IHS ECONOMICS AND COUNTRY RISK

The Effects of North Dakota Oil Production on the Minnesota Economy

April 2015

ihs.com

Brendan O'Neil
Managing Director, ECR Consulting

Phil Hopkins
Director, ECR Consulting

Kevin Lindemer
Managing Director, Downstream Consulting

Ryland Maltsbarger
Director, Economist, IHS Agriculture

Bob Brodesky
Director, ECR Consulting

Elizabeth Redman
Senior Consultant, ECR Consulting

Julie Gressley
Research Economist, ECR Consulting

Aleksandra Maguire
Industry Consultant, ECR Consulting

Contents

Executive summary 4
Background 4
Phase 1: energy production forecast 4
Phase 2: transportation impacts 5
Phase 3: economic impacts 5
Phase 4: SCOPE analysis 7

Introduction 9
Background 9
Organization 9

Phase 1: Energy production forecast 11
International context 12
Forecasts of non-OPEC liquids supply and the need for OPEC oil 13
Global breakeven costs 14
US context 15
US net imports 15
Regional context 15
Historical liquids supply-and-demand balance 16
Bakken shale formation 17
Bakken potential pipeline capacity and rail requirements 18
Frac sand 19
2014 Bakken breakeven cost and volume of production 20
Direct spending effects 21
Major findings 23
Policy considerations 23

Phase 2: Transportation impacts 25
Mode share distributions for all commodities 26
Commodity flows by rail and truck 27
Minnesota freight overview 29
Transportation summary 39

Phase 3: Economic impacts 42
Economic structure and performance 43
Comparative socioeconomic characteristics 47
Labor market characteristics 49
Key economic sectors in Minnesota 50
Backward-linkage sectors 52
Economic impacts of backward linkages 54
Estimating total economic impacts 59
Results: Total economic impacts 59
Tax impacts 65
Economic impacts in the Border Cities and their respective counties 66

IHS™ ECONOMICS AND COUNTRY RISK

Copyright notice and legal disclaimer
© 2015 IHS. No portion of this report may be reproduced, reused, or otherwise distributed in any form without prior written consent, with the exception of any internal client distribution as may be permitted in the license agreement between client and IHS. Content reproduced or redistributed with IHS permission must display IHS legal notices and attributions of authorship. The information contained herein is from sources considered reliable but its accuracy and completeness are not warranted, nor are the opinions and analyses which are based upon it, and to the extent permitted by law, IHS shall not be liable for any errors or omissions or any loss, damage or expense incurred by reliance on information or any statement contained herein. IHS and the IHS logo are trademarks of IHS. For more information, please contact IHS at www.ihs.com/CustomerCare.

Economic development and forward linkages 68
Other economic effects 71
Economic summary 72

Phase 4: SCOPE Analysis 74
Methodology 74
Situation today 74
Core competencies 76
Obstacles 78
Prospects 81
Expectations 86

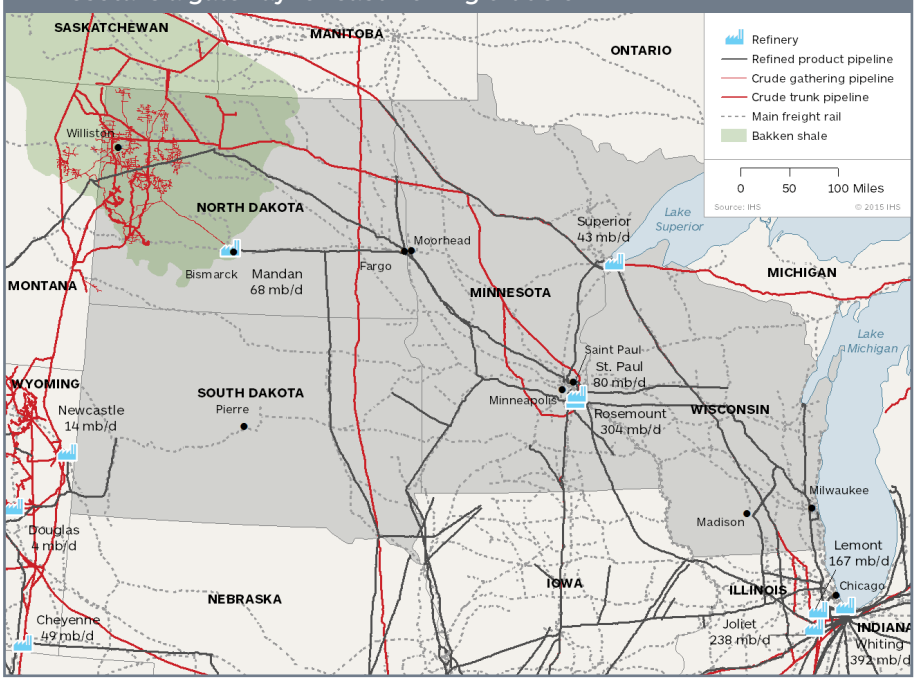
Executive summary

Background

The Minnesota Department of Employment and Economic Development engaged IHS to assess the effects on the Minnesota economy of crude-oil production originating from North Dakota's Bakken shale formation. Prior IHS research has found that unconventional oil and natural gas is having a transformational impact on the US economy, and there are clear trends shaping state level economies, as well. The Bakken shale formation is located in western North Dakota and eastern Montana, a driving distance of 200 miles from Moorhead and 427 miles from St. Paul. Oil production in the Bakken shale formation increased rapidly from 2007 to April 2014, from about 123,600 barrels per day to more than 1 million barrels per day, making North Dakota the second-largest oil-producing state. Crude-oil production generated high levels of direct spending in North Dakota, which has led to very high rate of economic growth since 2007 and higher demand for goods, services, and labor from many states, including Minnesota. As the level of daily oil production rose, increasing amounts of crude oil began to be shipped eastward across Minnesota by rail, which has increased the visibility of oil-production impacts in Minnesota and had disruptive effects in Minnesota's five Border Cities.

The five Border Cities are Breckenridge in Wilkin County, Dilworth in Clay County, East Grand Forks in Polk County, Moorhead in Clay County, and Ortonville in Big Stone and Lac qui Parle counties. The impacts in Minnesota presented in this study are based only on those effects that can be directly attributed to the production of oil in the Bakken formation. The IHS team evaluated these impacts in four project phases.

Minnesota is a gateway for east-flowing crude oil



Phase 1: energy production forecast

The economic impacts in Minnesota are determined primarily by the amount of crude oil that will be produced in North Dakota. The exploration, drilling, and extraction activities required to produce crude oil are a function of the number of wells drilled and brought online and the total number of wells in operation. These activities generate high levels of annual direct spending for capital equipment (capex) and operating expenditures (opex). IHS forecast the annual crude-oil production levels and their respective direct expenditures in North Dakota based on three oil-price scenarios:

- Low-price scenario: $50/barrel for West Texas Intermediate (WTI) crude oil, with oil prices remaining in the range observed in late December 2014 and January 2015
- Base-price scenario: $70/barrel WTI, with oil prices recovering quickly from the low levels of early 2015 and fluctuating in the $70/barrel WTI range
- High-price scenario: $90/barrel WTI, with oil prices rebounding quickly to the levels observed before mid-October 2014.

In the base scenario ($70/barrel), crude-oil production in the Bakken region continues to rise to just over 1.6 million barrels per day by the middle of the next decade. With prices now expected to be well below this range for the next

few years, Bakken oil-production growth is expected to slow. If oil prices return to $90/barrel or higher in the next few years, Bakken production could exceed 2.0 million barrels per day by the middle of the next decade. However, if oil prices remain in the $50/barrel WTI range, production is not expected to increase; rather, it will remain relatively steady at around 1.1 million barrels per day. The IHS long-term oil-price outlook foresees WTI crude-oil prices returning to the $70–90/barrel (inflation adjusted) range over the next few years, therefore the $70/barrel scenario is considered the base scenario for the analysis. Combined capex and opex spending in North Dakota in 2014 was estimated at $21.1 billion. Under the base scenario, direct spending is forecast at $15.5 billion in 2016, $17.4 billion in 2019, and $15.1 billion by 2030. Under the high-price scenario, combined capex and opex spending is projected at $24.9 billion in 2016, $28.2 billion in 2019, and $24.3 billion in 2030. Finally, combined capex and opex spending in North Dakota under the low-price scenario is forecast at $7.7 billion in 2016, $8.5 billion in 2019, and $7.3 billion in 2030. As shown in the economic impact table below, lower levels of capex and opex spending in North Dakota reduce the economic benefits that accrue to Minnesota.

Phase 2: transportation impacts

IHS examined the pattern of commodity flows—such as crude oil, coal, grain, other agricultural commodities, sand and gravel, and food products—both into Minnesota and flowing out of Minnesota to other regions, particularly North Dakota. Using IHS's proprietary Transearch commodity flow database, we estimated the demand for rail capacity in the form of the number of unit trains passing through Minnesota under the three oil-price scenarios.

Under the base scenario, which assumes that no additional crude-oil pipelines will be built, the number of unit trains per day transiting Minnesota carrying crude oil produced in North Dakota is forecast to drop from 9 in 2014 to 5 in 2015, and then increase to 7 in 2020, 10 in 2025, and 11 in 2030. If the proposed additional pipelines are completed, we forecast that the number of unit trains will fall to 5 per day in 2015; nearly all oil shipments would be diverted to pipelines between 2017 and 2020, resulting in total pipeline dependency after 2020. Under the high-price scenario, the number of unit trains per day would be 6 in 2015, before increasing to 14 in 2025 and 17 in 2030, assuming no additional pipelines.

Accommodating agricultural and crude-oil demand for transportation will require rail and highway system capacity expansions that ensure reliable and timely shipments of all commodity types. We anticipate growth of gravel and sand and stone-related commodities shipped by rail and truck to North Dakota and other Midwest locations. The Twin Cities are a significant intermodal hub for national, interregional, and regional shipments and warehousing. The North Dakota oil developments present an opportunity for the Twin Cities to leverage and maximize their role in providing intermodal connectivity and distribution services. This provides Border Cities an opportunity to identify sites that would facilitate railcar maintenance, manufacturing and parts assembly, and supply-chain management (e.g., warehouse and distribution centers).

Phase 3: economic impacts

Changes in statewide economic activity

IHS estimated the total economic impact on the Minnesota economy for three direct effects:

- Annual levels of capital and operational spending in North Dakota for oil production and the resulting indirect spending that would flow to Minnesota through the backward linkages (crude oil supply chain)
- Declines in agricultural commodity basis prices and the accompanying drop in farm income owing to competition with crude oil for scarce rail capacity
- Infrastructure investment in Minnesota directly attributable to the Bakken oil production.

The following table presents the total changes in the level of statewide economic activity under the three oil-price scenarios by year. The three future years were chosen to represent different combinations of direct spending (infrastructure spending is at its maximum in 2016; capex and opex spending in North Dakota peak in 2019 under the high-price and base-price scenarios).

IHS finds that the overall net economic impact of North Dakota oil production on the Minnesota economy is positive, but it results in only a small percent increase in statewide economic activity. Under the high-price scenario, total employment rises by 25,211 jobs in 2016 and generates an additional $2.5 billion in gross state product, compared with increases of 21,210 jobs and $2 billion under the base scenario. The increases in statewide economic activity in 2016 are between 0.4% and 0.9% over the IHS forecast for Minnesota across the three oil-price scenarios. By 2019, increases in gross state product range from 0.1% to 0.3% under the three price scenarios; by 2030, they are 0.2% or lower.

Economic impacts in Minnesota by scenario and year

Scenario and measure	2014	2016	2019	2030
October high scenario				
Output	$1,813.8	$4,643.3	$2,400.3	$1,740.9
Employment	7,748	25,211	10,950	7,984
Value Added	$1,065.0	$2,492.6	$1,355.8	$974.9
Labor income	$585.4	$1,574.9	$765.3	$547.6
December base scenario				
Output	$1,813.8	$3,789.1	$1,483.5	$1,112.5
Employment	7,749	21,210	6,671	5,068
Value Added	$1,065.0	$2,019.0	$845.7	$623.3
Labor income	$585.4	$1,299.2	$470.6	$346.7
February low scenario				
Output	$1,813.8	$3,077.9	$709.2	$567.7
Employment	7,749	17,902	3,089	2,569
Value Added	$1,065.0	$1,621.8	$411.1	$315.0
Labor income	$585.4	$1,071.3	$223.9	$174.7

Note: all dollar amounts are in millions, employment in total jobs

Sources: Minnesota Implan Group, IMPAN input/output models for Minnesota and North Dakota, 2014. Analysis performed by IHS.

© 2015 IHS

The percent effect is modest primarily because significant shares of the capex inputs—especially durable manufacturing inputs such as steel, pumps, and compressors—will come from other states. While Minnesota is relatively close to the Bakken compared with other states, it is not close enough to benefit from being a supplier of construction labor and raw materials, with the exception of frac (silica) sand. As the levels of capital and operational spending in North Dakota and infrastructure outlays in Minnesota decline in the future, the increases in statewide economic activity become smaller, as shown in the table above.

State tax revenues

In 2016, we estimate that the total additional state-level tax revenues in Minnesota generated by increases in economic activity from North Dakota oil production will range from approximately $104 million for the low price scenario to $155.5 million in the high scenario. The annual tax-revenue increase will gradually decrease thereafter as infrastructure spending declines, along with the levels of direct capex and opex spending in North Dakota that generate corporate and personal income taxes.

Agriculture

The adverse effects on agriculture income in 2014—owing to the drop in crop basis prices that resulted from a combination of world prices and transportation competition with crude oil for scarce rail capacity—will be largely short term (between 2014 and 2016). In the near term, pipeline and other infrastructure improvements (such as the completion of the Sandpiper pipeline and BNSF rail expansion) will help to shift crude oil from rail to pipeline, thus creating additional rail capacity for agricultural and other types of commodities, such as coal. The impact of the decline in agricultural income on statewide economic activity was more than offset by infrastructure growth and ripple effects of Bakken capex and opex spending; the net effects of agriculture income losses and infrastructure spending are included in the table above.

Border Cities

In the five Border Cities and their respective counties, the economic impacts from the backward, or supply chain, linkages will be minimal. These cities are not located close enough to the Bakken for their companies to benefit by being local suppliers or to provide significant amounts of labor. The rural economies of the five counties lack the structural diversity to provide the goods and services used in crude-oil production or the presence of large full-service firms that can meet the specific demands of oil producers. Finally, based on research by the Minneapolis Federal Reserve Bank, demand for skilled workers in the Bakken region has not increased the overall wage levels in the five Border Cities and their

counties. Local employers have experienced wage increases in a few specialized, high skill occupations that are in high demand in the Bakken region, such as construction and electrical workers.

Forward linkages

Minnesota's economy is diverse and benefits from its logistical advantages, especially the lower delivered price of Bakken crude oil in the Twin Cities compared with other refining locations in the US Midwest. The extent to which the Minnesota economy benefits over the long term from the increased supply of North Dakota crude oil will depend on the ability of Minnesota's two refineries to use the crude as an input to produce refined products that can be used by other forward-linkage, or value-added, sectors, such as chemicals and plastics. The ability of the two refineries in Minnesota to use Bakken crude oil will not be affected by the existing and planned refineries in North Dakota, as they are much smaller and are designed to produce fuel to meet local demand.

