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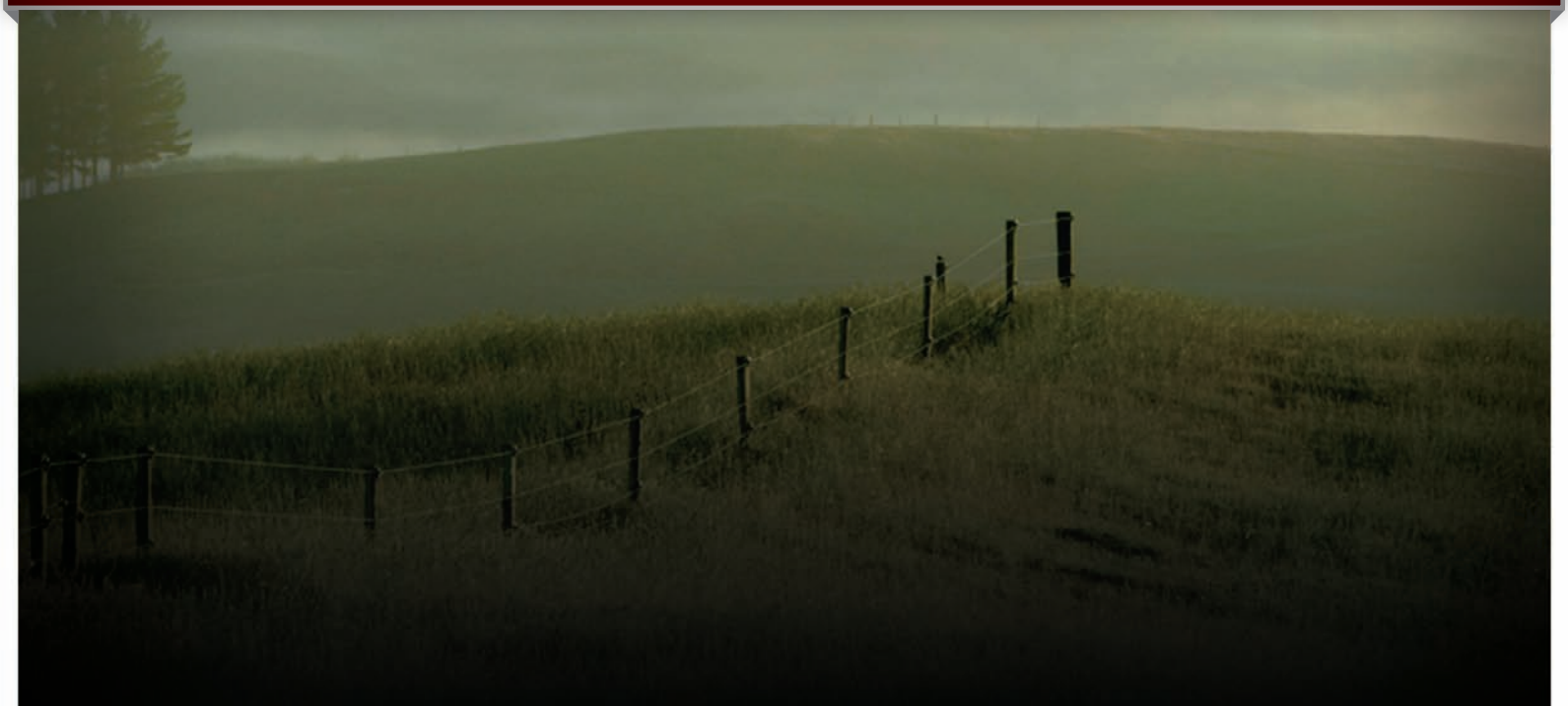
GETTING THE BOOM WITHOUT THE BUST:

GUIDING SOUTHWESTERN PENNSYLVANIA THROUGH SHALE GAS DEVELOPMENT



ENVIRONMENTAL LAW INSTITUTE
&
WASHINGTON & JEFFERSON COLLEGE
CENTER FOR ENERGY POLICY AND MANAGEMENT

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EXECUTIVE SUMMARY

Major production of natural gas in Pennsylvania from unconventional wells drilled into the Marcellus Shale began in earnest in 2008, with approximately 200 wells in operation by year's end.[1] Since then, drilling has grown exponentially, with over 6,649 shale gas wells in operation in 2013.[2] The rapid growth of shale gas extraction in Pennsylvania has presented both challenges and opportunities. The industry has created jobs, generated wealth for some property owners, and after the passage of a state impact fee, provided local governments with a new source of revenue. At the same time, the rapid development of these resources has raised questions of management and planning for local governments in the Commonwealth, including consideration of socio-economic, health, environmental, and economic impacts. This report is not intended to be a comprehensive examination of all issues concerning natural gas extraction in Pennsylvania. It focuses on one aspect of the phenomenon: avoiding the boom and bust cycle that has characterized other natural resource extraction efforts in our history. The report reviews impacts and opportunities facing communities in southwestern Pennsylvania – recognizing that there are different characteristics of the shale gas development process and highlighting approaches which might be useful in this region to avoid future adverse economic consequences.

This study is organized into ten discrete chapters, beginning with the historical background then moving to consideration of socio-economic, environmental, and health impacts. Of special importance to local Pennsylvania communities will be the chapter on economic impacts, including the state shale gas development impact fees. The last three chapters are directed at ameliorating the impact of a boom and bust scenario through economic strategies, community regulatory and planning alternatives, and community best practices.

It is wise to study the boom and bust cycle from a historical perspective. While resource extraction has long been regarded as an economic benefit, a body of academic literature suggests that long term growth based chiefly on resource extraction is rare, and may sometimes result in a "bust." Factors relevant to a bust cycle are summarized in Chapter II and include the 'crowding out' effect that resource extraction dominance can have on other economic sectors, the price volatility of commodities being extracted, the transience of an extractive industry workforce, localized inflation, and a tendency for communities to overestimate the need for and overspend on expansion and infrastructure. Pennsylvania has experience in this area in oil, coal, and timber production, where towns that once boomed mightily ultimately waned and where population decreases have left struggling communities. Elsewhere, communities, states, and nations have mitigated impending "busts" by investing their resource-based revenues into structured funds and by providing long-term good governance and stewardship of revenues generated.

Marcellus Shale gas development, explored in Chapter III, is in the opening moments of development and Pennsylvania has the largest share of the area of the formation. Development has advanced rapidly through the use of advances in drilling and production technology using horizontal drilling and hydraulic fracturing, which includes the injection underground of large volumes of water, additives, and proppants to secure the release of natural gas from tight shale formations. The productivity of the Marcellus Shale has steadily increased, so much that Pennsylvania is ranked as the fastest-growing state in the U.S. for natural gas production. In the past ten years, southwestern Pennsylvania has accounted for approximately one third of the gas produced in the Commonwealth.

Chapter IV focuses on socio-economic impacts in southwestern Pennsylvania, especially examining employment effects, workforce development, housing values, road impacts and repair, and the personal income of community residents.

There is great public concern about the impact of shale gas development on the environment, and Chapter V provides an overview of the use and fate of water throughout the life-cycle of a shale gas well, a discussion of air emissions and their impact on air quality, and a description of Pennsylvania's regulatory framework for shale gas development under Act 13 and other laws. Included in that important chapter are identification of potential air pollutants and consideration of greenhouse gas emissions, state water quality and quantity protections, habitat and ecosystem protections, and enforcement provisions.

The intensity and nature of the various industrial procedures involved in extracting shale gas have raised public concerns about potential health impacts, which are covered in Chapter VI. Researchers in Pennsylvania and elsewhere have identified the need for collecting baseline health and environmental data; the identification of exposure pathways for pollutants and contaminants generated by shale gas development; the identification of impacts of exposure to contaminants; and the examination of stress and environmental health risk in local populations. This chapter also covers health-related research projects in progress.

A key research product of value to local governments is Chapter VII on economic impacts; these include shale gas revenues available to local governments. While municipalities and school districts generally receive little direct revenue from the shale gas boom because of the structure of the Commonwealth's tax laws, Pennsylvania counties and municipalities do receive a share of state impact fees collected on drilling of unconventional gas wells. This chapter explores in some detail how the impact fee works, how the fees are distributed to state agencies and local governments, the authorized use of the fees, and the ways fees were actually used by four southwestern Pennsylvania counties and their municipalities in 2012. Finally, the chapter explores other taxing mechanisms not provided for under Pennsylvania law, but available in other states.

To avoid the bust potential, Chapter VIII provides economic strategies so that the current economic benefits can be made to outlast the period of extractive activity, drawing from the experiences in other states where oil and gas devolvement has been going on for many years. Key strategies to maintain economic viability include seeking economic diversification, as well as recognizing and preserving a base of renewable natural resources that can sustain outdoor recreation, travel, and tourism. Similarly, Chapter IX outlines three avenues that communities and residents can use to their benefit. Following the Pennsylvania Supreme Court's landmark decision in *Robinson Township v Commonwealth*, in December 2013, invalidating sections of Act 13, local governments have zoning authority that may allow them greater influence over shale gas siting decisions. According to the court, local governments have a "substantial, direct, and immediate interest in protecting the environment and quality of life" within their borders. Local governments can use their zoning powers to recognize locally-meaningful distinctions in land forms and compatible and incompatible land uses. This chapter discusses that authority and alternatives, including operator-community engagement and consensus building.

Chapter X concludes by identifying specific best practices that could advance community well-being over the long run and avoid or ameliorate any potential for a bust. The chapter highlights the need for jobs and workforce training, a careful examination of housing values and the effects of water use, potential preventive responses to damaged roads, opportunities to examine and seek correction of environmental impacts, priorities for needed public health research, planning for durable investments resulting from expenditures of short term impact fees, use of zoning powers to recognize incompatible land uses, and the opportunity to take advantage of community engagement plans and consensus methods.

I. INTRODUCTION AND METHODOLOGY

A shale gas boom is underway in Pennsylvania. The object of the boom is the development of the Marcellus Shale, a natural gas formation long known to exist beneath Pennsylvania, West Virginia, Ohio, New York and Maryland, but previously deemed unprofitable to develop because of the difficulty of extracting the gas from it. Using the combination of two techniques, horizontal drilling and hydraulic fracturing, that facilitated the successful development of the Barnett Shale in Texas, the shale gas industry has been profitably extracting natural gas from the Marcellus Shale. Following the drilling of a single horizontal well in Washington County in 2004, development quickly spread throughout southwestern and northeastern Pennsylvania.

This development has brought many changes to the communities that host shale gas sites, some positive and some less so. Understanding how best to respond to these immediate changes and to anticipate what future changes may occur has occupied much of the attention of the local officials responsible for managing these communities. A point of reference for many people has been the boom and bust cycles that have characterized past natural resource development in Pennsylvania, as well as in other states and nations.

A boom and bust economic cycle is marked by heightened industrial activity at the beginning of the development, accompanied by an influx of workers into hosting communities. These new residents place strains on the local government's ability to provide public services, including healthcare and public education, and upon the existing housing and public infrastructure. The environment and community health are often adversely affected. When the resource development ends, which can occur abruptly, it often leaves behind a community struggling to cope with a variety of residual conditions that compromise its ability to offer a sustainable way of life to its residents.

Against this backdrop, the Environmental Law Institute and the Washington & Jefferson College's Center for Energy Policy and Management collaborated to evaluate the impact of the current shale gas development upon communities in southwestern Pennsylvania. The goal of the project is to evaluate critical socio-economic, environmental, public health and economic impacts to identify strategies that communities can implement to better protect themselves against a bust experience.

To select the particular impacts that would be evaluated the research team first conducted a literature review of boom and bust experiences to identify the most common problems that arose in resource extraction economies. Next, the team conducted a series of interviews of individuals who were uniquely situated to understand the particular impacts that most affected southwestern Pennsylvania communities and to recommend issues to be pursued.

From a socio-economic standpoint, the study evaluates the impacts of the development on employment opportunities for the local workforce, on housing prices, and on roads. Growth in income disparity is also considered. To understand how employment opportunities for the local workforce have been impacted the research team analyzed public data, evaluated literature from a variety of sources, and conducted interviews of municipal officials. To evaluate how housing prices fared, the team conducted a literature review of several recent studies of housing price changes in shale gas communities in Pennsylvania and also conducted original research on changes over a several year period in housing prices in six southwestern Pennsylvania shale gas counties as compared with changes in housing prices in six Pennsylvania non-shale gas counties.

As to environmental conditions, the study examines the impacts of water handling procedures and air emissions at shale gas well sites throughout Pennsylvania, and evaluates Pennsylvania's regulatory framework with comparisons to that of other states that are regulating shale gas activities.

With regard to public health impacts, the research team determined that the most meaningful contribution to be made to the public discussion was to prepare a review of the published research on the potential public health impacts of shale gas development throughout the U.S. In this regard, the research focus was much broader than in southwestern Pennsylvania. In addition to identifying methodologies, findings and recommendations, the review includes a brief assessment of the significance of the research in the context of the current understanding of the public health implications of shale gas development.

The economic analysis addresses how public and individual finances have been affected by the shale gas development. The main focus is the new public funds created in 2012 by the Pennsylvania General Assembly, the Act 13 impact fees. The study examines the structure and distribution of those funds, how several southwestern Pennsylvania counties and municipalities have used them, and the adequacy of those funds. The analysis also considers how the impact fees compare with the structure and use of a severance tax.

Finally, the project explores a variety of strategies that communities can implement with the goal of minimizing impacts from natural gas development, including strategic use of impact fees, advancing economic development and diversification initiatives, protecting tourism and its economic benefits, and maximizing the value of community engagement and collaborative decision-making. These strategies, combined with a more comprehensive understanding of the economic cycle of the shale gas development, can enable communities to better use the development to their advantage and to enhance their sustainability.

The research into these issues was informed by a survey conducted of local (county and municipal) officials in Washington and Greene counties during the August 2013 to May 2014

time frame. The initial survey was submitted in paper format and it was followed by in person and telephone interviews of a number of the officials. The results of the survey have been tabulated and are presented along with a summary of the written comments and the interview notes in an appendix to this white paper.

The work product includes both this white paper and a short guidebook for local officials that provides in more straightforward terms information and recommendations that can help them in directing their municipalities. This white paper is structured so that it first presents the research concerning each impact and sets forth a consolidated analysis of the impacts and responses to them at the end of the document.

II. HISTORICAL BACKGROUND: RESOURCE EXTRACTION ECONOMIES AND THEIR IMPACTS

In light of the nature of the development, it is useful to review the literature concerning past resource activities. Because extractive industries can have both positive and negative economic effects, this section examines the economic literature relevant to extractive industry-related economies, reviews prior Pennsylvania experiences with resource development, and explores some international experiences.

A. General Experience with Resource Extraction Industries

Traditionally, resource extraction has been regarded as an economic benefit for national, state, and local economies, generating employment, wealth, and opportunities for economic growth and reinvestment. Proponents of resource-based economic growth argue that states and nations with significant natural resource endowments are able to overcome local capital shortfalls as well as attract outside investment to stimulate growth.[3] Thus, resource extraction may appear to be an advantageous economic growth strategy for communities with resource endowments. This dynamic manifests itself in the behavior of firms, individuals, and governments to move rapidly to capture the rewards from the extraction of resources.[4] The rapid pace and large scale of resource extraction in such communities led researchers to adopt the term "resource boom."[5]

A body of academic literature suggests that sustained growth resulting from an economy based chiefly on resource extraction is relatively rare, absent other important factors, however.[6] Where there is a resource boom, there is often a subsequent resource bust, which can create a cycle of economic highs and lows.[7]

This section describes some of the findings of the economic literature on extractive industry "bust" experiences. Factors that may lead to a bust include resource exhaustion, decreased demand and/or falling prices for the resource, or a combination of both.[8] Depleting a nonrenewable natural resource in the short-term may affect both field and economic conditions in the long-term. Additionally, if communities and investors miscalculate the total supply of a resource, depletion may occur more quickly than anticipated. Further, decreases in demand or falling prices may lie beyond the control of a community, but such price changes can turn extraction from a once profitable economic activity into an unprofitable one in particular communities.[9] Following a bust, communities may be able to extract natural resources again when conditions (such as prevailing price for a resource) improve, allowing the deployment of more expensive technologies and/or the extraction of previously marginal resources.[10] Thus, there can be a cyclical effect.

Research shows that dependence on extraction as a primary economic driver may affect a community's long-term economic prospects. Economic activities unrelated to resource extraction may experience limited growth.[11] This propensity has led economists to argue that there is a

resource "curse" in some settings.[12] Numerous factors relevant to such experiences include the 'crowding out' effect that resource extraction dominance can have on other economic sectors, the price volatility of commodities being extracted, the transiency of an extractive industry workforce, some localized inflation, and a tendency for communities to overestimate the need for and overspend on expansion of local infrastructure.[13]

The crowding out effect refers to the tendency of extraction as the dominant industry to pull capital (human and/or physical) away from other industries in an economy.[14] Other industries may not be able to compete with extractive industry wages and may shut down or avoid the market altogether. Less economic diversity is then associated with higher rates of unemployment and less employment stability. When a resource bust occurs, communities may be left with fewer viable alternative activities as a result of the crowding out.[15]

The second mechanism is price volatility. Prices for many resources fluctuate in international markets. When these commodity prices rise and fall, so too do the wages of workers and the prices for goods and services at the site of extraction.[16] The greater the dependence on resource extraction, the higher the variability of prices may be. An entire economy, then, can hang in the balance of the prevailing price for a particular commodity.[17]

A burgeoning extractive industry draws labor from elsewhere to the site of extraction.[18] Many workers opt to move to the community for a short time while others commute long distances on a daily basis.[19] The influx of workers creates the potential for significant economic leakages from the local economy if workers stay only temporarily in the community or commute from outside.[20] Thus, the economic benefits of resource extraction may not totally be reaped by those who live in the host community, as money ends up in the pockets of those who live elsewhere.

Localized inflation can occur in some economies associated with resource extraction. Complementing inflation induced by commodities prices is population growth in a community and subsequent increased demand for goods and services.[21] As a result of resource booms, communities can face inflated prices. Most noteworthy in the literature is the change in rents and home values as a result of resource extraction. With new labor moving into the area, even if only temporarily, rents and home values rise,[22] and an affordable place to live becomes unaffordable, particularly for those not engaged in extraction.[23]

Finally, the literature suggests that in response to increased demand for local goods and services, isolated or rural communities may build up local amenities and infrastructure only to over-shoot long-run demand.[24] The over-shoot can be attributed to the influx of labor to communities with resource extraction. Because new citizens demand homes to live in, roads to drive on, and entertainment to enjoy, communities increase the supply of goods and services available.[25] With the resource bust, however, demand drops back to pre-boom levels (or below), turning the expansion into excess.[26] Consequently, communities are left with a glut of houses, restaurants,

and shopping venues—all of which typically have up-front or fixed costs that may not be recovered post-bust.[27]

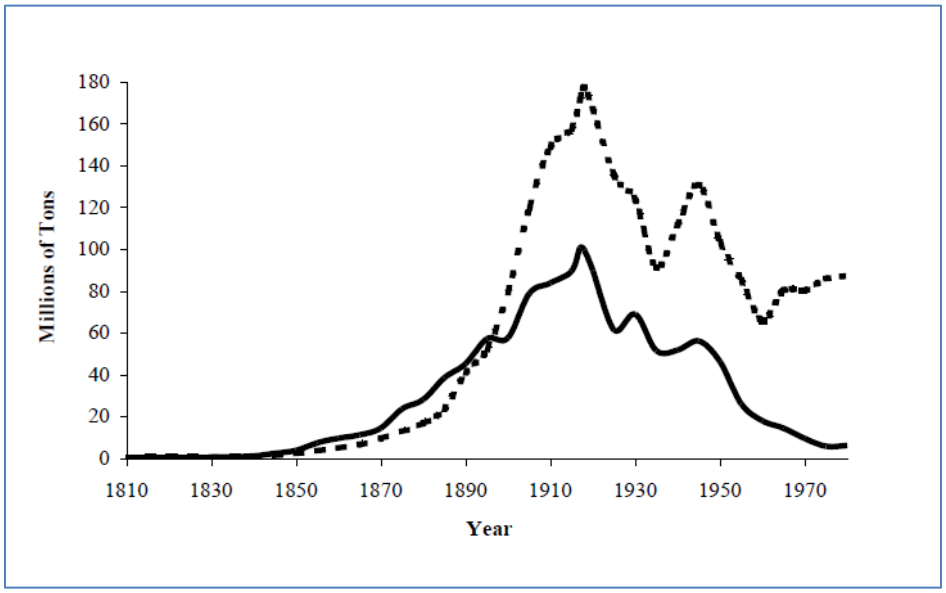
Such experiences are not unknown to Pennsylvania. Context is extremely important in the boom-bust cycle. Oil production, coal mining, and timber production, are some of the key extractive industries in which Pennsylvania has been involved. As each industry has expanded and contracted, Pennsylvania communities have experienced many of the advantages and disadvantages characteristic of the boom and bust cycle.

B. Pennsylvania's Historical Experience

Pennsylvania's involvement in oil extraction began in 1859, when the world's first oil well was drilled in Titusville. After the initial well was drilled, production surged. With the surge came immense growth. Pithole, Pennsylvania, grew from a single family farm to 15,000 people in a mere nine months due to an influx of workers seeking employment in the oil industry. With a vast supply of oil and burgeoning population, Pennsylvania was at the forefront of production. By the1860s, refinement and transportation of the resource attracted significant investment from outside of the state. The infusion of capital further boosted the industry in Pennsylvania, making it easier to distribute the resource. Not long after, however, Pennsylvania oil flooded the national market and prices dropped precipitously. By the 1870s, the combination of low prices and oil discoveries in Texas, Kansas, and Oklahoma undercut the economic viability of the industry.[28] Pithole shrunk to a mere 281 residents at the time of the 1870 census.[29] At the turn of the 20th century, oil production in the Commonwealth declined as production boomed elsewhere and easy recovery of the resource in the Commonwealth became much more difficult.[30] Consequently, the towns which once thrived under oil production waned or collapsed altogether. Pennsylvania's oil towns are a fraction of their former size and vitality—in part because of the prior oil bust, and in part because of greater efficiencies and the low labor demands of a mature industry.

Coal mining offers another familiar Pennsylvania experience with boom and bust. Throughout most of the 19th century demand for coal, especially the energy-rich anthracite, grew at a modest pace to satisfy home energy needs. Bituminous coal eventually outpaced anthracite coal, as it was viewed as a cheaper, albeit less efficient form of the resource.[31] Advances in steelmaking and coke production, were particularly salient factors in explaining the increase in demand for both anthracite and bituminous coal.

Figure 1: Coal production in Pennsylvania 1810-1980 (Anthracite-solid line, Bituminous-dashed line)



Source: Coal Mining and Regional Economic Development in Pennsylvania 1810-1980

Coal production in Pennsylvania peaked between 1910 and 1920 as the United States entered World War I. The war effort increased demand for steel, feeding additional growth in coal production. Shortly after, coal production began to decline as the United States lurched into the Great Depression. Coal failed to recover in the years after due in part to competition abroad, despite continued growth in the steel industry. After 1975, however, steel production dropped off significantly, further weakening the coal industry in Pennsylvania.[32] While coal production is much less than in the past, Pennsylvania still produces a combined 54.7 million tons of coal today, making the State the fourth largest producer in the United States.[33]

Much like the oil towns of yesteryear, coal mining communities throughout the Commonwealth experienced booms and busts in their populations and economies. In Northumberland County, for example, the population dropped by 20 percent between 1910 and 1950, and has not recovered since.[34] The rapid de-population of former coal mining communities contributed to significant blight. Abandoned homes, storefronts, warehouses, and schools in many mining towns are accompanied by defunct equipment and deteriorating infrastructure.[35] Residents have struggled to regain their economic footing after the collapse of the industry. With coal serving as the primary economic driver for so long, communities simply lacked the human or physical capital to recover after the bust. Local economic development efforts have achieved mixed results in former coal towns. Government and quasi-governmental bodies have attempted to jumpstart local economies by abating taxes, building industrial parks, and offering generous leases on buildings.[36] In some cases these measures have succeeded in attracting new firms and diversifying local economies. In other cases, these measures have promoted inter-jurisdictional competition or attracted predominantly low-wage jobs.[37]

Pennsylvania has also experienced boom and bust cycles in the production of lumber. Both hardwood and softwood have been important exports for the Commonwealth. Lumber production peaked just before the turn of the 20th century and declined significantly since then, dropping from about 2.5 billion board feet (combined softwood and hardwood) to about 750 million board feet in the 1970s.[38] More recently, after subsequent increase to a billion board feet, demand further declined as a result of the recent 2008 recession. As the economy has faltered, so too has construction. Today, Pennsylvania's production is approximately 500-600 million board feet.[39] The original boom and bust associated with the lumber industry was most apparent in North and Central Pennsylvania along the Susquehanna River. Between 1850 and 1900, the region grew significantly, as demand for lumber was high and the Susquehanna provided convenient transport for the resource. As a result, Williamsport, PA became a lumber boomtown during that time. At its peak, Williamsport was the site of 35 sawmills. Workers flocked to Williamsport for employment in the industry. Workers would then travel north to temporary cutting operations. Cutting progressed throughout the State's thick forests, leaving behind denuded mountainsides.[40] By the turn of the 20th century, the depletion of lumber in conjunction with a flood in 1894, which destroyed a number of sawmills on the Susquehanna, caused the lumber industry to falter. Shortly after, Williamsport and other towns, which had benefited from the industry experienced significant economic declines. Afterward, communities had to recover from an economic collapse. Erosion and flooding as a result of the stripped mountainsides became severe and served as a partial impetus for the Legislature to purchase large swaths of land for re-forestation. Since, Pennsylvania has implemented initiatives such as rebate offers to farmers and landholders to further encourage re-forestation.

Today, the conventional oil, coal, and timber industries of Pennsylvania are smaller versions of their former selves. Competition, technological change, and exogenous economic forces have dampened production, and resource-dependent communities have experienced the associated busts. Many of the communities in rural areas did not diversify and have not experienced lasting economic vitality from the boom years.

C. Successful Resource Extraction Experiences

Fortunately, it is not inevitable that resource extraction economies end in a bust. There are numerous cases in which communities, states, and nations have mitigated impending resource busts by making a concerted effort to spend less and save more of the revenue generated by extractive activity. Communities, states, and nations typically have been able to encourage such behavior first, by establishing structured funds for a portion of the revenue to be diverted into, and second, by providing long-term, good governance and stewardship of the monies saved.

One nation which has established such a fund is Norway. As the world's third largest exporter of oil, Norway has generated a significant amount of revenue from oil production. In the 1990s, as a

measure of good fiscal policy, Norway created a permanent fund to save all of the petroleum revenue collected by the State. Each year, the Norwegian Central Bank, under the leadership of the Ministry of Finance, uses the revenues to invest in foreign securities.[41]

To ensure that the funds collected are used wisely, Norway imposed an annual maximum withdrawal rate of 4 percent for the permanent fund. This cap ensures that the government draws only from the investment returns and keeps the principal intact. The Ministry of Finance regularly reports to the Parliament on the state of the Fund in order to maintain a high level of transparency and to prevent political currying and fiscal mismanagement.

By diverting oil revenue into a separate fund with limited access, Norway has effectively created a sustainable revenue stream. The funds are there to help to cover potential budgetary shortfalls, while still maintaining the fund for future generations. Because of its structure and management, the permanent fund in Norway serves as an excellent example of sound fiscal management for resource-rich economies.

The State of Alaska has also exhibited financial prudence to avoid an economic bust by establishing a separate fund for natural resource revenues. Through an amendment to the state constitution in 1976, Alaska established the Alaska Permanent Fund. The fund receives allocations from 25 percent of all mineral lease rentals, royalties, royalty sales proceeds, federal mineral revenue-sharing payments, and bonuses received by the state.[42]

To ensure the longevity of the fund, the State government also established guidelines for withdrawals. Per State law, the government is precluded from using the principal as a part of the General Fund. Only earnings from the principal can be used. In addition, a portion of the earnings are paid out as annual dividends to all Alaska residents.[43] The salience of the Permanent Fund has promoted transparency and good management, as all residents have a vested interest in the fund's success.

While the establishment of separate funds is important, examples of resource-rich economies which have relied solely on good governance exist. One such example is the nation of Botswana. There, leaders have consistently reinvested most of its mineral revenues back into the country, with a specific focus on physical and human capital.[44] Physical and human capital investments have been guided by a series of six-year National Development Plans (NDPs), set by the national government.[45]Through targeted investments, Botswana has used revenue generated by the diamond trade to promote economic growth and mitigate the effects of an impending bust.

As nations, state, and communities embrace resource extraction in the short-term, they must also account for economic sustainability in the long-term. As seen here, sustainability can be

achieved by establishing a specialized account or fund for revenue generated by non-renewable resources and/or promoting good stewardship of the revenue generated.

III. MARCELLUS SHALE GAS DEVELOPMENT IN PENNSYLVANIA

The past decade of shale gas development in the U.S. has revolutionized the country's energy landscape. The use of horizontal drilling and hydraulic fracturing technology has made it economical to access large volumes of gas from shale plays across the nation.[46] The shale plays in the Marcellus, Bakken, Niobrara, Permian, Eagle Ford, and Haynesville regions accounted for all domestic natural gas production growth from 2011 to 2013.[47] The proportion of natural gas produced in the U.S. from shale plays is expected to increase from 40% in 2012 to 53% in 2040.[48] One of the most significant results of this development is that the U.S. is predicted to become a net exporter of liquefied natural gas (LNG) in 2016 and a net exporter of natural gas in 2018.[49] Natural gas is also expected to replace coal as the greatest source of energy for electricity generation in the U.S. by 2035.[50] Furthermore, low prices and increased availability of natural gas is expected to promote growth in industrial production, particularly in bulk chemicals.[51] The Marcellus Shale has emerged as one of the most important shale plays contributing to the new American energy paradigm.

Approximately 60% of Pennsylvania lies atop the Marcellus Shale formation, [52] which spans a 95,000 square mile area extending across most of Pennsylvania and West Virginia, southern New York, eastern Ohio, western Virginia, and western Maryland.[53] Pennsylvania has the largest share (35%) of the area of the formation. The US Energy Information Administration (EIA) 2012 Annual Energy Outlook claims that the Marcellus Shale holds 141 trillion cubic feet of unproved technically recoverable natural gas.[54] The scale of these resources has resulted in substantial investments in drilling and production activities, in infrastructure and pipelines, and in Pennsylvania's local economies. At the same time, these activities have impacts on communities and the economy, with many changes yet to come. This section of the report examines current shale gas development activities in Pennsylvania broadly, then focuses more specifically on aspects of shale gas development that are unique or particularly important in the southwestern part of the Commonwealth.

A. Current Shale Gas Development in Pennsylvania

Drilling and Production Activities

The rapid development of the Marcellus Shale in Pennsylvania has been made possible by advances in drilling and production technology using both horizontal drilling and hydraulic fracturing – the injection of large volumes of water, additives, and proppants into natural gas wells to fracture underground gas-bearing shale formations and release the natural gas. This combination of technologies (referred to as unconventional gas development or shale gas development) has enabled companies to produce large volumes of natural gas, stimulating a great deal of investment in oil and gas rights, well and associated infrastructure development, and rapidly changing economies in both the southwestern and northeastern parts of Pennsylvania.

The first hydraulically fractured gas well in Pennsylvania was drilled in Washington County in 2003 and completed in 2004.[55] Drilling activity has increased rapidly since then.[56] Statewide, the Pennsylvania Department of Environmental Protection (DEP) has issued over 2,000 permits for unconventional wells every year since 2009. Recent permitting activity peaked in 2011 when over 3,500 permits were issued. After a decrease in new permits in 2012 when gas prices were lower, DEP issued 2,966 permits in 2013.[57] Drilling and production lag the permitting process. As of December 2013, there were 6,649 active unconventional gas wells in Pennsylvania.[58]

Fig 2: Number of Unconventional Wells Permitted and Drilled in Pennsylvania Since 2004

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Permitted[59]	6	19	58	185	576	2,004	3,364	3,562	2,648	2,966
Drilled[60]	2	8	37	115	332	816	1,603	1,962	1,348	1,207

Source: DEP

Production of natural gas from the Marcellus Shale has surged in Pennsylvania. Between 2002 and 2012, Pennsylvania's Marcellus Shale wells produced a total of 3.7 trillion cubic feet of natural gas. The speed of unconventional gas development is evidenced by the fact that 85% of this natural gas was produced in the last two years: 2011 and 2012. In 2013, Marcellus Shale wells in Pennsylvania produced about 3.103 trillion cubic feet of natural gas, nearly as much as had been produced since the beginning of the Marcellus play in the Commonwealth.[61]

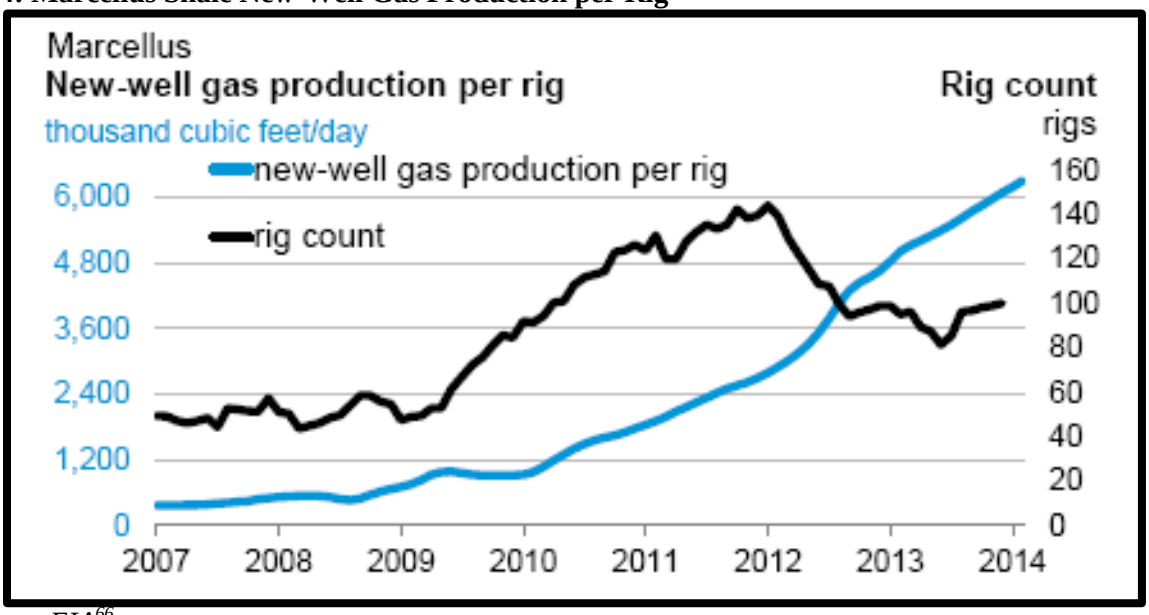
Fig 3: Annual Production from Pennsylvania Shale Gas Wells

	2008	2009	2010	2011	2012	2013
Million cu. ft (gross withdrawal)	9,757	89,074	399,452	1,068,288	2,042,632	3,102,771

Source: EIA[62] *and DEP*[63]

Meanwhile, the productivity of new wells is rising, chiefly due to improved technology and efficiencies developed through greater experience of operators with the Marcellus Shale. Half as many natural gas rigs are drilling new wells in Pennsylvania as compared to the number of rigs drilling three years ago.[64] On average, 2.3 wells were drilled per pad, and the maximum number of wells drilled on a pad was 12.[65]

Fig 4: Marcellus Shale New-Well Gas Production per Rig



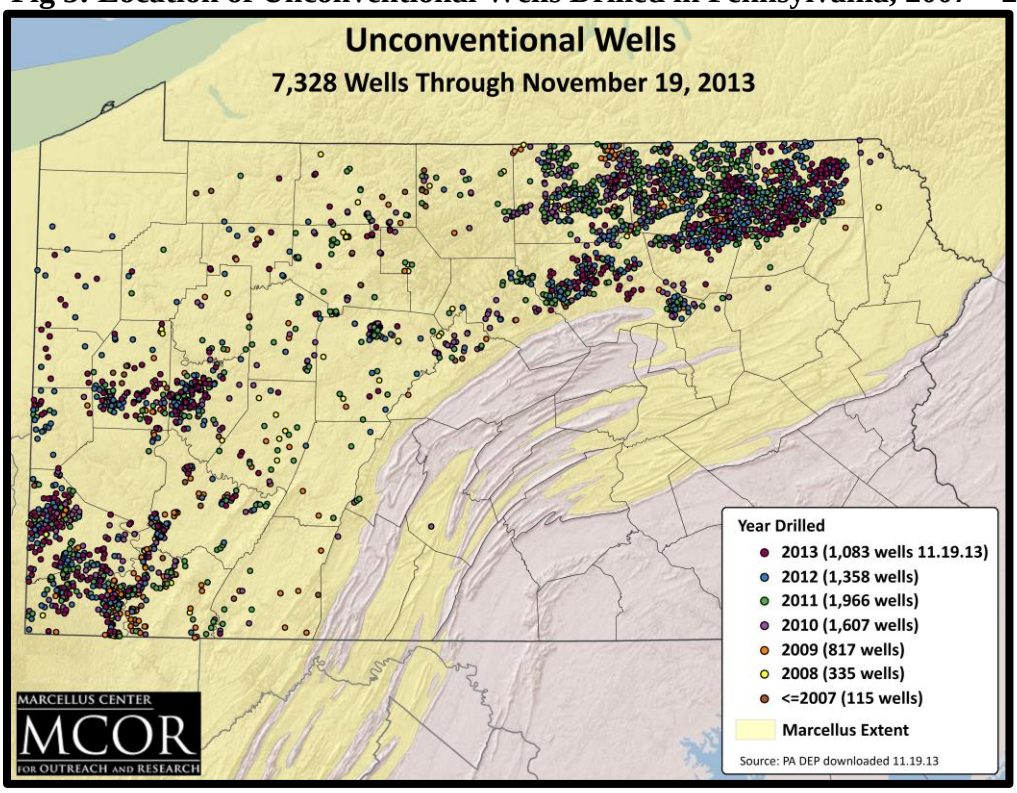
Source: EIA[66]

The productivity of the Marcellus Shale has steadily increased. In fact, productivity has increased so much that Pennsylvania is ranked as the fastest-growing state in the U.S. for natural gas production. In 2012, the state of Pennsylvania was the third-largest producer of natural gas nationally.[67] Preliminary data indicate that Pennsylvania may become the second-largest producer in 2013. [68]

Marcellus Shale drilling and production in Pennsylvania to date has been concentrated chiefly in two areas of the Commonwealth – in the southwest (particularly in the counties surrounding Allegheny County which includes the City of Pittsburgh), and in the northeast (centered particularly in the Bradford-Susquehanna-Lycoming County region near the New York state border).

Natural gas production varies across counties in Pennsylvania. Between January and December of 2013, of the top five counties producing natural gas in Pennsylvania, Bradford County produced the most, followed by Susquehanna and Lycoming; while Greene and Washington in the southwest were fourth and fifth.[69]

Fig 5: Location of Unconventional Wells Drilled in Pennsylvania, 2007 – 2013



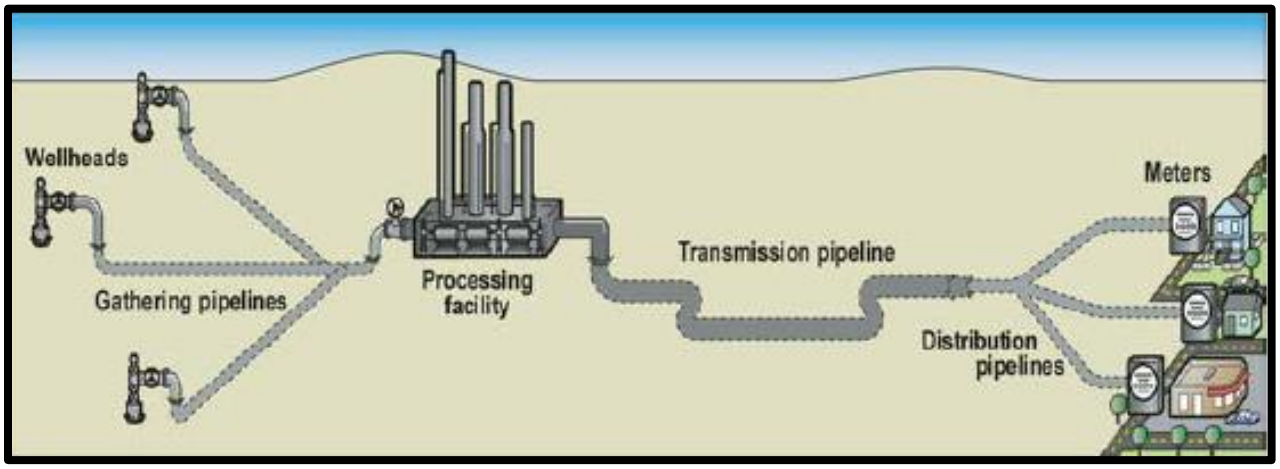
Source: Pennsylvania State University Marcellus Center for Outreach & Research (Wells drilled data taken from Pennsylvania DEP "SPUD Data Report", not updated past November 19, 2013.)[70]

There are 70 operators extracting natural gas in the Marcellus Shale,[71] although this number changes due to frequent mergers and acquisitions of operators and properties in the region.[72]

Natural Gas Development and Transmission Infrastructure

In addition to the wells and associated infrastructure necessary to produce natural gas, gathering, processing, transmission, and distribution require substantial investments in the construction and maintenance of pipelines. Even before the development of the Marcellus Shale began, Pennsylvania already had over 8,600 miles of large-diameter gas pipelines.[73] However, the state's existing infrastructure was insufficient to support the magnitude of natural gas development occurring after drilling and production from the Marcellus Shale began to accelerate. Each phase of production, processing transmission and distribution requires access to pipelines.

