Direct Job Creation in West Virginia’s Marcellus Shale

The Demand Generated by the Natural Gas Industry

Prepared By

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In Collaboration With the Marcellus Shale Education & Training Center

Prepared for The West Virginia Department of Education

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# Table of Contents

**Executive Summary**  
page 5

## 1. Introduction  
page 7

## 2. A Methodological Note  
page 7
Permits and Well Completion Data  
page 7
2011 Well Count Estimates  
page 8
2012-2014 Well Counts  
page 9
The Occupational Matrix  
page 10
The Nature of the Occupational Projections, and the Model's Assumptions  
page 11

## 3. The Evolution of the Industry  
page 12

## 4. Job Projections 2012-2014, and Other Workforce Considerations  
page 16
The Geography of Occupations  
page 23
Other Workforce Considerations  
page 24

## 5. Skills Required by In-Demand Occupations  
page 26

## 6. Recommendations and Concluding Thoughts  
page 28

**Appendix: Charts and Occupational Dictionary**  
page 33
# Table of Figures and Charts

<table>
<thead>
<tr>
<th>Figure/Chart</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Permits</td>
<td>12</td>
</tr>
<tr>
<td>Vertical vs. Horizontal Wells</td>
<td>13</td>
</tr>
<tr>
<td>Average Depth of Wells</td>
<td>13</td>
</tr>
<tr>
<td>The Geography of Change: 2008 DEP Permits</td>
<td>14</td>
</tr>
<tr>
<td>The Geography of Change: 2011 DEP Permits</td>
<td>14</td>
</tr>
<tr>
<td>Estimated Number of Marcellus Shale Wells, 2011-2014</td>
<td>16</td>
</tr>
<tr>
<td>Direct Jobs Created by Marcellus Shale Well Development, 2011-2014</td>
<td>16</td>
</tr>
<tr>
<td>Direct Job Demand: Low Scenario by Phases</td>
<td>17</td>
</tr>
<tr>
<td>Direct Job Demand: Medium Scenario by Phases</td>
<td>18</td>
</tr>
<tr>
<td>Direct Job Demand: High Scenario by Phases</td>
<td>18</td>
</tr>
<tr>
<td>Natural Gas Workforce Occupations by Category</td>
<td>19</td>
</tr>
<tr>
<td>Charts with Projections for Specific Job Categories</td>
<td>21-22</td>
</tr>
<tr>
<td>2011 Drilling Permits by County</td>
<td>23</td>
</tr>
<tr>
<td>Finding Employees: Areas of Challenge</td>
<td>25</td>
</tr>
<tr>
<td>Types of Challenge Facing Employers</td>
<td>26</td>
</tr>
<tr>
<td>O*NET Occupations by Knowledge Requirements</td>
<td>34</td>
</tr>
<tr>
<td>O*NET Occupations by Skill Requirements</td>
<td>35</td>
</tr>
</tbody>
</table>
Executive Summary

This report is the result of a contract between the West Virginia Department of Education and World-Class Industrial Network, LLC (WIN). WIN has worked in partnership with the Marcellus Shale Education and Training Center (MSETC), whose model was utilized to estimate the job demand generated by the growth of Marcellus Shale drilling in West Virginia.

MSETC’s model is based on an empirically derived matrix that defines the labor requirements needed to complete one well, by occupation. The WIN and MSETC team collected data on the expected number of wells per year, between 2011 and 2014, via in-depth interviews with companies, published corporate documents (both in print and on the web), an online survey, and permit and other information gathered by the Office of Oil and Gas of West Virginia’s Department of Environmental Protection and by the West Virginia Geological and Economic Survey. Once a figure was obtained for the number of wells per year, the expected jobs/year equaled the product of wells for the year times the labor requirements for one well. Please note that this methodology estimates only those jobs directly involved in developing a well and placing it into production. It does not consider the overall employment impact of Marcellus Shale activity on the full natural gas supply chain, nor its effects upon the broader economy (hotels, restaurants and other local businesses, for instance).

Projections for wells drilled between 2011 and 2014 are presented below:

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<tr>
<th>Estimated Number of Marcellus Shale Wells, 2011-2014</th>
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The number of wells drives the number of jobs. The next table presents the total number of jobs projected for West Virginia’s Marcellus Shale by the MSETC model under three scenarios (low, medium and high levels of drilling activity):

<table>
<thead>
<tr>
<th>Jobs Created by Marcellus Shale Well Development, 2011-2014</th>
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The model shows that over 90% of job creation takes place in the pre-drilling and drilling phases of well development. Jobs, however, will not disappear once a well is completed because new ones will be started elsewhere -- Marcellus activity is anticipated to last for decades.

Most job creation will take place in unskilled and semi-skilled categories: general labor (20% of positions), general office (20%), CDL (10%). However, a substantial share of employment will be in the skilled, technical, managerial and professional/scientific arenas. As revealed by the online survey, West Virginia’s critical challenge relating to the oil and gas industry consists of developing the upper reaches of the workforce; – recruiting, training and educating professionals (engineers, geologists and geophysicists, IT support), managers and supervisors, marketing and sales personnel, welders, skilled workers and technicians. These are the occupational arenas in which companies currently “import” people. The task ahead is to develop policies and mechanisms allowing for “import substitution”, i.e., for replacing out-of-state workers with well-prepared West Virginians.

Key recommendations to meet this goal include the following:

- Develop a high level partnership between the educational system and industry to define clearly what is expected of the education and training institutions, and to define boundaries between training undertaken by companies in-house versus training that is the responsibility of secondary schools, community colleges and universities;
- The partnership should include industry financial support to supplement public resources, be it via the provision of equipment and expertise or via grants targeted at specific projects;
- The secondary system and community colleges should coordinate their activities and leverage each other’s resources to meet the challenge of developing skilled personnel to supply the oil and gas industry in West Virginia. A joint committee should be formed with representatives of the Division of Technical, Adult and Institutional Education and the community college system to manage the relationship of the education and training sector with the industry;
- A position should be created within the Division of Technical, Adult and Institutional Education to function as a full-time liaison with the industry;
- Programmatic recommendations include: 1) Review existing courses of study (in areas such as mechatronics and engineering technologies) with the industry to ascertain how they can be adapted (if necessary) to meet the needs of oil and gas companies; 2) Consider the creation of a Petroleum Technology Associate Degree; 3) Consider adding a second location to the Appalachian Basin Oil & Gas Training Center in West Virginia’s northern panhandle; 4) Monitor the progress of the ShaleNet initiative, and consider having a few institutions in the state’s northern counties become licensed as ShaleNet training providers.
1. Introduction

This report is the result of a contract between World-Class Industrial Network, LLC, and the Department of Education of the state of West Virginia. In collaboration with the Marcellus Shale Education & Training Center, a joint venture of Pennsylvania College of Technology and Penn State Cooperative Extension, World-Class Industrial Network has sought to delineate the employment opportunities created by the growth of the natural gas industry in West Virginia’s Marcellus Shale area, and the measures and actions needed to ensure that West Virginians can take advantage of these opportunities.

This report is organized in several sections, of which the first is a methodological note on permits and well completion data, as well as on the approach underlying the job projections that will be presented. This is an important, if somewhat arid topic, since measures of industry activity and trends can be easily distorted by faulty information and assumptions. The second section will describe the industry and its evolution as a background to the report’s third segment -- a presentation of 2011-2014 job projections, including a discussion of the geography and timing of drilling. The next section will focus on the skill sets required for the anticipated jobs or job categories, and will be followed by recommendations and concluding thoughts.

2. A Methodological Note

a. Permits and Well Completion Data – The Office of Oil and Gas, Department of Environmental Protection (OOG) of the state of West Virginia issues permits for drilling and for all subsequent activities relating to natural gas and oil wells. Similarly, the OOG receives company reports, in particular the one referring to the completion of a well. Once a year companies also provide production data. At least in principle, therefore, the OOG has information that allows it to reconstruct the full history of each well over a period of time. This information is placed online and accessible to the public.

The OOG forwards its records to the West Virginia Geological and Economic Survey (WVGES). To these records the WVGES appends a variety of fields describing the location and the physical and geological characteristics of each well, including depth and target formation (Marcellus Shale or any other). The WVGES final product is also available online.

Between the OOG and the WVGES, the state of West Virginia offers interested citizens, policy-makers and companies one of the most comprehensive and fully documented portraits of industry activity in the United States. At the same time,
their is a complex enterprise: company accounts lag behind and are late in reaching the DEP, especially those relating to completions; further delays are introduced by the time it takes employees to process and enter data into electronic files; coding errors occur;\(^1\) DEP file structures are often awkward and can easily lead to the double counting of wells;\(^2\) data are transferred from the DEP to WVGES and then submitted to additional manipulations. Each one of these steps and processes can introduce inaccuracy, and increases the gap between the occurrence of an event and the moment it is electronically recorded. The consequence is that one must exercise great care when utilizing the permit and completion data made available by the DEP and WVGES.\(^3\)

Considering this overall picture, World-Class Industrial Network (WIN) decided to measure industry activity by utilizing permit data referring to the drilling of new wells. Permits referring to re-working, fracturing, increasing the depth and others relating to processes involving existing wells were excluded from the count. WIN chose permits primarily because they are close to being “just-in-time”: the DEP controls the operation of issuing permits and placing the information online. By contrast, completion data are hopelessly out of date, due both to the real time it takes to drill and finalize a well and to the frequent company delay in submitting reports. For the year 2011, for instance, WIN estimates that the DEP will have issued 557 permits by year’s end, but only a few dozen completions have been recorded in the DEP database as of early November 2011. Completion counts therefore are not a viable measure of current industry activity.

\(b. \) 2011 Well Count Estimate – 2011 is the base year for well count estimates, which in turn drive the job projections presented in the following sections. It is then critical to assess as well as possible the number of wells drilled by the industry in West Virginia’s Marcellus Shale in 2011, despite the absence of

\(^1\) One especially common error had to do with attributing a target formation to a specific well. Prior to 2008 many wells tapping other formations were coded as Marcellus wells, leading to an apparent surge of early activity in West Virginia’s Marcellus Shale. The WVGES has diligently cleaned up these early records, providing a much more accurate historical picture of Marcellus drilling in the state.

\(^2\) The DEP organizes its files by permit, which is understandable given its bureaucratic purpose (tracking individual permits). This, however, produces a situation in which multiple records are associated with a single well ID, easily leading to double counting.