Wealth and infrastructure effects

North Dakota's per capita personal income reached $53,040 in 2014, compared with $47,320 in Minnesota. Because of the size and diversity of its economy, Minnesota offers an array of specialized goods and services that are not available in North Dakota. As a result, North Dakota residents are increasingly spending their disposable income in Minnesota to purchase these specialized goods and services. While income growth is slowing in the short term, over the next five years disposable income in North Dakota will grow at a higher annual rate than in Minnesota. Therefore, Minnesota businesses should take steps to attract customers from North Dakota; many are already doing so.

Total state-level tax revenues in North Dakota grew at a very high compound annual growth rate of 20.8% between 2007 and 2013, giving the state a large tax-revenue windfall over the period in the US. North Dakota is using this windfall to lower state and local tax rates and to improve the capacity of its infrastructure and government services. Even with the recent decline in the price of crude oil, North Dakota expects to collect $4.3 billion in oil and gas revenues during 2015–17. The high level of oil and gas tax revenues will continue to allow North Dakota to allocate substantial spending toward improving the quality of its public services, such as education and infrastructure, and mitigating the impacts of oil and gas development on its communities. In February 2015, North Dakota enacted a $1.1-billion "surge" program to improve infrastructure and public services in the counties that have been most directly affected by oil-production activities in the Bakken formation. The high level of spending by North Dakota presents a significant opportunity for Minnesota companies to provide the required goods and services.

Phase 4: SCOPE analysis

The information in the first three chapters of this study was used to present a SCOPE analysis. The SCOPE analysis examines the **S**ituation today, delineates the **C**ore competencies, describes the **O**bstacles, presents **P**rospects, and develops **E**xpectations, which are summarized below. The SCOPE analysis was used to identify and evaluate issues that affect Minnesota's ability to maximize the potential economic development benefits of North Dakota's crude-oil production. Regardless of the price of crude oil, North Dakota will continue to be a major oil producer, creating economic development opportunities in Minnesota. Under the base-price scenario, we forecast North Dakota's annual oil production to be almost 1.6 million barrels per day in about 10 years; even under the low-price scenario, it will remain around the current level of 1.1 million barrels per day.

Expectations

Despite the recent fall in oil prices and projected relatively lower level of oil related revenues, the energy production forecast included in this report indicates that North Dakota will continue to be a major player in US oil production. However, sentiment regarding the opportunities versus challenges this will impose on the Minnesota economy varies by industry, personal experience, and location within the state.

In order to create a cohesive vision to maximize opportunities and mitigate the challenges associated with North Dakota oil production, Minnesota DEED, the Minnesota Chamber, and other statewide groups might take a lead role in getting

this issue on the agenda of local and bi-state economic and business development organizations. Specifically, the state has an opportunity to:

- Inform Minnesota businesses about the opportunities to participate in the crude-oil production supply chain. Actions would include informing them of standards and processes for obtaining contracts, performance specifications for goods and services, timeframes, risks, permitting requirements, insurance, and certifications and training required for workers. Over the long term, Minnesota is more likely to benefit from North Dakota oil production by providing specialized capex goods and opex services, as opposed to goods and services that have to be provided at well sites.

- Alert local businesses about the opportunities to supply transportation and infrastructure-related goods and services that will be needed in North Dakota as it continues to invest heavily in expanding the capacity and quality of its infrastructure and government services.

- Evaluate opportunities to take advantage of North Dakota's increasing wealth and per capita income levels to offer specialized goods and services that are not available in North Dakota.

- Design education and training programs to produce workers with the competencies, education, and certifications required by oil and gas production companies, firms in the supply chain, and local employers facing shortages of local workers in core occupations.

- Seek legislative appropriations to fund transportation infrastructure upgrades to reduce bottlenecks, improve transportation safety and efficiency along public transportation corridors, and mitigate adverse impacts on the quality of life in communities located in major transportation corridors. These efforts will require working collaboratively with the privately owned railways to expedite the planned rail upgrades, as well as with oil pipeline companies to increase the share of North Dakota crude oil carried by pipeline.

- Proactively seek areas for collaboration between Minnesota and North Dakota on economic development, transportation infrastructure, education and workforce development, and other areas of mutual interest. This type of collaboration is especially important in the five Border Cities and their respective counties.

- Assess the feasibility and value of expanding the economic development incentives available in the development districts under the Border Cities legislation to mitigate the "edge effect." Enhancing the incentive package could include increasing the maximum levels of grants and loans that can be made, lengthening the period of time in which tax credits and exclusions are available, reducing interest rates on loan programs, expanding the types of purchases for which tax credits or refunds are available, and ensuring that developable greenfield or brownfield sites have the required types and sizes of buildings, utility services, and access to critical transportation infrastructure.

Introduction

Background

Advances in extraction technologies, particularly in horizontal drilling and hydraulic fracturing, during the 1990s and early 2000s had made it possible to obtain natural gas and crude oil from unconventional resources, such as shale formations, where it had not been previously been technically or economically feasible to do so. As the cost per barrel of obtaining crude oil from unconventional resources fell, oil companies increasingly turned their attention to the Bakken and Three Forks shale formations in western North Dakota and eastern Montana. Crude oil production in North Dakota started to increase rapidly in 2007, rising from about 123,600 barrels per day to more than 1 million barrels per day by April 2014, making it the second largest oil producing state behind only Texas.

The production of crude oil generated high levels of direct spending in North Dakota that led to a very high rate of economic growth from 2007 onward. The high level expenditures by crude oil producers for capital equipment (capex) and operating inputs (opex) led to strong demand for goods and services from suppliers in many states including Minnesota. IHS estimates that combined capex and opex expenditures in North Dakota for crude oil production rose from $8.4 billion in 2010 to $21.1 billion in 2014. As the level of daily crude oil production rose, increasing amounts began to be shipped eastward across Minnesota by rail, while some of its resident workers in key occupations began taking jobs in the Bakken region. Concurrently, Minnesota companies began to sell goods and services to crude oil producing companies operating in the Bakken region. The effects of North Dakota oil production became increasingly visible in Minnesota, especially in five Border Cities that are located adjacent to North Dakota. In response, the Minnesota Department of Employment and Economic Development retained IHS to assess the effects of North Dakota crude oil production on the Minnesota economy.

The Bakken formation is located several hours drive from Minnesota, as shown in the accompanying map; one-way driving distances to Bismarck are 200 miles from Moorhead and 427 miles from St. Paul; distances are even further to the main producing locations within the Bakken. Although Minnesota borders North Dakota to the east, the long distances from Minnesota cities to the Bakken limit the competitive locational advantage in supplying inputs for crude oil production. The Five Border Cities that are located closest to the Bakken and the counties they are in are: 1) Breckenridge in Wilkin County; 2) Dilworth in Clay County; 3) East Grand Forks in Polk County; 4) Moorhead in Clay County; and 5) Ortonville in Big Stone and Lac qui Parle counties.

Organization

The study consists of four phases that were performed in sequence presented below:

Phase 1: energy production forecast—develop forecasts of the annual level of crude oil production in North Dakota along with accompanying estimates of capital equipment and operating expenditures. Production forecasts were prepared for three different crude oil price scenarios.

Phase 2: transportation impacts—analyze the patterns of commodity flows out of and into Minnesota by type and mode. This information was used to allocate the flow of crude oil through Minnesota by mode, including forecasts of the number of unit trains carrying Bakken crude oil.

Phase 3: economic impact assessment—estimate the changes in statewide economic activity in Minnesota directly attributable oil production activities in North Dakota. The following direct economic effects were considered: 1) spending for capex and opex in North Dakota; 2) impacts on agricultural income due to competition for rail capacity; and 3) spending for infrastructure such as crude oil pipelines and rail lines.

Phase 4: SCOPE analysis—incorporating the results of the first three phases, analyze the current **S**ituation, identify **C**ore competencies, list **O**bstacles, discuss **P**rospects, and then present **E**xpectations. The overall context of the SCOPE analysis was to provide an understanding of the economic development issues and opportunities in Minnesota that can be attributed to the effects of crude oil production in North Dakota.

Minnesota to Bakken shale contextual map

Phase 1: Energy production forecast

This document presents the IHS view of oil production activity in the Bakken/Three Forks area, including measures of activity that will be used to determine the economic effects in Minnesota, such as:

- Underlying factors in world oil markets that influence the forecast
- Total annual production of crude oil
- The total number of operating wells in Bakken/Three Forks
- The demand for sand used in hydraulic fracturing
- The number of new wells drilled and completed annually
- Capital expenditures (capex) incurred to drill and complete new oil wells and bring them online
- The annual operating expenditures (opex) required to operate the existing oil wells.

The Bakken formation lies under portions of 16 counties in western North Dakota and 11 counties in eastern Montana. As a result, not all of the crude oil being produced within the Bakken is actually produced within the state of North Dakota. According to IHS, the Three Forks formation lies below the Bakken in many of the same areas in Montana and North Dakota. It extends further east across North Dakota, but not as far west into Montana, and as far south as South Dakota. While the Three Forks is slightly thinner, there are two additional potential productive zones in the formation. To date, the vast majority of the drilling and extraction activity has occurred in the Bakken formation.

The crude oil production forecasts presented are for both the Bakken and Three Forks formations and include oil coming from Montana and North Dakota. The term "North Dakota oil production" refers to crude oil extracted from both formations and both states. Because the Bakken and Three Forks plays are each single, contiguous geological formations that generally cover the same geographies, the term "Bakken/Three Forks" refers to a single region in terms of production, transportation accessibility, proximity to markets, direct spending, etc. Finally, all the figures here, except where noted otherwise, are for unconventional energy production, which requires much larger levels of capex, (e.g., fracking fluid, sand, water, cement, waste disposal, etc.) than conventional oil wells, but similar amounts of opex (e.g., well operation, gathering, transport, and processing).

Three Bakken production scenarios were developed for this work, differentiated by the average crude oil price over the period to test the sensitivity of Bakken activity and its economic impact (prices are in constant dollars):

- Low production scenario of $50/barrel (bbl) West Texas Intermediate (WTI) crude oil: In this scenario, oil prices remain in the range experienced in late December 2014 and January 2015. The key assumptions for this scenario include:
  - The export ban is not lifted.
  - After rail transportation costs are deducted, the effective producer price is between $35 and $40 per barrel.
  - The low producer price causes a major rapid drop in rig activity, new well additions, and short-term production.
  - Drilling only occurs in the lowest cost areas of Bakken.
  - Up to 60% of the production from future new wells will have a breakeven cost above the effective producer price.
- Midline or base production scenario of $70/bbl WTI: In this scenario, oil prices recover quickly from the low level of early 2015 and average in the $70/bbl WTI range.
  - The effective producer price with or without rail transport is high enough to sustain a production increase.

  - If the export ban is lifted, pipeline capacity could be sufficient to move all production to Cushing, Oklahoma (the major crude oil logistics and trading hub in the US) and the Gulf Coast. However, some rail transport may occur to the East and West Coasts.
  - Up to one-third of production from future new wells will have a breakeven cost above the effective producer price.
- High production scenario of $90/bbl WTI: In this scenario, oil prices bounce back quickly to the levels experienced before mid-October 2014.
  - The export ban is assumed to be lifted to due high crude oil production.
  - Sufficient pipeline capacity is added to move all crude oil to the US Gulf Coast (USGC).
  - The effective producer price will be above the breakeven cost of production for nearly all of the resource base, including emerging- and higher-risk areas.

The IHS long-term oil price view is that prices will return to the $70–90 (inflation-adjusted) range for WTI crude oil over the next few years. Consequently, the $70-per-barrel scenario is considered the base scenario for the analysis.

International context

During the last 10 years, world oil prices and the expectations of where future oil prices may trend have been more volatile than any time since 1973–86, even taking into account the relative price calmness from 2012 to early 2014. Views have ranged from the widely held belief that supplies were near their peak and the already-high oil prices would go even higher, to concern of abundant supplies that would cause prices to decline. The transition from the perception of shortage to one of surplus has occurred over just the last few years due to rising unconventional oil and gas supplies in North America. This has been driven largely by the combination of (1) new technologies allowing economic use of horizontal drilling and hydraulic fracturing that has enabled the rapid development of tight oil and gas plays such as the Eagle Ford in Texas and Bakken in Montana and North Dakota and (2) higher oil and gas prices that have allowed these relatively high-cost resources to become commercial.

The level of unconventional oil and gas developments in North America is also supporting a broader change in the Atlantic Basin and global oil and gas markets. The combination of rising supplies of oil and gas in North America, Latin America, and Africa along with maturing demand in Europe and North America is having far-reaching geopolitical implications as regional production changes global crude oil and refined-products flows. In recent years, rising production in the United States had changed the dynamics of petroleum flows in the North Atlantic, which has pushed more African and Middle Eastern crude oils to the Asian market.

Recently, crude oil prices have declined from as high as $115 per barrel during the third week of June 2014 to under $50 per barrel in January 2015 (UK Brent prices). The decline was driven by rising worldwide surplus crude oil supplies that resulted, in part, from:

- Organization of Petroleum Exporting Countries' (OPEC) November decision to not reduce production to support prices
- Libyan oil's return to the world oil market after being severely disrupted by political instability
- A greater-than-expected increase in US oil production
- A slowdown in the rate of growth in oil demand, particularly in China, that has also influenced fundamentals.

In the coming years, the world crude oil markets will be driven primarily by the following factors:

- The responsiveness of US shale oil production growth to lower prices
- How OPEC responds, in terms of pricing and production decisions, after a period of very low prices

- The rate of increase in other non-OPEC crude oil production after the price collapse. Prior to the price collapse, the growth rate in non-OPEC liquids supply was the highest on record, as depicted on the accompanying chart.
- The postponement or cancellation of capital-intensive projects in deep water and other frontier regions.

OPEC has, at least temporarily, changed its approach to oil production and prices. For much of the last 40 years, OPEC has attempted to balance supply with demand by cutting production if prices fell too low and increasing production if prices went too high. However, in November 2014 OPEC changed its approach. OPEC is not reducing its own low-cost production to keep prices high enough to justify new production in high-cost areas. Rather, its policy is now based on forcing the market to balance supply and demand. As a result, world oil prices have collapsed under the weight of rising crude oil inventories. For the market to balance, non-OPEC supply will have to be reduced. Prices have fallen far enough that at least some resources in shale and oil sands areas of North America and expensive deep-water production in other countries may not be developed.

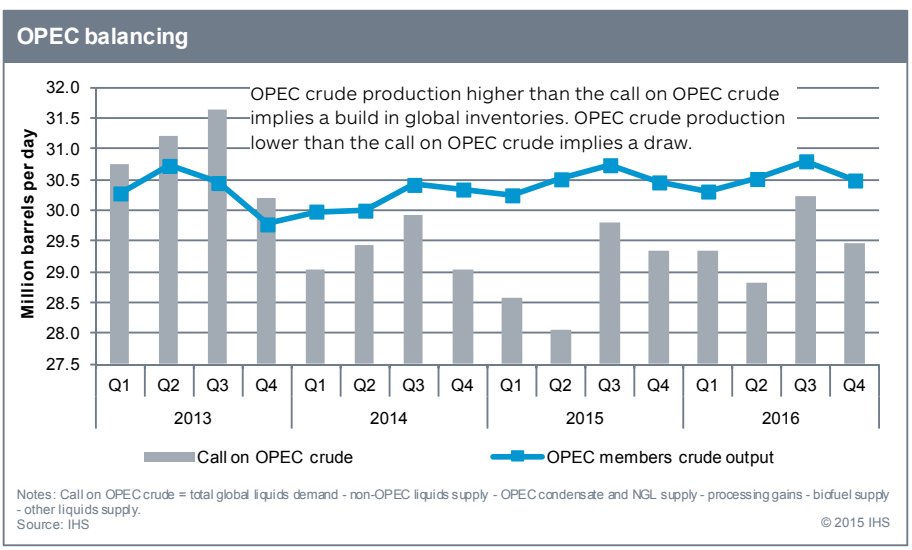
Low prices are expected to cause North American oil production to peak and begin a gradual decline during the next several months rather than continuing to rise as was expected prior to the price collapse. As US and other non-OPEC production growth slows, rising oil demand will gradually reduce the global surplus of crude oil and production capacity. Once the surplus is worked off, demand is expected to continue rising, resulting in the need for increased non-OPEC production. New non-OPEC production is higher cost, which will result in a return to rising oil prices over time. However, world oil prices are expected to remain volatile as the markets move toward a new balance between supply and demand.

