

## **Petroleum Industry's Economic Contribution to North Dakota in 2015**



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## EXECUTIVE SUMMARY

The purpose of this study was to estimate the economic contribution of crude oil and natural gas exploration, extraction, transportation, and processing in North Dakota in 2015. Expenditures made in North Dakota by oil companies represented the direct impacts of the industry. Secondary economic impacts result from the spending and respending of the direct impacts and were estimated using the North Dakota Input-Output Model.

Surveys were used to collect production, expenditure, and employment data for the petroleum industry in North Dakota. Oil operators (i.e., firms that own or operate oil wells) in the state were surveyed to obtain information on in-state expenses for oil and gas exploration, expenses for oil and gas extraction/production, general business expenditures, employment, oil and gas output, and information on leasing and drilling activity. A similar survey was conducted for firms engaged in pipeline transportation, crude oil rail loading, and processing of crude oil and natural gas in North Dakota.

The survey of oil operators produced financial data on 47 percent of North Dakota's oil and natural gas production in 2015. Secondary data, obtained from government agencies, were combined with survey data to estimate royalties, lease bonuses, and severance taxes.

Total in-state expenditures in 2015 for oil and gas exploration (e.g., seismic testing, well drilling, well completions) were estimated from survey data and statewide drilling statistics. A total of 1,583 wells were completed in 2015. Average expense per well for oil operators was estimated at \$6.9 million, yielding nearly \$11 billion in total financial outlays for well development. Financial data on expenses for well development were obtained from oil operators in previous studies, and adjustments to the capital costs to drill and complete a well were performed to reflect specific inputs supplied by in-state sources. The net effect of removing expenses for those capital outlays revealed that about 52 percent of the cost to complete a well in North Dakota represented economic leakage and was not included in the industry's direct economic impacts. The direct impact per well completed in the state was estimated at \$3.3 million. The combination of in-state expenses for exploration and lease bonuses resulted in \$5.3 billion in direct impacts in 2015. The secondary economic impacts associated with exploration activities were estimated at \$9.9 billion. The in-state gross business volume (direct and secondary impacts) of exploration/development activities was estimated at \$14.2 billion in 2015.

Estimates of oil and gas extraction/production expenses, general business expenses for oil operators, private and public mineral royalties, and state severance taxes were derived from survey data and secondary information obtained from various government agencies. The state had 12,799 producing wells (average monthly) which combined for nearly 432.3 million barrels of oil and 584.8 million mcf of natural gas in 2015. Those volumes of oil and gas production resulted in an estimated \$2.4 billion for in-state expenditures for extraction/production, \$850 million for general business expenses, \$1.9 billion in state severance taxes, and a combined \$1.6 billion of in-state private and public oil and gas royalties. Total direct impacts for oil and gas production were estimated at \$6.2 billion in 2015. Total secondary economic impacts associated with production activities were estimated at \$6.3 billion. The in-state gross business volume of oil and gas extraction/production was estimated at \$12.5 billion in 2015.

In-state expenditures for transportation of crude oil, pipeline operation, crude oil rail loading facilities, natural gas processing, and crude oil refining were estimated to have a direct impact in North

Dakota of \$1.2 billion in 2015. Total secondary economic impacts associated with processing and transporting crude oil and natural gas were estimated at \$2.2 billion. Processing and transporting crude oil and natural gas generated a gross business volume of \$3.4 billion in 2015.

The petroleum industry was estimated to have capital expenditures between \$2.5 billion to \$2.7 billion for infrastructure projects in the state in 2015. After adjustments for economic leakage (the portion of expenditures not captured in the North Dakota economy), it was estimated that about \$1.1 billion to \$1.2 billion were captured in the North Dakota economy. The gross business volume associated with infrastructure spending in North Dakota was estimated to range from \$3.5 to \$3.7 billion in 2015. Infrastructure spending, as defined in this report, would represent additional economic activity beyond that created by the exploration, production, and processing segments of the industry.

Industry-wide direct and secondary economic impacts from the petroleum industry were estimated at \$12.7 billion and \$17.5 billion, respectively. The gross business volume for the entire industry, including infrastructure spending, in North Dakota in 2015 was estimated at \$33.7 billion.

Additional measures of the petroleum industry's economic importance to the state include direct employment for 48,370 full-time jobs, economy-wide personal income of \$4.9 billion, statewide retail sales of \$8.8 billion, direct contributions to local and state government tax revenues of \$3 billion, indirect contribution of \$268 million in state government general tax collections, and secondary employment of 23,984 full-time equivalent jobs.

Biennial economic contribution studies for the petroleum industry have been conducted since 2005. This assessment is the first in that series where overall economic output from the industry declined from the previous period. The swift and substantial price collapse, beginning in late 2014/early 2015, resulted in dramatic reductions in drilling activity, reduced revenues from severance taxes, and reduced private income from a decline in employment and royalties. Processing and transportation expenditures, which are tied to oil and gas output and in-state infrastructure capacity were largely in 2015 than in 2013. However, increases in processing and transportation output represent a small segment of the industry in North Dakota and overall the gross business volume for the industry declined by 10 billion or 22 percent.

## **PETROLEUM INDUSTRY'S ECONOMIC CONTRIBUTION TO NORTH DAKOTA IN 2015**

Dean A. Bangsund and Nancy M. Hodur\*

### **INTRODUCTION**

North Dakota's largest basic sector industries, which include agriculture, manufacturing, and energy, provide much of the economic stimuli for the state's economy. These large industries are generally comprised of distinct sectors or economic groups. For example, agriculture in North Dakota often is considered a combination of crop production and livestock. The energy industry in North Dakota also is comprised of several distinct sectors that are commonly treated as separate activities. North Dakota's energy industries can be conveniently separated into the activities that produce and distribute electricity, coal, petroleum, and renewable fuels.

While separating the energy industry into similar activities is relatively straight forward, identifying the economic players within those sectors is less clear. In the case of electricity generation, a handful of firms and generating facilities exist within the state. The same situation exists with coal production – a handful of companies operate at a limited number of locations. However, the industrial organization associated with oil and natural gas production is different. Rather than having a handful of firms and a limited number of site-specific facilities and locations, the petroleum industry involves hundreds of firms and a multitude of facilities spread throughout the western third of North Dakota.

North Dakota has been a top 10 oil-producing state for over a decade. To those familiar with North Dakota's economy, the petroleum sector has always been an important part of the state's economic base. Recent upswings in oil production became prevalent in the 2000s. In 2006 during the beginning of the latest expansion of oil field development, the first comprehensive economic assessment of the petroleum industry in the state was conducted (Bangsund and Leistritz 2007). Another assessment was conducted two years later (Bangsund and Leistritz 2009). From 2006 through 2015, North Dakota witnessed an unprecedented increase in oil production. Production has dropped recently from the highs observed in 2015, but still ranks second in oil production behind Texas (U.S. Department of Energy 2017).

The expansion of oil development associated with shale formations that started in the mid-2000s has continued to garner local, state, and national headlines. No longer is the rapid development of the oil patch in North Dakota a phenomenon only visible to those working in the industry or living in western North Dakota. The economic value of the rapidly expanding petroleum industry is difficult to follow as the industry has grown and expanded beyond historical precedents. The state was beginning to adjust to an ever-expanding petroleum sector when a price collapse in the end of 2014 caused a substantial roll back in shale oil development, and substantially impacted employment, personal income, and government revenues. This assessment is the first to examine the economic footprint of the industry since the price collapse.

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Determining the economic contribution of a given industry quantifies its importance to state and local economies. Not only can the economic impacts to the state and local economies be measured, but the effects on specific economic sectors and related industries also can be identified. In addition, economic studies can demonstrate the susceptibility of the North Dakota economy to fluctuations in factors affecting petroleum exploration and production, demonstrate the economic dependence of the state on natural resource-based industries, and indicate the economic impacts that could result from potential changes in policies which affect the petroleum industry.

## **OBJECTIVES**

The purpose of this report is to estimate the economic contribution (direct and secondary effects) of the petroleum industry to the economy of North Dakota. Specific objectives include

- 1) estimate the economic size of petroleum exploration, extraction, and processing sectors,
- 2) estimate in-state spending on petroleum industry infrastructure, and
- 3) provide estimates of industry-wide employment, tax revenues, and other key economic measures.

## **BACKGROUND**

The industrial organization of the petroleum industry in the United States often is divided into upstream and downstream components. The upstream components of the petroleum industry generally include exploration, development, and production of crude oil and natural gas. The downstream components include transportation, processing, distribution, marketing, and retail delivery of petroleum products.

### Industry Organization

The petroleum industry in North Dakota consists of both upstream and downstream components. For this study, the petroleum industry was defined to only include in-state exploration, extraction/production, transportation, and processing of crude oil and natural gas. Exploration can be generally thought of as the process of finding mineral resources. Extraction or production is the process of developing and recovering mineral resources. Transportation components of the industry, in this study, were limited to the movement of oil and gas from wells to collection points, and then on to processing facilities located either in-state or out-of-state. Petroleum processing in North Dakota included refining of crude oil and natural gas processing. The distribution, marketing, and retail sale of processed petroleum products (e.g., diesel, gasoline, kerosene, motor oil, lubricants, propane, natural gas) were not included.

The exploration and extraction phases of the petroleum industry are not organized like other industries in the state. Firms that own producing wells (oil operators) contract much of the work of exploration and extraction of oil and gas to other firms that specialize in various aspects of those processes. As a result, much of the expenditures incurred in the state for oil and gas production start with the oil operator but flow through the various firms engaged in providing support and service within the oil fields. While oil operators represent a mix of small to large firms, a majority of the prominent oil operators in North Dakota also have operations in other states. For many oil operators, their operations

in North Dakota do not represent the majority of their oil and gas revenues. As a result of having operations and/or headquarters in other states, net revenues from North Dakota oil and gas production may leave the state for a variety of reasons. However, North Dakota is still the beneficiary of exploration and discovery expenses from firms that may have minimal operations in the state.

Oil and gas wells typically have three types of economic interests. These players are often referred to as royalty interests, owner/operator interests, and working interests. Royalty interests receive a share of the value of a well's output but do not share in the expenses associated with the well. Owner and working interests share, based on various percentages or arrangements, the remaining revenues and all of the expenses of a well. The well owner or operator is generally responsible or in charge of all operations. The owner arranges to have work completed for most of the necessary activities associated with the well, and charges working interests for their share of the expenses. As a result of these typical arrangements, the total number of firms receiving revenues and incurring expenses from oil and gas wells in North Dakota is unknown. However, the number of oil operators (firms that own or operate wells) is known.

For various reasons, the magnitude of economic effects of oil and gas production are not necessarily equivalent to the market value (i.e., price times quantity) of oil and gas produced. Exploration and extraction technologies use specialized inputs and services, many of which are not available in North Dakota and must be purchased from out-of-state sources. Many oil operators have operations and/or are headquartered in other states, and revenues for some firms may leave the state to be used for projects elsewhere. The same situation may exist where firms use resources obtained from out-of-state operations for oil and gas exploration in the state. In addition, oil operators headquartered out-of-state often have minimal general business expenses in the state. Similarly, firms that only have working interests in producing wells may or may not have physical operations in the state. All of these factors make it problematic to base economic importance of the petroleum industry solely on the value of oil and gas production.

### Production Statistics

Oil and gas production is limited to the western third of North Dakota (Figure 1). While crude oil has been produced in 19 western counties, 17 counties are currently producing crude oil (North Dakota Department of Mineral Resources 2017). Of the 17 counties producing oil, production is concentrated in Billings, Dunn, Bowman, McKenzie, Mountrail and Williams Counties. Those counties accounted for 90 percent of state oil production in 2015 (North Dakota Department of Mineral Resources 2017). Production in key counties has fluctuated over the last 50 years as new oil deposits are found and developed in various locations in the state. Since 2002, major increases in oil production have occurred in Bowman, McKenzie, Dunn, and Mountrail Counties.

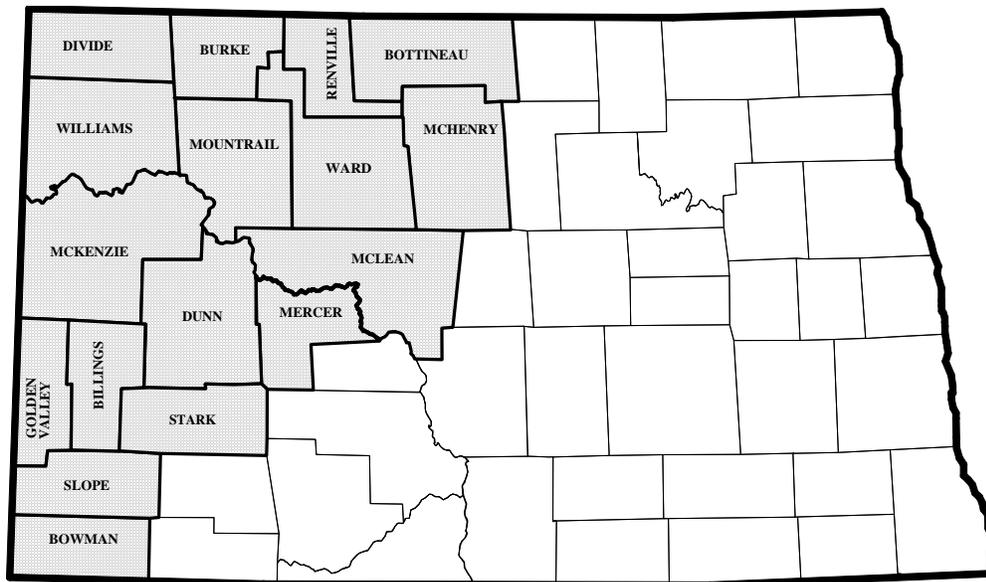


Figure 1. Oil Producing Counties, North Dakota

Nationally, North Dakota is sixth among all oil producing states based on cumulative crude oil production from 1981 through 2016 (U.S. Department of Energy 2017). North Dakota ranked second nationally among oil producing states since 2013 when measuring on-shore oil production. North Dakota accounted for about 14 percent of domestic crude oil (excluding federal off-shore) production in 2013 and 2016, and nearly 15 percent in 2014 and 2015.

Oil production in North Dakota has fluctuated substantially since commercial production began in the early 1950s (Figure 2). Overall, there have been four periods of rapid growth in oil production in North Dakota. The first period was from 1951 through 1962, the second period occurred from 1974 to 1984, the third period from 1994 to 1997, and the current period which began in 2003. After historic highs in 1984, overall oil production in the state declined rapidly for 10 years. Since 1994, oil production in the state has seen two periods of expansion and one period of declining production. Crude oil production in the state has been rapidly increasing since 2010.

The annual value of oil production in North Dakota was estimated using monthly average price and production data from the North Dakota Department of Mineral Resources (2017). The overall value of oil production in North Dakota, in nominal terms, has generally paralleled oil production despite price fluctuations over time (Figure 3). Nominal oil prices were converted to real dollars (2016) using the Gross Domestic Product-Implicit Price Deflator (Bureau of Economic Analysis 2017). In real terms, from 1980 to 2000 the value of crude oil production in North Dakota largely declined (Figure 6). However, in both real terms and nominal terms, the value of crude oil production in the state has increased substantially since 2000 (Figure 4).

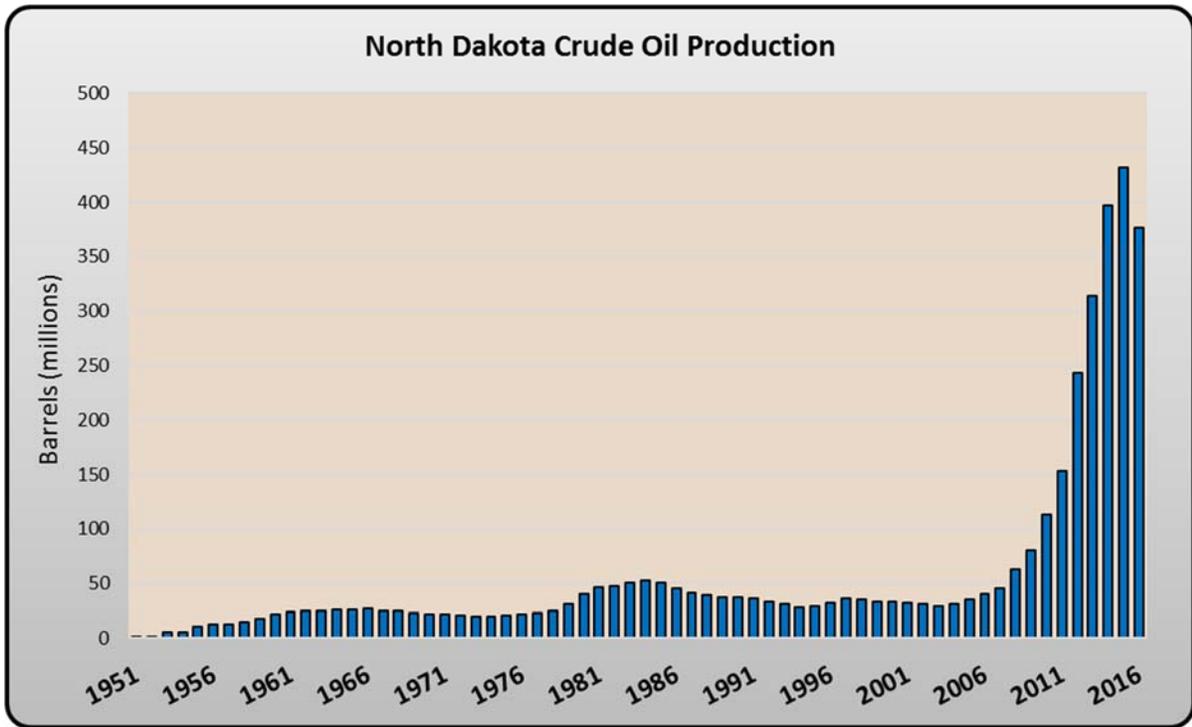


Figure 2. Crude Oil Production, North Dakota, 1951 through 2016  
 Source: North Dakota Department of Mineral Resources (2017).

