Marcellus Shale Workforce Needs Assessment

Southwest Pennsylvania

Counties: Beaver, Washington, Greene, Fayette, and Westmoreland

Southwestern Pennsylvania Oil & Gas Industry Partnership

Marcellus Shale Education & Training Center

www.msetc.org

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June 2010

Needs assessment conducted by:

Marcellus Shale Education & Training Center (MSETC)
A collaboration of Pennsylvania College of Technology
and Penn State Cooperative Extension

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Executive Summary

The purpose of this Southwest Pennsylvania Marcellus Shale Workforce Needs Assessment is to provide baseline data to assist workforce and economic development professionals estimate the *direct workforce* requirements regarding the types and number of jobs and occupations necessary for the development of Marcellus Shale in Beaver, Washington, Greene, Fayette, and Westmoreland counties in the Southwest region of Pennsylvania over the next five years (2010-2014). This assessment was created by the Marcellus Shale Education & Training Center (MSETC), which was formed to serve as a primary workforce development resource for the natural gas industry.

The workforce estimates created within this report are based on actual interviews and online workforce assessments of individuals directly involved with bringing a Marcellus well into production. This report is based solely on the actual employees directly involved in developing a well and placing it into production and does not consider employment impacts beyond those directly employed in that process. The projections in this report are not intended to serve as a measure of the total employment created by Marcellus Shale natural gas development or to estimate the economic impact of such development. The findings of this report, therefore, should not be compared to employment estimates of other studies that project the *overall* employment and economic impact of natural gas drilling in Pennsylvania using "multipliers" to estimate job creation in sectors other than those *directly* associated with the natural gas sector. This report provides the best estimate currently available of workers needed to bring a Marcellus well into production and projected growth in labor demands around high priority occupations for the oil and gas industry.

In the spring of 2010, MSETC team members performed in-depth interviews with many of the major Marcellus Shale energy companies, drilling companies, and service providers operating in the Southwest region. ***The exploration and production companies interviewed represent slightly more than 88% of all permitting activity in 2009-2010***. To further validate the interview data, the MSETC team created an online workforce needs assessment in the summer of 2010 for gas industry representatives. Thirty (30) respondents completed the online workforce assessment.

After the occupations were identified and the full time equivalent (FTE) numbers were determined, the next major step in creating a viable workforce projection model was to estimate future drilling rig activity. In addition to working with energy operators and subcontractors, the MSETC team reviewed investor statements, press releases, and public statements made by energy company officials regarding their plans for future drilling activity in the region. The results from company interviews and the online workforce assessment helped to confirm the rig/drilling estimates.

Since predicting future trends in the gas industry, particularly with respect to workforce needs, is challenging at best given the uncertain nature of the industry, the MSETC team developed three possible projection scenarios. These three scenarios provide a "low scenario" estimate, a "likely scenario" estimate, and a "high scenario" estimate.

Principal energy companies operating within the Southwest region include Range Resources, CNX, Chesapeake Energy, XTO, Atlas, Eastern American Energy Corp, and EQT. Rig counts and permitting activity within the first six months of 2010 indicate drilling activity in 2010 should equal or slightly eclipse 2009 levels.

The Southwest region has a distinct advantage over other Marcellus Shale regions because many of the large natural gas companies have located regional corporate offices in the greater Pittsburgh area, which provides local opportunities to fill large numbers of white-collar jobs located at these offices. White-collar, or "office" jobs, in the gas industry tend to be more geographically stable than other types of work that must be performed on a development location.

The MSETC model revealed that ***over 420 individuals working within nearly 150 different occupations*** are needed to perform all the operations required to complete and produce gas from a single Marcellus Shale well in Southwest Pennsylvania. The total hours worked by these individuals are the equivalent of 13.10 FTE direct jobs over the course of a year for dry gas wells and 13.30 FTE for high-BTU gas wells. Of these FTEs, 12.9 are required during the pre-drilling and drilling phase, while 0.18 are required during the production phase for dry gas wells and .38 are required for high-BTU gas. It is estimated that 60% or more of wells drilled in the Southwest region will require gas processing. According to an analysis of publicly made statements and personal interviews with companies operating in the region, the number of wells drilled could increase from approximately 330 wells per year in 2010 to roughly 470 wells per year in 2011 and 779 wells per year by 2013.

Applying the MSETC workforce projection model to the current and projected 2010 well drilling activity in Beaver, Greene, Fayette, Washington, and Westmoreland counties indicated that ***between 3,831 and 6,334 FTE direct jobs would be required, with 5,083 FTE jobs being the likely workforce development scenario*** based on development projections given by energy developers. Of the 3,831 to 6,334 FTE direct jobs, the number of long-term production phase jobs created will be between 155 and 257, with 206 being a best estimate based on extant 2010 information and an assumption of 60% of the wells requiring gas processing.

The model indicates that the number of jobs will increase over the five-year period from 2010 to 2014. ***The FTE direct workforce is expected to increase by over 2,000 within the next two years*** to between 6,880 and 11,424 workers required by 2012, with 9,152 required workers being a likely scenario estimate. ***By 2014, the number is expected to range from 8,160 to 13,559 depending on the development activity, with 10,860 workers being the likely workforce need.*** The total number of long-term production phase jobs (including gas processing) created by wells drilled between 2010-2014 will total between 800 and 1,300 full-time jobs, depending on the total number of wells actually drilled.

Introduction

Aim of This Report

This assessment is intended to provide baseline data to assist workforce and economic development professionals estimate the direct workforce requirements regarding the types and number of jobs and occupations necessary for the development of Marcellus Shale in Beaver, Washington, Greene, Fayette, and Westmoreland counties in the Southwest region of Pennsylvania over the next five years (2010-2014).

The workforce estimates created within this report are based on actual interviews and online workforce assessments of individuals directly involved with bringing a Marcellus well into production. The report is based solely on the actual employees directly involved in developing a well and placing it into production and does not consider employment impacts beyond those directly employed in that process. The projections in this report are not intended to serve as a measure of the total employment created by Marcellus Shale natural gas development or to estimate the economic impact of such development. The findings of this report, therefore, should not be compared to employment estimates of other studies, which project the *overall* employment and economic impact of natural gas drilling in Pennsylvania using "multipliers" to estimate job creation in sectors other than those *directly* associated with the natural gas sector. This report provides the best estimate currently available of workers needed to bring a Marcellus well into production and projected growth in labor demands around high priority occupations for the oil and gas industry.

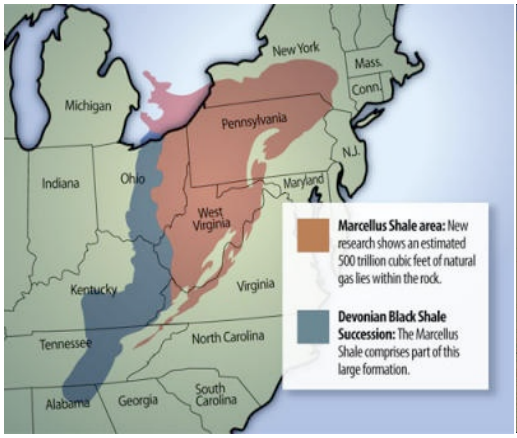
Marcellus Shale Natural Gas Play

Marcellus Shale is a large natural gas formation extending across roughly two-thirds of Pennsylvania and into parts of New York, West Virginia, Virginia, Maryland, and Ohio. Development of Marcellus began in 2003 and grew steadily through 2007 and 2008 in Southwestern Pennsylvania and Northern West Virginia. Growth has dramatically expanded during 2009 and 2010. Currently in Pennsylvania, two hubs of intensive Marcellus activity are centered in the Northern Tier and Southwestern Pennsylvania. These two areas of Marcellus currently comprise the core of development activity, although parts of Central Pennsylvania continue to see an increase in exploratory drilling activity.

Energy companies continue to invest billions of dollars in exploration and development programs throughout Pennsylvania. Investments by the exploration and production companies include securing mineral rights, land, drilling, production stimulation, pipeline, compressor stations, processing, and a variety of other infrastructure investments necessary to operationalize the potential of the Marcellus Shale Play. In 2010, two of the world's largest energy firms purchased large stakes of Marcellus Shale, and all of the major firms active in the area continue to plan dramatic expansions of their development operations beyond 2010.

The reasons for the planned Marcellus expansion by exploration and production companies are due to a number of factors, including the relative infancy of the Marcellus Play, the close proximity of large

consumer markets and major transmission lines, and the amount of natural gas thought to be recoverable. The amount of total recoverable natural gas located within the formation is currently unknown, although recoverable gas estimates in Marcellus Shale have recently ranged from 50 to 489 trillion cubic feet (Englander 2009). Regardless of the estimates, most geologists place the recoverable gas reserve potential among the largest in the nation.



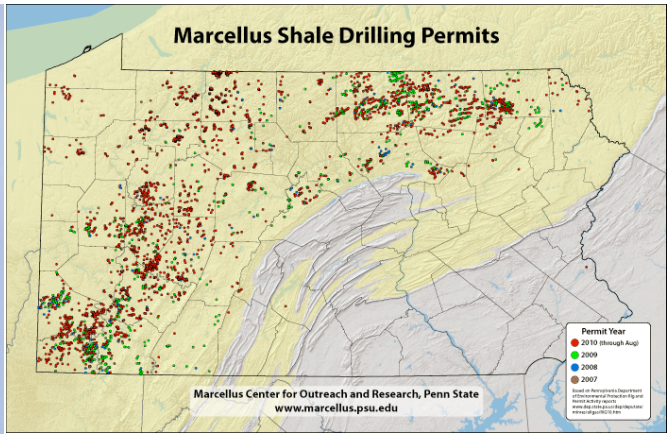


Figure 1 (left): Map of Marcellus Shale Occurrence
Figure 2 (right): Map of Marcellus Drilling Permits in Pennsylvania as of August 2010
(Source: Marcellus Center for Outreach and Research, Penn State)

Southwest Pennsylvania Region

Marcellus Shale development within Pennsylvania first occurred with significant intensity in the Southwest region, with the first well drilled by Range Resources LLC in 2003 in Washington County and corresponding gas production in 2005 (Harper 2008). As of 2010, the Southwestern Pennsylvania counties experiencing levels of significant development include Washington, Greene, Fayette, and Westmoreland. At this time, Allegheny and Beaver counties have not experienced significant Marcellus Shale drilling activity, although that may change in coming years as more suburban and urban areas surrounding Pittsburgh are developed. Allegheny County also appears to be emerging as a future energy hub on the East Coast with a very high concentration of oil and gas related businesses locating central operations there.