\(^3\) It is only fair to emphasize the courtesy and helpfulness of the staff of DEP and WVGES, who agreed to be interviewed several times on their data and answered additional questions via email. They helped World-Class Industrial Network and the Marcellus Shale Education & Training Center navigate what can be at times a complex and bewildering array of information relating to the state’s drilling activity.
compiled completion data. WIN and the Marcellus Shale Education & Training Center sought to meet this challenge in several ways:

- In-depth interviews were done with 14 Exploration and Production and Midstream companies operating in West Virginia representing 59% of all permits issued by the DEP in 2011\(^4\). These firms were asked about the number of completions planned for 2011 and for the 2012-14 period, and were asked to distinguish between wells actually finalized and tied to the natural gas distribution system and others whose completion might slide into a future year. Similarly, they were asked about the number and type of rigs they currently have in the state, and that they plan to have in 2012-14.

- An online industry assessment was prepared and distributed to the memberships of the West Virginia Oil and Natural Gas Association (WVONGA) and the Independent Oil and Gas Association of West Virginia (IOGA WV). 58 companies replied and offered information on a variety of items, including drilling plans between 2011 and 2014. This was not a ‘scientific’ survey (in the sense of drawing a random sample of a well-defined population), but it served to crosscheck the findings based on the in-depth interviews.

- Many types of company documents can be found in the public domain, which contain data on projected numbers of rigs and wells. WIN and the Marcellus Shale Education & Training Center have reviewed web sites, year-end company reports, press articles and other printed sources referring to companies operating in West Virginia’s Marcellus Shale.

- Specifically for 2011, the Baker Hughes’ Rig Count (http://www.bakerhughes.com/news-and-media/resources/rig-counts-app) and the Unconventional Oil and Gas Center (http://www.ugcenter.com) supply information on the number of rigs operating in West Virginia throughout the year. Given their high cost, it is safe to assume that companies maximize the utilization of rigs, i.e., no rig sits unutilized. Companies have confirmed that each large rotary rig, which is the industry’s “tool of choice” in the Marcellus Shale, drills about 10 to 12 wells per year. Knowledge of the number of rigs is therefore a powerful parameter that sets a “ceiling” to the projections on the number of wells. It also suggests a ‘floor’ – as indicated, firms will keep the rigs in operation as much as possible.

- Last but not least, WIN and the Marcellus Shale Education & Training Center have requested that industry experts review the projections and assess their plausibility.

These various steps led to the 2011 figures, which set the stage for the estimates for future years.

\(^4\) More precisely, 59% of the permits issued and placed online by 10/26/2011.
c. 2012-2014 Well Counts – In projecting figures for 2012-2014, WIN and the Marcellus Shale Education & Training Center followed as closely as possible the plans of companies as expressed in interviews or in published sources. WIN and the Marcellus Shale Education & Training Center (MSETC) added these figures to obtain one initial number for the expected count – a “floor”, so to speak. This figure was used as a control for the projection figures generated by the model. Based on industry interviews, online assessment and public data WIN and the MSETC assumed a modest growth rate of 10%, and applied this rate to the estimated number of completions in 2011 to obtain a number for 2012. The same procedure led to figures for 2013 and 2014. These various sets of numbers produced in different ways were discussed with industry experts and within the WIN/MSETC team. The end result was a set of figures based on the model and on the information provided by companies, but calibrated by the collective wisdom of people knowledgeable about the industry.

d. The Occupational Matrix – The core of the model employed in this study is the occupational matrix developed by the Marcellus Shale Education & Training Center (MSETC), which includes all the occupations necessary to plan, develop, complete and operate a well in the Marcellus Shale. On the basis of hundreds of hours of industry interviews, the MSETC estimated the number of hours per occupation needed to establish an operating well. These hours were then converted to full-time equivalent (FTE) employees. The estimates were originally developed and validated in various regions of Pennsylvania. WIN and the MSETC further validated the matrix via the 14 in-depth interviews undertaken with the major companies performing work in West Virginia. We requested respondents to review the matrix and to suggest additions if and where appropriate. Respondents were also asked to compare well development in West Virginia and in Southwestern Pennsylvania (the region whose terrain most resembles West Virginia’s) – specifically, WIN and MSETC probed issues like site preparation and road construction, where it seemed possible that additional hours of work per occupation would be required due to West Virginia’s rugged conditions.

This process led to the conclusion that no major differences exist between drilling

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5 For the key equation and a full discussion of the model see Marcellus Shale Workforce Needs Assessment, Southwest Pennsylvania, Marcellus Shale Education & Training Center, June 2010, pp. 13ff.

6 If one looks at the actual projected figures one can see the process at work. Growth from year to year is set at 10%, except for the transition from 2012 to 2013. Interviews strongly suggest that, for reasons that are not entirely clear, most companies project a lot of growth between in 2011 and 2012, “stop for breathing” in 2013 and then resume growth in 2014. We respected their input and modified the uniform trend that has us adding wells from one year to the next at a 10% rate.
in Southwestern Pennsylvania and West Virginia. As in Southwestern Pennsylvania, “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. 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.”

Once the labor requirements to develop and complete one well are established, the number of jobs produced by Marcellus Shale drilling is simply the product of the number of wells planned for a given year, times the labor requirements for one well. This is how WIN and MSETC generated the occupational projections displayed in what follows.

e. The Nature of the Occupational Projections, and the Model’s Assumptions -- It is important to reiterate that the methodology created by the MSETC, and employed in the present study, is concerned only with projecting the demand for jobs “directly involved in developing a well and placing it into production”. It does not consider the overall employment impact of Marcellus Shale activity on the full natural gas supply chain, nor the effects upon the broader economy (hotels, restaurants and other local businesses, for instance). As a result, the findings of this study are not immediately comparable to others that seek to estimate the full economic and employment impact of Marcellus Shale drilling upon the state of West Virginia.

The assumptions of the MSETC model are fully discussed elsewhere. One of these assumptions, however, is worth further elaboration – that the accuracy of the occupational projections depends on companies following the drilling plans and schedules disclosed in the interviews or in printed documents. Company plans rely on many assumptions on a variety of factors, prominent among them the price of gas and the regulatory environment. The price of gas has declined substantially since 2008, although on an average it has remained above $4.00 per thousand cubic feet in 2009 and 2010. At this price companies drilling in the Marcellus Shale can still realize significant profit, particularly because of the

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7 Marcellus Shale Workforce Needs Assessment, Southwest Pennsylvania, op. cit., pp. 18-19. FTE means full-time equivalent; high-BTU gas is that which has a higher content of hydrocarbons, such as methane, ethane and propane, which can be separated from the gas and sold on their own right.  
8 Marcellus Shale Workforce Needs Assessment, op. cit., p. 4.  
10 See for instance Range Resource’s 2010 Annual Report, Letter to Investors from the Range’s CEO and COO – at $4.00 per Mcf Range can realize a 50%-plus rate of return.
additional revenues produced by the separation and sale of the liquids that often accompany gas in the Marcellus Shale (methane, propane, ethane and others). Major oscillations in price, however, could account for unexpected expansion or contraction of drilling and create considerable deviation from the predicted number of wells. Similarly, the regulatory environment will have an impact, especially on the small independent producers.

One attractive feature of the MSETC model is that given its simplicity, it can be easily recalibrated if developments such as discussed dramatically affect the rate of drilling. Alternative scenarios can be created with new figures for the number of wells, and the latter can be utilized to produce revised occupational projections “just-in-time”.

3. The Evolution of the Industry

A brief review of the recent evolution of the natural gas industry will provide some context and background for the findings and recommendations that follow.

After a period of relative stability between 2008 and 2010, industry activity in West Virginia is growing as shown by the number of permits for new wells issued by the state’s Department of Environmental Protection, Office of Oil and Gas (OOG) (figure for 2011 is projected from permits issued through October, 2011):

![Number Of Permits](image)

The industry is also becoming more capital intensive and technologically sophisticated. A large part of the public has heard of hydraulic fracturing, the controversial technique that has unlocked the energy potential of shale plays. But many other tools and processes have been added to the industry’s arsenal,
ranging from 3-D Seismic Imaging for prospecting to directional drilling to rig improvements.

Data from the OOG highlight some of the changes occurring in Marcellus Shale drilling in the state since 2008. The chart below shows the increasing frequency of horizontal wells (2011 figures for the period from January to October).

**Vertical vs. Horizontal Wells**

In turn, information from the West Virginia Geological and Economic Survey (WVGES) documents the rise in the average depth of Marcellus Shale wells.

**Average Depth of Wells**

The geography of drilling is also undergoing transformation as industry moves decisively into prime land in the “Marcellus fairway”, those communities in West
Virginia’s northern panhandle adjacent or close to Southwestern Pennsylvania. Graphics from OOG’s interactive database illustrate the evolution.

**The Geography of Change: 2008 DEP Permits**

Note the contrast with the figure below, which presents 2011 drilling permit data.

**The Geography of Change: 2011 DEP Permits**
Underlying these shifts is the evolution of the firms driving the industry in West Virginia. Of the five companies that dominated the field in 2008 as measured by the number of permits obtained – Cabot Oil and Gas, Hard Rock Exploration, Chesapeake Appalachia, EQT Production and Hall Drilling –, only Chesapeake and EQT remain as major players in 2011.11 Consol (76 permits), Antero Resources (30 permits) and Gastar Exploration (26 permits) have joined them as the most active actors involved in exploration and drilling in 2011.

The three-year period since 2008, therefore, has seen a decline in the role of small independent West Virginia producers (such as Hall and Hard Rock) and the rise of larger legacy firms – both EQT and Consol control hundreds of thousands of acres of land in West Virginia and Southwestern Pennsylvania, as a result of their historic roles in the gas (EQT) and coal (Consol) industries. Chesapeake is a “first mover”, having very early negotiated leases and secured control of vast amounts of property. Antero Resources and Gastar Exploration are yet another kind of company – entrepreneurial concerns developed and managed by engineers and business personnel with oil and gas expertise, and with the backing of substantial investors. Smaller independent West Virginia producers such as Waco Oil and Gas and Mountain V Oil and Gas are still present by 2011, but in less prominent fashion.

Large amounts of capital are flowing into the industry, as made clear by the rise of joint ventures – Statoil and Chesapeake, Noble and Consol. The purpose of these ventures is to ensure that companies have the funds to pursue their ambitious drilling programs,12 and/or to guarantee access to technology. The scale of activity appears to be shifting to even higher levels with the recent investments of the majors in the Marcellus Shale: Shell’s purchase of East Resources (2010), Chevron’s acquisition of Atlas and Chief Oil and Gas (2011), Exxon Mobil’s acquisition of Phillips Resources (2011) and XTO Energy (2009-2010).