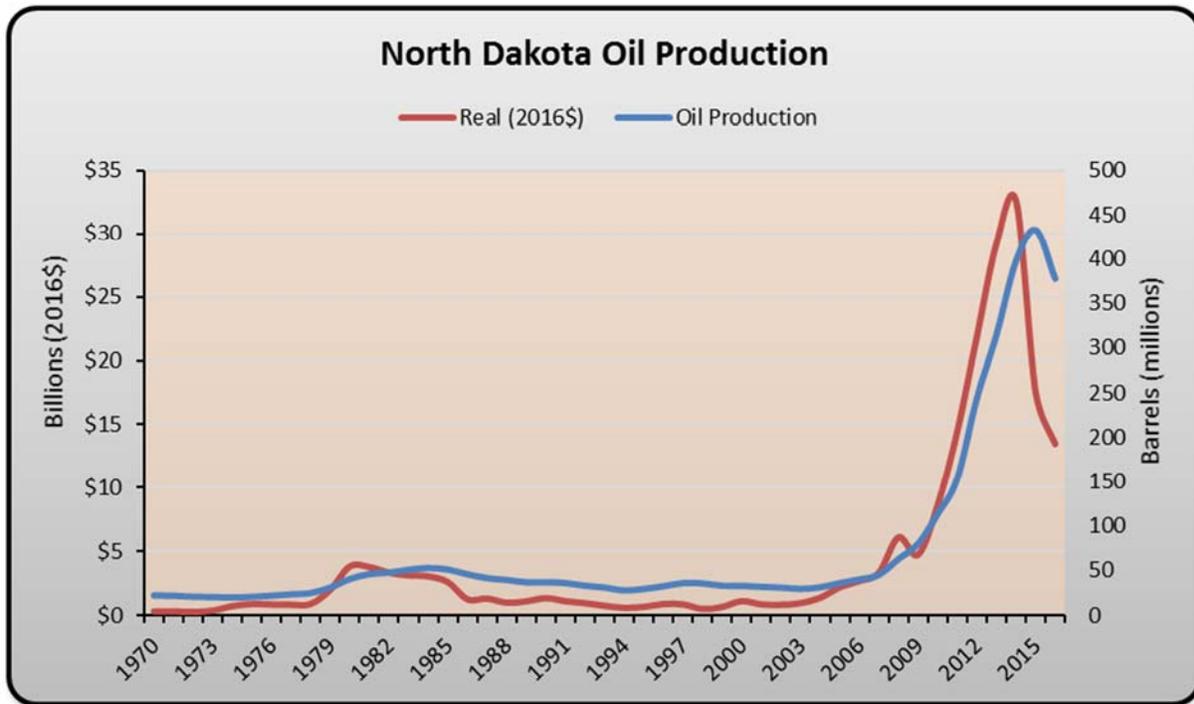


Figure 3. Production and Market Value of Crude Oil, North Dakota, 1970 through 2016  
 Source: North Dakota Department of Mineral Resources (2017); North Dakota Office of State Tax Commissioner (2017).

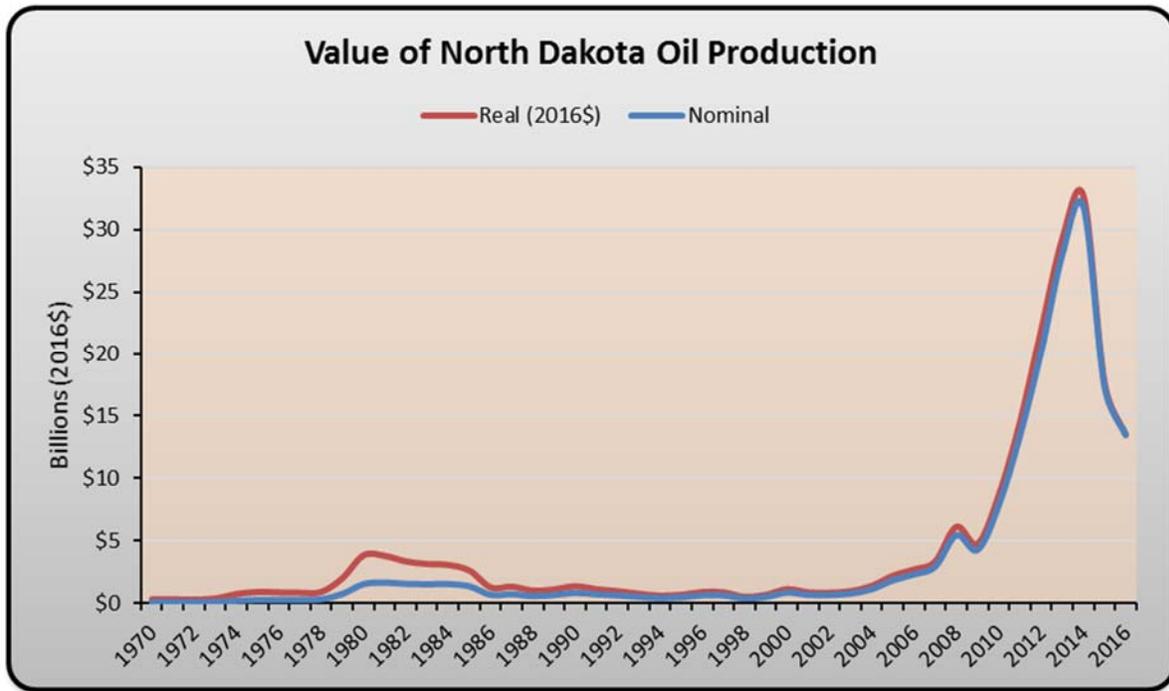


Figure 4. Value of Crude Oil Production in Nominal and Real Dollars, North Dakota, 1970 through 2016

## PROCEDURES

An economic contribution analysis, as defined in this study, represents an estimate of all relevant in-state expenditures and returns associated with an industry. The economic contribution approach to estimating economic activity has been used for several other industries in North Dakota (Bangsund and Leistritz 1995a, 1995b, 1998, 1999, 2004, 2005, 2010; Coon et al. 2012a, 2012b).

### Data Collection

Due to the complexities of how the oil and gas industry is structured, and that in-state effects (i.e., first round spending or direct impacts) from oil and gas production in any given year may not equal the market value of oil and gas production, an expenditure-based approach to measuring the economic size of the petroleum industry was used in this study. In this approach, a sample of firms active in the petroleum industry in North Dakota were asked to provide estimates of the amount of expenditures made to entities (i.e., individuals, firms, and governments) in North Dakota. Four separate survey efforts were conducted for the study and provided the basis for most of the economic data needed to complete the study.

### Oil Operators

Firms that own or operate oil wells in the state were surveyed to obtain information on expenses for oil and gas exploration and extraction/production, general business expenses in the state, employment, physical measures of oil and gas production, and leasing and drilling activity (Appendix A). The North Dakota Petroleum Council provided names and addresses for 53 oil operators in the state.

The survey process started with sending cover letters and a questionnaire to each firm on the mailing list. A second mailing was conducted for all firms that had not responded<sup>1</sup> to the first mailing. After two mailings, dissemination of survey materials and solicitation of industry cooperation were deferred to the study sponsor.

The combination of two mailings and personal contacts of oil operators conducted by the study sponsor resulted in useable information from 10 firms. The firms' production from owned/operated wells represented 47 percent of the state's 2015 production of crude oil and natural gas (Table 1).

Table 1. Basic Production Statistics from Survey of Oil Operators, North Dakota, 2015

Number of firms responding with useful information	10
Number of wells owned or operated in North Dakota (10 firms)	5,860
Crude oil production in 2015 in North Dakota (10 firms)	191,737,000 barrels <sup>a</sup>
Natural gas production in 2015 in North Dakota (10 firms)	280,098,000 mcf <sup>a</sup>
Number of oil wells drilled in 2015 with financials (7 firms)	660

<sup>a</sup> Output from wells operated or owned. Does not include production from working interests.

### Pipelines and Processors

Another survey was conducted for firms engaged in pipeline transportation of crude oil and unprocessed natural gas produced in North Dakota, firms operating crude oil rail loading facilities, and firms involved with processing of crude oil and natural gas in North Dakota. The survey was used to obtain estimates of the amount and type of expenditures made in North Dakota and in-state employment by those firms (Appendix B). A mailing list of 14 firms operating pipelines, gas processing plants, and oil refineries were provided by the North Dakota Petroleum Council. The firms on the mailing list received two mailings, with some firms being contacted numerous times by industry representatives. A total of eight firms provided useable information. While representative data for industry activities in this segment of the industry were obtained through the survey, a breakout of survey data for crude oil pipelines, natural gas processing plants and pipelines, crude oil refineries, and rail loading facilities is not possible due to confidentiality reasons. Firms operating pipelines for the transport of refined or processed petroleum products were not included in the study.

### Estimation Techniques

The survey of oil operators and survey of processors/pipeline operators provided data for two critical aspects of the study. First, data from the oil operator and processor surveys were used to set the level of spending in North Dakota. In other words, the data were used to determine the number of dollars spent in the state. Second, data from the surveys were used to determine the distribution of spending among various sectors of the North Dakota economy.

<sup>1</sup>Firms with non-deliverable addresses, those who responded with completed questionnaires, and those who indicated they would not or could not participate were excluded in the second mailing.

The survey of oil operators provided financial data on about 47 percent of all oil and gas production in the state in 2015. In addition, survey respondents provided information on exploration expenses, wells drilled, and operating expenses. Benchmark expenses for extraction/production, transportation, and operational expenses (e.g., general administrative costs) were estimated per barrel of oil equivalent<sup>2</sup> (BOE). Total state production in 2015, expressed in BOE, was then used with survey estimates of in-state expenditures per BOE to generate state-level estimates for production, transportation, and administrative spending. Benchmark expenses for exploration were estimated on a per-well completed basis and were used with data on the number of wells completed in North Dakota in 2015. Other economic components of the petroleum industry's direct impacts, such as severance taxes, public lease bonuses, and royalty revenues represented a combination of survey data, state-level statistics, and information obtained from various state and federal governmental agencies.

### Input-Output Analysis

Economic activity from a project, program, policy, or activity can be categorized into direct and secondary impacts. Direct impacts are those changes in output, employment, or income that represent the initial or first-round effects of the project, program, policy, or activity. Secondary impacts (sometimes further categorized into indirect and induced effects) result from subsequent rounds of spending and respending within the economy. This process of spending and respending is sometimes termed the multiplier process, and the resultant secondary effects are sometimes referred to as multiplier effects (Leistritz and Murdock 1981).

Input-output (I-O) analysis is an economic tool that traces linkages among sectors of an economy and calculates the total business activity resulting from a direct impact in a basic sector (Coon et al. 1985). The North Dakota I-O Model has 17 economic sectors, is closed with respect to households (households are included in the model), and was developed from primary (survey) data from firms and households in North Dakota.

Empirical testing has shown the North Dakota Input-Output Model is sufficiently accurate in estimating gross business volume, personal income, retail activity, and gross receipts in major economic sectors in North Dakota. Over the period 1958-2015, estimates of statewide personal income derived from the model averaged within 10 percent of comparable values reported by the Bureau of Economic Analysis (Coon et al. 2015, Bureau of Economic Analysis 2015). Coon et al. (2015) measured the statistical differences between the estimates of personal income from the two sources and found the absolute average difference was 7.07 percent, mean difference was -4.71 percent, and Theil's  $U_1$  coefficient was 0.0395 for the 1958 to 2015 period.

### ECONOMIC IMPACTS

The economic contribution of the petroleum industry was primarily based on estimates of in-state expenditures from exploration, extraction, transportation, and processing of crude oil and natural gas. Estimates of in-state expenditures were combined with estimates of oil and gas royalties, state severance taxes, and lease bonuses to determine total direct impacts. Subsequently, the direct impacts were applied to the North Dakota Input-Output Model to estimate the secondary impacts. Secondary impacts result from the respending of direct impacts within the economy. The following section is

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<sup>2</sup>Barrel of oil equivalent places oil and gas production on a common basis, and is estimated by dividing mcf of natural gas by 6 and adding barrels of oil.

divided into six major parts: (1) direct impacts, (2) secondary impacts, (3) employment, (4) tax revenue, (5) infrastructure spending, and (6) total economic impacts.

### Direct Impacts

From an economic perspective, direct impacts are those changes in economic output, employment, or income that represent the initial or first-round effects of a project, program, or activity. The direct impacts from the petroleum industry in North Dakota included expenditures for (1) oil and gas exploration, (2) oil and gas extraction/production, (3) transportation of crude oil and unprocessed gas, and (4) processing crude oil and natural gas. Direct impacts also included various revenue streams originating from either oil and gas exploration, such as lease bonuses, or oil and gas production, such as severance taxes and royalty payments.

### Exploration/Development

The economic effects of exploration come from expenditures within North Dakota for a variety of activities that involve searching and discovering viable oil and gas resources. Exploration was defined to include, but not limited to, seismic testing, geological research, lease expenses, other environmental research, land survey work, excavation, road building, construction of drill site, construction and delivery of electricity, pipeline development, and all other activities associated with drilling and completing oil and/or gas wells (Appendix A).

Estimates of total 2015 in-state expenditures for exploration were derived from the survey of oil operators and used with drilling statistics from the North Dakota Department of Mineral Resources (2017a). Gross expenditures for exploration, drilling, and well completion were estimated at about \$6.9 million per well drilled in North Dakota in 2015. The petroleum industry completed 1,583 wells in North Dakota in 2015, yielding about \$11 billion in total financial outlays for well development. Financial data on expenses for well development from Bangsund and Hodur (2015) were used to adjust for in-state spending. Considering the rapid expansion of well drilling, and the volume of economic activity, adjustments to the capital costs to drill and complete a well were performed to reflect specific inputs only supplied by in-state sources. Examples of well development expenses that were determined to be primarily supplied by out-of-state firms included drill bits, well casing, well head equipment, conductor pipe, fuel, cement, packers, christmas tree, sucker rod, heater/treater, fracture materials, and emissions control. Removing input expenses supplied primarily by out-of-state sources revealed that about 48 percent of the capital cost to complete a well came from in-state sources. Therefore, the \$6.9 million completion cost per well in North Dakota in 2015 was adjusted to reflect about \$3.3 million of expenses captured in the North Dakota economy.

Lease bonuses retained or paid to in-state entities were estimated at \$59.4 million in 2015, which included \$14.5 million for state leases, \$4.1 million for federal leases (Office of Natural Resources Revenue 2016), and about \$43 million for private mineral leases. The \$1.4 million in federal lease bonuses represented the portion of those leases that were returned to the North Dakota state government. Disbursements of lease bonuses from tribal lands back to North Dakota are not reported; however, tribal lease bonuses are contained within "gross" estimates of lease bonuses on Federal lands reported by the Office of Natural Resource Revenue, U.S. Department of the Interior.

The combination of in-state well completion expenses and lease bonuses resulted in \$5.3 billion in direct impacts in 2015 (Table 2). In-state expenditures for general exploration and well

drilling/completion were allocated to various economic sectors of the North Dakota Input-Output Model using information from the previous surveys of service and support firms (Table 2). State and federal lease bonuses were allocated to the *Government* sector and private lease bonuses were allocated to the *Households* (personal income) sector.