Fig 6: Pipeline Diagram



Source: Pipeline & Hazardous Materials Safety Administration (PHMSA) in Report to the General Assembly on Pipeline Placement of Natural Gas Gathering Lines[74]

There is some uncertainty as to exactly how many miles of natural gas pipelines of all types exist in Pennsylvania today as no single regulatory agency is responsible for the state's gas pipelines.[75] Pennsylvania's Public Utility Commission (PUC) is responsible for Pennsylvania's 46,000 miles of public utility distribution[76] pipelines, and 885 miles of intrastate pipelines.[77] The federal Department of Transportation oversees 55,000 miles of interstate pipelines that traverse Pennsylvania.[78] In general, the PUC regulates pipelines that are considered public utilities, such as distribution pipelines serving retail customers.[79] The PUC also regulates Class 2 through Class 4 gathering, transmission and storage facilities, and Class 1 transmission lines, and registers Class 1 gathering lines.[80]

Certain pipelines are associated with development of the Marcellus Shale. As of October 1, 2012, 43 unconventional pipeline operators had submitted annual reports to the PUC identifying 2,535.5 miles of unconventional gathering and transmission pipelines.[81] Some counties have begun monitoring natural gas gathering pipeline lengths themselves, such as Bradford County through its County Planning Commission.[82]

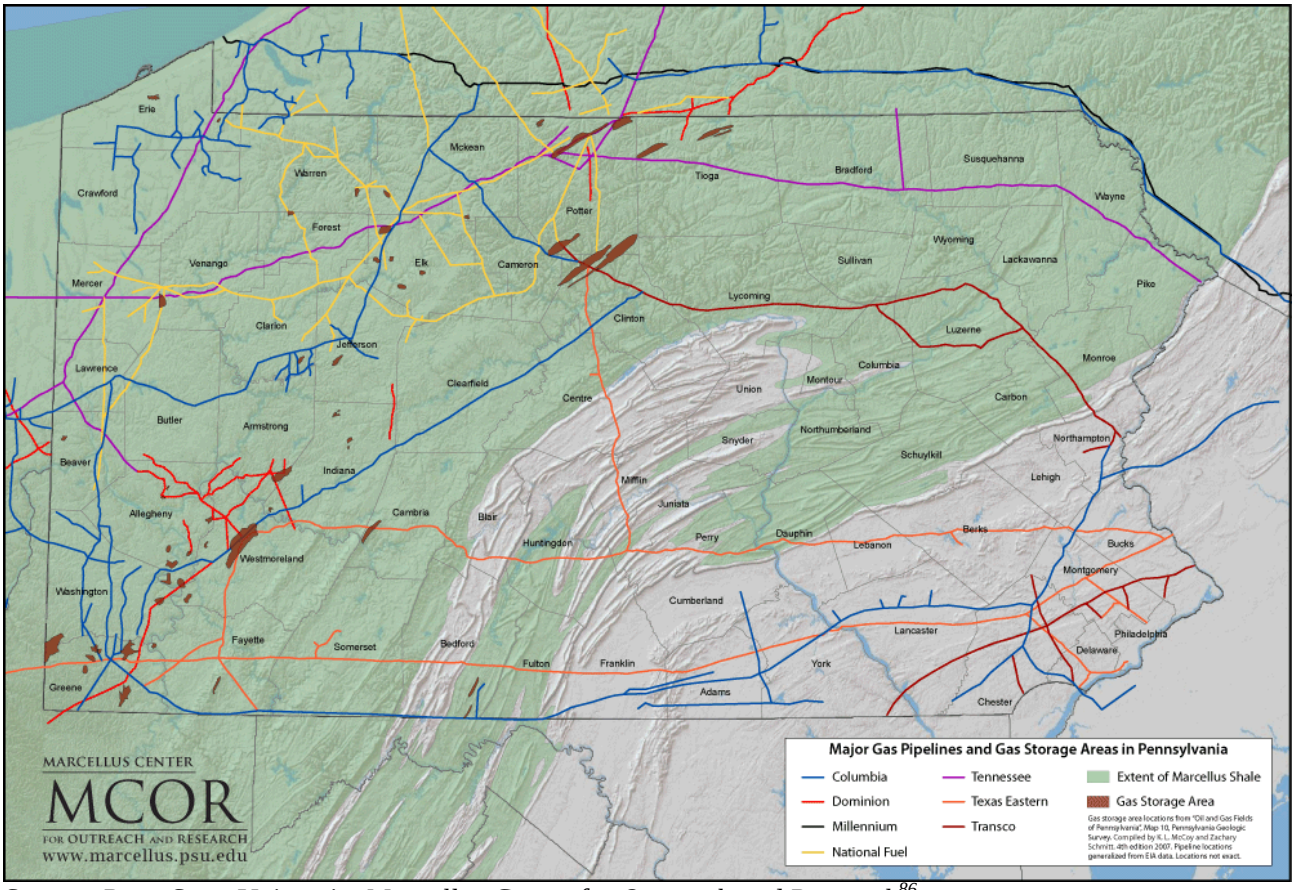
Fig 7: Top 10 Counties – Class 1 Unconventional Gathering Lines (2012)

County	Class 1 Unconventl Gathering Line Miles	County	Class 1 Unconventl Gathering Line Miles
Indiana	351.5	Washington	119.1
Bradford	244.5	Greene	111.4
Susquehanna	160.1	Westmoreland	90.4
Tioga	150.5	Clearfield	79.3
Lycoming	128.1	Jefferson	62.7

Source: Report to the General Assembly on Pipeline Placement of Natural Gas Gathering Lines[83]

Continued expansion of pipeline infrastructure is expected in Pennsylvania, with many pipeline construction projects already underway or approved for the near future. Using data from Bradford County in 2011, The Nature Conservancy generated estimates for required pipeline lengths under different natural gas expansion scenarios. In the lowest development scenario, 10,000 miles of new gathering pipeline would be required. However, in their highest development scenario, 25,000 miles of new gathering pipeline would be needed.[84] Examples of forthcoming pipelines include the Texas Eastern Appalachia to Market (TEAM) project of Spectra Energy. Pending approval by the Federal Energy Regulatory Commission, the pipeline is expected to be in-service by November 2014. 34 miles of 36 inch pipeline would be constructed with a transport capacity of 600 million cubic feet/day.[85]

Fig 8: Major Gas Pipelines and Gas Storage Areas in Pennsylvania



Source: Penn State University Marcellus Center for Outreach and Research[86]

Natural Gas Prices and Pennsylvania

Local, regional, national, and international factors affect the price of natural gas all along the chain from wellhead to retail customer. Price matters because it can affect the pace of new drilling, development, production, and construction of processing facilities and pipelines. Natural gas prices have been decreasing nationally and in Pennsylvania for the past five years, but consumer prices in Pennsylvania still tend to be higher than the national average. Customers are burdened with the fixed cost of extraction, collection, compression, treatment, and transport of natural gas, as reflected in the citygate price, along with their utility's overhead and distribution costs. [87]

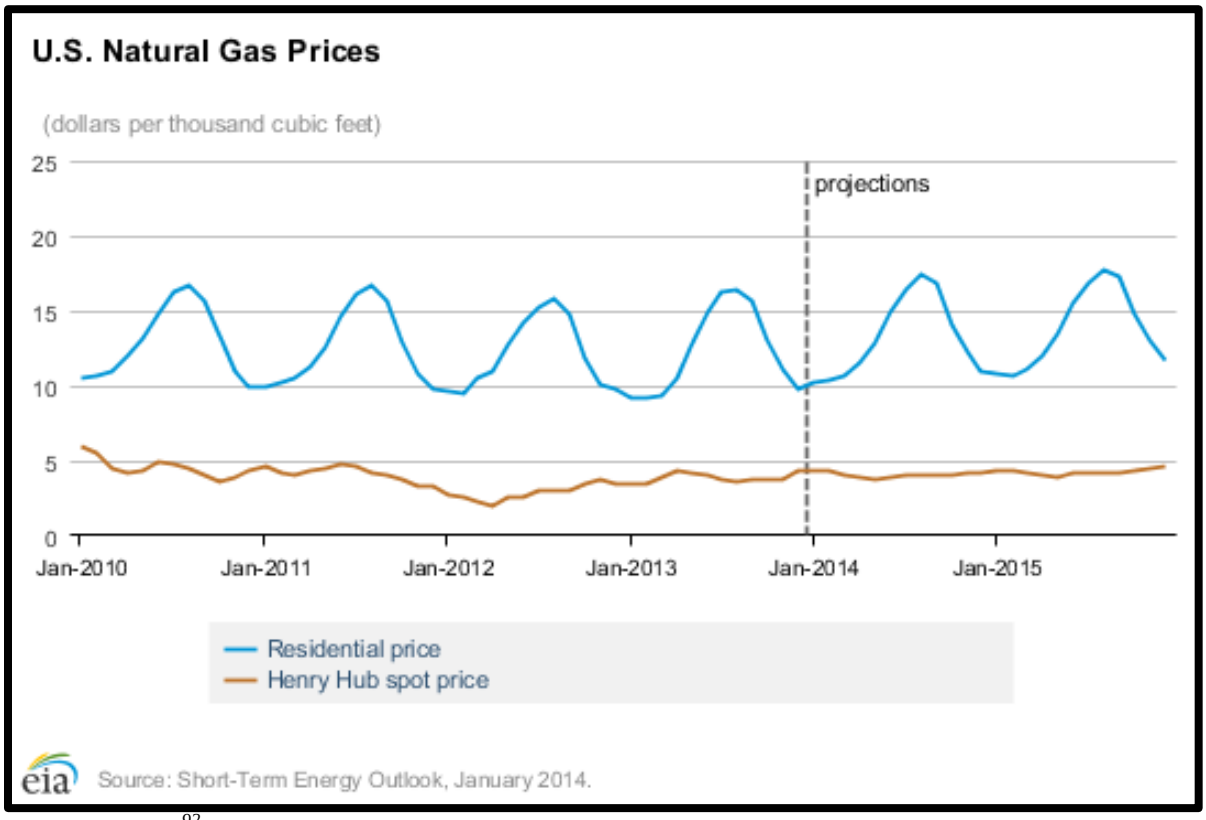
Fig. 9: Average Natural Gas Consumer Prices (2013 11-Month YTD)

	US[88]	**Pennsylvania**[89]
Citygate Price	$4.87	$5.27
Residential Consumer Price	$10.56	$11.82
Commercial Consumer Price	$8.17	$10.17
Industrial Consumer Price*	$3.80	$9.63
Electric Power Consumers	$4.43	$4.12

*2012 11-Month YTD Average is used; 2013 data was not available for Pennsylvania.
Source: U.S. EIA

Natural gas prices in general are affected by the amount of natural gas being produced, the volume imported or exported, the amount stored in facilities, levels of economic growth, variations in weather, and oil prices. Unexpected or severe winter weather can have a dramatic effect on natural gas prices if sufficient supply cannot be generated quickly enough to meet increased demand[90] as observed in the winter of 2013-2014 in the Northeast.[91]

Fig 10: U.S. Natural Gas Prices



Source: U.S. EIA[92]

EIA has predicted that the national average natural gas price will increase through 2015. EIA projects that the U.S. residential average will rise to $11.66 per thousand cubic feet of natural gas in 2014, and then to $12.18 per thousand cubic feet of natural gas in 2015.[93]

Projections as to Future Development

It is difficult to predict how long a shale play will produce natural gas, and how much total gas will be produced over the course of its productive lifetime. This uncertainty is first and foremost caused by uncertainty regarding the total gas reserves contained in a shale play. The volume of natural gas that can be extracted from a shale formation depends on the shale's permeability, porosity, and gas pressure, and estimates of this accessible gas are informed by economics, technological change, government regulations, and operating methods.[94] Understanding these estimates is further complicated by the breadth of terms used to describe a shale play's available resources. One of the most common terms is Technically Recoverable Reserves (TRR), which refers to "quantities of hydrocarbons which are estimated to be producible from accumulations, either discovered or undiscovered."[95] In 2002, the United States Geological Survey produced a mean estimate of Marcellus TRR of 1.9 trillion cubic feet (TCF).[96]

In 2011, USGS updated this value and provided a mean estimate of 84 TCF of Undiscovered Technically Recoverable Reserves (UTRR), or "oil and gas that may be produced as a consequence of natural pressure, artificial lift, pressure maintenance, or other secondary recover methods, but without any consideration of economic viability. These are primarily located outside of known fields."[97]

Finally, in 2012 the EIA stated that the Marcellus Shale contains 141 TCF of unproved technically recoverable reserves of natural gas,[98] which are "those quantities of oil and gas which, by analysis of geological and engineering data, can be estimated with reasonable certainty to be commercially recoverable, from a given date forward, from known reservoirs and under current economic conditions, operating methods, and government regulations but have not been proven to exist based on accepted geologic information, such as drilling or other accepted practices."[99]

Estimates of the Marcellus reserves are expected to evolve. As more data become available from ongoing exploration, development, and production, estimates will likely become more consistent over time. For example, while the Marcellus underlies over 100,000 square miles, most drilling has only taken place in southwestern and northeastern Pennsylvania, limiting production data available for estimates. [100] Furthermore, shale wells are characterized by high initial productivity but rapid decline curves, so high current production levels may not be representative of future production volumes.[101] EIA projections for production in the entire Marcellus shale show gas production growing from current levels to a peak production volume of 5.0 TCF per year in 2022 - 2025.[102] This peak volume of gas could supply 39% of the natural gas needed to meet annual demands in markets east of the Mississippi.[103] However, it is then expected that natural gas production will decline to 4.6 TCF per year by 2040.[104]

B. Shale Gas Development in Southwestern Pennsylvania

The development of shale gas has had differential impacts in the southwestern and northeastern regions of Pennsylvania. Southwestern Pennsylvania is generally considered to be composed of Allegheny, Armstrong, Beaver, Butler, Fayette, Greene, Indiana, Lawrence, Westmoreland, and Washington counties.[105] Northeastern Pennsylvania is generally considered to include Bradford, Lycoming, Snyder, Sullivan, Susquehanna, Tioga, and Wyoming counties.[106]

Southwestern Pennsylvania Production and Gas Types

In the past ten years, southwestern Pennsylvania has accounted for approximately one third of the unconventional oil and gas permits issued, wells drilled, and gas produced in the state.[107] Production in the southwest is growing as new drilling shifts from northeastern Pennsylvania, where the majority of Marcellus Shale production previously took place.[108]

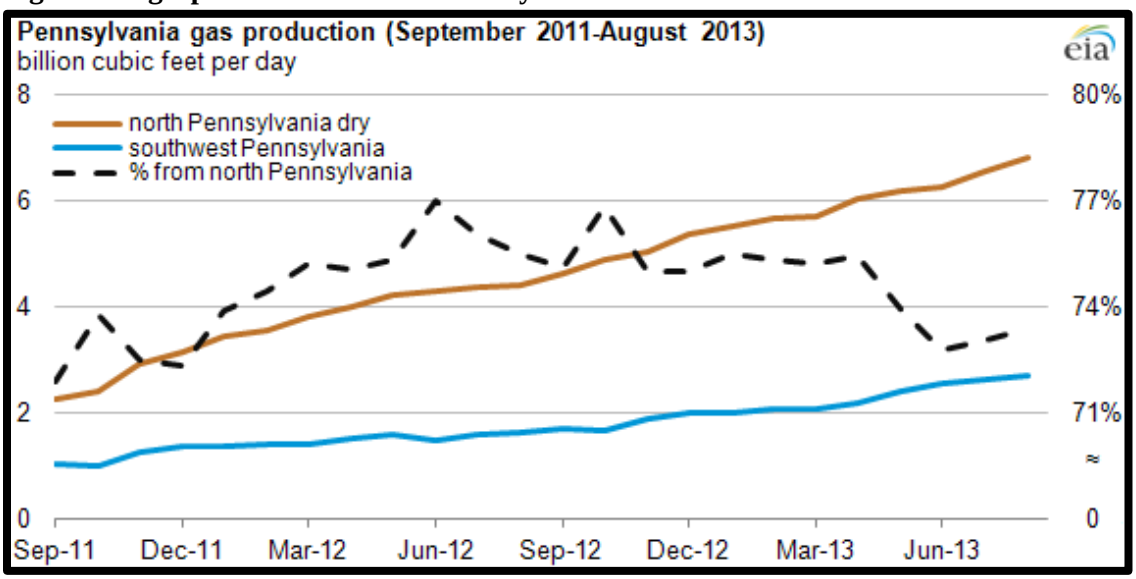
Fig 11: Gas Production by County from July to December of 2013

COUNTY	GAS QUANTITY (MCF)	COUNTY	GAS QUANTITY (MCF)
SUSQUEHANNA	389,723,909	JEFFERSON	4,094,533
BRADFORD	383,530,426	POTTER	3,420,899
LYCOMING	220,423,425	MCKEAN	2,983,913
GREENE	162,575,176	**INDIANA**	2,615,976
WASHINGTON	145,161,772	CENTRE	2,093,994
TIOGA	109,046,507	SOMERSET	1,938,836
WYOMING	90,939,699	**LAWRENCE**	1,614,709
WESTMORELAND	36,540,900	CLARION	1,110,272
FAYETTE	26,749,464	**BEAVER**	966,362
BUTLER	23,609,115		
SULLIVAN	21,887,743		
ALLEGHENY	14,770,677		
CLINTON	13,193,707		
ARMSTRONG	12,899,632		
CLEARFIELD	10,493,876		
ELK	4,331,006		

Source: StateImpact Pennsylvania [109] (Southwestern counties in bold)

This regional shift in production is driven by the difference in the gas available in the northeast and the southwest. Most natural gas in north central and northeastern Pennsylvania is "dry" gas, meaning it consists simply of methane. Meanwhile, gas in southwestern Pennsylvania is "wet" gas, which also contains natural gas liquids (or NGLs) in addition to methane.[110] NGLs include ethane, propane, butane, isobutene, and pentane, which all have a higher molecular weight than methane.[111] While indistinguishable under reservoir conditions (as they are found in the formation), these heavier hydrocarbons can be separated and compressed into liquids[112] for transport.[113]

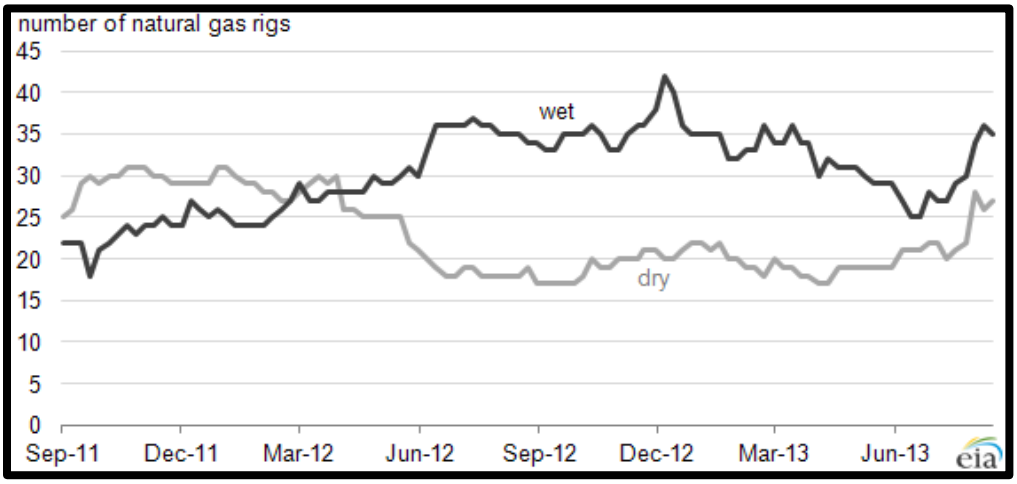
Fig 12: Geographic Distribution of Pennsylvania Gas Production



Source: U.S. Energy Information Administration (EIA)[114]*(production is on left axis)*

Washington County is the top liquids producer in Pennsylvania, and produced 1.26 million barrels of liquid in the first half of 2013, out of a total of 1.27 million barrels produced state-wide.[115] The growth in production in southwestern Pennsylvania reflects a national trend of increased liquids-rich production through 2013, spurred by the falling price of natural gas.[116] NGLs are typically priced much higher than natural gas, and are more profitable to extract.[117] As a result, drilling activity in the state's wet gas basins has overtaken that in its dry basins.[118]

Fig 13: Natural Gas Drilling Activity in Pennsylvania



Source: U.S. Energy Information Administration (EIA)[119]

Southwestern Pennsylvania Gas Infrastructure

Wet gas and dry gas have infrastructural requirements specific to their respective properties. As a result, gas-related development has progressed differently in southwestern and northeastern Pennsylvania. Well drillers may only benefit from wet gas to the extent that they have access to the necessary infrastructure to extract, fractionate, and transport these valuable hydrocarbons.[120] Processing natural gas liquids (NGLs) requires separating the heavier hydrocarbons from the natural gas stream extracted from a well, and then further separating these into individual liquids through a distillation process called fractionation.[121] NGLs require different types of pipelines, with higher Btu specifications, in order to be safely transported. If such pipelines are not available on-site, producers may be forced to shut in wells until appropriate downstream infrastructure becomes available.[122]

Market access and infrastructure for some NGLs are already in place. Propane can be used for regional home heating, and butane can be transported to East Coast refineries with trucks or railroads.[123] However, much of the requisite infrastructure to take full advantage of wet gas is still under development. The Mariner East pipeline is expected to bring up to 70,000 barrels a day of propane and ethane to the Marcus Hook refinery near Philadelphia, which is currently supplied by truck and rail systems.[124]

Ethane infrastructure in particular is expected to grow in southwestern Pennsylvania. Shell has extended its land option with Horsehead Corporation to build a "cracker" in Beaver County three times. A cracker is a facility that converts ethane into ethylene, which is in turn used to make plastics. Governor Corbett has offered Shell tax breaks valued at $1.65 billion over a 25-year window, and it is thought that the plant will create new production jobs in Beaver County.[125] Several pipelines, such as the Mariner West[126] and ATEX projects, are also being developed to transport ethane from Pennsylvania to processing and fractionation hubs in other states.[127]

Increased liquids-rich production southwestern Pennsylvania has been complemented by production growth in neighboring West Virginia. These areas have formed an integrated region for natural gas drilling, as rig operators move between the two states[128] and pipeline expansion in the regions, including the Equitrans Sunrise Project and Appalachian Gateway Project, expand production capacity.[129] New natural gas pipelines in the northern regions of Pennsylvania are also under development, but they are focused primarily on delivering gas to New York, New Jersey, and the Mid-Atlantic region.[130]

IV. SOCIO-ECONOMIC IMPACTS OF SOUTHWESTERN PENNSYLVANIA'S SHALE GAS DEVELOPMENT

Pennsylvania's emergence as a leading producer of shale gas has changed the national energy markets. This resource development has also changed Pennsylvania. Due in part to how quickly shale gas has been developed, there is some uncertainty concerning its impact on local communities, both in the short and long term.

The following chapter examines some of the socio-economic impacts that Marcellus Shale development has had on the surrounding communities in southwestern Pennsylvania. The key areas of concern for citizens in southwestern Pennsylvania as expressed by local officials are: effects on employment, the impact on housing values, and the impact on roads. We also briefly discuss the growth of income from royalties.

Arguably, some of these impacts might as likely be termed "economic impacts," however, for the purposes of this paper they are termed "socio-economic" in light of the very immediate effect these issues have on the local population. Later, the paper addresses "economic impacts," i.e. the revenues that have been generated by the industry and their use by local governments.

A. Employment Effects

One of the most important impacts of the Marcellus Shale play is the opportunity for local residents to work for the industry. Shale gas operations create or support a variety of jobs that are valuable in any economy and are particularly so in the rural communities where most shale gas sites are located. Assuring that their residents obtain employment in this expanding industry is important to municipal leaders (as wells as to the residents themselves) because they rely in significant part upon their residents' stable employment. It is important to everyone that the local employment be as robust as possible.

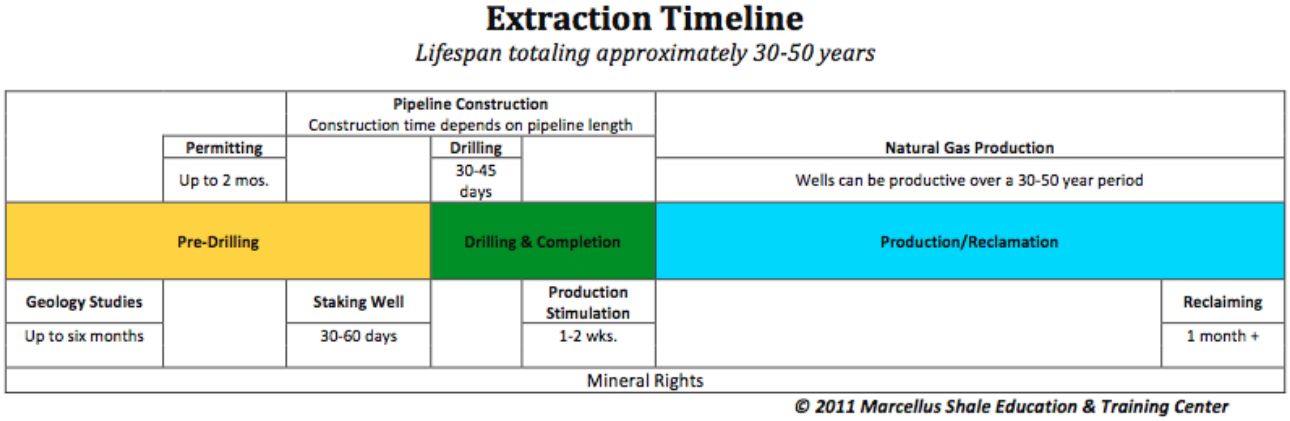
Fairly assessing the impact that Marcellus Shale development has had on the local workforce presents some challenges. There is a good deal of debate regarding the quantity and quality of Marcellus Shale jobs. Some of this debate stems from how shale gas employment is organized and some from disagreements between economists regarding how one assesses the numbers. Overall, however, there is strong evidence that this new industry has become more established in the region, employment is growing and efforts are underway to ensure that local residents can take advantage of this opportunity.

Shale Gas Employment

Because the industry is relatively new, policymakers and public officials are unsure just how many jobs will materialize in the Commonwealth, which sectors will see the greatest amount of growth, and how local residents can gain the skills and experience necessary to take advantage of the jobs the industry brings.

At least part of what makes the relationship between employment and natural gas development unclear is the industry itself. By nature, natural gas extraction is highly variable, with demand for labor increasing and decreasing as production levels ebb and flow. And because a majority of job opportunities materialize in the drilling and pipeline infrastructure phases (some estimate as high as 98 percent of all opportunities), employment is largely contingent on new wells being drilled and new pipeline being laid.[131] Thus, the labor market can be as volatile as the market for natural gas itself. The following timeline done by researchers at Penn State lays out the life cycle of shale gas employment:

Fig. 14: Timeline of Employment Activities



Source: Brundage et al 2011.

Employment Estimates Differ

Estimating employment gains associated with natural gas development is difficult not only because of the nature of the industry, but also because of the methodologies used by economists to establish such estimates. This has only made it more difficult for policymakers and public officials to identify impacts of the natural gas industry on local labor markets. To be more specific, economists count jobs created by the industry in different ways. Some studies, for example, count only jobs directly related to natural gas 'core industries', such as landmen, geologists, and heavy machine operators, as jobs created by natural gas development. Other studies, however, include as jobs created by natural gas development all the jobs of those who

work for support industries, such as water treatment contractors, which are considered "indirect employment", and the jobs resulting from the general economic growth, such as retail workers and home construction workers, which are referred to as "induced employment." Studies which embrace the former typically produce much *lower* estimates than those which embrace the latter.[132]

In terms of Marcellus Shale development in Pennsylvania, job creation estimates range from the low 10,000s to a high of 140,000 jobs. A Keystone Research Center Review of state employment data assembled by the Center for Workforce Information and Analysis of the Pennsylvania Department of Labor and Industry looking *only* at direct jobs, found that from the fourth quarter of 2007 to the fourth quarter of 2010, 9,288 direct jobs were created in Marcellus Core industries during this three-year period, while Marcellus Ancillary industries lost 3,619 jobs.[133]

Natural gas industry sources have suggested that shale gas development has led to direct and indirect job creation in Pennsylvania in the hundreds of thousands since the beginning of the boom. A May 2011 newspaper report, relying upon industry sources, stated that in the prior year Pennsylvania Marcellus natural gas development had created 48,000 jobs.[134]

A study by Penn State University economists using investment data and the IMPLAN model, estimated that in 2010 Marcellus Shale development in Pennsylvania generated $11.2 billion in value added, and supported nearly 140,000 jobs.[135] The authors used anticipated investment data from key shale gas companies to determine how much money would flow into the state due to shale development activity.

A careful analysis published by the Multi-State Shale Research Collaborative in November 2013 looked at job creation in all of the Marcellus Shale states from 2005 through 2012. Summing employment in oil and gas direct employment and support activities, the researchers determined that Pennsylvania alone had gained 22,441 net new jobs over the seven year period directly attributable to shale-gas related employment, with a state average of 3.6 jobs created for every shale gas well drilled.[136] This is a substantial contribution, but not quite the growth in employment suggested by methodologies that also predict the multiplier effect of these additional funds circulating in the economy. In a large economy, however, shale-related employment gains – including indirect employment gains – may be relatively small. The researchers found that total job growth in Pennsylvania over the period was 0.5% over the previous baseline, of which 0.4% was attributable to shale gas related employment. Such effects may be bigger, however, in particular parts of a state (e.g. on a county level). Greene County and Washington County experienced employment gains of 30.5 percent and 13.2 percent, respectively over the period.[137]

In the most recent statistics for the Commonwealth, the Pennsylvania Department of Labor and Industry noted an increase between 2009 and 2013 of 18,365 jobs in core industries and 16,354 in ancillary industries, with up to 11,304 and 6,449 respectively attributable to Marcellus Workforce Investment Areas.[138]

With such variation in estimates, confusion regarding the impact of natural gas development on labor markets is unsurprising. Policymakers and public officials must therefore be cautious in accepting any single estimate of jobs created by the industry. A trend of gradual growth, however, can be noted.

Employment Growth by Sector

In addition to uncertainty regarding the total number of jobs created by natural gas development, uncertainty regarding employment types also remains. That is, many municipalities are unsure about the mix of workforce and professional level positions, as well as the stability or duration of those positions in Pennsylvania.

As stated earlier, the most labor-intensive activities associated with natural gas development are completed in the drilling and pipeline construction phases. Because these phases require a highly specialized skill set, many out-of-state workers, who gained experience in previous natural gas development areas, gained employment within the Commonwealth. A 2010 Marcellus Shale Education and Training Center online survey of gas companies found that 37.3% of workers were non-residents, although some researchers suggest that the study may actually have understated the nonresident percentage.[139] Since 2008, a majority of hires have come from within the Commonwealth, with more than a quarter of the workers (about 26 percent) coming from elsewhere. While there is disagreement over the exact number, certainly many natural gas jobs are held by out-of-state workers, producing a significant transient worker population.

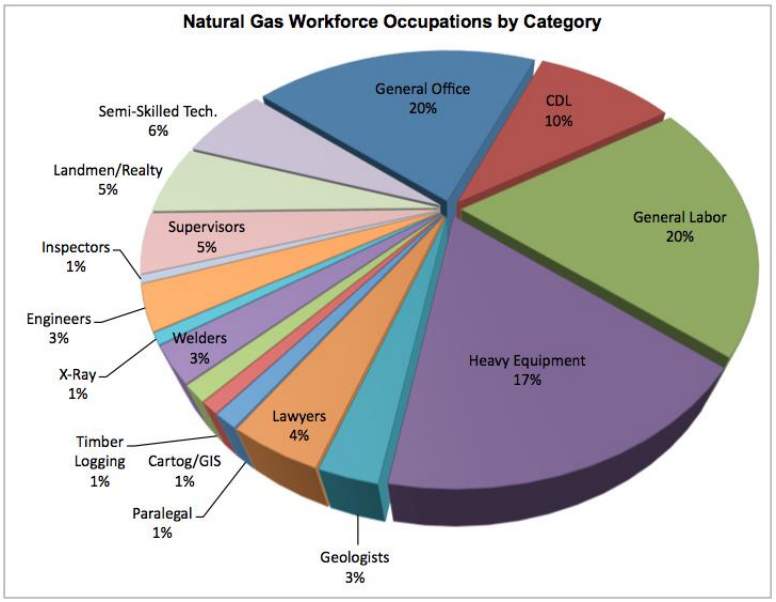
Sector	Fayette County			Greene County			Washington County		
	2005	2012	% Change	2005	2012	% Change	2005	2012	% Change
Natural Resources & Mining	433	892	106%	2,528	4,269	69%	1,403	3,126	123%
Construction	1,616	1,876	16%	415	1,214	193%	5,760	8,152	42%
Manufacturing	3,989	3,947	-1%	607	379	-38%	10,358	9,078	-12%
Trade, Transportation, Utilities	9,863	9,115	-8%	2,083	2,630	26%	15,722	16,999	8%
Information	959	548	-43%	90	71	-21%	1,527	1,063	-30%
Financial Activities	1,187	980	-17%	343	438	28%	2,243	3,584	60%
Professional and Business Services	2,951	2,905	-2%	511	576	13%	6,425	8,306	29%
Education and Health Services	6,832	7,702	13%	1,577	1,923	22%	12,073	13,923	15%
Leisure and Hospitality	4,972	4,852	-2%	579	816	41%	8,124	9,388	16%
Other Services	1,265	1,215	-4%	389	475	22%	3,069	3,125	2%
Total All Industries	34,067	34,032	0%	9,122	12,791	40%	66,704	76,744	15%

Figures from the Quarterly Census of Employment and Wages generally suggest that at least some employment gains have been made in a variety of sectors since natural gas development came to Pennsylvania. A report conducted by the Multi-State Shale Research Collaborative examined employment data in Greene County between 2005 and 2012. These data have been augmented here to include Fayette and Washington Counties.

As seen from the above table, employment gains in some sectors have been significant. Natural resources and mining has grown by 106 percent in Fayette County, 69 percent in Greene County, and 123 percent in Washington County. In addition, the three counties generally have seen sizable gains in construction, education/health services, and trade/transportation/utilities. However, other sectors, such as manufacturing and information services, have experienced declines.

A 2011 report by Brundage sought to identify more specific areas of employment growth generated by Marcellus Shale development. Researchers identified these areas by interviewing and surveying industry leaders familiar with workforce needs. The report revealed that the largest areas of employment growth included: General Office administration (20 percent), General Labor (20 percent), Heavy Equipment operation (17 percent), and CDL Drivers (10 percent). Most of these positions were anticipated to be low to mid-skill positions. Following is a diagram from this report illustrating these points:

Fig. 15: Natural Gas Workforce Occupations by Category



Source: Brundage et al 2011.[140]

The Marcellus Shale Coalition, an industry trade group, emphasizes the high paying quality and diversity of jobs created by the industry in Pennsylvania. The Coalition notes that "core industry jobs (drilling and completions, pipelining, etc.) average an annual salary of almost $90,000, more than $40,000 higher than the Pennsylvania average. And ancillary, or supply chain, jobs average an annual salary of more than $65,000, more than $17,000 higher than the state average." The Coalition has also encouraged its members to source and hire locally for supply chain needs for materials, supplies, and services. [141] Pennsylvania Department of Labor and Industry publications use a variety of government statistics and survey results to document increasing employment in the oil and gas sector and ancillary industries, and the increasing levels of wages and salaries.[142] In the southwestern counties of Pennsylvania, the Department noted that oil and gas core industries had an average annual wage of $73,797 and that ancillary industries also had a high average wage of $63,080.[143]

Some policymakers and public officials have argued that the jobs generated as a part of the Marcellus Shale provide less stability and fewer benefits to workers than certain other industries. Specifically, the share of contractual employment ("1099 employment"), which typically does not pay firm-sponsored benefits or overtime hours, accounts for a larger share of natural gas jobs than in other industries.[144] Therefore, the benefit of employment gains generated by resource extraction may be diminished. Further research on this issue is justified.

Southwestern Pennsylvania Regional Employment Effects

Employment effects of the Marcellus Shale boom are different in different areas of Pennsylvania. In addition to the regional differentiation arising from the distinctive features of wet and dry gas, pre-existing socioeconomic variation has caused the southwest and northeast to respond differently to the changes spurred by the gas development boom. Northeastern Pennsylvania experienced intense development in 2009 and 2010, while southwestern Pennsylvania maintained a steadier rate of development through the same time period.[145] This is in part because southwestern Pennsylvania includes one of the state's more urbanized regions.[146] In contrast, the northeastern counties experienced much more substantial economic and employment impacts because of their lower initial population and smaller economic base.

More diverse, urban areas also have a greater capacity to respond to development due to their higher baseline level of economic activity. Bradford County, in northeastern Pennsylvania has agriculture as one of the most important sectors of its economy. In contrast, Washington County, in southwestern Pennsylvania, is a much more populous and urban county. Thus, despite both experiencing Marcellus Shale drilling and activity, Washington County observed less of an increase in business activity and sales between 2008 and 2010 as compared to growth in Bradford. This was due, in part, to the fact that Washington's economy was already much larger and more diverse before drilling activity began.[147]

Marcellus Shale-related employment patterns are also likely to vary between the two regions. Southwestern Pennsylvania has a greater potential for production-phase and white-collar employment than the Northeast. As previously described, high Btu liquid-rich gas requires greater processing than dry natural gas, and yields additional saleable products.[148] The region's wet gas processing needs are creating an opportunity for production-phase jobs such as compressor operators, pipeline maintenance technicians, gauge monitors, supervisors, and process engineers. Production-phase jobs tend to remain in a single geographic area, usually for the lifetime of a producing well, and can therefore employ local workforces or result in the local residency of out-of-state workers.[149] These jobs are generally viewed as longer-term and more stable than shorter-term drilling jobs associated with natural gas "booms." Furthermore, processing jobs compound over time with each well drilled, unlike drilling jobs which instead shift to each new well site. For example, if 500 wells are drilled per year, requiring an estimated 90 production phase jobs each lasting 20-30 years, 5 years of drilling at the same pace would create demand for 450 jobs.[150]

The greater Pittsburgh area in particular could provide greater opportunity for white-collar jobs than other regions. This area has become a regional "sub-hub" for corporate governance of natural gas companies. While the national headquarters of most natural gas companies are in Texas, [151] many major companies have established regional corporate offices in Pittsburgh or in Southpointe, in Washington County, to oversee activity in West Virginia, Ohio, and New

York.[152] Much of this employment was initially filled with out-of-state workers, but this workforce is gradually beginning to be replaced with local workers.[153]

Workforce Development

To improve access to resource extraction jobs for local residents, many locales establish job training and workforce development initiatives to equip local residents with the necessary skills and technical knowledge. By launching workforce development initiatives, officials attempt to decrease companies' reliance on a transient or out-of-town workforce and increase the employment of local residents. Employment agencies, employer coalitions, and local community colleges have been instrumental in this process.[154] In Pennsylvania, training and development providers proliferated in the initial period of Marcellus Shale development to address workforce development and job training issues in the natural gas industry. To some extent, workforce development and job training in Pennsylvania was initially hampered by a complex network of providers, limited engagement in initiatives by employers in the field, and sometimes ineffective counseling and career mentoring. In 2012, the Forum for Economic Development, Inc. found that over 400 training and development providers existed in Pennsylvania and were managed by over 20 administrators funded through more than 10 different sources.[155] Over the past few years, however, several providers in the state have distinguished themselves and there are signs of progress in this arena.

An early example of collaborative workforce development efforts in Pennsylvania is the Marcellus Shale Education & Training Center (MSETC).[156] MSETC represents a collaborative effort between Workforce Development & Continuing Education at Pennsylvania College of Technology and Penn State Cooperative Extension. The mission of MSETC, which officially opened in January 2009, is to provide communities in the north-central/northeastern part of the state and the natural gas industry with a central resource for workforce development and community education needs related to Marcellus Shale gas. MSETC's goal is to serve as a central resource for training and curriculum specific to the development of shale gas. The central operation of MSETC is located in the Center for Business & Workforce Development on the campus Pennsylvania College of Technology in Williamsport, PA. MSETC utilizes the institutional infrastructure of both the Pennsylvania State University system as well as Penn College. MSETC additionally has partnered with the Workforce and Economic Development Network of Pennsylvania (WEDnetPA) for delivery and infrastructure capacity through WEDnetPA's 33 partner institutions, including community colleges and the various universities in the Pennsylvania State System of Higher Education system.

One of the best examples of workforce development efforts in southwestern Pennsylvania is ShaleNET.[157] ShaleNET is a collaborative effort by the oil and natural gas industries (Chevron, Shell, XTO, Anadarko, and Chesapeake), the public workforce system and training providers to

create a sustainable workforce development training program to link workers to industry needs. Created in 2010, the program was designed to enable the oil and gas industries to readily identify a local workforce with the skills they require and to provide valuable employment opportunities particularly for underserved individuals such as displaced veterans. The collaboration has led to the development of a uniform training, a certificate and associate degree program that focuses on developing/updating standardized curricula, mapping clear career pathways for students, and adopting best practices throughout the entire network.

The program began in 2010 with a $5 million grant to Westmoreland County Community College by the U.S. Department of Labor Employment and Training Administration. This grant served over 9,500 people, with 20 recognized training providers in four states, training over 3,000 people and facilitating the employment of more than 1,650 in the industry. In September 2012, ShaleNET received a second grant of $15 million to the Pennsylvania College of Technology, expanding the capacity of ShaleNET geographically and incorporating a new stackable credential model.

The stackable credential model is a system of progressive and transferrable educational experiences that builds from skills training to entry level certifications to certificate programs to associate degrees and culminates with a bachelor's degree. According to the terms of the federal grant, the certificate programs must provide credits that can be counted toward a two-year degree and ultimately to a four-year degree. Standardized curricula are used in each level of education. The system allows for multiple entry and exit points for students so that they can pursue their education at their own pace. It prepares workers for upstream, midstream and downstream jobs in the energy industry.

Although the training prepares individuals to work in the energy industry, the ShaleNET Strategic Plan has as its ultimate goal is to help individuals build skill sets that work across multiple industries in the energy/manufacturing sector, of which there are 1,000 companies in the ten-county region. To facilitate this training ShaleNET is encouraging industries to identify common skill sets that apply across various jobs, and then to teach those skill sets. ShaleNET designers have identified 14 occupations, with 150 different job titles, that need trained workers. They report that there are 24,000 jobs in these 14 occupations available in the region, and 57% of those jobs are IT-related. This training initiative will be critical to the important efforts of diversifying southwestern Pennsylvania's economy.

Improvements in STEM Education

Finding workers with the highly specialized skill sets required by resource extraction are not the only barriers to employing local residents, however. Employers engaged in extractive industries also cite general experience, mechanical aptitude, and technological know-how as barriers to employment.[158] A dearth of tech-savvy workers has prompted industry leaders to call for improvements in science, technology, engineering and mathematics (STEM) education. In Pennsylvania, the National Governor's Association and the Team Pennsylvania Foundation have partnered to establish a long-term initiative to improve STEM education programs at all levels of education and increase the number of students entering STEM-related careers.[159] Equipping students with more transferable skills learned in broader STEM-oriented programs may help to alleviate adverse effects of any future decline in employment in the case of a resource bust. Rather than re-training, these workers may be able to transition into other technology-oriented industries.

B. Housing Values

Housing concerns in southwestern Pennsylvania have centered most commonly on impacts of drilling and shale gas production activities on the value of housing – including changes in value based on community perceptions of possible risks and opportunities. Housing values are important not only to the individuals who own the homes, but also to the communities where they are located because housing values are a barometer of the economic health of the community and the sustainability of local governmental revenues. Current research suggests both positive and negative effects on home values depending on what factors are used to measure the effects.

A recent study by Lipscomb, Wang, and Kilpatrick examined the relevant literature and identified elements that might go into valuing residential properties in shale gas areas. These include ownership of the shale gas rights, local land use regulation, whether a mortgage can be obtained, and other factors.[160] The authors observed that there are several valid methods to determine impacts on property values. They noted that "stated preference" methods such as contingent valuation may be as useful as revealed preference methods such as examination of sales data, because of the complexity of the issues and their opacity in the marketplace. In rural areas, "the presence of gas wells on large rural tracts may restrict a property owner's ability to subdivide his/her property if drilling pads, containment ponds, access roads, and other building structures occupy certain portions of the property. Property values may suffer from decreased accessibility, difficulty of subdividing, and loss of acreage." Other factors that can be used to value property include habitability, ability to finance, refinance, or mortgage the property, and the risk perceptions of property owners, including perceptions of health risks (whether or not justified).

A study by Ohio State University economists examined housing sale prices, the number and location of shale gas wells drilled, and land cover data, to look for possible effects on housing values. The study used data on 3,646 sales of single-family homes in Washington County from 2008-2010. The analysis considered other characteristics of the properties to account for other value factors; these included dwelling size, lot size, garage, pool, distance to Pittsburgh, distance to highway, and relevant school district.[161] The researchers also noted whether the residential property was served by public water or private well water, and identified the relevant land cover within one mile of the home, in order to test several hypotheses.

The researchers found that for all home sales that had shale gas wells *within one mile* and permitted within *six months* prior to the sale, there was a decrease in home value (for each such well) of 1.45%. If the home also relied on well water, the study found a decrease in value of 3.8%. The researchers also tested alternative scenarios; they found that homes with shale gas wells within 0.75 miles and permitted within 3 months before the sale showed a decline in value of 12.2% for homes reliant on well water. However, the study found minimal effect on value where the drilling permit was issued up to a *year* before the home sale. These results suggest a meaningful downward effect of shale gas drilling on nearby housing prices, particularly in areas served by well water, but a rapid attenuation of the effect over one year. The study showed little effect associated with shale gas wells located more than one mile from the property.[162]

The same study found a larger negative effect of shale gas drilling than that associated with water supply for homes surrounded by agricultural lands. The 6-month permitting, <1-mile scenario showed a value decrease of 7.2%. (This decrease in value was 4% if the analysis included drilling permitted up to a year before sale). The researchers hypothesize that on these rural lands, the visibility of the shale gas development activity, together with the potential likelihood of additional shale gas activities might have accounted for the larger decline in value.