Development activity in the Northern Tier region of Pennsylvania expanded dramatically in 2009 and 2010, while the Southwestern region experienced a more sustained level of development. The disparity in development trajectories are likely due to a number of factors including high levels of existing development in the Southwestern region, land availability, infrastructure constraints, and geological differences. In the Southwestern region, the natural gas leasing market is more mature and prime real estate more established, in part because of historical factors such as previous mining and conventional natural gas drilling activity, corporate ownership, and a longer history of Marcellus-driven leasing and drilling activity. The Northern Tier region, in contrast, has recently offered emergent companies large acreages of attainable mineral rights. In addition, analyzing the differences in the geology of the two regions reveals that gas derived from the Southwestern region contains high-BTU gasses and gas liquids,

while the Northern region contains dry gas. The high-BTU gasses and liquids can be extremely marketable; however, limited high volume gas processing infrastructure in the Southwest region appears to have slowed Marcellus development. Construction of additional natural gas processing facilities is underway and will allow for increased gas development in the Southwest Pennsylvania region over the next few years.

Figure 3: Marcellus Shale Development Activity in Southwest Pennsylvania

2008 - August 1, 2010

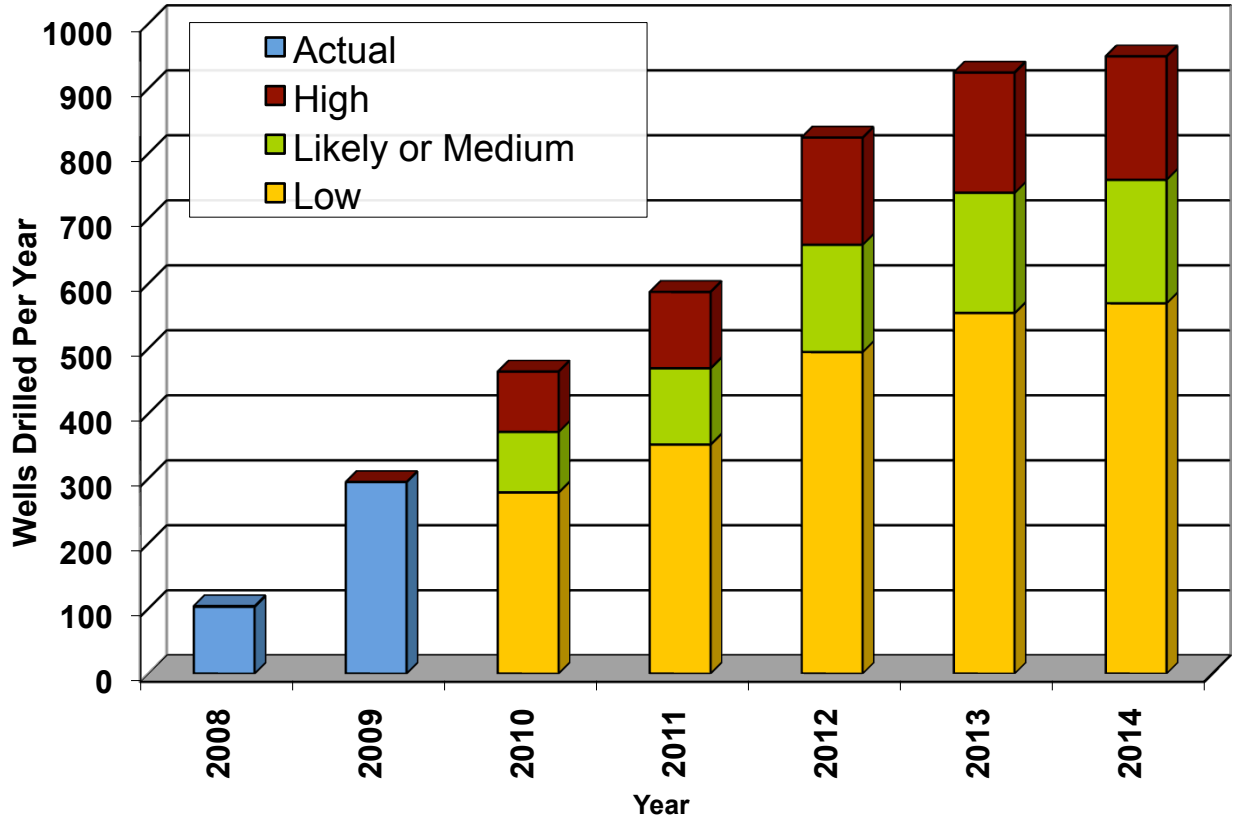
County	Wells Drilled			Permits Issued		
	2008	2009	Aug-10	2008	2009	Aug-10
Allegheny	1	2	0	1	5	2
Armstrong	2	17	13	8	42	18
Beaver	0	0	1	11	6	3
Butler	10	8	16	11	42	38
Indiana	3	8	8	11	19	14
Fayette	18	55	14	45	88	44
Greene	18	91	50	43	182	98
Washington	32	68	98	92	209	175
Westmoreland	19	46	17	28	89	46
Total Southwest	**103**	**295**	**217**	**250**	**682**	**438**
Rest of Pennsylvania	93	468	584	229	1303	1283
Total Pennsylvania	**196**	**763**	**801**	**479**	**1985**	**1721**

Source: PA DEP

Southwestern Pennsylvania Development Projections

Development growth of Marcellus Shale natural gas reserves in the Southwestern region has been moderate in recent years. Companies active in the area have made public statements that they intend to dramatically increase levels of development intensity within the Southwest region in 2011 and beyond. Principal energy companies operating within the Southwest region include Range Resources, CNX, Chesapeake Energy, XTO, Eastern American Energy Corp, Atlas, and EQT. These companies represent roughly 88% of all Marcellus Shale permitting activity in both 2009 and the first six months of 2010 for Beaver, Greene, Fayette, Washington, and Westmoreland counties. Rig counts and permitting activity within the first six months of 2010 show that drilling activity in 2010 should equal or slightly eclipse 2009 levels. According to an analysis by MSETC of publicly made statements and personal interviews with companies operating in the region, the number of wells drilled could increase from approximately 330 wells per year in 2010 to roughly 470 wells per year in 2011, and 779 wells per year by 2013.

Figure 4: Actual/Projected SW PA Marcellus Wells Drilled Per Year



High-BTU Gas

A big factor in the projected increase of drilling activity in the Southwest region is due to the economic attractiveness of liquids-rich, high-BTU gas found in parts of Marcellus Shale that is located in Southwestern Pennsylvania. High-BTU gas requires large processing facilities to extract the liquids such as oil and heavy gasoline and fractionate other gas compounds found within the produced methane. The result of high-BTU gas processing is a multitude of saleable products that can significantly raise the return on investment and produce potentially higher profits under lower natural gas commodity prices. Some media reports have labeled the attractiveness of high-BTU gas as a "Race to Liquids" as companies devote significant resources to liquid-rich areas (Braziel 2010). Like many aspects of natural gas development, the continued attractiveness of high-BTU gas will likely remain variable and dependent on a number of different factors, including commodity price.

The exact boundary of wet vs. dry gas is unclear at this time, although wet/high-BTU gas is understood to be principally found in Washington, Greene, and Beaver counties, as well as western portions of Fayette and Westmoreland counties and the southern portion of Butler County. Interestingly, all of Allegheny County is in the wet gas area and may contribute to future development activity in that county.

Projecting development activity that will occur specifically within the high-BTU gas region is more difficult. Permitting activity reported by the Pennsylvania Department of Environmental Protection, as well as discussions with operators in the area, suggest that between 60-75% of the wells drilled in the Southwest region within the next several years may be liquids-rich, high-BTU gas that requires additional processing.

Introduction to the Natural Gas Industry Workforce

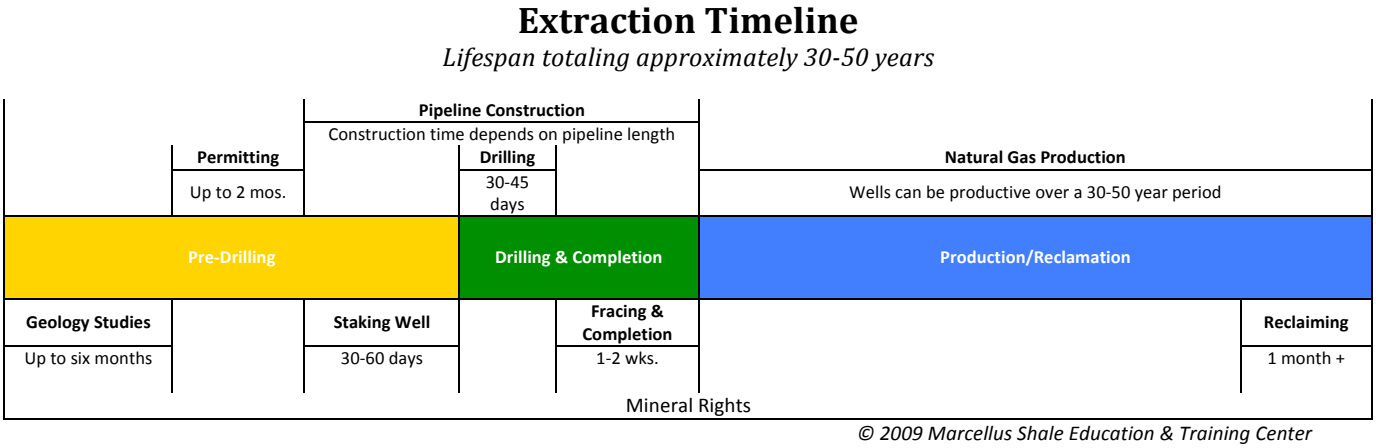


Figure 5: Phases and Timeline of Development of Marcellus Shale Natural Gas Wells

The Marcellus Shale development process differs significantly from that of Pennsylvania's long tradition of extracting shallow gas. Due to differences in geology, technology, and energy company practices the extraction of Marcellus Shale requires more employees and significantly greater input and utilization of supplies, materials, and equipment. Marcellus Shale gas is considered "unconventional" in that the formation requires directional drilling, hydraulic-fracturing, and other methods to produce commercial quantities of natural gas. These processes are much more industrial in nature, labor intensive, and technologically advanced than conventional shallow gas development. Additionally, the energy companies and contractors that initially developed and utilized the unconventional shale drilling and extraction technology were mostly national or international in size and, subsequently, utilized contractors and personnel with legacy shale gas knowledge from around the country and from other parts of the world to begin developing Marcellus Shale.