Forecasts of non-OPEC liquids supply and the need for OPEC oil

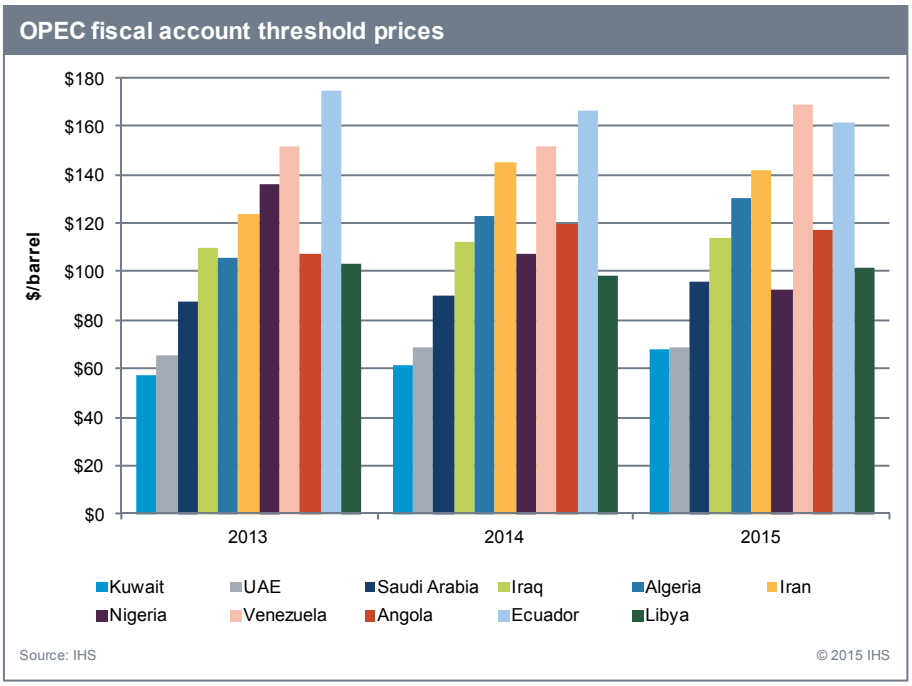
Geopolitical risk remains an issue for crude oil supplies, as is often the case, with continued concern over unrest and possible supply disruptions. However, the IHS assessment of the geopolitical risk in the major oil-producing countries does not show a clear trend toward greater risk despite rising political tensions in the Middle East and Ukraine. The major supply risk from the Middle East for the next few years could be too much supply rather than too little. The change in OPEC policy to not lower its own production but force higher-cost producers, such as North American shale oil producers, to cut back will reduce non-OPEC supply growth and overall production.

OPEC balancing

Despite less non-OPEC supply growth, OPEC production still expected to exceed market demand through mid-2016

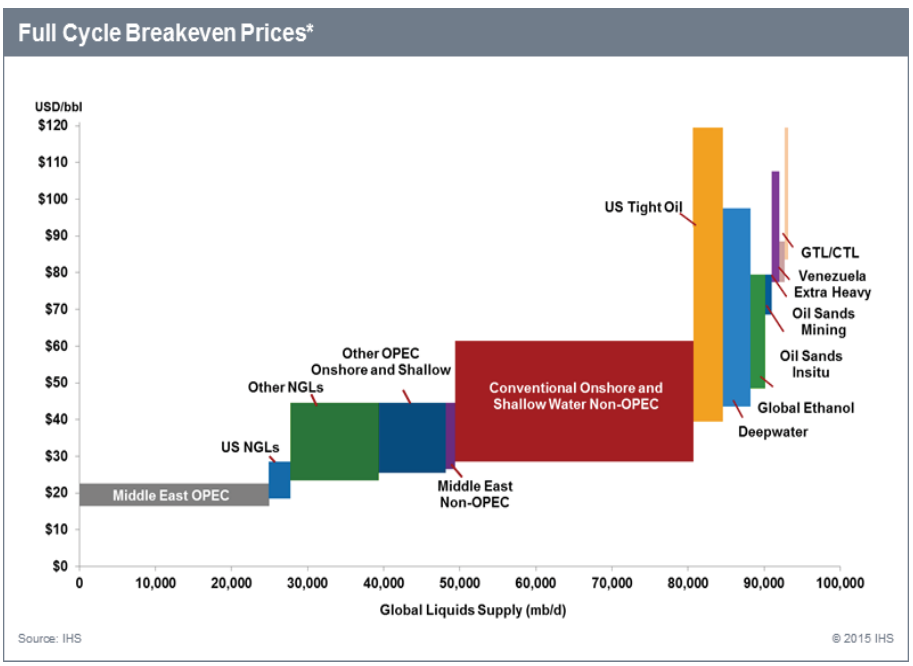


The current OPEC policy of not restraining production is difficult to manage for some producers (both OPEC and non-OPEC). OPEC producers' government budgets are based on oil prices that range from under $40/bbl to more than $100/bbl. However, the most powerful OPEC members of the "OPEC core" (Saudi Arabia, Kuwait, and the United Arab Emirates—UAE) have much more flexibility to handle lower prices, and all have substantial foreign-exchange reserves to make up any revenue shortfalls). As a result, the current OPEC production policy led by Saudi Arabia is expected to last at least long enough to bring supply and demand back into balance and, presumably, to higher prices.



Global breakeven costs

The breakeven cycle depiction shows that tight oil breakeven costs have a wide range, but overall are some of the highest in the world. The base scenario for the Bakken forecast (described in this report) is based on a $70/bbl range, which is below the highest-cost resources in US and Canadian unconventional oil plays. Consequently, production in some of these areas is expected to level off and, in some cases, begin to decline. We note that while breakeven costs vary within the Bakken, the overall average breakeven cost is between $58 and $62/bbl. This breakeven price threshold makes overall drilling and production in the Bakken vulnerable to drops in the oil price, so we would expect to see certain levels of reduction but not a complete shutdown of the play in response to current and anticipated oil prices. As the global oil supply surplus is reduced, oil production from higher-cost areas within the Bakken will be required to meet demand growth. However, higher oil prices will be needed to stimulate activity and bring that oil to market.



*Note: GTL are liquids produced from natural gas through chemical processing of gas and are similar to diesel fuel, CTL are similar to GTL, but produced from coal, and NGLs liquids that are naturally produced with natural gas in the field and include propane and butane.

US context

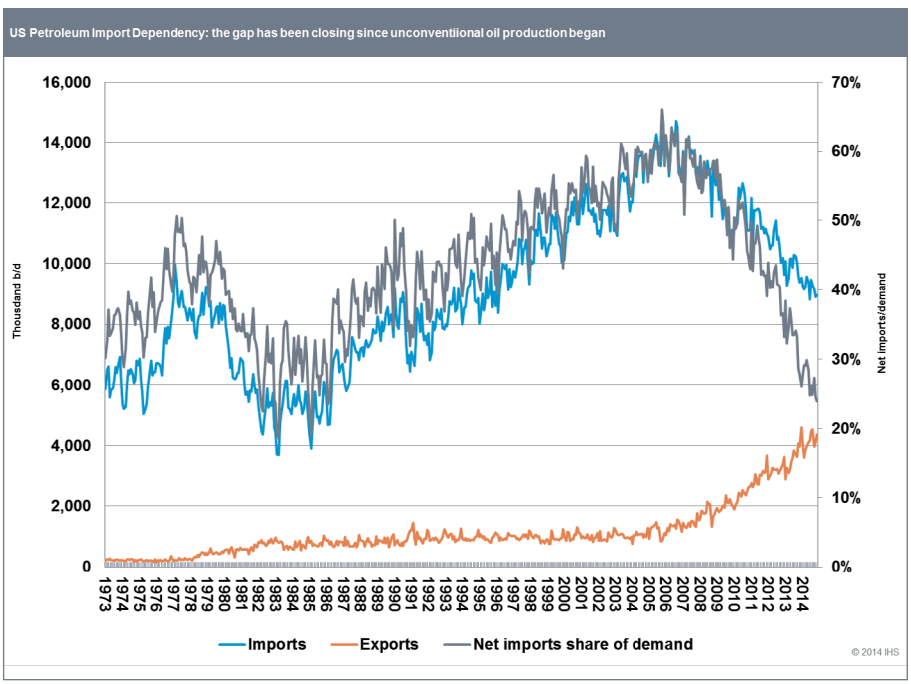
Tight oil and gas supplies have dramatically changed the oil and energy landscape in the United States. The United States produced over 9.0 million barrels per day (b/d) of crude oil by the end of 2014, equaling volumes produced in 1973/74 and showing growth levels only surpassed by one country in the history of oil production—Saudi Arabia. However, the collapse in oil prices in late 2014 and early 2015 is expected to reverse the recent production trends in the lower 48 states, including North Dakota.

The rise in tight oil supplies has contributed to a decline in US imports from a high of over 14.5 million b/d in August 2006 to 8.3 million b/d in July 2014—the lowest level since July 1995. Since early in the last decade, US petroleum exports have risen from an average of about 1.0 million b/d to nearly 4.4 million b/d in November 2014. All of these exports were either refined products or natural gas liquids because the United States has banned crude oil exports since 1973. The possible lifting of the crude oil export ban is being debated by Congress, and IHS currently expects the ban to be lifted in the next few years. Continued rising production will increase the pressure on lawmakers to allow crude oil exports.

US net imports

The combination of falling imports and rising exports has resulted in a dramatic decline in net imports (a measure of dependency on imported crude oil and energy security). In 2005, US petroleum net imports peaked at about two-thirds of demand. However, by late 2014, net imports had fallen to less than a quarter of US oil demand—the lowest level of import dependency since early 1986.

Imports from Canada have also been increasing, much of which either passes through or is refined in Minnesota. If US imports from Canada are excluded from the import figures, US net imports' share of demand peaked at about 55% in late 2005 and has since plummeted to only 6% in November 2014. When imports from Mexico are taken into account, US net imports from non-North American suppliers fell to just 1% of demand in November 2014.



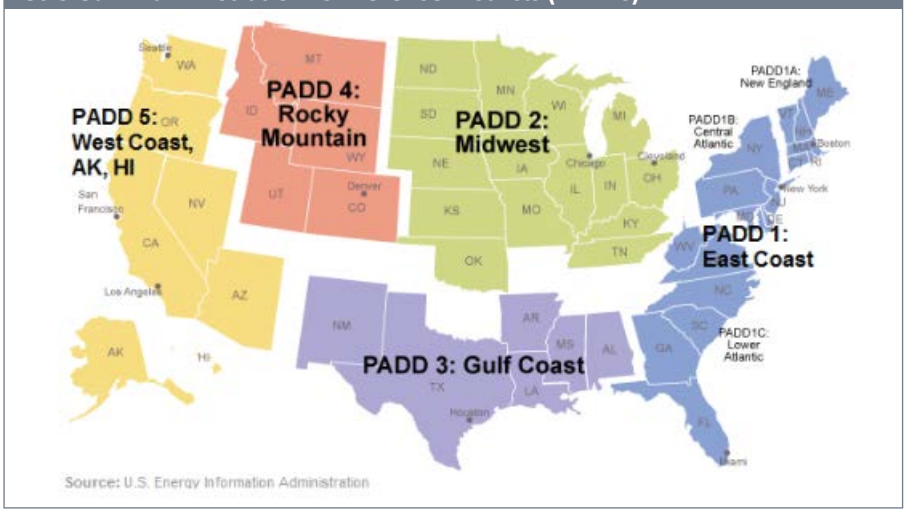
Regional context

The US Midwest (PADD 2), including Minnesota, has been moving to lower liquid energy costs relative to neighboring regions from three major regional supply waves that have been building on each other. These waves, described in this section, are changing the upper Midwest from a net importer to a net exporter of crude oil, refined products, and ethanol for the first time in history.

- Ethanol: The first wave of rising supply for PADD 2 was ethanol. Production began to increase in the middle of the last decade in response to the Renewable Fuels Act. The region has become a large exporter of ethanol for gasoline blending to other regions in the United States. Ethanol production has stabilized in recent years as the market has reached the maximum allowable level of 10% by volume. Additional ethanol growth will depend on policy measures.

- Canadian crude oil: Much of the crude oil exported from Canada to the United States passes through the US Midwest, particularly Minnesota. Canadian crude oil exports to and through PADD 2 were relatively stable until early 2011 when volumes began to rise. Most of the capital expenditure for heavy oil sand development has already occurred, and heavy oil is being brought on-stream. Consequently, IHS expects Canadian heavy oil production and the associated need for additional crude oil transportation capacity to continue rising over the next several years, despite lower world oil prices. Some of the expected increase will move through PADD 2 and Minnesota. The exact amount will depend on pipeline and rail developments.

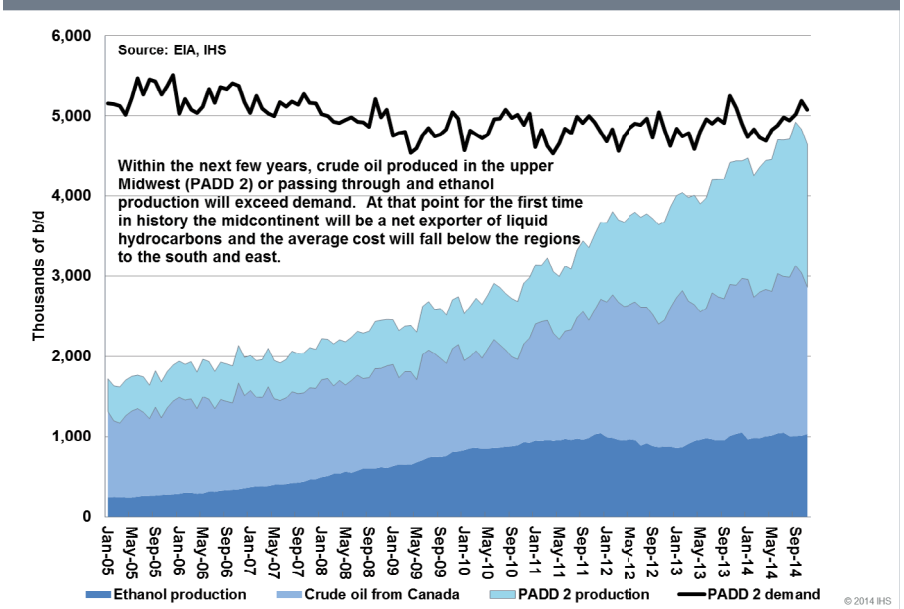
Petroleum Administration for Defense Districts (PADDs)



- Bakken/Three Forks: The combination of horizontal drilling and hydraulic fracturing has created an oil and gas production boom in parts of the United States. In western North Dakota's Bakken/Three Forks play, production has risen from fewer than 250,000 b/d in 2010 to more than 1.1 million b/d in 2014. Bakken production could rise to 1.6 million b/d by 2022 in the base scenario. IHS estimates as much as 50% of the recent production moves through Minnesota by rail, mainly toward refineries in Minnesota and on the East Coast.