Resources for the Future (RFF) conducted a statistically sophisticated study in 2013 using home sales data for the period January 1995-April 2012.[163] The research economists analyzed data for 36 Pennsylvania counties, and 7 New York counties bordering Pennsylvania (where shale gas development is not yet occurring), and applied detailed statistical methods to account for differences in housing and time period. They applied differing zones of distance, and (importantly) determined whether homes are served by public water systems or by private wells. This study included data from over 1 million single-family home sales in varying proximity to shale gas wells.

The RFF study found that in general terms proximity to shale gas wells has a positive impact on prices (albeit with a statistically insignificant positive coefficient). However, the study found significant negative impacts on prices for homes that depend on a private water supply when the

homes are within 1.5 kilometers of shale gas wells. The authors found that these negative impacts are "large and significant (ranging from -10% to -22%)." The price impacts are greater the nearer the gas well is to the home. However, the negative impacts on these groundwater-dependent homes are no longer significant at a distance from the gas well of 2 km or greater. In contrast, homes located near shale gas wells but served by public water experience a positive impact on prices; however, these positive impacts diminish the nearer the gas well is to the home.[164] The RFF study also examined "vicinity" effects - local regional effects on housing prices on homes within 20 km of wells (but excluding those within 2 km). The study found a small positive vicinity effect on prices. However, wells that are permitted but not yet drilled have a negative impact on home prices. And wells drilled more than a year prior to the sale "no longer have any economic impacts," suggesting a rapid attenuation of effects on vicinity property values.[165]

Regional impacts may also be of interest, as drilling and gas development may affect home prices whether or not wells are located on or near the properties. A Washington & Jefferson College faculty member examined possible effects on home prices by analyzing data from housing transactions in six southwestern Pennsylvania counties with conventional and/or unconventional natural gas development (Allegheny, Beaver, Butler, Westmoreland, Washington, and Greene Counties) and six Pennsylvania counties without conventional or unconventional natural gas development (Cumberland, Dauphin, Perry, York, Lancaster, and Berks) between 2008 and 2012. The period between 2008 and 2012 was selected in order to capture significant expansions in natural gas extraction efforts in the Commonwealth. This macroeconomic comparison suggested that drilling may have a negative, albeit minor, impact on housing prices.[166] More specifically, the analysis revealed that for each additional conventional well that is drilled, home values decreased by 0.05%. The effect was slightly more pronounced for unconventional wells, with a decrease in home value of 0.34% for each additional unconventional well drilled. Depending on the type of well drilled, home values may have decreased by a few hundred dollars. In Washington County, for example, where the median home value in 2012 was $158,000, this may have resulted in a loss of $282.

It is important to note, however, that the effects of drilling on home values may be more or less pronounced based on a county's situation within the region. Factors related to location, such as unemployment rate, population, building permits and distance to a major metropolitan city, can override the impact of the gas wells. [167] Additional research may be necessary to identify more fully the effects of shale gas development on housing values in southwestern Pennsylvania.

C. Road Impacts and Repair

Roads are among the biggest concerns for local governments in southwestern Pennsylvania. Officials have identified the wear and tear from the heavy truck traffic associated

with the shale gas development as one of the most significant impacts presented by the industry. Assigning responsibility for repairs, particularly in areas where roads are used for multiple purposes and by thousands of vehicles both related to, and unrelated to, the shale gas industry is often problematic. Local governments are concerned with how best to address these problems.

Pennsylvania's municipal and county governments have experienced impacts both to their local roads and the state roads that serve their communities. The Shale Gas Roundtable's Final Report notes that an average unconventional gas well can require anywhere from 320 to 1,365 two-way truck trips (including multiple tanker truck loads of water) to come into production.[168] The Pennsylvania Department of Transportation currently uses a figure of 1,500 truck trips per unconventional gas well development site in its current estimates. This level of heavy truck traffic can put substantial strain on the portion of Pennsylvania's 40,000 miles of state highways and 78,000 miles of county and municipal roads that are located in the Marcellus Shale development areas.

Pennsylvania law provides mechanisms that are intended to allow the state and local governments to impose repair obligations on operators whose truck traffic is shown to damage roads. Specifically, state law specifies the conditions under which PennDOT and local governments can post weight limits on the roads for which they are responsible. When a road is posted, the municipality or county (local posting authority) or PennDOT can then require truck operators exceeding those limits to obtain permits, enter into maintenance agreements, and post bonds in order to use the road.[169]

State law allows the local government to require posting of bonds of $6,000/mile for unpaved roads and $12,500 per mile for paved roads. These rates were established more than 30 years ago, and are orders of magnitude below the typical costs to reconstruct paved roads. The posting authorities also require operators to enter into "Excess Maintenance Agreements" to ensure their responsibility to repair damage caused by the vehicles. The permits and excess maintenance agreements must be state route/county or local road-specific – they cannot be generic to a county or municipality.[170]

Posting may only occur after completion of an engineering and traffic study conducted in accordance with PennDOT standards. The roadway must, in addition, be inspected by the posting authority (with participation by the road user) prior to commencement of hauling under an Excess Maintenance Agreement to determine the baseline conditions of the roadway and the nature and extent of existing damage for which the permit holder will not be responsible. Thereafter, inspections are made (with notice to the user) to determine the nature and extent of damage and repairs for which the user will be responsible. If there are multiple permitted heavy users, costs are to be apportioned among them.

While state law does provide the posting process as a means for counties and municipalities to protect their roads from heavy truck damage, the requirements to conduct an engineering and traffic study before a road may be posted, to erect required signs, to negotiate excess maintenance agreements, and to pay the cost of initial inspections impose threshold expenses that preclude Pennsylvania's municipal governments from posting all of their roads that are used by the industry.

Information on the posted and bonded roads program is maintained by PennDOT.[171] By the end of 2010, PennDOT had posted more than 3,000 miles of roads in connection with unconventional shale gas usage statewide, and in southwestern Pennsylvania, Washington, Greene, Fayette, and Westmoreland counties had posted 288 miles.[172] PennDOT's 2012 annual report says that 4,700 miles of roads have been posted relating to natural gas development since 2008, and more than 2,600 miles of roadway are "currently bonded and permitted" by the gas industry.[173]

For those damaged roads that have not been posted, municipalities often enter into informal agreements with the operator who damaged the road to repair it. Although it is to the industry's credit that many operators voluntarily agree to repair damaged roads, it is preferable from the standpoint of public accountability, transparency and sustainability, for a municipality to be able to post the road and have a clear remedy.

In July 2013, PennDOT records indicated that natural gas companies had repaired at least 413 miles of roadways adversely affected by operations. The industry asserts that it has expended more than $500 million on road repairs and replacement projects statewide since the beginning of the Marcellus Shale boom, not limited to roads covered by the posting provisions.[174]

County and local governments may need financial assistance in identifying and surveying the condition of roads likely to be affected by shale gas development activities in order to be able to post all municipal roads used by the industry. Unfortunately there is no ready source of funds for the studies. Thus, local governments will need to plan ahead to ensure that they can take full advantage of the protections provided by state law. It would be helpful if there were some state fund that could be drawn on to assist municipalities with identifying and supporting the necessary work and ensuring that they can monitor performance. Engineers at Carnegie Mellon University are exploring ways of using inexpensive dash-mounted cameras using commercially available apps to support inspection efforts.[175]

Although there are no dedicated funds for local government roads, the construction, reconstruction, maintenance and repair of roadways is one of the allowable uses of Pennsylvania's unconventional gas impact fees distributed to municipal and county governments (discussed below). The solution may be to use the impact fees to pay for the posting process.

Moreover all counties are also eligible for the portion of the Act 13 impact fees that is deposited in the state's Highway Bridge Improvement Restricted Account based solely on a population formula. PennDOT releases these funds upon approval of a plan submitted by a county or municipality to repair or replace an at-risk, locally-owned deteriorated bridge.[176]

A recent Rand Corporation study on road damage from the shale gas industry suggests some other options. The Rand study estimates that each shale gas well in Pennsylvania contributes between $5,400 and $10,000 in *uncompensated* damage and wear-and-tear to the state's roads.[177] Recognizing that drillers can assume responsibility for roads under laws described above, the study assumed either no damage or full compensation for local (Class E) roads that might be bonded or covered for repairs by local agreements with gas drillers, and found that in addition there would be substantial road impacts for which no funds are immediately available.

The Rand study suggests that an appropriate policy response for Pennsylvania might be enactment of new state laws providing authority to collect additional fees or taxes to cover damages from shale gas development truck traffic; the promulgation of regulations or incentives to reduce the use of trucks and the distance of truck travel (e.g. recycling of water, use of pipelines); and use of stronger road construction materials and adoption of targeted maintenance policies to address heavier traffic demand.[178]

Another policy response is suggested by a recent Texas statute. In 2013, in response to impacts on Texas roads from intensive shale gas development in that state, the Texas legislature enacted a new law targeted toward mitigating the negative impacts of oil and gas exploration, development, and production on transportation infrastructure. Senate Bill 1747 was entitled "an Act relating to funding and donations for transportation projects, including projects of county energy transportation reinvestment zones."[179] The new law established a transportation infrastructure fund and a corresponding grant program for transportation infrastructure projects in counties affected by oil and gas production, and it authorized counties by order or resolution to designate county energy transportation reinvestment zones. After determining that an area is affected by oil and gas exploration and production, and that it would benefit from grant funding, a county may designate a county energy transportation reinvestment zone ("CETRZ). The zone must be a contiguous geographic area in which one or more transportation infrastructure projects are or will be located.[180] Notice of CETRZ designation is provided by holding a public hearing at least 30 days before the proposed designation. The order or resolution designating a CETRZ must describe its boundaries and establish an ad valorem (local) tax increment amount for the zone.[181] The county also has the option of raising money through a sales tax increment. Existing law previously permitted the governing body of a county to determine an amount of sales and use tax increment attributable to a transportation reinvestment zone, above the sales tax base, for particular uses in that zone.[182] The Act extended this authority to CETRZs.[183] The Act also established a grant program within the Texas Department of Transportation "to make grants to

counties for transportation infrastructure projects located in areas of the state affected by increased oil and gas production.[184] A county applying for grant funding must provide a road condition report including the primary cause of road, culvert, or bridge degradation if reasonably ascertained.[185] Counties applying for grant funding must provide matching funds, from any source, for at least 10% of the grant amount in counties that the department determines to be economically disadvantaged, and at least 20% of the grant amount in all other counties.[186]

Further analysis of these various policy options needs to occur to determine their applicability to Pennsylvania, and to identify an appropriate remedy for Pennsylvania's municipalities.

D. Growth of Personal Income of Community Residents

Unconventional shale gas development has brought economic growth to a number of Pennsylvania communities, but the benefits are not evenly spread. Natural gas owners who receive lease and royalty payments for their mineral rights have been the principal beneficiaries of the shale gas boom. Industry employees and local businesses have also benefitted, but typically to a much lesser degree. In addition, economic benefits have been concentrated in counties with more intensive levels of shale gas development.

This income growth raises two questions: first, whether it is evidence of long-term and sustainable economic development, and second, whether it has been accompanied by an increase in social conflict.

A November 2013 study by two Penn State economists used state tax data to assess the economic effects of the Marcellus boom on Pennsylvania counties.[187] The study used data from 2007-2010. During this time, rents and royalties reported by taxpayers in Marcellus shale development counties showed a substantial increase. Reported rents and royalties rose by an average of 460.8 percent in the counties with 90 or more wells, 274.7 percent in counties with 10-89 wells, and lesser amounts in counties with fewer or no wells.[188]

The researchers found that the rents and royalties reported in the most active Marcellus counties were "major increases" over the past, averaging $26,537 per tax return reporting such income in 2010.[189] Greene County taxpayers reporting rent and royalty income in this period reported an average of $36,810 per return in 2010, and $41,161 in 2011.[190] Rents and royalties also accounted for a significantly larger share of taxable income in counties with 90 or more wells. In 2004, they constituted only 1.3 percent of total income; by 2010, that number had risen to 8.0 percent.[191] The proportion of income from rents and royalties also rose as the number of Marcellus wells increased within each county.[192]

Even within Marcellus counties, however, economic benefits from shale gas development are unevenly distributed. One community perception study on four counties in the region found that these disparities have generated some tensions. The authors noted that wealth creation in these communities "occurs when local people receive lease payments and/or royalties from the production of natural gas from wells on their properties."[193] Notably, large property owners and businesses that were established prior to the development of the Marcellus Shale industry have been the main beneficiaries.[194] The study found that concerns have grown over the significant gap between those who reap such benefits and those who "bear the burden of development."[195]

V. ENVIRONMENTAL IMPACTS OF SHALE GAS DEVELOPMENT

Municipal leaders and the general public regularly express uncertainty and general concerns about the impact of shale gas development on the environment. They are particularly concerned about impacts of these industrial processes on water resources, but also express concern with air emissions. They support rigorous enforcement of Pennsylvania's environmental laws and want to better understand how the industry is regulated. This chapter presents first an overview of the use and fate of water throughout the life-cycle of a shale gas well, second a discussion of air emissions and their impact on air quality, and finally a description of Pennsylvania's state regulatory framework for shale gas development activities, which includes a discussion of how the regulations address water and air impacts as well as other environmental concerns.

A. Use of Water in Unconventional Gas Development

Water is one of the Commonwealth's and the region's major resources. Although it is relatively abundant in contrast with other areas of the country, water requires careful management throughout the entire Marcellus Shale development and operations process. Protecting water quantity and quality is the focus of most of the concerns expressed by homeowners, communities, and water providers when environmental issues are discussed in the context of shale gas development in Pennsylvania.

Water is a critical component of the hydraulic fracturing process and must be managed appropriately to protect the quantity and quality of the waters of the Commonwealth and their protected uses. Shale gas well operators face two main categories of decisions in water management: water utilization in hydraulic fracturing operations, and the disposal of wastewater generated through the process.[196]

Water for hydraulic fracturing comes from multiple sources in Pennsylvania. Its source in any area will depend on the well site's proximity to water resources, access to technology for recycling and reuse, and transportation costs. *Fracking fluid* is composed of roughly 98% water and 2% proppant and chemicals. On average across the Commonwealth, 15% of the total fracking fluid used will consist of recycled fluid, which is partially treated wastewater from previously fracked wells; 20% will consist of water purchased from public water utilities; and 63% of fracking fluid will consist of withdrawals from surface waters of the Commonwealth.[197]

Sources of water will vary in different parts of the Commonwealth depending on access to and availability of fresh water, and the amount of re-usable fluid from recent hydraulic fracturing operations in the vicinity of a new well. Rules for withdrawing water for use in hydraulic fracturing differ in each of the three major river basins of the Commonwealth (Ohio, Susquehanna, and Delaware) as described in the regulatory section. There is a current moratorium on such withdrawals in the area subject to the Delaware River Basin Commission.

While it has been suggested that abandoned coal mine water could provide a convenient water source for hydraulic fracturing, as this wastewater is plentiful in the Marcellus Shale region,[198] shale gas well operators have been discouraged from undertaking this use by concerns with incurring permanent liability for discharges of mine waters.[199]

Typically, water is transported to the well site using either tanker trucks or temporary freshwater pipelines.[200] According to data provided by ALL Consulting,[201] transporting water alone to the well site can require an estimated 500 heavy trucks,[202] whose gross vehicle weight is usually 26,000 pounds.[203] The steel mobile storage tanks used on tanker trucks typically hold about 500 barrels of water.[204] Well operators are increasingly relying on freshwater pipelines to reduce vehicle impacts caused by this heavy trucking.[205]

The volume of water needed for the hydraulic fracturing of a well can vary greatly and, as a result, estimates for the average amount of water used per well span from 3 million[206] to upwards of 8 million gallons of water per well.[207] The volume used will depend on the characteristics of the geological formation,[208] the depth of the vertical portion of the well,[209]the length of the well's lateral,[210] and the number of successive stages of hydraulic fracturing used to bring the well into production.[211] The lateral portion of an unconventional well can extend as far as 1,500 meters, resulting in a much longer bore length (and in turn greater water use) than that of a conventional well.[212] According to the Susquehanna River Basin Commission, an average of 4.4 million gallons of water per well is a representative estimate of water needed to hydraulically fracture a well.[213] Water is used throughout the life-cycle of an unconventional well, and the volumes and fluid additives used are specific to each stage of the process.

Water is first used during the drilling of the well. Water, with some drilling additives, is used to keep the drill head cool and lubricated. This process produces a waste called *drilling water*, which is often characterized by high Total Dissolved Solids (TDS) and Total Suspended Solids (TSS).[214] Drilling an unconventional well in the Marcellus Shale requires an average of 85,000 gallons of water.[215] Following the drilling, a steel casing is inserted into the wellbore,[216] and drillers then inject oil-well cement that expands to fill the space between the casing and the wellbore.[217] The casing is then perforated within the target lateral zones of the formation that contain gas[218] using a tubing-contained perforating gun carrying explosive charges.[219] Perforation is conducted starting from the far end, or *toe*, of the lateral wellbore. Each section of the lateral wellbore is then successively isolated, perforated, and fractured in stages. [220] This allows well operators to maintain sufficient pressure to fracture the entire lateral wellbore. In addition, operators can adapt their process to variations in the formation's geology along the well length through controlled fracture placement.[221]

When the well is ready for hydraulic fracturing to begin, water is combined with chemical additives and proppant on-site to create the fluids used in the process.[222] Additives are typically stored in their original containers on the trucks used for their transport to the site for less than a week.[223] At each step in the hydraulic fracturing process, water and the additives specific to each stage are piped to blenders (often truck-mounted blending units[224]) and then pump trucks which pump the blended fluid into the well.[225]

The first stage of the process is called the *spearhead stage*[226] or *acid treatment*.[227] In this stage, a hydrochloric acid (HCl) solution is pumped into the well in order to clean up the residue left from drilling and cementing the well casing.[228] Aside from water, HCl is the largest liquid component used in fracking fluid, with a typical concentration of 15%.[229] Other additives may be included at this stage to reduce rust formation and prevent metal oxide precipitation that could clog the well perforations.[230]

The next stage of the process is called the *pad stage*[231] or *slickwater pad*.[232] In this stage, a fluid composed primarily of water and friction-reducing agents[233] is pumped at high pressures into the well and reaches the perforations in the casing. As pressure builds, the shale formation surrounding the lateral wellbore fractures vertically up from the perforation points. Fluid enters the formation through these fractures, and then generates more fractures that radiate horizontally outward following natural zones of weakness in the shale.[234] As the fracture increases in size, more fluid must be pumped into the wellbore to increase pressure and maintain the open fractures.[235]

This stage is immediately followed by the *proppant stage*, in which non-compressible materials, such as sand, are pumped into the formation to hold open the fractures.[236] Resin-coated sand or ceramics may also serve as proppant.[237] At this stage, other additives may be introduced into the fluid to increase its viscosity and ability to transport proppant into fractures.[238]

While a typical shale well may require 8-12 stages of fracturing[239] over the course of two to five days,[240] the fluids used in these stages are collectively referred to as *fracking fluid*. Over 99% of fracking fluid is composed of water and sand.[241] The rest of the fracking fluid is composed of chemicals used to keep the well flowing freely and prevent the accumulation of corrosive materials inside the wellbore.[242] These chemicals typically include acids, friction reducers, surfactants, gelling agents, scaling inhibitors,[243] and biocides or disinfectants.[244] Friction reducing agents reduce tubular friction, which in turn reduces the pressure needed to move fluid through the wellbore.[245] Surfactants reduce interfacial tension to promote water recovery by preventing the combination of water with other substances in the formation.[246] Gelling agents are used to thicken the fracking fluid which makes it more effective at transporting proppant into fractures.[247] Finally, scaling inhibitors control the precipitation of carbonate and sulfate materials.[248] A representative fracking fluid profile for one well would include: 3.81 million

gallons of water, 4.57 million pounds of sand, 1,333 gallons of hydrochloric acid, 1,695 gallons of a friction reducer, 2,211 gallons of an antimicrobial agent, and 386 gallons of a scale inhibitor.[249]

The contents of fracking fluid used at wells developed in Pennsylvania are available through FracFocus.org, a website used as a hydraulic fracturing chemical registry[250] by twelve states including Pennsylvania.[251] Well operators must report the chemicals used in their fracking fluid to the Department of Environmental Protection and FracFocus.org under Act 13.[252] However, Act 13 does not require companies to disclose all information about certain chemicals. A company can claim that some information is considered a "trade secret,"[253] unless the operator is faced with a medical or environmental emergency in which case he or she must disclose the exact quantities of all hydraulic fracturing chemicals used.[254] Lists of chemicals used per well are provided on FracFocus.org as individual PDFs[255] but the site is in the process of updating its database platform and search tools.[256]

The final stage is called the *flush stage* in which freshwater is pumped into the well to flush out excess proppant from the wellbore.[257] Finally, when the hydraulic fracturing process is completed, the well operator will release the pressure on the wellbore to begin the *flowback process* in which fluids and excess proppant in the well flow back up to the surface,[258] and are immediately piped into wastewater storage containers.[259] Impoundments are currently still used on some sites for freshwater and wastewater. Contamination concerns arise from this practice due to risks of leakage, evaporation of volatile organic compounds (VOCs), and the disposal of the ponds' nitrile liners, which often contain fluid residues.[260]

Recovery and Disposal of Injected Fluids and Wastewater

Between January and June of 2013, unconventional shale wells in Pennsylvania produced a total of 14,224,718 barrels of wastewater[261]-- all waste fluid recovered through the borehole.[262] Most wastewater is produced early in the life of a well, although estimates vary on what percentage of fluid is recovered and when. These variations in fluid recovery estimates and *decline curves* or measurements of wastewater production decline over the life of a well are driven in part again by natural variations between wells in different locations and the geology of the shale formation.[263]

Different and sometimes ambiguous terminology has been used to describe different wastewater types associated with oil and gas production. Two general types of wastewater are typically described as a byproduct of hydraulic fracturing operations*: fracking fluid waste* and *produced fluid*.

Fracking fluid waste is defined in the Pennsylvania Department of Environmental Protection Oil and Gas Production Waste Reporting Guide as:

> oil and gas fracturing/stimulation fluid waste and/or flowback. Flowback is defined as the return flow of water, fracturing/stimulation fluids, and/or formation fluids recovered from the well bore of an oil or gas well within 30 days following the release of pressure induced as part of the hydraulic fracture stimulation of a target geologic formation, or until the well is placed into production, whichever occurs first.[264]

Produced fluid in turn is defined as, "water, fracturing/stimulation, and/or formation fluids, including brine, recovered at the wellhead *after the flowback period*."[265] In the context of the Marcellus Shale, there is no meaningful distinction between the composition of produced fluid and fracking fluid waste. This is because the Marcellus Shale is a dry formation, with nearly no resident formation waters. Therefore, the flowback fluid component, which distinguishes fracking fluid waste from produced fluid, typically consists almost entirely of the fluid injected into the well during the hydraulic fracturing process. Produced fluid which surfaces after the flowback process while the well is in production is thought to also consist of the injected fluid--that continues to return to the surface over time.[266] While the greatest volumes on a per-day basis will surface within the first 30 days of fracking,[267] it is likely that a well will produce some volume of wastewater throughout its life, which can be greater than 30 years.[268] A well's life-cycle can also include re-fracturing of wells to increase their production rates,[269] again generating wastewater. Up to 10-30% of fluids injected into unconventional wells may return in the first 1-2 weeks of a well's life before production begins.[270] It is estimated that for unconventional wells in northern Pennsylvania, around 9-35% of injected fluid return as flowback water generally within 2-8 weeks of the beginning of the flowback process.[271]

While most of the chemicals identified in fracking fluid will also be included in wastewater, some will be consumed in the well (such as strong acids) or undergo reactions during fracking and create different products.[272] Naturally present brine fluid from the formation may also resurface as part of wastewater, which may contain high concentrations of sodium, chloride, bromide, and other inorganic constituents including arsenic, barium, other heavy metals, and associated radionuclides.[273] Some chemicals and contaminants will be released from the formation itself. Strontium, soluble organics,[274] and naturally occurring radioactive material or NORM, including radioactive radium-226 and radium-228 are other pollutants of concern.[275]

Additional categories of wastewater produced during hydraulic fracturing are drilling fluid waste, defined as, "oil and gas drilling mud and other drilling fluids (other than fracking fluid and spent lubricant)," servicing fluid, and spent lubricant.[276] 782, 271.62 Barrels of drilling fluid waste were recovered between January and June of 2013.[277] Servicing fluid, used for well maintenance, and spent lubricant are produced in quantities that are orders of magnitude smaller than produced fluids and fracking fluids.[278] All fluid wastes are collected into the same kinds of wastewater containers and are recovered nearly simultaneously, largely during the flowback process.[279]

Wastewater management costs can account for anywhere between 16 and 69% of an operator's budget.[280] Wastewater management in hydraulic fracturing is challenging in part because hydraulic fracturing has expanded faster than available wastewater treatment infrastructure. Furthermore, high volumes of wastewater are produced with chemistries that vary greatly over time and by location, precluding most traditional discharge or disposal options.[281] The primary options for wastewater disposal are recycling for reuse and deep injection wells.

In April of 2011, Pennsylvania's Department of Environmental Protection asked unconventional gas well operators to voluntarily stop sending wastewater to wastewater treatment plants that were not covered under the new regulations at 25 Pa. Code Chapter 95.[282] The regulations at Chapter 95 established new treatment requirements for new and expanding loading of total dissolved solids (TDS), and prohibit discharges of natural gas wastewater with a TDS concentration greater than 500 milligrams per liter.[283] The DEP's request applied to flowback and produced water from unconventional wells,[284] and was made in response to elevated levels of TDS and metals in the region's water bodies following the discharge of treated wastewater,[285] including significant levels of sodium, chloride,[286] and radium.[287] Publicly owned treatment works (POTWs) are not equipped to remove these dissolved solids from wastewater, and could discharge insufficiently treated wastewater into waterways.[288] Unconventional well wastewater is not well suited for disposal via traditional sewage treatment plants, as this wastewater can impair the biological processes employed in treatment[289] due to its high concentrations of salt, organics, and heavy metals.[290] Now that hydraulic fracturing wastewater is no longer disposed of via POTWs and discharged, well operators have primarily turned to recycling and deep well injection.

From January to June of 2013, 73.8% of wastewater was disposed of through direct reuse onsite (other than road spreading), a total of 10,871,178 Barrels,[291] and 16.2% was sent to centralized treatment plants for recycling, a total of 2,715,503 Barrels.[292] Recycling of wastewater on-site reduces the need to transport wastewater, which is one of the costliest elements of water management.[293] As a result, recycling also reduces vehicle impacts and minimizes spill risks due to transport.[294] The quality of wastewater in the Marcellus is attractive for reuse in hydraulic fracturing, and a sample treatment process can include collecting wastewater for storage in holding tanks; pumping the wastewater through a 100-micron filter followed by a 20-micron filter to remove suspended solids; and then pumping the filtered fluid into a tank for transport to the next well. Filters and the removed solids must then be disposed of in approved landfills. Finally, freshwater will need to be added to dilute the remaining compounds (primarily salts) for the fluid to be ready for reuse.[295] There are 38 zero-discharge centralized treatment plants operating in Pennsylvania which accept fluids transported on trucks, and provide partially treated water to be transported for reuse to the following well. These facilities remove suspended solids and barium, but do not treat dissolved solids such as salts.[296]

Deep well injection is the other primary disposal method employed in Pennsylvania. From January to June 2013, 9.7% of wastewater was disposed of through an injection disposal well.[297] In this method of disposal, fluids are forced into porous rock formations for permanent storage.[298] Generally deep saline aquifers that are much farther underground than drinking-water aquifers, and sometimes even below gas and oil-producing horizons, are best for deep well injections.[299] However, few of these formations exist in Pennsylvania,[300] and as a result only seven active deep injection wells are permitted (by the U.S. Environmental Protection Agency) in Pennsylvania.[301] The state's shale gas well operators are dependent on available deep injection wells in Ohio. For example, in the second half of 2012, when roughly 15% of unconventional wastewater disposal was through underground injection, 77.4 million gallons were disposed of in Ohio injection wells, 2.1 million gallons were disposed of in West Virginia wells, and only 1.5 million gallons were disposed of in Pennsylvania injection wells.[302]

Growth is expected in the water management industry, as the business of selling, storing, disposing of, or recycling water for unconventional oil and gas operators could be worth up to $34 billion according to HIS Inc.[303] Many emerging alternative wastewater treatment technologies are being pursued by private treatment companies. One example is the use of crystallizers in methanol recovery systems. These companies could sell methanol back to gas producers for use as a dehydrator and antifreeze. Sodium chloride is another component of wastewater that could be extracted and sold as an industrial salt or used in animal feed. Calcium, magnesium, strontium, barium, lithium, and radium are all candidates for profitable products of extraction processes.[304] Thermal distillation to recapture distilled water could be another useful technology, particularly in arid areas, although it is a very energy intensive process. The use of membrane systems in reverse osmosis, while prone to scaling and requiring technical experience, is less energy intensive than thermal distillation. Finally, chemical precipitation and electro-coagulation could be used at lesser expense than the previous options, but again would require experienced operators.[305]

As a crucial production factor in hydraulic fracturing, water is a priority for well operators. Proper water management has serious implications for both a company's operating costs and their potential environmental impact. Continued improvement in practices for water sourcing, use in the hydraulic fracturing process, and proper disposal or reuse will be significant for the future of hydraulic fracturing in Pennsylvania.

B. Air Quality Effects and Concerns

Air emissions sources from shale gas development are typically characterized as diffuse and relatively small, but they can nonetheless have a significant impact on air pollution across a region.[306] Concerns about air pollution associated with shale gas development range from

potential health risks posed by localized pollutants to the broader ramifications of methane leakage for climate change. There are many challenges to understanding the magnitude and nature of air pollution emissions, which vary depending on the source of the emission and the pollutants themselves.

Sources of Air Pollution from Shale Gas Development

As with most wastes associated with shale gas development, different air emissions are produced from various sources in each phase of operation. For example, the diesel engines of drilling rigs pose different risks than the venting and flaring activities associated with well completion processes.[307] In addition, air emissions occur as part of regular operations during shale gas development, not solely as the result of an accident or malfunction.[308]

Air pollution may be emitted from numerous stages of natural gas operations. Compressor stations are used to compress natural gas for transport through pipelines, and both may emit nitrogen oxides (NO_x) and volatile organic compounds (VOCs).[309] The storage of wastewater in impoundments could lead to evaporation and the release of VOCs.[310] Storage tanks containing liquids released from wells may also release methane and VOCs through leaks.[311] In some instances, gas is also sometimes flared, burned off or vented, before a company is prepared to collect gas into a pipeline, leading to the potential release of methane and benzene.[312] Diesel exhaust from trucks, along with the machinery used on a well site, is another significant source of air emissions.[313] In addition, sulfur dioxide SO_2 may be produced through the combustion of fossil fuels containing sulfur, for example from the use of gasoline or diesel-powered equipment.[314] Leaks in connections and valves in pipelines and other equipment, such as pneumatic instrument systems, may release small amounts of natural gas as part of normal operations.[315] Dehydrators, which are used to remove water vapor from natural gas well streams, are another source of emissions. Well completion and workovers, or major repairs and modification procedures, are may also produce air emissions.[316] Particulate matter (PM) is generated as soil and dust may enter the air from a well pad during construction activities, during strong truck traffic,[317] and also as a result of improper handling of proppant materials including silica and sand.[318]

Potential Air Pollutants

These sources may release multiple pollutants. Some may have negative health impacts in certain exposure contexts. NO_x emissions formed from the combustion of fossil fuels, for example during the operation of compressor stations or flaring,[319] may have negative respiratory impacts, similar to what may be experienced due to exposure to increased NO_x concentrations near roadways.[320] VOCs, emitted from dehydrators and other sources, have also been found to cause negative health impacts in some contexts. However, these impacts vary greatly across

chemicals.[321] These include benzene, toluene, ethylbenzene, and xylene which are also emitted by shale gas development, although usually at low levels as they are not generally found in significant quantities in natural gas.[322] These gases may cause negative impacts, especially following long-term exposure, ranging from respiratory irritation to more serious conditions.[323]

Collectively, the individual sources of air emissions on a well site may have a significant air pollution footprint. In 2012 alone, the natural gas development industry in Pennsylvania released 16,361 tons of nitrogen oxides, 101 tons of sulfur dioxide, 7,350 tons of carbon monoxide, 548 tons of particulate matter (PM), 600 tons of PM10 (particulate matter that is 10 micrometers in diameter); and 4,024 tons of volatile organic compounds.[324]

Much more research is left to be done to provide a better understanding of the impact of shale gas development on air quality. Researchers from the Scott Institute for Energy Innovation at Carnegie Mellon University identified three overarching questions of importance for policymakers:

> What is the positive and negative marginal impact of shale gas development on regional and local air pollution? What is the spatial distribution of these benefits and costs?
>
> From a regulatory perspective, should each site be viewed as an individual source of air pollution emissions or a very large chemical plant or refinery distributed over a large area such as an air basin or valley?
>
> Are toxic air emissions such as diesel particulate matter and formaldehyde likely to create local problems?[325]

Greenhouse Gas Emissions

One of the most controversial aspects of air emissions associated with shale gas development is the release of greenhouse gases. This is in part due to the great uncertainty regarding the extent of methane emissions produced from shale gas operations. Natural gas is composed of methane (CH_4), which is a more potent greenhouse gas than carbon dioxide.[326] The controversy reflects differences in the methodologies used, sources assessed, and regions examined across methane leakage studies. There are two broad approaches to studying methane emissions, referred to as bottom-up and top-down measurements.

Bottom-up measurements refer to the direct measurement of emissions from specific sources at the emission point on shale gas production sites. On the other hand, top-down measurements include larger-scale studies, often conducted with planes flown through methane plumes or using

satellite imagery.[327] Each technique has its own strengths and weaknesses, and they are best employed together as complements to provide a more complete understanding of emissions.

While bottom-up studies do provide essential data about the emissions of specific sources, they may also miss some potential emissions sources on well-pads and affiliated infrastructure. These omitted sources could include a small percentage of sources emitting the most methane, resulting in underrepresentation of emissions. On the other hand, top-down studies are useful for measuring total methane emissions over large areas, as they capture more sources than bottom-up studies. However, this approach makes it difficult to attribute methane leaks to individual sources.[328]

One particularly notable effort to address questions of methane leakage was begun by the Environmental Defense Fund (EDF) in 2012. EDF is partnering with 100 university, research institutes, and companies, including companies involved in shale gas development. The initiative will produce 16 studies employing different methodologies and assessing emissions in many different regions.[329] Two recently published studies from this initiative, one from the University of Texas-Austin and one from the collaboration between NOAA and CU-Boulder, have sparked controversy about measuring methane leakage. No study has yet provided a conclusive determination of methane leakage from shale gas development, but our understanding of the industry's impact continues to improve with additional research.

The University of Texas study provided data from direct measurements on unconventional shale gas wells from nine participating natural gas companies. The study found that methane leakage was roughly in line with EPA estimates, although some differences were identified between phases of production. For example, emissions from well completions were lower than EPA estimates while emissions from pneumatics were higher.[330] In contrast, the study produced through collaboration between NOAA and the Cooperative Institute for Research in Environmental Sciences (CIRES) at UC-Boulder was conducted through 12 study flights in the Denver Julesburg Basin. This study produced methane leakage measurements that were much higher than EPA's estimates.[331]

An important reference in evaluating the methane impact of shale gas development is the US Greenhouse Gas Inventory. The Inventory is an EPA report that tracks total US emissions using national energy data, national data on agricultural activities, and other national statistics to provide a comprehensive account of total national anthropogenic greenhouse gas emissions.[332] A literature review published in Science found that top-down national-scale studies generally indicate that national emissions are about 50% higher than reported by the Inventory. Scientists are currently trying to identify what could account for the excess methane emissions, and what portion of these emissions could be attributed to shale gas development.[333] Furthermore, the

group found that there is high variability in the empirical results of emissions studies conducted at smaller-scales.

Results suggest that the high variability among bottom-up studies may be related to what are called "super-emitters" or individual sources on well sites that contribute a large portion of the total leakage. This may imply that only a small fraction of devices have very large leaks, and most do not leak at all, which could in turn allow for significant reductions in emissions through limited equipment repairs. Furthermore, significant spatial variations in technology used and operational practices in different fields mean that the analysis conducted in one area is likely not broadly applicable across shale plays.[334]

Overall, there is a need for greater data from a variety of emissions sources to better characterize the methane emissions of shale gas development, and understand how to account for excess methane emissions. Remaining questions again identified by researchers from the Scott Institute for Energy Innovation regarding the climate change impact of shale gas development include:

- What are the eventual production volumes (ultimate recoveries) of Marcellus Shale wells?
- What will the impact be of the most common industry practices related to flaring and venting at Marcellus wells (e.g., "green completions" which capture methane and VOC compounds during well completions instead of venting and flaring)?
- What are the greenhouse gas emissions from shale plays other than Marcellus? Regional environmental variability and reservoir heterogeneity must be evaluated.
- What is the overall methane leakage rate from the entire shale gas system?[335]

C. Environmental Laws Governing Natural Gas Development in Pennsylvania

Agencies Responsible

The Pennsylvania Department of Environmental Protection (DEP) has the primary responsibility for regulating oil and gas operations, including administration of Act 13 of 2012, which governs shale gas development.[336] In addition to Act 13, the DEP's authority also derives from other statutes, including the Pennsylvania Clean Streams Law,[337] the Solid Waste Management Act,[338] and the Air Pollution Control Act.[339] Within the DEP, the Office of Oil and Gas Management develops and implements regulations through the Bureau of Oil and Gas Planning and Program

Management and the Bureau of District Operations.[340] Other DEP bureaus with regulatory responsibility affecting oil and gas include the Bureaus of Waste Management,[341] Water Quality,[342] Radiation Protection,[343] and Air Quality.[344] The DEP manages the environmental impacts of oil and gas operations through a bonding, [345] well permit, [346] and enforcement process defined by Act 13 and other laws. The DEP also requires a well operator to have an erosion and sedimentation control permit for surface disturbances over five acres[347] and a centralized impoundment permit for wastewater storage.[348] Well operators must also have Preparedness, Prevention, and Contingency Plans and Emergency Response Plans for incidents such as spills that can have an impact on the environment.[349] Comprehensive information on permits is publicly available through the DEP's eFACTS database.[350]

Other agencies are involved in regulation and information related to the shale gas industry. The Department of Conservation and Natural Resources (DCNR) conducts geologic and topographic surveys relevant to the industry.[351] The DCNR, the Fish and Boat Commission, and the Pennsylvania Game Commission administer the Commonwealth's threatened and endangered species programs.[352] The Pennsylvania Public Utility Commission has an advisory role in municipal land use decisions involving shale gas development,[353] although the consequences of that advisory authority are uncertain after a recent Pennsylvania Supreme Court decision that upheld some and overturned other aspects of Act 13.[354]

The Susquehanna River Basin Commission (SRBC)[355] and the Delaware River Basin Commission (DRBC)[356] -- regional interstate agencies with both federal and state members -- regulate water withdrawals and allocations in the central and eastern parts of the Commonwealth. The SRBC and DRBC issue water allocation permits in the Susquehanna River Basin and the Delaware River Basin, respectively. Hydraulic fracturing is not currently authorized in the Delaware River Basin, and the DRBC has not adopted regulations for water withdrawal and use for that purpose. In the Ohio River Basin, where most of Pennsylvania's southwest region sits, the DEP requires water management plans.[357]

Federal agencies with regulatory responsibilities include the Environmental Protection Agency (EPA), the U.S. Fish and Wildlife Service (FWS), and the Army Corps of Engineers. The EPA regulates underground injection for disposal of chemicals and fluids used in the hydraulic fracturing process of shale gas development under the Safe Drinking Water Act, but not hydraulic fracturing itself.[358] And the EPA administers the federal Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act, in conjunction with DEP. The FWS administers the federal Endangered Species Act. The Army Corps of Engineers issues permits for dredge and fill activities in the navigable waters of the United States, including wetlands, pursuant to the Clean Water Act.

Water Quality Protection

Each stage of shale gas development presents opportunities for causing or preventing contamination of surface- and ground-water. Prior to drilling, land clearing and infrastructure development can increase stormwater runoff. During drilling and well stimulation, leaks or spills of stored fracturing fluid or a failure to contain flowback and produced water in onsite pits and ponds, or leaks related to faulty well casing can pose threats to the waters of the Commonwealth. The vertical well casing must ensure that gas and fluids rising from the fracture zone do not escape into intermediate rock strata, into underground aquifers used for water supplies, or into the atmosphere. In addition, leaks and spills can occur at any point throughout the process, and are therefore the target of state regulatory requirements. Pennsylvania's Clean Streams Law protects the waters of the Commonwealth, and is supplemented by specific requirements imposed by Act 13 and the regulations implementing both statutes.

Pennsylvania's Act 13 creates a presumption of liability for contamination of a private water supply (a water well or developed springs) located within 2500 feet of the shale gas well if the contamination occurs within a year after well-related activities such as drilling, stimulation, alteration, or completion.[359] The well operator can rebut the presumption by affirmatively proving that the pollution existed prior to drilling; that there is another cause for the pollution; or that the landowner refused to allow predrilling access to water supplies to test water quality.[360] The presumption of liability serves to encourage shale gas operators to test all water supplies, both public and private, within the 2500-foot zone prior to drilling.

In addition, Act 13 has setback and siting requirements—all shale gas wells must be 500 feet from a building or private water supply, 1000 feet from a public water supply intake, and may not be in floodplains, among other restrictions, such as 300 feet from a surface stream or water body.[361] However, some of those setbacks are in doubt given the Pennsylvania Supreme Court's December 2013 decision in *Robinson Township*[362], which struck down a provision in Act 13 that allowed operators to demonstrate that DEP could waive a setback requirement upon a showing of "additional [water protection] measures," and which found the setback provisions to be intertwined with the unlawful provisions.

With the DEP well permit application, operators of shale gas wells must include a map of all of the water supplies within 3000 feet, and the map must be sent to any municipality and all landowners within that range.[363] For activities causing more than five acres of surface disturbance, the required erosion and sedimentation control permit[364] must provide for the implementation and maintenance of best management practices, must maximize the protection of existing vegetation and drainage features, and must implement other measures to minimize stormwater runoff, among other things.[365]

In addition, a bond is required to ensure compliance with all aspects of the well permit and the applicable regulatory statutes.[366] Under Act 13, "upon filing an application for a well permit and before continuing to operate an oil or gas well, the owner or operator of the well [must] file with the department a bond covering the well and well site." Such bond must, "be payable to the Commonwealth and [be] conditioned upon the operator's faithful performance of all drilling, water supply replacement, restoration and plugging requirements of this [Act]."[367] The amount of the bond is dependent in part upon the length of the well bore including horizontal lengths and while Section 3225(a)(1) establishes bond amounts for individual wells it also establishes a cap on the amount of the bond that may be required for a series of wells. In general, wells with a total well bore of less than 6,000 feet must provide a bond of $4000 per well and those over 6,000 feet a bond of $10,000 per well. But the amounts are capped based on the total number of wells being operated. The cap amount is significantly lower than the total bond amount that would be calculated if each of the wells were to be bonded individually. For example, the individual bond amount for wells with a well bore of less than 6,000 feet is $4,000 per well for up to 50 wells, "but no bond may be required under this clause in excess of $35,000".[368] In that instance, the approximate bond amount for an operator of 50 wells would be roughly $700 per well. An operator may choose to post a statewide "blanket bond" for all of its wells.