Table 2. Direct Impacts from General Exploration, Drilling Activities, and Lease Bonuses, North Dakota, 2015

Economic Sector	In-state Expenditures (000s \$)
Communications and Public Utilities	59,486
Retail Trade	1,875,194
Finance, Insurance, and Real Estate	309,641
Business and Personal Services	438,185
Professional and Social Services	218,537
Households (personal income)	2,221,138
Government	178,778
Total	5,300,959

### Extraction/Production

The economic effects of extraction/production come from expenditures for a variety of activities that involve bringing crude oil and natural gas from underground formations to the earth's surface. Extraction/production was defined to include, but not limited to, all activities associated with the removal of crude oil and natural gas from the ground, and maintenance and periodic inspections of equipment used to extract oil and gas, and other production related activities, such as well work overs, well idling, shutdown, and abandonment activities (Appendix A). Also included in this segment of the industry are the general business expenditures incurred by oil operators in North Dakota. Examples of these expenditures include, but are not limited to, office rent, office supplies, wages and salaries, communications, public utilities, business and professional services, insurance, and interest expenses (Appendix A). Royalty revenues, both private and public, were included as direct impacts in the extraction/production segment of the petroleum industry. Collections from state severance taxes, which include the gross production tax and extraction tax, also were included in the direct impacts.

Estimates of total in-state expenditures in 2015 for extraction/production and general business expenses were derived from the survey of oil operators and estimated on a BOE basis. Data obtained from the survey of oil operators for general business expenses and oil and gas production expenses were specific to expenses paid to entities within North Dakota.

North Dakota produced 432,286,156 barrels of oil and 584,774,236 mcf of natural gas in 2015 (North Dakota Department of Mineral Resources 2017a). Those volumes of oil and gas production resulted in an estimated \$2.4 billion for in-state expenditures for extraction/production and \$850 million for general business expenses. State oil and gas royalties were about \$242.6 million (North Dakota State Land Department 2016). Total federal royalties returned to North Dakota were about \$500 million, which includes tribal royalties (Office of Natural Resources Revenue 2016, U.S. Forest Service 2017). Separate estimates of tribal royalties are not published by the Office of Natural Resources Revenue, U.S. Department of the Interior.

Private royalties were based on production data obtained from the survey of oil operators and information on the distribution of in-state and out-of-state mineral payments. Overall royalty percentages reported by oil operators were estimated at 17.91 percent and 18.04 percent of well output for oil and gas, respectively. The total value of oil and gas production was estimated at \$18.292 billion using data obtained from the North Dakota Department of Mineral Resources (2017) and the North Dakota Office of State Tax Commissioner (2017b). Total royalties were estimated by applying the industry-wide oil and gas royalty percentages to the gross sales value of crude oil and estimated sales value of natural gas. Private royalties were estimated by subtracting state and gross federal royalties from estimated total royalties. Private royalties (i.e., both in-state and out-of-state mineral owners) from oil and gas production in North Dakota in 2015 were estimated to be \$2.4 billion. In-state payments of private royalties were estimated by applying the percentage of in-state versus out-of-state mineral owners royalty payments (40.26 percent) to the estimated total private royalties (\$2.4 billion). The in-state percentage of mineral ownership (40.26 percent) was estimated from private royalty payments made by oil operators in the state. The survey of oil operators provided information on total private mineral payments from North Dakota wells (includes both mineral owners who reside in the state and those that live elsewhere) and total private in-state mineral payments from North Dakota wells (only private mineral payments going to North Dakota mailing addresses).

In-state private royalties in 2015 were estimated at \$967 million (without adjustments for severance taxes) or \$829 million net of severance taxes (severance taxes were included as a separate component of direct impacts and subtracted from private in-state mineral royalty payments).

Total collections from the gross production tax and extraction tax in calendar year 2015 were about \$903 million and \$1 billion, respectively (North Dakota Office of State Tax Commissioner 2017a). Those tax collections were included in the extraction/production segment of the petroleum industry.

Total direct impacts in the extraction/production segment of the petroleum industry in North Dakota in 2015 were estimated at \$6.211 million (Table 3). Data from previous surveys of firms providing oil field services and data obtained from the survey of oil operators were used to allocate the in-state expenditures for oil production to various sectors of the North Dakota Input-Output Model. Direct impacts for general business expenses for oil operators, royalties, and state severance taxes also were allocated to various sectors of the North Dakota Input-Output Model (Table 3).

Table 3. Direct Impacts from Oil and Gas Extraction and Production Activities, North Dakota, 2015

Economic Sector	In-state Expenditures (000s \$)
Construction	21,809
Transportation	37,021
Communications and Public Utilities	70,893
Manufacturing	171,104
Retail Trade	889,539
Finance, Insurance, and Real Estate	218,230
Business and Personal Services	263,548
Professional and Social Services	111,561
Households (personal income)	1,562,850
Government	2,864,593
Total	6,211,148

### Processing

The processing segment of the petroleum industry included transportation of crude oil and natural gas by truck and pipeline to collection points and processing centers, natural gas processing, and crude oil refining. In-state transportation expenses paid by oil operators were estimated on a BOE equivalent. Those expenses were extrapolated based on state production statistics. Estimates of in-state expenditures for natural gas pipeline operation, crude oil pipeline operation, natural gas processing, crude oil rail loading facilities, and crude oil refining were obtained from the survey of processors. Results from the survey of processors were combined with state statistics to estimate state-level expenditures.

Direct impacts included \$567 million in transportation expenses paid to in-state entities by oil operators. Processing activities, which included pipeline transportation of unprocessed natural gas and crude oil, natural gas processing, crude oil rail loading, and crude oil refining were estimated to have in-state expenditures of \$636 million. One-time spending for infrastructure by processors was included in processing expenditures prior to the 2011 industry assessments; however, infrastructure spending has been estimated separately since the 2011 assessment. Processors were directed to omit any infrastructure spending in their operational expenditures (Appendix C). Total direct impacts of \$1.2 billion were allocated to the North Dakota Input-Output Model (Table 4). To avoid double counting of potential impacts, in-state purchases of crude oil and unprocessed natural gas by processors were excluded in the study.

Table 4. Direct Impacts from Oil and Gas Processing, North Dakota, 2015

Economic Sector	In-state Expenditures (000s \$)
Construction	55,687
Transportation	571,254
Communications and Public Utilities	75,396
Manufacturing	19,998
Retail Trade	63,147
Finance, Insurance, and Real Estate	45,725
Business and Personal Services	95,105
Professional and Social Services	16,343
Households (personal income)	188,203
Government	75,587
<b>Total</b>	<b>1,204,445</b>

#### Total Direct Impacts

Direct impacts are defined as the initial or first-round effects of a project, program, or activity. The petroleum industry in North Dakota was divided into several segments or components for purposes of reporting study results. Total direct impacts for the petroleum industry included in-state expenditures for oil and gas exploration/development, oil and gas extraction/production, transportation of crude oil and unprocessed gas, processing crude oil and natural gas, lease bonuses, severance taxes, and royalty payments.

Total direct impacts from the petroleum industry in North Dakota in 2015 were estimated at \$16.2 billion (Table 5). Exploration/development (i.e., primarily well drilling and well completion) and oil extraction/production accounted for nearly equal shares of the industry's direct impacts, 46.8 and 47.3 percent, respectively. Processing and transportation accounted for the remaining 5.9 percent of the industry's direct impacts.

Expenditures and revenues which constitute the petroleum industry's direct impacts were allocated to various economic sectors of the North Dakota Input-Output Model. The sectors of the North Dakota economy that received the greatest direct impacts were *households* (economy-wide personal income) (\$6 billion), *government* (tax collections and public royalties) (\$4 billion), *retail trade* (\$3.4 billion), *business and personal services* (\$853 million), and *finance, insurance, and real estate* (\$714 million) (Table 5).

Table 5. Total Direct Impacts, Petroleum Industry, North Dakota, 2015

Economic Sector	Industry Component			Totals
	Exploration	Extraction	Processing	
----- 000s \$ -----				
Construction		21,809	55,687	77,496
Transportation		37,021	571,254	608,275
Communications and Public Utilities	59,486	70,893	75,396	205,775
Manufacturing		171,104	19,998	191,102
Retail Trade	1,875,194	889,539	63,147	2,827,880
Finance, Insurance, and Real Estate	309,641	218,230	45,725	573,596
Business and Personal Services	438,185	263,548	95,105	796,838
Professional and Social Services	218,537	111,561	16,343	346,441
Households (personal income)	2,221,138	1,562,850	188,203	3,972,191
Government	178,778	2,864,593	73,587	3,116,958
<b>Total</b>	<b>5,300,959</b>	<b>6,211,148</b>	<b>1,204,445</b>	<b>12,716,552</b>

### Secondary Impacts

Secondary economic impacts result from subsequent rounds of spending and respending within an economy. Input-output (I-O) analysis traces linkages (i.e., the amount of spending and respending) among sectors of an economy and calculates the total business activity resulting from a direct impact in a basic sector (Coon et al. 1985). An economic sector is a group of similar economic units (e.g., communications and public utilities, retail trade, construction).

This process of spending and respending can be explained by using an example. A single dollar from an in-state wheat producer (*Households* sector) may be spent for a loaf of bread at the local store (*Retail Trade* sector); the store uses part of that dollar to pay for the next shipment of bread (*Transportation* and *Agricultural Processing* sectors) and part to pay the store employee (*Households* sector) who shelved or sold the bread; the bread supplier uses part of that dollar to pay for the grain used to make the bread (*Agriculture-Crops* sector) ... and so on (Hamm et al. 1993).

Secondary economic impacts were estimated separately for exploration, production, and processing components of the petroleum industry. Results from the North Dakota Input-Output Model revealed that secondary economic impacts from exploration in North Dakota in 2015 would be about \$8.8 billion (Table 6). The \$6.2 billion in direct impacts for oil and gas extraction (production) activities produced an estimated \$6.3 billion in secondary economic impacts. Finally, the transportation and

processing segment of the petroleum industry was responsible for about \$2.2 million in secondary economic impacts. Total secondary economic impacts from all components of the petroleum industry were estimated at \$17.5 billion. Across all three major components of the petroleum industry, considerable secondary impacts were generated in the *retail trade* (\$5.3 billion), *households* (economy-wide personal income) (\$2.1 billion), *finance, insurance, and real estate* (\$2.1 billion), and *communications and public utilities* (\$1.4 million) sectors (Table 6).

Table 6. Total Secondary Impacts, Petroleum Industry, North Dakota, 2015

Economic Sector	Industry Component			Totals
	Exploration	Extraction	Processing	
	----- 000s \$ -----			
Construction	522,125	360,893	112,659	995,677
Transportation	81,502	71,680	231,654	384,836
Communications and Public Utilities	746,132	506,316	169,516	1,421,964
Agricultural Processing and Miscellaneous Manufacturing	342,870	487,220	77,068	907,159
Retail Trade	2,745,880	1,912,721	622,647	5,281,248
Finance, Insurance, and Real Estate	1,131,611	763,987	209,145	2,104,742
Business and Personal Services	606,529	382,914	109,642	1,099,085
Professional and Social Services	660,192	418,122	99,034	1,177,349
Households (personal income)	1,082,144	678,251	305,661	2,066,056
Government	406,039	288,832	196,081	890,952
Other sectors <sup>a</sup>	543,878	474,255	108,694	1,126,827
<b>Total</b>	<b>8,868,902</b>	<b>6,345,191</b>	<b>2,241,801</b>	<b>17,455,894</b>

<sup>a</sup> Includes various agricultural and mining sectors.

## Employment

The petroleum industry is responsible for creating and supporting direct and secondary employment. Direct employment is a measure of the number of full-time jobs within an industry. Secondary jobs are an estimate of employment outside of an industry, but employment that is created from the industry's economy-wide economic activity.

### Direct Employment

Direct employment is a term used to describe jobs that are considered to be a part of an industry. For example, workers operating an oil drilling rig would represent direct employment in the petroleum industry. Similarly, someone who works at a natural gas processing plant or crude oil refinery would be considered direct employment in the petroleum industry.

While employment figures are frequently reported by various governmental agencies and are broken into a hierarchy of categories (e.g., North American Industry Classification System), deriving specific estimates of employment for large basic-sector industries can be problematic. Much of the problem arises in defining the type of job, and attributing to which industry(s) created that employment. For example, the process of drilling an oil well typically requires developing a road and a drilling site; work that requires heavy construction with earth moving or excavating equipment. Most oil companies will contract that work to local firms that specialize in heavy construction or excavating. The individuals performing the road building and preparation of the drill site are likely to be employed with some type of construction firm, and as a result, those jobs are typically classified and reported by government agencies as construction.

Government agencies (e.g., Bureau of the Census, Bureau of Labor Statistics) that track employment often base the classification of those jobs on the type of activities that generate the most revenue for a firm (primary activities). In this example, the primary activity for this firm is likely to be construction, even if the revenues for the construction firm are derived from road building and drill site preparation for an oil firm. However, in the case of assigning which basic-sector industry created that employment, it may be more accurate to suggest those jobs exist as a result of the petroleum industry rather than the construction industry. Yet, in other cases, the level of oil well drilling activity may be insufficient to sustain employment in heavy construction for an entire year. Those situations result in seasonal or part-time job creation. The challenge is to measure or estimate the total number of full-time jobs created and sustained by the petroleum industry, even if those jobs appear to be part of another industry or are only created for part of a year.

Job Service North Dakota published an assessment of direct jobs relating to the oil and gas industry in North Dakota in 2016. The goal of the study was to address many of the issues identified above, that is, how many jobs in other sectors are actually employment within the oil and gas industry. Job Service North Dakota (2016) conducted the study on behalf of the North Dakota Legislature to better understand the magnitude and location of employment in the industry.

As discussed above, various metrics can be used to determine the industry classification for employment. Job Service North Dakota evaluated all private sector jobs covered by unemployment insurance in North Dakota during calendar year 2015. Private, self-employed workers are generally not required to report employment information to government agencies or required to contribute to

unemployment insurance programs. Individuals employed in those capacities were not measured in the study.

Job Service North Dakota (2016) estimated that statewide direct employment in the petroleum industry was 48,369 jobs in 2015. The study reported employment in the petroleum industry in five groups: oil and gas drilling, extraction, production, and refining; infrastructure development; professional services; transportation; and wholesale and manufacturing. Statewide, 13.2 percent of all private sector jobs covered by unemployment insurance were in the oil and gas industry. Total wages/salaries for employment covered by the study was estimated at \$18.9 billion, of which 29.7 percent was attributable to the petroleum industry. Jobs associated with the oil and gas industry in North Dakota had higher wages, on average, than jobs outside the industry.

Previous studies have used several data sources and estimation techniques to measure employment in the petroleum sector. Those previous estimates, along with results from Job Service North Dakota (2014) are presented in Table 7.

#### Survey Data

Previous studies of the economic contribution of the petroleum industry relied on survey data to estimate statewide employment (Bangsund and Hodur 2015). This study used the data from Job Service North Dakota (2016) which specifically addressed the issue of statewide employment in the industry.

Table 7. Estimates of Direct Employment, North Dakota Petroleum Sector, 2003 Through 2015

Source	Direct Employment in Petroleum Industry <sup>a</sup>												
	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003
<u>NDSU Survey Data<sup>b</sup></u>	na	na	na	na	40,856	na	18,328	na	11,812	na	5,051	na	na
<u>Job Service North Dakota</u>													
Statewide NAICS code 211	2,906	2,489	1,983	1,616	1,167	844	704	544	432	427	474	445	443
Statewide NAICS code 213	<u>18,111</u>	<u>25,115</u>	<u>22,032</u>	<u>20,627</u>	<u>13,759</u>	<u>8,119</u>	<u>4,608</u>	<u>4,651</u>	<u>3,103</u>	<u>2,688</u>	<u>2,090</u>	<u>1,605</u>	<u>1,334</u>
Total	21,017	27,604	24,015	22,243	14,926	8,963	5,312	5,195	3,535	3,115	2,564	2,050	1,777
<u>Oil &amp; Gas Drilling, Extraction, Production, &amp; Refining</u>													
Oil & Gas Drilling, Extraction, Production, & Refining	21,348	27,865	24,254	na	na	na	na	na	na	na	na	na	na
Infrastructure Development	7,978	10,983	9,541	na	na	na	na	na	na	na	na	na	na
Professional Services	4,891	6,277	5,055	na	na	na	na	na	na	na	na	na	na
Transportation	8,540	11,331	10,173	na	na	na	na	na	na	na	na	na	na
Wholesale Trade and Manufacturing	<u>5,613</u>	<u>6,486</u>	<u>6,114</u>	na	na	na	na	na	na	na	na	na	na
Total	48,369	62,942	55,137	na	na	na	na	na	na	na	na	na	na
<u>Workforce Safety and Insurance<sup>e</sup></u>													
Oil and Gas Operations (WSI code 1320)	na	na	na	na	7,188	3,954	2,622	2,100	1,496	1,063	957	1,003	na
Oil Refining-Synthetic Fuels Mfg (WSI code 4740)	na	na	na	na	1,064	1,003	994	981	953	919	896	821	na
Oil and Gas Development-Drilling (WSI code 6203)	na	na	na	na	12,039	8,147	4,867	4,256	2,914	2,000	1,738	1,175	na
Oil and Gas Well Suppliers/Equip. Dealers (WSI code 6204)	na	na	na	na	2,642	1,609	954	640	423	316	254	186	na
Oil Well Trucking (WSI code 6205)	na	na	na	na	10,162	4,085	2,076	1,565	908	672	492	337	na
Oil Well Servicing (WSI code 8605)	na	na	na	na	12,557	5,691	2,977	2,747	1,780	1,487	1,266	1,043	na
Clerical Office Employees (WSI code 8805)	na	na	na	na	<u>2,173</u>	<u>1,257</u>	<u>924</u>	<u>856</u>	<u>737</u>	<u>662</u>	<u>601</u>	<u>561</u>	na
Total					51,603	27,800	16,879	14,322	10,190	7,983	6,921	5,864	na
<u>Oil and Gas Division, Dept. of Mineral Resources, Petroleum Sector Coefficients<sup>f</sup></u>													
	35,731	48,620	44,442	42,310	35,064	25,618	14,153	16,548	10,959	9,996	7,662	6,507	6,116

na=not available.