History has shown that predicting future trends of the natural gas industry can be challenging and estimating the workforce requirements of this particular industry represents an even greater challenge. Natural gas development trends can be difficult to predict as commodity prices, technological changes, new plays, and other factors can change the intensity and scope of development rather quickly. Additionally, a wide array of energy companies and an even wider array of subcontractors comprise the industry, and the resulting complex web of occupational needs and workforce requirements can be difficult to estimate even under ideal circumstances. Additionally, the industry challenges the general definition of an industry sector and local worker, as employees supporting natural gas development work across a variety of industry sectors and often work in multiple locations within a region to develop hundreds of different wells and infrastructure projects. Furthermore, industry employees will sometimes work 12-hour shifts for weeks at a time and then be afforded several continuous weeks of leave while an entirely new crew of workers takes their place.

Locations and Residency in the Southwest Region

Due to the inherent uncertainty of development intensity, as well as the need to work at multiple locations, many of the initial Marcellus Shale-related workers remain only transient residents of the region and keep permanent residency at a location hundreds or even thousands of miles away. As the Marcellus Play continues to mature, the industry is moving towards a workforce that contains fewer transient workers and more permanent Pennsylvania residents.

Since many contractors and subcontractors are accustomed to working at multiple and changing locations throughout North America and the world, it is commonplace within the natural gas industry to initially utilize non-local workforces and supply-chain services. However, as development moves forward over the course of months and years, contractors and subcontractors will either relocate to the local area or local businesses will be created to meet industry needs. Development activity in the Southwestern region of Pennsylvania is not new, and this transition has been underway for some time. National and international drilling companies, gas field service, and gas field construction firms have already opened regional offices in Southwestern Pennsylvania. Many of these companies initially brought an external workforce with them to the area, but are in the process of replacing this workforce with local workers as opportunities arise. In addition, companies that have historically catered to

conventional shallow natural gas and oil field development have significantly augmented their businesses to include work in Marcellus Shale.

The Southwest region also has a large advantage over other Marcellus Shale regions in that many of the large natural gas companies have located their regional corporate offices in the greater Pittsburgh area, which provides local opportunities to fill large numbers of white-collar jobs located at these offices. White-collar, or "office", jobs in the gas industry tend to be more geographically stable than other types of work that must be performed on a development location.

Data on the geographic origin or residency of the current natural gas workforce present in Southwestern Pennsylvania is not yet available; however, anecdotal evidence and experience from natural gas plays in other areas have shown that many of the jobs created by natural gas development in Southwestern Pennsylvania have been initially filled by transient or non-local workers, but that the majority of these jobs have the potential to be filled locally if/when the properly trained and skilled workers are available.

Drilling Phase Jobs vs. Production Phase Jobs

The natural gas development process is such that a large proportion of the total industry workforce will be required during the well drilling phase, while a small minority of the workforce will be required for the long-term production phase. Pre-drilling and drilling phase jobs are grouped together for purposes of this section of the assessment.

Drilling Phase Jobs

The phase of natural gas development during which the natural gas wells are drilled and the associated pipeline infrastructure is put into place is an extremely labor-intensive process. The workforce needed during this phase constitutes over 98% of the industry workforce needs, and this segment of the workforce will no longer be needed once the process of drilling gas wells in an area is completed. In the oil and natural gas industries, this drilling phase period is often referred to as "the boom" as vast workforces are often suddenly required to perform tasks associated with natural gas development. Conversely, the drilling phase can suddenly decline, which is often referred to within the industry as the "the bust". Given the level of uncertainty, many employees in the drilling phase of gas development maintain temporary residency in a given area – such as in motels, RVs, "man camps", monthly apartment/house leases, etc.

No one can say for certain how long the drilling phase will last within Marcellus Shale or within specific areas of the shale formation. Drilling phase estimates have ranged from 10 to 70 years, which in part reflects uncertainty created by future fluctuations in commodity prices, economic conditions, and technological changes, among other variables. A number of scenarios can be envisioned, ranging from sustained decades-long drilling activity to drilling activity that jumps from hotspot to hotspot within the state after a few years in each area to a relatively quick flurry of activity that subsides after a number of years.

Production Phase Jobs

In contrast to drilling phase jobs, jobs associated with the production phase are well defined and predictable, as these jobs are required to manage production operations for existing wells. Industry experts believe the wells created as part of the Marcellus Shale region will likely produce gas for 30 years or more. Even if drilling were to cease completely, the "production phase" jobs necessary to manage and maintain these wells would still be required.

Within the industry, careers associated with the production phase are often referred to as long-term or even "permanent". Occupations during the production phase tend to be less labor-intensive, with fewer hazards involved, and more specialization than development phase occupations, while still retaining excellent salary and benefits. Jobs associated with production activities almost always result in local residency and often utilize local workforces.

The high-BTU gas that is present in roughly 60% of the Southwestern study area offers an additional opportunity for local production phase jobs. Local high-BTU natural gas processing is needed to fractionate or remove non-methane compounds (non-natural gas such as butane, ethane, propane, etc.) and liquids (oil, water, heavy gasoline, etc.) that naturally occur in the area. Similar to other natural gas production, high-BTU processing facilities and jobs will remain for the life of the well and significantly longer than drilling operations. Occupations associated with high-BTU gas production are somewhat similar to other production phase occupations and include compressor operations, pipeline maintenance and technicians, information technology, gauge monitoring, supervisory positions, process engineers, loader/testers, etc.

MSETC Workforce Model

Given the complex web of occupations that constitute the natural gas industry workforce, traditional methods of measuring future job creation used in other industries are often inadequate. Many of the industries that participate in the development of a natural gas field are usually not present in the area before the natural gas development process begins; thus capturing their workforce needs using most workforce projection models is ineffective at best given there is no local baseline data. Similarly, given the uncertainty in natural gas development, job estimates predicated solely on posted job openings or industry questionnaires – while providing an accurate snapshot of current demand – are largely inflexible to the constantly changing intensity of development activity. Finally, given the intense use of subcontractors by most exploration and production companies, using a strict definition of "local" as a municipal boundary or "industry" as only a natural gas industry economic code does not accurately reflect the complexity, interconnectedness, and the true scope of natural gas related jobs and opportunities.

Methodology

The Marcellus Shale Education & Training Center (MSETC) developed the method used in this study to estimate the workforce requirements of the natural gas industry. The proprietary methodology focuses on analyzing the types and numbers of workers needed to drill a single Marcellus Shale gas well and then extrapolates that data to achieve a total workforce requirement based on estimates of future well drilling activity. At the core of the MSETC model is a full time equivalent (FTE) calculation for each worker associated with drilling a single Marcellus Shale well. An FTE for each worker is 260 days per year. Many tasks that occur during the well drilling process may only require a few workdays to complete. Therefore, the "per well" work requirement for most of the occupational categories ranged from 1/10 to 1/100 of an FTE. In addition, some very labor-intensive occupations such as heavy equipment operation, office staff, and drilling rig operation (roughnecks) constituted an equivalent that ranged between 1/10 to as many as two (2) FTEs per well.

Determining fractional FTE numbers for each worker directly associated with drilling a natural gas well is a complex process. FTE numbers for the majority of occupations involve identifying the number of workers in a particular occupation or work crew and then determining the number of days the workers typically spend on a well site or in support of well site development. FTE numbers for a portion of the occupations - including pipeline construction, land clearing, office staff, etc. – are highly variable from company to company based on specific conditions; therefore, rough averages were used to reduce the differences in company development practice.

$$\frac{(\text{Workers Per Well}) \times (\text{Work Days per Well})}{260} \times (\text{Drilling Rigs} * 10) = \textbf{Workforce Requirements}$$

Figure 6: General Equation Behind Workforce Model

(The average number of workdays for one FTE worker is equal to 260. A Marcellus Shale drilling rig will drill 10 wells per year on average.)

History of This Workforce Model

In 2009, the MSETC team worked closely with representatives from a number of energy firms, drilling companies, and subcontractors operating in the Northern Tier and Central regions of Pennsylvania to produce a workforce needs assessment for the Central Pennsylvania Workforce Development Corporation, Northern Tier Regional Planning and Development Commission, through Pennsylvania Department of Labor and Industry Partnership funding. During the initial assessment process, nearly 150 occupational categories and/or skill groups were identified.

In the spring of 2010, MSETC team members performed in-depth interviews with many of the major Marcellus Shale energy companies, drilling companies, and service providers operating in the Southwest region. ***The exploration and production companies interviewed represent slightly more than 88% of all***

permitting activity in 2009-2010. These discussions were designed to reconfirm the data obtained in the 2009 study and to identify differences in industry practices and jobs in the Southwest region. To solidify the interview data, the MSETC team created an online workforce needs assessment in the summer of 2010 for gas industry representatives. Thirty (30) respondents completed the online workforce assessment.

After the occupations were identified and the FTE numbers were determined, the next major step in creating a viable workforce projection model was to estimate future drilling rig activity. In addition to working with energy operators and subcontractors, the MSETC team reviewed investor statements, press releases, and public statements made by energy company officials regarding their plans for future drilling activity in the region. The results from company interviews and the online workforce assessment helped to confirm the rig/drilling estimates. With this method, estimates were determined for all the major and most minor energy companies operating in the region, even though 50% of the companies operating in the five-county study area had two or fewer permits.

Advantages, Limitations, and Key Assumptions of the MSETC Model Methodology

This model allows the user to identify a projected level of development intensity as measured by wells drilled per year (the input) and project the number of workers based on occupational categories (the output) required for the expected level of development.

For the purposes of assessing potential workforce needs and workforce development/education capabilities, this type of model is superior to a number of different methods; however, this model still has a number of different limitations. The advantages, limitations, and key assumptions of the model and methodology follow.