"Liability under the bond [must] continue until the well has been properly plugged … and for a period of one year after filing of the Certificate of Plugging with the department." In lieu of a corporate surety, the operator may deposit with the department, "certificates of deposit or automatically renewable irrevocable letters of credit;[369] negotiable bonds of the United States Government or the Commonwealth;"[370] and "United States Treasury Bonds..."[371]

Oil and natural gas development necessarily involves impacts to the surface and subsurface environment.[372] Site restoration generally occurs in two stages. Shortly after the drilling of the well, the size of the well pad is reduced and the impoundment is removed.[373] However, site access roads and various well site equipment must remain until the well is abandoned (no longer economically productive), in order to provide site access for maintenance and removal of produced water (brine that comes up with the gas). Subsequently, at the conclusion of production, the well must be plugged and the site reclaimed.[374] DEP has not estimated formally the costs of plugging a deep shale gas well. However DEP has estimated the costs of plugging and restoring the site of an orphaned conventional gas or oil well at an average of $60,000; such costs also have exceeded $100,000.[375] Other researchers examining well site reclamation costs, estimated that, "the average reclamation cost for a well in the Marcellus Shale will be in the vicinity of $100,000."[376]

In September of 2013, the State Review of Oil and Natural Gas Environmental Regulations, Inc. ("STRONGER") organization issued its report concerning Pennsylvania's Oil and Gas Regulatory Program. STRONGER is a nonprofit organization whose Board is comprised of

stakeholders representing states, industry and public interest groups; it conducts reviews requested by states who volunteer for such reviews. The process involves appointment of a review team, the issuance of a questionnaire to the state, the preparation of responses by the state to the questionnaire, and the compilation of the responses into a report that compares the state program with a set of model guidelines developed by the STRONGER organization through a collaborative process among its stakeholders. With respect to Act 13's financial assurance requirements, the STRONGER report found "that the financial assurance requirements for [exploration and production] environmental and regulatory facilities meet the guidelines."[377] The authors of the Site Reclamation Report referenced above would not agree, finding that Pennsylvania bond amounts do not appear sufficient to cover reclamation costs, and that this disparity may incentivize operators to adopt conduct that would save money while avoiding liability.[378] However, the DEP's ability to deny permits to a permittee (or the parent or subsidiary of a permittee) in violation, as well as the obligation on the part of permittees if they are publicly traded companies to disclose such information to shareholders, provide disincentives to such conduct. Act 13 does authorize the Environmental Quality Board to adjust the statutory bond amounts "every two years" to reflect projected costs to the Commonwealth of plugging wells, but this process would require substantial data to initiate.

During the hydraulic fracturing process, operators must disclose chemicals used, including their concentration, for publication on the FracFocus website[379] unless the operator claims that the identity or concentration of the chemical is a trade secret or confidential proprietary information.[380] Certain technical requirements are designed to protect water quality as well: permanent cement casing is required for all wells through freshwater-bearing strata to a depth of 50 feet[381] and operators must use impervious materials at well sites to prevent spills.[382] More generally, operators must control and dispose of brines in accordance with the Clean Streams Law and federal Clean Water Act[383] and well sites must be designed to prevent all chemicals from impacting a water supply.[384]

After drilling, operators must restore the well site in accordance with Act 13 and the Clean Streams Law and the plan in the erosion and sediment control permit.[385] Operators must inspect wells at least quarterly.[386] Abandoned wells must be plugged to prevent vertical flow of fluids.[387] However, operators can be granted inactive status for five years if the condition of the well is sufficient to prevent contamination.[388] After restoration, plugging, water supply replacement, and faithful compliance with the well permit, the bond will be released back to the operator.[389]

Comparisons with Other States

Although it is difficult to fairly compare individual provisions of the regulatory programs of other states that have shale gas development with those of Pennsylvania's regulatory program, comparisons can offer some insight to alternate ways of controlling impacts. For example, in

Illinois, before drilling an independent third party must conduct baseline sampling of all water sources within 1500 feet of a well site.[390] More testing is required at prescribed intervals: six months, 18 months, and 30 months after operations have been completed.[391] Private property owners can refuse to allow sampling—if the property owner does not provide written proof of the refusal, the operator must provide documents indicating its good faith attempt to sample.[392] Ohio has a similar provision extending 1500 feet from wells,[393] requiring compliance with the state's best management practices manual.[394] Colorado's provision extends to 2640 feet, or a half-mile.[395] A maximum of four available water sources must be tested within that radius, and "[w]ell maintained domestic water wells are preferred over other Available Water Sources."[396]

A number of states have setback restrictions. West Virginia enacted the Horizontal Well Act, which says that wells may not be within 250 feet of "any existing water well or developed spring used for human or domestic animal consumption," within 100 feet from a perennial stream, and within 300 feet of a trout stream.[397] However, a variance from siting restrictions may be granted upon a showing of sufficient measures.[398] Illinois requires 500-foot setbacks from water wells, 300-foot setbacks for streams, and 1500-foot setbacks for public water supply intakes.[399] In Colorado, hydraulic fracturing wells must be more than 500 feet from any building, absent a waiver from a private landowner.[400]

Ohio's insurance and bonding rule requires all well operators to maintain liability insurance of at least $5 million.[401] West Virginia requires a $50,000 bond per well, or a $250,000 blanket bond for multiple horizontal wells.[402] Illinois has the same per-well bond requirement as West Virginia, but the blanket bond is $500,000.[403] Like Ohio, Illinois has a $5 million liability insurance requirement.[404]

During well development, Colorado requires cement casing to a depth of 50 feet (similar to the Pennsylvania requirement), but also requires operators to meet a standard that cementing will occur "in a manner sufficient to protect all fresh water."[405] In Wyoming, casing must be to "a depth below all known or reasonably estimated utilizable groundwater," or a minimum of 100 to 120 feet.[406]

Illinois' chemical disclosure rule states that well operators must submit master lists of base fluids, additives, and chemicals to be used in operations, and are prohibited from using any chemicals not included on their master lists.[407] The master lists are published in complete form unless an operator claims a trade secret, in which case the list is redacted.[408] Ohio requires disclosure during all aspects of drilling, and proprietary formulas can be obtained to conduct an investigation or in response to a spill.[409] Ohio also allows property owners and other persons whose interests are adversely affected to bring a civil suit contesting trade secret protection.[410]

In contrast to Pennsylvania's authority to grant a five-year inactive status, Colorado limits the grant of inactivity to six months, after which plugging is required.[411] In Ohio, inactive status can last for two years.[412] Ohio also requires ongoing pressure testing of wells during the period of inactivity.[413]

Regulations in Illinois, Colorado and Ohio are in some respects more protective than those in Pennsylvania. All three states require pre- and post-drilling water resources testing for a comprehensive set of chemicals, with analysis occurring in third-party laboratories. Ohio adds ongoing testing of well integrity, and Colorado allows less time to pass before abandoned wells must be plugged.

Water Quantity Safeguards

Some regions of Pennsylvania with active shale gas operations are moderately water stressed with the potential for increased water shortage over time.[414] Some municipal water supplies are potentially disadvantaged by industrial withdrawals, which can range from three to seven million gallons per hydraulic fracturing well.[415]

Pennsylvania requires all shale gas well operators to have a water management plan that demonstrates that the withdrawals will not affect the quantity or quality of the water source or the watershed as a whole.[416] These requirements are presumed to be satisfied if the withdrawal is approved by the SRBC or the DRBC.[417]

There is a moratorium on hydraulic fracturing in the DRBC region until the Commission finalizes (long-delayed) regulations.[418] DRBC's revised draft regulations for hydraulic fracturing require that no withdrawals have significant adverse effects on other users, wetlands, or aquatic wildlife, among other requirements.[419] The SRBC regulates any hydraulic fracturing withdrawal, regardless of quantity.[420] Withdrawals can be limited to the reasonably foreseeable need of the operator and cannot cause significant adverse impacts to water resources, considering factors including the needs of other users, water quality, and habitat.[421]

Illinois has stringent requirements for water management plans. Similar to Pennsylvania, Illinois plans must show the anticipated source and location for water withdrawals, along with the anticipated rate and volume of each water withdrawal.[422] However, Illinois adds several other requirements. Plans must specify the months in which each withdrawal location is expected to be used, the methods to be used to minimize water withdrawals, and the methods to be used for withdrawing surface water so as to minimize adverse impacts on aquatic life.[423]

Treatment and Disposal of Wastewater and Underground Injection

After water is injected to hydraulically fracture a well, 10 to 50% returns to the surface during the flowback stage. Produced wastewater must be handled and disposed safely because—in addition to chemicals and proppants added prior to drilling—it may contain concentrations of sodium, chloride, bromide, arsenic, barium, and radionuclides.[424] To protect surface- and ground-water supplies, produced wastewater can be stored in pits or tanks, transported off-site for treatment, or recycled. In addition, underground injection can be used to store gas and waste substances, though the practice is often not practical in Pennsylvania due to the local geology.

In Pennsylvania, operators do not need a separate waste disposal or storage permit under the Solid Waste Management Act if the well is permitted under Act 13 and the operator posts a bond and otherwise practices environmental compliance.[425] Containment systems must be used for drilling mud, hydraulic oil, diesel fuel, drilling mud additives, hydraulic fracturing additives, and hydraulic fracturing flowback.[426] Well permit applicants must describe the containment practices that will be used for these substances and the location of the containment site relative to the well.[427] Containment practices must be sufficiently impervious to contain waste until it can be removed, treated, or reused, must be compatible with the type and quantity of waste stored, and must be instituted throughout the drilling process.[428] All containment vessels must have 10% extra space to allow for precipitation,[429] and must comply with corrosion control requirements.[430] Well operators must obtain permits for wastewater impoundments with capacity in excess of 250,000 gallons, and two feet of freeboard on the impoundments is required at all times.[431] Pennsylvania has proposed regulations under the Clean Streams Law and Act 13 to regulate containment practices. In addition, all well operators must submit a wastewater source reduction strategy characterizing the waste stream and methods used for recycling and minimizing waste.[432]

Wastewater from drilling, fracturing, or completion cannot be discharged into the waters of the Commonwealth if the wastewater contains 500 mg/L Total Dissolved Solids, 250 mg/L total chlorides, 10 mg/L total barium, or 10 mg/L total strontium.[433] Discharges may not be authorized from a publically owned treatment works facility unless the discharges are first authorized and treated by a centralized waste treatment facility.[434] Well operators that transport wastewater must maintain records of the amount, location, and disposal methods used.[435] In order to dispose of waste via injection, operators must submit a map and certain data prescribed by regulation, and must provide notice to local municipalities.[436]

In Pennsylvania, the federal EPA rather than the Commonwealth administers the Underground Injection program. Thus wastewaters injected for disposal into underground formations must receive an EPA permit. There are 7 such permitted wells currently operating in Pennsylvania. In

addition to concerns with impacts to underground aquifers (disposal formations are typically far below aquifers used for domestic purposes, but cross-contamination must be prevented), there has been some evidence in several other states that disposal injection activities can cause seismic events in some settings. After several events associating seismic events with disposal of fracking wastewater into deep wells near Youngstown, Ohio, that state established rules for permitting disposal wells that include the option to require submittal of a plan for monitoring seismic activity, authority to order suspensions of injection, and to conduct monitoring activities.[437] In Pennsylvania, it is the EPA that would determine relevant requirements. In 2014, landowners and county commissioners appealed EPA's issuance of a permit in Pennsylvania to inject fracking wastewater into an underground formation in Clearfield County, contesting among other things, the federal agency's lack of a determination related to possible induced seismicity.[438]

In Ohio operators must have a state permit or be operating under an order to "store, recycle, treat, process, or dispose" of brine or waste substances associated with the hydraulic fracturing process.[439] Brine can be disposed of via underground injection, surface application, recycling, or other method approved of in a permit.[440] Local governments must adopt a resolution to allow surface application for that disposal method to be used, subject to minimum statewide standards.[441] Pits or dikes cannot be used for the ultimate disposal of brine or waste—for both temporary and longer-term storage, Ohio favors steel tanks and impoundments constructed using synthetic liner.[442]

Similar to Ohio, Illinois requires a permit to include a plan for handling, storing, transporting, and disposal or reuse of hydraulic fracturing fluids and flowback.[443] It must identify any injection wells to be used for disposal of flowback and include the capacity of tanks and reserve pits for flowback storage.[444] Illinois also requires annual reports on flowback management and transportation.[445]

Colorado requires a synthetic or engineered liner beneath all buried or partially buried storage pits.[446] Produced water pits and other containment vessels cannot be within 500 feet of any building.[447] Pits, tanks, and other vessels are subject to ongoing testing and inspection requirements.[448] Unlike Pennsylvania, which requires permits for impoundments over 250,000 gallons, West Virginia requires permits for impoundments over 210,000 gallons.[449] Oklahoma has a general freeboard requirement of two feet, which (unlike Pennsylvania) is increased to three feet in some instances, such as certain commercial pits.[450]

Air Quality Protection

During well development, vehicle traffic and industrial operations can result in emissions of conventional air pollutants like volatile organic compounds (VOCs) and nitrogen oxides (NOx),

which are the primary precursors in the reaction that creates smog. In addition, methane can leak during the drilling process, flowback period, well completion stage, and transmission.

Air quality regulation is primarily a federal concern. Hydraulic fracturing wells are subject to New Source Performance Standards (NSPS) under the Clean Air Act. Under NSPS Subpart OOOO, flowback emissions must be captured and directed to a completion combustion device.[451] Beginning in 2015, reduced emissions completions are required for most wells.[452] However, aggregating wells in order to compile total emissions from a drilling site is an uncertain issue. A Pennsylvania guidance document indicates that the DEP does not support aggregation in many instances,[453] but the EPA has indicated that it may not agree with that interpretation.[454]

In Pennsylvania, well operators must submit an annual source report identifying and quantifying air emissions, including calculation methods.[455] VOCs and NOx require an emissions statement that complies with the Pennsylvania Code section for stationary sources.[456] Well drilling, completion, and work-over activities are exempt from air permit requirements, as are hydraulic fracturing wells that use a leak detection and repair program. The Pennsylvania DEP recently revised the requirements for such exemptions to achieve better control.[457]

Air quality regulation for hydraulic fracturing wells is a dynamic and evolving field, with certain states proposing innovative strategies to reduce emissions. Colorado recently passed stringent air quality rules for hydraulic fracturing that regulate NOx, VOCs, and methane.[458] Generally, the regulations require "good air pollution control practices for minimizing emissions."[459] The regulations include specific control requirements for storage tanks at oil and gas exploration and production operations, well production facilities, natural gas compressor stations, and natural gas processing plants, among other locations.[460] For example, storage tanks emitting more than six tons per year of VOCs must install control equipment with 95% efficiency, or 98% for flaring operations.[461] Notably, Colorado regulates methane, a greenhouse gas, requiring uncontrolled emissions to be reduced by at least 95% in some instances and requiring most emissions to be routed through air pollution control equipment.[462] Colorado introduced new reporting, monitoring, and design requirements as well.[463]

In Ohio, a proposed permit-by-rule states that operators may not exceed 34.0 tons per year (tpy) VOCs, 9.3 tpy carbon monoxide, 1.7 tpy nitrogen NOx, and 1.0 tpy sulfur dioxide during well completions.[464] Ohio's newest regulatory actions to address fugitive air pollution emissions from unconventional oil and gas operations include the release of a "model general permit" in April 2014 that requires detailed monitoring and testing by oil and gas permittees for leaks of methane and other air pollutants from their oil and gas operations. The new Ohio requirements direct new permittees to test quarterly for leaks, to attempt repairs within five days after detection emissions from leaks, and to complete repairs within 30 days.[465]

Habitat and Ecosystem Protection

Shale wells, transport pipelines, and compressor stations require infrastructure development that can, in some circumstances, lead to habitat fragmentation, land clearing, ecosystem shift, and diminished species diversity. In Pennsylvania, well operators must consider impacts on public resources, including habitat of rare and endangered plants and animals.[466] Operators must submit proof that a Pennsylvania Natural Heritage Program (PNHP) review was conducted, which involves screening projects that cause five or more acres of surface disturbance for impacts to endangered and threatened species.[467] If the PNHP review finds the potential for adverse impacts, they must be prevented, avoided, or minimized in accordance with state and/or the federal Endangered Species Act where applicable.[468]

In comparison, Colorado's oil and gas code has a section dedicated to protection of a broader range of wildlife resources."[469] Operators must provide sensitive wildlife habitat maps and must consult with Colorado Parks and Wildlife in order to minimize adverse impacts to sensitive habitat.[470] Minimizing adverse impacts means, whenever reasonably practicable, to avoid, minimize, or mitigate impacts, considering cost-effectiveness and technical feasibility.[471] In establishing conditions for permit approval in identified habitat areas, considerations include best management practices, species- and site-specific issues, and minimization of habitat fragmentation, among other factors.[472] When drilling in sensitive habitat areas, numerous general requirements apply, including engineering pipelines that minimize habitat damage, using boring instead of trenching across perennial streams, and planning transportation routes that minimize adverse impacts to wildlife resources.[473]

Enforcement

Environmental protection provisions in oil and gas regulations must be enforced to ensure compliance. Most states conduct enforcement activities through departments of environmental protection or equivalent agencies.

In Pennsylvania, the DEP is responsible for enforcement, with the exception that criminal prosecutions are handled by the Pennsylvania Office of Attorney General or by county District Attorneys. Any person with a direct interest in a matter that could lead to an enforcement action can request a conference to discuss and attempt to resolve an issue, with notice given to all parties by the DEP and the conference held within 90 days of the request.[474] Violations of the provisions of Act 13 relating to protection of fresh groundwater and casing requirements, protection of water supplies, use of safety devices, and plugging requirements constitute a public nuisance under Pennsylvania law.[475] The DEP may issue orders to aid in the enforcement of the

statute, including orders to suspend or revoke permits.[476] The DEP may also bring a suit in equity for an injunction to restrain a violation of the statute, regulations, standards, and orders and to restrain the maintenance or threat of a public nuisance.[477] A person in general violation is subject upon conviction of a summary offense up to $1000 in fines and up to a 90-day prison sentence, with each day of non-compliance constituting a separate offense.[478] Willful violations constitute a misdemeanor and subject the violator to up to $5000 in fines and up to one-year imprisonment.[479] Civil penalties also may be imposed, subject to appeal before the Environmental Hearing Board. An operator may be subject to civil penalties of $75,000 per violation plus $5000 for every day of non-compliance.[480]

In Illinois, the Department of Natural Resources is in charge of enforcement. Most knowing violations are Class A misdemeanors, for which the penalty is a fine not to exceed $10,000 for each day of violation.[481] Knowing violation of certain enumerated sections, however, is a Class 4 felony, for which the penalty is a fine not to exceed $25,000 per day of violation.[482] Civil penalties are generally not to exceed $50,000 for the violation and an additional $10,000 for each day the violation continues.[483] For some enumerated provisions,[484] the civil penalty is up to $100,000 for the violation and up to $20,000 for each day the violation continues.[485]

VI. HEALTH IMPACTS OF SHALE GAS DEVELOPMENT

One of the more difficult issues presented by shale gas development in the United States is assessing its impact upon public health. The intensity and nature of the various industrial procedures involved in extracting shale gas have raised concerns by some members of the public that the activity could adversely affect public health. Accurately characterizing any exposure pathways and the particular health impacts posed by the various development activities is key to determining whether individuals working on or living near shale gas sites face heightened health risks. This can only be accomplished through a robust research effort that examines the issues rigorously and in ways that allow for extrapolation of research findings across various populations and physical environments. To date, no comprehensive study of the public health impacts of shale gas development has been conducted. Health studies have been undertaken by state governments in both New York and Maryland, but have not been completed. Maryland's report should be available later in 2014.[486]

One of the most important research initiatives that can be undertaken is the creation and maintenance of a health registry that collects and tracks data about the health conditions of individuals who may be at a higher health risk from the impacts of shale gas development.[487] This is an important tool for health care providers seeking to diagnose patients' conditions and researchers exploring the connection between air and water contamination exposures and health. The Governor's Marcellus Shale Advisory Commission, in its July 22, 2011 Report, recommended that the Pennsylvania Department of Health partner 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 by creating a population-based health registry.[488] Despite this recommendation, the final version of Act 13 made no funding provision for any public health research.[489] Until a health registry is created, and more comprehensive research on connections between exposure pathways and health conditions is completed it will be difficult to develop the consensus necessary to establish public policy on this aspect of shale gas development.

The need for a coordinated research effort relating to shale gas issues generally was evaluated by the Shale Gas Roundtable organized by the University of Pittsburgh's Institute of Politics.[490] The Roundtable concluded that the amount of research on shale gas development, including its public health implications, was minimal in comparison with the need for such research by the public and policymakers and likely due to a lack of funding. The Roundtable also concluded that there was a perception that much of the research completed or underway was biased because of funding sources or review processes used and that research has not been well aligned with the information or timing needs of policymakers. To address this significant need for additional balanced research, the Roundtable recommended the creation of a Shale Gas Research Fund that would support rigorous and enhanced research on shale gas development by creating a diverse

and transparent funding stream and a regularly updated multi-year strategic research plan that provides for the completion of scientifically rigorous research by awarding funding on a competitive basis and using peer-review protocols. It is precisely this type of research initiative that is needed to conduct the coordinated and comprehensive research effort which can fully identify the public health implications of shale gas development.

In the interim, researchers in various academic institutions, public health organizations, and local government organizations throughout the United States have been researching different aspects of the shale gas public health experience. Although the research projects are often small in scope, use different methodologies, and have not been coordinated, they provide an important backdrop for and can inform future public health research. The remainder of this chapter discusses 1) the findings and conclusions of those completed research efforts and 2) the goals and methodologies of important on-going research projects.

The research team recognizes that some of the completed research projects have been criticized because of methodologies and other limitations. The goal in describing this body of research is not to endorse the conclusions of every project, but to identify the issues that have been examined and what conclusions have been drawn. The descriptions of each completed research project are not exhaustive, and the reader should review the publication of each research project for a full understanding of the research, its sponsors, and its limitations.

A. Completed Research

Researchers in Pennsylvania and other shale gas states have pursued several key research streams. These include the need for collecting baseline health and environmental data; the identification of exposure pathways for pollutants and contaminants generated by shale gas development; the identification of impacts of exposure to contaminants; and the examination of stress and environmental health risk in local populations.

Collecting Baseline Health and Environmental Data

To identify health risks associated with shale gas development, baseline environmental and health data is necessary. Researchers in several studies call for initiatives that document baseline environmental and health conditions. Researchers also call for future monitoring in communities hosting shale gas sites. Taking a snapshot of the state of the community before drilling begins can aid in the identification of negative environmental and health changes and help policy makers and the industry to manage future risk.

One of the earliest precedents for baseline data collection and long-term monitoring for shale gas development was set by Witter et al. in a 2010 study designed to provide the Garfield County

Board of County Commissioners (BOCC) in Colorado with specific health information and recommendations relevant to a plan for a local shale gas development site (Battlement Mesa).[491] To complete the study, Witter et al. worked collaboratively with Garfield County Public Health to conduct a Health Impact Assessment (HIA), a study method which includes stakeholder input, quantitative assessment of chemical exposure, qualitative assessment of industrial operations, and qualitative assessment of community changes and limitations, pertinent to the local community. The researchers suggested that an examination of existing conditions, coupled with future air and water quality monitoring, would allow adverse health and community impacts to be observed and their risks managed. Although the Battlement Mesa HIA has never been finalized, this study showed that the HIA can be an effective tool for community leaders to use when they need to include information on health concerns in their decision-making processes. The HIA serves as a template for other community HIAs in relation to shale gas development.

The need for establishing community baselines and monitoring environmental and health changes also emerged as a key recommendation of a 2011 study conducted by Colborn et al.[492] The goal of this study was to comprehensively identify and characterize the various chemicals used in drilling and developing shale gas wells and to better understand the public health implications of the use of those chemicals. In addition to investigating chemicals in water, the researchers recommended that air monitoring programs that detect the presence of contaminants, including individual volatile organic compounds (VOCs) and ozone, be established in every area with shale gas development, and that public health officials establish an epidemiological monitoring program that integrates state and national data. The researchers concluded that documenting these conditions before and after development occurs may help to identify future environmental and health risks.

In a multidisciplinary analysis of potential public health issues related to shale gas development, Korfmacher et al., in 2013[493] reinforce calls for baseline data collection and monitoring. The researchers counter the commonly accepted view that policies that address environmental concerns simultaneously meet public health needs. They identify the most important sources of potential health impacts associated with shale gas development and argue for evaluating those impacts in the context of a framework based on five public health perspectives: prevention, risk management, co-benefits, economic impacts and ethical issues. To assure successful prevention and risk management, the researchers suggest that documentation of conditions before and after drilling is paramount. Specifically, they argue that to reduce risk, public health officials should support examination of the full life cycle of shale gas development at local, regional and global levels, and model cumulative impacts under different extraction scenarios.

Identifying Exposure to Potential Pollutants

The previous section highlighted the importance of collecting baseline data to identify changes in environmental and worker/community health conditions and to lay the groundwork for identifying potential cause and effect relationships between natural gas development and public health impacts. Of equal importance is exploring that cause and effect relationship. Studies on exposure to potential pollutants can be categorized into two sub-streams—workplace or occupational exposure (effects on workers) and ambient or non-occupational exposure (effects on community members).

Workplace/Occupational Risk

A 1981 study of the Green River shale oil formation in Utah, Colorado and Wyoming by Rom et al. [494] produced some of the earliest findings on potential occupational hazards associated with shale gas development. In that study, Rom concluded that workers may be exposed to chemicals during the development process - many of which had been previously linked to a number of chronic and acute illnesses. He further concluded that if the chemicals that were used leak, diffuse, or otherwise are released into the community they would create a public health problem.

Many years later, in 2013, during the recent boom in shale gas extraction, Esseweine et al.[495] examined occupational risks associated with exposure to silica, a substance which has been known to cause acute and chronic diseases. Silica sand is one of the proppants used in the hydraulic fracturing process. Because silica is a powder, the probability of its traveling by wind is high, thus increasing the potential for exposure. Esseweine et al. recommended that where possible, substitute products should be used, mechanical modifications should be made to decrease the amount of dust generated, administrative controls should be introduced to limit or reduce exposure, and the use of appropriate personal protective equipment should be mandatory. This study, conducted by the National Institute, for Occupational Safety and Health, is the first systematic study of workplace exposures to silica dust during the shale gas development process.

Similar occupational health concerns were echoed in the work of McDermott-Levy in 2013[496] and Colborn et al. in 2011.[497] Researchers further examined hydraulic fracturing processes to learn about the chemicals used for shale gas development. These studies have generally concluded that chemicals used by shale gas workers have the potential to be toxic, and have prompted researchers to raise questions concerning the risks of non-occupational exposure.

A recently completed study by Simona Perry evaluates another aspect of workplace health and safety concerns – that of emergency first responder training needs related to pipeline emergencies.[498] The study provides a core curriculum for firefighters in Chester County, Pennsylvania, and produced a set of recommendations for a standardized pipeline notification protocol for use by Chester County and operators to advise each other, local municipalities, and

residents about new proposed pipeline developments and maintenance, upgrade, and other activities along existing right of ways. This project may ultimately serve as a model for improving education and public safety (including local emergency first responder capabilities) as Pennsylvania's pipeline infrastructure continues to expand.

Non-Occupational Risk: Air and Water Quality

In recent years, numerous studies have examined shale gas processes and the ways in which those processes may affect air, water, and soil. These studies indicate that the greatest potential for contamination comes from dusts and residues from activities involved in hydraulic fracturing, leakage of substances into groundwater, and emissions of hydrocarbons and VOCs during operations.

Many of these studies are intended to identify potential risk pathways and were not designed to correlate health outcomes with actual industry practices.

The first of these studies of exposure pathways, by Witter for Garfield County discussed above,[499] identifies ways in which shale gas development operations can degrade air quality. The researchers found that truckloads of dirt, sand, aggregates, drill cuttings, and similar materials in transit could affect human health. Additionally, Witter contends that if well pads do not have berms around their perimeters, runoff from the pads could pollute water and soil with chemicals and compounds used in well development, and spills and gas pipeline leaks could also occur.

Exposure to hazardous materials associated with shale gas wells and compressor stations through air and water contamination was a major focus of a study launched by the Texas Department of State Health Services (TxDSHS) in 2010[500], after preliminary environmental sampling results from Dish, TX showed elevated amounts of atmospheric benzene. As a part of the study, TxDSHS collected adult blood and urine samples and analyzed them for VOCs. In addition to the air samples, TxDSHS also collected tap water samples from participant homes. The study found that although a number of VOCs were detected in some of the blood samples, the pattern of VOC values was *not consistent* with a community-wide exposure to airborne contaminants, such as might be associated with shale gas operations. The same general conclusion was drawn for results from urine tests. Water contaminants were detected in some of the water samples but at levels that were many times lower than the contaminant specific regulatory limits. Thus, the researchers concluded that the potential for exposure to hazardous materials associated with shale gas development through water was low.

This research also reflects that there are limitations to blood and urine tests for evidence of contamination. VOCs have a very short half-life in the body. Furthermore, the tests represent a

one-time sample that may be affected by unknown external factors. Ultimately, the study concluded that potential health risks cannot be determined by single tests of chemical levels found in the blood.

A study conducted by the Fort Worth League of Neighborhoods (FWLN)[501] in 2011 examined potential air impacts of shale gas development. This study is significant for its focus on schools and potential health impacts on children if shale gas development is not well regulated. The study was undertaken by the FWLN in response to citizen concerns regarding natural gas development near local schools. The FWLN formed an independent committee of scientific and health professionals and tasked them with reviewing available testing data from various sources. The study found several pollutants, at least one of which has been linked to neurological, cardiovascular, and behavioral abnormalities, at the majority of sites tested.

The study determined that no master plan for well facilities in the City was available, no information was available on the future placement of pipelines, and emissions monitoring of natural gas sites was nonexistent. The FWLN proposed a number of technical requirements for the location of well pads and compressor stations, for the use of certain equipment, and for independent monitoring of air emissions. The FWLN also made technical recommendations for the location and operation of gas pipelines, as well as maintenance of liability insurance and emergency evacuation plans. The study highlighted the potential impacts of shale gas development on air quality and the importance of identifying the proper location of natural gas sites in relation to schools.

Rather than testing current levels of contaminants in the air and water in a specific locale, Ronald Bishop[502] took an alternative approach of analyzing past defects in performance by the natural gas industry to predict future performance and to assess the risk of contamination caused by its development as well as to identify the potential for health impacts from contamination. Bishop used information on incidents available through state, federal, and industry reports. Based on historical trends, Bishop contends that more than one in every six shale gas wells will leak fluids to surrounding land over the next century. Fluid leaks and discharges could be particularly dangerous given the composition of industrial chemicals involved. Bishop also identified certain industrial practices, such as air/foam-lubricated drilling and the use of impoundments to store flowback fluids, as having the potential degrade air quality and affect nearby humans, livestock and crops.

A survey by Earthworks and researchers Nadia Steinzor, Wilma Subra, and Lisa Sumi [503] in Pennsylvania, in 2012-2013, tested air and water quality in counties with natural gas development to identify potential links between the gas development and air/water quality degradation. The researchers first surveyed individuals from households located in proximity to natural gas sites in various southwestern Pennsylvania counties as to their health conditions.

They then analyzed air and water samples for the presence of numerous hazardous substances and to investigate correlations between the citizens' health conditions and their exposures. The Earthworks Report concluded that contaminants that are associated with oil and gas development are present in air and water in areas where residents are experiencing health symptoms consistent with such exposures. However, the variability of changing conditions surrounding natural gas development, including weather, topography and geology, which were also documented in the report, makes it very difficult for short term measurements to adequately capture exposures which may come and go, thus additional testing is needed.

Nearby in West Virginia, in 2013, Michael McCawley[504] examined air, noise, light, and radioactivity exposures near drilling sites at various stages of development. The study found elevated levels of particulate matter and hydrocarbons. Noting that the BTEX compounds are found in diesel emissions, McCawley argues that diesel emissions should be considered a health threat associated with natural gas development, as diesel traffic typically increases with the development. With regard to noise, the average levels were below the EPA's recommended long-term level, however, at the levels measured, the researchers concluded that noise can lead to increased stress levels that in turn can carry health effects. Radiation samples were well below levels of concern.

A recently published study by David Brown and researchers at the Southwest Pennsylvania Environmental Health Project, explores the limitations of current methods of collecting air emissions data from shale gas sites and limitations in the analyses of the data with regard to accurately assessing risks to individuals or protecting the health of those near shale gas sites.[505] Specifically, the researchers found that current protocols do not adequately determine the intensity, frequency, or duration of the actual human exposure to the mixtures of chemicals released at shale gas sites; the typically used periodic 24-hour average measures can underestimate actual exposures by an order of magnitude; reference standards are set in a form that inaccurately determines health risk because they do not fully consider the potential synergistic combinations of toxic air emissions, and because local weather conditions are strong determinates of individual exposures, appropriate estimations of safety require protocols that measure real time exposures. They recommend development of new protocols to address these concerns.

Although much of the research conducted in the field thus far suggests that shale gas development has the potential to degrade air and water quality at shale gas sites and at nearby communities, additional studies are needed, particularly studies which monitor air and water quality over a longer time span and/or have a larger sample size, to draw more definitive conclusions.

Identifying Health Impacts of Exposure

The previous two sections have focused on the importance of monitoring exposure to materials associated with shale gas development and the pathways by which communities can be exposed. This section discusses the effects that may be associated with exposure both in terms of acute and chronic illnesses. The studies in this section examine the possibility that chemicals involved in this industry may be related to the incidence of cancer, headaches, skin and respiratory irritation, and many other illnesses. Most of these are preliminary and identify areas for potential follow-on work.

Wilma Subra[506], on behalf of Earthworks' Oil & Gas Accountability Project and Powder River Basin Resource Council, conducted a survey to learn how people in an area of shale gas development assessed their own health and characterized odor events caused by shale gas extraction, and then investigated the associations between the two. Based on the survey, Subra recommends identification of the original sources of air and water contamination, additional air testing, implementation of health symptom tracking for both contamination events through water and air pathways, and establishment of a medical monitoring program in which individuals suffering from health impacts may receive blood and urine testing.

In a 2012 study, Bamberger and Oswald[507] examined reports on exposure of animals and humans to unconventional gas operations. The researchers argued that including exposure of animals was an important contribution to the field, as animals can be viewed as sentinels for human health impacts. In the study, Bamberger and Oswald conducted interviews of residents and animal owners in six states (including Pennsylvania) who believed that the natural gas development had affected their or their animals' health. When possible, the researchers also interviewed the animal owners' veterinarians.

Bamberger and Oswald provide a qualitative understanding of health risks faced by farm animals and farm families. This study is one of the first to provide case study analyses of animal and human exposures, including some in Pennsylvania. Bamberger and Oswald summarize the results of their investigation and provide several case studies along with recommendations for preventing contamination and minimizing health risks in the future. While the researchers recognized that their case studies cannot necessarily be generalized to the entire population and that conducting comprehensive research faces significant impediments, the authors maintain that the several possible links between gas drilling and health effects need further study.

In a study released in January 2014, McKenzie, et al.[508] examined associations between maternal residential proximity to natural gas development and birth outcomes in a study of births between 1996 and 2009 in rural Colorado. The researchers observed an association between density and proximity of natural gas wells within a 10-mile radius of maternal residence and prevalence of congenital heart defects and possibly neural tube defect.

In a 2012 study, McKenzie, Witter, Newman, and Adgate[509] used air quality data collected at the perimeter of wells in Battlement Mesa, Garfield County, Colorado to examine the relationship between exposure and human health issues. The researchers used a standard EPA methodology to estimate non-cancer hazard index (this index is calculated by taking into consideration the estimated daily intake of the chemical and its toxicity over a specific time period) and excess lifetime cancer risks (the probability that an exposed individual will develop cancer because of that exposure, by age 70) for exposures to hydrocarbons. The researchers found that subchronic exposures to air pollutants during well completion present the greatest potential for adverse health effects. (The EPA defines subchronic exposure as repeated exposure by mouth, skin or inhalation for more than 30 days, up to approximately 10% of the life span in humans.) The results of the analysis indicate that the non-cancer health risk and cancer risk are greater for those living closer to wells. Health effects reported by residents of the area are consistent with known health effects of many of the hydrocarbons evaluated in this analysis.

The researchers suggested that additional studies be conducted to reduce the uncertainties in understanding the health effects of shale gas emissions and to better direct efforts to prevent exposures. Research employing emissions data, local meteorological information, and topography would provide guidance for the minimum distances industrial activity should be conducted to homes, businesses and schools. Lastly, the authors recommended prospective medical monitoring and surveillance for health effects potentially caused by air pollution.

Stress and Environmental Health Risk

The final stream of research focuses on the impacts of stress and perceived environmental risk. That is, a number of studies have examined how *perceived* contamination and pollution by natural gas development affects populations. These studies are primarily psychological in nature and report on the findings of interviews and surveys completed in townships where shale gas development occurs.

The first of these studies, conducted by Ferrar et al. sought to identify self-reported health impacts of shale gas drilling and assess how symptoms change over time.[510] To this end, the researchers conducted two sets of interviews with a small sample of community members living near Marcellus Shale development. The interviews were intended to elicit information on the health and stressor impacts individuals had experienced during the period of gas extraction activities. In the initial set of interviews three-quarters of the residents resided in five of the seven most heavily developed counties in Pennsylvania.

The study found that participants in the study attributed 59 unique health impacts and 13 stressors to Marcellus Shale development; with stress being the most frequently reported

symptom. Among the leading causes of stress reported by the participants were feelings of being taken advantage of, having their concerns and complaints ignored, and being denied information or misled. Over time, perceived health impacts increased, while stressors remained constant. The researchers concluded that perceptions of health may be affected by shale gas development whether or not the health impact is due to direct exposure to chemical and physical agents resulting from drilling or to the psychosocial stressors of living near development activity.

Similarly, in 2013 Simona Perry examined psychological, sociocultural, and environmental factors that may lead to chronic stress in individuals and communities experiencing Marcellus Shale gas development in Pennsylvania.[511] Perry conducted two separate focus groups, one comprised of farmers and the other comprised of individuals using their land for timbering, hunting and wildlife watching. Through various activities, Perry identified three themes that link environmental and social changes related to shale gas activity to *self-reported* increases in psychological and social stress. First, Perry found that anticipated or perceived loss in certain aspects of quality of life, especially fresh air, minimal traffic, and quiet communities as a result of shale gas development caused stress. Second, Perry found that the income disparity between farmers and woodland owners was a source of stress. Third and finally, Perry identified that a rise in acts of violence, especially bullying and intimidation of landowners by pro-drilling individuals, increased stress. The case study approach used in this research provides an understanding of factors potentially influencing the stress levels of community members, collecting qualitative data by multiple methods. The small number of participants in the study argues against generalizing its findings to other communities. However, the ethnographic methods can be replicated elsewhere to determine if results are similar.

In a 2013 study, Lenore Resick and colleagues provide a qualitative sensitive approach to understanding the meaning of health to women in southwestern Pennsylvania who are living near shale gas development sites.[512] The fourteen women who were interviewed at length discussed their sense of powerlessness over changes in their lives that resulted from the presence of the shale gas industry and how that defined their sense of ill health. The women expressed concerns about anticipated long-term health effects for themselves, their families and their communities. They also noted changes in their trust and comfort with the neighbors and larger communities.

This research elucidates the qualitative experiences of those living near shale gas development. Because health can be broadly defined, this study illuminates several components of health that relate to functioning, emotional well-being, and community cohesion. Lastly, the study implicitly provides guidance to others who need to understand what factors to measure in future research on shale gas and health. The weaknesses in the study are the small number of subjects and the somewhat unsystematic process for selecting study participants, although these are accepted methods for qualitative researchers.

Also of note is the work of the Southwest Pennsylvania Environmental Health Project, which analyzes health symptoms of individuals living near shale gas development activities.[513] The Project team has created a series of case histories of face-to-face interviews, conducted by a health professional, of individuals who were not selected by the team but elected on their own to seek assistance from the Project. In nearly all cases, the most prevalent symptom they present is stress. The Project reports the most comprehensive collection of case histories of individuals impacted by shale gas activities. It is an important and evolving source of information about health impacts.

Overall, the studies reviewed here highlight the importance of gathering baseline environmental and health data, monitoring community changes, identifying pathways for worker and resident exposure to pollutants and contaminants, and researching the health effects exposure may have. By doing so, medical practitioners, policy-makers, and individuals will be able to make critical decisions about natural gas development and potential hazards to public health.

B. Health-Related Research in Progress

Several valuable research projects are on-going, and are expected to broaden the understanding of the public health implications of shale gas development. The Geisinger Marcellus Shale Research Initiative is conducting a study in partnership with the Guthrie Health System and the Susquehanna Health System, to analyze comprehensive health data from electronic health records of residents in Lycoming, Bradford, Tioga, Sullivan, Susquehanna, and Wyoming counties.[514] The goal of the study is to determine if certain health conditions documented in patient records are associated with shale gas activities in the northeast region of Pennsylvania. The research will occur in multiple phases of three to five years, each with specific aims. The first phase will last approximately five years and will include an inventory of existing data; gaps in data and how to fill them; creation of a shared data warehouse; identification of social and policy concerns; and studies of respiratory diseases, reproductive health, cardiovascular disease, trauma and motor vehicle injuries, and socially-mediated health problems associated with shale gas activities. In gathering health records of three health systems this project is assembling potentially the largest database available to examine the frequency of various health conditions in conjunction with shale gas development activities. Its large numbers may generate statistically significant results, and could lay the groundwork for successive studies including a full-scale epidemiological study of the connection between air and water contamination exposures and changes in health conditions.

A collaborative project of the comprehensive Geisinger study, staffed by researchers at Bloomsburg University, will examine the positive and negative impacts of shale gas development on local communities in northeastern Pennsylvania.[515] The project will examine a

range of community health issues, likely including stress, community cohesion, use of and access to healthcare, several specific health outcomes, and perceptions of health. Some sites will be within and some outside the shale impact area to allow for comparisons. The research may suggest a research design for similar studies in southwestern Pennsylvania.

A joint study by the University of Pennsylvania and Columbia University is evaluating health outcomes and measuring water quality in 6 counties with and without shale gas extraction along the Pennsylvania-New York border.[516] Mapping of the proximity of drilling sites, health outcomes data and water quality data will provide insight into any correlations. By attempting to collect data on health impacts that have been treated by medical professionals and find any association that might exist between them and potential water contamination, this study may move beyond the anecdotal evidence reported by news outlets.

A team from the Yale University School of Medicine has been conducting a household environmental health survey in Washington County while separately conducting a study focusing on animal illnesses in areas of shale gas development.[517] The team is assessing the health of animals in the community, as well as human inhabitants, as animals may exhibit health symptoms from environmental hazards more quickly than humans. Because the health effects and environmental impacts of shale gas extraction may only appear over time there will be advantages to following the health of this survey population (both humans and animals) over a period of years.

A multidisciplinary team of Lehigh University investigators are developing an index to measure the impact of shale gas development in Pennsylvania on quality of life (QoL).[518] The index will include the Gallup wellbeing index which measures both general satisfaction with life and emotional happiness. The index will also measure solastalgia, a concept that indicates the distress that is produced by environmental change impacting people while they are in their home environment. By focusing on various types of Pennsylvania communities, it may provide a more in-depth understanding of how shale gas development can have differential social, economic, and health impacts.

An interdisciplinary study by Resick and Irwin, at Duquesne University, will analyze the impacts of Marcellus Shale activity on individual health and community well-being in rural Pennsylvania communities, using survey and qualitative data.[519] Irwin creates and digitizes social maps of Pennsylvania that illustrate demographic booms and busts along the Marcellus Shale region while Resick examines perceptions of those who live near shale gas sites as it relates to their health. This research will build findings from the recent pilot research conducted by Resick on mental health impacts of environmental changes in the region.

Each of these ongoing research projects will provide information that may be used in the future to develop and improve industry best practices, regulatory standards, and public health responses.