Historical liquids supply-and-demand balance

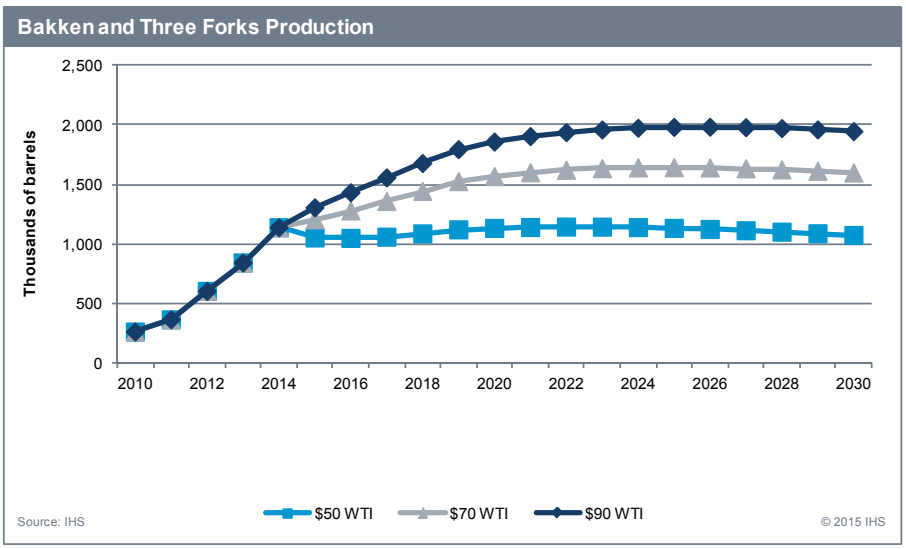
US Petroleum Import Dependency: the gap has been closing since unconventional oil production began



As supplies in the upper Midwest increase relative to the rest of the United States, relative costs of liquids to local manufacturers and consumers will decline, refiners and processers will have the incentive to expand production, and consumers of transportation fuels will have an incentive to expand energy-intensive business activities. Midwest refiners have already invested in additional capacity to process more Canadian heavy crude oil as these supplies increased. Similar investments to utilize new light/sweet Bakken crude oil are likely as production continues to rise. As Minnesota refiners are the closest to the Bakken/Three Forks formation (i.e., about 600 miles to the east), they would have the lowest delivered cost of crude oil coming from there. However, the refined products logistics system may need to adapt to handle increased production from refiners. The decline in oil prices may slow the upper Midwest's move to being a regional net petroleum liquids (including ethanol) exporter. There are three new small refiners in the Bakken area being discussed or underway designed to provide diesel fuel to the region. The area needs increased diesel supply and these plants will reduce the need to bring diesel fuel into the region. However, the total volume is relatively small.

Bakken shale formation

Bakken production levels, field activity, and economics were developed using three long-term WTI price scenarios: $50/bbl, $70/bbl, and $90/bbl. These price levels were chosen to cover the wide range of price and expectation swings that have come through the industry since the middle of the last decade. However, a great deal of uncertainty currently exists around how the oil industry in the Bakken and other unconventional oil plays will respond to lower prices. After all, much of the production increase and industry experience has occurred in a high-price environment. The combination of hydraulic fracturing and horizontal drilling in shale continues to be a developing technology. IHS believes costs will continue to fall as the industry gains experience and competitive pressures from lower oil prices increase.



These forecasts take into account economic fundamentals such as well performance, capital expenditure, expected breakeven costs by well, fiscal systems and royalties, and future prices, all of which are relatively easy to measure and analyze. On the other hand, operator behavior is often predicated on (1) available cash flows and funding, (2) company strategy, (3) unusual behaviors, such as drilling, but not completing wells, and (4) perceived future commodity price expectations, all of which vary considerably from operator to operator and are difficult to detect and measure. We have noted that historically these factors have sometimes contributed to behavior that runs counter to economic fundamentals. While some slight upward adjustment has been incorporated into our forecasts to account for these behaviors, the forecasts are based primarily on the economic fundamentals, as stated.

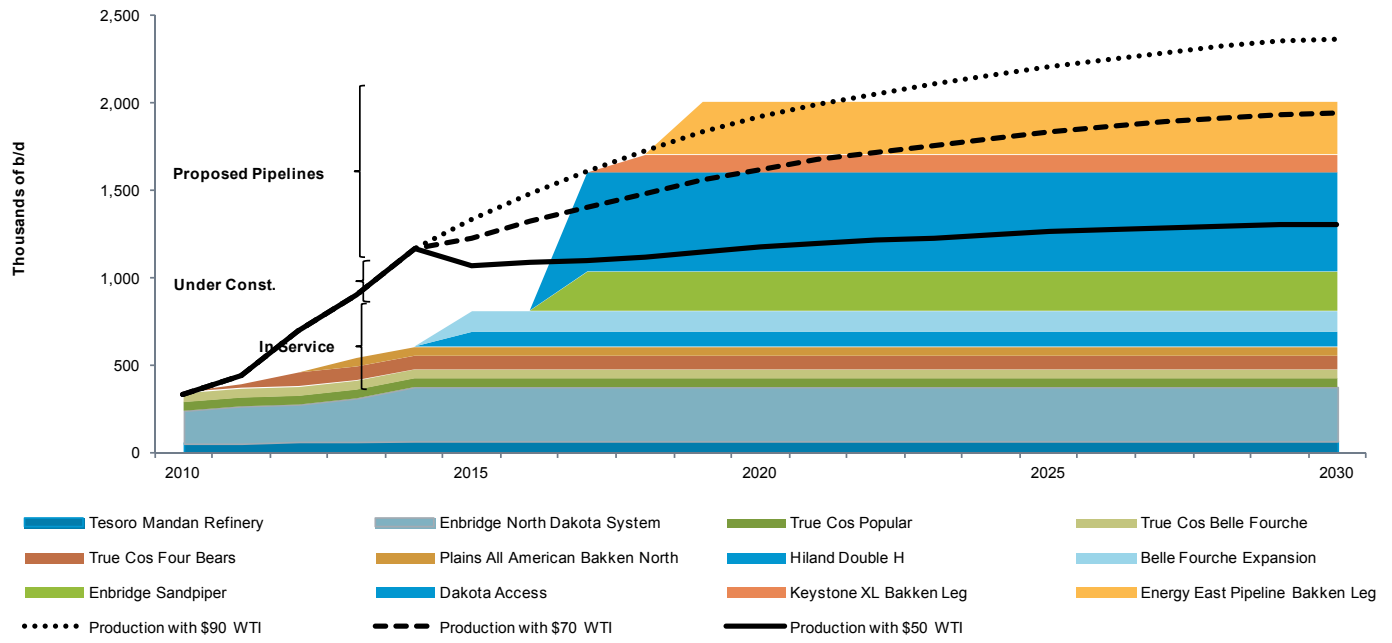
Crude oil production in the Bakken region is expected to continue to rise in the base scenario ($70/bbl WTI). IHS expects Bakken unconventional oil production to reach just over 1.6 million b/d by the middle of the next decade. WTI averaged $100 per barrel in the first three quarters of 2014. About 10% of 2014 production had full-cycle breakeven costs above $90/bbl WTI. With prices now expected to be well below this range for the next few years, Bakken oil production growth is expected to slow. If oil prices do return to $90/bbl or higher in the next few years, Bakken production could exceed 2.0 million b/d by the middle of the next decade. However, if oil prices remain in the $50/bbl WTI range, production is not expected to increase, but remain relatively steady at around 1.1 million b/d.

Bakken crude oil production has developed so fast that the pipeline system has not yet had time to add sufficient capacity to take production to market. As a result, rail is being utilized to move over 60% of production. Rail shipments from Bakken are expected to fall in the next couple of years if oil prices remain below $70/bbl. Some growth is possible if the proposed crude oil pipelines are not built. If the proposed lines are built, there would be sufficient pipeline capacity to eliminate rail shipments through 2021 in the high-price scenario, and through the end of the period for the base- and low-price scenarios. However, continued low prices and production uncertainty could delay future pipeline additions, resulting in continued need for rail to move Bakken crude oil.

Rail shipments will continue to be required under any of the price scenarios if the proposed pipelines are not built. Transporting Bakken crude by rail is attractive in refining markets not served by pipelines, such as the US East Coast and US West Coast refineries; it is expected to remain a major source of supply for them. Without new pipelines, rail traffic will increase to higher levels as production grows with higher crude oil prices. If crude averages in the $50/bbl range, production is not expected to be sufficient to cause an increase in rail volumes from recent levels.

Pipelines are being added to move Bakken crude oil to market. For crude oil producers, railroads have not only been critical because of their ability to quickly add capacity. Prior to 2010, almost no crude oil was moved by rail in North America; now, nearly 1.0 million b/d move long distances from the midcontinent and western Canada to refineries on three US coasts. Bakken producers have been able to quickly move crude oil production to all major refining centers in the United States and as far away as eastern Canada by rail. Rail has provided producers with some degree of market flexibility. However, the cost of rail is higher compared with pipelines. As a result, the price the producers receive is lower.

Bakken crude production scenarios versus pipeline capacity



Source: IHS

© 2015 IHS

Natural gas is also produced in the Bakken region but the distance to the nearest major market makes new pipeline capacity prohibitively expensive. Therefore, transport to market is limited to the existing interstate pipelines and must compete with Canadian gas for the limited capacity. North Dakota natural gas production reached over 1.5 billion cubic feet per day in December 2014, some of which is flared. Natural gas supplies in the region are abundant when shale resources in Canada are taken into consideration. Reduced flaring and changes in Bakken crude oil production will contribute to corresponding changes in natural gas production. However, the impact on the price of gas in the region is expected to be relatively small considering the overall supply picture on both sides of the border and in Colorado and Wyoming. In addition, natural gas supplies from shale resources in Pennsylvania are pushing west and adding to the supply abundance in the upper Midwest.

Bakken potential pipeline capacity and rail requirements

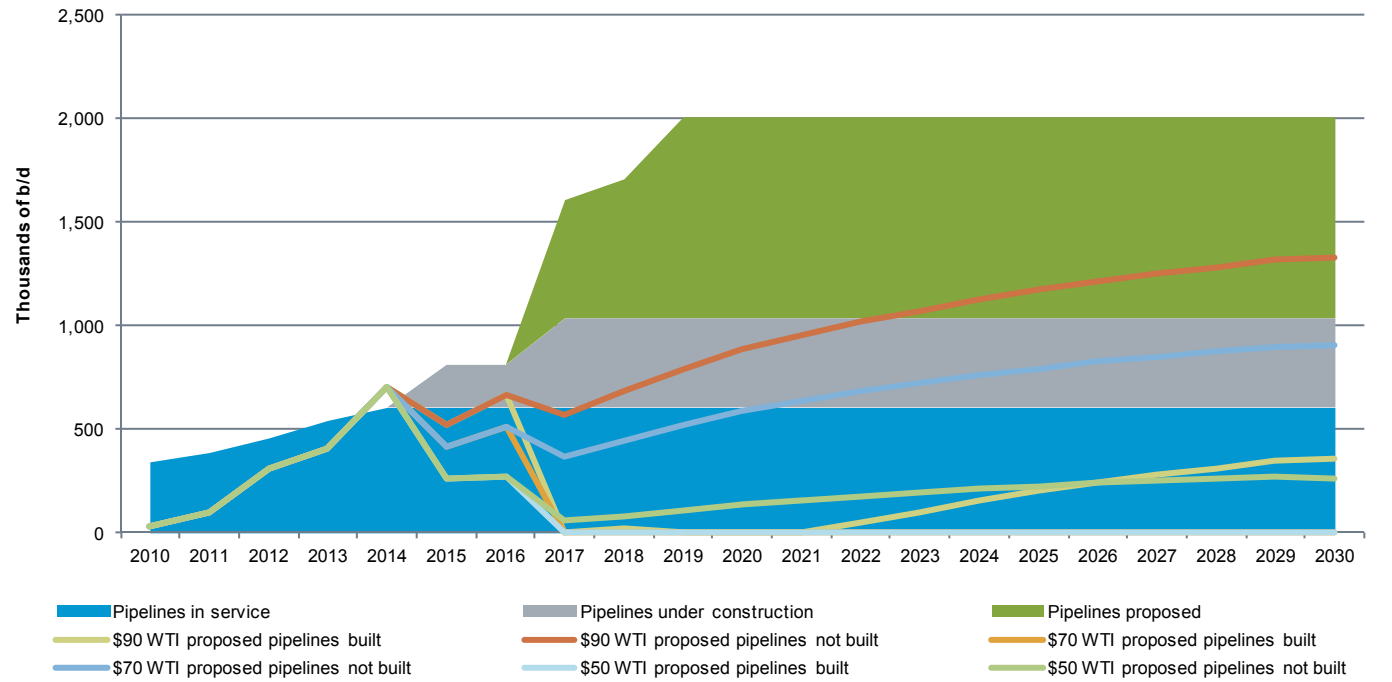
Pipeline capacity could eventually develop to transport all future Bakken production depending on the oil price and subsequent level of production in Bakken. The new pipeline capacity announced so far cannot take all of the expected increase if the oil price returns to the $90/bbl leveling during the near term. However, if oil prices remain low, or increase to the $70/bbl range and all announced pipelines are built, there will be more than enough capacity to move production without rail.

Nearly all of the pipeline capacity being considered can deliver Bakken crude oil to the USGC market, and all has the potential for reducing rail traffic through Minnesota. However, only one of the planned pipelines will cross the state of Minnesota—the Sandpiper pipeline—which will carry Bakken crude oil to Clearbrook, Minnesota, and then on to

Superior, Wisconsin, for eventual shipment by pipeline to the eastern PADD 2 refiners and USGC market. Sandpiper, if approved, is expected to be operational in 2017.

Crude oil shipments by pipeline to the USGC market could be impeded if the US crude oil export ban is not lifted. Bakken crude oil is light/sweet crude, which is in surplus supply today in the USGC market since other growing tight oil plays such as Eagle Ford and the Permian Basin, which are more local to the USGC, also produce light oil. Without an end to the export ban and increased pipeline shipments to the USGC, lower prices and production from the Bakken could result. If the export ban is lifted, more light oil would be exported from the USGC region, which would free up more light-oil refining capacity so that more Bakken crude would flow to the USGC by pipeline—and rail if pipelines are not yet available—for export. If the export ban is not lifted, more Bakken crude oil will be moved by rail to other US refineries.