Advantages:

- Offers much more specific occupational descriptions than generic “industrial classifications”
- Does not include/exclude based on industrial classifications
- Uses direct worker requirements, not complex imputations of requirements
- Does not include/exclude based on the geographic locations of business offices
- Does not rely primarily on sampling or response rates (such as surveys)
- Can easily be changed as development scenarios fluctuate
- Allows for triangulation of multiple data sources

Limitations:

- Does not (currently) calculate the specific workplace locations of all the occupations; most occupations will occur at the development site, but other occupations may occur elsewhere in the state or country
- Does not (currently) specifically calculate or define indirect or induced economic or workforce impacts of these jobs (e.g. additional jobs created by businesses providing this indirect or supply-chain support, such as for parts and materials, maintenance and repair, equipment, janitorial services, office supplies, etc., and additional jobs created by the workers spending their income)
- Does not include many indirect or supply-chain industries or workforces
- Does not provide business-specific information such as name, size, location, etc.
- Does not include all workers/contactors (such as all contracted legal services)

Key Assumptions:

- Full time equivalent (FTE) is defined at 260 workdays per year.
- The average drilling rig will drill approximately 10 wells per year.
- Each well will require, on average, 1 mile of pipeline construction.
- One compressor station will be constructed, on average, for every 20 wells.
- Companies' current drilling rig projections are relatively accurate (for the 'likely' scenarios).

Key Assumptions of High-BTU Gas Workforce Estimates

The workforces associated with high-BTU gas processing facilities do not easily conform to a per-well estimate, as *these workforces are directly tied to the amount of total gas production and not numbers of development sites*. The amount of total gas production in a geographical area will accumulate each and every year during the phase of intensive drilling; however, the production from each well will dramatically decline each year after the well first produces gas. This means that the total gas production for a given area will depend on the cumulative number of wells producing, subject to the age of each of the wells.

After detailed interviews with gas processing companies, we based the high-BTU processing workforce estimates on the following assumptions.

- The production facility capacity and staffing is approximately one FTE for every 7.5 million cubic feet of gas processed per day.
- Each well will follow an average production curve of Year 1: 4MMcf/d; Year 2: 1.2MMcf/d; Year 3: 900Mcf/d; Year 4: 800Mcf/d; Year 5: 700Mcf/d.
- Approximately 60% of wells drilled in the Southwest region will require processing.

Natural Gas Workforce Requirements Interviews and Online Workforce Assessment

MSETC team members performed eight in-depth interviews with Marcellus Shale-related companies operating in Southwestern Pennsylvania and created an online workforce assessment that received responses from an additional 30 companies. The purpose of the interviews and online workforce assessment was to obtain projections of drilling activity, re-affirm key occupation and FTE assumptions of the workforce model, and obtain data on workforce training and recruitment trends.

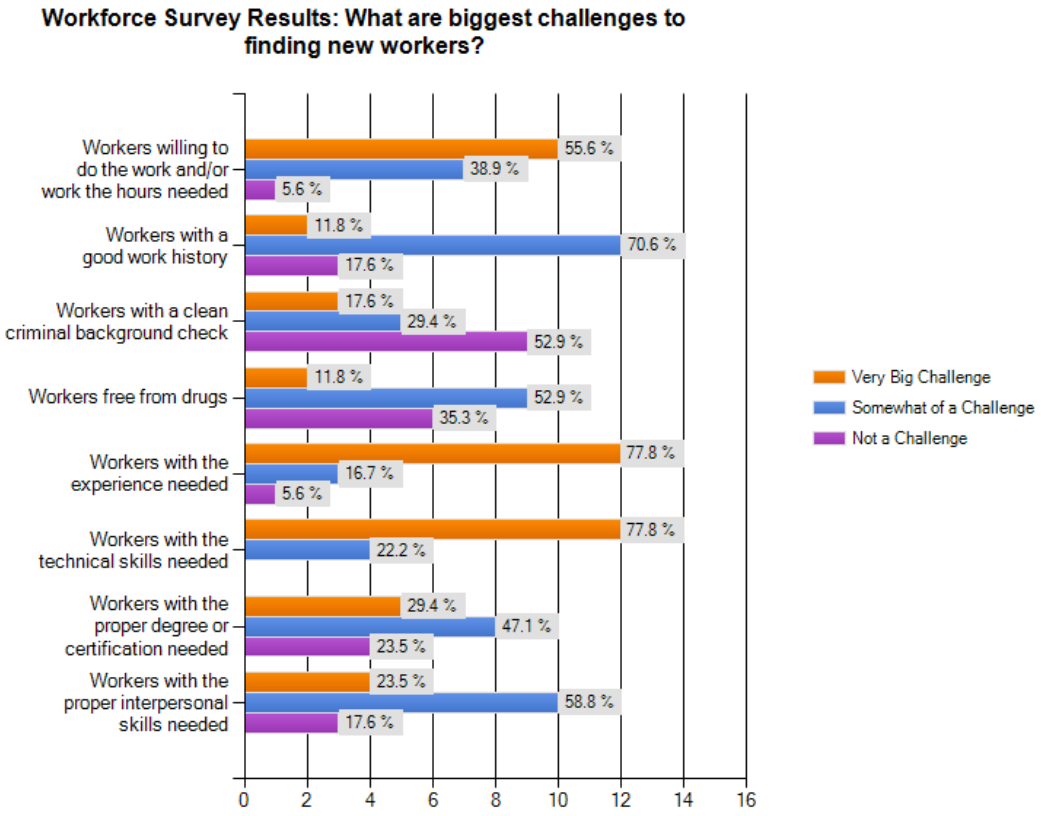


Figure 7: Biggest Challenges to Finding New Workers

In general, the results of the online workforce assessment confirmed much of the interview data regarding well development projections, workforce development, and assumptions about workforce needs. While the respondents to the online workforce assessment remained anonymous, respondent estimates of well development activity within the next five years were very similar to published reports and in person interviews with operators.

Online workforce assessment results regarding questions about workforce development and hiring practices revealed similar results to the 2009 MSETC report and historical data from other natural gas plays. Companies indicated that finding individuals with the proper work ethic, general mechanical aptitude, and general experience within the industry remained the largest barriers to finding local

workers. Most respondents indicated they used some type of training programs, although the vast majority utilized private or in-house training services, suggesting an opportunity for public workforce development organizations.

Specific occupational areas that have shown the greatest demand include general and semi-skilled office staff, engineering and geology-related occupations, and supervisory roles throughout a range of different types of companies.

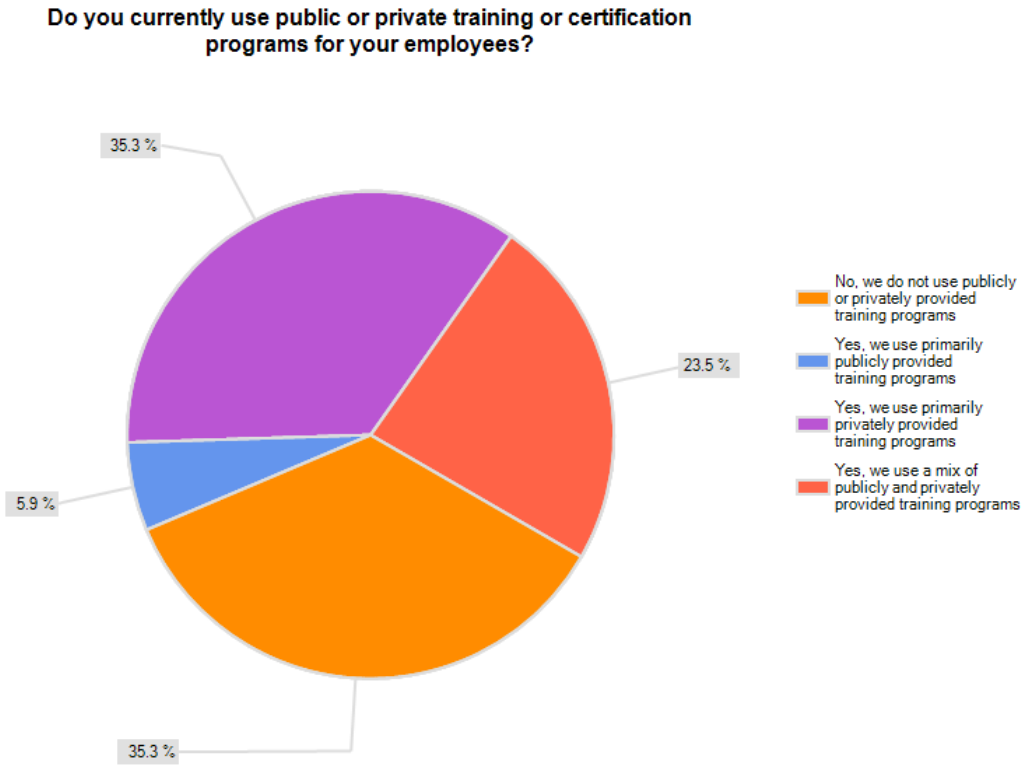


Figure 8: Do you currently use public or private training or certification programs?

Workforce Model Results

Full Time Work Equivalent (or FTE) to Drill One Marcellus Shale Well

The MSETC model revealed that over 420 individuals working within nearly 150 different occupations are needed to perform all the operations required to complete and produce gas from a single Marcellus Shale well in Southwest Pennsylvania. The total hours worked by these individuals are the equivalent of 13.10 FTE direct jobs over the course of a year for dry gas wells and 13.30 FTE for high-BTU gas wells. Of these FTEs, 12.9 are required during the pre-drilling and drilling phase, while 0.18 are required during

the production phase for dry gas wells and .38 are required for high-BTU gas. It is estimated that 60% or more of wells drilled in the Southwest region will require gas processing. As is discussed in the following section, the FTE for high-BTU gas wells will change over time.

In addition to the FTEs associated with the high-BTU gas processing, the findings in this report represents a slight increase over the results of the Northern Tier and Central WIB region workforce assessment performed by MSETC in 2009, partly due to more specific data, as well as additional gas field construction (tank battery and well head natural gas processing equipment) and supervisory jobs that were identified in the Southwestern region. That previous study estimated 11.53 FTEs were required during the drilling phase.