<sup>a</sup> Petroleum sector defined to include exploration, production, processing, and transportation of crude oil and unprocessed natural gas. Does not include distribution from processors to retail markets or sale of petroleum products in retail outlets.

<sup>b</sup> Industry-wide employment, including estimates for employment in manufacturing, construction, wholesale trade, transportation, and self-employed individuals. Based on data collected from surveys of oil operators, processing firms, pipeline companies, and businesses that provide products and technical services in the petroleum industry in North Dakota.

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<sup>c</sup> Support activities for mining include drilling oil and gas wells, support activities for oil and gas operations, support activities for coal mining, support activities for metal mining, and support activities for nonmetallic minerals mining.

<sup>d</sup> Job Service North Dakota (2017) examination of all private employment with unemployment insurance classified as working in the Oil and Gas Industry. Employment estimates do not include sole proprietors or self-employed individuals not contributing to unemployment insurance.

<sup>e</sup> Represents a head count of employees (not full-time equivalent jobs) for fiscal years. Some duplication of employee counts exists in the data. Employee counts for the Professional and Business Representatives and Clerical Office Employees categories represent a strong connection to companies working in the petroleum sector. Employee counts in all categories only include sole proprietors and self-employed individuals who voluntarily opt to participate in workers' compensation system.

<sup>f</sup> The Oil and Gas Division of the North Dakota Department of Mineral Resources compiled employment coefficients for various activities in the oil and gas industry in North Dakota. Bangsund and Hodur (2012) describe the use of those coefficients to provide estimates of direct employment in the petroleum sector. Estimates of direct employment in the oil and gas industry, using Oil and Gas Division coefficients, were part of a research project to forecast employment, housing, and population for the Williston Basin (Bangsund and Hodur 2017). Oil and Gas Division coefficients do not include petroleum refining and represent employment in oil producing counties only.

Sources: Job Service North Dakota (2016a, 2015a, 2014a, 2013, 2012, 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004), North Dakota Job Service (2016b, 2015b, 2014b), North Dakota Workforce Safety and Insurance (2014), Bangsund and Hodur (2012), and Bangsund and Hodur (2013a, 2013b, 2015, 2017).

## Job Service North Dakota

Job Service North Dakota reports employment and wages/salaries by county, multi-county region, and for the state using the North American Industry Classification System (NAICS). The NAICS is a federal standard for measuring, collecting, and reporting business activity in the United States. The classification system consists of specific codes, aggregated into 20 broad industry groupings (e.g., Utilities, Construction, Education, Health Care, Finance and Insurance, Manufacturing, Wholesale Trade).

Data are presented for NAICS codes 211 and 213. NAICS code 211 is classified as oil and gas extraction. NAICS code 213 is classified as support activities for mining. Within code 211, there are specific codes for oil and gas extraction (2111), which is further broken into code 211111 (crude petroleum and natural gas extraction) and 211112 (natural gas liquid extraction). Similarly, code 213 (support activities for mining) is further broken into codes 213111 (drilling oil and gas wells), 213112 (support activities for oil and gas operations), 213113 (support activities for coal mining), 213114 (support activities for metal mining), and 213115 (support activities for nonmetallic minerals mining). However, NAICS codes are only available at the 3-digit level for the above employment classifications.

The combination of NAICS code 211 and 213 represents a fairly narrow interpretation of employment in the petroleum sector. A number of specific business activities which are part of the petroleum industry are contained in NAICS codes for other industries. For example, code 23 (construction) contains oil and gas pipeline and related structures construction (code 23712). Other examples include codes 31 through 33 (manufacturing) which include codes 324110 (petroleum refineries), 324191 (petroleum lubricating oil and grease manufacturing), and 324199 (all other petroleum and coal products manufacturing). The same situation also exists for codes 48 and 49 (transportation and warehousing), which include all of the activities associated with crude oil and unprocessed natural gas pipelines. A recent assessment of direct jobs relating to the oil and gas industry in North Dakota was published in 2014 by Job Service North Dakota and addresses the concerns of identifying employment related direct to oil and gas activities that are reported in non-oil and gas economic sectors.

Since 2013, Job Service North Dakota has conducted a survey-based assessment of employment in the petroleum industry (Job Service North Dakota 2014b; 2015b; 2016b). The assessment combines input from employers on the percentage of time workers are involved in the petroleum industry and employees with unemployment insurance listed for oil and gas activities and matches that information with NAICS classifications for those workers. Delineations of employment, by NAICS code, are made at the city (selected cities), county, and state level. The definition of employment within the petroleum industry includes NAICS codes 21, 22 (utilities), 23 (construction), 31-33 (manufacturing), 42 (wholesale trade), 48-49 (transportation and warehousing), 52 (Finance and Insurance), 53 (Real Estate and Rental & Leasing), 54 (Professional and Technical Services), 55 (Management of Companies & Enterprises), 56 (Administrative and Waste Services), and 81 (Other Services).

State-level employment statistics from the Job Service North Dakota reports are used in this assessment to represent direct employment in the petroleum industry. Statewide direct employment in the petroleum industry was measured at 55,000 in 2013, increased to nearly 63,000 in 2014, and subsequently declined to a little over 48,000 in 2015 (Table 7).

## Workforce Safety and Insurance

Workforce Safety and Insurance (WSI) manages and regulates the workers' compensation system in North Dakota. As part of that system, WSI tracks employees in North Dakota. Workforce Safety and Insurance uses a classification system for defining employment that consists of 142 categories based on the type of work activity performed. Several of those categories are specific to various activities in the petroleum sector. The classifications directly attributable to the petroleum sector include Oil and Gas Operations (code 1320), Oil Refining - Synthetic Fuels Manufacturing (code 4740), Oil and Gas Development - Drilling (code 6203), Oil and Gas Well Suppliers or Equipment Dealers (code 6204), Oil Well Trucking (code 6205), Oil Well Servicing (code 6206), Oil and Gas Instrument Logging (6208), Geologists and Scouts (code 8605). Some petroleum sector employment can be traced through Professional and Business Representatives (code 8747) and Clerical Office Employees (code 8805). Other employment classifications contain petroleum sector employees but are not distinguished or credited as being part of the petroleum sector.

Workforce Safety and Insurance does not provide measures of full-time employment, but rather tracks the number of employees by job classification. The subtle difference between tracking a job versus an employee is that if an employee has more than one employer during the year that individual is counted twice. Further if an employee works at any time during the year, that individual is included within the WSI data even if the position or duration of work was temporary. Therefore, the head-count data from WSI can include temporary work and can include duplications from those who worked for more than one employer during the year.

The WSI data has some employees placed in job classifications that are not attributable to the petroleum sector, even if those activities occur within the petroleum sector. Examples of those classifications include Street and Road Construction (code 6042), Sewer-Water-Gas-Pipeline Construction (code 6301), and Trucking and Hauling - Interstate and Intrastate (code 7215). Further, employment that would remain unmeasured includes employees performing repairs, consulting, or other professional functions within the petroleum industry as those positions fall within other employment codes. WSI information also does not count self-employed or sole proprietors, unless they are required to report to WSI or voluntarily contribute to the workers' compensation system.

Based on WSI data, the petroleum sector had over 51,600 employees working in the petroleum sector during fiscal year 2011 (Table 7) (North Dakota Workforce Safety and Insurance 2012). The greatest number of employees was found in oil well servicing activities (12,557 individuals), oil well drilling activities (12,039 individuals), oil well trucking (10,162 individuals), oil and gas operations (7,188 individuals), and oil and gas well suppliers (2,642 individuals). Those categories collectively accounted for 86 percent of the workers in the petroleum sector in North Dakota in fiscal year 2011.

Workforce Safety and Insurance employee data were obtained back to fiscal year 2004, which represents an approximate beginning period for the current oil shale development in the state (Table 7) (Workforce Safety and Insurance 2012). From fiscal year (FY) 2004 to FY2011, the number of employees working in the petroleum sector increased by 780 percent. A regional analysis of employment in the core activities of the petroleum sector (NAICS codes 211 and 213) by Job Service North Dakota showed similar levels of employment change over the period; a 628 percent increase from 2004 to 2011 (Table 7). By comparison, overall production of crude oil in the state has increased by 390 percent from 2004 to 2011. It would appear that direct employment in the petroleum sector has increased slightly greater than the overall

change in oil production over the period. The substantial increases in employment have resulted from disproportionately greater increases in drilling activities in 2011.

### Oil and Gas Division Coefficients

The Oil and Gas Division of the North Dakota Department of Mineral Resources has conducted an examination of the labor requirements for various segments of the oil and gas industry (North Dakota Department of Mineral Resources 2012c). That effort produced details on the amount and type of labor required for drilling, fracking, construction of oil field gathering systems, well operations, well maintenance, oil and gas transportation, and associated processing activities. The coefficients are expressed as a labor requirement per unit of activity (e.g., employment per drilling rig, service employment per well).

Using those coefficients, along with historic estimates of rig counts and operating wells, can produce estimates of employment in the petroleum sector. Bangsund and Hodur (2012) describe the use and application of those coefficients in a model that embodies the Oil and Gas Division coefficients. Output from that model shows similar trends and levels of employment as found with estimates from Job Service North Dakota (Table 7). However, the use of Oil and Gas Division coefficients produces a lower estimate of direct employment than the methods used in this study and provides a lower measure of employment obtained from Workforce Safety and Insurance data. Differences may be attributable to the interpretation of what constitutes direct employment in the industry. Other differences may be related to the degree of well servicing employment in the early periods of Bakken/Three Forks wells.

This study uses a fairly broad definition of direct employment that crosses over a wide range of service and support activities in the oil fields. Some of those service and support jobs are not likely counted in the Oil and Gas Coefficients. Also, jobs associated with crude oil processing are included in the survey data but not included in the Oil and Gas Division coefficients. Finally, Oil and Gas Division coefficients likely underestimate the degree of well servicing employment in the early periods of Bakken/Three Forks wells. Nevertheless, direct employment, as measured by using employment coefficients, shows similar overall rates of change in employment in the petroleum sector (Table 7).

### Secondary Employment

Secondary employment is a term used to describe jobs that are created and supported by the volume of business activity generated by an industry, but does not include jobs that are part of the industry. Direct employment and secondary employment are two distinctly different measures.

Due to examinations of the rate of secondary job creation in the Williston Basin by Bangsund and Hodur (2012), estimates of secondary employment for the petroleum industry in this study were modified from the methods used in previous industry assessments. To arrive at estimates of state-level secondary job creation by the petroleum industry, the analysis was divided into two components. Estimates of statewide secondary job creation were developed from North Dakota's economic base data set (Coon et al. 2013) for a 15-year period prior to 2005. Those estimates were generated using traditional methods associated with productivity ratios<sup>3</sup> and secondary business volume. Secondary business volume was generated using the

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<sup>3</sup> A measure of the amount of business activity needed in an economic sector to support one full-time job.

North Dakota Input-Output Model with petroleum sector Sales to Final Demand from North Dakota's economic base data set (Coon et al. 2013). The economic base data set does not contain estimates of in-state expenditures associated with oil and gas exploration. Adjustments to employment estimates were performed to account for the missing expenditures associated with oil exploration in the state over the period. Further, the economic base data set assigns estimates of oil and gas royalties and lease bonus payments to the Households sector (economy-wide personal income).

The secondary job creation resulting from net in-state oil and gas royalties and in-state lease bonuses over the period also were estimated. Therefore, historic estimates of secondary job creation, using North Dakota's economic base data set, were estimated using techniques consistent with recent economic contribution analyses (Bangsund et al. 2012; Coon et al. 2012a, 2012b; Bangsund et al. 2011; Bangsund and Leistriz 2010). Estimates of secondary employment created by the petroleum sector from 2000 to 2004 were averaged and represent a traditional level of secondary job support in the North Dakota economy.

The second portion of the analysis relied on recent observations that traditional methods of estimating secondary employment are overestimating job creation in the state (Bangsund and Hodur 2012). To account for the incremental change in secondary job creation attributable to the industry since 2005, the methods developed by Bangsund and Hodur (2012) to assign employment coefficients to direct employment in the industry were used in this study. Estimates of direct employment prior to 2005 were obtained from an employment model developed by Bangsund and Hodur (2012) that combines historical data on drilling rigs and well counts in combination with employment coefficients from the Oil and Gas Division of the Department of Mineral Resources. Average employment prior to 2005 was subtracted from estimates of direct employment in 2005, 2007, 2009, 2011, and 2013 (years for which economic contribution analyses were performed). The net gain in direct employment within the industry was then multiplied by secondary job coefficients (multipliers) to estimate the incremental increase in secondary job creation above historical observations. The combination of the incremental change in secondary job creation and historical observations for secondary job creation represent a state-wide estimate of total secondary job support attributable to the industry. The industry was expected to have supported 23,984 full-time secondary jobs in North Dakota in 2015. Secondary employment estimates represent both indirect and induced employment.

### Government Revenues

Governmental revenues, usually based on tax collections, are another important measure of the economic impact of an industry on an economy. The petroleum industry in North Dakota, specifically oil and gas production, is responsible for substantial amounts of state and local government revenues. One distinction is that unlike many other industries in North Dakota, severance taxes (taxes placed on the value of oil and gas removed from the ground) collect money based on gross revenues produced by the industry. In contrast, taxation for most other industries is more traditional and usually limited to real property and net income. Another distinction that makes the petroleum industry different from other industries in the state is that governments can hold oil and gas leases and receive royalties from the value of oil and gas production. Of course, the petroleum industry also generates revenues from traditional sources, such as personal income, corporate income, sales and use, and property tax collections.

Severance taxes, sales and use taxes, personal income taxes, corporate income taxes, property taxes, royalties, lease bonuses, charitable donations, and licenses, fees, and permits combined for \$3.06 billion in government revenues that were directly attributable to the petroleum industry in North Dakota in 2015

(Table 8). Exploration/development, extraction/production, and processing segments of the industry were responsible for about 6, 92, and 2 percent, respectively, of the total government revenues from the petroleum industry in North Dakota.

Severance taxes accounted for 62 percent of all government revenues from the petroleum industry in North Dakota in 2015. The second largest source was government royalties at 24 percent, followed by the most common general taxes (i.e., property, personal income, sales and use, and corporate income) at 9 percent. The remainder of government revenues represented lease bonuses, permits/fees/licenses, and miscellaneous revenues.

In addition to the government revenues that were included as direct impacts, collections from personal income and sales and use taxes were estimated based on the secondary economic activity generated by the petroleum industry. Secondary economic impacts in the *Retail Trade* sector were used to estimate revenue from sales and use taxes. Economic activity in the *Households* sector (which represents economy-wide personal income) was used to estimate personal income tax collections. Total collections of personal income and sales and use taxes arising from secondary economic activity were estimated at \$267 million (Table 8).

Table 8. State and Local Government Revenues Attributable to the Petroleum Industry, North Dakota, 2015		
Revenue Type	Revenue included as part of direct impacts	Revenue estimated from secondary economic impacts
	----- 000s \$ -----	
Sales and Use Taxes	28,677	243,856
Property Taxes	174,441	not applicable
Personal Income Tax	21,906	24,136
Corporate Income Tax	22,881	not available
Royalties	744,461	not applicable
Severance Taxes	1,903,582	not applicable
Lease Bonuses	15,958	not applicable
Licenses, Permits, Fees	48,289	not available
Charitable Donations	587	not available
Undetermined Taxes <sup>a</sup>	99,448	not applicable
<b>Total</b>	<b>3,060,230</b>	<b>267,992</b>

<sup>a</sup> Represents general in-state taxes paid to local and state government that were not specifically identified by survey respondents.