Bakken crude rail shipments under different crude oil prices and pipeline capacity developments

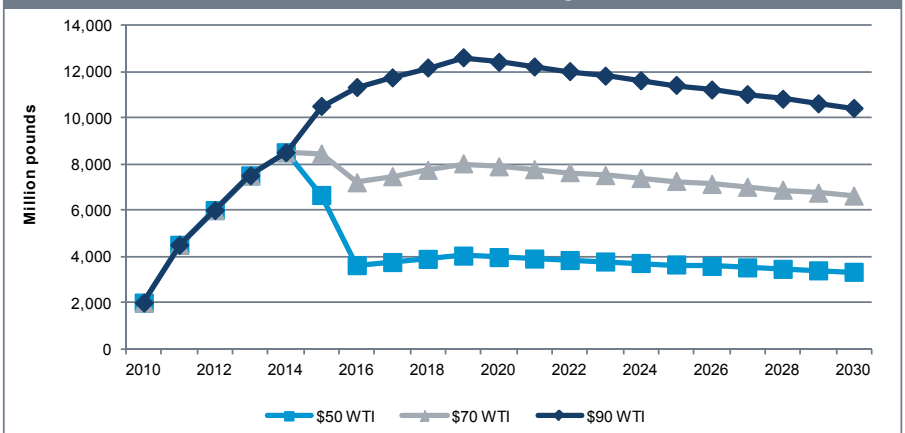


Source: IHS © 2015 IHS

Frac sand

Drilling practices and technology continue to advance in the shale plays. Hydraulic fracturing technology continues to evolve and could increase production or slow the rate of decline caused by low oil prices. One of the operators in the Bakken uses a practice called "superfracking," which could dramatically increase the amount of sand used per well and increase production. In 2014, the average Bakken well required an average of about 4.5 million pounds of sand—equivalent to an estimated 409 unit trains for frac sand (40,909 cars at 110 tons/car) per year. If many of the other operators were to adopt

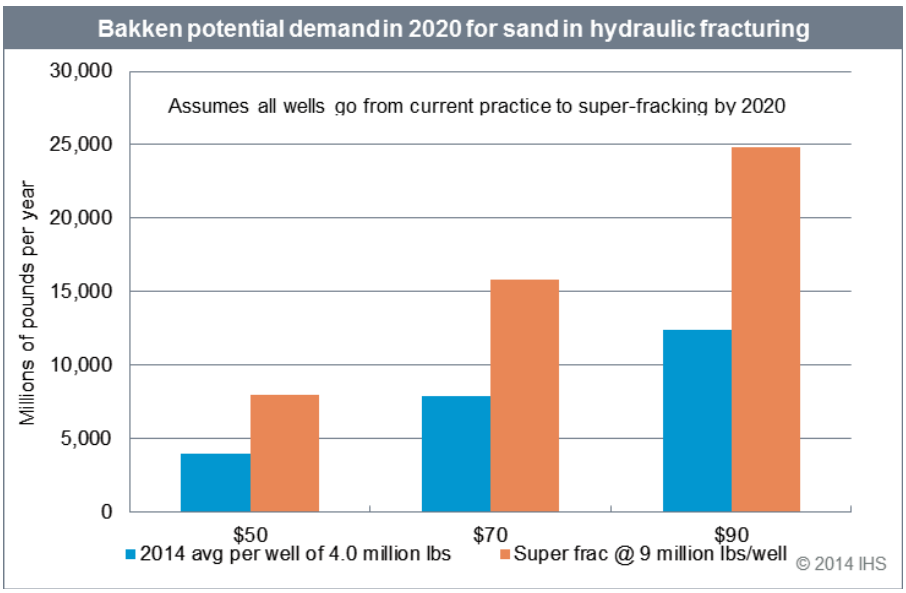
Bakken and Three Forks Frac Sand Demand—assuming 4.0 million lbs/well



Source: IHS © 2015 IHS

superfracking, the average sand used per well could go as high as 9.0 million pounds or more. If we were to consider the upside for the high scenario with an increase to 9.0 million pounds of sand for the average well, the demand for rail cars could increase to about 80,000 per year or 800 unit trains in the high scenario. As a result, frac-sand unit trains could increase from about one per day in 2015 to over two per day in 2020.

The potential impact from superfracking



The demand for frac sand is not expected to increase in the base scenario or the low oil price scenario, assuming no increase in the use of superfracking. Total production of industrial sand in Minnesota is estimated to be about 7 million tons, where about two-thirds are used for fracking and the majority is used in locations other than the Bakken.[1] The decline in the number of wells drilled is expected to roughly offset the increase in frac sand use per well in the $70/bbl scenario. In the low oil price scenario, frac sand demand will fall roughly 50% from recent levels and not increase for the remainder of the period. The Minnesota Department of Natural Resources has already observed a slight decline in silica sand production.[1] Only in the high-price scenario would frac sand demand rise, and it could peak at 75% above recent levels by 2020. This assumes superfracking is not widely used.

The impact on the overall long-run well economics from superfracking is not yet fully understood. Superfracking increases the initial production rates, but at a higher cost. It is unclear if it will also increase the total oil recovery during the life of the well and how fast this additional oil could be recovered. Production would be higher in all oil price scenarios if superfracking does increase per well oil recovery. In addition, the total amount of sand required would increase. For example, if we reconsider universal adoption of superfracking and if all wells in all three price scenarios moved to, say, 9 million pounds of sand per well, the amount of sand per well would increase 70%. The frac sand-related infrastructure and logistics would also increase. In the base scenario, for example, the increase in the amount of sand required would be equivalent to going from requiring fewer than 40,000 rail cars per year to nearly 80,000 rail cars.

2014 Bakken breakeven cost and volume of production

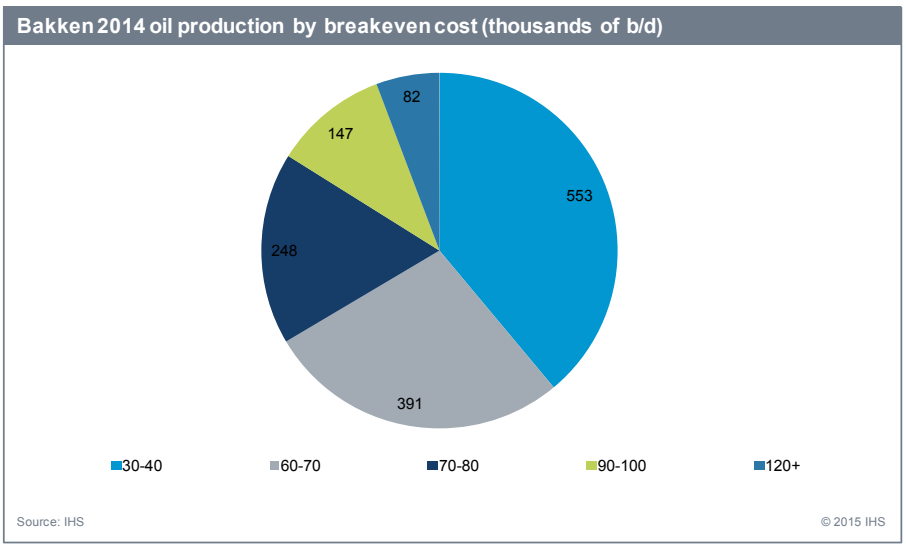
The average breakeven price in the established Bakken/Three Forks play ranges from $58 to $62/bbl based on WTI with two-thirds having a breakeven under $70/bbl WTI in 2014. However, the cost of transportation to move Bakken to market is about $10–11/bbl by pipeline to the USGC and about $15–16/bbl to ship it by rail to the USGC. As a result, the actual price a Bakken producer would receive is at least $11 per barrel under WTI (WTI minus transportation). The WTI price fell below $45 per barrel in January 2015, putting even the lowest-cost Bakken production at or below breakeven in the mid-$30/bbl range.

As oil prices recover over time, more Bakken crude oil will become economically attractive and production increases will occur. The amount of the production increase will depend on the price received at the sales point, which may be either the Cushing hub or an East Coast refinery. Two factors will increase the Bakken producer price of oil:

- Rising global oil prices

1 Personal conversation with Heather Arends, Minnesota Department of Natural Resources, 16 March 2015.

- A lifting of the US crude oil export ban, which leads to the addition of pipeline capacity to move crude oil to the USGC and reduces shipments on higher-cost rail.

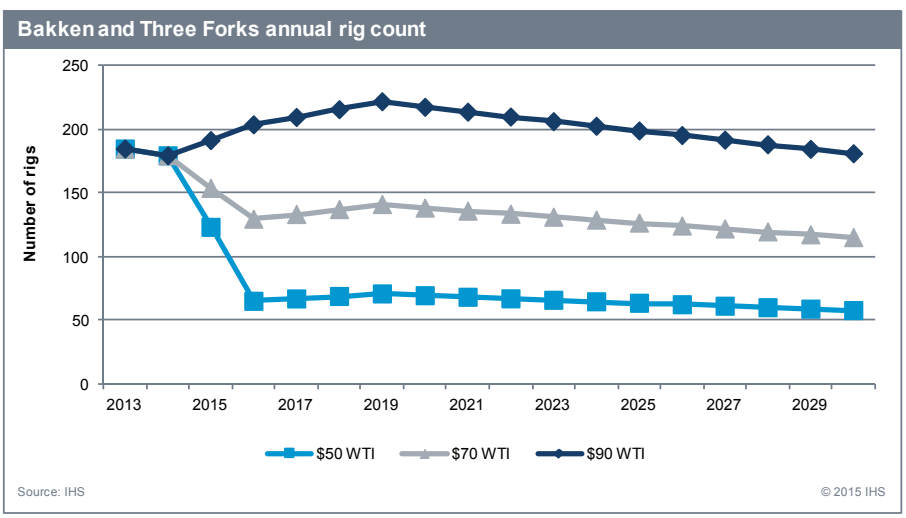


Caution is needed when making determinations regarding breakeven prices and the impact of lower commodity prices on potential production cutbacks. For example, breakeven prices in the emerging and potential new areas of the Bakken/Three Forks average about $74 per barrel. These areas include the development of additional zones in the Three Forks as well as tighter down hole spacing, which is currently only in the piloting phase. Our higher price forecasts include these emerging areas, but if prices remain low, the development of these areas is in serious jeopardy.

A $74 average breakeven price for these emerging areas also suggests operators will focus solely on the better-producing mature areas now that the global crude oil price is low. However, breakeven prices are also likely to fall because of increased competition from suppliers and service companies such as drillers and fracking crews. Furthermore, improvements have been occurring in production performance and reductions in drilling and cost, which will continue to drive down breakeven costs. Drilling and production costs tend to decrease during periods of low commodity prices as operators become even more cost conscious, which ultimately reduces breakeven costs. Ultimately, we would expect fewer wells to be drilled, but less impact on overall production.

Direct spending effects

The capital expenditure and operating expenses are determined by how many wells are brought online. Both rig count and new wells are directly related to the price of crude oil. Shown in the accompanying charts are the rig counts and new wells for each of the three crude oil price scenarios.



The cost for drilling, completion, and facilities for one well in the Bakken/Three Forks has averaged about $8.65 million and the average operating costs are on the order of $5.99 per barrel with crude oil in the $90–100/bbl range. Combined, these capital and operating costs allow *average* Bakken unconventional crude oil production to breakeven at about $58–62 per barrel, if we include production taxes and royalties.

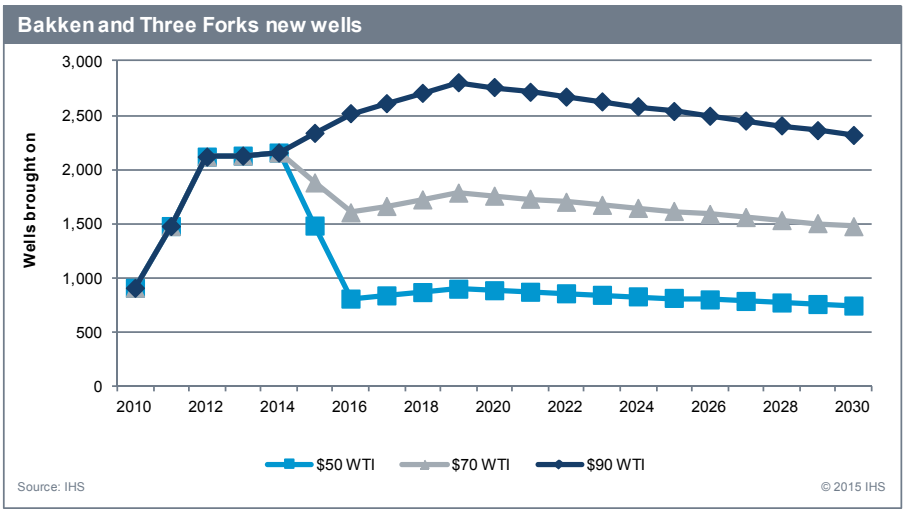
The level of demand for goods and services used by Bakken/Three Forks oil producers that are purchased from suppliers located in Minnesota will be determined by the following measures of oil production activity in Bakken/Three Forks:

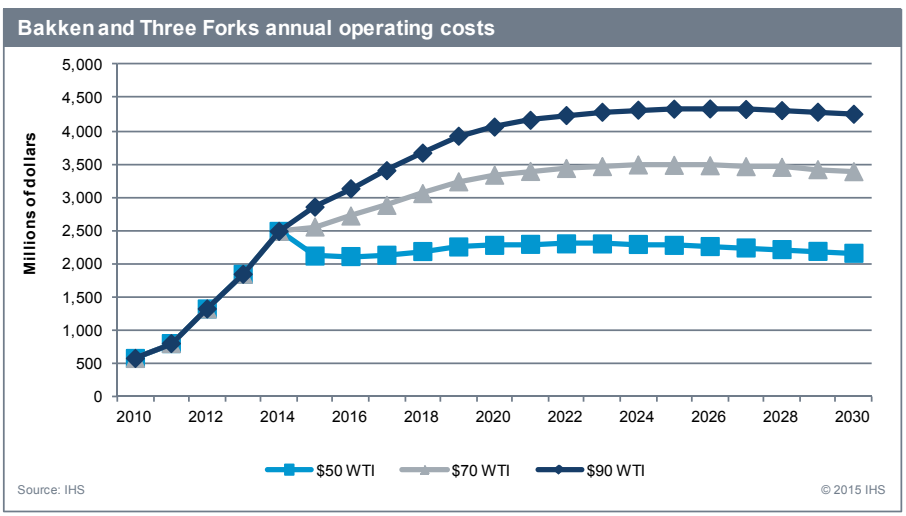
- The number of new wells drilled and completed annually, which will determine the demand for capex associated with well development, and the demand for such inputs as frac sand
- The total number of operating wells in a year, which determines the demand opex spending
- The annual level of crude oil production in Bakken/Three Forks, and the resulting share that is transported to and through Minnesota. Together, they determine the level of capacity required in the rail, pipeline, and highway systems that is needed to move the crude oil and other commodities, especially agriculture. The total demand for transportation capacity, in turn, will determine the levels of capex needed for transportation infrastructure.