It is important to note that the equivalent of 12.9 pre-drilling and drilling phase jobs for each well do not compound year after year. These workers are required only while wells are being drilled and are a function of the number of wells being drilled each year. For example, if 100 wells are drilled per year, then the total drilling phase workforce will be 1,290. If 100 wells are drilled per year for 10 straight years, the total drilling phase workforce will still remain very close to 1,290. Although these jobs follow the drilling development and the true length of activity remains uncertain, drilling jobs, while geographically short-term, may still be long-term Pennsylvania jobs depending on the development scenario (sustained, hot spot, or flurry development outlined).

The vast majority of jobs directly associated with the staking, scoping, permitting, engineering, logging, clearing, drilling, moving, finishing, cementing, completing, fracturing, and producing a well are included in the estimate, as well as the majority of jobs required to clear, dig, and construct collector pipeline and compressor station infrastructure for the well. The workforce estimate includes the vast majority of occupations directly associated with the drilling and completion process, but does not include many of the indirect jobs that will be created in a variety of occupations ranging from legal advice to gravel quarrying to steel pipe fabrication.

Production Phase FTEs

While the vast majority of jobs associated with the natural gas industry occur during the pre-drilling and drilling phase, a number of jobs are associated with monitoring the long-term health and production capability of a natural gas well. These “production” jobs will be required for as long as wells are producing commercial quantities of natural gas, which is currently estimated by university scientists and the exploration and production companies in Marcellus Shale to be over a 30 to 40 year period. The workforce model estimates that 0.18 of these long-term, full-time jobs are created for each dry gas well drilled in a given field (or approximately one worker for every five wells drilled), and 0.38 jobs for every high-BTU well drilled over the next five years. Production jobs do compound each year as more wells are drilled. For example, if 100 dry gas wells were drilled per year for 10 years, 18 of these long-term jobs would be created each year, for a total of 180 long-term jobs created after 10 years. In addition to being long-term in nature, these jobs typically retain the generally excellent salary and benefits found in natural gas development but are generally less hazardous and less labor-intensive than jobs associated with the drilling phase.

Jobs associated with high-BTU gas processing also compound each and every year; however, the amount of required workers per well will decrease over time as the amount of gas that is produced from a well also decreases. Approximately 0.20 production jobs are created per high-BTU gas well for the first five years of production, while over the 30-year life of a well, the average FTE needed for gas processing may be closer to 0.02. However, since this report is concerned with a five-year time horizon, it is the 0.2 number that is used to extrapolate total workforce estimates. During the drilling phase of development, new wells will continue to be drilled; therefore, even though the amount of production for each well is decreasing, the total gas production within a region may continue to increase and thus require a larger workforce until drilling activity slows.

"Direct" Job Creation

As previously noted, the jobs discussed in this assessment are only those *directly* associated with drilling and completing a Marcellus Shale natural gas well and related pipeline construction. Jobs that are not directly associated with the industrial process are not included in this model and are outside the scope of this report. Since the analysis focuses on the specific jobs required for drilling and production without regard to formal industry sectors, it would be illogical to apply workforce or economic multipliers to it, which typically are based upon specific industry sectors.

Total Direct Workforce Requirements for the Southwest Pennsylvania Region

Applying the MSETC workforce projection model to the current and projected 2010 well drilling activity in Beaver, Greene, Fayette, Washington, and Westmoreland counties indicated that between 3,831 and 6,334 FTE direct jobs would be required, with 5,083 FTE jobs being the likely workforce development scenario based on development projections given by energy developers. Of the 3,831 to 6,334 FTE direct jobs, the number of long-term production phase jobs created will be between 155 and 257, with 206 being a best estimate based on extant 2010 information and an assumption of 60% of the wells requiring gas processing.

The model indicates that the number of jobs will increase over the five-year period from 2010 to 2014. The FTE direct workforce is expected to increase by over 2,000 within the next two years to between 6,880 and 11,424 workers required by 2012, with 9,152 required workers being a likely scenario estimate. By 2014, the number is expected to range from 8,160 to 13,559 depending on the development activity, with 10,860 workers being the likely workforce needed.

As described in previous sections, this model does not factor in employment created by natural gas development occurring in other parts of the state or country. Large regional offices are being constructed in Southwest Pennsylvania, and some of these offices will oversee development activity occurring in places such as West Virginia, Northern Pennsylvania, and New York. Employment created by this development is not tallied in this report even though the employees may be based in the Southwestern region.

The total number of long-term production phase jobs (including gas processing) created by wells drilled between 2010-2014 will total between 800 and 1,300 FTE jobs, depending on the total number of wells drilled.