In summary, industry activity is growing and will continue to grow in West Virginia’s Marcellus Shale, driven by joint ventures (JVs) and especially by the majors. Legacy companies and entrepreneurial ventures will keep their space, but rig employment and demand for well site services will come primarily from the majors and JVs commanding vast financial resources. The expectation is that of an environment where drilling programs will become bigger and more predictable, where service providers will need to operate in scale and be capable of meeting the standards of large exploration and production companies. It is also worth emphasizing that, for geographic and physical reasons, the industry in West Virginia already is, and will continue to be, fully integrated with that of

11 Cabot had 108 permits in 2008 and none in 2011; Hard Rock, 52 and none; and Hall Drilling 28 and none. EQT and Chesapeake grew, respectively from 29 to 42 permits and from 41 to 62.
12 Each Marcellus well can easily cost $5 to $6 million dollars.
Southwestern Pennsylvania. The concentration of drilling in the northern panhandle responds to the location of the “Marcellus fairway”, the prime drilling venues where the most productive wells are found and which extend without a break from Pennsylvania’s southwestern counties to northern West Virginia. From the point of view of the dominant players in the industry, the Marcellus is one economic unit regardless of political boundaries.\textsuperscript{13}

The implications of this changing environment for workforce development will be discussed in forthcoming sections.

4. Job Projections 2011-2014, and Other Workforce Considerations

As described in the methodological note, well counts in West Virginia’s Marcellus Shale were estimated for the 2011-14 period. These counts are displayed in the table below for three scenarios of possible industry activity – low, medium (expected) and high.

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<tr>
<th>Estimated Number of Marcellus Shale Wells, 2011-2014</th>
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<tr>
<td>2011</td>
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<tr>
<td><strong>Low</strong></td>
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<tr>
<td><strong>Medium</strong></td>
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<td><strong>High</strong></td>
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The number of wells drives the number of jobs. The next table presents the total number of direct jobs projected for West Virginia’s Marcellus Shale by the MSETC model under each of the three scenarios.

<table>
<thead>
<tr>
<th>Direct Jobs Created by Marcellus Shale Well Development, 2011-2014</th>
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<tr>
<td>2011</td>
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To understand better the meaning of these figures it is necessary to examine the timing of job creation. The MSETC’s assessment is that on an average the

\textsuperscript{13} This analysis of the potential evolution of the industry is largely based on the excellent piece by Richard Mason, “Crystal Balling the Marcellus Shale”, an online article in Unconventional Oil & Gas Center, http://www.ugcenter.com/Marcellus/Crystal-Balling-Marcellus-Shale_88666.
development of a well involves a pre-drilling phase lasting 9 to 10 months, and consisting of geological studies, permitting, and staking; a drilling phase which, with the inclusion of fracing and completion, may last up to 60 days; and a production phase that will extend over many years. The point to keep in mind is that over 90% of the jobs created by the development of a well are associated with the pre-drilling and drilling phases. These jobs are not "permanent" in the sense that they “disappear” once each well is completed. Fortunately, because drilling in the Marcellus Shale is expected to last decades, the employed workforce simply moves to the next well. Note, however, that jobs associated with drilling and pre-drilling are not cumulative – for instance, if 100 wells are developed in year 1 and 100 more in year 2, the number of people working in these two phases of the process will remain the same from one year to the next. By contrast, production phase jobs – although much smaller in number – do accumulate, and will be roughly double in year 2 of what they were in year 1.

The following graphs show pre-drilling, drilling and production jobs for each of the three scenarios:

Direct Job Demand: Low Scenario by Phases

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14 No one is certain how long it will last, but everyone agrees that the magnitude of the Marcellus reserves is such that drilling in the play will go on for a long time. In addition, there are other Devonian plays with commercial potential, such as the Utica and the Huron.
Direct Job Demand: Medium Scenario by Phases

Direct Job Demand: High Scenario by Phases
Looking more closely at the medium (expected) scenario illustrates the dynamics portrayed by the MSETC model. Pre-drilling jobs will decline between 2011 and 2014 (from 717 to 436), primarily because the number of real estate jobs required by the industry diminishes as the available land is leased; drilling jobs increase with the number of wells (from 3,536 to 3,986), but not as much as they otherwise would because of the evolution of technology (the trend towards multi-well pads is especially important, since less labor is required to drill 5 wells out of a single pad than it would be if each well had its own pad); and production jobs rise because of the cumulative effect discussed before, from 177 to 405. The dynamics are the same – with different figures – for the low and high scenarios.

Turning to specific jobs and categories of jobs, the following graph offers an overview of the relative size of the various occupational sectors:

The occupational distribution reveals that a majority of the jobs in the industry – over 70% -- are unskilled or semi-skilled. General laborers (20% of the jobs) include the members of the gas rig crew, from floor hands (entry-level workers that perform odd manual jobs and assist others in the crew with any tasks that

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15 Graph courtesy of the MSETC.
need to be done) to the derrick man (who works on the derrick above the rig floor and manually handles drill pipe) and the driller (the team leader for the drilling process). Training for these occupations has typically taken place on the job, although a systematic initiative now exists addressing the preparation of general laborers for the industry. General office (20% of the jobs) encompasses professional activities requiring higher levels of education and interpersonal polish, such as Public and Corporate Relations, but also a majority of positions involving few skills – clerks, receptionists, data entry, and individuals in charge of security. Heavy equipment operators account for another 17% of the positions, and CDL – truck drivers with the specialized skills required by the industry – for 10%. In turn, semi-skilled workers and technicians refer to pipe fitters, rig movers, the “mud man” (who is in charge of ensuring that the drilling fluid remains within the designed specifications), electricians, directional drillers and the cement crew (the members of which do the cementing job that holds in place the casing, i.e., the pipe inserted into a section of a borehole). They comprise another 6% of the positions. The remainder of the jobs includes managers, inspectors, engineers, geologists, real estate personnel and a few others.

In general, it is fair to say that although the majority of jobs generated by the industry (over 70%) are unskilled or semi-skilled, “…nearly all of them require the skills and knowledge unique to the natural gas industry, skills and knowledge that are best learned through experience.” In other words, training can impart industry-specific knowledge up to a point, but on-the-job learning will always remain a significant component of the process of developing oil and gas workers. The 25% to 30% of the workforce made of technicians and professionals, on the other hand, require higher levels of training and education.

The following series of charts present the 2011-2014 projections for specific jobs or job categories. The upper figure in each graph corresponds to the projection under the “high” scenario, while the lower figure stands for the “low” case. The range displayed, therefore, offers the upper and lower boundaries estimated for each occupation or occupational category by the MSETC model.

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16 The initiative is ShaleNET, a multi-state program that includes West Virginia and which will be discussed in what follows.
Perhaps most noticeable in the above charts is the projected decline of the pre-drilling occupations, those related to the initial rush to secure control of the land.
and to construction and site preparation activities – lawyers, land agents, X-ray technicians and similar.

*The Geography of Occupations* – The majority of the pre-drilling and drilling jobs will be located in the site where the well is being drilled or in its immediate vicinity. In the case of West Virginia’s Marcellus Shale, this means presently the state’s northern communities, especially Wetzel, Marshall and Harrison counties. The map below shows the 2011 distribution of drilling permits by county.

![2011 Drilling Permits by County](image)

The permits measure drilling activity, which in turn determines the location of most of the workforce. The situation is different for General Office jobs and some professional jobs (lawyers, some engineers and geologists), which will be based in company offices. Where the latter are is difficult to determine – contractors and sub-contractors do most of the work in the industry, and they come from a wide area. Contractors in Southwestern Pennsylvania operate often in northern West Virginia, and vice-versa.
As opposed to contractors, Exploration and Production companies show some degree of geographic concentration. The major firms have corporate offices elsewhere – Consol and EQT in Washington County, PA; Chesapeake Energy in Oklahoma City with a regional office also in Washington County; Antero Resources in Denver, Colorado; and so on. However, they all have regional and/or field offices in West Virginia: EQT in Clarksburg and Charleston; Consol and Chesapeake in Jane Lew, a 20-minute drive from Clarksburg; Antero Resources in Ellenboro and Mount Clare, the latter only 12 minutes from Clarksburg by car; Mountain V Oil and Gas in Buckhannon and Mount Clare (again, only a 12-minute drive from Clarksburg). The centrality of Clarksburg is apparent, and with good reason: the city is located in Harrison County, currently one of the three busiest counties in the state in terms of Marcellus Shale activity (as measured by the number of drilling permits); furthermore, the city lies in the intersection of I-79 and Route 50, the second most used interchange in West Virginia.

It is reasonable to infer that Clarksburg is an emerging center for office and professional jobs related to the industry. Similarly, it should turn into the primary West Virginia location for production jobs, i.e., those held by well tenders and others in charge of operating and maintaining the wells once the latter have been completed and tied to the distribution system.

Other Workforce Considerations -- The online assessment of companies, which included both energy companies and their contractors, provides additional insight regarding the industry’s workforce.\(^{18}\) Assessment results cannot be considered more than suggestive, given the small number of respondents\(^ {19}\) and the absence of a statistically valid sample. On the other hand, the findings are congruent with those of the in-depth interviews.

The chart below shows the percentages of companies finding it challenging or very challenging to find employees in different occupational categories:

\(^{18}\) The survey encompassed all members of the West Virginia Oil and Natural Gas Association (WVONGA) and the Independent Oil and Gas Association of West Virginia (IOGA WV). Both associations sent cover letters to members soliciting responses to the questionnaire appended to the letter. We offer our thanks to the staff of WVONGA and IOGA WV for their tireless assistance to WIN and MSETC.

\(^{19}\) 58 firms filled the questionnaire; specific questions, however, invariably had less than 58 replies.
Percentages are below 50% because of the large number of respondents who did not offer ratings to specific occupations. This is actually to be expected given the variety of types of firms involved in the survey – not every company will hire geologists or heavy equipment operators, for instance.

The significant pattern in the chart is the prominence of occupations requiring at least some level of professional and technical skills – marketing and sales, management and supervision, engineering, geology, IT, welding, skilled and semi-skilled technicians. By contrast, respondents considered it “easy” to find general labor or general office workers. It is important to qualify this assertion by pointing out that exploration and production companies responding to the survey, when separated from contractors, are clear about the difficulty of locating general laborers (roustabouts and similar) – a fact much emphasized in the in-depth interviews. It seems likely that while unskilled workers are not hard to find overall, this is not the case for laborers with the specific, unique experience and on-the-job skills required by the natural gas industry.