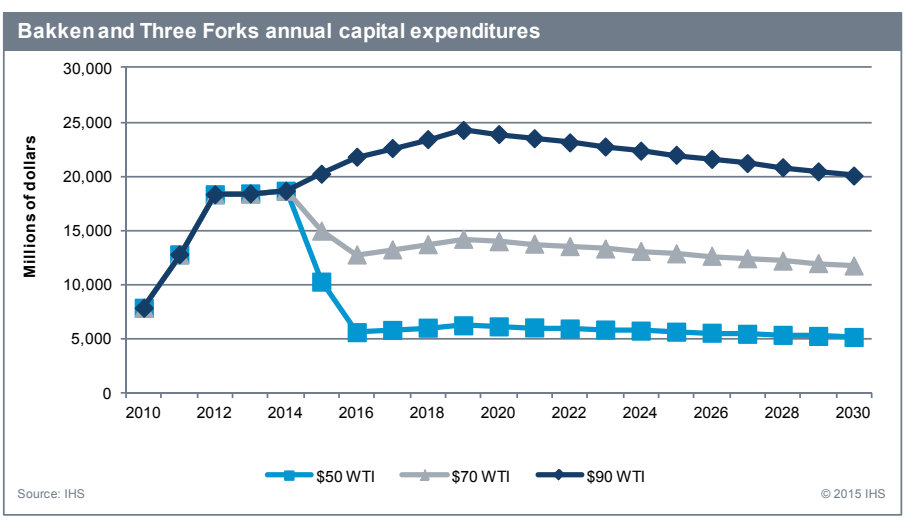
If crude oil prices return to the range of the high-price scenario, IHS expects both capital and operating costs to remain at the recent levels. However, lower oil prices are expected to cause surplus capacity in drilling, production, and other services, stimulating increased competition and lower costs. IHS estimates costs to fall from current levels for the base and low scenarios as follows:

- Base scenario: capital expenditures to $7.96 million per well and operating costs to $5.84/bbl
- Low-price scenario: capital expenditures to $6.92 million per well and operating costs to $5.51/bbl.

The charts show the level of capital expenditures and operating costs, respectively, for each scenario.







Major findings

The key points from the most recent IHS forecast of oil production for the Bakken/Three Forks shale formations are summarized in this section. Additional details are provided in the remainder of the section.

- In both the base and high oil price scenarios, Bakken production is expected to continue rising and peak in the middle of the next decade. In the low oil price scenario, production drops slightly in 2015 and remains relatively constant at or near the 2014 average.
- Crude-oil-by-rail shipments will decline in 2015 as new pipelines come into service. However, the long-term level of rail shipments will depend on the production of crude oil and the capacity of pipelines that have not yet been approved. This approval is not likely to occur if long-term prices remain in the $50/bbl range. Nevertheless, major markets for Bakken crude are located on the East and West Coasts, where no pipelines are planned and transport is likely to continue by rail for the foreseeable future.
- In the base scenario, Bakken/Three Forks production will continue to increase until at least 2022 with fewer rigs and new wells, as drilling practices and hydraulic fracturing technologies continue to advance. Operators will also focus on drilling in high-graded areas where production per well is highest. Later in the decade, we expect annual well counts and rig counts to decrease substantially and production will begin a slow, steady decline.
- The number of wells drilled is expected to decrease unless oil prices return to the $90-plus/bbl range. At these high price levels, the number of new wells could rise to as many as 2,800 per year before declining. In the base scenario, the number of new wells will fall for the next couple of years to 1,600 per year. In the low-price scenario, the number of new wells drops sharply to 800 in 2016 and remains at that level for the period.
- The average rig count will closely match the trend in new wells.
- Frac sand demand in Bakken will follow the number of new wells. Sand use per well has increased over time to approximately 4.5 million pounds per well. Current trends suggest some increase in the future, which may offset some of the decreases in drilling through practices such as superfracking.
- Capital expenditures will follow the trends of new wells in each scenario and operating expenses will follow production levels.
- In the Petroleum Administration for Defense District (PADD) 2, which includes 15 states around the Great Lakes and upper Midwest, including Minnesota, energy supplies are growing relative to demand and it could become a net exporter of crude oil and liquid fuels by 2020.

Policy considerations

Energy policy is a constantly changing concept. Over the longer term, energy policy in the United States tends to change as perceptions of future energy supplies and prices change. Frequently, policy changes occur in response to unanticipated or unintended consequences or market dislocations resulting from past policies; recent examples include those for methyl tertiary butyl ether (MTBE) and ethanol, which are both used as gasoline additives to reduce vehicle emissions. US oil and gas production growth and the supply/demand balance could be influenced by future policy changes. The net impact of any policy change is eventually reflected in the price or cost of oil and gas relative to other products and markets. Energy policy areas where changes could significantly affect the level and price of oil extracted in the Bakken/Three Forks formation are identified in this section.

- *US ban on crude oil exports*: Primary among the existing US policies that have an impact on US crude oil prices and, eventually, production growth is the ban on crude oil exports. The ban was put into effect in 1973 and effectively prohibits the exportation of US crude oil to any country except Canada without a special waiver. There have been two waivers granted 1) which allows the exporting of Alaskan crude oil with certain shipping considerations and 2) includes the recent waiver to allow some condensates to be exported. Production of light/sweet crude oil such as Bakken continues to increase putting pressure on domestic crude oil prices. The domestic refining system is not

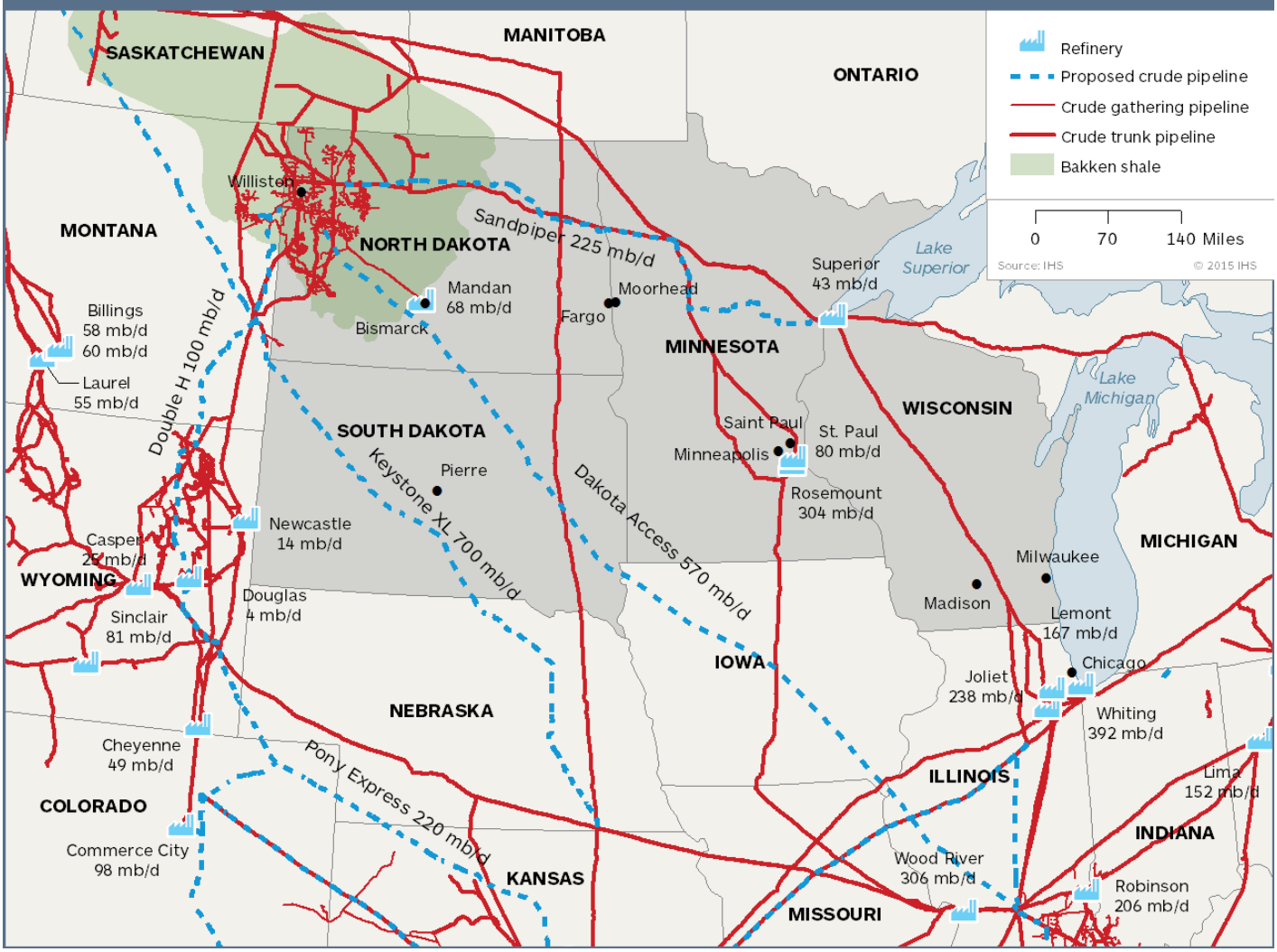
designed to run the amount of light/sweet crude oil being produced. To absorb the growing surplus of light/sweet crude oil would require significant investment in new refinery capability while reducing the value of existing refining capacity. Modifying or lifting the export ban would bring domestic crude oil market back into balance with refining capability and prices back to world parity. IHS anticipates the crude oil export ban will be modified or lifted in 2017. The implication for Bakken will eventually be higher relative prices compared with the current price, once sufficient pipeline and rail takeaway capacity is built to the Gulf Coast. This lifting of the ban will also narrow the gap between WTI and Brent and between Bakken and WTI.

- *Jones Act*: The Jones Act was passed in 1920. It requires all goods shipped between US ports to be transported on US-built, -crewed, and -flagged ships. US ships carry higher costs than international vessels. This is important for Bakken because the higher cost of Jones Act ships contributes to the attractiveness of rail shipments from Bakken to the US East and West Coast refiners rather than moving the USGC light/sweet crude oil to these markets by tanker. IHS does not expect changes to US shipping policies.

Phase 2: Transportation impacts

As part of the Minnesota Department of Employment and Economic Development's project to examine the effects of North Dakota oil production on the Minnesota economy, IHS conducted an analysis of trade by commodity type across different modes of transportation. Annual crude-oil production in the Bakken/Three Forks shale play in western North Dakota and eastern Montana has increased rapidly, and this has significantly contributed to the tonnage and volume of crude oil being sent through Minnesota. This recent trend has raised concerns about the ability of Minnesota's transportation systems (notably railroads) to accommodate the flows of crude oil originating in North Dakota, and to a lesser extent in Canada, as well as flows of all other types of commodities (especially all types of agricultural products).

Geographic overview of Minnesota and the Bakken oil play



This report presents rail and truck commodity flows through, into, and out of Minnesota for selected years through 2030 based on alternative energy scenarios. Estimates for crude petroleum transiting by rail have been revised based on the recent reductions in the cost of crude oil and Bakken and in Canadian oil field production. As a result, the estimates for the number of unit trains[2] transiting Minnesota through 2030 have been revised. The revised oil-production forecasts indicate the variability in the possible number of unit trains, particularly over the short term, owing to per-barrel pricing. We present the original forecast prior to the recent reduction in oil prices. The accompanying map shows the proximity

2 A unit train is a freight train composed of cars carrying a single type of commodity that are all bound for the same destination. By hauling only one kind of freight for one destination, a unit train does not need to switch cars at various intermediate junctions and so can make nonstop runs between two terminals. It can include 100 freight cars.

of Minnesota to the Bakken formation, and to major oil pipelines, existing and proposed; rail lines are shown in a map presented below.

We also present three alternative scenarios based on $90/barrel West Texas Intermediate (WTI) holding steady, $70/barrel WTI, and $50/barrel WTI. We anticipate the $70/barrel WTI to be more likely over the long-run; therefore, we focus on this scenario and present it as a base scenario for planning. These production levels have been generated by IHS Energy of alternative futures for Bakken production on a yearly basis. It must be understood, however, given pricing fluctuations, the number of unit trains per day will vary on a year-to-year basis. When Bakken production returns to 2013–14 levels, the number of Bakken-related unit trains could be, again, as many as 10 per day.

The commodity flows originally presented were derived from the 2012 IHS Transearch database (the most current history year available). They were used to estimate the demand for transportation capacity, such as the number of unit trains. Our analysis focuses on crude-oil shipments originating in North Dakota and in the Canadian provinces of Alberta and Saskatchewan that we forecast to be shipped through Minnesota. Importantly, our analysis also considers flows of other commodities, such as agricultural products (e.g., grain; oil kernels, nuts, or seeds; and nut or vegetable oils), coal, gravel and sand (including frac sand), and iron ore. These commodities are competing with crude oil for transportation capacity, especially on the rail system.

The 2012 IHS Transearch database provides county-to-county trade and transportation flows by mode, commodity type, weight, and value for more than 340 commodities. Transearch is used by governments and transportation service providers to analyze market demand and transportation system capacity and to identify investment priorities. The trade flow estimates and forecasts consider the large increases that have occurred during the last two years owing to the amount of crude oil produced by the Bakken/Three Forks shale formations. The commodity flows produced by Transearch were based on the findings of the Phase 1 "Forecast of oil production levels in the Bakken/Three Forks formations," which was presented earlier in this study.

Mode share distributions for all commodities

To analyze the transportation capacity needed to accommodate the demands from crude oil and other commodities, it is helpful to provide the context of the movements of all types of commodities through, into, and out of Minnesota. Approximately 96% of all commodities, by weight, were transported by rail and truck. The rail and truck shares in 2030 are forecast to be 48% and 49%, respectively, compared with mode splits of 54% and 42% in 2012. During the analysis period, truck tonnage is forecast to grow at an average annual rate of 2.3%, the highest rate of all modes. The average annual growth rates for air, rail, and water tonnage are estimated at 1.4%, 0.8%, and -0.6%, respectively. Rail tonnage will experience slow growth because coal shipments will steadily decline between 2012 and 2030. Truck movements constitute the largest value of all trade, with a 41% share in 2012.

Total commodity flow tonnages in Minnesota by mode

Mode	2012	2014	2015	2019	2030	Percent of 2012	Percent of 2030	CAGR 2012-30
		(Tons in thousands)						
Rail	456,512	458,607	464,144	487,779	525,327	53.5%	47.9%	0.8%
Truck	357,048	390,754	402,225	444,001	534,787	42.0%	48.8%	2.3%
Water	39,328	38,297	38,682	38,392	35,328	5.0%	3.2%	-0.6%
Air	195	201	205	215	252	0.0%	0.0%	1.4%
Total	**853,083**	**887,859**	**905,256**	**970,387**	**1,095,694**	**101%**	**100%**	**1.4%**

Notes: Percent sums vary +/- due to rounding error; CAGR: compound annual growth rate

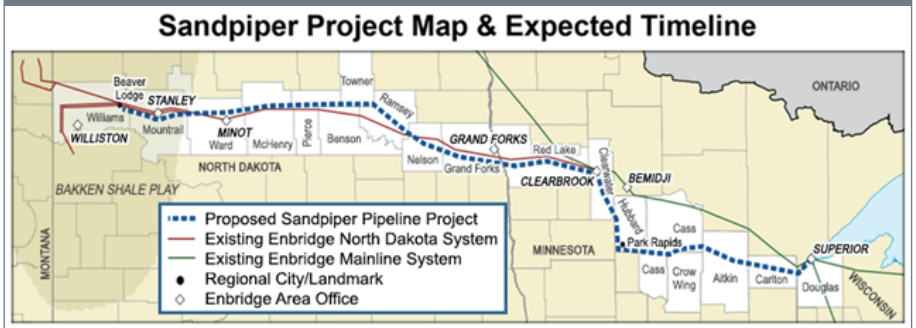
Source: IHS, Transearch database for 2012, 2015

© 2015 IHS

We forecast that the truck share of the value of commodities carried will reach 51% in 2030. Trucking's share of value carried is higher than its share of tonnage carried because trucks carry higher-value products, as opposed to bulk commodities like crude oil, grain, and sand and gravel, which have much lower ratios of value to weight and are more likely to move by rail.