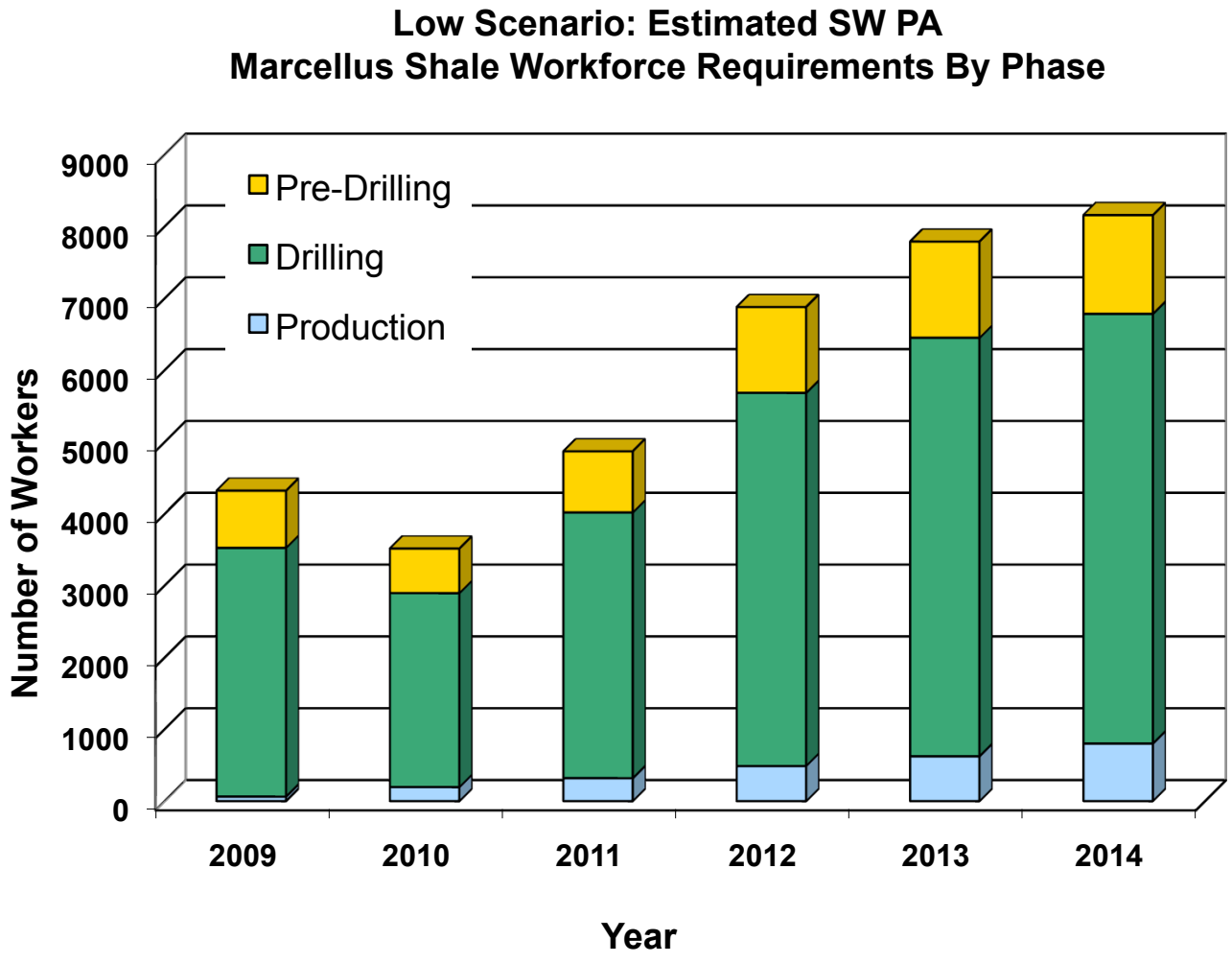


Figure 5: Low Scenario – Marcellus Shale Workforce Requirements by Phase

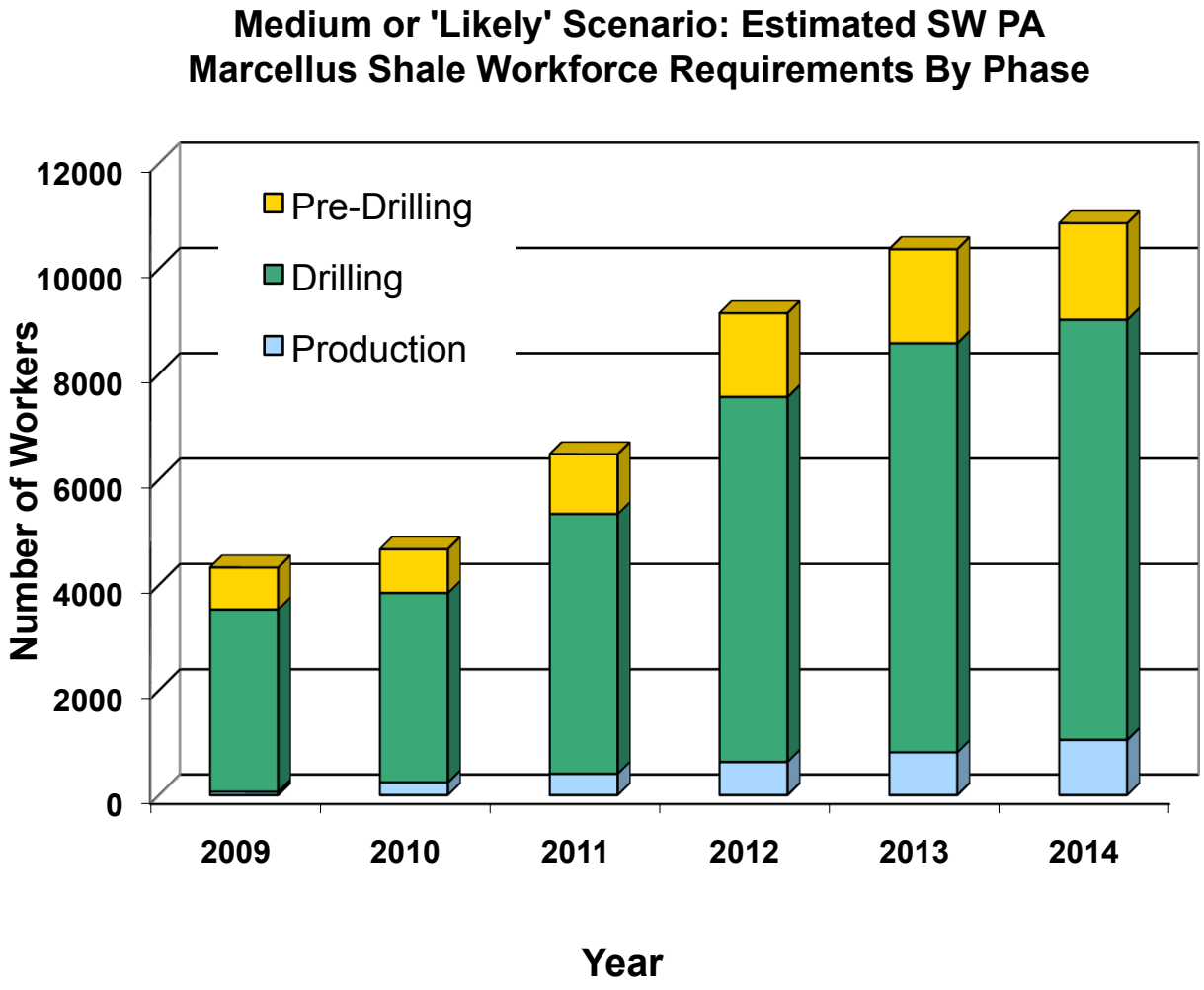


Figure 6: Medium (Likely) Scenario – Marcellus Shale Workforce Requirements by Phase

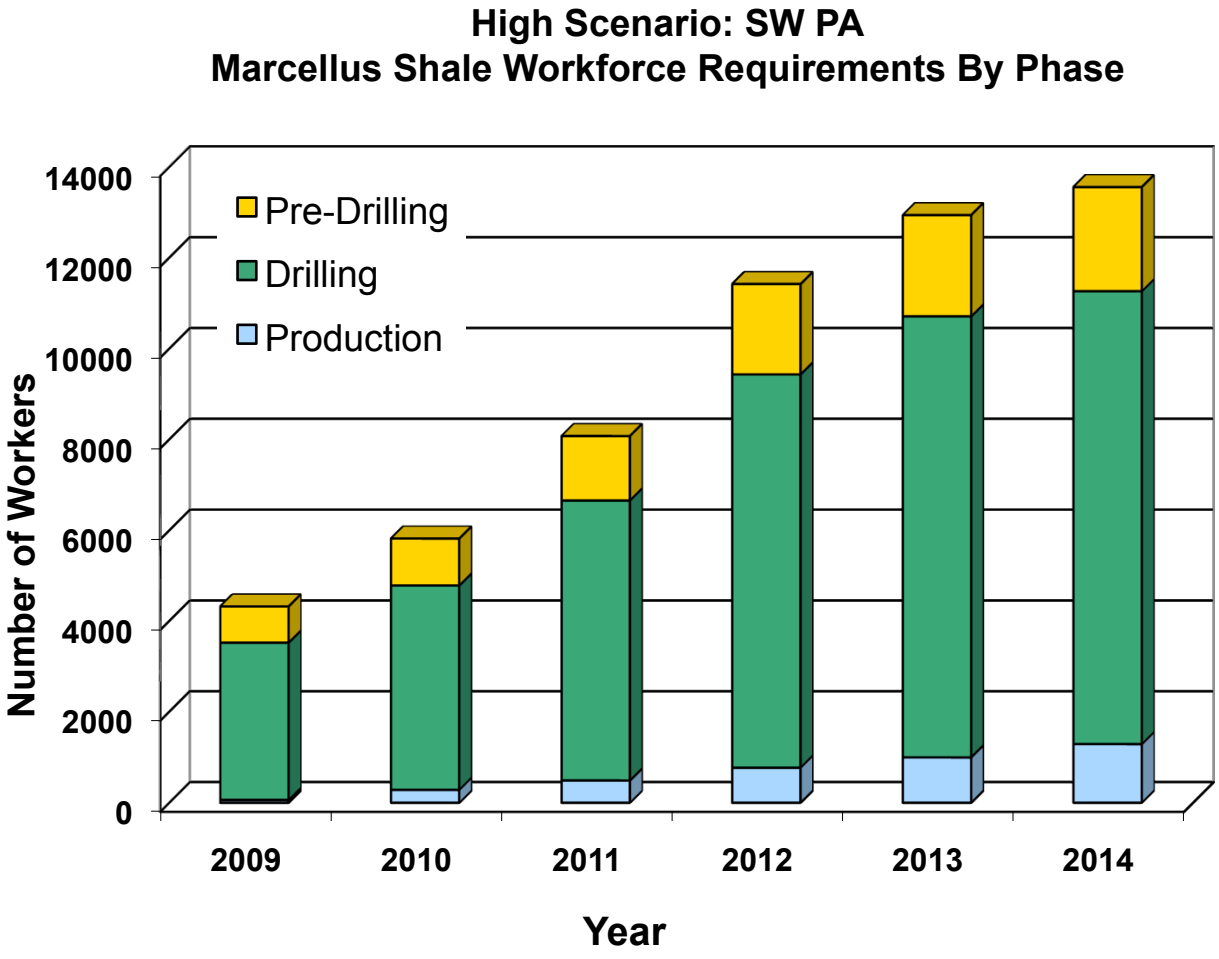


Figure 7: High Scenario – Marcellus Shale Workforce Requirements by Phase

Beyond 2014

Given the fluctuations in development activity that are inherent in the natural gas industry, multi-year development projections can be unreliable. However, the projections in this study are formulated using the best information available at the current time. Projections beyond 2014 are difficult to estimate; however, some indications are that drilling activity may increase over the projected 2014 levels. Continued growth will depend on a multitude of factors, including economic conditions, market demand, supply, commodity prices, technological innovations, competition from other natural gas fields, and infrastructure constraints.

Workforce Locations

The majority of the pre-drilling and drilling phase jobs will be located in the immediate vicinity of the well being drilled. Office workers and some geologic science, engineer, and supervisor jobs will be located at energy company offices, which may or may not be located near the vicinity of the well site or even within the region. The location of these jobs is difficult to determine, as many of these office locations vary from company to company and subcontractor to subcontractor, and companies may change the location of their offices as new development locations emerge. The location of regional

offices will also determine the location of long-term production jobs created in the region. However, the Southwest region is at an advantage over other regions of Marcellus Shale because corporate regional offices are established in the greater Pittsburgh area, and these offices will likely oversee development in West Virginia, Ohio, and New York. The location, or regional corporate offices, within the Southwest area of Pennsylvania means a larger majority of office, supervisory, and other white-collar jobs should remain local.

Occupational Categories Within the Natural Gas Industry

The model and related research found that the majority of the occupations in the direct workforce associated with Marcellus Shale natural gas development are comprised of low-skilled or semi-skilled occupations including heavy equipment operation, commercial driver's license truck operation, general labor, pipe and gauge operation, and a variety of office-related occupations. These occupations account for roughly 70-80% of the workforce. Industry representatives, online workforce assessment respondents, and additional research indicated that most of these occupations require no formal post-secondary education and only a few (such as CDL, welding, X-ray, etc.) require a specialized license or trade certification; however, nearly all of them require the skills and knowledge unique to the natural gas industry, skills and knowledge that are best learned through experience. Workers within all occupations of the natural gas industry are additionally praised for their hard work ethic and willingness to work very long hours in unfavorable conditions. Many of the remaining 25% of workers are in occupations that are white collar in nature, including foremen, supervisors, legal, realty, engineering, and geological sciences, which require some post-secondary education.