The following chart presents those workforce characteristics that employers consider scarce, a “very big challenge” or “somewhat of a challenge” to secure:
Experience, technical skills, good work history, employees with the proper degree or certification and with sound interpersonal skills are all seen as needed by more than 80% of the employers. The emerging picture is that of a workforce that must be built to meet industry requirements via appropriate training and education.

The survey also reveals that West Virginia residents make up a half or less than a half of the workforce of 50% of the interviewees. The survey therefore suggests both a challenge and an opportunity: adequately prepare West Virginians to fill the positions being created by the natural gas industry and to replace those employees currently “imported” from elsewhere, primarily in the professional, scientific and skilled fields.

5. Skills Required by In-Demand Occupations

Appendix One presents a short dictionary including a few occupations critical to the natural gas industry. The dictionary, which is directly transcribed from O*Net Online, defines each occupation by its tasks and be the knowledge and the skills it requires. Appendix One also displays a summary chart tabulating each occupation by skill and knowledge.

One point to be noted is that the titles of the nearly 150 occupations included in the MSTEC model were developed using industry job titles which do not directly correspond to the Standard Occupational Classification (SOC) utilized by O*Net. In some cases, such as Lawyers, the two classificatory schemes match well; in

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most cases the correspondence is rough at best. As a result, the following attempt to describe the skills required by the natural gas industry by utilizing O*Net should be seen as no more than a first attempt to tackle this challenge.

This said, the summary chart displayed in the Appendix appears to offer a few clues to educators interested in preparing well-rounded employees for the industry:

• Among skills, critical thinking is a requisite of all occupations and active listening of almost all (the exceptions are roustabouts and logging equipment operators);
• For labor, ranging from pipefitters and steamfitters to logging equipment operators, monitoring, operations monitoring and judgment and decision-making are skills required of almost every occupation;
• For office and professional employment the skills required of most occupations are monitoring, judgment and decision-making, speaking and reading comprehension;
• The remainder of the skills apply only to groups of occupations with specific characteristics – scientists, engineers and certain professionals, for example, are the only ones needing to know science (the applications of the scientific method) or operations analysis.

In terms of knowledge requirements, some patterns also emerge:

• Mechanical knowledge is necessary for all labor-related endeavors. For laborers, other knowledge arenas are occupation-specific – some call for mathematics, some for engineering and technology, and so on;
• Limited science knowledge (chemistry, biology, physics) is required for the blue-collar occupations;
• Among office workers and professionals, limited mechanical knowledge is needed except for occupations such as supervisors and mechanical engineers (which require more inclusive expertise in these areas);
• Customer Service and English Language are the two universal requirements for professionals and white collar workers;
• Knowledge of Mathematics and Engineering Technology is critical to cartographers, GIS technicians, supervisors, construction managers and, of course, engineers and scientists.

The most interesting implication of these findings is perhaps their coincidence with observations often voiced by employers when looking for workers,

21 In O*Net, “skill” is always used in an applied sense while “knowledge” refers to the theoretical realm. Mathematics as knowledge refers to an understanding of the abstract language of mathematics; mathematics as a skill refers to the application of the language to solve real-life problems.
22 For definitions of each of these skills please see the dictionary in the Appendix.
specifically their difficulty in finding individuals who can solve problems and who are team players. Critical thinking, a skill demanded by all occupations under analysis, refers to “using logic and reasoning to identify strengths and weaknesses of alternative solutions, conclusions or approaches to problems.” In turn, active listening is understood as “giving full attention to what other people are saying, taking time to understand points being made, asking questions as appropriate, not interrupting at inappropriate times.” Critical thinking is a rough equivalent of problem solving, while active listening can be thought of as covering a wide range of features employers feel are necessary or desirable in employees – interpersonal skills, ability to work with others, self-discipline.

The findings also highlight the basics – mechanical knowledge as a common foundation of blue-collar activity, English and understanding of customer service as essential to office and professional occupations.

The significance of these observations is that training for natural gas occupations, or any others, cannot be overly focused on narrow job skills -- except in those cases where the goal is to get people quickly into the workforce to meet personal needs of individuals and/or an urgent company need for employees. Other than these situations, it is important to introduce courses where individuals learn to work in teams, exercise and nurture creative ways of looking at problems, and gain a general knowledge of machinery and technology (on the blue-collar side) and of the English language (on the white collar side). Only by teaching these skills which one could name foundational, in addition to the particular knowledge needed to perform a given job, can training and educational programs fully meet the expectations and demands of employers in the natural gas industry.

6. Recommendations and Concluding Thoughts

The growing importance of large players within the industry – joint ventures and the majors – was highlighted earlier. This prominence suggests that an effective workforce development program targeting the oil and gas segment must rely on a high level partnership between the educational system of West Virginia (secondary education, community colleges, universities) and the industry: both the players involved and the challenges to be addressed have grown too large to be tackled through piecemeal efforts. The partnership should define clearly what is expected of the educational system, should involve the contribution of

23 Corporate training has devised ingenious ways and exercises whose goal is to develop teamwork and creativity, for instance. Some of these programs can perhaps be adapted to the training of the natural gas workforce. See for instance the programs of the Center for Creative Leadership (CCL) at http://www.ccl.org/. CCL focuses on corporate leadership, but it aims at developing many of the features that employers consider the foundational skills of all good employees.
company resources as needed, and should define the boundaries between training to be done in-house by firms and training and education to be performed by universities, community colleges and secondary institutions. The goal would be the establishment of a complementary and mutually supportive system.

A high level partnership such as described would raise the profile of workforce training and education on a par with other efforts designed to attract/develop business or to support industry access to capital, and would accelerate the pace of integration between industry and the academic community. As of now, such integration is limited to a few initiatives such as the Appalachian Basin Oil & Gas Training Center – an industry-sponsored program located at the Pierpont Community and Technical College, and focused on pre-employment and basic skills training; ShaleNET, a multi-state project involving the West Virginia Northern Community College and aimed at developing curriculum for the industry and providing quick employee development and placement; and a spattering of oil and gas-related real estate programs. Except for these, there is little training and education below the 4-year college degree offerings in petroleum engineering and geology/geophysical sciences available at the state’s major universities.

The partnership proposed should include industry financial contribution to supplement public resources, be it via provision of equipment and expertise or via targeted grants for specific training and education projects. It also has the potential of working closely with the public sector system’s efforts to re-train and re-employ the unemployed and under-employed population of West Virginia.

This broad framework calls for a close collaboration between industry and education to address the fundamental challenge highlighted by companies in the in-depth interviews and online survey – the scarcity of a skilled workforce in West Virginia. Much more than general labor (such as roustabouts), companies have pinpointed the skilled and technical occupations as hard to fill – land agent/real estate-related activities; skilled and semi-skilled operators and technicians; welders; and truck drivers with industry-specific training (an oilfield services CDL). Occupations requiring 4-year degrees or more were also highlighted – engineering; geology/geophysical sciences; IT, GIS and related; management and supervision; PR and government relations; and marketing and sales.

Historically, West Virginia has placed responsibility for adult and technical education with the secondary schools, and only in recent years (since 2003) has grown a statewide community college system. Significant resources lie at the

24 Recall, however, the qualification made earlier – energy companies in the online survey as well as in one-on-one interviews emphasized the difficulty of finding general laborers such as roustabouts. They appear to differ from firms in the overall supply chain, which see no problems in the procurement of unskilled workers.
secondary level and keep increasing, as exemplified by the recent opening of a major welding laboratory and training center in Clarksburg, Harrison County. The existing secondary-level adult education structures served 4,369 full-time students in 2009-10, and over 71,000 part-time students. Furthermore, the system is flexible and responsive, and can be customized to the demands of companies; it is also geographically distributed throughout the state. On the other hand, the growth of the community college system has spurred involvement with the important initiatives mentioned before, the Appalachian Basin Oil and Gas Training Center (ATC) and ShaleNET. It is apparent that the secondary and community college activities overlap to some degree and potentially duplicate each other. One important recommendation of this report is that the community college and the secondary systems coordinate their activities, so as to add to and leverage each other’s resources. The details of how to implement this latter proposal need to be developed, but a few practical suggestions are presented in what follows. The idea is to start the collaboration around specific activities, and let it grow on the basis of the achievement of common success.

Key recommendations to further the envisioned collaboration and to enhance the development of a skilled workforce for the oil and gas industry are:

- Form a joint committee including representatives of the Division of Technical, Adult and Institutional Education and of the community college system to manage the relationship of the educational sector with the oil and gas industry;
- Create a position to function as a full-time liaison with the industry. The position would be responsible for developing a detailed understanding of the oil and gas sector and its needs, to propose rapid response programs to meet the sector’s demand, and to make industry aware of the offerings of both the secondary and community college systems, among other things. Institutionally, the position should be located within the Division of Technical, Adult and Institutional Education; however, it would ultimately respond to the directions of the joint committee including the Division and the community college representatives.

These two broad proposals would underlie a host of other programmatic suggestions:

- Have industry representatives review courses and programs in community colleges and secondary institutions in areas such as mechatronics and engineering technologies, to ascertain how closely they meet oil and gas needs. Make curriculum modifications and additions as needed to meet these needs; disseminate information on existing courses and programs throughout the industry;
- Consider expanding industry-specific training – two models to consider are those of the Gas Technology Institute (GTI), which provides an abundance of introductory and advanced courses in oil and gas, and the curriculum
developed by ShaleNET to meet the specific requirements of drillers in the Marcellus Shale. The joint committee involving the secondary and the community college systems should manage any expansion of training, so as to maximize the effective use of resources;

- Consider the creation of a Petroleum Technology Associate degree to be delivered statewide through the community college system. A two-year associate degree focused on applied technology could help address the urgent need for engineers of all types. (This is a suggestion raised by respondents to the survey as well as by educators interviewed.) Many of the courses required for the degree could/should be offered at the secondary level as advanced placement offerings;

- Supervisory/management training with a focus on the needs of the oil and gas sector is also to be considered – perhaps a training program focused on incumbent workers that companies are looking to promote to supervisory positions. (This request has already surfaced in Pennsylvania and a full supervisory/management curriculum has been developed by the MSETC to address this industry request);

- Consider creating a second physical location for the Appalachian Basin Oil and Training Center (including a training rig) in the northern panhandle, near the geographic core of Marcellus drilling in the state. This initiative should be coordinated with the West Virginia Northern Community College, which is entering the field via its participation in ShaleNET. It should also be closely coordinated, via the joint committee, with the secondary level. The latter could become a source of trainees for the ATC, recruited from the pool of secondary students who wish to enter the labor force immediately upon acquiring their High School degrees;

- Develop a module on the oil and gas industry to be integrated into the curriculum delivered in secondary schools;

- Build geology, geophysical sciences and industry-specific engineering examples into STEM activities at the secondary level;

- Develop an industry speaker’s bureau and schedule it to cover systematically the state’s secondary schools on a year-round basis;

- Develop an industry career path that is clearly understandable, and outline the steps (courses to be taken, grade requirements) necessary to successfully “walk” the path. This should be an effort that seamlessly integrates secondary and post-secondary resources, as the career path should show multiple ways of accessing the industry – including non-traditional ways available to adults seeking to re-enter the labor force;

- Utilize online resources, such as the Appalachian Basin Oil & Gas Training Center’s recently acquired Coole Immersive’s modules on service rig training, for teaching purposes within both secondary and post-secondary programs.