Commodity flows by rail and truck

Proposed Sandpiper crude-oil pipeline route



Project Stage	Timeframe
Planning, design, landowner outreach and permitting	2013 - Late 2014
Construction	Late 2014 - 2016
Restoration	2016 Until Complete
In-Service	2016

Source: Enbridge

Policymakers and the media in Minnesota have been concerned about the increase in the amount of crude oil from the Bakken/Three Forks formations and the Canadian oil sands moving by rail through the state. The rapid increases in the amount of crude-oil production and the accompanying strong growth in demand for rail service have strained the state's rail system. The competition for rail capacity has spurred discussions about how to accommodate the additional flows of crude oil by rail and balance it with the demand to ship other commodities (particularly agricultural products) by rail. Minnesota's farmers recently produced bumper crops that have increased the demand for timely rail service. One way to decrease demand for rail capacity is to expand the capacity of crude-oil pipelines in Minnesota. As IHS concluded in the Phase 1 report, rail shipments of crude oil out of the Bakken are expected to begin declining within the next several years as new pipelines overtake production growth. Prior to the recent drop in oil prices, we anticipated that rail traffic would fall below current levels within the next two years and by 2020 average about 25% below 2014, assuming that the Sandpiper pipeline project is completed. With $70/barrel WTI, rail traffic transiting Minnesota carrying Bakken oil will drop by about 50% in 2015; it will then reach 2014 levels in 2030 as oil production increases, assuming that no new pipelines come into service. Conceivably, if all proposed pipelines are built, almost all of the required rail service transiting Minnesota with Bakken-produced oil could be diverted to the new pipelines starting around 2020. This is also greatly dependent on the Dakota Access pipeline, which is proposed at this time.

For the most part, the oil shipments originating in North Dakota and Canada move through Minnesota to destinations in the Midwest, the Gulf Coast, and the Mid-Atlantic. Based on revised Bakken oil production and the eventual completion of the Sandpiper East pipeline by 2016, required rail service could drop by as much as 70%. Remaining rail service could be required to deliver oil to East Coast refineries. East Coast deliveries will depend on available capacity and the economics of Gulf Coast refineries and the potential of moving refined products via Jones Act vessels to East Coast ports.

Approximately 300 miles of the 612-mile, $2.6-billion project will be in Minnesota. Enbridge, the developer of the Sandpiper pipeline, is completing two other projects in Minnesota that will expand the capacity of its crude-oil pipeline system: 1) increasing the capacity of line 67 by adding new pumping stations and 2) replacing the pipes of line 3, which includes 338 miles in Minnesota. Lines 67 and 3 both end at Enbridge's oil terminal in Superior, Wisconsin.

The primary characteristics of commodity flows through Minnesota are summarized below:

- 69.9% of all commodities destined to North Dakota originate in Minnesota. Of these, 39.7% shipped on truck, 25.7% are shipped on rail and 4.5% are air cargo commodities originated in Minnesota.
- 39.7% of all commodities originating in Minnesota are destined to North Dakota. For commodities originating in Minnesota, 33% are shipped on truck to North Dakota, 3.7% are shipped on rail and 3% are air cargo commodities.
- 19.2% of all commodities that originate in North Dakota are sent to Minnesota. For commodities destined to Minnesota, 13.6% are shipped on truck, 4.6% are shipped on rail, and less than 1% is air cargo commodities.
- Crude petroleum rail shipments currently moving through Minnesota originate in North Dakota and in the Canadian provinces of Alberta and Saskatchewan.

- Based on historical data, North Dakota crude petroleum rail tonnage moving through Minnesota is estimated to have grown very rapidly (increasing by as much as 190% and growing at a rate of 43% per year) between 2012 and 2014. Based on new oil production at $70/barrel WTI, the tonnage transiting Minnesota by rail could drop by as much as 70% by 2016. This would have a proportional effect on Minnesota's Border Cities, particularly Moorhead, since it experienced the heaviest increase in rail transits through 2014 with as many as 8 unit trains per day.

- Based on historical data, Canadian crude petroleum shipments moving through Minnesota by rail rose from about 3.9 million tons in 2012 to 4 million tons in 2014, an increase of only 3.1%. Before the drop in oil prices, shipments were anticipated to gradually rise to 4.1 million tons by 2019 and 4.3 million tons in 2030. Based on revised Canadian crude production rates (due to the recent price reductions), we are anticipating that Canadian tonnage transiting Minnesota will drop but remain around 3.7 million tons by 2030.

- North Dakota crude petroleum through rail shipments required approximately 3,300 unit trains in 2014. We originally estimated that the number of unit trains per year would peak at about 3,700 in 2019 and then gradually decline to about 2,800 by 2030. Per-day estimates were about 8 to 9 trains in 2014, 10 to 11 trains between 2015 and 2019, and 7 to 8 trains in 2030. With the revised North Dakota oil production, at $70/barrel WTI, we estimate that approximately 1,600 unit trains per year, or about five per day, will transit Minnesota in 2015. By 2020, we expect approximately 2,400 unit trains per year, or seven per day. Assuming that no new pipelines come online, the annual number of unit trains could increase to approximately 4,000, or as many as 11 trains per day. However, if all proposed pipelines are built, the demand for Bakken carrying unit trains is highly likely to fall close to zero by 2020.

- Our original estimate of unit trains carrying crude oil from Canada through Minnesota was approximately 428 trains in 2014, 441 trains in 2015, and 472 trains in 2030, equivalent to one to two unit trains per day. The majority of these through rail shipments are destined for the US East Coast, Midwest, and Gulf Coast and for locations in eastern Canada such as Montreal, Toronto, and Chicoutimi, Quebec. Based on new production estimates, the number of annual unit trains is estimated to be about 400, or about one train per day, from 2015 through 2030.

- Outbound agricultural tonnage from Minnesota is forecast to have the fastest growth rate among the high tonnage commodities. Agricultural tonnage includes oil kernels, nuts, or seeds, which are forecast to grow at almost 5%, followed by grain and soybean oil, which should each grow close to 2%. Large quantities of these agricultural products are shipped to the US Northwest, where they are consumed or exported to Asia.

- Large quantities of iron ore are being shipped from Minnesota to locations in the Midwest and Southeast US.

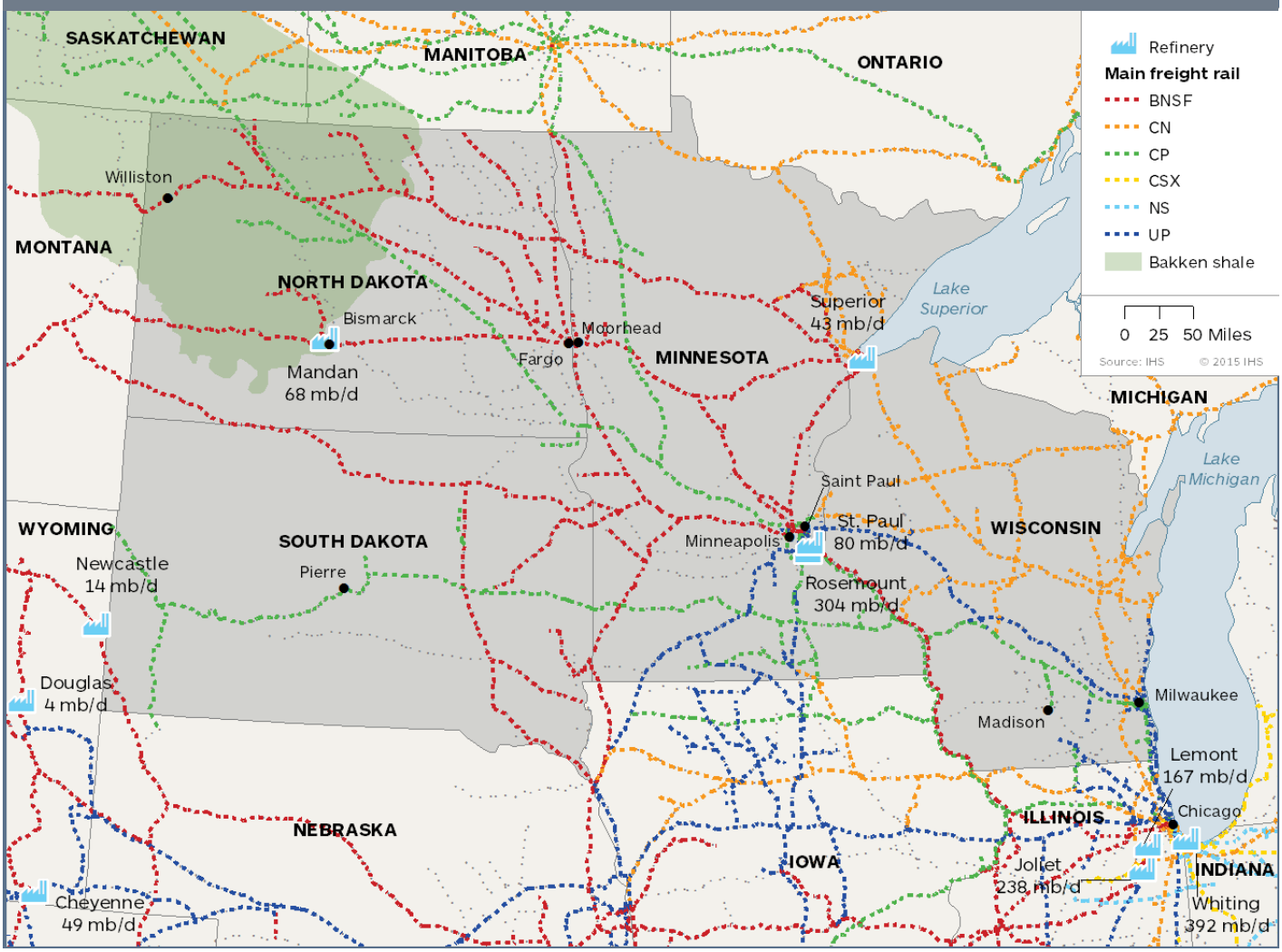
- By far, coal represents the largest amount of tonnage being shipped to Minnesota. However, the annual flow should decline from 12.3 million tons in 2012 to 9.6 million in 2030, at an average annual rate of 1.4%. Intermodal shipments and fertilizers represent the next largest amount of inbound tonnage shipments.

- Grain will be the largest tonnage of commodities shipped out of Minnesota by truck between 2012 and 2019. Annual outgoing shipments of grain moving by truck will average 30 million tons between 2019 and 2030. Gravel or sand will become the largest outbound commodity shipped by truck starting in 2020, regardless of oil price scenarios; shipments will gradually rise to 40.7 million tons by 2030. Of this, it is estimated approximately 4.0 million to 7.3 million tons of frac sand (equivalent to about 1 to 2 unit trains per day) would be shipped through Minnesota to North Dakota through 2030, depending on production levels.

Minnesota freight overview

This section presents detailed data on the movement of commodities through, into, and out of Minnesota by rail and truck. The characteristics of the trade flows are presented, including tonnage by type of commodity for both modes, value by type of commodity, and origins and destinations. The trade flows were estimated using our 2012 Transearch database; values for subsequent years are forecasts. The accompanying map shows the major freight rail lines serving Minnesota and the Bakken shale formation.

Freight rail connections in Minnesota



Minnesota through rail traffic

Through traffic makes up about three-fourths of total rail traffic in Minnesota. By far, coal shipments were the greatest amount of through tonnage in 2012 at approximately 178.1 million tons; annual through shipments are forecast to decline to 124.2 million tons by 2030 at an average annual rate of about -2%. The reason for the decline is the decreasing use of coal as a fuel to generate electric power, as utilities switch to natural gas. The coal shipments primarily originate in Wyoming; destinations include St. Louis, Houston, Peoria, Dallas, Little Rock, Duluth, Chicago, and San Antonio.

The top 10 commodities by weight moving through Minnesota originating in North Dakota and Canada are listed in the table below. Based on Transearch data, crude oil was the individual commodity with the largest tonnage in 2012 transiting Minnesota from North Dakota and Canada at about 13.8 million tons, increasing to 40.0 million tons in 2015 and then declining to approximately 23.9 million tons in 2030. The steep increase in tonnage between 2012 and 2015 represents a 191% increase and an annual growth rate of 43%. The forecast presented below anticipates crude petroleum

tonnage declining to 34 million tons in 2019 and eventually 23.9 tons in 2030. The annual growth rate, however, from 2012 to 2030 is estimated to be 3.1% (accounting for the steep annual increases and then the decline later during the 2030 time period).

Top 10 commodities from Canada and North Dakota transiting Minnesota by rail

Commodity	2012	2014	2015	2019	2030	CAGR 2012-30
			(Tons in thousands)			
Crude Petroleum	13,754	32,147	40,038	34,088	23,857	3.1%
Potassium or Sodium Compound	11,566	11,353	11,504	12,033	13,163	0.7%
Lumber or Dimension Stock	9,072	9,870	10,290	11,395	14,507	2.6%
Grain	6,604	7,377	7,357	8,209	11,299	3.0%
Oil Kernels, Nuts or Seeds	4,851	4,461	4,593	5,752	11,397	4.9%
Plastic Mater or Synth Fibers	3,494	3,919	4,160	5,018	8,026	4.7%
Nut or Veg Oils or By-products	2,924	2,932	2,975	3,147	3,512	1.0%
Misc. Industrial Organic Chemicals	2,843	3,052	3,224	4,289	7,693	5.7%
Pulp or Pulp Mill Products	2,530	2,629	2,706	2,925	3,489	1.8%
Motor Vehicles	2,334	2,538	2,646	2,927	3,724	2.6%

CAGR: compound annual growth rate

Source: IHS, Transearch database for 2012, 2015

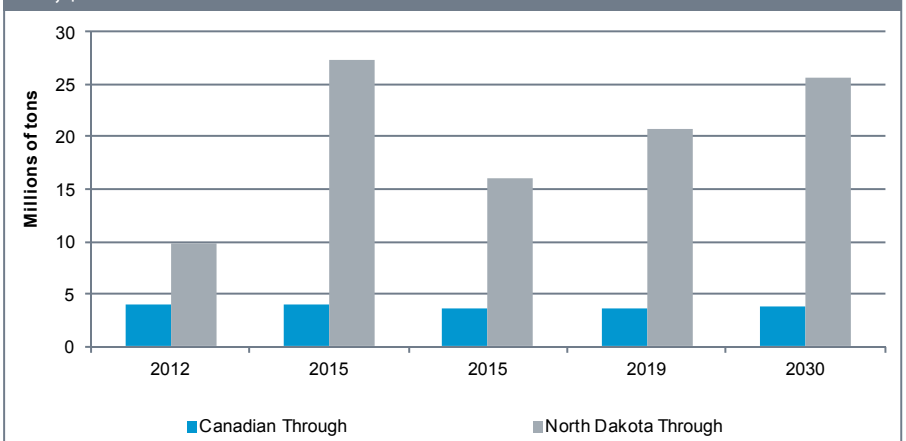
© 2015 IHS

Based on new North Dakota production forecasts at $70/barrel WTI and assuming no major increases in pipeline capacity, crude petroleum tonnage transiting Minnesota in 2015 could decline to approximately 19.7 million tons. It should reach approximately 21 million tons in 2019 and 30 million tons in 2030 (assuming a return to 2014 crude-oil production levels).