## Infrastructure Spending

The petroleum industry in North Dakota has been adding infrastructure to the Williston Basin since the beginning stages of developing the Bakken/Three Forks Formations. Additional transportation capacity has been added to the region in the form of new export pipelines, expansions of existing crude oil pipelines, crude oil gathering systems, and crude oil rail loading facilities. New gas plants and expansions of existing plants have been added to the region, along with associated expansion and development of new collection systems to capture and transport natural gas and natural gas liquids to processing locations. Additional infrastructure added by the petroleum industry includes office buildings, regional transportation and distribution centers, worker housing, frac water re-cycling facilities, and general facility and building upgrades and renovations. Capital expenditures for many forms of infrastructure have not been directly included in the previous industry assessments (Bangsund and Leistritz 2007, 2009, 2010), as industry costs and expenses have focused on expenditures associated with well drilling/completion, oil and gas production, transportation, and processing operations.

Separate surveys of oil operators and processors/shippers included a standardized set of questions specific to various categories of infrastructure development and capital expenditures in North Dakota (Appendices A and B). The surveys were explicit in that expenditures were to represent projects in North Dakota for calendar year 2015.

Information to estimate capital expenditures for infrastructure came from survey data and secondary sources containing published estimates of project costs. Some estimates of capital expenditures represent discrete projects (e.g., gas plant) whereas other estimates represent projects that have less definable start and finish dates and less site-specific designations (e.g., oil field gathering systems).

Estimating industry-wide infrastructure spending in 2015 requires addressing several key issues. First, timing of the start and completion of project-based infrastructure (e.g., gas plant) does not necessarily coincide with the study time frame. Projects can be initiated in one year and completed in another (e.g., started in 2015 while completion may not occur until 2016 or later). Survey data represented expenditures made for project(s) in 2015, while various secondary estimates of capital expenditures represent total costs for specific projects that might involve spending over extended periods. Therefore, the first task was to reconcile secondary data on infrastructure costs with the anticipated timing of project-based expenditures. A project's total cost does not necessarily require all spending to occur in a single year, or occur solely in 2015.

Information was not available, on an industry-wide basis or on a project basis, to determine what portion of capital expenditures was captured in the North Dakota economy. For example, a substantial portion of the cost of a new gas processing plant or pipeline represents specialized equipment. Specialized equipment is acquired from out-of-state sources as primary suppliers are not available in North Dakota. Other studies have identified that a high proportion of specialized equipment for various types of processing facilities constructed in North Dakota results in economic leakage (Bangsund et al. 2012; Coon et al. 2012a; Leistritz 1995).

Two problems exist with current infrastructure spending. The portion of those capital expenditures captured in the North Dakota economy is unknown. Also, the distribution of in-state capital expenditures among various economic sectors is unknown. The survey questionnaires did not solicit information on the above issues. cursory information on those details was obtained from conversations with industry officials.

For purposes of this study, it was assumed that labor represented two-thirds of capital expenditures while equipment/materials represented the other one-third. Within that split, an additional assumption was made regarding the approximate portion that was retained or circulated within the North Dakota economy. About 60 percent of labor was expected to be captured in North Dakota and 10 percent of material and equipment was captured in North Dakota. The adjustments resulted in about 44 percent of capital expenditures circulating in the North Dakota economy. Leistriz (1995) found that in-state capture of labor and materials associated with the ProGold corn processing plant in the Red River Valley was 43 percent.

Based on published estimates of project expenditures, survey data, and extrapolation of survey data in combination with unpublished data, the petroleum industry was estimated to have spent around \$2.6 billion on infrastructure projects in the state in 2015 (Table 9). After adjustments for economic leakage (the portion of expenditures not captured in the North Dakota economy), it was estimated that about \$1.1 billion were captured in the North Dakota economy (Table 9).

The gross business volume associated with infrastructure spending in North Dakota was estimated to range from \$3.5 to \$3.7 billion in 2015 (Table 10). Infrastructure spending, as defined in this report, would represent additional economic activity beyond that created by the exploration, production, transportation, and processing segments of the industry.

Table 9. Infrastructure Investment Spending, Petroleum Industry, North Dakota, 2015

Category/Examples of Companies With Expenditures	Capital Expenditures <sup>a</sup>			
	Incurred in 2015		Retained in North Dakota	
	Low	High	Low	High
	----- millions \$ -----			
Gas Processing Plants ONEOK, Hess, Whiting, Targa Resources	904.7	946.4	392.1	410.1
Gas Midstream Projects (not including gas plants) Hess, Pecan, Targa Resources, Bison Midstream, Aux Sable, American Midstream Bakken	284.5	305.2	123.3	132.2
Crude Oil Pipelines, Crude Oil Rail Loading Facilities, and Refineries Belle Fourche, Bridger, Hiland Partners, Enable Bakken Crude Services, Bakken Oil Express, BakkenLink, Tesoro High Plains, Hess	692.2	742.2	299.9	321.6
Water Re-cycling Facilities <sup>b,c</sup>	113.2	136.	49.1	57.0
Housing and Lodging <sup>b,c</sup>	19.5	22.6	9.4	10.9
Office and Other Facilities <sup>b,c</sup>	150.0	174.3	72.5	84.3
Other (miscellaneous) <sup>b,c,d</sup>	12.8	14.8	5.3	6.2
<b>Total</b>	<b>2,546.8</b>	<b>2,733.5</b>	<b>1,146.6</b>	<b>1,228.9</b>

<sup>a</sup>Represent an estimate of capital expenditures spent in calendar year 2015. Capital expenditures in 2015 will not necessarily equal the total estimated cost of any particular project. Dollars retained in North Dakota

represent estimates of the portion of capital expenditures captured and circulated in the North Dakota economy (i.e., local and regional suppliers of labor, materials, and equipment).

<sup>b</sup> Estimated based on extrapolation of survey data.

<sup>c</sup> Only includes expenditures for firms surveyed as part of the oil and gas industry.

<sup>d</sup> Based on survey of firms providing service and support in the oil fields, and represented miscellaneous or unclassified infrastructure investments. This category also includes capital expenditures for development of the crude oil refinery in Dickinson.

Sources: North Dakota Pipeline Authority (2017), North Dakota Department of Mineral Resources (2017a), North Dakota Public Service Commission (2017), North Dakota Office of the State Tax Commissioner (2017) and confidential survey data.

Table 10. Total (Direct and Secondary) Economic Impacts, Infrastructure Spending, Petroleum Industry, North Dakota, 2015

Economic Sector	Range of Impacts <sup>a</sup>		
	Low	High	Average
	----- 000s \$ -----		
Construction	173,334	187,105	180,219
Transportation	11,661	12,530	12,095
Communications and Public Utilities	120,667	129,636	125,151
Manufacturing	48,794	52,434	50,614
Retail Trade	712,612	765,321	738,966
Finance, Insurance, and Real Estate	451,327	485,434	468,380
Business and Personal Services	271,561	291,146	281,353
Professional and Social Services	123,696	94,225	108,960
Households (personal income)	1,343,514	1,443,539	1,393,526
Government	106,962	114,922	110,942
Other sectors <sup>b</sup>	100,451	107,932	104,191
Gross Business Volume	3,464,579	3,684,224	3,574,401

<sup>a</sup> Based on range of expenditures captured in North Dakota economy (see Table 9).

<sup>b</sup> Includes various agricultural and mining sectors.

## Total Economic Impacts

The total economic effect of an industry on a local, state, or regional economy can be measured by estimating the total amount of business activity generated by that industry. Total business activity, sometimes called gross business volume, is generally defined as a combination of direct and secondary economic impacts. Direct impacts are those changes in output, employment, or income that represent the initial or first-round effects of a project, program, policy, or activity. Secondary impacts (sometimes further categorized into indirect and induced effects) result from subsequent rounds of spending and respending within an economy. This process of spending and respending is sometimes termed the multiplier process, and the resultant secondary effects are sometimes referred to as multiplier effects. Further, additional economic measures, such as personal income, tax revenue, and employment, are often used to measure the relative size of an industry.

The petroleum industry in North Dakota was defined to include exploration/well development, extraction/production, transportation, and processing of crude oil and natural gas. Direct impacts were based on in-state expenditures, private and public royalties, taxes, lease bonuses, and expenditures retained in North Dakota for infrastructure development. Direct impacts were allocated to various sectors of the North Dakota Input-Output Model to generate estimates of the secondary economic impacts.

The direct impact of exploration/development in 2015 was estimated at \$5.3 billion. Total secondary economic impacts associated with well drilling and completion activities were estimated at \$8.9 billion. The in-state gross business volume of exploration activities was estimated at \$14.2 billion in 2015 (Table 11).

The direct impact of extraction/production in 2015 was estimated at \$6.2 billion. Total secondary economic impacts associated with extraction and production activities were estimated at \$6.3 billion. The in-state gross business volume of oil and gas extraction was estimated at \$12.6 billion in 2015 (Table 11).

The transportation and processing component of the petroleum industry was estimated to have a direct impact in North Dakota of \$1.2 billion. Total secondary economic impacts associated with processing and transporting crude oil and natural gas were estimated at \$2.2 billion. The in-state gross business volume of processing and transporting crude oil and natural gas was estimated at \$3.4 billion in 2015 (Table 11).

About \$1.2 billion of infrastructure spending were captured in the North Dakota economy after adjusting total capital expenditures for economic leakage (the portion of expenditures not captured in the North Dakota economy). The gross business volume associated with infrastructure spending in North Dakota was estimated to range from \$4.5 to \$4.7 billion in 2015. Infrastructure spending, as defined in this report, would represent additional economic activity beyond that created by the exploration/development, extraction/production, transportation, and processing segments of the industry.

Industry-wide direct impacts from the petroleum industry were estimated at \$13.9 billion in 2015. Total secondary economic impacts associated with the industry were estimated at \$20 billion. The gross business volume for the petroleum industry in North Dakota in 2015 was estimated at \$33.7 billion (Table 11).

Additional measures of the petroleum industry's economic importance to the state include direct employment for 48,369 full-time jobs, economy-wide personal income of \$7.5 billion, statewide retail sales of \$8.8 billion, direct contributions to local and state government revenues of \$3 billion, indirect contribution of

\$261 million in state government tax collections, and secondary employment of 23,984 full-time equivalent jobs. For every dollar spent in the state by the petroleum industry, another \$1.40 in additional business activity was generated.

Some generic or average impact figures can be produced for basic oil and gas production statistics. Based on a gross business volume of \$38.5 billion for the petroleum industry (not including infrastructure spending), total economic effects in North Dakota would be about \$57 per BOE, or if impacts were only evaluated for crude oil production, total effects would be \$70 per barrel. Based on active wells in the state, the overall economic effect (direct and secondary impacts from all segments of the industry) per well (averaged for all producing wells) would be about \$2.4 million annually.

Table 11. Total (Direct and Secondary) Economic Impacts, Petroleum Industry, North Dakota, 2015

Economic Sector	Industry Component				Totals
	Exploration	Extraction	Processing	Infrastructure <sup>a</sup>	
-----000s \$-----					
Construction	522,125	382,702	168,346	248,430	1,321,603
Transportation	81,502	108,701	802,908	16,676	1,009,787
Communications and Public Utilities	805,618	577,209	244,912	172,529	1,800,268
Manufacturing	342,870	658,324	97,066	69,772	1,1168,033
Retail Trade	4,621,074	2,802,260	685,794	739,036	8,848,164
Finance, Insurance, and Real Estate	1,441,252	982,217	254,870	645,643	3,323,981
Business and Personal Services	1,044,714	646,462	204,747	388,038	2,283,960
Professional and Social Services	878,729	529,683	115,377	125,390	1,649,180
Households (personal income)	2,221,138	1,562,850	188,203	933,023	4,905,214
Government	584,817	3,153,425	269,668	110,954	4,118,864
Other sectors <sup>b</sup>	543,878	474,255	108,694	107,321	1,234,148
Gross Business Volume	14,169,861	12,556,339	3,446,246	3,556,811	33,729,257

<sup>a</sup> Represents an average of a low estimate (\$3.5 billion) and a high estimate (\$3.7 billion) of the gross business volume of infrastructure spending in the state.

<sup>b</sup> Includes various agricultural and mining sectors.

## COMPARISON OF PREVIOUS INDUSTRY ASSESSMENTS

The first comprehensive economic evaluation of the petroleum industry in North Dakota was conducted in 2006 and was reflective of conditions present in the industry in calendar year 2005 (Bangsund and Leistriz 2007). Biennial assessments have been conducted since the 2005 study (Bangsund and Leistriz 2009, 2010; Bangsund and Hodur 2013, 2015). The results reported in this study were based on conditions present in the industry in calendar year 2015.

Biennial assessments from 2005 through 2015 have documented the meteoric rise in economic output as the industry ramped up development of shale oil resources and have measured the precipitous drop in output as the industry contracted from a price collapse at the end of 2014. Nominal oil and gas prices were adjusted for inflation using the Gross Domestic Product-Implicit Price Deflator. Crude oil prices over the 2005 to 2009 period were similar, but prices in 2011 were considerably higher than observed in the previous periods. Prices received for natural gas have decreased over the 2005 to 2015 period. Oil production has increased over 1,000 percent from 35 million barrels to 432 million barrels over the period. Gas production jumped from around 58 million mcf in 2005 to over 585 million mcf in 2015. In addition to increases in oil and gas production, exploration/development activities in the state continued to increase the number of producing wells from about 3,400 in 2005 to 12,800 in 2015 (Table 12).

Methods and data sources among the six studies were largely unchanged, although refinements in data collection and estimation techniques have been implemented since the first economic assessment in 2005. In the 2007 study, a separate survey of lease/brokerage firms was initiated to help generate estimates of in-state lease bonuses on private land in North Dakota. By comparison, lease bonuses on private land in 2005 were based on information obtained from the survey of oil operators and data on well drilling activity. Firms providing oil field services were not surveyed in the 2007 study, but those firms were surveyed in the 2005, 2009, and 2011 studies. Several refinements were implemented in the 2011 study. Detailed data on input sourcing for well drilling and well completions were obtained from oil operators to examine economic leakage associated with well drilling and well completion activities. Also, estimation of in-state mineral royalty revenues was refined based on payment data obtained from oil operators in the state. Finally, the 2011 study collected survey data on infrastructure spending by the industry. The 2013 study expanded the survey of firms to include rail loading facilities. The 2013 and 2015 studies used data from Job Service North Dakota to estimate direct employment in the industry, rather than develop estimates from survey or other secondary data.

In 2005, the survey of oil operators resulted in obtaining information from 17 firms representing about 19 percent of oil and gas production in the state (Table 13). In 2007, the survey of oil operators obtained information from 14 firms representing about 34 percent of oil and gas production (i.e., BOE) in the state. In 2009, 13 firms provided useable information representing about 43 percent of state production. In 2011, 10 firms provided useable information representing about 31 percent of state production. Overall, firms responding to the survey have averaged about one-third of state production (Table 13). The survey of processors in the six studies resulted in nearly identical survey participation by the industry (data not presented).

Table 12. Oil and Gas Production Statistics, North Dakota, 2005, 2007, 2009, 2011, 2013, and 2015

Measures of Industry Output	Calendar Year 2005	Calendar Year 2007	Calendar Year 2009	Calendar Year 2011	Calendar Year 2013	Calendar Year 2015	Percent Change	
							2005 - 2015	2013 - 2015
Crude oil (barrels)	35,659,583	45,057,874	79,706,495	153,015,266	313,801,706	432,286,156	1,112	37.8
Natural gas produced (mcf)	57,970,459	70,799,663	92,491,011	155,424,007	347,640,253	584,774,236	908	68.2
Natural gas sold (mcf)	50,695,691	55,094,857	65,077,431	98,216,881	232,816,380	451,923,695	791	94.1
Number of operating/active wells (monthly average)	3,391	3,759	4,190	5,555	8,949	12,799	277	43.0
Number of wells completed	240	336	522	1,271	2,183	1,583	560	-27.5
Average annual price per barrel of crude oil in North Dakota*	\$51.41 nominal	\$65.10 nominal	\$54.03 nominal	\$87.69 nominal	\$88.97 nominal	\$40.05 nominal	-22.1	-55.0
	\$60.01 real	\$69.03 real	\$59.46 real	\$92.86 real	\$91.03 real	\$40.05 real	-33.9	-56.0
Average annual price per mcf of natural gas in North Dakota*	\$8.57 nominal	\$6.69 nominal	\$3.75 nominal	\$3.56 nominal	\$3.29 nominal	\$2.17 nominal	-84.7	-34.1
	\$10.11 real	\$7.09 real	\$4.13 real	\$3.78 real	\$3.37 real	\$2.17 real	-78.5	-35.6

\* Nominal dollars adjusted to real (2015) dollars using the Gross Domestic Product-Implicit Price Deflator.