Last but not least, the joint committee should carefully monitor the progress of ShaleNET in West Virginia. ShaleNET is a coalition of education and training organizations in Pennsylvania, West Virginia, Ohio and New York whose mission
is to develop a comprehensive recruitment, training, placement and retention program for the natural gas industry; it has been funded by a 3-year, $4.9 million grant from the U.S. Department of Labor, Employment and Training Administration. The West Virginia Northern Community College is West Virginia’s lead participant. Currently ShaleNET is close to completing the development of curriculum for a few high priority occupations – roustabout, truck driver (CDL), welder helper, floorhand and production technician (fracing). ShaleNET has the potential to advance significantly the agenda proposed above, especially the recommendation to expand industry-specific training. In particular, ShaleNET performs the function of adapting existing training, in areas such as welding or truck driving, to the specific requirements of the industry. The proposed joint committee should investigate the possibility/opportunity of having a few central institutions in the state’s northern area to become licensed providers of ShaleNET training, as an initial step towards enhancing the industry-focused skills of the state’s workforce.²⁵

²⁵ Currently the West Virginia Northern Community College is a ShaleNET Approved Training Provider, and Pierpont and Stanley Tech have received conditional approval to participate in ShaleNET (pending clarifications and submission of additional data). It should be noted that ShaleNET involves recruitment and placement of workforce in addition to training -- ShaleNET works with Workforce West Virginia and has developed an online system that can assist companies with locating and hiring workers.
Appendix One

Charts and Occupational Dictionary

Natural Gas Industry Occupations By O*Net-Derived Knowledge Requirements

Natural Gas Industry Occupations By O*Net Derived Skills

O*Net Approximation of Natural Gas Industry Occupations: Dictionary of Occupational Tasks, Knowledge Requirements, Skills
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<thead>
<tr>
<th>O*NET Occup</th>
<th>Knowledge</th>
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<tr>
<td>Pipefitters/Stmft</td>
<td>Mechanical</td>
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<td>Chemistry</td>
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<td>Biology</td>
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<td>Geography</td>
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<td>Computers &amp; Electronics</td>
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SEMI-SKILLED TECHNICIANS

Pipefitters

O*Net approximation, Pipefitters and Steamfitters (47-2152.01)

Tasks

Plan pipe system layout, installation, or repair, according to specifications.

Inspect, examine, or test installed systems or pipe lines, using pressure gauge, hydrostatic testing, observation, or other methods.

Select pipe sizes, types, or related materials, such as supports, hangers, or hydraulic cylinders, according to specifications.

Measure and mark pipes for cutting or threading.

Attach pipes to walls, structures, or fixtures, such as radiators or tanks, using brackets, clamps, tools, or welding equipment.

Assemble or secure pipes, tubes, fittings, or related equipment, according to specifications, by welding, brazing, cementing, soldering, or threading joints.

Lay out full scale drawings of pipe systems, supports, and related equipment, following blueprints.

Turn valves to shut off steam, water, or other gases or liquids from pipe sections, using valve keys or wrenches.

Cut, thread, or hammer pipes to specifications, using tools such as saws, cutting torches, pipe threaders, or pipe benders.

Remove and replace worn components.

Knowledge

Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

Building and Construction — Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.
English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

Education and Training — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.

Skills

Coordination — Adjusting actions in relation to others' actions.

Time Management — Managing one's own time and the time of others.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Speaking — Talking to others to convey information effectively.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Operation and Control — Controlling operations of equipment or systems.

**Rig Movers**

O*net approximation – Riggers (49-9096.00)

**Tasks**

Signal or verbally direct workers engaged in hoisting and moving loads, in order to ensure safety of workers and materials.

Test rigging to ensure safety and reliability.

Attach loads to rigging to provide support or prepare them for moving, using hand and power tools.

Select gear such as cables, pulleys, and winches, according to load weights and sizes, facilities, and work schedules.

Control movement of heavy equipment through narrow openings or confined spaces, using chainfalls, gin poles, gallows frames, and other equipment.

Tilt, dip, and turn suspended loads to maneuver over, under, and/or around obstacles, using multi-point suspension techniques.

Align, level, and anchor machinery.

Fabricate, set up, and repair rigging, supporting structures, hoists, and pulling gear, using hand and power tools.

Manipulate rigging lines, hoists, and pulling gear to move or support materials such as heavy equipment, ships, or theatrical sets.
Attach pulleys and blocks to fixed overhead structures such as beams, ceilings, and gin pole booms, using bolts and clamps.

**Knowledge**

Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

Building and Construction — Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

Transportation — Knowledge of principles and methods for moving people or goods by air, rail, sea, or road, including the relative costs and benefits.

Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

**Skills**

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Operation and Control — Controlling operations of equipment or systems.

Time Management — Managing one's own time and the time of others.
Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.

**Electricians**

O*net approximation Electrical & Electronic Repairers, Commercial & Industrial Equipment (49-2094.00)

**Tasks**

Test faulty equipment to diagnose malfunctions, using test equipment or software, and applying knowledge of the functional operation of electronic units and systems.

Inspect components of industrial equipment for accurate assembly and installation or for defects, such as loose connections or frayed wires.

Install repaired equipment in various settings, such as industrial or military establishments.

Examine work orders and converse with equipment operators to detect equipment problems and to ascertain whether mechanical or human errors contributed to the problems.

Perform scheduled preventive maintenance tasks, such as checking, cleaning, or repairing equipment, to detect and prevent problems.

Study blueprints, schematics, manuals, or other specifications to determine installation procedures.

Set up and test industrial equipment to ensure that it functions properly.

Repair or adjust equipment, machines, or defective components, replacing worn parts, such as gaskets or seals in watertight electrical equipment.
Maintain equipment logs that record performance problems, repairs, calibrations, or tests.

Calibrate testing instruments and installed or repaired equipment to prescribed specifications.

**Knowledge**

Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Public Safety and Security — Knowledge of relevant equipment, policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions.

Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

Production and Processing — Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.

**Skills**

Repairing — Repairing machines or systems using the needed tools.

Quality Control Analysis — Conducting tests and inspections of products, services, or processes to evaluate quality or performance.
Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.

Troubleshooting — Determining causes of operating errors and deciding what to do about it.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Equipment Maintenance — Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Equipment Selection — Determining the kind of tools and equipment needed to do a job.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

HEAVY EQUIPMENT OPERATORS

O*net approximation – Operating Engineers and Other Construction Equipment Operators (47-2073.00)

Tasks

Learn and follow safety regulations.

Take actions to avoid potential hazards or obstructions, such as utility lines, other equipment, other workers, or falling objects.

Adjust handwheels and depress pedals to control attachments, such as blades, buckets, scrapers, or swing booms.

Start engines, move throttles, switches, or levers, or depress pedals to operate machines, such as bulldozers, trench excavators, road graders, or backhoes.

Locate underground services, such as pipes or wires, prior to beginning work.
Monitor operations to ensure that health and safety standards are met.

Align machines, cutterheads, or depth gauge makers with reference stakes and guidelines or ground or position equipment, following hand signals of other workers.

Load and move dirt, rocks, equipment, or other materials, using trucks, crawler tractors, power cranes, shovels, graders, or related equipment.

Drive and maneuver equipment equipped with blades in successive passes over working areas to remove topsoil, vegetation, or rocks or to distribute and level earth or terrain.

Coordinate machine actions with other activities, positioning or moving loads in response to hand or audio signals from crew members.

**Knowledge**

Building and Construction — Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.

Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

Public Safety and Security — Knowledge of relevant equipment, policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Education and Training — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.

Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs
assessment, meeting quality standards for services, and evaluation of customer satisfaction.

**Skills**

Operation and Control — Controlling operations of equipment or systems.

Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Speaking — Talking to others to convey information effectively.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**GENERAL LABOR**

**Roustabouts**

O*net approximation – Roustabouts, Oil & Gas (47-5071.00)

**Tasks**

Keep pipe deck and main deck areas clean and tidy.

Unscrew or tighten pipes, casing, tubing, and pump rods, using hand and power wrenches and tongs.

Walk flow lines to locate leaks, using electronic detectors and by making visual inspections, and repair the leaks.

Move pipes to and from trucks, using truck winches and motorized lifts, or by hand.

Bolt together pump and engine parts.
Guide cranes to move loads about decks.

Supply equipment to rig floors as requested, and provide assistance to roughnecks.

Dismantle and repair oil field machinery, boilers, and steam engine parts, using hand tools and power tools.

Clean up spilled oil by bailing it into barrels.

Dig drainage ditches around wells and storage tanks.

Knowledge

Public Safety and Security — Knowledge of relevant equipment, policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions.

Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

Skills

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.

Quality Control Analysis — Conducting tests and inspections of products, services, or processes to evaluate quality or performance.

Troubleshooting — Determining causes of operating errors and deciding what to do about it.

Drillers

O*net approximation, Rotary Drill Operator, Oil & Gas (47-5012.00)
Tasks

Train crews, and introduce procedures to make drill work more safe and effective.

Observe pressure gauge and move throttles and levers in order to control the speed of rotary tables, and to regulate pressure of tools at bottoms of boreholes.

Count sections of drill rod in order to determine depths of boreholes.

Push levers and brake pedals in order to control gasoline, diesel, electric, or steam draw works that lower and raise drill pipes and casings in and out of wells.

Connect sections of drill pipe, using hand tools and powered wrenches and tongs.

Maintain records of footage drilled, location and nature of strata penetrated, materials and tools used, services rendered, and time required.

Maintain and adjust machinery in order to ensure proper performance.