VII. ECONOMIC IMPACTS: SHALE GAS REVENUES AND LOCAL GOVERNMENTS

A. Tax Revenues Collected by Local Governments

With a few exceptions, Pennsylvania municipalities and school districts receive little direct revenue from the expansion in shale gas development activities within their borders. However, they may benefit from increases in residents' earned income and real property values subject to local taxation. Municipalities also share in state impact fees collected on drilling of unconventional shale gas wells (discussed below).

Pennsylvania local governments and school districts rely most heavily on the real property tax for their revenues. However, under Pennsylvania law, real property tax valuations *do not include the value of oil and gas resources*.[520] Thus unlike many other gas producing states including Texas,[521] Pennsylvania municipalities do not benefit from increases in property values that are directly attributable to oil and gas discoveries. Also, under longstanding provisions for machinery and equipment used in manufacturing, mining, or industry, natural gas drilling rigs, wells, processing facilities and other improvements are excluded from real property assessments.[522] Thus, although real property may become more valuable to the owner by virtue of its developable oil and gas resources, the increase adds nothing to the local tax base. Indeed, if, as some research suggests, values of homes and other improvements in close proximity to gas wells suffer declines in value at least for certain periods of time, then the immediate effect on the tax base may actually be negative.[523]

In contrast, Considine and others have suggested that state "and local" tax receipts should be higher across the Commonwealth due to Marcellus activity, based on modeled indirect impacts. They projected real property tax revenues (the only local tax that is disaggregated in their research) as increasing by $351.31 million statewide, based on economic model projections about rising land values due to increased indirect economic activity.[524] Looking at actual state data, Kelsey and others found some increases in property values in municipalities with Marcellus drilling, but minimal increases in assessed values (increase of 2.8 percent in municipalities with drilling compared to 2.2 percent in municipalities without drilling over three tax years) – suggesting that local tax bases may not rise very much. These results are "consistent with prior research that found negligible or mixed revenue impacts of Marcellus Shale development on local governments."[525]

The other substantial tax revenue source for Pennsylvania local governments and school districts is the local tax of up to one percent that may be levied on *earned income*. However, rents and royalties paid to landowners are not earned income, and are thus not subject to this tax. Earned income taxes may be collected on wages of natural gas field workers. School districts may not

collect earned income taxes on nonresidents; however municipalities may levy such taxes on non-residents subject to a credit if the tax is also levied by the individual's residence in another Pennsylvania jurisdiction.[526] The earned income tax is withheld by the employer and remitted at the employer's place of business in Pennsylvania, which may not be in the same municipality as a particular well-site.[527] As a result of these provisions, even if these tax receipts do increase, the municipalities and school districts that experience the direct impact of shale gas activities may not be those that benefit from earned income taxes collected from oil and gas field workers.

Municipalities and school districts may levy a one percent real property transfer tax for conveyances of property when the same transactions are subject to the state transfer tax.[528] However, while this tax is applicable to a conveyance of the mineral estate, it is expressly not levied on leases for the "production or extraction of coal, oil, natural gas or minerals and assignments thereof."[529] Thus, newly executed or assigned shale gas leases will not contribute tax revenues to local governments, unless associated with outright purchases of land.

Because of these limitations, local tax receipts will depend upon hoped-for increases in revenues from taxes on individuals that benefit from the wages paid by oil and gas companies, businesses serving the natural gas industry that occupy real property within the municipality, and from property taxes paid directly or indirectly by natural gas development companies with office facilities in the municipality. In most instances, even if these indirect revenues are generated there is no substantial probability that the revenues will accrue to the same municipality in which any shale gas wells are located – as opposed to other municipalities in the area, the county, or even an adjacent county. This is why, in part, economic analyses of tax effects in Pennsylvania tend to focus on statewide and county-level economic benefits and impacts.

B. Rentals and Royalties for Leases of Publicly-Owned Land

Leasing publicly-owned lands for exploration and development can be a source of revenue for state and local governments yet also a source of conflict. In February 2013, after extensive debate and public interest, Allegheny City Council approved a contract to drill for natural gas on Pittsburgh International Airport land. The deal is estimated to bring in $500 million in royalty and lease payments.[530]

State lands have also been leased. Of the 2.2 million acres of state forest land in Pennsylvania, more than 700,000 acres containing 559 gas wells are leased as of April 2013.[531] Former Governor Rendell instituted a moratorium on further leasing before leaving office; in May 2014 Governor Corbett lifted the moratorium, issuing an order allowing leasing that does not involve surface occupation of these lands. Debates over natural gas development on public land are also taking place in other contexts. The Pennsylvania Game Commission began accepting leasing bids from gas companies in May 2012 and recently approved a bid for 586 acres in Lawrence

County. Due to the proximity of this land to an elementary school, this lease sparked some controversy and resulted in a petition asking the Game Commission to oppose the lease. In October 2012, a bill to open up 14 of Pennsylvania's public universities to natural gas development, oil drilling, and coal mining on campus was signed into law by Governor Corbett.[532]

C. Shale Gas Development Impact Fees

On February 8, 2012, the Pennsylvania legislature enacted Act 13. Chapter 23 of Act 13 concerns the collection of an impact fee from natural gas drillers and its distribution to state and local governments. In contrast to a severance tax, where the tax revenues typically go into a state general fund, more than half of impact fee revenues are delivered to local and county governments and are intended to address the impacts of natural gas production. The fee is collected statewide and distributed statewide – a municipality's or county's share is not tied to the particular age or productivity of specific wells in that particular municipality. However, a formula described below links distributions from the statewide fund to numbers of active wells in or near counties and municipalities.

How the Impact Fee Works

Collecting the Impact Fee from Producers

The Pennsylvania Public Utility Commission (PUC), the body charged with administering the impact fee, is required to collect fees from producers by April 1 each year. [533] Act 13 sets a 15-year rate schedule for each horizontal unconventional Marcellus well that varies from year to year based on: (1) how many years the well has been in operation; and (2) the average annual price of gas (established based on the New York Mercantile Exchange price) for the year for which the fee is imposed. The fee is also adjusted based on the consumer price index, but the adjustment only comes into effect if the number of wells spud that year is more than that of the previous year. Producers pay a declining impact fee for up to, but not more than, 15 years on each unconventional gas well. Vertical wells pay 20 percent of the amount applicable to horizontal wells and the fee ends after 10 years rather than 15.

Table 1. Act 13 Impact Fee Schedule for Horizontal Unconventional Wells

	Average Annual Price of Gas [NY Mercantile Exchange]				
Year	$0-2.25	$2.26-2.99	$3.00-4.99	$5-5.99	$6 and up
1	$40,000	$45,000	$50,000	$55,000	$60,000
2	$30,000	$35,000	$40,000	$45,000	$55,000
3	$25,000	$30,000	$30,000	$40,000	$50,000
4	$10,000	$15,000	$20,000	$20,000	$20,000
5	$10,000	$15,000	$20,000	$20,000	$20,000
6	$10,000	$15,000	$20,000	$20,000	$20,000
7	$10,000	$15,000	$20,000	$20,000	$20,000
8	$10,000	$15,000	$20,000	$20,000	$20,000
9	$10,000	$15,000	$20,000	$20,000	$20,000
10	$10,000	$15,000	$20,000	$20,000	$20,000
11	$5,000	$5,000	$10,000	$10,000	$10,000
12	$5,000	$5,000	$10,000	$10,000	$10,000
13	$5,000	$5,000	$10,000	$10,000	$10,000
14	$5,000	$5,000	$10,000	$10,000	$10,000
15	$5,000	$5,000	$10,000	$10,000	$10,000

Source: Pennsylvania Public Utility Commission
http://www.puc.state.pa.us/NaturalGas/doc/Act13/Act13_Fee_Schedule_2012_Rev.docx

The total fees generated by a well can differ over any applicable 15-year period. For example, if a well is spud in a year where the average annual price was $2.25/mcf or less and gas prices were to remain at that level over each of the 15 years in which the fee is applicable, the total amount paid would be limited to $190,000.

In contrast, the maximum amount that can be due for any one well is $355,000 (viz. if prices were over $6/mcf for the first three years and did not fall below $3 in the succeeding 12 years).

Pennsylvania has already experienced the effect of these price-based schedules. In 2012, for example, the fees were $50,000 for a new horizontal well (based on the 2011 calendar year average); but in 2013, the fees were $45,000 for a new horizontal well (first year) and $35,000 for a horizontal well in year two (based on the 2012 calendar year average). In 2014, the fees went back up to what they had been in the initial year. These fluctuations reflected changes in the average annual price of gas (which went from over $3/mcf for calendar 2011, to $2.78/mcf in calendar 2012, to $3.652/mcf for calendar 2013). So a well drilled in 2011 that owed $50,000 for its first year, owed only $35,000 in its second year – rather than $40,000 had the price of gas remained the same.

The most noteworthy feature of the impact fee structure is its relatively low level after the first three years. This makes its financial benefit to the Commonwealth and the counties and municipalities sharing in fee receipts heavily dependent on new drilling. Specifically, at any of

the prices for gas, 40-50 percent of the impact fee is paid in the first three years, and the remainder over the ensuing twelve years. Thus, municipalities and counties relying on impact fees will see these revenues drop steeply unless the Commonwealth as a whole has substantial new drilling.

The obligation to pay the impact fee is suspended if the well is capped, or does not produce natural gas exceeding more than an average of 90,000 cubic feet per day within two years after paying the initial fee. Once the fee has been paid for 15 years, or if the well ceases production and is plugged, no further fee is imposed.

Distributing the Impact Fees to State and Local Governments

Impact fee collections in 2012 for reporting year 2011 amounted to $204.2 million, and in 2013 for reporting year 2012 were $202.5 million. Impact fee collections in 2014 for reporting year 2013 are projected to be $224.5 million.[534] As described below, just over half of the revenues are distributed directly to local and county governments. Under Act 13, the PUC is required to distribute impact fees to state and local governments by July 31 each year.[535] Pennsylvania counties had 60 days from enactment of Act 13 to enact legislation enabling them to participate in the fee sharing, and 35 counties did so.[536] The PUC is responsible for assessing whether a municipality is in compliance with the Act 13 requirement that local ordinances allow "for the reasonable development of oil and gas resources." If a municipality is in violation of Act 13, then it may become ineligible to receive impact fee funds.[537]

The impact fees collected from producers are first deposited in the state's Unconventional Gas Well Fund and then distributed as follows:

1) About $25.5 million is earmarked for state agencies to offset the statewide impacts of drilling (Table 2.a)
2) After the earmarks:

- 60% of the remaining funds are distributed to counties and municipalities, using a complex formula linked to number of wells, location, population, and road miles. (Table 2.b)
- 40% is deposited into the Marcellus Legacy Fund to fund statewide initiatives with potential local impacts and value. 15% of the Marcellus Legacy Fund is distributed to all counties, regardless of whether the county has wells located within its borders, to be used for certain environmental initiatives, as set forth in Section 2315(a.1)(5) of Act 13. (Table 2.c)

Table 2: Distribution of 2011 Year Impact Fees in 2012

Table 2.a: Initial Distributions to State Agencies

State Agency	Amount Distributed ($25,500,000 total)	% of Amount Distributed*
County Conservation Districts	$2,500,000#	10%
Fish and Boat Commission	$1,000,000	4%
Public Utility Commission	$1,000,000	4%
Department of Environmental Protection	$6,000,000	26%
Emergency Management Agency	$750,000	3%
Office of State Fire Commissioner	$750,000	3%
Department of Transportation (rail freight)	$1,000,000	4%
Natural Gas Energy Development Program	$10,000,000##	43%
Housing Affordability and Rehabilitation Enhancement Fund	$2,500,000###	2%

* Percentages may not add to 100% due to rounding.

#Conservation district funding rises to $5 million for 2012 and to $7.5 million in all subsequent years.

Energy development allocation drops to $7.5 million for 2012 and to $2.5 million in 2013.

Housing affordability allocation rises to $5 million for 2012 and all subsequent years.

Table 2.b: Local Government Allocations

Local Government	Actual Amount Distributed ($108,726,000)	Amount Distributed as a % of Total *	Formula for calculating the amount allocated to <u>each</u> county or municipality
Counties with producing unconventional wells	$38,241,360	36%	Divide the number of wells in the county by the number in the Commonwealth; multiply the resulting percentage by the amount available for distribution to counties.
Municipalities with producing unconventional wells	$39,303,620	37%	Divide the number of wells in the municipality by the number in the Commonwealth and multiply the resulting percentage by the amount available for distribution.
Municipalities in counties with producing wells	$28,681,020	27%	Divide the number of wells in the county by the number in the Commonwealth and multiply the resulting percentage by the amount available for distribution. Then, 50% of that amount goes to municipalities with wells or contiguous to or within 5 miles of municipalities with wells, and 50% is divided among all municipalities in the county.+

* Percentages, which are specified in Act 13, may not add to 100% due to rounding.

+ Within these awards, half of each of these pools of money is distributed to municipalities using a population formula (ratio of municipal population to total population of other eligible municipalities or total county population) and half using a highway mile formula (ratio of highway miles of municipality to highway miles of other eligible municipalities or total county highway miles).

Table 2.c: Marcellus Legacy Fund Allocations

Marcellus Legacy Fund Category	Amount Distr. ($72,484,000 total)	% of Total Amount Distributed
Commonwealth Financing Authority	$14,496,800	20%
Environmental Stewardship Fund	$7,248,400	10%
Highway Bridge Improvement	$18,121,000	25%
Water and Sewer Projects	$18,121,000	25%
Rehabilitation of Greenways, Recreation Trails, Open Space, Nature Areas	$10,872,600	15%
Projects to Liquefy/Convert Natural Gas	$3,624,200	5%

Source: Pennsylvania Public Utility Commission 2012

Finally, distributions to municipalities are capped. In any year, a municipality may receive no more than the greater of $500,000 or 50 percent of its budget for the prior fiscal year.

The Pennsylvania Housing Affordability and Rehabilitation Enhancement Fund distributed just under $8 million to county-level housing agencies for a total of 25 projects in December of 2013, 6 of which would be carried out in southwestern Pennsylvania. These funds may be used for rental assistance, improving the quality of existing properties, or the redevelopment of areas. The Fund aims to meet housing demands sparked by the gas boom, as well as addressing ongoing issues of affordability in areas where prices and rents have increased in response to wages in the gas industry.[538] Typically, counties that previously experienced development due to a history of economic growth have a greater capacity to mobilize resources to address the housing impacts of gas development. For example, local builders will be familiar with area housing needs, zoning regulations, and local officials, and therefore better able to respond to the increased need.[539]

Authorized Uses of Impact Fees

Under Act 13, county and municipal government spending of the local government impact fee distributions must fall within the following thirteen broadly-defined spending categories, and must be accounted for annually. The allowable categories for expenditure are:

1. Construction, reconstruction, maintenance and repair of roadways, bridges and public infrastructure
2. Water, storm water and sewer systems, including construction, reconstruction, maintenance and repair
3. Emergency preparedness and public safety, including law enforcement and fire services, hazardous material response, 911, equipment acquisition and other services

4. Environmental programs, including trails, parks and recreation, open space, flood plain management, conservation districts and agricultural preservation
5. Preservation and reclamation of surface and subsurface waters and water supplies
6. Tax reductions, including homestead exclusions
7. Projects to increase the availability of safe and affordable housing to residents
8. Records management, geographic information systems and information technology
9. Delivery of social services
10. Judicial services
11. For deposit into the county or municipality's capital reserve fund if the funds are used solely for a purpose set forth in this subsection
12. Career and technical centers for training of workers in the oil and gas industry
13. Local or regional planning initiatives under the Pennsylvania Municipalities Planning Code.[540]

Using data obtained from the PUC[541] in conjunction with municipal financial data obtained from the Pennsylvania Department of Community and Economic Development,[542] we analyzed the use of impact fees reported by municipalities and county governments in Allegheny, Greene, Washington and Fayette counties in southwestern Pennsylvania.

These counties differ greatly in population. Greene County is very rural and has a population of under 40,000; Fayette of 136,000, Washington of 207,000, and Allegheny of 1.2 million (2010 census).

Municipal Use of Impact Fees (2011 Impact Fees distributed in 2012)

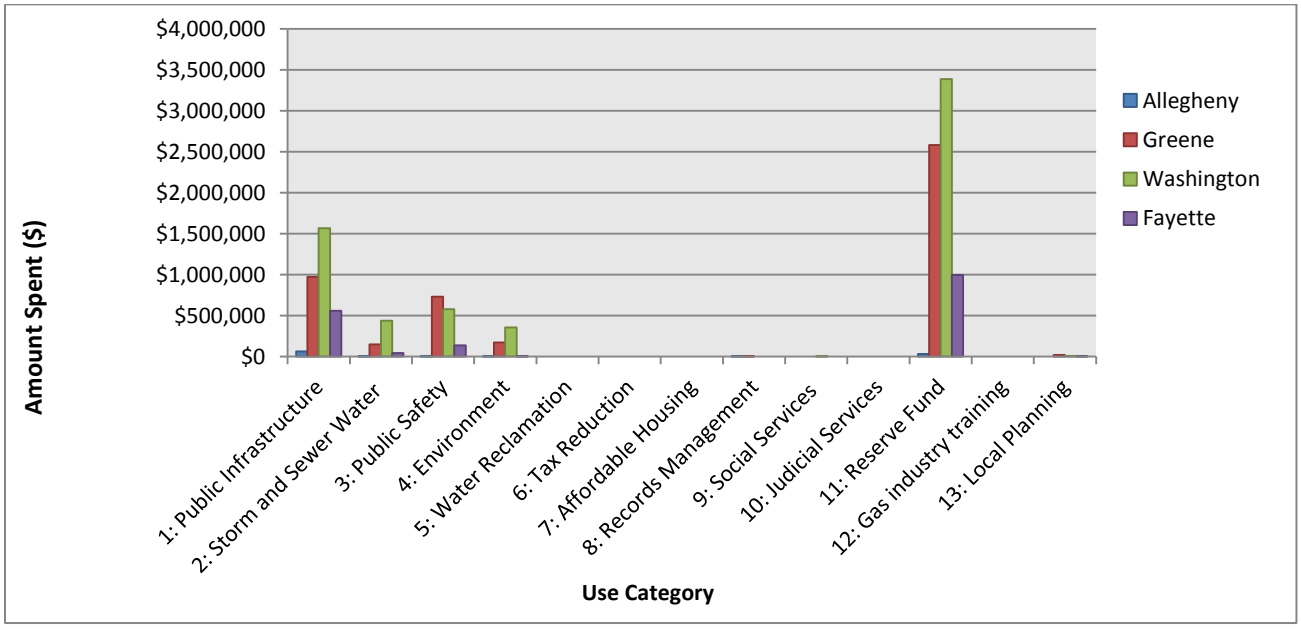
The municipalities within Allegheny, Greene, Washington and Fayette counties received a total of $14.9 million of the total $204 million in 2011 impact fees distributed within the Commonwealth. Table 3 summarizes municipal impact fee receipts in each of the counties. While Washington County municipalities received the largest amount in total impact fees, Greene County municipalities received the largest amount relative to their municipal revenues by a very large margin. The impact fees received by Allegheny County municipalities were insignificant as compared to annual municipal revenues. Counties with municipalities that received the most impact fees also showed the greatest range in impact fee distributions. In Greene County, for example, the maximum amount received by a municipality was $1,039,586 (Cumberland Township) and the minimum was $9,349 (Clarksville Borough).

Table 3: Impact Fee Disbursements for Municipalities in Four Counties (2011 Fees)

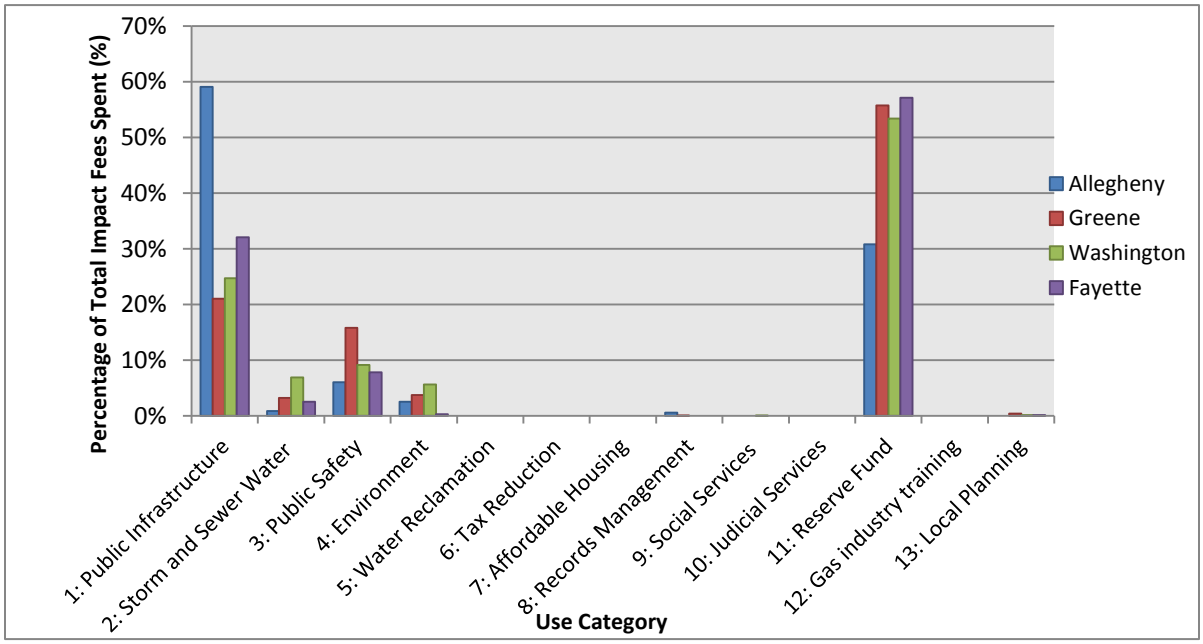
	Allegheny	Greene	Washington	Fayette
Total Fees Received by all Municipalities	$140,904	$5,155,144	$7,218,472	$2,369,184
Maximum Fees Received by a Municipality	$54,587	$1,039,587	$682,017	$376,132
Minimum Fees Received by a Municipality	$1	$9,349	$223	$757
Mean Fees Received by a Municipality	$1,110	$198,275	$109,371	$55,097
Mean Fees Received as a Percentage of Mean Municipal Revenue	0.01%	25.20%	5.12%	4.74%
Median Fees Received by a Municipality	$149	$119,209	$57,887	$23,053
Median Fees Received as a Percentage of Median Municipal Revenue	0.00%	23.02%	4.16%	4.26%

Graphs 1 and 2 illustrate how the municipalities within these four counties chose to spend their impact fees. The municipalities in Greene, Washington and Fayette (the counties which received higher payments relative to total municipal revenues) all chose to deposit over 50% of their fees into capital reserves whereas Allegheny County municipalities spent over half their (small) fees on public infrastructure.

Graph 1: Impact Fee Spending by Municipalities in Four Counties

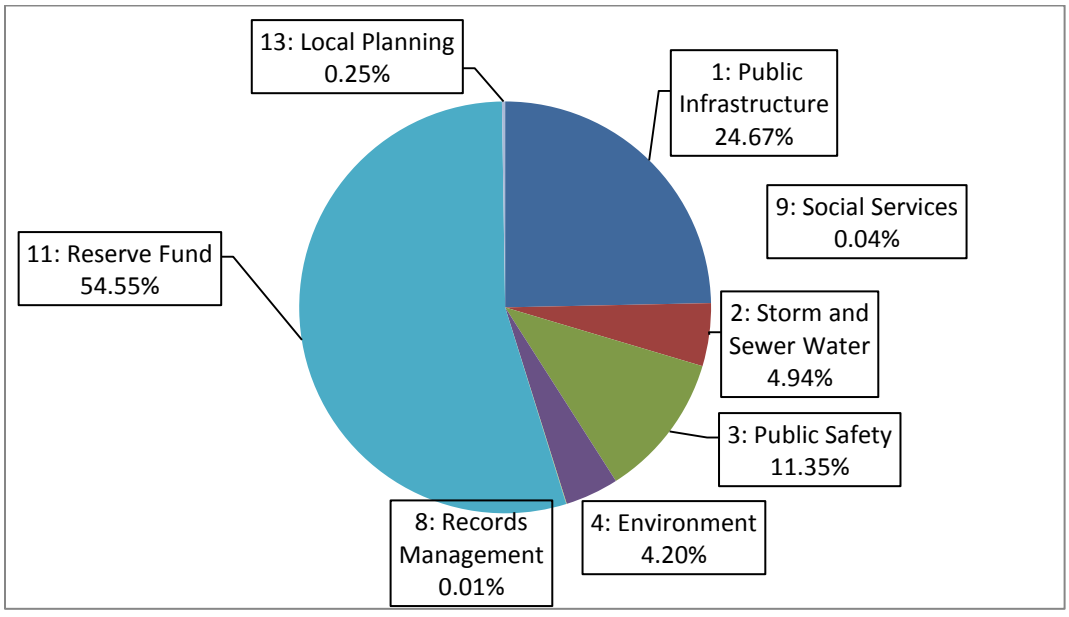


Graph 2: Percentages of Impact Fees Spent by Municipalities in Four Counties



Combining the data for all the municipalities, we found that over 90% of impact fee spending was within three categories: the reserve fund, public infrastructure and public safety. No municipality in any of the four counties reported spending in the categories of water reclamation, tax reductions, affordable housing, judicial services or gas industry training.

Graph 3: Municipal Impact Fee Spending in each Category as a Percentage of Total Impact Fees Spent by Municipalities in Four Counties

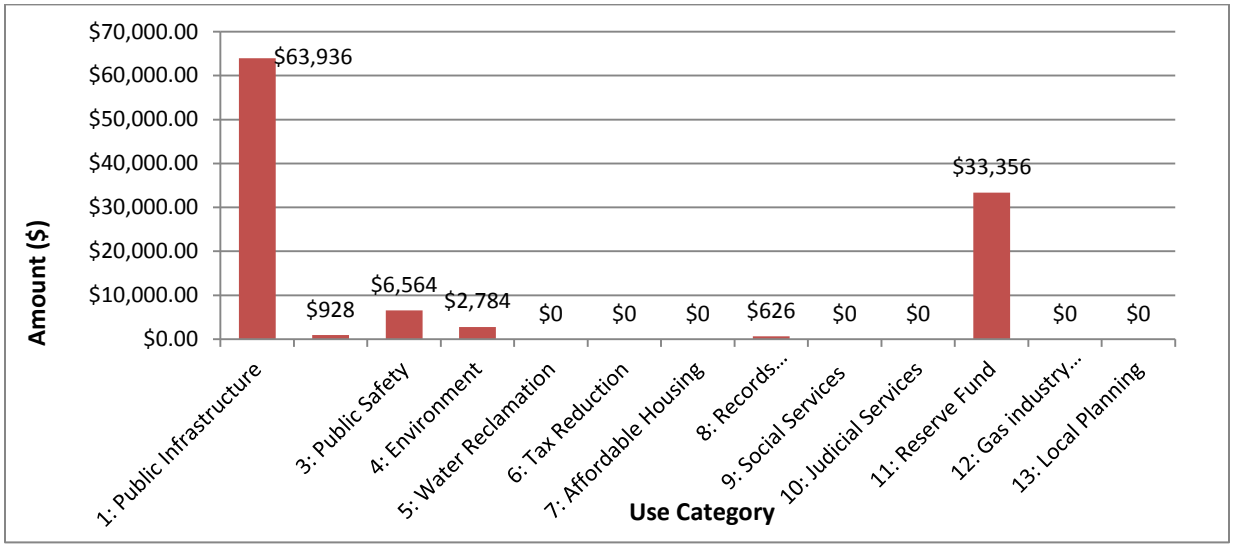


The graphs below give breakdowns of municipal impact fee spending in each of the four counties individually.

Allegheny County Municipalities

Graph 4 demonstrates that Allegheny County municipalities, which received, on average, the lowest amount of impact fees relative to municipal budgets, chose to spend the majority of their money on public infrastructure, placing comparatively less in a reserve fund. Aside from public infrastructure and the reserve fund, Allegheny County municipalities chose to spend 6.1% of their fees on public safety (category 3), 2.6% on environmental programs (category 4) and 0.86% on stormwater and sewer systems (category 2).

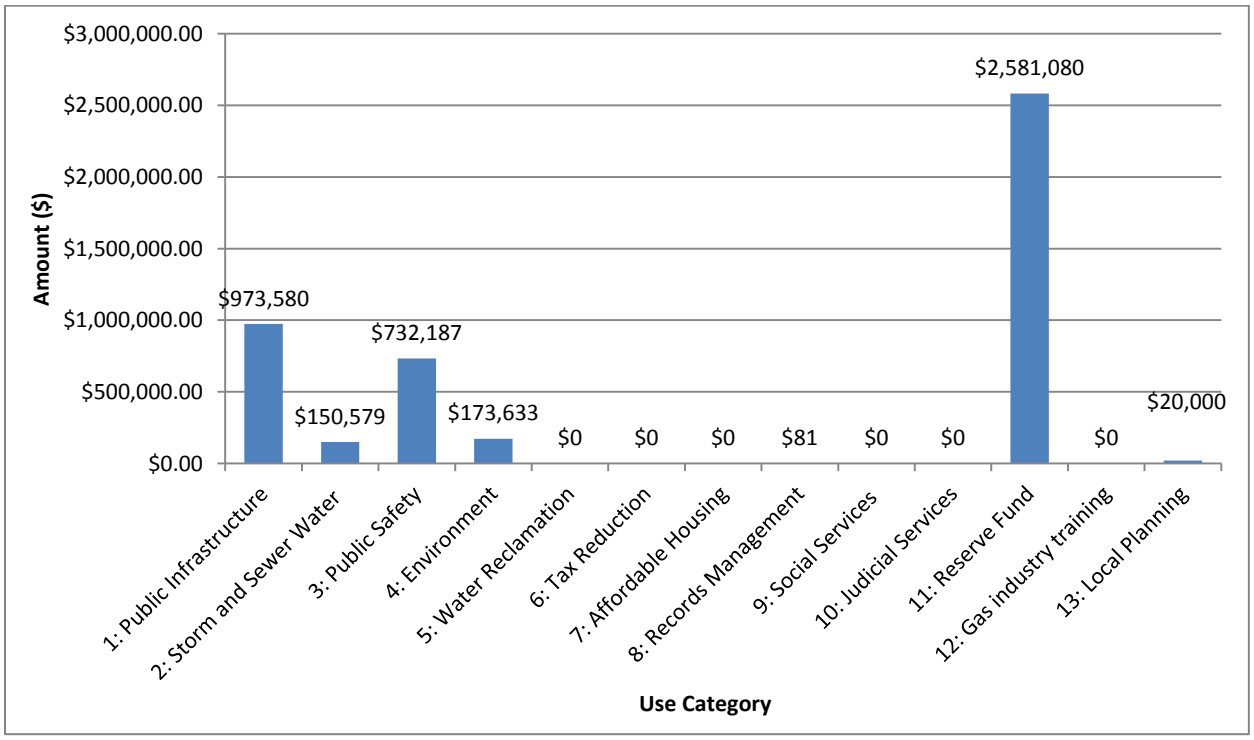
Graph 4: Impact Fee Spending by Municipalities in Allegheny County



Greene County Municipalities

Greene County municipalities, which received the largest amount of impact fees relative to municipal budgets, placed over half the impact fees they received in a reserve fund (see Graph 5 below). While they still dedicated 21% to public infrastructure, this was significantly less than the four-county average spending of 34% on public infrastructure. In addition to public safety and environmental programs, Greene County municipalities spent the remainder of their allocated funds on stormwater and sewer systems and a very small amount (0.43%) on local planning.

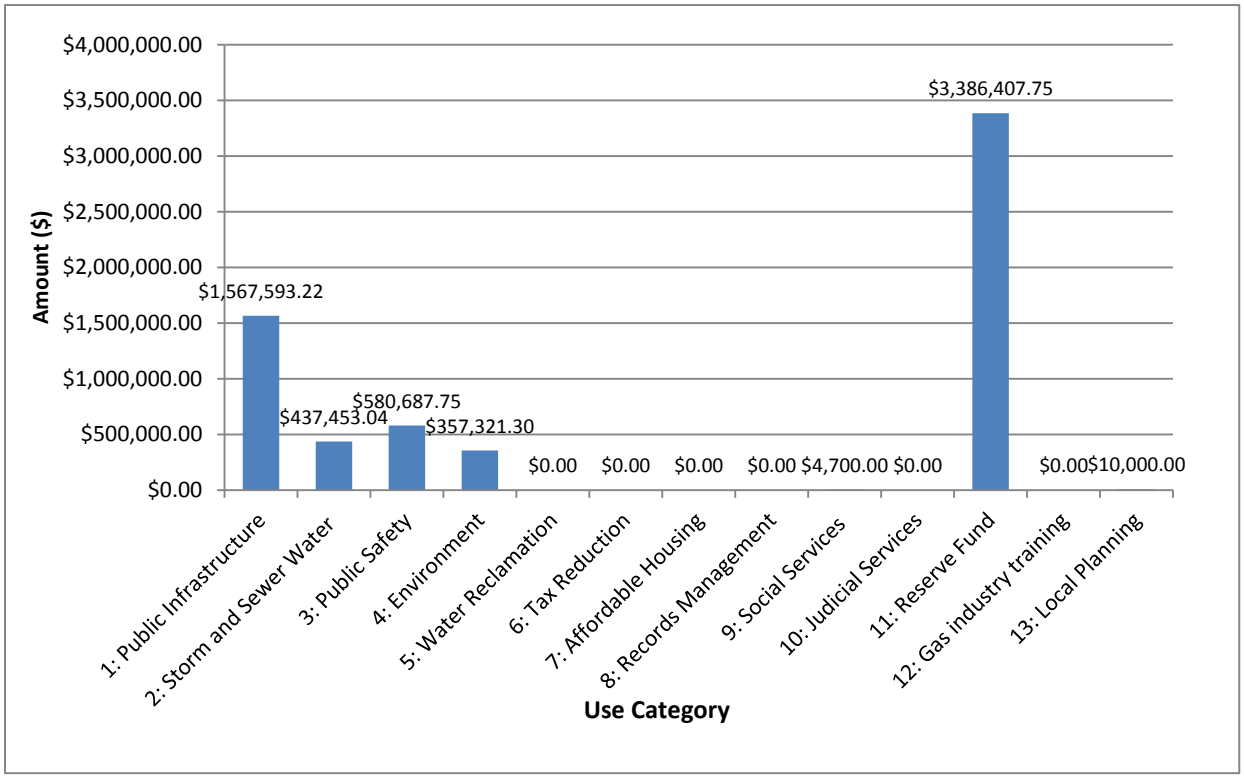
Graph 5: Impact Fee Spending by Municipalities in Greene County



Washington County Municipalities

Washington County municipalities made, on average, very similar impact fee spending decisions to their neighbors in Greene County, with over half of the money going to a reserve fund and the rest largely spent on public infrastructure (see Graph 6). Again, the remaining approximately 20% of funds went to stormwater and sewer systems, public safety, environmental programs and local planning. Washington County municipalities also chose to spend a very small amount (0.07%) on social services.

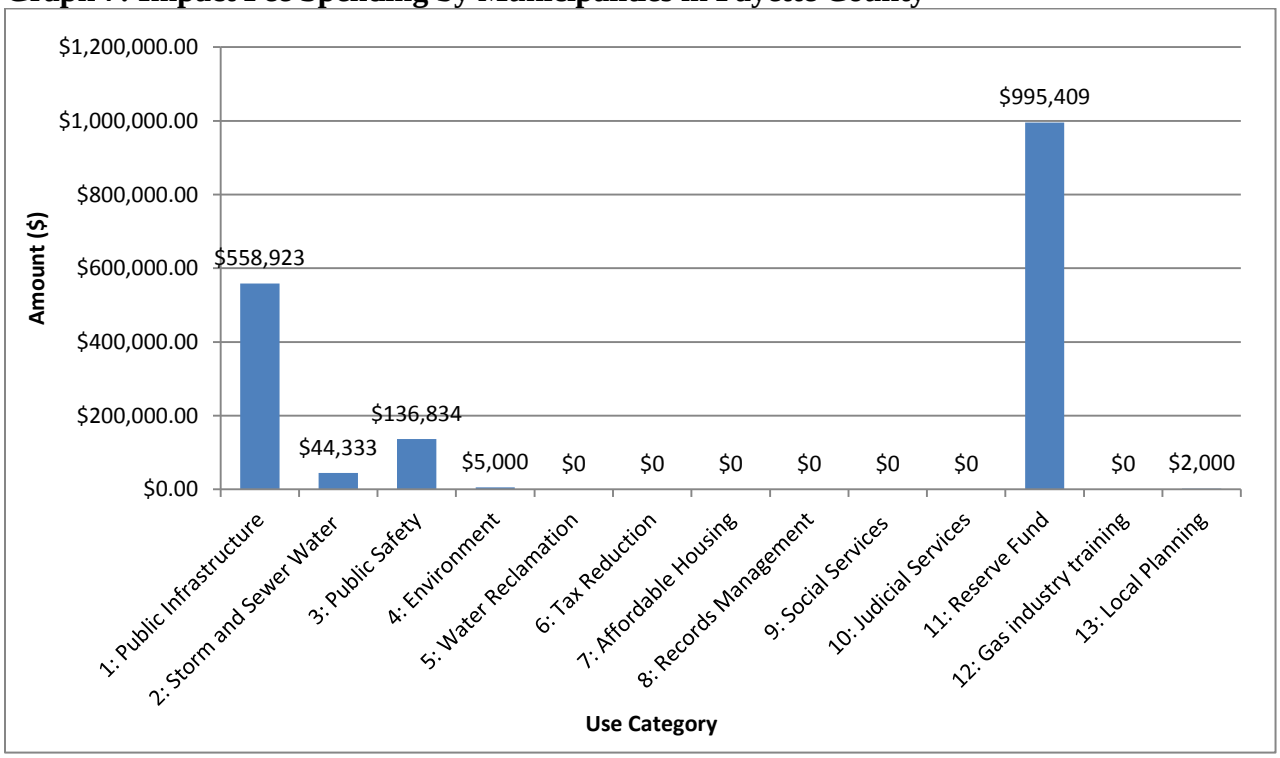
Graph 6: Impact Fee Spending by Municipalities in Washington County



Fayette County Municipalities

Fayette County municipalities also deposited over half their allocated fees in a reserve fund; the rest going largely to public infrastructure in addition to stormwater and sewer systems, public safety, environmental programs and local planning. Notably, Fayette County municipality spending was somewhat less diversified than that of the other three counties in the study: Washington, Greene and Allegheny County municipalities all spent on average between 75-80% of the fees they received on public infrastructure and the reserve fund, with 20-25 % spent amongst the remaining categories. Fayette County municipalities dedicated 89% of their fees to just the two categories of public infrastructure and the reserve fund, allocating only 11% of their funds to the remaining categories.

Graph 7: Impact Fee Spending by Municipalities in Fayette County

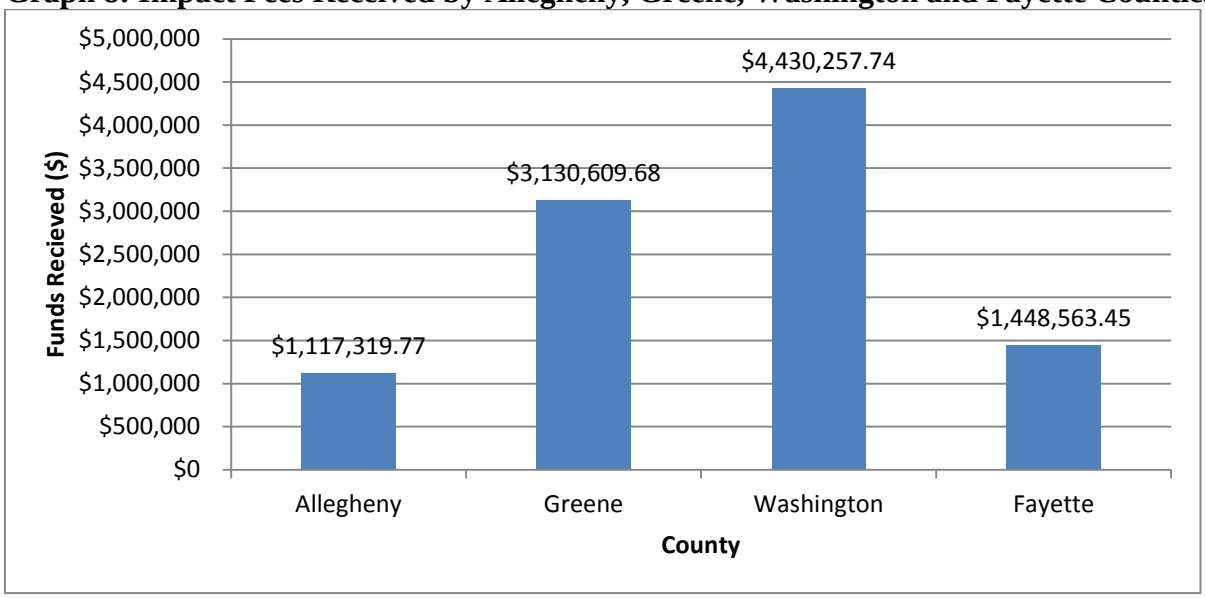


Spending data are not yet available for the year 2012 impact fees received by the municipalities. Total impact fee dollars available to the municipalities in these four counties are $0.25 million (Allegheny), $5.11 million (Greene), $8.04 million (Washington), and $2.19 million (Fayette) according to the PUC reports.