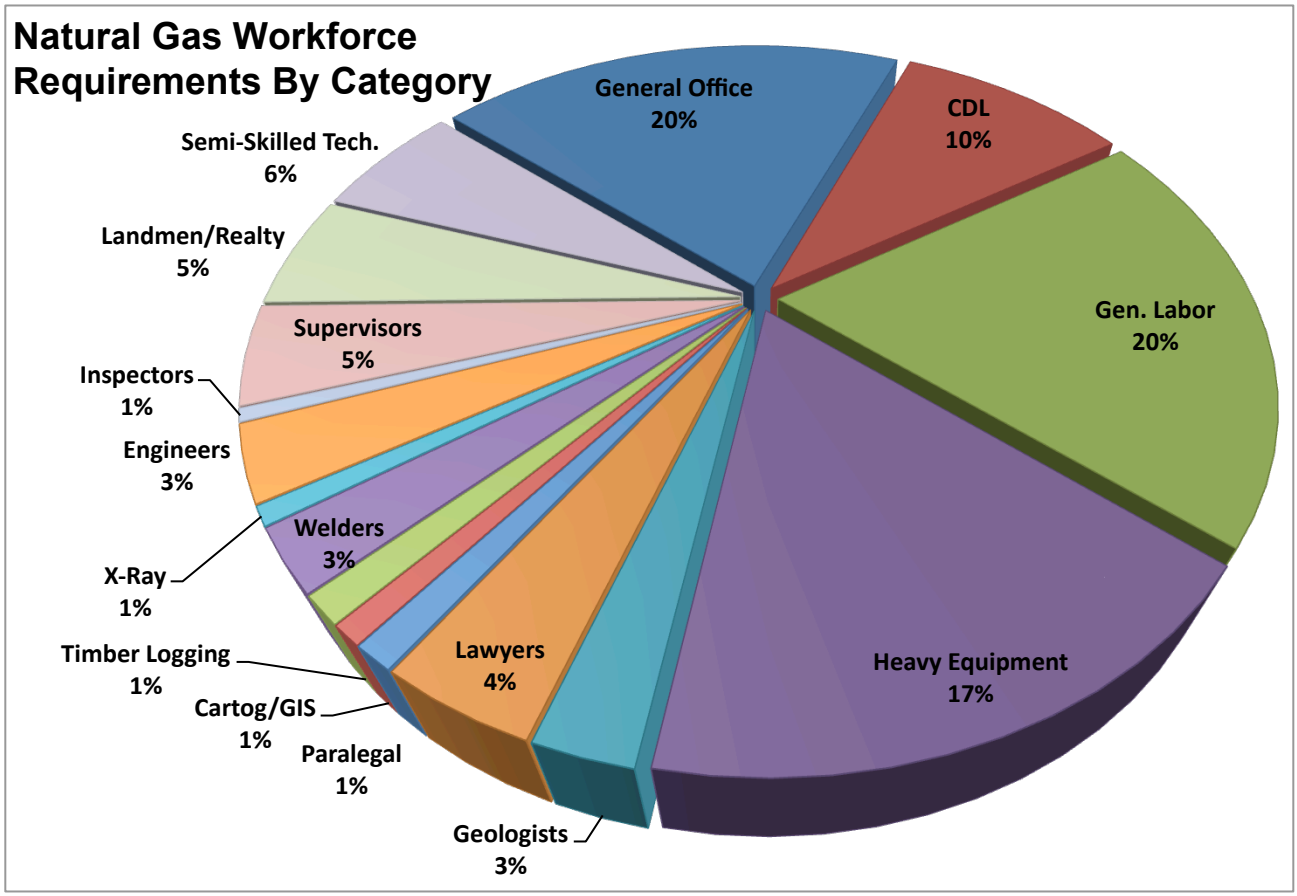


Figure 8: Occupational Composition of Natural Gas Workforces

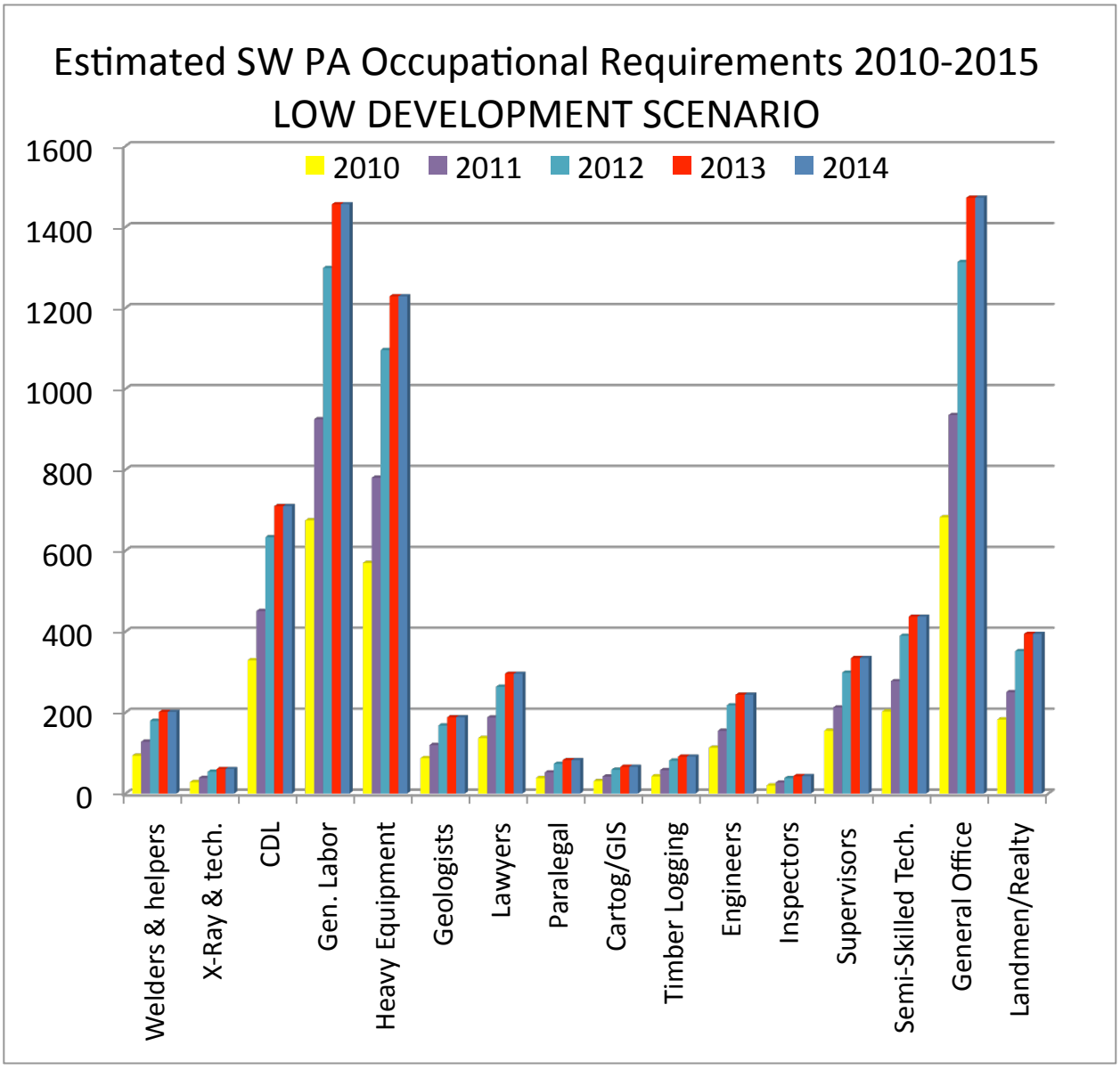


Figure 9: Estimated Occupational Requirements – Low Scenario

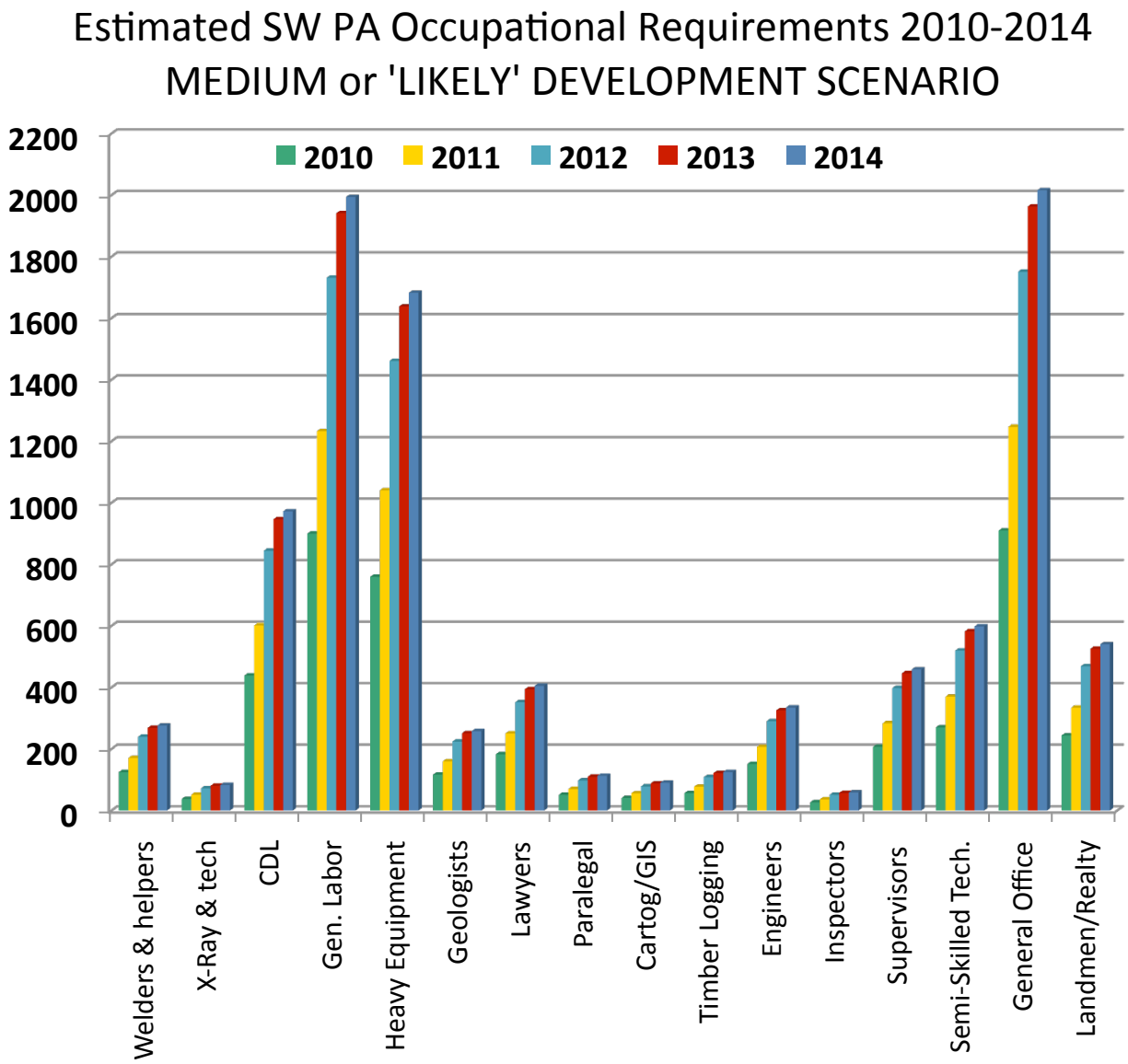


Figure 10: Estimated Occupational Requirements – Medium (Likely) Scenario

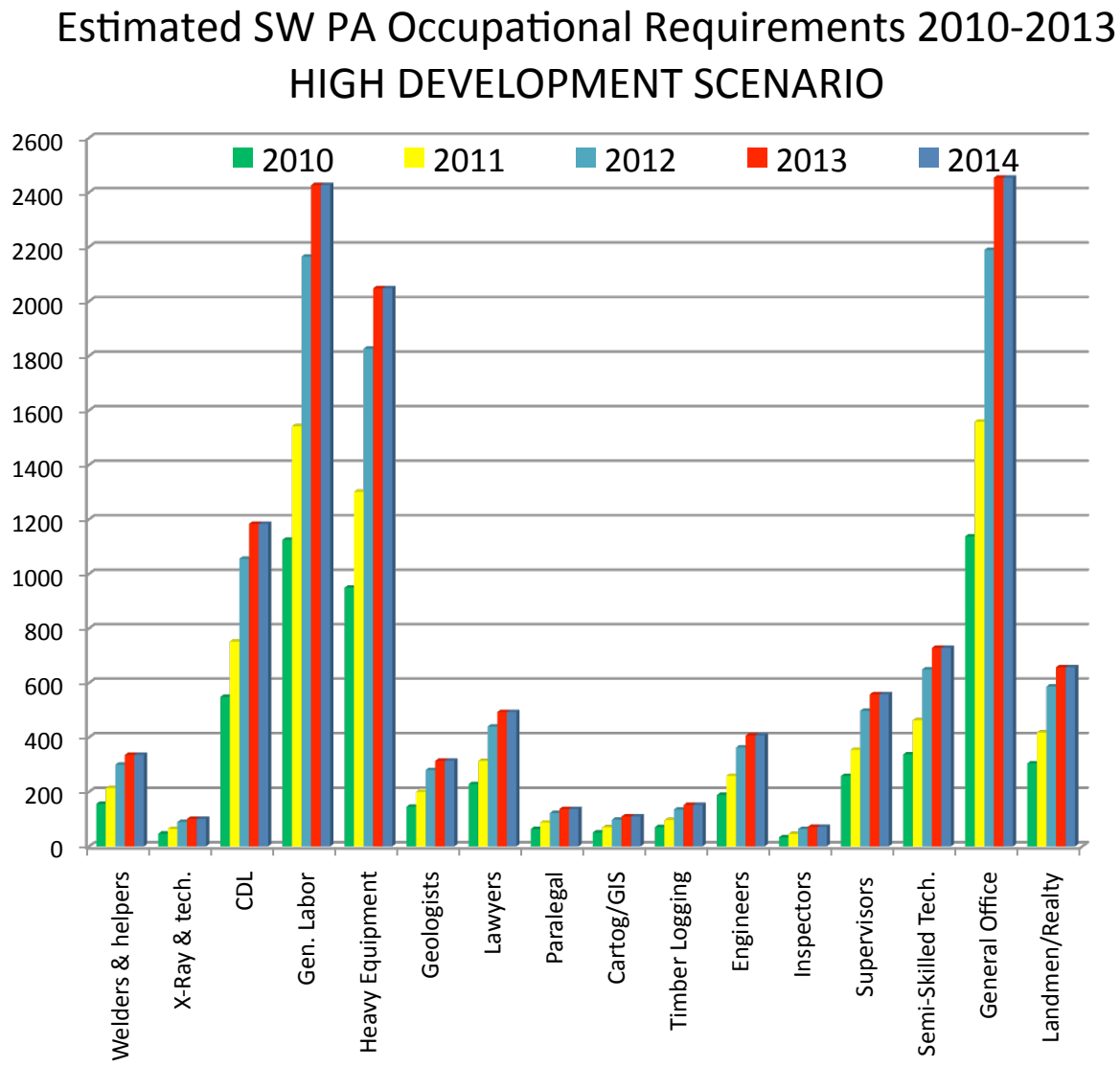


Figure 11: Estimated Occupational Requirements – High Scenario

Appendices

Pre-Drilling

Natural Gas Extraction
Education / Job Matrix
Pre-Drilling Phase

Pre-Drilling	Associated Jobs
Geological Studies	Cartographer
	Geologists & Geophysicists
	GIS Technicians
	Hydro Geologist
	Petroleum Chemists
	Petroleum Engineers
Seismic	CDL Drivers
	Helicopter Pilot/Crew
	Landman
	Project Management
	Seismic Crew
Public Land Only	Archeologist
	Biologist
	Forester
	Lawyers
	Water Management
Mineral Rights	Landman
	Lawyers
	Lease Administration
	Lease Acquisition
	Paralegal
	Title-Abstract
Permitting Process	Archeologist
	Biologist
	Community Affairs
	Corporate Development
	Environmental Technicians
	Lawyers
	Permitting Technician
	Public Relations Division
Staking the Well	Civil Engineer
	Civil Engineering Technician
	Heavy Equipment Maintenance Technician
	Heavy Equipment Operator
	Land Clearing
	Lawyers
	Leasing Agents (Right-of-Way)
	Logging
	Roadman
	Surveyors
Water Mgmnt	Electricians
	Environmental Compliance Coordinator
	Hydrologist (Stream Monitoring)
	Mechanics
	Private Water Supply Testing Coordinator
	Water Management Technician
	Water Transfer/Driver CDL
	Welders
Over -all	Human Resources

Drilling

Natural Gas Extraction
Education / Job Matrix
Drilling Phase

Drilling	Associated Jobs
Pipeline Construction	Boring Crew
	Civil Engineer
	Environmental Compliance Coordinator
	Environmental Technician-Monitor Reclamation
	Foreman
	General Labor
	Heavy Equipment Operator
	Landman
	Logging
	Mechanical Engineering
	Petroleum Engineers
	Pipe Fitters
	Safety Coordinator
	Superintendent
	Surveyors
	Weld Inspectors
	Welder Helpers
	Welders
	X-Ray
	X-Ray Technician
Compressor Construction	Construction Managers
	Foreman
	General Labor
	Land Clearing
	Pipeline Inspection
	Welder Helpers
	Welders
	X-Ray
	X-Ray Technician
Facility Constru	Electricians
	Engineers
	General Construction
	Pipeline
	Welders
	Well Tenders/Roustabout

Continued on next page

Natural Gas Extraction
Education / Job Matrix
Drilling Phase (Continued)

Drilling	Associated Jobs
	CDL Drivers
	Company Man/Geologist
	Diesel Technicians
	Drilling Engineer
	Drilling Superintendent
	Electricians
	Environmental Compliance Coordinator
	Flaggers
	Heavy Equipment Operator
	Light Truck Delivery
	Machine Shop
	Mudmen
	Pilot Drivers
	Rig Move
	Roughnecks
	Roustabouts
	Safety Coordinator
	Security
	Surveyors
	Tool Pushers
	Welders
Fracing and Completion	Casing Crew
	CDL Drivers
	Cement Pumpers
	Crane Operations
	Directional Drilling
	E-Technicians
	Electricians
	Engineers
	Environmental Compliance Coordinator
	Finishing Rig
	Foreman
	Frac Crew
	Heavy Equipment Maintenance Technician
	Heavy Equipment Operator
	Mechanics
	Perforators
	Petroleum Engineers
	Roustabouts
	Safety Coordinator
	Site Management
	Supervisors
	Well Logging

Continued on next page

Natural Gas Extraction
Education / Job Matrix
Drilling Phase (Continued)

Drilling	Associated Jobs
Water Management	Completion-Xaferers
	Engineers
	Environmental Compliance Coordinator
	Flowback Analyzer
	Hydrologist/Water Supervisor
	Inspectors
	Safety Coordinator
	Water Transfer/CDL Driver
	Water Re-Use Supervisor
	Water Re-Use Technician
	Water Testing/Quality