Start and examine operation of slush pumps in order to ensure circulation and consistency of drilling fluid or mud in well.

Locate and recover lost or broken bits, casings, and drill pipes from wells, using special tools.

Weigh clay, and mix with water and chemicals to make drilling mud.

Knowledge

Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

Education and Training — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.
Personnel and Human Resources — Knowledge of principles and procedures for personnel recruitment, selection, training, compensation and benefits, labor relations and negotiation, and personnel information systems.

Skills

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Operation and Control — Controlling operations of equipment or systems.

Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Instructing — Teaching others how to do something.

Coordination — Adjusting actions in relation to others' actions.

Speaking — Talking to others to convey information effectively.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Derrick Man

O*net approximation – Derrick Operators, Oil & Gas (47-5011.00)

Tasks

Inspect derricks, or order their inspection, prior to being raised or lowered.

Inspect derricks for flaws, and clean and oil derricks in order to maintain proper working conditions.

Control the viscosity and weight of the drilling fluid.
Repair pumps, mud tanks, and related equipment.

Set and bolt crown blocks to posts at tops of derricks.

Listen to mud pumps and check regularly for vibration and other problems, in order to ensure that rig pumps and drilling mud systems are working properly.

Start pumps that circulate mud through drill pipes and boreholes to cool drill bits and flush out drill-cuttings.

Position and align derrick elements, using harnesses and platform climbing devices.

Supervise crew members, and provide assistance in training them.

Guide lengths of pipe into and out of elevators.

Knowledge

Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Education and Training — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.

Skills

Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.

Operation and Control — Controlling operations of equipment or systems.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.
Repairing — Repairing machines or systems using the needed tools.

Speaking — Talking to others to convey information effectively.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Quality Control Analysis — Conducting tests and inspections of products, services, or processes to evaluate quality or performance.

Troubleshooting — Determining causes of operating errors and deciding what to do about it.

**TRUCK DRIVERS (CDL)**

O*net approximation – Heavy and Tractor-Trailer Truck Drivers (53-3032.00)

**Tasks**

Check vehicles to ensure that mechanical, safety, and emergency equipment is in good working order.

Maneuver trucks into loading or unloading positions, following signals from loading crew and checking that vehicle and loading equipment are properly positioned.

Collect delivery instructions from appropriate sources, verifying instructions and routes.

Maintain logs of working hours or of vehicle service or repair status, following applicable state and federal regulations.

Report vehicle defects, accidents, traffic violations, or damage to the vehicles.

Secure cargo for transport, using ropes, blocks, chain, binders, or covers.

Drive trucks to weigh stations before and after loading and along routes to document weights and to comply with state regulations.
Drive trucks with capacities greater than 3 tons, including tractor-trailer combinations, to transport and deliver products, livestock, or other materials.

Obtain receipts or signatures for delivered goods and collect payment for services when required.

Inventory and inspect goods to be moved to determine quantities and conditions.

**Knowledge**

Transportation — Knowledge of principles and methods for moving people or goods by air, rail, sea, or road, including the relative costs and benefits.

Public Safety and Security — Knowledge of relevant equipment, policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions.

Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

**Skills**

Operation and Control — Controlling operations of equipment or systems.

Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Time Management — Managing one's own time and the time of others.
Troubleshooting — Determining causes of operating errors and deciding what to do about it.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Repairing — Repairing machines or systems using the needed tools.

WELDERS

O*net approximation – Welders, Cutters and Welder Fitters (51-4121.06)

Tasks

Operate safety equipment and use safe work habits.

Weld components in flat, vertical, or overhead positions.

Ignite torches or start power supplies and strike arcs by touching electrodes to metals being welded, completing electrical circuits.

Clamp, hold, tack-weld, heat-bend, grind or bolt component parts to obtain required configurations and positions for welding.

Detect faulty operation of equipment or defective materials and notify supervisors.

Operate manual or semi-automatic welding equipment to fuse metal segments, using processes such as gas tungsten arc, gas metal arc, flux-cored arc, plasma arc, shielded metal arc, resistance welding, and submerged arc welding.

Monitor the fitting, burning, and welding processes to avoid overheating of parts or warping, shrinking, distortion, or expansion of material.

Examine workpieces for defects and measure workpieces with straightedges or templates to ensure conformance with specifications.
Recognize, set up, and operate hand and power tools common to the welding trade, such as shielded metal arc and gas metal arc welding equipment.

Lay out, position, align, and secure parts and assemblies prior to assembly, using straightedges, combination squares, calipers, and rulers.

**Knowledge**

Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

**Skills**

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

**GENERAL OFFICE**

*Office Clerks*

O*net approximation – Office Clerks, General (43-9061.00)

**Tasks**

Operate office machines, such as photocopiers and scanners, facsimile machines, voice mail systems, and personal computers.

Answer telephones, direct calls, and take messages.

Maintain and update filing, inventory, mailing, and database systems, either manually or using a computer.
Communicate with customers, employees, and other individuals to answer questions, disseminate or explain information, take orders, and address complaints.

Open, sort, and route incoming mail, answer correspondence, and prepare outgoing mail.

Compile, copy, sort, and file records of office activities, business transactions, and other activities.

Compute, record, and proofread data and other information, such as records or reports.

Type, format, proofread, and edit correspondence and other documents, from notes or dictating machines, using computers or typewriters.

Complete work schedules, manage calendars, and arrange appointments.

Review files, records, and other documents to obtain information to respond to requests.

Knowledge

Clerical — Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Skills

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Speaking — Talking to others to convey information effectively.
Social Perceptiveness — Being aware of others' reactions and understanding why they react as they do.

Time Management — Managing one's own time and the time of others.

Writing — Communicating effectively in writing as appropriate for the needs of the audience.

Service Orientation — Actively looking for ways to help people.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**Receptionists**

O*net approximation – Receptionists and Information Clerks (43-4171.00)

**Tasks**

Operate telephone switchboard to answer, screen, or forward calls, providing information, taking messages, or scheduling appointments.

Greet persons entering establishment, determine nature and purpose of visit, and direct or escort them to specific destinations.

Transmit information or documents to customers, using computer, mail, or facsimile machine.

Hear and resolve complaints from customers or the public.

Perform administrative support tasks, such as proofreading, transcribing handwritten information, or operating calculators or computers to work with pay records, invoices, balance sheets, or other documents.

File and maintain records.

Provide information about establishment, such as location of departments or offices, employees within the organization, or services provided.

Collect, sort, distribute, or prepare mail, messages, or courier deliveries.

Process and prepare memos, correspondence, travel vouchers, or other documents.

Receive payment and record receipts for services.
Knowledge

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Clerical — Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

Skills

Speaking — Talking to others to convey information effectively.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Service Orientation — Actively looking for ways to help people.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Coordination — Adjusting actions in relation to others' actions.

Social Perceptiveness — Being aware of others' reactions and understanding why they react as they do.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Writing — Communicating effectively in writing as appropriate for the needs of the audience.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.
Time Management — Managing one’s own time and the time of others.

**Accountants**

O*net approximation – Accountants (13-2011.01)

**Tasks**

Prepare, examine, or analyze accounting records, financial statements, or other financial reports to assess accuracy, completeness, and conformance to reporting and procedural standards.

Report to management regarding the finances of establishment.

Establish tables of accounts and assign entries to proper accounts.

Develop, implement, modify, and document recordkeeping and accounting systems, making use of current computer technology.

Compute taxes owed and prepare tax returns, ensuring compliance with payment, reporting or other tax requirements.

Maintain or examine the records of government agencies.

Advise clients in areas such as compensation, employee health care benefits, the design of accounting or data processing systems, or long-range tax or estate plans.

Develop, maintain, and analyze budgets, preparing periodic reports that compare budgeted costs to actual costs.

Provide internal and external auditing services for businesses or individuals.

Analyze business operations, trends, costs, revenues, financial commitments, and obligations, to project future revenues and expenses or to provide advice.

**Knowledge**

Economics and Accounting — Knowledge of economic and accounting principles and practices, the financial markets, banking and the analysis and reporting of financial data.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Clerical — Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.

Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Law and Government — Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.

Skills

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Mathematics — Using mathematics to solve problems.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Writing — Communicating effectively in writing as appropriate for the needs of the audience.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Speaking — Talking to others to convey information effectively.
Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Time Management — Managing one's own time and the time of others.

Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.

**IT/Computers**

O*net approximation – Computer User Support Specialists (15-1151-00)

**Tasks**

Oversee the daily performance of computer systems.

Answer user inquiries regarding computer software or hardware operation to resolve problems.

Enter commands and observe system functioning to verify correct operations and detect errors.

Set up equipment for employee use, performing or ensuring proper installation of cables, operating systems, or appropriate software.

Install and perform minor repairs to hardware, software, or peripheral equipment, following design or installation specifications.

Maintain records of daily data communication transactions, problems and remedial actions taken, or installation activities.

Read technical manuals, confer with users, or conduct computer diagnostics to investigate and resolve problems or to provide technical assistance and support.

Refer major hardware or software problems or defective products to vendors or technicians for service.

Develop training materials and procedures, or train users in the proper use of hardware or software.

Confer with staff, users, and management to establish requirements for new systems or modifications.
Knowledge

Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Telecommunications — Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.

Clerical — Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.

Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

Skills

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Speaking — Talking to others to convey information effectively.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
Writing — Communicating effectively in writing as appropriate for the needs of the audience.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Time Management — Managing one's own time and the time of others.

Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.

Instructing — Teaching others how to do something.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

SUPERVISORS

Superintendents

O*net approximation – First Line Supervisors of Construction Trades and Extraction Workers (47-1011.00)

Tasks

Examine and inspect work progress, equipment, and construction sites to verify safety and to ensure that specifications are met.

Read specifications, such as blueprints, to determine construction requirements or to plan procedures.

Estimate material or worker requirements to complete jobs.

Supervise, coordinate, or schedule the activities of construction or extractive workers.

Confer with managerial or technical personnel, other departments, or contractors to resolve problems or to coordinate activities.

Coordinate work activities with other construction project activities.

Order or requisition materials or supplies.
Locate, measure, and mark site locations or placement of structures or equipment, using measuring and marking equipment.

Record information such as personnel, production, or operational data on specified forms or reports.

Assign work to employees, based on material or worker requirements of specific jobs.

Knowledge

Building and Construction — Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.

Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

Public Safety and Security — Knowledge of relevant equipment, policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions.

Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

Production and Processing — Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.

Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles,
techniques, procedures, and equipment to the design and production of various goods and services.

Personnel and Human Resources — Knowledge of principles and procedures for personnel recruitment, selection, training, compensation and benefits, labor relations and negotiation, and personnel information systems.