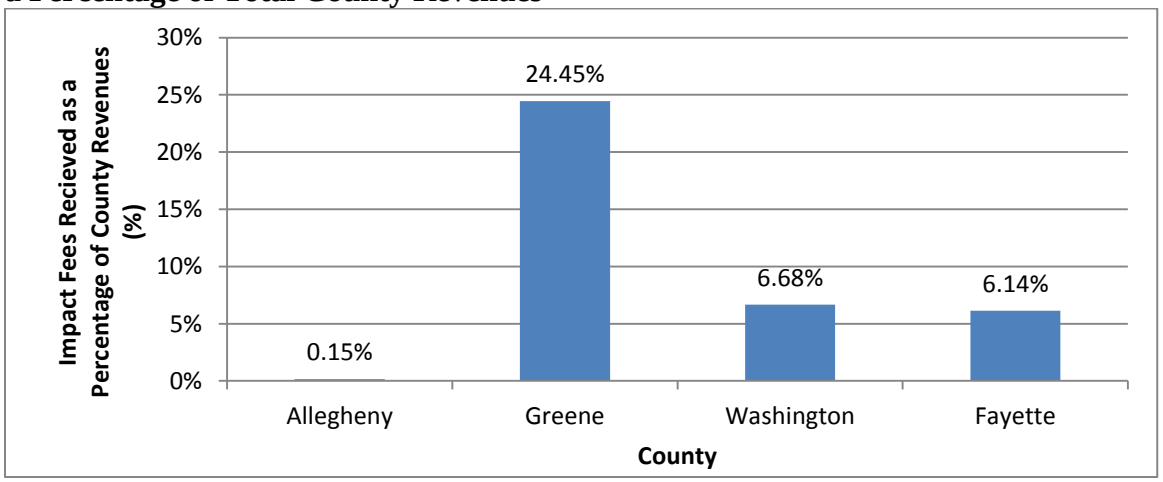
County Government Use of Impact Fees (2011 Impact Fees)

County governments also received impact fee distributions. Of the four county governments we examined, Washington County received the most total dollars, while Greene County received the largest amount relative to its total county government revenues.[543]

Graph 8: Impact Fees Received by Allegheny, Greene, Washington and Fayette Counties



Graph 9: Impact Fees Received by Allegheny, Greene, Washington and Fayette Counties as a Percentage of Total County Revenues



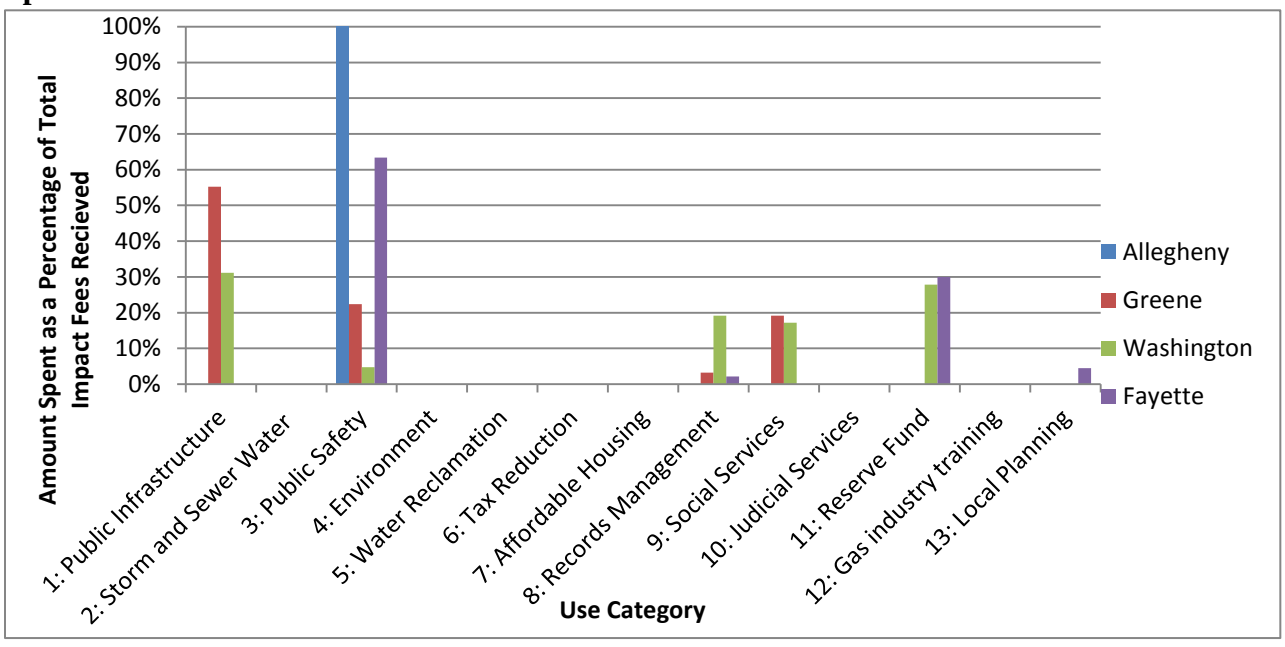
In most counties with shale gas wells, the bulk of the impact fee funds comes through section 2314(d)(1), which targets funds to counties with shale gas wells, and which requires the counties to account for expenditures in the same 13 categories as the municipalities. But funding to all Pennsylvania counties also comes from the counties' share of greenway funds from the

Marcellus Shale Legacy Fund under Section 2315(a.1)(5). In the case of Allegheny County, which has a large population but minimal shale gas development, only $79,430 came from the county distribution in 2011, but over a million from the Legacy Fund. In contrast, in Fayette County, the figures were $1,223,667 and $115,896; in Greene County $3,097,788 and $32,821; and in Washington County $4,253,943 and $176,315.

In terms of accounting for county government impact fee spending, Allegheny County had to account for an insignificant amount of well-based impact fees under (d)(1) -- $79,430 compared to county revenues of $736.2 million. It chose to spend 100% of its fees on public safety. However, the other three counties chose to distribute their impact fees amongst multiple categories.

As seen in Graph 10, overall the counties (Allegheny being the exception) distributed their impact fees more evenly across the 13 categories than did the municipalities, with most of the fees going towards public infrastructure, public safety, the reserve fund, records management and social services. Like the municipalities, the counties chose to spend no money on water reclamation, tax reductions, affordable housing, judicial services and gas industry training.

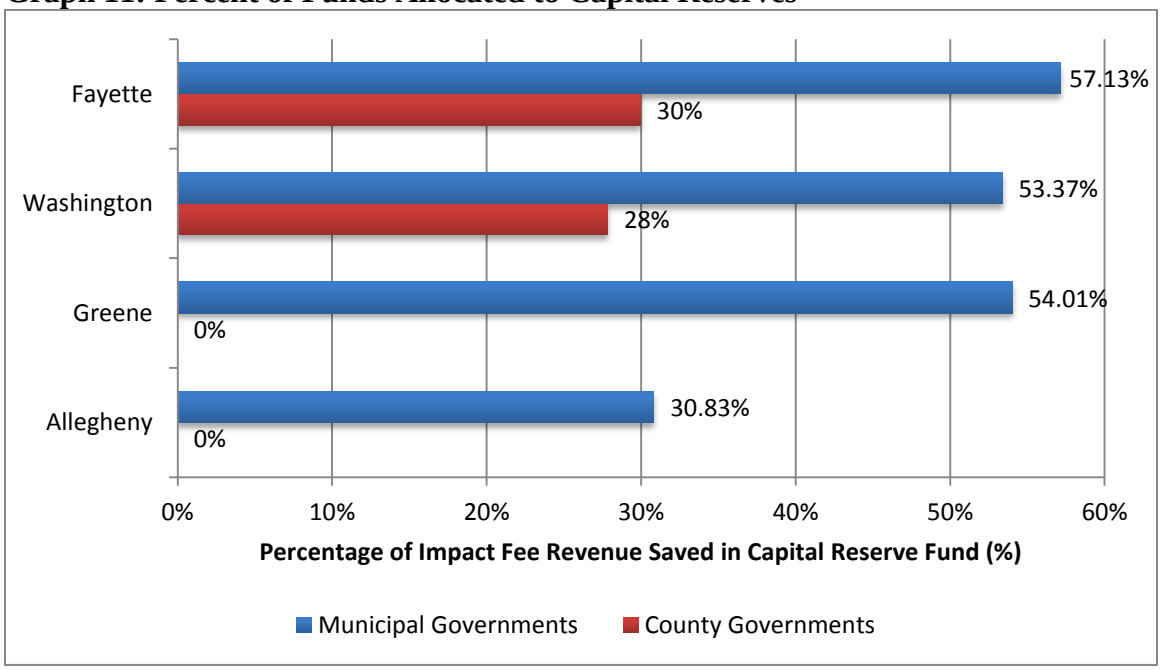
Graph 10. County Government Impact Fee Spending as a Percentage of Total Impact Fees Spent



Overall Comparisons

In this section, we examine specifically how much the counties and municipalities in our study chose to save versus spend their impact fee revenue. Graph 11 below shows the percentage of impact fee revenue placed in a capital reserve fund by the municipal governments and the county government in each county. The municipal governments in all four counties saved more than did the county governments.

Graph 11: Percent of Funds Allocated to Capital Reserves



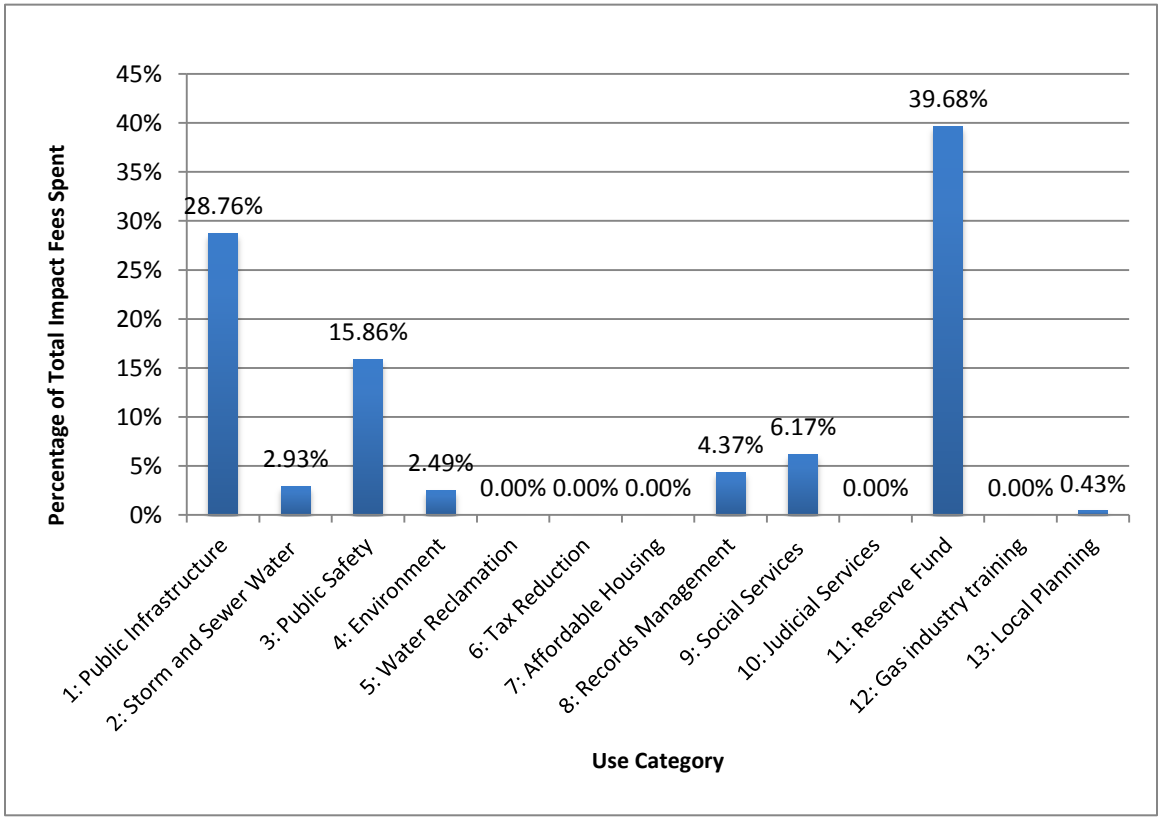
One possible way to understand this trend is in terms of *windfall revenue*. Natural resources revenue, such as the Pennsylvania impact fee revenue, can be considered windfall revenue in the sense that it is difficult to forecast—as a result of factors such as commodity price volatility—and in the sense that it is temporary. Academic research on windfall spending has resulted in two main conclusions. Research on individuals and households reveals that windfalls are often consumed in proportion to the size of the windfall to an individual or household's total income. The marginal propensity to consume windfall revenue has been found to decrease as the relative size of the windfall to the overall individual or household budget increases. In other words, households and firms are generally more likely to spend windfalls that are small and save those that are large. However, research on public spending of windfall revenues has reached a different conclusion. A number of studies have shown that the propensity to consume public windfall revenues is high regardless of the proportional size of the revenue to the overall budget, although it must be noted that most of this research has been conducted in an international context with a focus on developing economies.[544]

The trend exhibited in Graph 11 seems to be more in line with the research on individual and household windfall spending as the local governments with greater impact fee revenue relative to government income tended to save a greater proportion of their impact fees (Greene County government being the exception). Although this hypothesis would certainly require further investigation, it is possible that local impact fee spending in the context of natural resource development in southwestern Pennsylvania is closer to the individual or household model than it is to that of a larger public economy.

County receipts from the 2012 impact fees received by counties in 2013 were similar in scale to 2011 - $1.7 million (Allegheny), $1.35 million (Fayette), $2.91 million (Greene), and $4.70 million (Washington), according to the PUC's report for that distribution year. We may expect spending patterns to follow a similar profile. Data will be available in the months following the April 2014 reporting deadline.

In our final review of the use of the 2011 impact fees, we combined the data for each of the county and municipal governments within all four counties and looked at total impact fee spending (see Graph 12 below). Overall, county and local governments in these four Southwest Pennsylvania counties deposited 39.68% of their impact fee revenue in a reserve fund. Significant amounts were also spent on public infrastructure (28.76%) and public safety (15.86%). They distributed the remaining 15.7% of their impact fee revenues amongst the following categories (from highest to lowest amount spent): social services, records management, stormwater and sewer systems, environmental programs, and local planning. No money was spent on water reclamation, tax reduction, affordable housing, judicial services or gas industry training.

Graph 12: Impact Fee Spending as a Percentage of Total Impact Fees Spent for Municipality and County Governments in Four Counties



Notes on the Data

The data in this analysis concern the first year (the 2011 reporting year/2012 distribution year) that the impact fee was in effect. It was thus the first time that the municipal and county governments were required to manage their impact fee revenue and complete the PUC Unconventional Gas Well Fee Report Form. As such, it is possible that the first year's data might not exhibit the same trend as that of later years; it may also reflect mistakes associated with completing and submitting the new PUC forms. For example, a number of municipalities (as well as the Allegheny County government) did not report the same amount spent as received. Some of these local governments noted on their forms that they were still in the process of determining how to spend the money and others just left the relevant sections blank without explanation. A PUC spokesman explained that there should be no circumstances under which the amount reported does not equal amount spent: if a local government does not spend the entirety of its impact fee within the given year, it should note that amount in the capital reserve spending category.[545] As of 2013, the use of many impact fee dollars remained unaccounted for across the Commonwealth, purportedly due to similar paperwork confusion.[546] It may be useful to examine the second year's impact fee spending trends and compare this with the first year's spending

when the data become available in the months following April 2014, the reporting deadline. In addition, there were a number of municipalities in each county for which there was either no PUC data or Pennsylvania Department of Community and Economic Development revenue data available. We were thus unable to include these municipalities in our analysis.[547]

D. Alternative Taxing Mechanisms

Other mechanisms not provided for under Pennsylvania law could be considered for generating public revenues from large-scale resource extraction activities. It is instructive to review, for comparison purposes, how such taxes or fees are calculated and used in other states.

Severance Taxes and Impact Fees

In general, there are two key purposes for taxing the extraction of an exhaustible natural resource such as natural gas. The first is to compensate the state and its citizens for the asset being removed. It is part of the valuable natural resource base that, once alienated, will not be regenerated or replaced. In this respect it is unlike most other objects of taxation. The second purpose is to compensate the public for the environmental, economic, and social costs (externalities) associated with that removal.[548]

The most common mechanism for accomplishing these objectives is a severance tax. There are 34 states in the U.S. that impose some type of severance tax on the extraction of nonrenewable resources within their borders.[549] Severance taxes are based on the economic value of the resource and can be structured in various ways, including taxing some percentage of the gross value, production value, market value, sale price, volume, or income generated by the sale, of the resource.[550]

In most instances, severance taxes, unlike the impact fee, factor the production of a well, i.e. its economic value, into the calculation of the tax. As a consequence, the revenues generated by a severance tax increase as the economic value or production volume of the extracted resource increases. In contrast, and as described above, the impact fee revenues are expected to remain at a relatively stable level even though the production of the natural gas in Pennsylvania and its economic value have increased. [551] The fee was first paid in 2012, based on well activity that occurred in the years up to 2011. The fee generated $204.2 million in 2012 (when gross withdrawals in 2011 were 1,310,592 MMcf), $202.5 million in 2013 (when gross withdrawals in 2012 were 2,256,696 MMcf); and $224.5 million in 2014 (when estimated gross withdrawals in 2013 were 3,094,413 MMcf).[552]

- 2012 $204.2 million
- 2013 $202.5 million
- 2014 $224.5 million

Because the fee declines rapidly over the first four years for each well, maintaining similar funding levels statewide will require substantial numbers of new wells to be spud each year to offset the revenue declines. For example, assuming a New York Mercantile Exchange price of $3.00-4.99, about 1,200 new unconventional wells will need to be drilled in 2014 to offset the declining impact fee amounts being paid by those wells currently paying the fee, in order to achieve similar amounts of revenue in the 2015 distribution. This is even though, as shown above, the amount of gas likely to be produced will continue to increase.

Recently the Commonwealth's Independent Fiscal Office (IFO) conducted a study that compared Pennsylvania's impact fee with the severance taxes of ten other states, each of which produces significant quantities of natural gas.[553] The IFO calculated the amount of tax revenue a single gas well would generate over its life under each state severance tax/fee policy. Because of the unique features of each state's tax and fee policies (what is taxed, what rates are used, and what exemptions or credits are permitted) a simple comparison of the state tax *rates* could not provide a valid analysis.

To address this issue, the IFO adopted a uniform metric, an "effective tax rate," which takes into account the severance tax or impact fee rate in each state *as well as* the local real property tax when that tax is levied on the value of natural gas reserves or by gross receipts. After computing the effective tax rate for each state, the IFO then applied the effective tax rates to a specific amount of gas, sold at a specific price. For the amount of gas, the IFO used the amount of natural gas that would be produced over the life of a well drilled into the Marcellus Shale formation and hydraulically fractured, and which begins production on January 1, 2014. For the price, the IFO used the Henry Hub spot price, which serves as the national spot price and shares a very high correlation with the average U.S. wellhead price reported by the Energy Information Administration. To account for variations in price and production, each effective tax rate was then applied to four scenarios: low and high prices for a low-producing well and low and high prices for a high-producing well. The effective tax rate equals the net present value of severance and property taxes levied upon a well divided by the net present value of the market value of natural gas sales from that well over a 30 year time period.

Because West Virginia and Ohio, two of the eleven states included in the study, are located in and extract natural gas from the Marcellus Shale formation, it is instructive to compare the effective tax rates of these two states with Pennsylvania. The IFO found that Pennsylvania has the lowest effective tax rate in *each production level and price scenario* among all eleven states evaluated. Ohio has the second lowest effective tax rate, both in comparison with Pennsylvania

and West Virginia and among all eleven states evaluated. West Virginia has the highest effective tax rate, both in comparison with Ohio and Pennsylvania and among all eleven states evaluated.

Effective Tax Rates -- Low Production Scenario

Pennsylvania	Low Price 1.6%	High Price 1.3 %
Ohio	Low Price 1.8%	High Price 1.4%
West Virginia	Low Price 7.2%	High Price 7.2%

Effective Tax Rates -- High Production Scenario

Pennsylvania	Low Price 0.8%	High Price 0.6%
Ohio	Low Price 1.8%	High Price 1.4%
West Virginia	Low Price 7.5%	High Price 7.5%

These IFO findings are influenced by the inclusion of local taxes in the comparison. Because Pennsylvania does not include natural gas in the assessed value of real property subject to local taxation, its total "effective tax rate" is generally going to be lower than in states that do tax natural gas locally. However, the IFO found that even considering severance taxes or impact fees *alone*, Pennsylvania's rate is second lowest among the eleven states, using the low production scenario, and tied for lowest (with Ohio) in the high production scenario.[554]

Effective *Severance* Tax Rates -- Low Production Scenario

Pennsylvania	Low Price 1.6%	High Price 1.3%
Ohio	Low Price 0.8%	High Price 0.6%
West Virginia	Low Price 5.8%	High Price 5.7%

Effective *Severance* Tax Rates -- High Production Scenario

Pennsylvania	Low Price 0.8%	High Price 0.6%
Ohio	Low Price 0.8%	High Price 0.6%
West Virginia	Low Price 5.8%	High Price 5.7%

In reviewing the findings of the IFO study it is important to understand its limited objective. Although the study establishes that the Act 13 impact fee generates less revenue than the severance taxes/impact fees considered in other states, (except for the low production scenario and excluding local taxes, where Ohio is lower), the IFO does not make any policy recommendations as to whether Pennsylvania should enact a severance tax. The IFO's goal was simply to provide a meaningful comparison of Pennsylvania's impact fee with the severance taxes of similarly situated states.

Because insufficient information was available the IFO could not factor into the effective tax measure certain other taxes that the natural gas industry pays in any state, including corporate and personal income taxes and personal property taxes. However, the report discusses these other taxes in its narrative section and provides insight as to the effects of those taxes. Finally, the

study does not take into consideration labor, equipment, and transportation costs which can vary from state to state and from location to location affecting the profitability of a particular natural gas extraction site.[555]

Use of Revenues from Natural Resource Extraction

As a general matter, in the 34 states in the U.S. that have developed severance taxes, the revenues primarily have been allocated to a permanent severance tax trust fund ("permanent fund") for investment, shared with local governments, or earmarked for environmental protection purposes through a designated fund.[556]

Permanent Funds

The long-term success of severance taxes often turns on whether some portion of the tax revenues are placed in a permanent fund and invested to provide long-term benefits from the one-time extraction of a resource. Permanent funds allow states to invest their tax revenues into securities, business investments and real estate, enabling the states to generate future earnings which are independent of the revenues generated directly by the natural resource extraction industries. These funds are called "permanent' because they are either constitutionally protected or require the approval of a significant portion of the legislature to withdraw money from the fund principal. The earnings generated by the fund can be retained, or distributed to the public through state programs and through allocations to local governments. Alaska, Montana, New Mexico, North Dakota, Utah, and Wyoming all invest a significant part of their severance tax revenues in permanent funds.[557]

Alaska places 25% of income generated from extraction of its mineral resources into the Alaskan Permanent Fund. These funds are invested in stocks, bonds, and real estate by the Alaska Permanent Fund Corporation, and dividends are paid out based on 5-year average realized earnings for each given year. The earnings are distributed to qualifying state residents, or used for inflation-proofing.[558]

Montana places 50% of the revenues it gains from a coal severance tax into the Coal Severance Tax Trust Fund. The investment of the fund is managed and overseen by the Montana Board of Investments. The earnings gained by the fund are spent on economic development, water distribution infrastructure, and drinking water development. In 2010, the permanent fund was valued at $836 million and received an annual investment return of 4.9%.[559] As of 2009, outside of the permanent fund, 48% of the severance tax revenue was distributed to counties and school districts within the state.[560]

New Mexico on average allocates 12.5% of the revenue it gains by its severance tax into its Severance Tax Permanent Fund. The earnings gained by the fund are then disbursed for general revenue and educational purposes. Between 1990 and 2010, New Mexico's Permanent Fund allocated $3.3 billion for these uses.[561]

North Dakota places 30% of oil and gas production and extraction taxes into its Legacy Fund. This fund is not invested but is held in an account and cannot be spent until June 30, 2017. At that time, any expenditure must be approved by a two-thirds vote from the members of the North Dakota Legislative Assembly. The spending of the fund is limited to no greater than 15% of the principal during a biennium.[562]

Utah places severance tax revenue in excess of $77 million from oil and gas extraction and in excess of $27.6 million from coal mining into the Endowment Fund. The earnings from investment can only be spent if approved by a three quarters majority of the state legislature and the Department of Local Affairs and the Department for Natural Resources. The Department of Local Affairs distributes the funds to local governments within Colorado, while the Department of Natural Resources spends the revenue on oil and gas regulation, energy assistance programs, wildlife conservation, and water conservation projects.[563]

Investment via a permanent fund allows the state to produce a cycle of revenue that can operate independent of the revenues generated by the gas, coal, and oil industries present in the local economy. Therefore, if these extractive industries decline or terminate the state is still able to generate revenue and invest in its economy.

Distributions to Local Governments

Several states, including West Virginia, Louisiana, Montana and Colorado, have followed the path of the impact fee policy and provide for the distribution of severance tax revenue to their local governments. In 2008, West Virginia returned $35 million of severance tax revenues to local governments; 75% was distributed to coal and gas producing counties, while the other 25% was distributed to counties without any coal or gas production activities, based on the population of those counties.[564] Because all localities receive revenue and have the opportunity to invest it in the development of their local economies, West Virginia's policy allows for the development and diversification of local economies all across the state rather than only those that are related to the industrial activity that generates the revenues.

In Montana, 48% of severance tax revenue is allocated to local governments and school districts.[565] The allocation of revenues to school districts is one aspect of Montana's tax policy that distinguishes it from Act 13. Investment in schools and education is generally viewed as an investment into human capital, or knowledge, of the future generations that will be raised within

the state. Investment into education/human capital promotes the growth and diversification of an economy because individuals with a higher level education generally are able to contribute at a higher level to the development of local and state economies. In this way, Montana's severance tax policy fosters the state's ability to support a wider range of economic activities and promotes the diversification of its economy.

Colorado's severance tax policy resembles Act 13, in part. A portion of the severance tax revenue is allocated to local governments that support extractive industries based on a formula similar to the allocation method used by Act 13. However, 25% of the tax revenue in Colorado is separately earmarked for a permanent fund which is invested and whose earnings can be used to aid recovery from an economic downturn resulting from a decline in extractive activity.[566]

VIII. RESPONDING TO IMPACTS: ECONOMIC STRATEGIES

Economic benefits should outlast the primary period of extractive industry investment and activity. Local governments must plan carefully for growth in the immediate future while developing projects, facilities, and services that will remain viable after growth has diminished.[567]

Municipal leaders can learn a great deal from communities in other states where oil and gas development has been conducted for many years. These communities have already developed strategies for adapting to and overcoming the impacts of nearby operations. Communicating with leaders and residents in these regions, or visiting if possible, can assist in anticipating and combating the inevitable difficulties the community will face.[568] Communities can create a task force to assemble information and provide aid to local governments undergoing rapid social and economic changes related to oil and gas development. Identifying social and economic changes can help mitigate disruption and ease social conflict among residents. The task force, which should include broad participation, can assist local officials in identifying these problems and developing responses to them, as well as guide community discussions, information gathering, and decision making. Some of the keys to developing a successful task force include having an organized plan (including goals for the task force), establishing a leadership team to guide the process, transparency, focused discussions, and developing detailed operating protocols for how decisions will be made and to ensure accountability.[569]

Key strategies for Pennsylvania communities include, in addition to consideration of a capital or permanent fund to ensure that today's gas revenues and impact fees are available to support tomorrow's economy, a focus on economic diversification; and recognition and preservation of a renewable natural resource base to sustain outdoor recreation, travel, and tourism based on Pennsylvania's unique amenities and resources.

A. Economic Diversification

Economists suggest that regions should rely on a multitude of economic activities to be competitive in the global market.[570] This means that a region should establish a diverse portfolio of economic activities to stay viable. While regional industries need not be entirely mutually exclusive, some differentiation is necessary. For example, a city that relies on information technology may benefit from a firm that manufactures computer chips, another that writes software, and another that manages data. These activities are interrelated but not identical; thus a decline in one industry may not necessarily precipitate a decline in the others. Establishing a wider range of economic activities proves more tenable than relying on a single industry in the long-term.[571]

Furthermore, economists argue that cities and regions must also have greater specialization and flexibility in order to remain competitive. Specialization in this context means that a region should strive to be the eminent source of expertise in a particular industry or industries. If a region is home to a number of technologically related industries, then that region ought to be the epicenter of innovation in those industries.[572] In addition, a region should be able to quickly adapt to changing circumstances or be flexible (e.g. technology, knowhow, changes in supply/demand) in order to remain competitive. Thus, regional economies must be agile in order to compete with other regions.

These tenets of competitiveness—diversification, specialization, and flexibility—should stay at the forefront of the minds of policymakers in communities across Pennsylvania. For diversification will be a key component in the mitigation of the effects of any boom and bust associated with shale gas extraction.

One needs only to look at the Pittsburgh experience to appreciate the importance of these tenets for economic development and economic resilience. The steel industry began to decline in the 1970s, and by the end of the decade had all but collapsed.[573] As the steel industry faltered, so, too, did the region's economy. Between 1979 and 1983, the unemployment rate nearly tripled, with unemployment reaching 17.1 percent in 1983.[574] The magnitude of the economic downturn in Pittsburgh can be at least partially attributed to the fact that the City had few other manufacturing-based industries to absorb the economic shockwave that followed steel's decline. In order to re-gain its footing, Pittsburgh was forced to reinvent itself and its economy. Rather than waiting for steel to rebound, city leaders promoted a complete structural shift away from manufacturing and toward the service sector.[575] Employment statistics show that heavy metal manufacturing shrunk from 100,000 employees in 1979 to a mere 28,600 employees in 1987; but health care, technology, and other professional services increased.[576] By the mid-1990s, the City had almost fully transitioned into a high-end service economy.[577]

There were a number of factors at play in facilitating the complete structural overhaul of the City's economy. Pittsburgh supported the transition by embracing and capitalizing on the success of two major universities, Carnegie Mellon and the University of Pittsburgh, and specifically, strengths in computer technology and medicine.[578] The City's reliance on its major universities (higher education) as well as its hospital system (medicine) and related industries led to the colloquial use of the terms "eds" and "meds" to describe Pittsburgh's economic development strategy.

A hallmark of the economic transition in Pittsburgh was the collaborative effort among City officials, private firms, and public organizations.[579] Appreciating the gravity of the City's economic situation, public officials embraced the advice and guidance of major public and private actors in the region.[580] The dialogue between these actors and City officials laid the

foundations for public-private partnerships to improve Pittsburgh's economy.[581] One of the dominant partnerships in Pittsburgh's renaissance was that of the City and the Allegheny Conference on Community Development (AACD), an organization headed by a number of Pittsburgh's corporate leaders. In 1984, the organization released *A Strategy for Growth: An Economic Development Program for the Pittsburgh Region*. In this blueprint, the AACD called for growth in corporate headquarters, financial services, education, and health with a deliberate shift away from manufacturing.[582] Public officials embraced many of the recommendations made by the AACD and acted to implement the blueprint shortly after. In 1985, Mayor Richard Caliguiri, in conjunction with the Allegheny County Commissioners and leaders from Carnegie Mellon and the University of Pittsburgh, passed a funding proposal to accomplish the goals outlined by the AACD. The funding proposal commonly referred to as *Strategy 21* officially set the City on a path toward the service sector and away from manufacturing.[583]

Other organizations formed to coordinate efforts between various neighborhood and community groups to promote economic development initiatives. One such organization was the Pittsburgh Partnership for Neighborhood Development (PPND), founded in 1982. The PPND was formed by representatives from the Ford Foundation, Heinz Endowments, and Mellon Bank Foundation.[584] The PPND worked to provide capital to local community development groups as well as technical assistance. And while interactions among the many interested groups, government officials, and private organizations were at times contentious, the mere engagement of a multitude of actors proved invaluable. Partnerships and coalitions like those discussed here will be important in developing economic alternatives for communities engaged in natural gas extraction today.

Many of the groups formed during the economic restructuring would not have been viable without the beneficence of Pittsburgh's charitable and philanthropic organizations.[585] As seen with the PPND, foundations often served as intermediaries between community groups and charitable donors to provide community groups with much needed capital.[586] In a number of cases, however, philanthropies took the leading role in major revitalization projects through both investment and coordination.[587]

While not every community in Pennsylvania is fortunate enough to have several major philanthropies and charitable organizations, revenue collected from shale gas impact fees might be used, within the limits allowed by Act 13, as an endowment for future economic development initiatives. Other states and countries around the world have established such endowments to ensure that wealth generated from extraction today is sustained tomorrow.

Labor and Human Capital

Arguably the most problematic of the growing pains felt during Pittsburgh's structural shift was stubborn unemployment. When steel collapsed, thousands of manufacturing jobs were lost, displacing 10 percent of the manufacturing workforce.[588] The decided shift away from manufacturing and toward the service sector thus required thousands to find not only a new job but also a new industry. With so many out of work, City officials and community organizations established job-training programs and career services to help prepare workers for employment in the new economy. In many cases these organizations were funded by the Pittsburgh Partnership JTPA (Job Training Partnership Act). By establishing the training centers and job networks in tandem, organizations were able to establish a pipeline of labor to serve new companies forming in the region.[589] Organizations, firms, and leaders realized early on that collaboration to re-train displaced workers would benefit all parties involved—that is, by working together, citizens could get back to work, companies could fill vacancies more quickly, and the City could reduce the unemployment rate.

As demand for labor decreases, particularly in the highly-specialized field of shale gas extraction, municipalities and the region are facing the task of re-tooling the labor force. Planning collaboratively, as in the 1980s and 1990s, may help smooth the workforce transition.

Clustering and Spillovers

The "eds" and "meds" strategy employed by Pittsburgh required collaboration and cooperation on the parts of public officials and university leaders. Rather than relying on the universities and hospitals to simply generate business vis-à-vis consumption (dollars spent by students and visitors on housing, accommodations, restaurants, and retailers), through partnerships, negotiations, and public policy, the City facilitated the expansion of the universities in an effort to promote technology transfers and innovation throughout Pittsburgh. One major expansion occurred in 1986 when Carnegie Mellon partnered with the Department of Defense to locate its Software Engineering Institute near Carnegie Mellon's campus. The project brought in millions of federal dollars and spawned a multitude of technology and software related spin-off firms. Carnegie Mellon and University of Pittsburgh partnered to found the Western Pennsylvania Advanced Technology Center, a multimillion dollar project designed to help small technology start-ups grow.[590]

Communities engaged in natural gas extraction can learn from Pittsburgh. This does not mean that municipalities must seek out a community college or university partner. Rather, communities should look for ways to nurture entrepreneurship, and new start-up businesses.

Local economic development agencies as well as universities and colleges can help in this process.

Business and Technology Incubators

Many communities have established business incubator programs. These programs are collaborative in nature and typically involve an agency or organization (such as a local economic development agency or university) providing work spaces (offices, labs, etc.), infrastructure (telecommunications, internet, etc.), and business support (mentoring, training, managerial assistance) at affordable prices to select new or fledgling business ventures. Many incubators focus on a common theme, such as empowering minority or female-owned firms, while others focus on a particular industry, such as advanced manufacturing or automotive engineering. Over the past several years, communities have embraced incubator programs because they boost employment and open up new sources of revenue at a relatively low cost. The Economic Development Administration estimates that incubators generate as many as 47 to 69 local jobs per $10,000 of public funds invested—a higher rate of return than many other investments.[591] Conversely, businesses have embraced incubator programs because they provide much needed support and knowhow at a low cost to the firm.

While the business incubator model varies widely from community to community in design and function, most offer affordable rates for office space in a single office or office park, promote knowledge sharing and mentoring, incorporate educational and/or training initiatives, and feature a leadership coalition or central management team. These standard aspects of the business incubator are found in most programs across the country.

The affordability of offices, studios, workshops, and other spaces is one of the most common if not most popular aspects of business incubator programs. The coordinating agency for a business incubator often rents spaces to start-up firms at an affordable rate in order to reduce fledgling firms' overhead. Further to this end, the coordinating organization may also provide furniture, office supplies, internet, and telephone for participating firms at a free or reduced rate. Generally, firms benefit from not having to lease a space (and necessary supplies and services) at prevailing market rates, while the coordinating agency benefits from higher occupancy rates in spaces that are usually less costly to build and maintain. In other words, start-ups take advantage of bargain-basement prices in rent and infrastructure while coordinating agencies take advantage of packing the space with as many promising firms as possible

Another common aspect of business incubators is the promotion of knowledge sharing and mentoring. Generally, business incubators encourage knowledge sharing and collaboration between member firms by coordinating social events, conventions, meet-ups, and summits on a regular basis. Such events allow firms to not only share knowledge with one another but also

share knowledge with members of the industry and community at large. In addition, most incubators also match fledgling firms with industry or business mentors. Established firms and/or industry representatives may be invited to mentor members of the incubator and provide advice and knowhow to sustain the fledgling firms' growth. In many cases, start-ups that join incubators have an impressive knowledge of a particular field, but lack the general business acumen necessary to capitalize on that knowledge and make the start-ups successful. In such cases, mentoring and knowledge sharing prove pivotal.

In addition to providing affordable spaces and outlets for knowledge sharing and mentor matching, many business incubators also incorporate formal educational or training initiatives into the program. These initiatives typically take one of two forms. The first involves the start-up assuming the role of the student and enrolling in classes or seminars provided by the coordinating agency for the incubator. In this case, the coordinating agency may offer formal business classes and seminars to the start-ups (e.g. classes in bookkeeping, management, etc.). The second involves the start-up assuming the role of teacher and training members of the community in the start-ups particular field. Oftentimes, the latter develops as a formal internship program with a local college or university. Internship programs and other similar initiatives are beneficial in that the start-up is provided with cheap and necessary labor as well as a pipeline of future talent, and students and members of the community gain formal training in a potentially lucrative field.

Finally, most business incubators have a central leadership team in place to direct activities and coordinate efforts for collaboration and partnership growth. Without such a team, the other aspects just discussed would be nearly impossible to integrate into the business incubator program. In fact, effective central management of the incubator is so important, four of the ten "Best Practices" for running a business incubator, as established by the National Business Incubator Associations, relate to the management team of an incubator.[592] Thus, effective coordination and direction is paramount to ensuring that the incubator continues to grow and empower fledgling firms.

More recently, economic developers have advocated for many of the aspects of the business incubator discussed here to be expanded into the community at large. In other words, economic development professionals believe that more public and private entities should provide affordable office space, promote knowledge sharing and mentoring, establish formal educational and/or training initiatives, and create a leadership coalition or central management team to foster the growth and development of fledgling firms and budding entrepreneurs. Expanding the business incubator model into the community results in an "entrepreneurial ecosystem"—an environment which is hospitable to the birth and growth of a new business or industry.[593]

As the extraction of natural gas in Pennsylvania continues, communities may want to consider adopting pieces of the business incubator model to create their own "entrepreneurial ecosystems" to diversify their economies. In doing so, communities will be more likely to bounce back after any downturns in the shale gas industry.

Tourism and Related Resources

A further source of diversification is the economic base provided by Pennsylvania's many natural resources that attract visitors and visitor dollars from across the eastern U.S. and the world. The tourism industry is a significant sector in Pennsylvania's economy. In 2012, tourists spent over $38.4 billion in Pennsylvania, which in turn generated $67 billion in total economic activity across all industries in the state. The success of tourism in Pennsylvania depends on the state's urban, rural, and natural resources. In southwestern Pennsylvania, tourism is promoted through close collaboration between local agencies supporting travel to landmarks such as Fallingwater, urban areas like Pittsburgh, whitewater recreation areas like Ohiopyle, and the recreational and scenic resources of the Laurel Highlands.[594]

Opportunities to see and experience nature were identified by the U.S. Fish and Wildlife Service as a major draw for tourists to Pennsylvania. These opportunities include wilderness areas, camping, fishing, hunting, and destinations for winter sports.[595] In 2011, expenditures by state residents and nonresidents for outdoor activities totaled $485 million for fishing, $971 million for hunting, and $1.3 billion for wildlife watching.[596] Many of these recreational activities are made possible by Pennsylvania's extensive undeveloped contiguous forests, including state forests comprising nearly 2.2 million acres.[597]

Shale gas development activities may present some potential conflicts with tourism. Some of the important natural areas in Pennsylvania that overlap with the Marcellus Shale include the Northern Tier region, the Pennsylvania Wilds, and the Laurel Highlands. The Northern Tier region, composed of Bradford, Sullivan, Susquehanna, Tioga, and Wyoming counties, is a 4,000 square mile rural region famous for the Allegheny Mountains, waterfalls, and picturesque rural communities.[598] The Pennsylvania Wilds consists of roughly 12 northern counties and encompasses over six million acres in north-central Pennsylvania. The area boasts 29 state parks, eight state forests, 50 state game lands, two National Wild and Scenic Rivers, a National Forest, and over two million acres of public lands.[599] Tourism is one of the most important industries in these regions.[600] Shale development impacts to forests are concentrated in north central and southwestern Pennsylvania, where both some of the state's largest intact forests and most Marcellus activity are located.[601] The Marcellus Shale underlies 1.5 million acres within state forests and 211,000 acres in state parks.[602] Natural gas exploration, extraction, processing and distribution activities in both regions have been expanding rapidly since 2008, leading to interest

in the possible impact of natural gas development activities on tourism and the tourism-related economy.[603]

Unconventional natural gas development could affect tourism due to the process's infrastructure demands, environmental impacts, and economic impacts. One of the key issues is the impact of shale development activities on state forests, state parks, and state game lands which overlay the Marcellus Shale. Only about 10% of Pennsylvania's public lands where the state owns the subsurface mineral rights are legally protected from development for natural gas.[604] While the Commonwealth of Pennsylvania does not own the subsurface mineral rights for roughly 80% of state park and state game lands, 700,000 acres of state forest have already been leased to gas companies.[605] Leasing is not currently occurring in state parks, but doing so would enable companies to lease mineral rights and access them through adjacent properties. Some uncertainty remains as to whether doing so would also allow permits for gas-related infrastructure.[606]

One of the primary concerns about the impact of natural gas activities on tourism in natural areas, such as state forests, is the effect of the industry on viewsheds. Scenic viewsheds in areas like the Pennsylvania Wilds, which include lakes, unique geological features, forests, open expanses of agricultural lands, town centers, and historic sites, are critical to attracting tourists.[607] Unconventional natural gas development creates several different types of visual impacts which may affect viewsheds. Some impacts may be localized around sites associated with different stages of the shale gas development process. Well pads, drilling rigs, compressor stations, and water storage areas all generate visual impacts in noticeable contrast to natural or rural areas.[608] While drilling rigs, which may stand up to 150 feet tall, are some of the most visible individual elements of the well development process, perhaps the most significant long-term visual impact of concern is the cumulative effect of the infrastructure associated with unconventional gas development.[609] Elements including pipelines and easement cuts can lead to the development of a primarily industrial landscape, altering rural and natural viewsheds of particular value for tourism.[610]

The visual impact will depend on the pace of drilling, the distance of well sites from important scenic visitor sites, and finally the efforts of gas companies to camouflage their operations.[611] The infrastructure associated with unconventional natural gas development can also have a significant impact on natural areas by causing fragmentation, with related habitat degradation. Secondary roads and pipelines may cut through intact contiguous forest. This fragmentation subdivides habitats, creates smaller forest patch sizes, and decreases the interior-to-edge ratio of a forest.[612] These effects threaten habitats for interior forest species in particular by exposing species to predation, changing light and humidity levels in the forest, and potentially introducing invasive species. Forest interior species that live in the 91,000 to 220,000 acres of forest land near Marcellus development are particularly vulnerable to these effects.[613] Furthermore, 40% of

Pennsylvania's globally rare and threatened species are found in areas with high potential for Marcellus gas development.[614] Hunting activities may also be limited in forested and other areas with active natural gas operations.

High volumes of water extraction and the risk for water contamination also pose concerns for some visitor-related activities.[615] Pennsylvania is known for its eastern brook trout, and healthy populations of the species are largely concentrated in mountain watersheds. The Nature Conservancy has noted that nearly 80% of these watersheds could experience shale gas or wind development in the next twenty years, particularly in north central Pennsylvania. Hundreds of well pads are also expected to be developed in close proximity to Exceptional Value Streams.[616] Protection of these habitats and valuable fishing resources will be necessary to protect tourism associated with this activity.

Unconventional gas development activities can also have an effect on outdoor night activities – an important recreational resource in the heavily populated mid-Atlantic region. These activities can generate significant light pollution, which could cause a reduction in tourism affiliated with activities requiring dark night skies. For example, Cherry Springs State Park is designated an "International Dark Sky Park" by the International Dark-Sky Association. This park and several others in Pennsylvania are popular for star-gazing.[617] Drill-rigs equipped with bright lights operate nearly 24-hours a day in the early phases of well drilling, which could impair the dark-sky parks as tourist resources. Gas flaring is another activity which may cause day-glow and affect the value of these night-sky opportunities.[618] Most well pads can employ large lights overhead and horizontally over drill sites.[619] Responsible use of lighting equipment will be necessary to preserve the value of dark-sky parks.

Hotels and motels in northern Pennsylvania have benefited in part from unconventional gas development activity. Occupancy rates in the region have risen to nearly 95% despite the recession.[620] However, at times this high occupancy by gas workers has introduced competition with tourists for accommodations. During major tourist events, as when several hotels were unable to provide accommodations for attendees of the Little League World Series in 2010, congestion may negatively affect tourism.[621] The peak season for drilling activities, which is when drilling and development operations require the greatest number of workers, often coincides with peak travel and tourist demands in warmer months. This can cause a shortage of RV parks, campgrounds, and vacation rentals as gas workers seek short-term housing.[622] Occupancy of more than 30 days in a hotel qualifies a guest for a residency exclusion, which means he or she would not pay a room tax. This may partially limit the potential benefit of increased hotel occupancy for tax receipts.[623]

Road congestion is also of concern, as shale gas development requires intense truck traffic to transport water and other materials on the same infrastructure used by tourists.[624] This is of

particular relevance because many roadways in Pennsylvania are attractive to tourists for scenic drives and bike rides. For example, Elk Scenic Drive is a 127-mile route popular among tourists.[625] Sensitivity to the demands on tourist amenities, particularly in the timing of gas operations, could be useful in resolving some of these potential conflicts.