Sources: North Dakota Department of Mineral Resources (2016).

Table 13. Summary of Oil Operator Surveys, North Dakota, 2005, 2007, 2009, 2011, 2013, and 2015

Description	2005	2007	2009	2011	2013	2015
Number of firms surveyed (first mailing)	135	140	84	60	61	53
Number of firms responding with useful information (2 or more mailings)	19	14	13	10	11	10
Number of wells owned/operated by survey respondents	1,633	1,897	2,105	2,161	3,789	5,860
Share of state totals	49%	50%	50%	39%	42%	45%
Crude oil production by survey respondents	8,062,219	13,503,595	34,480,312	46,861,655	113,331,223	191,737,000
Share of state totals	23%	30%	43%	31%	36%	44%
Natural gas production by survey respondents	10,289,325	34,360,934	51,011,755	51,137,922	108,257,277	280,098,000
Share of state totals	18%	48%	54%	33%	31%	48%
Barrel of Oil Equivalent (BOE)	9,777,106	19,230,418	42,982,271	57,089,239	131,299,339	238,420,000
Share of state totals	22%	34%	45%	32%	37%	45%
Number of wells completed by survey respondents	75	126	274	384	689	660
Share of state totals	29%	37%	52%	30%	32%	42%

Several notable changes were observed with oil and gas exploration/development between 2005 and 2015 (Table 14). The number of wells completed increased from 240 per year in 2005 to 2,183 per year in 2013 but fell to about 1,600 in 2015. The average cost to drill and complete a well in the state increased in real terms from \$1.8 million in 2005 to \$9.7 million in 2011, but decreased to just under \$7 million in 2015. The result of both an increase in the number of wells drilled and the change in the cost to complete oil wells increased exploration/development expenditures by the industry by about 900 percent from 2005 to 2015. However, well completion costs were evaluated for economic leakage, which adjusted total in-state expenditures. Those adjustments indicated that in-state expenditures per well completions went from \$1.7 million in 2005 to \$3.3 million in 2015, only an 91 percent increase.

The gross business volume (direct and secondary economic effects) associated with exploration/development went from around \$1.4 billion in 2005 to about \$14.2 billion in 2015, which reflect adjustments to the in-state capture of well drilling and completion expenses. The amount of direct expenditures for only exploration/development activities in 2007, 2009, and 2011 exceeded the sum of direct expenditures for all other segments (i.e., production, processing, and transportation) of the industry (see Tables 14 and 15). However, in 2015, industry expenditures for oil production exceeded those for well development.

Table 14. Comparison of Economic Estimates, Exploration Component of Petroleum Industry, North Dakota, 2005, 2007, 2009, 2011, 2013, and 2015

Category	2005*	2007*	2009*	2011*	2013	2015	Percent Change	
							2005 - 2015	2013 - 2015
Number of wells drilled & completed	240	336	522	1,271	2,183	1,583	560	-27
----- 000s 2015\$ -----								
Average total cost per well completed	1,783	4,799	5,155	9,652	6,562	6,919	288	5.4
In-state expenditures per well completed	1,783**	4,799**	5,155**	4,761	3,184	3,328	87	4.5
<b>Lease bonuses</b>								
Net federal and state	20,214	10,016	166,536	111,774	55,027	15,958	-21	-71
Private***	76,691	102,757	226,920	340,906	302,571	43,433	-43	-86
<b>Direct Impacts</b>								
Well Drilling****	427,903	1,612,486	2,691,090	6,050,724	6,950,315	5,267,628	1,131	-24
Lease Bonuses	96,905	112,773	393,456	452,680	357,598	59,391	-39	-83
Total Direct	524,808	1,682,928	3,084,546	6,503,404	7,307,913	5,327,019	915	-27
Secondary Impacts	914,000	3,050,000	5,182,000	11,303,000	13,086,000	8,869,000	871	-32.2
<b>Gross Business Volume</b>	<b>1,439,000</b>	<b>4,772,000</b>	<b>8,255,000</b>	<b>17,791,000</b>	<b>20,872,000</b>	<b>14,196,000</b>	<b>887</b>	<b>-32.0</b>

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\* Nominal 2005, 2007, 2009, 2011, and 2013 dollars were adjusted for inflation using Gross Domestic Product-Implicit Price Deflator and reflect 2015-equivalent dollars.

\*\* Per-well expenses in the 2005, 2007, and 2009 studies were based on reported total costs to complete a well in North Dakota. The 2011, 2013, and 2015 studies refined the estimate to consider economic leakage associated with purchases of inputs primarily supplied by out-of-state firms.

\*\*\* Estimation techniques for private lease bonuses in North Dakota differed between the 2005 study and the subsequent studies. Private lease bonuses were not adjusted for in-state mineral ownership in the 2005 study, and were based primarily on data obtained from the survey of oil operators. Private lease bonuses represented only payments to in-state mineral owners in the 2007, 2009, 2011, 2013, and 2015 studies and were based primarily on a survey of oil lease/brokerage firms and in-state and out-of-state royalty payments reported by oil operators.

\*\*\*\* Numbers in 2011, 2013, and 2015 reflect economic leakage associated with well drilling and completion activities.

Changes in oil and gas production have implications on the gross business volume of the industry in the state. Based on the reported expenses associated with oil and gas production, volume of production has a greater effect than the expenses per unit of output (i.e., in-state expenditures per BOE) (Table 15). Also, increases in the overall royalty rates paid on mineral ownership have contributed to increased royalty payments, which were considered a direct impact in the estimation of gross business volume. Likewise, collections of severance taxes, also considered a direct impact, increased substantially, reflecting an increase in the overall value of oil and gas production in the state. From 2005 to 2015, total direct expenditures for oil and gas production increased by about 525 percent. The gross business volume from oil production increased by 380 percent over the period (Table 15).

The processing sector of the petroleum industry also showed substantial increase in expenditures over the 2005 to 2015 period (Table 16). Some of the increase came from expansion of pipeline capacity and expansion of natural gas processing capacity in the state. Some change in expenditures was a result of greater processing volumes, pipeline shipments, and growth in rail shipments. The other change came from a substantial increase in transportation expenses reported by oil operators. Overall, the change in direct expenditures in this segment of the industry reflected an increase in processing/transporting volumes and an increase in transportation expenses. The gross business volume for the processing and transportation component of the petroleum industry increased by about 560 percent from 2005 through 2015 (Table 16).

Some of the most closely monitored measures of the petroleum industry are estimates of government revenues. Government revenues attributable to the petroleum industry stem from collections of property, sales and use, personal income, and corporate income taxes. Other direct revenue sources include royalties on oil and gas production and lease bonus payments. The largest single source of government revenue from the petroleum industry in the state has been severance taxes. Overall, not all sources of government revenues changed in equal proportion over the period; however, collectively annual governmental revenues from the petroleum industry increased by \$2.8 billion or 800 percent in real terms over the period (Table 17). The largest single increase (\$1.7 billion) comes from changes in the collection of severance taxes which went from \$180 million in 2005 to \$1.9 billion in 2015.

Employment in the industry also showed substantial change from 2005 through 2015. While employment has increased in all segments of the industry (Table 17). Overall, total direct employment within the industry was estimated to increase by nearly 43,300 FTE jobs from 2005 to 2015 (Table 18). While industry employment in 2015 remained considerably higher than in 2015, employment in 2015 was down from employment in 2013 and 2014. Direct employment in the state in 2014 was nearly 63,000 (see Table 7).

Table 15. Comparison of Economic Estimates, Oil and Gas Extraction/Production Component of Petroleum Industry, North Dakota, 2005, 2007, 2009, 2011, 2013, and 2015

Category	2005*	2007*	2009*	2011*	2013	2015	Percent Change	
							2005 - 2015	2013 - 2015
Oil and gas production (BOE terms)	45,321,000	56,858,000	95,122,000	178,919,267	371,741,748	529,748,529	1,069	42
Production and General Business Expense per BOE	\$14.29	\$17.25	\$12.19	\$10.58	\$9.94	\$7.17	-49.8	-27.9
Oil Royalties**	13.0	14.9	16.6	17.58	17.52	17.9	38.0	2.0
Gas Royalties**	13.3	14.2	16.7	17.35	17.43	18.0	36.0	4.0
----- 000s \$ -----								
Direct Impacts								
Production Expenditures	359,000	494,800	655,400	984,900	2,049,100	2,381,800	564	16
General Business Expenses	257,400	397,300	423,200	684,700	712,600	851,000	231	19
Royalties								
Net federal and state	44,200	62,200	76,100	320,200	668,700	743,100	1,583	11
Private***								
Total	232,200	414,600	714,100	2,173,600	4,085,900	2,059,700	787	-50
In-state	na	223,100	388,700	845,200	1,431,700	829,300	na	-42
Total Royalties	276,400	285,300	464,800	1,165,400	2,100,300	1,572,400	469	-26
Severance Taxes	179,900	280,600	430,800	1,369,400	2,968,800	1,903,600	958	-36
Total Direct Impacts	1,072,700	1,457,500	1,972,300	4,201,500	7,857,200	6,708,700	525	-15
Secondary Impacts	1,660,700	2,192,800	2,692,200	4,936,100	7,846,200	6,345,200	282	-19
Gross Business Volume	2,733,400	3,650,300	4,664,500	9,137,700	15,703,400	13,053,900	378	-17

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\* Nominal 2005, 2007, 2009, 2011, and 2013 dollars were adjusted for inflation using Gross Domestic Product-Implicit Price Deflator and reflect 2015-equivalent dollars.

\*\* Average percentage of production. Data obtained from oil operator survey and based only on owned/operated wells.

\*\*\* Direct comparisons between the 2005 and later studies are difficult. Private royalties in the 2005 study were not adjusted for in-state versus out-of-state mineral ownership. As such, private royalties in 2005 represented a gross measure of payments. Total payments of private royalties in 2007, 2009, 2011, 2013, and 2015 were adjusted for in-state mineral ownership. Private royalties in 2011, 2013, and 2015 were net of severance taxes. Severance tax adjustments were not performed on 2005, 2007, and 2009 net private in-state royalties.

Table 16. Comparison of Economic Estimates, Processing Component of Petroleum Industry, North Dakota, 2005, 2007, 2009, 2011, 2013, and 2015

Category	2005*	2007*	2009*	2011*	2013	2015	Percent Change	
							2005 - 2015	2013 - 2015
----- 000s \$ -----								
Direct Impacts								
Transportation	31,500	77,800	76,200	218,900	376,700	566,500	1700	50
Processing and Pipeline Activities	124,700	216,100	252,900	284,100	454,800	637,900	411	40
Total Direct Impacts	156,100	293,900	329,100	503,000	831,500	1,204,400	671	45
Secondary Impacts	280,800	499,300	620,800	945,700	1,510,000	2,241,800	698	48
Gross Business Volume	436,900	793,200	949,900	1,458,700	2,341,500	3,446,200	559	47

\* Nominal 2005, 2007, 2009, 2011, and 2013 dollars adjusted for inflation using Gross Domestic Product-Implicit Price Deflator and reflect 2015-equivalent dollars.

Table 17. Estimates of State and Local Government Revenues Generated by Petroleum Industry, North Dakota, 2005, 2007, 2009, 2011, 2013 and 2015

State and Local Government Revenues	2005*	2007*	2009*	2011*	2013	2015	Percent Change	
							2005 - 2015	2013 - 2015
----- 000s \$ -----								
<b>Included as Direct Impacts</b>								
Sales and Use, Property, and Income taxes	43,600	116,100	130,900	209,300	260,300	283,700	551	9
Royalties**	44,200	62,200	76,100	320,200	668,700	743,100	1,583	11
Severance Taxes	179,900	280,600	430,800	1,369,400	2,968,800	1,903,600	958	-36
Lease Bonuses (net federal and state)	20,200	10,000	166,500	111,800	55,000	16,000	-21	-71
Licenses, Fees, Permits, Donations, and undetermined taxes	42,700	113,500	97,000	369,800	193,300	148,300	248	-23
<b>Totals</b>	<b>330,500</b>	<b>582,400</b>	<b>901,300</b>	<b>2,380,400</b>	<b>4,146,100</b>	<b>3,094,600</b>	<b>836</b>	<b>-25</b>
<b>Estimated from Secondary Economic Activity</b>								
Sales and Use	42,300	83,000	126,500	256,100	329,800	243,900	477	-26
Personal Income	11,400	18,100	20,800	30,600	32,600	24,100	113	-26
<b>Direct and Secondary Estimates of State and Local Government Revenues</b>	<b>384,100</b>	<b>683,500</b>	<b>1,048,600</b>	<b>2,667,100</b>	<b>4,508,600</b>	<b>3,362,600</b>	<b>775</b>	<b>-25</b>

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\* Nominal 2005, 2007, 2009, 2011, and 2013 dollars adjusted for inflation using Gross Domestic Product-Implicit Price Deflator and reflect 2015-equivalent dollars.

\*\* Net federal and state royalties from oil and gas production, and included royalties from processing activities returned to North Dakota entities by the Office of Natural Resources Revenue (2016).

Table 18. Direct and Secondary Employment, Petroleum Industry, North Dakota, 2005, 2007, 2009, 2011, 2013, and 2015

Category	2005	2007	2009	2011	2013	2015	Percent Change	
							2005 - 2015	2013 - 2015
Direct Employment (from survey data)								
Oil Operators	1,118	1,402	1,668	2,269	na	na	na	na
Service and Support	3,463	9,831	15,911	37,737	na	na	na	na
Processing and Pipelines	471	579	748	850	na	na	na	na
Totals	5,051	11,812	18,328	40,856	na	na	na	na
Direct Employment (Source: Job Service North Dakota 2014)								
Oil and Gas Drilling, Extraction, Production, and Refining					24,254	21,348		
Infrastructure Development					9,541	7,978		
Professional Services					5,055	4,891		
Transportation					10,173	8,540		
Wholesale Trade and Manufacturing					6,114	5,613		
Total					55,137	48,370	858 <sup>a</sup>	-12.3
Secondary Employment	15,171	17,612	17,729	18,703	26,403	23,984	58	-8.7
Direct and Secondary	20,222	29,424	36,057	59,559	81,540	72,353	258	-11.1

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<sup>a</sup> Percentage change based on Job Service North Dakota (2016) compared to survey estimates from previous studies.

All segments of the industry showed substantial gains in direct and secondary economic impacts from 2005 through 2013, but economic output from drilling/exploration and oil production declined from 2013 to 2015 (Table 19). The causes for those increases between 2005 and 2013 varied by segment of the industry. In exploration, the increase in drilling activity combined with an increase in the cost per well resulted in substantial changes in gross business volume. Gross business volume associated with extraction/production was largely similar to changes in oil and gas production. After correcting for inflation, natural gas prices decreased over the period while oil prices showed little change from 2005 through 2009, but increased substantially from 2009 through 2013. Reductions in economic contributions from well drilling/exploration and oil production are directly attributable to a swift and substantial decline in oil prices starting at the end of 2014. Despite the downturn in oil prices, transportation expenditures, expansions of industry infrastructure (i.e., gas plants and pipeline capacities), and increased processing volumes have contributed to an increase in the gross business volume for the processing/transportation segment of the industry.

The petroleum industry in North Dakota showed real growth in each of the first five biennial studies. Over that period, drilling/exploration dominated the economic contribution from the industry. Over the same period oil production increased in economic importance relative to drilling/exploration. The transition from economic output being dominated by well drilling to one being largely driven by oil production, transportation, and processing is consistent with the process of growing the oil field over the last decade.