Overall	Accountants
	Calibration Technician
	CDL Drivers
	Clerks/Data Entry/Reception
	Environmental Compliance Coordinator
	Field Representatives
	Financial/Business Management
	First Aid
	Fleet Managers
	Flowback
	Heavy Equipment Operator
	Human Resources
	IT Technicians
	Local Liaison
	Lunch Wagon
	MSHA Compliance
	MSHA Training
	Noise Abatement
	Office Management
	Office Support - Administrative Assistant
	OSHA Compliance
	OSHA Training
	Public Affairs
	Purchasing
	Road Crews
	Safety Coordinator
	Security
	State Law Compliance
	State Law Training
	Surveyors
	Trainers for On-the-Job Training

Production/Reclamation

Natural Gas Extraction
Education / Job Matrix
Production/Reclamation Phase

Production/ Reclamation	Associated Jobs
Natural Gas Production	Communications Technician Offsite Monitoring
	Compressor Operator
	Equipment Calibration
	Gas Control Center
	Gas Dispatcher
	Gathering Operations
	Heavy Equipment Maintenance Technician
	Operator
	Petroleum Engineers
	Production Engineer
	Production Foreman
	Service Rig Operator
	Well Tenders/Roustabout
Reclamation	CDL Drivers
	Civil Engineer
	Environmental Health & Safety
	General Construction
	Government Officials
	Heavy Equipment Operator
	Landscapers-Architect
	Plugging Crew
	Site Management
Overall	Business Development/Sales
	Calibration Technician
	CDL Drivers
	Corrosion Technicians
	Environmental Health & Safety
	Fleet Managers
	Human Resources
	Inspectors
	IT Technicians
	Lobbying
	Local Liaison
	Marketing
	Noise Abatement
	Office Management
	Office Support-Administrative Assistant
	Public Relations Division
	Purchasing
	Sewage Treatment

Continued on next page

Natural Gas Extraction
Education / Job Matrix
Production/Reclamation Phase (Continued)

Production/ Reclamation	Associated Jobs
High-BTU Gas/Gas Processing	Bi-Product Marketing/Sales
	Bi-Product Transportation
	Compressor Operator
	Facility Construction
	Gathering Operations
	Information Science Technology
	Instrumentation/Reader Technicians
	IT Technicians
	IT Trainers
	Pigging Technicians
	Pipeline Operators
	Pipeline Technicians
	Processing Engineers
	Processing Loader/Testers
	Processing Maintenance/Mechanics
	Processing Operators
	Processing Supervisors/Managers

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History of the Marcellus Shale Education & Training Center

The Marcellus Shale Education & Training Center (MSETC) concept originated in late summer of 2008 and officially opened in January 2009. The MSETC is collaboration of Workforce Development & Continuing Education at Pennsylvania College of Technology and Penn State Cooperative Extension. The mission of the MSETC is to provide both the regional community and the natural gas industry with a central resource for workforce development and community education needs related to Marcellus Shale gas. The MSETC serves as a central resource for training and curriculum that is specific to the development of this natural resource. In addition, the MSETC has the capacity to deliver training at multiple locations throughout the Commonwealth to satisfy the needs of the industry.

The central operation of the MSETC is located in the Center for Business & Workforce Development on the campus of Pennsylvania College of Technology in Williamsport, PA. The MSETC is able to utilize the institutional infrastructure of both The Pennsylvania State University system as well as Penn College. In addition, through the Workforce and Economic Development Network of Pennsylvania (WEDnetPA), MSETC also has 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.