It is possible that the economic value of gas development could be greater than that of tourism in the short-term. Furthermore, some tourism related businesses, such as hotels, restaurants, and shops, will benefit from the increased patronage brought on by an influx of natural gas employees. However, tourism and its associated resources provide other benefits to Pennsylvania, including amenities and the maintenance of rural or natural assets. Tourism businesses are also usually owned and operated by permanent state residents, and may provide long-term jobs.[626]

Recognizing the importance of both these resources, before drilling operations begin, officials at multiple levels have an opportunity to protect resources important to tourism through the provisions of a gas lease. For example, Allegheny County has been establishing provisions in a lease with Range Resources and Huntley & Huntley to prevent surface drilling operations on a proposed lease of Deer Lakes Park. Instead, the companies plan to drill horizontally from three well pads on adjacent private property to minimize surface disturbance.[627]

County and tourism officials should consult with companies before the siting of any gas-related developments to protect important scenic viewsheds.[628] Some lease agreements have established *Areas of Special Consideration* to protect important viewsheds and allow for increased monitoring of surface disturbance.[629]

Additional actions taken by companies during operations can also minimize the visual impact of natural gas operations. Such ongoing actions could also be mandated in the provisions of gas leases. Throughout the gas development process, companies should be encouraged to avoid building facilities on the outer edges of ridges and hilltops, where they would likely obstruct viewsheds.[630] Companies can develop infrastructure on existing surface disturbances and minimize the construction of new access roads and other elements. For example, existing snowmobile trails could be used as service roads in warmer seasons.[631] Companies could concentrate necessary facilities on comprehensive sites to limit the number of individual sites of surface disturbance with industrial appearances.[632] Tree screens or other landscape buffers should also be encouraged or mandated in lease terms to disguise facilities near scenic or recreational areas.[633]

Operators can take into consideration the timing and location of different recreational activities, particularly holidays or other major tourist events, when planning gas development.[634] Regarding their use of tourist accommodations like campgrounds for worker housing, operators should coordinate with tourism officials.[635] Dates of particular importance to the tourism industry, and

implicitly of high congestion, as highlighted by the DCNR include Memorial Day weekend; Independence Day weekend; Labor Day weekend; and the opening of trout, gobbler, bear, and deer seasons. These, along with other special local activities or events might be observed by companies through limitations on heavy hauling or other heavy uses of infrastructure and local accommodations.[636] Operators should also provide notice before flaring activities and attempt to avoid conflicts with special events associated with stargazing.[637]

Site restoration is another key element of harmonizing shale gas development and tourism. Restoration provisions should be included in gas leases before development begins, to ensure the site is returned to its original state, or is sufficiently restored to be suitable for tourism. This will often require more than the simple site restoration required under erosion and sedimentation control and bond release provisions. Companies can aim to minimize any long term negative impacts from their activities on resources of economic significance.[638] Another aspect of site restoration could include the conversion of roads or easements developed to service drilling sites into new public access ways or trails after industry use ends.[639] This type of provision is again most likely to be successful if included in the gas lease before development begins.

The tourism industry is both an important part of Pennsylvania's economy and dependent upon the maintenance of the state's natural assets. As such, tourism should be a special consideration in Pennsylvania's shale gas development.

IX. COMMUNITY RESPONSES TO IMPACTS

One of the biggest challenges presented by the surge of oil and gas development from unconventional shale formations in Pennsylvania and elsewhere across the United States is the absence of a satisfactory process for local stakeholders to have constructive input to determinations concerning where and how shale development activities should occur in their communities. In the name of statewide uniformity proponents of shale development have advocated reliance on state-wide standards that preempt local decision-making authority. In Pennsylvania, the principle that municipalities have authority to regulate at least where oil and gas activities can occur through generally applicable land use ordinances has been reaffirmed in the *Robinson Township* case, discussed below. How now should such decisions best be made? The significance of the cumulative effects of unconventional oil and gas development in areas where development operations are concentrated, the projected duration of those operations, the complexity of the environmental, public health, social and economic issues presented by such oil and gas development activities, and the widely divergent interests of stakeholders who have legitimate reasons to care about where and how shale development occurs in communities, all make this a difficult task to resolve.

Communities and local governments do have opportunities to influence the location and characteristics of company activities in the Marcellus Shale. It is important to recognize the ways that these interactions may occur if there is to be longer-term benefit. It is not the case that communities have no authority, nor that operators are answerable only to the state and to their shareholders and investors. In fact, there is a growing recognition in some parts of the industry of the need for operators to obtain a "social" license to operate, grounded in relationships with communities and landowners. And local governments have asserted both persuasive and regulatory authority at times to gain necessary accommodations and changes in practice.

This section discusses three avenues that need further intentional action if the Marcellus Shale experience is to be improved for Pennsylvania communities and their residents.

A. Local Land Use Regulation of Some Aspects of Shale Gas Operations

Local governments have some power to regulate oil and gas activities in Pennsylvania, but state laws place limitations on these powers. It is important to understand what powers local governments may currently exercise with respect to oil and gas operations – and especially unconventional shale gas operations. The applicable limits were initially laid out in Section 602 of Pennsylvania's 1984 Oil and Gas Act, as amended in 1992, which provided that:

> Except with respect to ordinances adopted pursuant to the…Municipalities Planning Code, and the…Flood Plain Management Act, all local ordinances and enactments purporting to regulate oil and gas well operations regulated by this act are hereby superseded. No ordinances or enactments adopted pursuant to the aforementioned acts shall contain provisions which impose *conditions, requirements or limitations on the same features* of oil and gas well operations regulated by this act *or that accomplish the same purposes* as set forth in the act. The Commonwealth, by this enactment, hereby preempts and supersedes the regulation of oil and gas wells as herein defined.[640]

In 2009, the Pennsylvania Supreme Court interpreted this language in a pair of cases testing the limits of municipal regulation. In the first case, the court upheld a municipality's applying an existing zoning ordinance that required review of a proposed oil and gas well as a "conditional use" in a residential zoning district. The court held that local zoning regulation determining where such an operation may be conducted is not preempted by the Oil and Gas Act.[641] In the second case, decided at the same time, the Court determined that the same provision of the Act prohibited another municipality from applying detailed oil and gas regulations it had adopted as part of a new zoning ordinance. The court found that the latter ordinance reflected an attempt to enact a "comprehensive regulatory scheme relative to oil and gas development," and hence was preempted *in toto* as covering many of the same purposes set out in the state Oil & Gas Act.[642] Interestingly, in the latter case, the court singled out several provisions that, in its view, clearly covered the same purposes as the Oil and Gas Act. These included a local ordinance provision that *required* drillers to conduct pre-drilling water sampling rather than allowing them to forego such testing and risk liability as allowed under the state act.[643]

These decisions are typically summarized as limiting Pennsylvania municipalities' powers to prescribe "how" oil and gas operations are to be conducted, while affirming that they retain powers to prescribe "where" they may be conducted -- provided that the zoning restrictions are applied in ways generally consistent with zoning controls applied to other forms of industrial activity.

In February 2012, the General Assembly substantially amended the 1984 Oil and Gas Act and recodified it in enacting Act 13.[644] As part of Chapter 33 of Act 13, the General Assembly re-enacted Section 602 as Section 3302, with several wording changes.[645] Act 13, however, went well beyond the former Oil and Gas Act, by enacting several new sections in Chapter 33 which the Pennsylvania Supreme Court subsequently characterized as prohibiting "local regulation of oil and gas operations, including via environmental legislation, and requir[ing] statewide uniformity among local zoning ordinances with respect to the development of oil and gas resources."[646]

Act 13's new section 3303 preempted, excluded, and superseded all local ordinances regulating oil and gas operations regulated by state and federal "environmental acts." And new section 3304 contained a long list of preemptions expressly applicable to local governments' residual Municipalities Planning Code zoning authority. It provided that Pennsylvania local governments with a zoning ordinance must make oil and gas operations (except compressor stations and processing plants) a permitted use in *all* zoning districts. It made impoundments a permitted use in all zoning districts provided that the edge of an impoundment is not closer than 300 feet to an "existing" building. It directed local governments to make compressor stations permitted uses in agricultural and industrial zoning districts and conditional uses in "all other zoning districts" if setbacks are met and 60 decibel noise limits at property lines are met, and to make processing plants permitted uses in industrial zoning districts and conditional uses in agricultural districts provided the same setback and noise standards are met.

The same section expressly prohibited municipalities from including "conditions, requirements or limitations on the heights of structures, screening and fencing, light or noise" that are more stringent than those imposed on other industrial operations within the same zoning district. (This is a peculiar provision given that many zoning ordinances would not allow any other industrial activities in residential zoning districts, but are required to allow oil and gas activities under this section of Act 13). Section 3304 further prohibited any local government from imposing limitations or conditions on hours of operation for compressor stations and processing plants, or hours of operation for drilling or assembly or disassembly of drilling rigs.

In *Robinson Twp. v. Commonwealth*, decided in December 2013, the Pennsylvania Supreme Court in a 4-2 decision struck down Sections 3303 and 3304, as well as several other sections of Act 13 affecting local governments' authority to regulate oil and gas operations. Although the 4-member majority relied on two different rationales, the justices found that these sections of Act 13 violate Pennsylvania's Constitution. Three justices, in a plurality opinion by Chief Justice Castille, found that these provisions violate Pennsylvania's Environmental Rights Amendment (Art. 1, Sec. 27).[647] The Environmental Rights Amendment guarantees the right of the people to "clean air, pure water, and the preservation of the natural, scenic, historic, and esthetic values of the environment…" and it defines the duties of the Commonwealth, as trustee, to conserve and maintain Pennsylvania's public natural resources for present and future generations. The Chief Justice's opinion found that Act 13 had reduced the local government's zoning role to "pro forma accommodation" of oil and gas development in every zoning district.[648] The justices found that the General Assembly had unlawfully removed local governments' ability to carry out their constitutional duties by requiring them "to be complicit in accommodating a new environmental regime irrespective of the character of the locale."[649] The opinion found that the General Assembly's action prescribing oil and gas operations as an "of right use" in every zoning district irrespective of local conditions "is incapable of maintaining constitutionally protected aspects of the public environment and of a certain quality of life" guaranteed by the environmental rights

provision. In constitutional terms, "[t]he Act degrades the corpus of the [public] trust [in the environment].[650] Both the plurality opinion (relying on the Environmental Rights Amendment) and the single concurring opinion (relying on due process protections) criticized the "blunt approach" of Act 13 which, in failing to account for differing impacts in different zoning districts and differing local conditions, violates constitutional guarantees.[651]

The Pennsylvania Supreme Court further found that Act 13's setback provisions were inextricably linked with mandatory waiver provisions, and also violated Pennsylvania's constitutional guarantees. Section 3215(b)(4) prescribed certain setbacks from water but also required DEP to "waive the distance restrictions upon submission of a plan identifying additional measures, facilities or practices to be employed…necessary to protect the waters of this Commonwealth."[652] The Supreme Court found that this required waiver, given the lack of criteria for the "necessary" conditions and the lack of any ability for municipalities to participate effectively, could not be sustained. These provisions were inextricably coupled with provisions in 3215(d) that allowed municipalities only a limited opportunity to comment but that did not require DEP to take their comments into account, and with provisions prohibiting anyone but the oil and gas drilling applicant from obtaining review of DEP's decision. The court found that this combination of limitations reduced the environmental protections to "a set of voluntary setbacks or…the opportunity for a permit applicant to negotiate" its own set of setbacks, while "marginaliz[ing] participation by residents, business owners and their elected representatives."[653] The plurality opinion held that this "inequitable treatment of trust beneficiaries is irreconcilable with the trustee duty of impartiality."[654] The Supreme Court therefore enjoined enforcement of all of the setback provisions in 3215(b), as well as provisions in (c) and (e) – which instructed the DEP to "consider" impacts on various public trust natural resources and natural areas, but which prohibited it from doing anything about such impacts without regulations adopted by the Environmental Quality Board. The court also invalidated Act 13's requirement that such regulations place on DEP the *burden of proving* the necessity of any conditions it might impose on oil and gas operators to prevent a "probable harmful impact" to trust resources.

Finally, the Court also enjoined enforcement of Sections 3305-3309, which imposed sanctions, including losses of impact fees, and payments to operators, on municipalities which attempted to regulate oil and gas operations. The Court found these provisions "not severable" to the extent to which they implement or enforce the preemptions and setback provisions which the court had found invalid. The Court remanded certain determinations to the Commonwealth Court for further consideration, including which provisions of the law are severable given the analysis.

While using two different, but related rationales, the Supreme Court majority was clearly unwilling to allow the General Assembly to wipe out local governments' abilities to make distinctions in differing zoning districts. The Court disapproved the General Assembly's prescription of what zoning limitations could be applied (such as what districts require "of right"

development), and also enjoined a one-way, standard-less DEP review process where oil and gas operators would be entitled to waivers of setbacks while local governments could be ignored on the same topics and prohibited from seeking review.

While section 3302, the prior preemption provision carried over from the 1984 Oil and Gas Act, was not addressed in the Pennsylvania Supreme Court's *Robinson Township* decision, it was reviewed by the Commonwealth Court on remand to determine whether it was affected by the portions of Act 13 struck down by the Supreme Court. In a decision rendered July 17, 2014, the Commonwealth Court held that part of 3302 is invalid because it cannot be severed from the invalid provisions. The Commonwealth Court noted that in enacting Section 3302, the General Assembly had changed the last sentence from "the Commonwealth, by this enactment, hereby preempts and supersedes the regulation of oil and gas wells *as herein defined*" to "the Commonwealth, by this section, preempts and supersedes the regulation of oil and gas operations *as provided in this chapter*" [viz. Chapter 33, much of which was invalidated by the Supreme Court].[655] This led the Commonwealth Court to conclude that because the "only operative provisions in Chapter 33 relating to the regulation of oil and gas operations" had been stricken by the Supreme Court, the final sentence of Section 3302 is "necessarily declared unconstitutional" and is incapable of execution and is severed from the remaining valid provisions of 3302.[656]

So, where does this leave municipalities seeking to deal with the effects of oil and gas development within their boundaries today?

First, the Supreme Court has made it clear that local governments have "substantial, direct, and immediate interest in protecting the environment and quality of life" within their borders sufficient to support their ability to carry out governmental functions and constitutional obligations.[657] Second, local governments can use their zoning powers to recognize locally-meaningful distinctions in land forms and compatible and incompatible land uses. It would appear that oil and gas operations may be excluded from some zoning districts. Third, given the absence of most setback provisions (struck down by the Supreme Court) it is up to local governments to adopt provisions determining setbacks needed to address the location of these oil and gas activities.[658]

Shale gas wells result in infrastructure and industrial development, often occurring in and around residential areas, that is accompanied by noise, lighting, and aesthetic changes that can disrupt communities. Provisions limiting local governments' powers to regulate noise and light were in sections of Act 13 that were ruled unconstitutional in *Robinson Township*. Those provisions stated that municipalities "may not impose conditions, requirements, or limitations" on noise, lighting, and height of oil and gas operations that are more stringent than those conditions on other industrial uses within that zone.[659] It is possible that Pennsylvania local governments might now be able to address timing and hours of operations, structure heights, lights, and noise

impacts. In attempting to address any of these last areas, local governments should seek to do so in a way that does not treat oil and gas operations in a discriminatory fashion and that links the conditions closely to issues of where such operations may occur rather than how they should, in general, be conducted.

It is not unusual to have such regulations. For example, Colorado has noise restrictions for shale gas operations that vary by time of day—55 dbA is permissible in residential zones from 7 AM to 7 PM and 50 dbA is permissible from 7 PM to 7 AM.[660] During the day, noise may increase by 10 dbA for 15 minutes during any one hour period.[661] Periodic, impulsive, or shrill noises are reduced by 5 dbA from those totals.[662] Low frequency noise is also subject to regulation.[663] Lighting must be directed downward or inward to avoid glare on roads and buildings within 1000 feet, to the extent practicable.[664] Odors, dust, and appearance are regulated as well.[665]

B. Operator-Community Engagement Practices in Southwestern Pennsylvania

Although Pennsylvania communities have regained the ability to use their zoning authority to limit certain of the impacts of shale gas development, it does not mean that this will be an optimal approach for local governments in most settings. The authority remains limited, and there are alternative ways of achieving their goals that may lead to additional solutions.

These alternate ways have emerged from a growing recognition of the value of the industry's maintaining positive relationships with hosting communities and working with them to resolve problems. The importance of developing a positive community relationship has been addressed by several natural gas industry organizations, including the American Petroleum Institute (API), the Marcellus Shale Coalition (MSC), and the Appalachian Shale Recommended Practices Group (ASRPG).

The API discusses, on its website, the role of cooperative public-private partnerships in assisting the industry to find sustainable solutions to shared problems, and includes within that realm of relationships those with communities hosting extraction sites.[666] The API identifies several trends that are influencing how those public-private partnerships are shaped, including the concept of a social license to operate, which industry obtains from a community by gaining its trust. This relationship is based in industry's engaging the community so as to understand the varied needs and expectations of the relevant stakeholders and then to build plans which address those needs and concerns. The ultimate goal is for the industry to actively work with community and other partners to create a more stable and desirable environment in which both the community can prosper and industry may operate in a sustainable manner.[667]

Two other industry organizations, the MSC and ASRPG, separately have developed recommended practices for commencing natural gas operations that include community

engagement provisions. The MSC, the primary trade group for the upstream, downstream, and supply chain partners in the shale gas industry operating in the Marcellus Shale and the Utica Shale plays in the Appalachian region, has developed a set of Recommended Practices for its members.[668] One of the Recommended Practice addresses "Site Planning, Development and Restoration", and provides, "Coalition members recognize that responsible development should acknowledge the needs and concerns of all relevant stakeholders. We encourage parties engaged in such development to utilize procedures and technologies that will protect and preserve environmental resources for generations to come." The Practices further provide for conducting a constraints analysis, prior to finalizing a site plan, which includes identifying "landowner and local community desires/preferences."

The ASRPG, a consortium of eleven of the largest producers in the Appalachian Basin which have come together to identify and disseminate Recommended Standards and Practices for exploring for and producing natural gas and oil in the Appalachian Shales, also addresses this issue.[669] In the Introduction to its Recommended Standards and Practices, the ASPRG identifies its goals as including, to "provide a framework for protecting workers, the environment and the communities in which we operate" and to conduct its operations in "a…socially responsible manner."[670] In the Pre-Operational Planning section, it advises operators to "[e]ngage the local communities to provide information about the nature of the planned operation and to receive input regarding local concerns." [671]

Consistent with the trend embraced by these organizations, many of the shale gas operators in Pennsylvania have developed plans for how they will engage with the communities hosting their well sites.[672] These "community engagement plans" generally are published on the operators' websites, and may appear either as stand-alone policies or as components of their annual corporate responsibility or corporate sustainability reports.

Although each operator describes its approach in slightly different terms and has slightly different mechanisms for accomplishing its goals, there is an overall consistency among the plans from which emerges a three-pronged approach to community engagement. The approach consists of proposed undertakings to:

- Protect the environment and health and safety of the community (and workers) by complying with regulatory standards and best industry practices, minimize the operator's footprint, and employ responsible contractors who will accomplish these goals;

- Advance the economic development of the community by supporting and employing a local workforce, contract with local businesses to encourage their growth, encourage education and training initiatives, and make philanthropic contributions to the community; and

- Earn community acceptance of an operation by communicating regularly and in a transparent manner with the community about development activities, identify community values and concerns about the development before beginning development and take those values and concerns into consideration in planning and operating their sites; provide the community with a readily available mechanism for raising concerns with the operator throughout the life of the operation, and be a good and ethical neighbor.

These community engagement plans should provide local governments with a platform where they can raise with operators their interests in protecting and preserving important community features and values. These discussions need to occur at the pre-planning stage and throughout the operation, as conflicts can arise at any point during the life of the operation. This approach represents a first step in the direction of collaborative decision-making about land use. It has the potential to avoid, or at least minimize, controversies if it enables the parties to reach an agreement as to land uses and operating practices that respect and protect both parties' interests.

C. Community Consensus-Building Processes for Planning Shale Resource Development

The rapid emergence of unconventional shale resource development has challenged governments to rethink the traditional framework for regulating oil and gas operations. The issuance of site-by-site permits by state regulatory agencies, the traditional mechanism for regulating the environmental consequence of industrial activities including conventional oil and gas well development, does not adequately address the cumulative effects of locally concentrated shale development activities conducted by unrelated operators. Statewide regulations which require comprehensive planning for areas with concentrated shale development activities have been proposed in several states but not yet adopted. Local governments that have sought to regulate shale development activities through local land use planning ordinances have encountered challenges based on the doctrine of state preemption.

As noted above, the *Robinson Township* decision reaffirms the proposition that local governments in Pennsylvania have the right to engage in place-based planning through the application of generally applicable land use ordinances to shale development activities. However, the application of formal local land use decision-making processes alone may not provide outcomes that are satisfactory to all stakeholders.

Two related developments suggest an additional path forward. The first development is that of the principle of corporate social responsibility, resulting from an emerging body of work which stands for the proposition that principles of corporate social responsibility require business enterprises that engage in locally disruptive activities to obtain the free, prior and informed

consent of the communities in which they operate and that it is in the enterprise's self interest to obtain what has come to be known as a "social license to operate" from host communities. The second development is a body of work that has evolved over the past 30 years and which stands for the proposition that *ad hoc* stakeholder engagement processes designed to achieve consensus-based decisions on community issues, result in more widely accepted outcomes.

In the first years of commercial-scale Marcellus Shale development in Pennsylvania, the surge approach of the shale gas operators, the mindset of opponents to shale gas development, and the uncertainty as to the legal decision-making authority of local governments created a situation that was not conducive to stakeholder consensus-building processes. However, the oil and gas markets' reaction to increased production from shale formations around the country, and recent legislative, regulatory and judicial developments in Pennsylvania, may signal the end of the surge phase of development. Consequently, there now may be an opportunity to promote the implementation of community-scale consensus-building processes that enable stakeholders to formulate satisfactory framework agreements as a supplement to state-level permit processes and local land use authorization processes. These may address aspects of shale development operations that are not adequately addressed in either the state permit or local land use decision-making processes.

There are significant levels of accumulated distrust among proponents and opponents of shale development and skepticism as to whether a consensus-building process will be constructive. Perhaps stakeholders in one or more locations can be solicited to implement a *pilot project* to test the feasibility of community-scale consensus-based decision-making processes in Pennsylvania. If necessary to overcome threshold mistrust or skepticism concerning the utility of the process, the pilot project could initially focus on the performance of an *interests and issues assessment* conducted by a well-experienced consensus-building practitioner. The resulting assessment report would inform the design of a consensus-building process which, if accepted by key stakeholders, could establish a foundation for constructive stakeholder engagement and, hopefully, a durable framework agreement for shale formation development at the community scale.

The Case for Community-Scale Consensus-Building Processes

Some states, most notably New York and Maryland, have imposed moratoria on the extraction of oil and gas from shale formations pending the completion of environmental and public health impact assessments. Other states, including Pennsylvania, have allowed the development of unconventional shale formations to proceed while they update their oil and gas regulatory programs to address the issues presented by the new extraction methodology.[673]

In those states where the development of shale formations has proceeded, the initial surge of intense exploration and well development activity in the most prolific production areas overwhelmed the pre-existing, obsolete state regulatory programs and local decision-making processes. As governments have endeavored to catch up through the reformation of state regulatory standards and local ordinances, tension has arisen concerning the appropriate allocation of decision-making authority between state and local governments.

Traditionally, oil and gas development activities have been regulated by the issuance of well-specific permits issued by the designated state regulatory agency. Local authority to regulate the activities covered by the state regulatory program has typically been constrained through application of a legal doctrine which dictates that state regulatory standards preempt local regulation. Local decision-making authority, to the extent it exists, has typically been exercised through the application of generally applicable land use planning ordinances.

The controversy that arose and has persisted since the earliest days of Marcellus Shale development in Pennsylvania suggests that exclusive reliance on state and local regulatory decision-making procedures does not adequately address all of the issues and interests of the wide variety of stakeholders who have reason to care about where and how the Marcellus and other shale formations are developed in Pennsylvania.

Effective implementation of stakeholder engagement processes, carried out at a scale where cumulative impacts can be considered and addressed, enables all interested community stakeholders (*e.g.* landowners who have oil and gas lease interests, landowners who do not have oil and gas lease interests but may be affected by oil and gas development, unconventional shale formation development companies, nongovernmental public interest organizations, and other interested stakeholders) to reach collaborative decisions on issues relating to attributes of shale formation development activities not satisfactorily addressed either by state-wide environmental regulatory requirements or local land use ordinances.

When successfully executed, such stakeholder processes provide a pathway for a more mutually satisfactory exchange of trustworthy information, more informed decision-making, more flexibility in satisfying interests not covered by prescriptive state or local requirements, better informed planning, and less persistent conflict. These processes should result in more widely accepted outcomes with regard to the environment, community health, and energy development because the processes are consensual rather than imposed.

Limitations of the Environmental Regulatory Framework

Generally speaking, the Pennsylvania environmental regulatory framework for the authorization of oil and gas well development activities, both under the 1984 Oil and Gas Act and Act 13, is a

typical site-by-site permit-based system. This paradigm, which has been a core component of environmental regulatory programs in the United States, has proven effective for the control and mitigation of environmental consequences from individual, fixed location, steady-state operations which are controlled by a single entity. It is not nearly as effective for the control of localized or regional cumulative effects of similar but independently controlled operations concentrated in a wider, but still concentrated specific area. This is especially true of local concentrations of shale formation development projects by multiple unrelated operators that are transitory as well as operationally independent of one another.

In 2010, the Pennsylvania Environmental Council ("PEC") recognized the need to account for and mitigate the localized cumulative effects of Marcellus Shale gas well development and recommended that Pennsylvania develop a process for comprehensive planning in areas of concentrated shale gas development to achieve this important, albeit difficult objective.[674] Specifically, PEC advocated that:

> Every effort should be made to assess potential cumulative impacts from proposed well development; not only from individual sites but also from a broader perspective. Communities in proximity to well infrastructure development should be afforded input into the review process to ensure consistency between [state] agency action and local protection efforts. This process should be well understood by all parties, and be fair and timely.[675]

As a corollary to comprehensive area-wide planning PEC recommended that the well siting permit process be modularized to separate the well siting authorization from the well development authorization. As proposed, the two-part permit process is designed to provide more notice and opportunity for input from county and local governments and abutting property owners; provide time for a more thorough, iterative investigation of current and pre-existing site conditions to reduce the chance of unexpected occurrences during the well development phase; and enable well developers to accumulate approved well site locations in an area over time to afford the opportunity for individual developers to formulate multiple-well, area-wide plans.[676] Neither of PEC's proposals was recommended by the Governor's Marcellus Shale Advisory Commission and neither was considered by the General Assembly for incorporation into Act 13. PEC's proposal for a two-part permit process was motivated in part by recognition of the complexity of establishing a statewide comprehensive planning process for areas with concentrated shale formation development activities. The proposed two-part permit process would be easier to implement and could be put in place in relatively short order. The permit process proposed by PEC could significantly improve the existing well permitting process by providing the opportunity for constructive input on specific well siting decisions from local government and abutting land owners.

However, the scope of that process in and of itself is not broad enough to address all of the potential interests of stakeholders at the community scale.

Limitations of the Land Use Decision-Making Process

Generally speaking, government action is constrained by constitutional and statutory requirements that include specified procedures designed to protect the constitutional due process rights of citizens. In controversial local land use matters, decision-making processes that are limited to the legally specified procedural requirements tend to create an adversarial context for the interactions of interested parties. "Parties become consumed with trying to win the battle instead of working constructively to identify appropriate solutions."[677] In the case of land use decisions relating to complex matters such as the siting of oil and gas well operations, the limitations of a process that strictly adheres to the minimum due process requirements will likely not lead to optimal, interest-based outcomes.[678]

In addition, the decision-making authority relating to oil and gas development is bifurcated, with at least some local authority to determine where an activity is conducted, and virtually exclusive state jurisdiction to determine how an activity is performed – subject to interpretation and court review. However in the case of shale formation development operations, a large number of operations conducted by unrelated parties result in localized cumulative effects as well as other social and economic effects that are not adequately addressed by this bifurcated regulatory regime.

The Utility of Consensus-Based Decision-Making Processes for Shale Development

Proponents of alternative dispute resolution methodologies have advocated the use of consensual, problem solving processes as supplements to purely legal decision-making procedures. These methodologies are applicable to public, as well as private, disputes.[679]

The Corporate Responsibility Perspective

From the corporate responsibility perspective there is a growing body of literature which differentiates the "social license to operate" from the "legal right to operate." A "social license to operate" has been defined as: "when a project has the ongoing approval within the local community and [with] other stakeholders…."[680] As applied specifically to the development of shale formations by oil and gas companies, the Investor Environmental Health Network and the Interfaith Center on Corporate Responsibility advocate that:

> [Oil and Gas Companies should seek] "Free, Prior and Informed Consent" of host communities for new development activities, such as reaching advance written agreements with local government officials and community organizations outlining company practices related to specific community concerns (noise, setbacks, road use and damage repair, monitoring and addressing social, environmental and health impacts, etc.) *Such agreements may include operating practices above and beyond requirements of state regulations, zoning codes, and land use plans applicable to oil and gas drilling and production operations*." (Emphasis added.)[681]

The Land Use Conflict Resolution Perspective

From the land use conflict resolution perspective, there is also a body of literature which differentiates legalistic, rights-based outcomes from consent-based outcomes. In a recently published work focusing on the resolution of highly contentious land use conflicts, the authors advance the proposition that *ad hoc*, consent-based processes are more effective than generally applicable land use decision-making procedures to resolve land use conflicts where a proposed land use has substantial impacts on the community or local landscape and where numerous stakeholders are affected or have expressed an interest in the outcome of the land use decision-making process.[682] The point of departure for the advocacy of consensus-building is the proposition that:

> …communities have many choices about how to handle controversial land use decisions. However, many leaders believe they have no choice or voice in land use decisions, since decisions about regulating the use of land must follow specific procedures codified in state and local laws. Yet these legal requirements serve only as procedural minimums and do not preclude the addition of more collaborative forms of decision making. A community may elect to use the required minimal procedure or it can elect to implemental a supplemental process that enhances the interaction between the stakeholders involved. Some communities even chose to incorporate the collaborative processes of the mutual gains approach into their bylaws and ordinances.[683]

A number of counties in active or potential shale gas regions in Pennsylvania formed task forces in response to actual or anticipated shale formation development activities.[684] The level of readily available information concerning the activities of these county task forces varies widely. However, it appears that most, if not all, of the county task forces have been primarily engaged in information gathering and dissemination activities. In some cases they also established systems to record activities such as the location of well pads, gathering lines, and compressor stations. These are useful endeavors on the spectrum of stakeholder participation processes but they do not involve a high degree of interactive public engagement and collaborative problem solving, or planning.

Community-Scale Consensus-Building

The Consensus-Building Spectrum

The practice of consensus building employs a spectrum of methodologies designed to facilitate interest-based, problem-solving behavior. Practitioners and theoreticians use different terminology; however, conceptually speaking, the spectrum includes:

- Information exchange (exchange of existing information)
- Collaborative fact finding
- Stakeholder dialogue
- Stakeholder advisory panels
- Collaborative decision-making.

The hallmark of all of the methods on the spectrum is that they are consensual and not prescriptive. Stakeholders voluntarily convene to identify issues and interests and work together, pursuant to agreed-upon ground rules, toward agreements which satisfy as many of the identified interests as feasible.

The foundation for success of consensus-building in complex public conflict scenarios is often the identification of a convener that has the influence and credibility to bring all of the interested stakeholders together and the performance of an *interest and issues assessment* that will inform the threshold decision of whether a consensus process is useful in the circumstances of a given situation and, if it is, the preparation of the proposed process design as well. Generally speaking the scope of work for such an assessment would include:

- The designation of the convener and the party responsible for the performance of the assessment
- Identification of the initial cohort of stakeholders to be interviewed or surveyed
- Preparation of a protocol for stakeholder interviews and surveys
- Identification of other sources of relevant information and topics for background research
- The specification of milestones for completion of the assessment
- Preparation of the budget for completion of the assessment; and identification of funders and securing funds for the assessment
- The completion of the assessment activities.

Once completed, the assessment will result in a report that includes:

- A synthesis and analysis of the information gathered from stakeholder interviews surveys, research and other information gathering activities
- Identification of stakeholders' interests, needs, and concerns
- Proposed topics that should be addressed in the collaborative process
- An assessment of the feasibility of a collaborative process
- A design of a proposed collaborative phase including: specification of proposed funding sources; a proposed time for completing the process, proposed ground rules for stakeholder participation, and proposed operating procedures.

The analysis, findings and recommendations in the assessment report provide the basis upon which the convener and stakeholders make an informed decision on whether to initiate the consensus-building phase.

Managing a Consensus-Building Process in the Marcellus Shale of Pennsylvania

The development of the Marcellus Shale and other shale formations in Pennsylvania is projected to be a decades-long endeavor. Consequently, in those counties and municipalities located within the commercially productive areas of the shale plays, concentrated well development and associated infrastructure construction operations will be a long-term experience. The degree to which shale development activities are viewed to be unacceptably disruptive to a community will depend upon the varying interests and perceptions of the array of stakeholders having an interest in shale development. Not all of the cumulative impacts, real or perceived, can be addressed by either state environmental standards or local land use standards.

The localized, cumulative effects of shale formation development present the scenario in which individualized, consensus-based processes are likely to better address stakeholder interests than generally applicable land use authorization procedures.

As communities seek to act on their rights and duties concerning shale formation development operations following the Supreme Court's opinion in the *Robinson Township* case, outcomes should be more satisfactory if they are based on a recognizable process. Such a process would enable communities, landowners, nongovernmental organizations, companies, and other interested stakeholders to reach collaborative decisions on issues relating to attributes of operational activities not suitably addressed either by state-wide environmental regulatory requirements or local land use ordinances. While this process will require the investment of time and effort in the near term, it has the real prospect of substantially reducing avoidable, persistent conflict, which also imposes a substantial cost burden, over the long term.

The Pennsylvania Environmental Council and RESOLVE, a nonprofit organization with extensive experience in facilitating solutions to environmental and community acceptance issues involving the extractive minerals sector, have sought to identify one or more places in Pennsylvania to conduct a pilot community-scale consensus-building process. The objective of the process would be to endeavor to reach a memorandum of understanding among shale developers and community stakeholders that establishes a framework agreement for shale development operations in the community. If successful, such a pilot process would serve as a proof of concept model for application in other places.

PEC and RESOLVE have heard from potential conveners and stakeholders that there is a significant level of skepticism concerning the prospects for constructive engagement in a consensus-building process. For example, parties expressed concerns about the possibility of irreconcilable differences in the respective goals and expectations among various stakeholders. There is also concern among stakeholders that, in the event a framework agreement is achieved, the implementation of an agreement will nonetheless be thwarted by obstinate objectors who purposely refrain from participating in the consensus-building process. These and other concerns cause a threshold reluctance to commit the substantial time and resources that will undoubtedly be necessary to achieve the goal of a framework agreement.

These impediments to the initiation of a stakeholder consensus-building process are not unique to the circumstances of shale development. The need to overcome threshold mistrust and skepticism as to the utility of the consensus-building process is common. A more feasible approach may be to solicit a limited commitment from key stakeholders to support and participate in the performance of the issues and interests assessment as a discrete first phase of the process. Under this approach, it would be explicitly understood by all parties that support of and participation in the interests and issues assessment phase did not necessarily imply a commitment to participation in a full-scale consensus-based decision-making phase thereafter.

This approach has the merit of a substantially lower initial commitment of time and resources. If done well by an experienced consensus-building practitioner, the assessment process itself offers an opportunity for stakeholders to overcome the existing mistrust among them and the prevailing skepticism that a consensus-building process could be constructive. Furthermore, depending upon the analysis and conclusions of the assessment, the consensus process could be phased with go-no-go decision points if necessary. For example, the initial phase of the consensus process might be limited to joint fact finding facilitated by a neutral party as an extension of trust-building achieved in the assessment process. If that phase succeeds, the second phase could be designed to focus on facilitated dialogue as a precursor to a final phase which, if implemented, would focus on agreement-making and implementation protocols.

Another potential threshold barrier is funding. Ideally, the funding of the process would come from multiple stakeholders of varying perspectives within the process. However, for the reasons stated previously, the stakeholders may not have sufficient conviction in the merit of the process to advance significant funds for the implementations of the project at the outset. It is also possible that some key parties, *e.g.*, local governments and local nongovernment public interest organizations, do not have the financial wherewithal to contribute substantial funding for the process. Again, the segregation of the assessment phase from the consensus-building phase will reduce the level of funding needed initially to test the proposition that engaging in a consensus process is potentially worthwhile. If necessary, foundation support might be solicited to fund a portion of the cost of the assessment phase as a way to kick-start the process and induce affordable levels of contribution from other stakeholders.

Some will argue that the proposed process will take an inordinate amount of time. The one-step-at-a-time process is in recognition of the current attitudinal barriers to consensus-building that have to be overcome. If the proposed pilot project is successful, it will serve as a model for application in other places. The expectation is that over time, the threshold barriers that suggest proposed design of the pilot project will dissipate. Under that scenario, when the process is scaled up, it should become increasingly more streamlined. In any event, given the scale of change to communities and the fact that Pennsylvania is only five years into an endeavor that is projected to last for generations, it is now a good time to invest in establishing durable framework agreements that can serve as the foundation for future shale development. To the extent that community acceptance is increased and unnecessary conflict is avoided, all stakeholders will be better off.

The nature and complexity of the decision-making matrix presented by unconventional shale development in Pennsylvania suggests that an unconventional decision-making process is required. The effective implementation of stakeholder engagement processes, carried out at a scale where cumulative impacts can be considered and addressed, should enable all interested stakeholders to reach collaborative decisions on issues relating to attributes of development activities not satisfactorily addressed either by state-wide environmental regulatory requirements or local land use ordinances. When successfully executed, such stakeholder processes provide a pathway for a more mutually satisfactory exchange of trustworthy information, more informed decision-making, more flexibility in satisfying interests not covered by prescriptive state or local requirements, better informed planning, and less persistent conflict. These processes could result in more widely accepted outcomes with regard to the environment, community health, and energy development because the processes are consensual rather than imposed

X. COMMUNITY BEST PRACTICES

The focus of this research is to review the current Marcellus Shale development in the context of historical boom and bust experiences, with the goal of identifying strategies that southwestern Pennsylvania communities can implement to protect and enhance the sustainability of their communities. The study identifies key socio-economic, environmental, public health and economic impacts that southwestern Pennsylvania communities are experiencing and also examines approaches that could allow local governments to better respond to these continuing, and likely increasing impacts. Resource extraction economies trying to avoid a bust generally seek to find ways to use the development as an opportunity to advance the well-being of their communities over the long term.

A. Jobs and Workforce Training

Natural gas development has had a positive impact on employment in Pennsylvania. Although the magnitude of that impact remains unclear based on differing methodologies for counting and attributing jobs, it is clear that jobs are being created directly and indirectly by the industry. The research reflects that the growth of the industry has resulted in increased employment and increased salaries in both the core industry and supply chain businesses. In addition, there has been increased development and commercial activity in the counties supporting shale gas development.

- As Pennsylvania learns more about the industry and the demands of employers, communities should support the expansion of workforce development and continued education programs to provide workers with a core set of skills that will prove useful in the natural gas industry, but also prove transferrable to other industries. Adopting and expanding workforce development programs will help to keep jobs created by natural gas extraction local, but also enable workers to transition into other industries and to diversify the regional economy.

- Communities should support economic diversification strategies as well, using available funding and infrastructure investments to ensure that supply chain and downstream industries also generate employment and opportunities are created for new businesses in the middle years of the shale gas boom that can sustain the local economy over the longer term.

B. Housing Values

The impact of shale gas development on housing prices is important to the owners of the homes, but also to the local governments and school districts that rely upon property tax revenues to fund their operations. If property values deteriorate because of the shale gas development this could impair community vitality and erode the community tax base. The current research reflects that shale gas development in a community has both positive and negative effects on home values. Factors affecting housing prices include the distance between the house and a gas well, the time period between the permitting of the well and the sale of the house, whether the house relies upon a public or private water supply, and surrounding land uses. Overall, there is a negative effect on housing value when the house is located within a relatively short distance from a gas well (1.5 km/approximately one mile) and the property is sold between when the well has been permitted up until one year after it has been drilled. The decline in value is greater if the home relies upon a private water supply. However these effects dissipate about a year after the well is completed. Houses located between 2 and 20 kilometers from a gas well experience a small positive vicinity effect on prices.

- Because the impact of the shale gas development on housing prices is somewhat fluid and depends upon the combination of critical factors at any given property, this impact should be regularly monitored to evaluate how the housing market evolves under the continued development that is expected.

- It may be helpful to provide additional information or monitoring assistance to owners of homes that are dependent on private water supplies, in order to ensure that they are well-informed and can take actions as needed to ensure property values are maintained.

C. Roads

The shale gas industry does have impacts on the region's roads. The information provided in the survey of local government officials in Greene and Washington counties and in the interviews of individual officials reflects that local governments believe that their core responsibility is to maintain and repair/replace the infrastructure so as to facilitate ingress to and egress from the community and to protect public safety. This perspective is expressed most clearly in the overwhelming use of impact fees by municipalities for road maintenance and replacement. The related expenditures of impact fee for public safety are consistent with this view.

Road damage has been significant in each community hosting shale gas wells sites whose officials responded to the survey, and even in communities that host no shale gas sites but which are throughways for traffic going to such sites in other municipalities. This is not surprising

given the size and structure of the roads and the volume and weight of the shale gas-related traffic that often passes on them.

The primary legal remedy that local governments have to require repair of damage in excess of typical road damage is posting roads. However, in order to use this remedy, a local government first has to conduct an engineering and traffic study of each road to be posted, and many smaller municipalities do not have the funds to do this for all of their roads used by the industry. In addition, for posting to be a successful remedy the local governments have to have the resources to monitor usage of the roads, and many do not. The willingness of many shale gas operators to repair roads that they damage regardless of whether they are posted is laudable, and their efforts have helped many local governments to maintain traffic flow in their communities and have even improved the overall quality of many roads. However, this is not a sustainable long-term arrangement over the life of the industry in the region. There are a variety of possible policy responses to this problem that would ease the burden of road maintenance that now falls to the local governments.

- To support local governments' monitoring usage of the roads and road conditions, collaborative approaches may help. Perhaps neighboring municipalities could collaborate by pooling some portion of their impact fees to purchase equipment, to survey road conditions, or to address roads traversing more than one community. Counties could also assist in this approach.

- State-funded support for the technical side of monitoring road conditions prior to posting, and afterwards during use, may also be important in addressing this set of impacts. One solution could be to create a separate account that is funded by a portion of the Act 13 impact fees at the state level, or designated by counties, to assist local governments in paying for the up-front costs involved in posting roads used by the industry.

D. Environmental Impacts

Municipal officials and the public generally express uncertainty and concern about the impacts of shale gas development upon water quality and water supplies, and, to some degree, local air quality. Some of their concern arises from not understanding how and what is regulated by the various regulatory agencies involved. Although local government has no direct responsibility for regulating the environmental impacts of shale gas development, it does have an interest in having access to at least basic information about environmental regulation.

- Each municipality that has gas well sites within its border needs to understand what the DEP regulates and what it does not, and what a DEP inspector examines when he or she conducts an inspection of a shale gas well site.

- Each municipality should obtain copies of the permits authorizing operation of the gas wells, and it should understand how to access the various databases on shale gas development that the DEP maintains.

- Interactions with companies in advance of key activities will be very important in order for municipal officials to understand what will occur, and how accidents or hazards can best be addressed.

- It may be of value to both the DEP and the local governments for DEP to create a class of community outreach specialists who could act as liaisons with local government officials to provide this type of information on an on-going basis and serve as a point of contact for the local officials.