Table 19. Key Economic Values, Petroleum Industry, North Dakota, 2005, 2007, 2009, 2011, 2013, and 2015

Category	2005*	2007*	2009*	2011**	2013	2015	Percent Change	
							2005 - 2015	2013 - 2015
----- 000s \$ -----								
<u>Direct Impacts</u>								
Well Development	524,900	1,722,000	3,084,500	7,786,300	7,786,300	5,301,000	910	-32
Extraction/Production	1,072,700	1,457,600	1,980,300	4,211,700	7,855,200	6,211,100	479	-21
Processing/Transp.	156,200	293,400	342,100	503,000	831,500	1,204,400	671	45
All Segments	1,753,800	3,473,000	5,406,900	11,218,000	16,623,000	12,716,600	625	-23
Infrastructure Spending	na	na	na	1,210,400	1,497,400	1,142,300	---	-24
Grand Total	1,753,800	3,473,000	5,406,900	12,428,500	18,120,400	13,858,900	---	-23
<u>Secondary Impacts</u>								
Well Development	914,000	3,050,300	5,203,200	11,329,200	13,085,700	8,868,900	870	-32
Extraction/Production	1,661,000	2,192,800	2,703,600	4,948,700	7,846,500	6,345,200	282	-19
Processing/Transp.	280,800	499,300	623,200	947,800	1,898,700	2,241,800	698	48
All Segments	2,855,800	5,742,400	8,529,100	17,225,800	22,831,000	17,455,900	511	-22
Infrastructure Spending	na	na	na	2,561,700	3,170,600	2,414,600	---	-24
Grand Total	2,855,800	5,742,400	8,529,100	19,787,500	26,001,600	19,870,500	---	-23
<u>Gross Business Volume</u>								
Well Development	1,438,900	4,772,400	8,287,800	17,832,600	20,872,000	14,195,900	887	-32
Extraction/Production	2,733,700	3,659,300	4,682,900	9,159,300	15,703,800	13,053,900	377	-17
Processing/Transp.	437,000	792,600	965,400	1,450,800	2,878,200	3,446,200	689	47
All Segments	4,609,600	9,224,300	13,936,100	28,442,800	39,454,000	30,696,100	566	-21
Infrastructure Spending	na	na	na	3,772,200	4,668,000	3,602,400	---	-23
Grand Total	4,609,600	9,224,300	13,936,100	32,214,900	44,122,000	34,298,400	---	-21
Governmental Revenues	384,130	683,540	1,048,600	2,667,100	4,508,600	3,362,600	775	-25
Industry-wide Employment	5,051	11,812	18,328	40,856	55,137	48,370	858	-12

na = not available.

\* Nominal 2005, 2007, 2009, 2011, and 2013 dollars were adjusted for inflation using Gross Domestic Product-Implicit Price Deflator and reflect 2015-equivalent dollars.

\*\* Infrastructure spending represented average of a low and high estimate.

## SUMMARY

The purpose of this study was to estimate the economic contribution of the petroleum industry in North Dakota in 2015. The petroleum industry was defined to include exploration/development, extraction/production, transportation, and processing of crude oil and natural gas. Also included in this study was an assessment of capital expenditures for infrastructure projects. Exploration was defined to include, but not limited to, seismic testing, geological research, lease expenses, other environmental research, land survey work, excavation, road building, construction of drill site, construction and delivery of electricity, pipeline development, and all other activities associated with drilling and completing oil and/or gas wells. Extraction/production was defined to include, but not limited to, all activities associated with the removal of crude oil and natural gas from the ground, and maintenance and periodic inspections of equipment used to extract oil and gas, and other production related activities, such as well work overs, well idling, shutdown, and abandonment activities. Transportation was limited to the movement of oil and gas from wells to collection points, and then onto processing facilities located either in-state or out-of-state. Petroleum processing in North Dakota included refining of crude oil and natural gas processing.

Due to the complexities of how the oil and gas industry is structured, and that in-state effects (i.e., first round spending or direct impacts) from the petroleum industry in any given year not unlikely to equal the market value of oil and gas production, an expenditure-based approach to measuring the economic size of the petroleum industry was used in this study. In this approach, only money spent in North Dakota by companies involved in the petroleum sector was included in the study and represented the direct impacts of the industry. In addition to in-state expenditures for exploration/development, extraction/production, transportation, and processing activities, private and public royalties, lease bonuses, and severance taxes also were included as direct impacts. Secondary economic impacts result from the spending and respending of the direct impacts and were estimated using the North Dakota Input-Output Model.

Two surveys were used to collect production, expenditure, and employment data for the petroleum industry in North Dakota. Firms that own or operate oil wells in the state were surveyed to obtain information on in-state expenses for oil and gas exploration, oil and gas extraction/production, general business expenses, expenditures for infrastructure projects, employment, oil and gas production, and drilling activity. A similar survey was conducted for firms engaged in pipeline transportation of crude oil and unprocessed natural gas and included firms involved with processing of crude oil and natural gas in North Dakota

The survey of oil operators produced financial data on about 47 percent of North Dakota's oil and gas production in 2015. Also, financial data were collected on pipeline transportation, gas processing, and crude oil refining which represented over 50 percent of oil and gas volumes in those industry segments in 2015. Secondary data, obtained from government agencies, were combined with survey data to estimate royalties, lease bonuses, and severance taxes. Secondary data also were used in estimating project-based capital costs for selected infrastructure projects in the state (e.g., gas plants, pipeline expansions).

Estimates of total in-state expenditures in 2015 for oil and gas exploration/development were derived from the survey of oil operators and used with drilling statistics from the North Dakota Department of Mineral Resources (2017). A total of 1,583 wells were completed in 2015. Average expense per well for oil operators was estimated at just under \$7 million, yielding about \$11 billion in total financial outlays for well development. Financial data on expenses for well drilling and completion from previous studies were used to adjust the capital costs to drill and complete a well to reflect specific inputs supplied by in-state sources. The

net effect of removing expenses for those capital outlays revealed that about 52 percent of the cost to complete a well in North Dakota represented economic leakage that was not included in the industry's direct economic impacts. The direct impact per well completed in the state was estimated at \$3.3 million. The combination of in-state expenses for exploration and lease bonuses resulted in \$7.6 billion in direct impacts in 2015. The secondary economic impacts associated with exploration activities were estimated at \$12.8 billion. The in-state gross business volume (direct and secondary impacts) of exploration activities was estimated at \$20.4 billion in 2015 (Figure 7).

Estimates of oil and gas extraction/production expenses, general business expenses for oil operators, private and public royalties, and state severance taxes were derived from survey data and secondary information obtained from various government agencies. The state averaged 12,799 active wells per month in 2015 that produced 432 million barrels of oil and over 584 million mcf of natural gas. Total direct impacts for oil and gas production were estimated at \$6.2 billion in 2015. Total secondary economic impacts associated with oil and gas production were estimated at \$6.3 billion. The in-state gross business volume of oil and gas extraction/production was estimated at \$12.6 billion in 2015 (Figure 7).

The processing component of the petroleum industry was estimated to have a direct impact in North Dakota of \$1.2 billion. Total secondary economic impacts associated with processing and transporting crude oil and natural gas were estimated at \$2.2 billion. The in-state gross business volume of processing and transporting crude oil and natural gas was estimated at \$3.4 billion in 2015 (Figure 7).

The petroleum industry was estimated to have spent between \$2.5 billion to \$2.7 billion on infrastructure projects in the state in 2015. After adjustments for economic leakage (the portion of expenditures not captured in the North Dakota economy), it was estimated that about \$1.1 billion to \$1.2 billion were captured in the North Dakota economy. The gross business volume associated with infrastructure spending in North Dakota was estimated to range from \$3.5 to \$3.7 billion in 2015. Infrastructure spending, as defined in this report, would represent additional economic activity beyond that created by the exploration, production, transportation, and processing segments of the industry.

Industry-wide direct impacts from the petroleum industry were estimated at \$12.7 billion in 2015 (not including infrastructure spending). Total secondary economic impacts associated with the industry were estimated at \$17.5 billion. The gross business volume for the petroleum industry in North Dakota in 2015 was estimated at \$30.2 billion (Figure 7). When including in-state expenditures for infrastructure projects, the petroleum industry was estimated to have \$13.9 billion, \$19.9 billion, and \$33.7 billion in direct impacts, secondary impacts, and gross business volume, respectively.

Additional measures of the petroleum industry's economic importance to the state include direct employment for 48,370 full-time jobs, economy-wide personal income of \$4.9 billion, statewide retail sales of \$8.8 billion, direct contributions to local and state government revenues of \$3 billion, indirect contribution of \$267 million in state government tax collections, and secondary employment of 23,984 full-time equivalent jobs. For every dollar spent in the state by the petroleum industry, another \$1.43 in additional business activity was generated.

A number of comparisons to information collected and estimated for 2005, 2007, 2009, 2011, and 2013 was made to similar figures for 2015. While energy prices were not directly used in the study to generate estimates of industry activity, prices directly influence some measures of industry output, such as tax

collections and royalties. Oil prices increased from 2005 to 2007 in real terms by 26 percent to around \$65 per barrel, but decreased to 2005 levels in 2009. Prices in 2009 remained well below the extreme price spikes observed in 2008; however, prices in 2011 and 2013 remained above annual values for 2005, 2007, and 2009. Oil prices, average monthly, were down 56 percent from 2013 and nearly 34 percent from 2005. Gas prices, both in real terms, decreased by 79 percent from 2005 to 2015 and prices declined by 36 percent from 2013 to 2015. Oil production increased from 35 million barrels to 432 million barrels over the period. Natural gas production jumped from around 58 million mcf in 2005 to over 584 million mcf in 2015. The number of producing wells went from around 3,400 in 2005 to about 12,800 in 2015.

# North Dakota Petroleum Industry

## Key Segments of the Industry

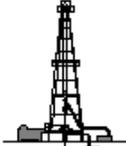
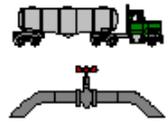
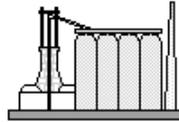
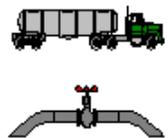
	Exploration	Extraction	Transportation	Processing	Infrastructure	Distribution	Retail
	drilling and locating oil reserves 	bringing oil and gas to the surface 	moving oil and gas from pumps to processing centers 	oil refining and natural gas processing 	construction of plants, pipelines, and other facilities 	moving products from processors to retail markets 	selling petroleum products to end users
Direct Impacts	\$5.3 billion	\$6.2 billion	\$1.2 billion		\$1.1 billion	not included	
Secondary Impacts	\$8.8 billion	\$6.3 billion	\$2.2 million		\$2.3 billion		
Gross Business Volume	\$14.1 billion	\$12.5 billion	\$3.4 million		\$3.4 billion		
Direct Employment	48,370 full-time equivalent jobs						
Secondary Employment	23,984 full-time equivalent jobs						
Direct Government Revenues	\$179 million	\$2.7 billion	\$93 million				

Figure 5. Economic Effects of Key Segments of the North Dakota Petroleum Industry, 2015

## CONCLUSIONS

Changes in energy prices, drilling activity, and oil and gas production in North Dakota have made the petroleum industry one of the largest single basic-sector industries in the state. Comparisons of the industry's economic importance in 2015 with previous estimates from 2005, 2007, 2009, 2011, and 2013 reveal the industry has increased 6-fold (570 percent) in economic size in 10 years (i.e., 2005 to 2015). While some of that increase can be directly attributable to an increase in the number of producing wells, which has led to increased oil and gas production, the primary reason for the substantial increase has been due to expenditures for oil drilling and well completion activities.

The economic contribution of the petroleum industry was measured based on factors present in the industry in 2015. As such, the figures presented in this report represent a snapshot in time, and will not necessarily reflect the future economic impact of the industry. This point should be readily apparent as the industry underwent a substantial contraction during 2015 due to swift and substantial price declines. As such, many elements of the industry's economic contribution to North Dakota's economy will increase and decrease with changes in variety of factors that affect petroleum exploration, extraction/production, and processing levels.

The industry was estimated to have capital expenditures for infrastructure-related projects in the state ranging from \$2.5 to \$2.7 billion in 2015. Considering the dramatic price declines in 2015, the industry continued to finish and expand existing infrastructure projects to meet current and future anticipated needs. The decision to invest billions in infrastructure in the state reveals the industry's long-term perspective on the value of crude oil and gas reserves in the Williston Basin.

Several studies have recently identified potential long-term growth in well counts and oil and gas production in North Dakota (North Dakota Department of Mineral Resources 2015, KLJ 2014). All of these independent assessments, while not necessarily agreeing on the exact path or future size of the industry, confirm expectations that the petroleum sector in North Dakota will continue to grow over the next two decades, and will be considerably larger (i.e., well counts, oil and gas output) in the future. This study demonstrates the economic benefits of expanding oil production in the state, and the economic value that oil and gas development can have on the state's economy. Of particular interest from a policy perspective is the potential to capture economic activity from the anticipated growth in the development of the Bakken/Three Forks Formations. Shale oil development is now occurring in numerous locations in North America and given that most oil operators in the state also are active in other shale plays across the continent, the economic opportunity of developing the Bakken/Three Forks Formations in North Dakota should not be taken for granted. North Dakota has an enormous potential for continued economic growth in its economy that can come from development of shale energy in the state.

Regardless of the economic measure used, currently the petroleum industry is one of the largest basic-sector industries in North Dakota, despite the recent contraction of industry output since early 2015. Considering that the industry's direct impacts (i.e., first round of spending) are concentrated geographically in the western portion of the state, the economic health of western North Dakota is perhaps tied more to the petroleum industry than any other single industry. Yet, despite the strong influence of the petroleum industry in western North Dakota, the magnitude of the contributions to both the state and local governments and the sheer volume of secondary economic effects in nearly all sectors of the North Dakota economy would suggest that the economic effects of the industry are felt statewide. Current activity levels in the petroleum industry clearly make it one of the key forces in the North Dakota economy.

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**APPENDIX A**

**Questionnaire, Oil Operators,  
North Dakota, 2015**

# Contribution of the Petroleum Industry to the North Dakota Economy

## Survey of Oil Operators

Department of Agribusiness and Applied Economics  
North Dakota State University  
and  
North Dakota Petroleum Council

## Instructions and Guidelines for Filling Out the Questionnaire

Data provided from this survey will be used to help estimate the economic contribution of the oil industry to the North Dakota economy. The goal is to determine how much money the oil industry spends in North Dakota. All expenditure data will be synthesized in a manner that only industry-wide totals will be reported. In no way will any information presented in the study identify or be reflective of any single firm or operation.

The following is a list of general guidelines for the questionnaire.

1. Use information from 2015 or your most recently completed fiscal year.
2. Expenditures should be expressed in U.S. dollars.
3. If the actual amount of the expenditure is not easily determined or is not readily known, please provide an estimate of the expense.
4. For contractor expenditures (Part II of this questionnaire), please include all expenditures made for services provided in North Dakota, even if the office or headquarters of the contractor or service provider is not located in North Dakota.
4. For infrastructure expenditures (Part III of the questionnaire), include costs associated with the various categories for 2015.
5. For general expenditures for day-to-day operations (Part IV of the questionnaire), include only how much your company paid out to entities in North Dakota.
6. If you cannot identify whether an expenditure was made in North Dakota or in another state, indicate this on the form.
7. Definitions for some expenditure items and their corresponding Standard Industrial Classification (SIC) code listing are included to help in determining allocation of expenditures.
8. Please complete the survey by **September 1** and mail the questionnaire in the return envelope.
9. If you have questions, please contact:

Dean Bangsund  
701-231-7471

Email: [d.bangsund@ndsu.edu](mailto:d.bangsund@ndsu.edu)

or

Dr. Nancy Hodur  
701-231-7357

Email: [nancy.hodur@ndsu.edu](mailto:nancy.hodur@ndsu.edu)

Department of Agribusiness and Applied Economics  
North Dakota State University  
Fargo, ND 58108-6050

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**Part I - - General Information**

Business Name:

Mailing Address:

Contact Person:

The following questions pertain only to wells for which your company is the operator.

Number of producing oil wells in ND in 2015 for which your company was the operator _____		
	<b>Oil</b>	<b>Gas</b>
Total production from your operated wells in 2015	_____ bbls	_____ mcf
Operator interest share of production	_____ %	_____ %
All royalty interest share of production	_____ %	_____ %
Remaining working interest share of production	_____ %	_____ %

Total number of employees working in North Dakota: _____ (Full-time equivalents)	
Number of jobs (FTE's) above dedicated to exploration/drilling	_____
Number of jobs (FTE's) above dedicated to general production/extraction	_____

**Part II. Payments made to Contractors, Sub-contractors, and Consultants**

The following instructions pertain to **Part II** of the Questionnaire.

- 1) Only report contracted expenses for wells in North Dakota for which your company serves as the operator even if your company's stake in those wells is small. Do not include expenses for wells for which your company only has a working interest share—those expenses will be reported by other oil operators.
  
- 2) Please include the total cost for the contracted service for those wells. The total cost will include your company's share of the costs as well as the costs billed to the working interest holders on the well.

Please indicate expenses for producing wells, wells currently being drilled, and wells that were drilled, but never used.

- 4) Only include contracted expenses for the last year.
  
- 5) Please include all expenditures made for services provided in North Dakota, even if the office or headquarters of the contractor or service provider is not located in North Dakota.