Skills

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Coordination — Adjusting actions in relation to others' actions.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Speaking — Talking to others to convey information effectively.

Time Management — Managing one's own time and the time of others.

Management of Personnel Resources — Motivating, developing, and directing people as they work, identifying the best people for the job.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Social Perceptiveness — Being aware of others' reactions and understanding why they react as they do.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Construction Managers

O*net approximation — Construction Managers (11-9021.00)

Tasks

Schedule the project in logical steps and budget time required to meet deadlines.
Confer with supervisory personnel, owners, contractors, or design professionals to discuss and resolve matters, such as work procedures, complaints, or construction problems.

Prepare contracts and negotiate revisions, changes and additions to contractual agreements with architects, consultants, clients, suppliers and subcontractors.

Prepare and submit budget estimates, progress reports, or cost tracking reports.

Interpret and explain plans and contract terms to administrative staff, workers, and clients, representing the owner or developer.

Plan, organize, or direct activities concerned with the construction or maintenance of structures, facilities, or systems.

Take actions to deal with the results of delays, bad weather, or emergencies at construction site.

Inspect or review projects to monitor compliance with building and safety codes, or other regulations.

Study job specifications to determine appropriate construction methods.

Select, contract, and oversee workers who complete specific pieces of the project, such as painting or plumbing.

**Knowledge**

Building and Construction — Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.

Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Public Safety and Security — Knowledge of relevant equipment, policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

Personnel and Human Resources — Knowledge of principles and procedures for personnel recruitment, selection, training, compensation and benefits, labor relations and negotiation, and personnel information systems.

**Skills**

Time Management — Managing one’s own time and the time of others.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Management of Personnel Resources — Motivating, developing, and directing people as they work, identifying the best people for the job.

Speaking — Talking to others to convey information effectively.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Coordination — Adjusting actions in relation to others’ actions.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.
Negotiation — Bringing others together and trying to reconcile differences.

Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.

**CARTOGRAPHERS/GIS**

*Cartographers*

O*net approximation – Cartographers and Photogrammetrists (17-1021.00)

**Tasks**

Determine map content and layout, as well as production specifications such as scale, size, projection, and colors, and direct production to ensure that specifications are followed.

Inspect final compositions to ensure completeness and accuracy.

Revise existing maps and charts, making all necessary corrections and adjustments.

Compile data required for map preparation, including aerial photographs, survey notes, records, reports, and original maps.

Prepare and alter trace maps, charts, tables, detailed drawings, and three-dimensional optical models of terrain using stereoscopic plotting and computer graphics equipment.

Delineate aerial photographic detail such as control points, hydrography, topography, and cultural features using precision stereoplotting apparatus or drafting instruments.

Build and update digital databases.

Examine and analyze data from ground surveys, reports, aerial photographs, and satellite images to prepare topographic maps, aerial-photograph mosaics, and related charts.

Identify, scale, and orient geodetic points, elevations, and other planimetric or topographic features, applying standard mathematical formulas.

Determine guidelines that specify which source material is acceptable for use.
Knowledge

Geography — Knowledge of principles and methods for describing the features of land, sea, and air masses, including their physical characteristics, locations, interrelationships, and distribution of plant, animal, and human life.

Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Skills

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Writing — Communicating effectively in writing as appropriate for the needs of the audience.

Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.

Time Management — Managing one's own time and the time of others.
Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Coordination — Adjusting actions in relation to others' actions.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

**GIS**

O*net approximation – Geographic Information Systems Technicians (15-1199.05)

**Tasks**

Design or prepare graphic representations of Geographic Information Systems (GIS) data, using GIS hardware or software applications.

Analyze Geographic Information Systems (GIS) data to identify spatial relationships or display results of analyses, using maps, graphs, or tabular data.

Maintain or modify existing Geographic Information Systems (GIS) databases.

Enter data into Geographic Information Systems (GIS) databases, using techniques such as coordinate geometry, keyboard entry of tabular data, manual digitizing of maps, scanning or automatic conversion to vectors, or conversion of other sources of digital data.

Review existing or incoming data for currency, accuracy, usefulness, quality, or completeness of documentation.

Perform geospatial data building, modeling, or analysis, using advanced spatial analysis, data manipulation, or cartography software.

Design or coordinate the development of integrated Geographic Information Systems (GIS) spatial or non-spatial databases.

Select cartographic elements needed for effective presentation of information.

Provide technical support to users or clients regarding the maintenance, development, or operation of Geographic Information Systems (GIS) databases, equipment, or applications.
Interpret aerial or ortho photographs.

**Knowledge**

Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

Geography — Knowledge of principles and methods for describing the features of land, sea, and air masses, including their physical characteristics, locations, interrelationships, and distribution of plant, animal, and human life.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

**Skills**

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Speaking — Talking to others to convey information effectively.
Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Mathematics — Using mathematics to solve problems.

Writing — Communicating effectively in writing as appropriate for the needs of the audience.

Coordination — Adjusting actions in relation to others’ actions.

PARALEGALS

O*net approximation – Paralegals and Legal Assistants (23-2011.00)

Tasks

Prepare affidavits or other documents, such as legal correspondence, and organize and maintain documents in paper or electronic filing system.

Prepare for trial by performing tasks such as organizing exhibits.

Prepare legal documents, including briefs, pleadings, appeals, wills, contracts, and real estate closing statements.

Meet with clients and other professionals to discuss details of case.

File pleadings with court clerk.

Gather and analyze research data, such as statutes, decisions, and legal articles, codes, and documents.

Call upon witnesses to testify at hearing.

Investigate facts and law of cases and search pertinent sources, such as public records, to determine causes of action and to prepare cases.

Direct and coordinate law office activity, including delivery of subpoenas.
Keep and monitor legal volumes to ensure that law library is up-to-date.

Knowledge

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Law and Government — Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.

Clerical — Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.

Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Skills

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Speaking — Talking to others to convey information effectively.

Writing — Communicating effectively in writing as appropriate for the needs of the audience.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Time Management — Managing one's own time and the time of others.
Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.

Coordination — Adjusting actions in relation to others' actions.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

**TIMBER LOGGING**

O*net approximation – Logging Equipment Operators (45-4022.00)

**Tasks**

Inspect equipment for safety prior to use, and perform necessary basic maintenance tasks.

Drive straight or articulated tractors equipped with accessories such as bulldozer blades, grapples, logging arches, cable winches, and crane booms, to skid, load, unload, or stack logs, pull stumps, or clear brush.

Drive crawler or wheeled tractors to drag or transport logs from felling sites to log landing areas for processing and loading.

Drive tractors for the purpose of building or repairing logging and skid roads.

Grade logs according to characteristics such as knot size and straightness, and according to established industry or company standards.

Control hydraulic tractors equipped with tree clamps and booms to lift, swing, and bunch sheared trees.

Drive and maneuver tractors and tree harvesters to shear the tops off of trees, cut and limb the trees, and then cut the logs into desired lengths.

Fill out required job or shift report forms.

Calculate total board feet, cordage, or other wood measurement units, using conversion tables.

**Knowledge**
Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

**Skills**

**Operation and Control** — Controlling operations of equipment or systems.

**Operation Monitoring** — Watching gauges, dials, or other indicators to make sure a machine is working properly.

**Quality Control Analysis** — Conducting tests and inspections of products, services, or processes to evaluate quality or performance.

**Equipment Maintenance** — Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.

**Complex Problem Solving** — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

**Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**Judgment and Decision Making** — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

**Monitoring** — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

**Repairing** — Repairing machines or systems using the needed tools.

**INSPECTORS**

*Inspectors, Testers, Sorters, Samplers, and Weighers* (51.9061.00)

**Tasks**

Discard or reject products, materials, or equipment not meeting specifications.

Analyze and interpret blueprints, data, manuals, and other materials to determine specifications, inspection and testing procedures, adjustment and certification methods, formulas, and measuring instruments required.
Inspect, test, or measure materials, products, installations, or work for conformance to specifications.

Notify supervisors and other personnel of production problems, and assist in identifying and correcting these problems.

Discuss inspection results with those responsible for products, and recommend necessary corrective actions.

Record inspection or test data, such as weights, temperatures, grades, or moisture content, and quantities inspected or graded.

Mark items with details such as grade or acceptance-rejection status.

Observe and monitor production operations and equipment to ensure conformance to specifications and make or order necessary process or assembly adjustments.

Measure dimensions of products to verify conformance to specifications, using measuring instruments such as rulers, calipers, gauges, or micrometers.

Analyze test data, making computations as necessary, to determine test results.

Knowledge

Production and Processing — Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Skills

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Speaking — Talking to others to convey information effectively.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.
Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.

**Environmental Compliance Inspectors** (13-1041.01)

**Tasks**

Determine the nature of code violations and actions to be taken, and issue written notices of violation; participate in enforcement hearings as necessary.

Examine permits, licenses, applications, and records to ensure compliance with licensing requirements.

Prepare, organize, and maintain inspection records.

Interview individuals to determine the nature of suspected violations and to obtain evidence of violations.

Prepare written, oral, tabular, and graphic reports summarizing requirements and regulations, including enforcement and chain of custody documentation.

Monitor follow-up actions in cases where violations were found, and review compliance monitoring reports.

Investigate complaints and suspected violations regarding illegal dumping, pollution, pesticides, product quality, or labeling laws.

Inspect waste pretreatment, treatment, and disposal facilities and systems for conformance to federal, state, or local regulations.

Inform individuals and groups of pollution control regulations and inspection findings, and explain how problems can be corrected.

Determine sampling locations and methods, and collect water or wastewater samples for analysis, preserving samples with appropriate containers and preservation methods.

**Knowledge**
Law and Government — Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Chemistry — Knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. This includes uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.

Biology — Knowledge of plant and animal organisms, their tissues, cells, functions, interdependencies, and interactions with each other and the environment.

Public Safety and Security — Knowledge of relevant equipment, policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Skills

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Speaking — Talking to others to convey information effectively.
Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Quality Control Analysis — Conducting tests and inspections of products, services, or processes to evaluate quality or performance.

Social Perceptiveness — Being aware of others' reactions and understanding why they react as they do.

Writing — Communicating effectively in writing as appropriate for the needs of the audience.

REAL ESTATE/LANDMEN

O*net approximation – Title Examiners, Abstractors & Searchers (23-2093.00); Real Estate Brokers (41-9021.00)

**Title Examiners, Abstractors & Searchers** (23-2093.00)

**Tasks**

Prepare lists of all legal instruments applying to a specific piece of land and the buildings on it.