- Local government leaders should advise individuals who rely upon private water supplies to test the quantity and quality of their water supplies prior to gas well development in their locale and to regularly test it thereafter. Because it can be costly to do this, consideration should be given to creating a special fund with some of the Act 13 impact fees to provide financial assistance to those individuals who want to test their private water supplies but lack the resources to do so.

E. Public Health Research

The public health implications associated with shale gas development remain among the least clear aspects of this activity. Although a number of organizations and individuals have evaluated public health impacts in different parts of the country where shale gas is being extracted, the body of research is fragmented and insufficient to draw accurate conclusions. There is a great need for research that is coordinated, comprehensive, scientifically rigorous, and which relies on funding sources and methodologies that eliminate arguments of bias to the greatest degree possible.

- The recommendation of the Shale Gas Roundtable for the creation of a research initiative that conducts scientifically rigorous research according to a multi-year strategic plan and which relies on a diverse and transparent funding stream should be endorsed and implemented.

- Prompt communication of health related information should be undertaken by the Commonwealth and by county health officials.

- Creation of a health registry may also be of value, in order that perceived problems can be accurately identified, tracked, and evaluated.

F. Planning for Impact Fees

The Pennsylvania General Assembly has made impact fees paid by oil and gas operators the primary means of providing revenues for local governments from the shale gas boom. Impact fees are particularly important to local governments because locally taxable real property does not include the value of oil and gas resources, and because locally taxed income does not include income from shale gas royalties and rentals received by residents.

Impact fees will rise over time but not very fast, and will be divided among increasing numbers of participating governments and state agencies. Statewide the fee generated $204.2 million in 2012, $202.5 million in 2013, and $224.5 million in 2014. Maintaining similar funding levels will require substantial new wells to be drilled each year to offset the revenue declines. For example, about 1,200 new unconventional wells will need to be drilled in 2014 to offset the declining fee amounts being paid by those wells currently paying the fee, in order to achieve similar amounts of revenue for the 2015 distribution.

- Counties and municipalities should focus their impact fee expenditures on capital improvements that provide lasting value to the community, and on planning for longer term development activities. In the initial distribution, many municipalities seemed uncertain about how best to allocate these funds. As experience is gained, investing in longer term community assets will be seen to be of most value.

- Because the impact fees are divided in so many ways, it is important for municipalities and counties to plan for careful use of their fee distributions for longer term value. Some municipalities receive only very small amounts of fee distributions, and these municipalities may need to coordinate their expenditures with other local governments in order to meet longer term needs.

- It will be useful for communities to expend some of the impact fee funds on planning efforts designed to ensure sustainable uses of the funds for lasting capital projects in the subsequent years.

- County governments can also coordinate regionally appropriate expenditures through use of funds for planning and addressing needs that require municipalities to coordinate with one another.

G. Community Responses to Impacts

The Pennsylvania Supreme Court's *Robinson Township* decision reaffirms the proposition that local governments have the right to engage in place-based planning through the application of generally applicable land use ordinances to shale gas development activities. According to the court, local governments have "substantial, direct, and immediate interest in protecting the environment and quality of life" within their borders. Local governments can use their zoning powers to recognize locally-meaningful distinctions in land forms and compatible and incompatible land uses.

- Advice from municipal solicitors will be particularly important in this area, given ongoing litigation and uncertainty. It would appear that oil and gas operations may be excluded from some zoning districts and conditioned in others. Such regulation must not treat the oil and gas industry differently from other industries, nor seek to regulate how oil and gas operations are conducted. The Commonwealth Court's July 2014 opinion suggest that even the preemption provisions based on the previous Oil & Gas Act are not fully operative given its striking of the last sentence of Section 3302.

- Given the setback provisions struck down by the Supreme Court, it may be up to local governments to adopt provisions determining setbacks needed to address the location of certain oil and gas activities that may affect sensitive areas.

- It is possible that Pennsylvania local governments might now be able to address some issues related to timing and hours of operations, structure heights, lights, and noise impacts. In attempting to address any of these last areas, local governments should seek to do so a way that does not treat oil and gas operations in a discriminatory fashion and that links the conditions closely to issues of where such operations may occur rather than how they should, in general, be conducted.

One aspect of the current natural resource development that distinguishes it from past natural resource development is the growing recognition of the need for industry to obtain a social license to operate, i.e. to obtain and maintain the community's approval to operate. To obtain that approval, an operator must demonstrate respect for the community's values and must commit to accommodate those values in conducting site activities. Many of the operators have developed community engagement plans that specifically provide for consulting with the community in the development of site plans. Corporate-community engagement may provide

opportunities for achieving some commitments that may be more durable and comprehensive than regulation alone can address.

- As early as possible, communities should review the community engagement plans of the operators working in their communities and meet with the operators to better understand their site and operating plans and to advance appropriate requests that will best protect the community's interests. These will, in particular, address issues of maintaining barriers to sensitive areas and issues that involve light, noise, dust, and vibrations during site development.

- Communities should work with each operator to develop an acceptable method for communicating about issues related to site development and operation.

- It would be ideal to approach these issues from a regional or area standpoint wherever possible. A site-by-site or even an operator-by-operator process may leave issues and areas insufficiently addressed or addressed inconsistently. If possible, initiating processes that can establish consensual protocols that all operators within the region would follow (and which would supplement the regulatory framework) can create a sustainable model.

- Because the relationship between the industry and communities has matured and both can appreciate the potential value of a consensus-based approach to community protection, the time may be ripe for accomplishing such a change. Without either party making a binding commitment to the process, the parties could test this approach in a phased manner, exploring first in small steps the value of this approach.

APPENDIX A

Research Survey on Effects of Marcellus Shale Development on Communities Survey Results: Washington & Greene Counties 2013-14

A. Survey Description

In the fall of 2013, the Washington and Jefferson College Center for Energy Policy and Management conducted a survey of 440 local officials in Washington and Greene counties in southwestern Pennsylvania, the counties that are the locus of Marcellus Shale development in that region. The goal of the survey, which was entitled "*Research Survey on Effects of Marcellus Shale Development on Communities*," was to elicit the reaction of these officials to the unconventional gas development in their area and to Pennsylvania's Act 13, one of the purposes of which is to provide revenues to local governments to address the impacts of shale gas development. These officials, themselves longtime residents and acquainted with many, if not most, of the people in their community, provide us a glimpse of how people in the region perceive the shale gas development.

The survey, a 4-page questionnaire consisting of 16 questions (a condensed example of which appears here at the end), was conducted by mail, given that it was the most reliable way to reach all of the officials. The survey covers the period up to and including the third quarter of 2013, thus covering the first two rounds of Act 13 impact fee disbursement. The response rate for the survey was 20%. The survey respondents were given the choice to respond anonymously, but 60% of the respondents chose to identify themselves fully and another 14% identified at least their municipality. Of those respondents who included their geographic information, 79% were from Washington County and 21% were from Greene County, again, however, a full 40% of the total respondents were anonymous. Throughout our discussion, we will adhere to this anonymity because it allows officials the opportunity to express their opinions freely.

Prior to conducting the survey we interviewed Greene and Washington County Commissioners, along with a variety of other stakeholders, which influenced the content of the survey. We followed up the survey with interviews of these same Commissioners approximately one year later. Additionally, one on one interviews were conducted fall through spring (2013-14) with those municipal officials who had completed the survey and had expressed a willingness to speak at greater length on these issues. The results of these interviews are interwoven with our discussion of the survey results proper because they provide clarification of the results and serve to give a fuller picture of how local officials see the development and its impacts.

B. Overall Reaction to Marcellus Shale Development

Jobs

The first issue (question #1) to be addressed in the survey was the question of employment – had residents in their community obtained jobs in the natural gas industry; if so, what was the nature of their jobs; and if not, what did the officials believe were the obstacles to their obtaining employment there. The overwhelming majority of respondents, 80%, noted that residents had obtained work in the gas industry (15% answered "no" and 5% did not answer). The majority of jobs obtained, as reported by these officials, were concentrated in unskilled and skilled labor (55% and 16% respectively). The jobs most commonly noted were truck driver, security guard, and field/well hand. The next most frequently noted category (accounting for 16%) was professionals, including accountants, PR and sales, management, geologists, and engineers. The final category noted was landman/title searcher, accounting for 13% of the jobs obtained.

For the 15% of the respondents who reported that residents in their community had not obtained jobs, the reason most commonly cited was a lack of training or skills (30%). This was followed closely by a lack of interest by employers to hire local residents (25%), a lack of interest on the part of the local residents (20%), the inability of the local residents to meet employment requirements on a basis other than skills (15%), and finally the 10% citing "other" reasons noted that their population was either too old or too small. For example, citing an aged population, one municipal official explained, "Residents are older people and gas companies will not hire older people. Some residents have gotten jobs, but these people are not property owners." This interviewee was not alone in mentioning out-of-town workers. The implication was that jobs have gone to transplants, as opposed to long-time residents of the area. Conversely, it also indicates that younger workers have moved into an otherwise moribund area and could potentially revitalize it. A county commissioner expressed this latter view, stating, "They're not taking local jobs. [The development] is bringing in skilled, knowledgeable workers that understand the jobs and technologies. They can teach local residents, maybe move into the area and contribute to [our] county." Another county commissioner added that the problem of jobs going to non-residents was resolving itself: "at first jobs went to out-of-staters, but now 7 out of 10 are held by locals." Another municipal official explained, "in the beginning the industry wanted to hire local workers, but they were hampered by the drug problem."

Regarding the issue of why some residents might lack interest in pursuing gas work, one official noted in an interview that some workers might not want to make a transition from the local coal industry to gas because of "the long hours and hard work" and "drugs – the very stringent drug tests." Another Washington County official argued, "the challenge is with parents" not wanting their children to go into this type of work, but "this industry is creating more jobs that don't require a college degree and compensation is flipping. A kid with a college degree can go into HR and make in the $30s, but welders are making $80-90,000! We are in the middle of a

paradigm shift…this is a new industry to our area…and there are unknowns, but it tends to pay well and provides a multitude of opportunities…but the general public is often unaware of the opportunities that are actually available in the industry."

It should be noted that even among those officials who answered positively regarding employment, 23% still noted that there were obstacles to their residents obtaining work, citing the same reasons as those who had responded negatively. These respondents noted that the employment picture was complicated by the fact that opportunities were few, mostly comprised of low paying job, unskilled jobs, involved lay-offs once work (such as laying pipelines) was completed, and that the jobs obtained often went to "transplants from out of the region" who already worked in the industry and therefore had the requisite experience and training.

What these responses highlight is that the employment picture is complicated – while the overwhelming majority of areas can report increased employment, there is still a great need for training of local residents to help them make the transition to the new industry. There is also a need for work on the issue that a significant number of municipal officials perceive a lack of interest by operators in hiring local residents. Either the municipalities need to be more proactive in working with the industry to promote the case for hiring local people and working to resolve the reasons for the operators' lack of interest or there is a misperception on the officials' part and the industry needs to make it clear that they do want local workers.

Municipal Revenues

Question #2 asked officials to assess whether Marcellus Shale development had affected their municipality's revenues, either positively or negatively, in what ways revenues had been affected, and if the effect had been positive how the municipality was using the new revenues. (It should be noted that officials were instructed to exclude from consideration Act 13 Impact Fees, but a thorough examination of the responses suggests that most respondents lumped impact fees together with other revenues emanating from the shale gas development and considered them as one whole.)

Overall, the number of respondents noting a positive impact on their municipal revenues was 44.7%. They noted increased tax revenues, particularly on earned income tax and real estate tax, monies from permit fees, and even money for gas developed on borough property. Common responses from this group are: "we are blessed to receive this money. Probably without it we would be over budget!" "Aside from new construction paid for by bonus checks and royalties, which will raise property values and property taxes, we got a one shot transfer of property from Consol to CNX that brought [our] township a one-time windfall of 100 thousand." "[We] now have some income to work with to better our township." "This money is additional revenue for our small municipality [and has] enabled us to purchase a new police car;" and "Positive – more money to do projects that we would not be able to do otherwise."

These municipal leaders also note a revitalization of their local economies "by industry employees buying homes, products and services from our businesses"; "increased water sales, fast food sales, hotel rooms, general business pick up;" and "it has expended billions of dollars in our local economy. These dollars are being spent at local businesses and eventually coming in to the municipality." The county commissioners with whom we spoke supported this view of the broader positive economic impact made by the industry. As one county commissioner stated in early 2014: "Our biggest challenge is how to grow economically. We need to establish a greater tax base…we have seen economic growth as a consequence of Marcellus Shale development. Local businesses have seen a great increase in business, for example, an increase in the sale of tractors, the local small grocery store has seen a lot of activity, and a local men's store in our community has switched to selling fire proof overhauls and other work gear. The past year has been the best they ever had…This bus in not coming through here again. We have to turn this development into real economic development! It's upsetting that other counties are fighting this development. That only hurts us. If everyone understood the manufacturing opportunities that this natural gas offers they would not fight it." Another county commissioner echoed these thoughts, saying, "It's our turn…we are going to make something out of this." A Washington county official concurred, "I don't see the downside economically. Washington County has had the greatest county growth in America. Community psyche has altered incredibly. There is a sense of pride, where before it was an economically depressed area."

All officials noting a positive impact reported that the extra revenues were used most frequently on infrastructure improvements: repairing/rebuilding roads and other public works improvements; purchase of public works equipment, general operating expenses; installation of water lines; fire protection funds; and increased police protection. In other words, most revenues were immediately expended on community maintenance and development

Admittedly, not all respondents noted a positive effect on their municipality's revenues. 32.9 % of respondents noted no impact on revenues. 9.4% noted a mixed impact and 8.2% noted an overall negative impact. Invariably, those citing a mixed impact explained it as did one official: "revenues have increased significantly, but expenditures have also increased." The expenditures most frequently cited are repairs for roads destroyed by heavy trucks and sharply increased traffic. As one official explained it, "because the use is increased – basic maintenance of affected roads is increased. Thus, most additional funds are depleted by this activity." For those noting a negative impact on revenues, the most commonly cited reason was that additional revenues were dwarfed by the increased expenditures on services. As one official put it, "We've gotten no additional revenue, but the services that are provided have increased, such as: police, road crew, and management involvement."

Our interviews with officials clarified the reason for this great divergence in opinion. On the county level, both counties benefitted enormously, but at the municipal level not all municipalities have benefitted equally. Some have had direct well development and thus more generous impact fees and other revenue growth. Other areas have received impact fees, but little of the impacts as they have no development. And others are surrounded by development but have no wells and not enough of a population to generate impact fees, and thus received mostly impacts and little revenue to offset them.

Changes to the Municipality

Questions #6 and 7 on the survey dealt with whether the local government had made any personnel changes in response to Marcellus Shale development (additions, changes in duties, new committees, etc.) or had begun to provide additional services to its community. Regarding personnel, the overwhelming response was negative: 94% responding that no personnel changes had been made with only 6% noting additions of personnel. With regards to additional services, answers were also mostly negative (with 80% noting no additional services, 18% answering affirmatively and 2% providing no answer).

A closer examination of the comments reveals, however, that even though personnel didn't increase, duties and services provided did – even among those who had answered negatively. There are two notable exceptions, where extra help was acquired: one municipality which hired an additional part-time police force, and another which reported that it had contracted with an outside road engineering company to inspect roads. Otherwise, the other communities were simply doing more work, providing the same type of services but more of it, with the same number of people. These responses bear this out: "supervisors, now have hearings on unconventional wells drilled instead of Zoning Board, to be in compliance with Act 13;" "road master spends more time on complaints by residents (from drilling activity) than on road work as before drilling came," and "one or more employees [now] deal with gas related issues daily;" our "planning committee is working more." The most common additional services cited were: road repairs and increased police protection.

Most Difficult Impact

Question #8 of the survey asked respondents to rate which impacts from Marcellus Shale development they considered to be the most difficult to address and why. Not surprisingly given the earlier answers, the impacts most commonly cited were road damage (33%) and traffic (26)%, followed by noise from compressor stations (at 8%). The next complaints (each garnering 5-6% of answers) were: public opinion/keeping the public informed; dust; environmental impacts; and dealing with Act 13 rules. The impacts cited least frequently (1.6% all) were: water quality; air quality; public health; lack of preparation for development; dealing with the pace; impacts to human services and community discord. What is, perhaps, most interesting here is that the impacts most frequently cited in the press in relation to Marcellus

Shale development actually rank rather low on the list of what officials in the communities rate as most difficult. Moreover, it bears noting that in interviews several officials put these impacts in perspective. For example, "the impact is positive more than negative. There's noise, dust, and traffic, but benefits. There's a new surface coal mine and stone quarry near us and there's more impact from that blasting and shaking the houses than there is from the gas development."

As regards the focus on roads and bridges, it is logical for the municipalities to focus on these because as one county commissioner noted "for municipalities it's roads…the supervisors spend a lot of time on the local level taking care of roads." It is one of their central responsibilities and many of the locales had infrastructure that was already in poor condition, and then was strained further. The growth of traffic in many of these areas has been dramatic. As an example, one municipal leader explained that traffic in their rural area had increased twenty-fold, "whereas before in a 24 hour period you might see 5-6 vehicles now you see 100+ vehicles in the same 24 hour period" in an area with 58 miles of gravel roads.

Relationship with Industry

Questions #13 and 14 of the survey dealt with the locale's relationship with the gas industry. The first addressed whether or not the municipality has been involved in any conflict over Marcellus Shale development. The majority of respondents (72%) answered that they were not involved in any conflict with the industry. Among those responding affirmatively regarding conflict (23%), the most commonly cited issue was damaged roads and bridges. Several respondents did note that their municipalities were part of the group that challenged Act 13, however they did not mention direct conflict with the operators.

Question #14 addresses how each municipality communicates with both the industry and the public regarding Marcellus Shale development. The largest single group (27%) responded that it communicated directly with the industry via phone, email, and one-on-one meetings and handled matters as they arose. 21% cited public meetings where industry reps were frequently in attendance. 7% of communication is done via media (including magazines and websites). Only 6% of areas cited no communication whatsoever.

As regards the officials' satisfaction with the level of communication, very few made negative comments, suggesting that most found it satisfactory. This was borne out in our interviews with municipal officials – most of whom reported a good working relationship with the operators. As one municipal official stated, "we have a good relationship with the companies…they're better than the loggers. They're responsible about the roads. They're good neighbors." Another Washington county official also felt the operators were responsive. As an example, he cited an instance when he called an operator at 9:00 p.m. about a matter caused by heavy rains and there was a crew on site to address the problem by 8:00 a.m. the following morning." One official from a municipality with a significant amount of gas development explained that the relationship with the operators had developed over time: "It's been a learning experience and there were

growing pains! The industry has improved a great deal, but it's taken a lot to get there. Now we have much better communication."

Even among those who cited a good relationship, though, a common request was for operators to provide more information regarding their plans for activity, as this would allow officials to plan accordingly. A Green County official explained, "I think the only strain is figuring out how to handle any type of accidents…to properly notify emergency services when roads are closed down. Sometimes the drilling companies close down roads to do work and don't notify the county/township, that is such a risk…how can emergency services get to people?" A county commissioner echoed this concern, referring to accidents on the sites, saying "we need more contact between us and operators so we can tell emergency responders where to go." Another commissioner suggested a "one-stop number where we could call to resolve problems" – this in light of the fact that many companies are involved in the areas (contractors and a multitude of sub-contractors), and sites often changed ownership, such that county and municipal officials sometimes did not know to whom to direct issues.

C. Reaction to Act 13

Adequacy of Impact Fees

The next section of the survey concerned Pennsylvania Act 13, one of the purposes of which was to provide funds to areas to address the impacts from unconventional gas development. The goal of this portion of the survey was to determine as much as possible whether these local officials have found Act 13 and the fees to be an adequate mechanism for addressing the impacts occurring in their communities.

The first question (#3) asked whether the respondents consider the fees received in 2012 and 2013 to be adequate to address the impacts and if they are not adequate which impacts could not be addressed. 22% responded that the Act 13 fees were inadequate, the most commonly cited problem being road damages that could not be addressed with the amount provided. The majority of respondents (65%) noted that the fees were adequate to address the impacts, but a significant number added that while the fees are currently adequate it was not clear if they would be in the future. As one official remarked, "the fees are enough for the time being – probably not in the future." Another remarked, "at this time [they are enough]. But as the industry's future is uncertain it is too soon to tell." Others noted that the fees were enough only because development was still limited or had not reached their area. A county commissioner observed early on, "we are hopeful that the fees will continue, but are cautious in recognizing that they could end abruptly."

In interviews, most officials expressed the belief that shale gas development would continue and grow, and along with it the impacts, and there was a worry that the fees would not keep pace.

This was particularly the case because many we interviewed anticipated that their fees would decrease in the upcoming round of disbursements. There was concern about the current structuring of the fees, many noting that communities with few impacts had received more than some areas with greater levels of impacts. For example, one small Washington County community had received only $16,000 (because they had no wells and a small population) but was completely surrounded by development and experienced significant traffic and other impacts. Some we interviewed also worried that future changes to the fee structure might disadvantage the municipalities even further. For example, one official queried, "all the candidates for governor want to do an excise tax on the gas industry. We only get 1/3 of the impact fees now and the state gets 2/3. Would that mean we would get even less as the state government gets more?"

Question #4 asked whether the communities are experiencing impacts that are not covered by Act 13, and if so what they are. 80% of respondents answered negatively, i.e. they feel that there are no impacts not covered by Act 13. This suggests that the Act was reasonably well formulated in this respect. A small group (9%) felt that there were additional impacts – again citing principally those from vehicles: damaged roads, traffic (frequently speeding), noise and dust. 11% of the respondents did not answer this question.

Overall, the principal dissatisfaction with the impact fees is less what impacts they cover and more the amounts and whether the money was equitably distributed among the municipalities.

Spending Impact Fees

Question #5 of the survey addressed the issue of how local governments reach decisions about spending their Act 13 Impact Fees. This question was designed to elicit information about the process and how much public input was integrated into the decision. Most of the answers regarding the process for decision making suggest that in general the local governments do not have a special process for determining how to spend the fees. They decide on spending them in accordance with their typical budgetary process – voting on them at regular meetings. The variety of answers simply point to which municipal body handles the decision-making. The most commonly cited body was the Borough Council. As concerns public input, 6% noted that decisions were made at public meetings and that public input was considered.

An issue that came to the fore in the interviewing process was a discernable split not so much in how the locales decided on spending, but in what they regarded as the best use of the fees. For example, many areas treated the fees not as special monies, but simply as additions to their general fund, a supplement to their general budget to be used to fill budget gaps. However, some officials argued for regarding the fees as an opportunity to accomplish special projects for the county/municipality. This split was particularly clear on the county level. As one county commissioner noted, "[we do] not put any money into operational support…not for salaries…[that] leads in the long run to debt and the need to cut programs." His concern was

these funds not be used to bridge the gap between this budget year and the next, but that they be reserved for special long-term needs and opportunities. Generally, however, Greene County officials argued for using the monies immediately, putting them into infrastructure projects such as water and sewer line upgrades and bridge repairs that would help their county grow and develop. One official explained, "for me I think my opinion would be to spend only because the need is so great now. There has been deferred maintenance for things put off in the past. The need is too great to justify saving." And another commented, "We need water lines and sewer lines [upgraded]. If we don't have that, we can't expand and then there goes taxes." In essence, both approaches are focused on the future – one emphasizes saving, the other spending to lay the groundwork for future growth.

In terms of actual spending of the fees, according to submitted PUC forms, Greene County spent 55.26% of its initial impact fee revenue on public infrastructure, 22.36% on public safety, 19.15% on social services and 3.23% on records management. Greene County decision-makers placed no impact fee revenue in a capital reserve fund. In contrast, Washington County chose to save 28% of their impact fees and the municipal governments in both Washington County and Greene County saved on average 53% and 54% of their impact fees respectively.

Operators Before & After Act 13

In the next set of questions regarding Act 13, our goal was to elicit whether or not Act 13 had changed how the operators dealt with impacts in the communities. Question #10 asked whether, prior to the impact fees, the operator corrected or compensated for corrections to impacts and if so what types of impacts they addressed. 41% of respondents answered no, i.e. the operators did not correct or compensate for impacts. Another 28% did not answer or indicated that the issue was not applicable. 31% responded that the operators did correct/compensate for impacts. Again, the overwhelming majority of impacts cited were road repairs. Some respondents did feel that the gas industry was more responsive to impacts prior to enactment of Act 13. As one put it, "In my opinion they are more reluctant to repair damages after Act 13 because they seem to think that the Act gives them license to damage without compensation."

Question #11 asked respondents whether operators continue to correct/compensate for impacts since enactment of Act 13, and if so for what types of impacts. 40% responded no, i.e. the operators are not continuing to correct/compensate for impacts. 25% responded that they are continuing to correct/compensate (35% cited N/A or gave no answer). It should be noted here that even among those stating that the industry was continuing to correct/compensate, a number reported that road repairs (again the impact most often cited) are not handled in a timely fashion or without vigilance on the part of the communities.

The results from these two survey questions are not entirely clear. That 28% did not answer the first question and 35% did not answer the second question suggests that there was some confusion. In the interviews with municipal leaders, most responded that in terms of roads the

operators continued much as they had prior to Act 13, i.e. for those whose roads were not bonded, they tried to work with the operators on a case by case basis to get damages addressed – and they got results; and for those whose roads were bonded – the mechanism was already in place for damages to be taken care of.

As regards their dealings with the operators, perhaps the most revealing remarks come from those officials who have dealt with several different operators. They reported that before and after Act 13 some were responsive to community complaints/ requests and some were less so. This answer goes some distance towards explaining how different communities can report such different experiences. What this suggests, though, is that there is a need to ensure that impacts are addressed by all operators. For example, measures to ensure that more roads were bonded, thus requiring the operators to do or fund repairs, would ease the situation.

D. Other Strategies for Dealing with Impacts

In this final group of questions we hoped to elicit ideas and information regarding what the communities can do moving forward to deal with the changes and impacts in their communities.

Potential for Collaboration

Question #9 asked whether respondents thought it might be productive to collaborate with another municipality, or county, to combine Act 13 impact fees to address an impact; and if so – regarding which impacts. On this issue, 64% responded that they did not see the potential for collaboration. One county commissioner criticized this reticence on the part of most of the communities to pool their funds, remarking, "the municipalities need to combine their efforts in spending impact fees! It would increase their buying power."

22% responded "yes" or "possibly" regarding collaboration. Among this latter group, the impact cited most often was road repair (particularly of roads spanning two townships or the co-operative purchase of road equipment). Other potential areas for cooperation noted were: police, fire and emergency services; help with water systems; and job creation. Several respondents, who did not necessarily see the potential for pooling funds, did see the benefit of "consulting with other townships on issues concerning ordinances and strategies to lessen impacts" or "reviewing their dealings with drillers. So as to have solutions ready before problems arise."

Other Funds

Question #12 asks officials whether there are any other funds (aside from tax revenues and Act 13 Impact fees) available to them to help finance correction of Marcellus Shale development impacts. The majority (65%) responded no on this issue, though some of these indicated that they just didn't know. 32% did not answer or noted that it was not applicable. 3% of the respondents answered affirmatively. The funds they noted were principally casino funds.

The issue of the availability of other funds is clearly one where municipalities generally need more information. One community in Washington County reported using a portion of their impact fees for strategic economic planning services, using a professional planner. This group, as part of their development study, had provided information on grants that are available. The municipality recently applied for funding to cover more comprehensive planning. Funds are available, but municipalities are not always aware of them.

Need for More Information

Question #15 asked respondents whether they want more information on some particular aspect of Marcellus Shale development and if so what? 61% of the respondents noted that they did not have any such issue. 26% of the officials, however, did express a desire for more information. Fundamentally, the topic cited most frequently was environmental impacts: water quality; air quality; effects on farmlands and livestock; and long term health issues. Regarding water issues, one commissioner stated, "I don't think some people understand water and documenting water problems…People complain that now their water smells but you have to have proof of contamination and we need to promote education regarding testing to maintain proof." Another county commissioner suggested that there needed to be state enforced monitoring of cisterns, wells, and springs. Respondents also cited a need for information about legal issues, including the rights of municipalities and individual property owners. Officials also asserted the need to be better informed about the plans the industry has for development, as noted earlier.

Innovative Ideas

The final question in the survey #16 asks respondents to tell us if they have any innovative approaches to dealing with impacts from the Marcellus Shale development. The vast majority (80%) noted that they did not have any such strategies. Of those that did answer affirmatively, the following strategies were cited: the use of truck scales in police traffic enforcement; new ordinances for drilling and seismic testing and an ordinance requiring 7 acres of land before putting in a well; and a system for notification of road usage and a time table.

In interviews, one Washington county municipality noted that its planning commission was looking at what other areas were doing and were discussing establishing barrier areas for schools and homes (as a consequence of the Greene County well blowout). They also noted that the PA State Association of Township Supervisors has an excellent website (***psats.org***) with a good deal of useful information and that at its convention there was a lot of discussion about the use of impact fees.

Research Survey on Effects of Marcellus Shale Development on Communities
Washington & Jefferson College
Center for Energy Policy and Management

Directions:

1. **We are conducting this survey to assess the impacts of Marcellus Shale development on southwestern PA communities. Impacts can be positive or negative. Please consider both in responding to the questions.**
2. **If you are unable to answer a specific question, or questions, please leave the question(s) blank, but answer the others.**
3. **PLEASE RESPOND BY NOVEMBER 15, 2013.**

---

1. Have residents of your municipality obtained jobs in the natural gas industry?
   ☐**yes** ☐**no**
   If they have, please identify the types of jobs they have obtained.
   _____
   If they have not, please identify what you believe are the principal obstacles to their obtaining these jobs? (Please check all that apply)
   ☐ Lack of training/skills
   ☐ Lack of interest by employers to hire local residents
   ☐ Inability of local residents to meet employment eligibility requirements (other than skills)
   ☐ Lack of interest by local residents
   ☐ Other (Please describe)

2. Apart from the Act 13 Impact Fees, has Marcellus Shale development had any effect, positive or negative, on your municipality's revenues?
   ☐**yes** ☐**no**
   If it has had an effect, in what ways have your municipality's revenues been affected?
   _____
   _____
   If the effect has been positive, how have the new revenues been used?
   _____

3. Are the Act 13 Impact Fees that your municipality received in 2012 and 2013 adequate to address the Marcellus Shale development impacts that your municipality experienced?
   ☐**yes** ☐**no**

   If they are not adequate, what impacts could not be addressed with the Impact Fees?
   _____

4. Has your municipality experienced, or is it experiencing, any impacts of Marcellus Shale development other than those identified in the list of thirteen authorized uses of the Act 13 Impact Fees?
   ☐**yes** ☐**no**
   If your municipality has experienced or is experiencing other impacts, what are these impacts?
   _____

5. What process does your municipality use for deciding how to spend your Act 13 Impact Fees?
   _____

6. Has your municipality added any positions, changed any job descriptions, added any committees, or changed any committee charges in response to the Marcellus Shale development?
   ☐**yes** ☐**no**
   If changes have been made, please describe them and describe why the changes were made.
   _____

7. Has your municipality provided, or is it providing, any additional services to your community as a consequence of the Marcellus Shale development?
   ☐**yes** ☐**no**
   If additional services have been provided, or are being provided, please identify what those additional services are, and identify the time frame when they have been or will be provided.
   _____

8. Of the Marcellus Shale development impacts that your municipality has experienced, which ones do you consider the most difficult to address? Why? _____

9. Are there instances where you think it would be productive to collaborate with another municipality, or a county, to combine your Act 13 Impact Fees to address a particular Marcellus Shale development impact?

☐**yes** ☐**no**
If you think it would be productive, please identify which impacts lend themselves to this process.

_____

10. Before the Act 13 Impact Fees were distributed, did the operators who conducted Marcellus Shale development activities in your municipality correct, or compensate you for correcting, Marcellus Shale development impacts?
☐**yes** ☐**no**
If they did, what types of impacts did they address?

_____

11. Have the operators continued to correct, or compensate you for correcting, impacts of Marcellus Shale development now that your municipality is receiving the Act 13 Impact Fees?
☐**yes** ☐**no**
If they have, what types of impacts have they corrected or compensated you to correct?

_____

12. Aside from routine tax revenues and the Act 13 Impact Fees, are there any other funds, such as matching grants, available to your municipality to help finance correction of Marcellus Shale development impacts?
☐**yes** ☐**no**
If there are funds, please identify them.

_____
If any of these funds require an application, have you filed the application?
☐**yes** ☐**no**

13. Has your municipality become involved (either as a party to the conflict or as an observer) in any conflict over Marcellus Shale development?
☐**yes** ☐**no**
If it has, what was the nature of this conflict and has it been resolved?

_____

14. How does your municipality communicate with both industry and the public concerning Marcellus Shale development?

_____

15. Are there any aspects of Marcellus Shale development (such as certain legal issues or particular laws or environmental impacts) that you wish you had more information about?
☐**yes** ☐**no**
If there are, what would you like to learn more about?

_____

16. Has your municipality implemented any innovative strategies for addressing the impacts of Marcellus Shale development?
☐**yes** ☐**no**
If you have implemented any innovative strategies, please describe them.

_____

If you would like to provide your name and/or identify your municipality, please do so in the spaces below. **It is not required**. We will hold any identifying information in the strictest confidence and will not disclose it in any of the research publications in which the survey information itself is used.

Name:_____Municipality:_____

On behalf of Washington & Jefferson College, thank you for your time in completing this survey. We greatly appreciate your participation. Please return the completed survey to Dr. Leslie Dunn at W&J College, 60 S. Lincoln Street, Washington, PA 15301, using the enclosed self-addressed and stamped envelope.

ENDNOTES

[1] Anthony Andrews, Peter Folger, Marc Humphries, Claudia Copeland, Mary Tiemann, Robert Meltz, et al., *Unconventional Gas Shales: Development, Technology, and Policy Issues*, Congressional Research Service (2009).
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[395] COLO. RULE § 609(b).
[396] *Id.*
[397] W. VA. CODE § 22-6A-12(a).
[398] *Id.*
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[401] OHIO REV. CODE § 1509.07.
[402] W. VA. CODE § 22-6A-15
[403] Hydraulic Fracturing Regulatory Act (Illinois), § 1-65(a)–(b).
[404] *Id.* § 1-35(a)(3); § 1-35(b)(19).
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[422] Hydraulic Fracturing Regulatory Act (Illinois), § 1-35(b)(10)(A).
[423] *Id.* § 1-35(b)(10).
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[425] 58 PA. CONS. STAT. § 3273.1.
[426] 58 PA. CONS. STAT. § 3218.2(c).
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[465] Stephanie Paige, *Ohio becomes 3rd state to adopt stricter rules on oil and gas leaks*, E&E DAILY, April 7, 2014. The Ohio EPA, Division of Air Pollution Control issued revised Model General Permits (MGPs) for oil & gas well sites, *available at* http://www.epa.ohio.gov/dapc/genpermit/genpermits.aspx. Ohio joins Colorado and Wyoming in addressing this area of concern specifically.
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[469] COLO. RULE 1200.
[470] *Id.* 1202.
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[472] *Id.*
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[481] Hydraulic Fracturing Regulatory Act (Illinois), § 1-100 (a).
[482] *Id.* § 1-100(b). The enumerated sections are: § 1-25(c) ("It is unlawful to inject or discharge hydraulic fracturing fluid, produced water, BTEX, diesel, or petroleum distillates into fresh water"); § 1-25(d) ("It is unlawful to perform any high volume horizontal hydraulic fracturing operations by knowingly or recklessly injecting diesel"); § 1-30(a) (requiring a permit to drill, deepen, or convert a well for horizontal hydraulic fracturing); § 1-75(c)(9) ("Discharge of hydraulic fracturing fluids, hydraulic fracturing flowback, and produced water into any surface water or water drainage way is prohibited"); and § 1-87(a) (requiring high volume horizontal hydraulic fracturing operations permitted under this Act to comply with Section 12 of the Illinois Environmental Protection Act (also prohibiting the discharge of contaminants so as to cause water pollution, 415 ILL. COMP. STAT. 5/12 (2012), or surface water or groundwater regulations adopted under that Act).
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[640] 58 P.S. 601.602 (emphasis supplied).
[641] Huntley & Huntley Inc. v. Borough Council of Borough of Oakmont, 600 PA. 207, 964 A.2d 855 (Pa. 2009).
[642] Range Resources v. Salem Township, 600 PA. 231, 964 A. 2d 869 (Pa. 2009).
[643] Range Resources, at n.7.
[644] Act No. 13 of Feb. 14, 2012, P.L. 87, 58 PA. C.S. §§2301-3504.
[645] 58 PA. CONS. STAT. ANN. §3302. Section 4 of Act 13 provided that Section 3302's re-enactment of this provision "is not intended to change or affect the legislative intent, judicial construction, or administration and implementation of section 602 of the Oil and Gas Act."
[646] *Robinson Township et al. v. Commonwealth of Pennsylvania et al.*, 83 A.3d 901 (Pa. 2013).
[647] Article 1 Section 27 of the Pennsylvania Constitution states: "The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic, and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people."
[648] Chief Justice's opinion at p. 111. This observation was quoted and cited with approval in Justice Baer's concurring opinion, Baer opinion at 18-19.
[649] Chief Justice's opinion at p. 121. Justice Baer concurred that this mandate to municipalities that they enact only zoning ordinances without any available remedy consistent with the individualized concerns of each municipality is arbitrary and discriminatory, thus violating Art. 1, Section 1's guarantee of due process. Baer opinion at 17-18,
[650] Chief Justice's opinion at p. 125. "Imposing statewide environmental and habitability standards appropriate for the heaviest of industrial areas in sensitive zoning districts lowers environmental and habitability protections for affected residents and property owners below the existing threshold and permits significant degradation of public natural resources. The outright ban on local regulation of oil and gas operations (such as ordinances seeking to conform development to local condition) that would mitigate the effect, meanwhile, propagates serious detrimental and disparate effects on the corpus of the trust." Chief Justice opinion, at p. 126–127.
[651] Chief Justice opinion at p. 126; Justice Baer opinion at p. 17–18.
[652] Act 13 3215(b)(4). Section 3304(b)(10) prohibited local governments from increasing any of the setbacks in the Act; and while 3215(b) required DEP to waive or reduce setbacks upon showings by operators, it gave DEP no power to increase them either.
[653] Chief Justice opinion at p. 132–133, Justice Baer opinion at 20–21. The Chief Justice's opinion also notes the anomaly in 3215(e) that places the burden of justifying any "conditions" upon the DEP rather than the applicant, should the applicant appeal.
[654] Chief Justice opinion at p. 133.
[655] Robinson Township v. Commonwealth, No. 284 M.D. 2012 (Pa. Commw. July 17, 2014) (Robinson Twp III), slip op. at 22-23, n.27.
[656] Id. at 22. The consequences of this are not entirely clear. The Commonwealth Court's opinion says in a footnote that this means that reliance on *Huntley & Huntley v. Oakmont* is "misplaced" but does not say that the test articulated in that case for valid oil and gas regulation no longer applies; while the dissenting and concurring opinions characterize the "where" vs. "how" distinction articulated in *Huntley & Huntley* as still operative via the surviving portion of Section 3302. Thus, the majority opinion may open the door for future litigation over the extent of municipal powers under the MPC to regulate aspects of oil and gas activities.
[657] Chief Justice opinion at 17–18.
[658] The Court did not address or invalidate the setback provisions in Section 3215(a) providing that unconventional gas wells not be drilled any closer than 500 feet to an *existing* building or water well, nor within 1,000 feet of the well or intake point of a water supply used by a water purveyor, unless consented to by the owner or purveyor.
[659] 58 PA. CONS. STAT. § 3304.
[660] COLO. RULE 802. Noise levels are measured 350 feet from the source.

[661] *Id.*
[662] *Id.*
[663] *Id.* 802.d.
[664] *Id.* 803.
[665] *Id.* 804, 805.
[666] American Petroleum Institute, Environmental Performance/Public-Private Partnerships, http://www.api.org.
[667] The American Petroleum Institute has developed a set of Guidelines (Community Engagement Guidelines, ANSI/API 1003, issued July 9, 2014) for how to best structure this type of community engagement plan, *available at* http://www.api.org.
[668] Marcellus Shale Coalition, Recommended Practices: Site Planning, Development and Restoration MSC RP 2012-1, http://www.MarcellusCoalition.org (last updated June 20, 2013).
[669]Appalachian Shale Recommended Practices Group, http://www.asrpg.org.
[670] Appalachian Shale Recommended Practices Group, Introduction to Recommended Standards and Practice, http://www.asrpg.org.
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[672] Chesapeake Energy Corporation, 2012 Corporate Responsibility Report, http://www.chk.com/media/Publications/Corporate-Responsibility-Report/Documents/pdf/2012CorporateResponsibilityReport.pdf; Chevron, 2013 Corporate Responsibility Report, Marcellus Brochure, http://www.chevron.com/corporateresponsibility; CONSOL Energy, Corporate Responsibility Report (2013), http://www.consolenergy.com; EQT, Corporate Social Responsibility Report (2012), http://www.eqt.com; Range Resources, Corporate Responsibility Report, Community Engagement and Leadership Chapter, http://www.rangeresources.com.
[673] It should be noted that the Delaware River Basin Commission has also imposed a moratorium on the development of unconventional shale resources by means of high volume hydraulic fracturing pending the promulgation new regulations governing the siting and development of well pads. Consequently, shale gas development in the area of Pennsylvania that is within the Delaware River Basin is currently not permitted.
[674] Pennsylvania Environmental Council, *Developing the Marcellus Shale: Environmental Policy and Planning Recommendations for the Development of the Marcellus Shale Play in Pennsylvania* (2010), *available at* http://marcellus.pecpa.org/wp-content/uploads/2011/06/Developing-the-Marcellus-Shale.pdf.
[675] *Id.* at 10.
[676] *Id.* at 15, *et seq.*, *see also*, Pennsylvania Environmental Council and Chesapeake Bay Foundation, *The Marcellus Shale Amendments: A Proposal for Reforming the Pennsylvania Oil and Gas Act* (2011), at 4 *et seq.*, *available at* http://marcellus.pecpa.org/wp-content/uploads/2011/06/The-Marcellus-Shale-Amendments.pdf.
[677] Sean Nolon *et al.*, Chapter 2: The Limitations of the Required Process, *in* LAND IN CONFLICT: MANAGING AND RESOLVING LAND USE DISPUTES [Kindle E-reader version] (2013).
[678] *Id.*, Chapter 2.
[679] *See* e.g., LAWRENCE SUSSKIND & JEFFREY CRUIKSHANK, BREAKING THE IMPASSE: CONSENSUAL APPROACHES TO RESOLVING PUBLIC DISPUTES (1987); SUSAN L. PODZIBA, Civic Fusion: Mediating Polarized Public Disputes (2012).
[680] On Common Ground Consultants Inc. & Robert Boutilier and Associates, Social License.Com, http://www.socialicense.com.
[681] Interfaith Center on Corporate Responsibility and Investor Environmental Health Network, *Extracting the Facts: An Investor Guide to Disclosing Risks from Hydraulic Fracturing* (2011) at 13, *available at* http://iehn.org/documents/frackguidance.pdf; *see also*, International Energy Agency, *Golden Rules for a Golden Age of Gas: World Energy Outlook Special Report on Unconventional Gas* (2012) at 42, *et seq.*, *available at* http://www.worldenergyoutlook.org/media/weowebsite/2012/goldenrules/WEO2012_GoldenRulesReport.pdf; and Richard A. Liroff, Shareholder Engagement as a Tool for Risk Management and Disclosure, Beyond the Fracking Wars: A Guide for Lawyers, Public Officials, Planners, and Citizens (Erica Levine Powers and Beth E. Kinne eds., 2013).
[682] Nolon, *et al.*, *supra* note 677, at Preface.
[683] *Id.*, Preface; *see also*, Susskind & Cruikshank, *supra* note 679; and Podziba, *supra* note 679.

[684] The Penn State Extension has published a list of County Natural Gas Task Forces at http://extension.psu.edu/natural-resources/natural-gas/service-directory/county-natural-gas-task-forces.