<b>Part II.</b> <b>Type of Contracting Work Performed</b>	<b>Payments for work done in North Dakota</b>
<b>General Exploration</b> Examples of services include lease brokerage costs (lease arrangements and landowner negotiations), landman expenses, environmental services, seismic testing and geological research	\$
<b>Drilling Activities (Capital Investments)</b> Examples of services include land survey work, excavation, road building, construction of drill site, other drill site preparations such as providing electricity, setting up storage facilities, etc., erecting derrick, mudding operations, spudding operations, wellbore casing, case perforation, logging, fracing services, wellhead placement, pipeline development and construction, and any other services provided that are associated with drilling activities  This category of expenses should include all phases of drilling for both primary wells and secondary/tertiary/EOR injection wells	\$
<b>Oil and Gas Extraction and Production (Operating Expenses)</b> Examples of services include pump, well, and storage tank maintenance and servicing; daily & weekly well visits for tank switching, periodic inspections, general monitoring, and other activities; well stimulations; well work overs; well idling, shutdown, and/or abandonment activities	\$
<b>Transportation</b> Include expenses for <u>truck transportation</u> of oil from well site to pipeline collection points (terminal) and expenses for truck transportation of other products and by-products from well site to secondary locations, also include all charges for transportation of gas and oil <u>by pipeline or rail</u> until products are sold to a purchaser or buyer	\$
<b>Any other services</b> or activities provided by contracted arrangements not listed above:  _____ (please specify) _____ (please specify) _____ (please specify) _____ (please specify)	\$ _____ \$ _____ \$ _____ \$ _____

**Part III.** This section relates to your company’s expenses associated with infrastructure development in North Dakota. To avoid double counting, do not include any expenditures here that are reported in Part II dealing with exploration, drilling/well development, or operating expenses. Please report total expenditures in 2015 for the following categories with respect to infrastructure in North Dakota. Figures can be rounded to thousands.

**If your company had no expenses in a particular category, please enter zero.**

<b>Infrastructure Categories</b>	<b>Expenses for projects in North Dakota in 2015</b>
<b>Oil Field Gathering Systems</b> Construction of oil pipeline gathering systems (field systems) to move crude oil to transmission pipelines or rail facilities.	\$
<b>Gas Midstream Projects</b> Construction of gas gathering systems, construction of gas plants, construction of fractionation facilities, and pipelines for distribution of gas to main pipelines.	\$
<b>Oil Shipment Facilities</b> Facilities for shipment of crude oil, including pipeline capacity enhancements, rail loading facilities, and any storage facilities associated with those facilities.	\$
<b>Water Treatment Facilities</b> Construction expenses for water disposal facilities, frac water recycling facilities, and any distribution systems (in-field pipelines) for movement of frac and brine water to treatment or disposal facilities.	\$
<b>Housing and Lodging</b> Include expenses associated with the construction/development of man camps, lodging facilities at work sites, and construction of other housing projects (e.g., company owned apartments and houses). NOTE: please include all lodging expenses for actual housing of workers (motel rooms, meals, other arrangements) that are not related to constructing housing infrastructure in Section II.	\$
<b>Office and Other Facilities</b> Expenditures for construction/development of company offices, central facilities, maintenance facilities, and holding/transit facilities.	\$
<b>Other Facilities</b> Please specify	\$

**Part IV.** The following expenses relate to your company's general business operations in North Dakota and should represent expenses paid only to North Dakota entities. These expenses should not include any payments made to oil industry contractors or consultants associated with exploration or extraction. Please refer to the accompanying sheet for definitions and clarification of what expenses should be included in the expenditure categories.

**If your company had no expenses in a particular category, please enter zero.**

<b>General Business Expenses</b>	<b>Expenses paid to North Dakota entities</b>
Building and equipment leases (e.g., office space, vehicles)	\$
Business and personal services	\$
Professional and social services	\$
Communications	\$
Construction	\$
Public utilities	\$
Employee wages and salaries	\$
Employee benefits (retirement, health insurance, etc.)	\$
Payroll taxes (FICA, etc.)	\$
Insurance	\$
Interest, finance, and banking expenses	\$
Retail trade	\$
Wholesale trade	\$
Research and development	\$
North Dakota taxes:	
Property	\$
Income	\$
Sales and use	\$
Transportation (note: pipeline expenses should be reported in Part II)	\$
Any miscellaneous payments to working interests	\$
Any miscellaneous payments to royalty interests	\$
Other expenses (please specify).	\$

### Definitions for Expenditure Categories—Part III of Questionnaire

The following definitions are derived from Standard Industrial Classification Manual (SIC codes) and have been provided to assist in allocating expenses into common categories. If needed, please refer to the following web site for additional examples of the expenses included in each category: [http://www.osha.gov/pls/imis/sic\\_manual.html](http://www.osha.gov/pls/imis/sic_manual.html) Each category has several Major Group numbers, which contain additional detail on the type of activities in each category.

**Construction:** Includes expenses for construction projects, such as construction (including new work, additions, alterations, remodeling, and repairs) of residential, industrial, public, office, warehouse, and other buildings and structures. (Major Groups 15, 16, and 17)

**Transportation:** Includes expenses for railroad, motor freight, water transportation, air transportation, and other transportation to include packing and crating services, and rental of transportation equipment. (Major Groups 40, 41, 42, 43, 44, 45, 46, and 47)

**Communications:** Includes expenditures for telephone, telegraph, radio, television, satellite services, Internet transactions, and other communication services. (Major Group 48)

**Public Utilities:** Includes expenses for natural gas, electricity, water supply, and sanitary (sewer & garbage) services. (Major Group 49)

**Wholesale Trade:** Expenses paid to establishments primarily engaged in selling merchandise to retailers; to industrial, commercial, institutional, or professional users; or to other wholesalers, or acting as agents in buying merchandise for or selling merchandise to such persons or companies. (Major Groups 50 and 51)

**Retail Trade:** Includes expenses for building materials, hardware, food, general merchandise, office supplies, automobile fuel, computers, eating and drinking establishments, work uniforms, and most other business and office-related supplies. (Major Groups 52, 53, 54, 55, 56, 57, 58, and 59)

**Finance, Insurance, and Real Estate:** Includes expenses for loan service, interest on loans, investment counseling, insurance, real estate transactions, brokerage fees, and any other financial service expenditures. (Major Groups 60, 61, 62, 63, 64, 65, 66, and 67)

**Business and Personal Services:** Examples of business and personal services include expenses for advertising, collection services, photocopying/duplication/printing services, equipment rental, computer services, computer software, security services, tax preparation, automotive/equipment/miscellaneous repairs, entertainment, janitorial services, and overnight lodging. (Major Groups 70, 72, 73, 75, 76, 78, 79, and 87)

**Professional and Social Services:** Includes expenses for health/pharmaceutical, medical, legal, educational, research and development, child care, vocational training, and other professional services. (Major Groups 80, 81, 82, 83, 84, 86, 88, and 89)

**Part V. Drilling Activity in North Dakota.** Please summarize your company's drilling activities in North Dakota over the past year.

<b>Drilling</b>	<b>2015</b>
Overall number of wells drilled	
Number of wells drilled that were plugged (dry holes)	
Number of wells drilled that went into production (completed as a producer)	

**Part VI. Mineral Royalty Payments.** This section is looking for total private mineral royalty payments and mineral payments mailed to entities in North Dakota.

<b>Payments to Private Mineral Royalty Owners</b>	<b>2015</b>
<p>Gross Payment of mineral royalties to all private mineral owners associated with oil and gas wells in North Dakota</p> <p>Note: Only include payments to private mineral owners, <u>exclude</u> payments to working interests and public mineral owners (e.g., state, Federal).</p>	
<p>Gross Payments for private mineral royalties that went to North Dakota addresses</p> <p>Note: This is the portion of the payment above that went to some entity (person, bank, trust) in North Dakota.</p>	

**Part VII. List of Contractors/Venders.** Please provide the name and mailing address of all companies that your firm has contracted with over the last year to perform work in the oil fields in North Dakota. Please include all companies even if they do not have a North Dakota address. If a computer listing is not available, please use the following space to provide the information.

Name of Company

Address (street, city, state, zip)

Please add sheets or attach printouts as needed.

## **Thank You for completing this questionnaire!**

Please return the questionnaire in the postpaid envelope.

If you would like a copy of the study results mailed to you, make sure you have provided a mailing address in Part I of the questionnaire. Otherwise, you may contact Edie Nelson in the Department of Agribusiness and Applied Economics at North Dakota State University for more information on our departmental reports. Phone (701)231-7441, fax (701)231-7400, email: [ndsu.agribusiness@ndsu.edu](mailto:ndsu.agribusiness@ndsu.edu) or visit our departmental listing of research reports on the internet at <http://ageconsearch.umn.edu/>

Study results should be available at the end of 2016.

**APPENDIX B**

**Questionnaire, Processors,  
North Dakota, 2015**

Contribution of the Petroleum Industry  
to the North Dakota Economy

Survey of Gas Pipelines and Gas Plants

Department of Agribusiness and Applied Economics  
North Dakota State University  
and  
North Dakota Petroleum Council

## Instructions and Guidelines for Filling Out the Questionnaire

Data provided from this survey will be used to help estimate the economic contribution of the oil industry to the North Dakota economy. The goal is to determine how much money the oil industry spends in North Dakota. All expenditure data will be synthesized in a manner that only industry-wide totals will be reported. In no way will any information presented in the study identify or be reflective of any single firm or operation.

The following is a list of general guidelines for the questionnaire.

1. Use information from 2015 or your most recently completed fiscal year.
2. Expenditures should be expressed in U.S. dollars.
3. If the actual amount of the expenditure is not easily determined or is not readily known, please provide an estimate of the expense.
4. Only include expenditures made to businesses, governments, or individuals in North Dakota.
5. If you cannot identify whether an expenditure was made in North Dakota or in another state, indicate this on the form.
6. Definitions for some expenditure items and their corresponding Standard Industrial Classification (SIC) code listing are included to help in determining allocation of expenditures.
7. We would prefer to have the questionnaire completed and returned by **September 1, 2016**.

If you have questions, please contact:

Dean Bangsund

701-231-7471

Email: [d.bangsund@ndsu.edu](mailto:d.bangsund@ndsu.edu)

or

Dr. Nancy Hodur

701-231-7357

Email: [nancy.hodur@ndsu.edu](mailto:nancy.hodur@ndsu.edu)

Department of Agribusiness and Applied Economics  
North Dakota State University  
Fargo, ND 58108-6050

## Part I - - General Information

Business Name:

Mailing Address:

Contact Person:

Total MCF of gas processed in the last year for operations and facilities located  
in North Dakota (if applicable) \_\_\_\_\_

Percent of gas processed that was from North Dakota sources \_\_\_\_\_

Percent of gas processed that was from sources in other states \_\_\_\_\_

Percent of gas processed that was from Canadian sources \_\_\_\_\_

Total MCF of gas transported in the last year for operations and facilities located  
in North Dakota (if applicable) \_\_\_\_\_

Percent of gas transported that was from North Dakota sources \_\_\_\_\_

Percent of gas transported that was from sources in other states \_\_\_\_\_

Percent of gas transported that was from Canadian sources \_\_\_\_\_

Number of employees in North Dakota (full-time equivalents) in 2015 \_\_\_\_\_

## Part II: Annual Expenses

The following expenditures should represent expenses paid only to North Dakota entities. Please refer to the accompanying sheet for definitions and clarification of what expenses should be included in the expenditure categories.

<u>Operating Expenses in 2015</u>	Expenses paid to North Dakota entities
Building and equipment leases (e.g., office space, vehicles)	\$
Business and personal services	\$
Professional and social services	\$
Communications	\$
Construction	\$
Public Utilities	\$
Employee wages and salaries	\$
Employee benefits (retirement, health insurance, etc.)	\$
Payroll taxes (FICA, etc.)	\$
Insurance	\$
Interest, finance, and banking expenses	\$
Purchases of gas (from ND sources)	\$
Transportation	\$
Retail Trade	\$
Research and Development	\$
North Dakota Taxes	\$
Property	\$
Income	\$
Sales and Use	\$
Other expenses (please specify)	\$
	\$

## Definitions for Expenditure Categories

The following definitions are derived from the Standard Industrial Classification Manual (SIC codes) and have been provided to assist in allocating expenses into common categories. If needed, please refer to the following web site for additional examples of the expenses included in each category: [http://www.osha.gov/pls/imis/sic\\_manual.html](http://www.osha.gov/pls/imis/sic_manual.html) Each category has several Major Group numbers, which contain additional detail on the type of activities in each category.

**Construction:** Includes expenses for construction projects, such as construction (including new work, additions, alterations, remodeling, and repairs) of residential, industrial, public, office, warehouse, and other buildings and structures. (Major Groups 15, 16, and 17)

**Transportation:** Includes expenses for railroad, motor freight, water transportation, air transportation, pipeline transportation of petroleum, and other transportation to include packing and crating services, and rental of transportation equipment. (Major Groups 40, 41, 42, 43, 44, 45, 46, and 47)

**Communications:** Includes expenditures for telephone, telegraph, radio, television, satellite services, Internet transactions, and other communication services. (Major Group 48)

**Public Utilities:** Includes expenses for natural gas, electricity, water supply, and sanitary (sewer & garbage) services. (Major Group 49)

**Wholesale Trade:** Expenses paid to establishments primarily engaged in selling merchandise to retailers; to industrial, commercial, institutional, or professional users; or to other wholesalers, or acting as agents in buying merchandise for or selling merchandise to such persons or companies. (Major Groups 50 and 51)

**Retail Trade:** Includes expenses for building materials, hardware, food, general merchandise, office supplies, automobile fuel, computers, eating and drinking establishments, work uniforms, and most other business and office-related supplies. (Major Groups 52, 53, 54, 55, 56, 57, 58, and 59)

**Finance, Insurance, and Real Estate:** Includes expenses for loan service, interest on loans, investment counseling, insurance, real estate transactions, brokerage fees, and any other financial service expenditures. (Major Groups 60, 61, 62, 63, 64, 65, 66, and 67)

**Business and Personal Services:** Examples of business and personal services include expenses for advertising, collection services, photocopying/duplication/printing services, equipment rental, computer services, computer software, security services, tax preparation, automotive/equipment/miscellaneous repairs, entertainment, janitorial services, and overnight lodging. (Major Groups 70, 72, 73, 75, 76, 78, 79, and 87)

**Professional and Social Services:** Includes expenses for health/pharmaceutical, medical, legal, educational, research and development, child care, vocational training, and other professional services. (Major Groups 80, 81, 82, 83, 84, 86, 88, and 89)

## Part III: Infrastructure Expenditures

This section relates to your company's expenses associated with infrastructure development in North Dakota. To avoid double counting, do not include any expenditures here that are reported in Part II that may have already been included in your annual operating expenses. Please report total expenditures in 2015 for the following categories with respect to infrastructure in North Dakota. Figures can be rounded to thousands.

**If your company had no expenses in a particular category, please enter zero.**

<b>Infrastructure Categories</b>	<b>Expenses for projects in North Dakota in 2015</b>
<b>Oil Field Gathering Systems</b> Construction of oil pipeline gathering systems (field systems) to move crude oil to transmission pipelines or rail facilities.	\$
<b>Gas Midstream Projects</b> Construction of gas gathering systems, construction of gas plants, construction of fractionation facilities, and pipelines for distribution of gas to main pipelines.	\$
<b>Oil Shipment Facilities</b> Facilities for shipment of crude oil, including pipeline capacity enhancements, rail loading facilities, and any storage facilities associated with those facilities.	\$
<b>Water Treatment Facilities</b> Construction expenses for water disposal facilities, frac water recycling facilities, and any distribution systems (in-field pipelines) for movement of frac and brine water to treatment or disposal facilities.	\$
<b>Housing and Lodging</b> Include expenses associated with the construction/development of man camps, lodging facilities at work sites, and construction of other housing projects (e.g., company owned apartments and houses). NOTE: please include all lodging expenses for actual housing of workers (motel rooms, meals, other arrangements) that are not related to constructing housing infrastructure in Section II.	\$
<b>Office and Other Facilities</b> Expenditures for construction/development of company offices, central facilities, maintenance facilities, and holding/transit facilities.	\$
<b>Other Facilities</b> Please specify	\$

## **Thank You for completing this questionnaire!**

Please return the questionnaire in the postpaid envelope.

If you would like a copy of the study results mailed to you, make sure you have provided a mailing address in Part I of the questionnaire. Otherwise, you may contact Edie Nelson in the Department of Agribusiness and Applied Economics at North Dakota State University for more information on our departmental reports. Phone 701-231 7441, fax 701-231-7400, email: [nds.agribusiness@nds.edu](mailto:nds.agribusiness@nds.edu) or visit our departmental listing of research reports on the internet at <http://agecon.lib.umn.edu>

Study results should be available the end of 2016.