Examine documentation such as mortgages, liens, judgments, easements, plat books, maps, contracts, and agreements in order to verify factors such as properties' legal descriptions, ownership, or restrictions.

Read search requests in order to ascertain types of title evidence required and to obtain descriptions of properties and names of involved parties.

Copy or summarize recorded documents, such as mortgages, trust deeds, and contracts, that affect property titles.
Examine individual titles in order to determine if restrictions, such as delinquent taxes, will affect titles and limit property use.

Prepare reports describing any title encumbrances encountered during searching activities, and outlining actions needed to clear titles.

Verify accuracy and completeness of land-related documents accepted for registration; prepare rejection notices when documents are not acceptable.

Confer with realtors, lending institution personnel, buyers, sellers, contractors, surveyors, and courthouse personnel in order to exchange title-related information or to resolve problems.

Enter into recordkeeping systems appropriate data needed to create new title records or update existing ones.

Direct activities of workers who search records and examine titles, assigning, scheduling, and evaluating work, and providing technical guidance as necessary.

Knowledge

Clerical — Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Law and Government — Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.

Geography — Knowledge of principles and methods for describing the features of land, sea, and air masses, including their physical characteristics, locations, interrelationships, and distribution of plant, animal, and human life.

Skills

Speaking — Talking to others to convey information effectively.
Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Time Management — Managing one's own time and the time of others.

Writing — Communicating effectively in writing as appropriate for the needs of the audience.

Social Perceptiveness — Being aware of others' reactions and understanding why they react as they do.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Coordination — Adjusting actions in relation to others' actions.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Real Estate Brokers (41-9021.00)

Tasks

Sell, for a fee, real estate owned by others.

Obtain agreements from property owners to place properties for sale with real estate firms.

Monitor fulfillment of purchase contract terms to ensure that they are handled in a timely manner.

Compare a property with similar properties that have recently sold to determine its competitive market price.

Act as an intermediary in negotiations between buyers and sellers over property prices and settlement details and during the closing of sales.
Generate lists of properties for sale, their locations, descriptions, and available financing options, using computers.

Maintain knowledge of real estate law, local economies, fair housing laws, types of available mortgages, financing options, and government programs.

Check work completed by loan officers, attorneys, or other professionals to ensure that it is performed properly.

Arrange for financing of property purchases.

Appraise property values, assessing income potential when relevant.

Knowledge

Sales and Marketing — Knowledge of principles and methods for showing, promoting, and selling products or services. This includes marketing strategy and tactics, product demonstration, sales techniques, and sales control systems.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

Clerical — Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.

Law and Government — Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

Building and Construction — Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.

Economics and Accounting — Knowledge of economic and accounting principles and practices, the financial markets, banking and the analysis and reporting of financial data.

Skills

Speaking — Talking to others to convey information effectively.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Persuasion — Persuading others to change their minds or behavior.

Social Perceptiveness — Being aware of others' reactions and understanding why they react as they do.

Coordination — Adjusting actions in relation to others' actions.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Negotiation — Bringing others together and trying to reconcile differences.

ENGINEERS
Petroleum Engineers (17-2171.00)

Tasks

Assess costs and estimate the production capabilities and economic value of oil and gas wells, to evaluate the economic viability of potential drilling sites.

Develop plans for oil and gas field drilling, and for product recovery and treatment.

Direct and monitor the completion and evaluation of wells, well testing, or well surveys.

Analyze data to recommend placement of wells and supplementary processes to enhance production.

Monitor production rates, and plan rework processes to improve production.

Interpret drilling and testing information for personnel.

Specify and supervise well modification and stimulation programs to maximize oil and gas recovery.

Assist engineering and other personnel to solve operating problems.

Confer with scientific, engineering, and technical personnel to resolve design, research, and testing problems.

Coordinate the installation, maintenance, and operation of mining and oil field equipment.

Knowledge

Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

Physics — Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic and sub-atomic structures and processes.
Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

Economics and Accounting — Knowledge of economic and accounting principles and practices, the financial markets, banking and the analysis and reporting of financial data.

Chemistry — Knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. This includes uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Skills

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Speaking — Talking to others to convey information effectively.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Writing — Communicating effectively in writing as appropriate for the needs of the audience.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Coordination — Adjusting actions in relation to others' actions.
Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Systems Analysis — Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.

**Mechanical Engineers (17-2141.00)**

**Tasks**

Read and interpret blueprints, technical drawings, schematics, or computer-generated reports.

Assist drafters in developing the structural design of products using drafting tools or computer-assisted design (CAD) or drafting equipment and software.

Research, design, evaluate, install, operate, and maintain mechanical products, equipment, systems and processes to meet requirements, applying knowledge of engineering principles.

Confer with engineers or other personnel to implement operating procedures, resolve system malfunctions, or provide technical information.

Recommend design modifications to eliminate machine or system malfunctions.

Conduct research that tests or analyzes the feasibility, design, operation, or performance of equipment, components, or systems.

Investigate equipment failures and difficulties to diagnose faulty operation, and to make recommendations to maintenance crew.

Develop and test models of alternate designs and processing methods to assess feasibility, operating condition effects, possible new applications and necessity of modification.

Develop, coordinate, or monitor all aspects of production, including selection of manufacturing methods, fabrication, or operation of product designs.

Specify system components or direct modification of products to ensure conformance with engineering design and performance specifications.

**Knowledge**
Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

Physics — Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic and sub-atomic structures and processes.

Production and Processing — Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.

Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

Skills

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Mathematics — Using mathematics to solve problems.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Science — Using scientific rules and methods to solve problems.

Operations Analysis — Analyzing needs and product requirements to create a design.

Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.

Speaking — Talking to others to convey information effectively.

GEOLOGISTS

O*net approximation – Geoscientists, Except Hydrologists and Geographers (19-2042.00)

**Geoscientists, Except Hydrologists and Geographers** (19-2042.00)

Tasks

Analyze and interpret geological, geochemical, or geophysical information from sources such as survey data, well logs, bore holes, or aerial photos.

Locate and estimate probable natural gas, oil, or mineral ore deposits or underground water resources, using aerial photographs, charts, or research or survey results.
Plan or conduct geological, geochemical, or geophysical field studies or surveys, sample collection, or drilling and testing programs used to collect data for research or application.

Analyze and interpret geological data, using computer software.

Search for and review research articles or environmental, historical, and technical reports.

Assess ground or surface water movement to provide advice regarding issues such as waste management, route and site selection, or the restoration of contaminated sites.

Prepare geological maps, cross-sectional diagrams, charts, or reports concerning mineral extraction, land use, or resource management, using results of fieldwork or laboratory research.

Investigate the composition, structure, or history of the Earth's crust through the collection, examination, measurement, or classification of soils, minerals, rocks, or fossil remains.

Conduct geological or geophysical studies to provide information for use in regional development, site selection, or development of public works projects.

Measure characteristics of the Earth, such as gravity or magnetic fields, using equipment such as seismographs, gravimeters, torsion balances, or magnetometers.

**Knowledge**

**Engineering and Technology** — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

**Geography** — Knowledge of principles and methods for describing the features of land, sea, and air masses, including their physical characteristics, locations, interrelationships, and distribution of plant, animal, and human life.

**Computers and Electronics** — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

**Mathematics** — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Physics — Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic and sub-atom structures and processes.

Chemistry — Knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. This includes uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Law and Government — Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.

Skills

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Science — Using scientific rules and methods to solve problems.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Speaking — Talking to others to convey information effectively.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
Time Management — Managing one’s own time and the time of others.

Writing — Communicating effectively in writing as appropriate for the needs of the audience.

Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.

**LAWYERS** (23-1011.00)

**Tasks**

Represent clients in court or before government agencies.

Present evidence to defend clients or prosecute defendants in criminal or civil litigation.

Select jurors, argue motions, meet with judges and question witnesses during the course of a trial.

Study Constitution, statutes, decisions, regulations, and ordinances of quasi-judicial bodies to determine ramifications for cases.

Interpret laws, rulings and regulations for individuals and businesses.

Present and summarize cases to judges and juries.

Prepare legal briefs and opinions, and file appeals in state and federal courts of appeal.

Analyze the probable outcomes of cases, using knowledge of legal precedents.

Examine legal data to determine advisability of defending or prosecuting lawsuit.

Evaluate findings and develop strategies and arguments in preparation for presentation of cases.

**Knowledge**

Law and Government — Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.
English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Administration and Management — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

Clerical — Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.

Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

Personnel and Human Resources — Knowledge of principles and procedures for personnel recruitment, selection, training, compensation and benefits, labor relations and negotiation, and personnel information systems.

Economics and Accounting — Knowledge of economic and accounting principles and practices, the financial markets, banking and the analysis and reporting of financial data.

Skills

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Speaking — Talking to others to convey information effectively.

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
Writing — Communicating effectively in writing as appropriate for the needs of the audience.

Negotiation — Bringing others together and trying to reconcile differences.

Persuasion — Persuading others to change their minds or behavior.

Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.

**X-RAY & RELATED TECHNICIANS**

O*net approximation – Non-Destructive Testing Specialists (17-3029.01)

**Tasks**

Interpret or evaluate test results in accordance with applicable codes, standards, specifications, or procedures.

Interpret the results of all methods of non-destructive testing (NDT) such as acoustic emission, electromagnetic, leak, liquid penetrant, magnetic particle, neutron radiographic, radiographic, thermal or infrared, ultrasonic, vibration analysis, and visual testing.

Select, calibrate, or operate equipment used in the non-destructive testing (NDT) of products or materials.

Examine structures or vehicles such as aircraft, trains, nuclear reactors, bridges, dams, and pipelines using non-destructive testing (NDT) techniques.

Make radiographic images to detect flaws in objects while leaving objects intact.

Identify defects in solid materials using ultrasonic testing techniques.

Prepare reports on non-destructive testing (NDT) results.

Conduct liquid penetrant tests to locate surface cracks by coating objects with fluorescent dyes, cleaning excess penetrant, and applying developer.

Document non-destructive testing (NDT) methods, processes, or results.

Produce images of objects on film using radiographic techniques.
Knowledge

Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

Production and Processing — Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.

Education and Training — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.

English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

Skills

Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Monitoring — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

Quality Control Analysis — Conducting tests and inspections of products, services, or processes to evaluate quality or performance.

Reading Comprehension — Understanding written sentences and paragraphs in work related documents.
Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.

Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Judgment and Decision Making — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

Operation Monitoring — Watching gauges, dials, or other indicators to make sure a machine is working properly.

Speaking — Talking to others to convey information effectively.