survey." 2006 - 2009.

Van Tyne, A. "Natural gas potential of the Devonian black shales of New York." *Northeastern Geology*, v. 5, 1983: 209-216.