Three agricultural products—grains; oil kernels, nuts, or seeds; and nut and vegetable oils—as an aggregate were the largest trade flows by tonnage in 2012; they are forecast to grow at average annual rates of 3.0%, 4.9%, and 1.0%, respectively, between 2012 and 2030. IHS estimates that, at 32.1 million tons, 2014 crude petroleum tonnage far exceeded the aggregate tonnage of these three agricultural commodities. We forecast that the aggregate tonnage of the three agricultural commodities listed above will reach 26.2 million tons by 2030. Based on new production forecasts (at $70/barrel WTI), crude petroleum tonnage shipments could reach 30 million in 2030, still exceeding the aggregate agricultural tonnage.

Two figures are presented of North Dakota and Canadian flows transiting Minnesota. One illustrates the original forecast based on Transearch 2012; the other is based on revised production levels through 2030 at $70/barrel. Under the original forecast, tonnage of crude oil shipped by rail and originating in North Dakota was expected to peak in 2015 and slowly decline. However, at $70/barrel WTI, tonnage being shipped through Minnesota dips in 2015 with a gradual increase occurring through 2030.

Crude-oil flows from Canada & North Dakota passing through Minnesota by rail, $70/barrel



Source: IHS

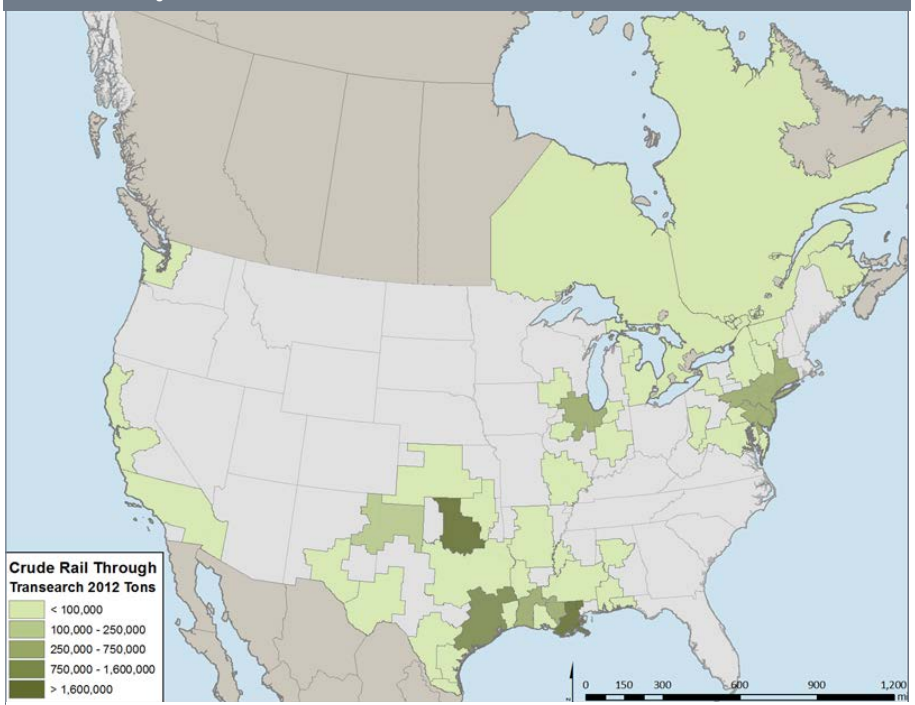
© 2015 IHS

The figure below illustrates the destinations of crude petroleum trade flows originating in North Dakota and Canada that pass through Minnesota on rail, based on Transearch 2012 data. Transearch-generated data indicate that the largest tonnage flows are going to the Gulf Coast, other locations in Texas and Oklahoma, the Midwest, and the Mid-Atlantic.

Minnesota through truck traffic

Top origins and destinations for truck through-traffic by Bureau of Economic Analysis (BEA) economic area indicates supply chains that serve the Upper Midwest. Des Moines, Iowa, is an important origin and destination for commodities moving through the Upper Midwest and transiting Minnesota. Two-way truck tonnage between the Minneapolis and Des Moines BEA economic areas represents the largest amount of traffic moving through Minnesota. Between 2012 and 2030, truck tonnage flowing from Minneapolis to Des Moines is forecast to grow at an average annual rate of only 0.2%, while the growth rate for the reverse flow is 2.2%—the highest among all the origin-destination pairs shown in the table. The Fargo, North Dakota, BEA area includes Clay and Norman counties in western Minnesota. The Minneapolis BEA area contains 54 counties in Minnesota. The Bakken and Three Forks formations are located in the Bismarck, North Dakota; Minot, North Dakota; and Billings, Montana, BEA economic areas.

Destinations of crude oil from Canada and North Dakota moving through Minnesota by rail



Source: IHS Transearch 2012

Top origin and destinations pairs for through Minnesota commodities carried by truck

Origin BEA economic area	Destination BEA economic area	2012	2014	2015	2019	2030	CAGR 2012–30
			(Tons in thousands)				
Minneapolis, MN	Des Moines, IA	1,421	1,576	1,566	1,522	1,471	0.2%
Des Moines, IA	Sioux, Falls, SD	720	869	920	1,033	1,042	2.1%
Sioux, Falls, SD	Des Moines, IA	712	828	838	910	990	1.8%
Wausau, WI	Des Moines, IA	556	619	622	624	640	0.8%
Des Moines, IA	Fargo, ND	499	591	626	696	578	0.8%
Des Moines, IA	Minneapolis, MN	485	564	591	688	714	2.2%
La Crosse, WI	Des Moines, IA	451	505	502	488	473	0.3%
Des Moines, IA	La Crosse, WI	407	477	504	589	502	1.2%
Minneapolis, MN	Cedar Rapids, IA	399	443	440	443	515	1.4%
Casper, WY	Wausau, WI	355	341	334	312	270	-1.5%

CAGR: compound annual growth rate

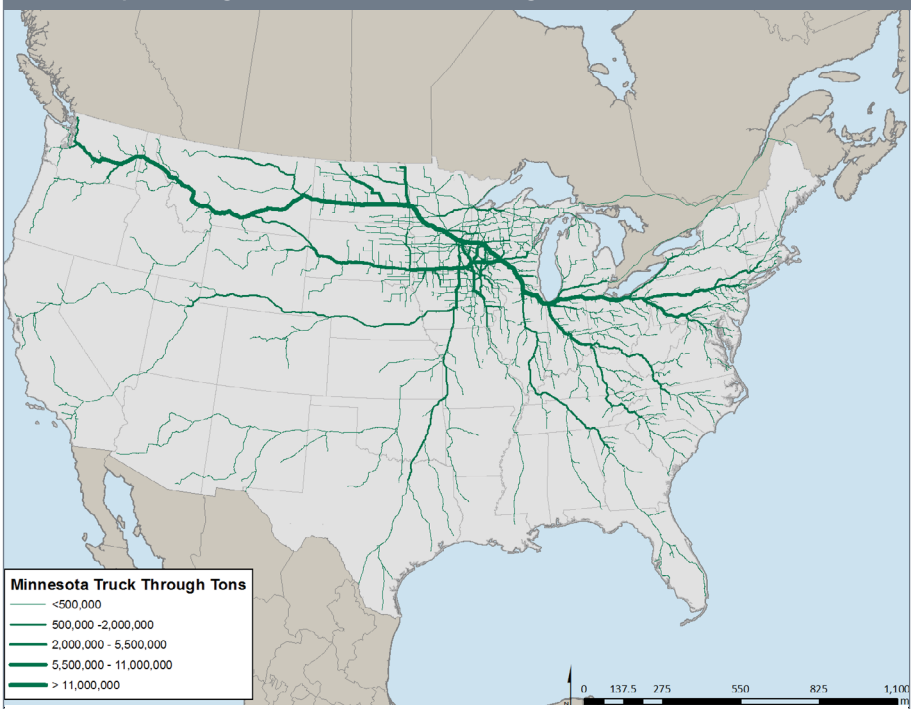
Source: IHS Transearch 2012

© 2015 IHS

Interstate 94 is important for truck movements through the Upper Midwest, with the Twin Cities serving as a pivotal transportation hub in the region. Interstate 94 also provides direct highway access between the major cities in Minnesota and the Bakken/Three Forks shale play. Much of the capital equipment (e.g., drilling rigs, pumps, compressors, instruments, and steel) and materials (e.g., cement and fracking fluid) used in the drilling of new oil wells are transported by trucks that undoubtedly move along Interstate 94. As the principal east-west highway connecting the Twin Cities to Moorhead and North Dakota, it is an important conduit for the delivery of materials to North Dakota. Truck traffic carrying heavier loads will increase along Interstate 94 as North Dakota's investments in development occur. Inevitably the increased truck traffic will contribute to congestion particularly in urban areas and accelerated roadway deterioration.

The top commodity flows in 2012, by tonnage, moving on trucks through Minnesota are gravel and sand, including sand used for fracking; it is expected to grow at an average annual rate of 3% between 2012 and 2030. Other bulk commodities with significant tonnage flows in 2012 included grain, broken stone or riprap, and dairy products. Clay ceramic and refractory minerals are forecast to have the highest average annual growth rate, at 4.8%. The economic recovery—including new construction, increased manufacturing output in Minnesota and North Dakota, and the expected increases in North Dakota crude-oil production—is the likely reason for the high growth rates for sand and gravel, clay materials, and lumber truck shipments. The warehouse and distribution center commodity consists of many different goods that use warehouse and distribution services. As noted below, the Twin Cities serve as an important, multimodal distribution center for the Upper Midwest.

Trucks trips through Minnesota (2014 tonnages)



Source: IHS Transearch 2012

Top through-Minnesota commodities carried by truck

Commodity	2012	2015	2019	2030	CAGR
		(Tons in thousands)			2012–30
Gravel or sand	5,241	7,018	8,527	8,977	3.0%
Grain	5,014	6,148	6,173	6,617	1.6%
Broken stone or riprap	4,990	5,629	6,339	4,961	0.0%
Warehouse and distribution centers	2,291	2,584	2,922	4,158	3.4%
Dairy farm products	1,370	1,462	1,587	1,824	1.6%
Oil kernels, nuts, or seeds	1,190	956	1,042	1,246	0.3%
Deciduous fruits	992	1,059	1,117	1,235	1.2%
Clay ceramic or refractory minerals	694	832	1,122	1,608	4.8%
Frozen fruit, vegetables, or juice	590	618	682	823	1.9%
Lumber or dimension stock	588	697	757	973	2.8%

CAGR: compound annual growth rate

Source: IHS Transearch 2012

© 2015 IHS

The origin and destination trade flows for the top commodities, including grain and coal, moving through the Upper Midwest by truck highlights the movement of broken stone and riprap trade flows from the Des Moines, Iowa, and Rochester, Minnesota, BEA economic areas to the Fargo BEA economic area. Broken stone and riprap trade flows will grow through 2015 but decline thereafter. The tonnage of broken stone or riprap moving from Rochester to Fargo will decline by almost 5% annually through 2030. Broken stone and riprap are likely proxy indicators for construction activity. Grain tonnage remains relatively constant, with modest increases in tonnage moving between Sioux Falls and Des Moines.

Top origin-destination pairs for through Minnesota commodities carried by truck

Origin BEA economic area	Destination BEA economic area	Commodity	2012	2015	2019	2030	CAGR
				(Tons in thousands)			2012–30
Minneapolis, MN	Des Moines, IA	Grain	666	780	745	748	0.6%
Minneapolis, MN	Des Moines, IA	Gravel or sand	533	552	535	483	-0.5%
Sioux, Falls, SD	Des Moines, IA	Grain	508	623	645	692	1.7%
Des Moines, IA	Fargo, ND	Broken stone or riprap	353	434	490	350	0.0%
Casper, WY	Wausau, WI	Bituminous coal	333	310	285	244	-1.7%
Des Moines, IA	Sioux, Falls, SD	Grain	304	400	403	406	1.6%
Wausau, WI	Des Moines, IA	Grain	301	356	342	349	0.8%
Rochester, MN	Fargo, ND	Broken stone or riprap	300	322	308	121	-4.9%
La Crosse, WI	Des Moines, IA	Grain	260	304	290	290	0.6%
Des Moines, IA	Sioux, Falls, SD	Broken stone or riprap	238	304	380	346	2.1%

CAGR: compound annual growth rate

Source: IHS Transearch 2012

© 2015 IHS

Minnesota outbound rail traffic

Although outbound freight makes up a relatively small percentage of total rail transportation, it is nonetheless an important mode of transport for getting numerous Minnesota commodities—including iron ore and agricultural products -- to market. Oil kernels, nuts, or seeds are forecast to grow at the highest annual rate (4.9%), followed by grain and soybean oil (each growing close to 2%). The annual growth rate for sand tonnage is about 2.8%, largely owing to the demand for frac sand produced in Minnesota. Rail freight moves large quantities of iron ore out of Minnesota to locations in the Midwest and Southeast. Large quantities of agricultural products are shipped to the US Northwest, where they are consumed and/or transshipped to Asia.

Top outbound Minnesota commodities carried by rail

Commodity	2012	2015	2019	2030	CAGR
		(Tons in thousands)			2012–30
Iron ores	16,401	16,791	20,408	23,709	2.1%
Grain	9,078	9,828	10,506	12,773	1.9%
Gravel or sand	4,856	5,372	6,362	8,024	2.8%
Oil kernels, nuts, or seeds	3,791	3,613	4,531	8,951	4.9%
Misc. industrial organic chemicals	2,648	2,947	3,792	4,663	3.2%
Soybean oil or by-products	2,570	2,720	2,997	3,578	1.9%
Petroleum refining products	1,563	1,710	1,812	1,979	1.3%
Intermodal shipments	1,216	1,340	1,436	1,821	2.3%
Wet corn milling or milo	1,156	1,288	1,467	1,813	2.5%
Paper	912	1,106	1,192	1,194	1.5%

CAGR: compound annual growth rate

Source: IHS Transearch 2012

© 2015 IHS

Top origin-destination pairs for all outbound Minnesota commodities carried by rail

Origin BEA economic area	Destination BEA economic area	Commodity	2012	2015	2019	2030	CAGR 2012–30
				(Tons in thousands)			
Duluth, MN	Duluth, MN	Iron ores	8,846	9,255	12,100	13,971	2.6%
Duluth, MN	Atlanta, GA	Iron ores	2,724	2,623	2,856	3,351	1.2%
Duluth, MN	Des Moines, IA	Iron ores	2,717	2,616	2,849	3,342	1.2%
Minneapolis, MN	Seattle, WA	Grain	1,862	1,700	1,870	2,460	1.6%
Minneapolis, MN	Seattle, WA	Oil kernels, nuts, or seeds	862	829	1,039	2,036	4.9%
Fargo, ND	Portland, OR	Oil kernels, nuts, or seeds	849	789	991	1,992	4.9%
Minneapolis, MN	Denver, CO	Gravel or sand	820	952	1,124	1,034	1.3%
Minneapolis, MN	New York, NY	Misc. industrial organic chemicals	760	849	1,066	1,072	1.9%
Fargo, ND	Seattle, WA	Oil kernels, nuts, or seeds	689	666	834	1,634	4.9%
Minneapolis, MN	Odessa, TX	Gravel or sand	630	652	725	789	1.3%

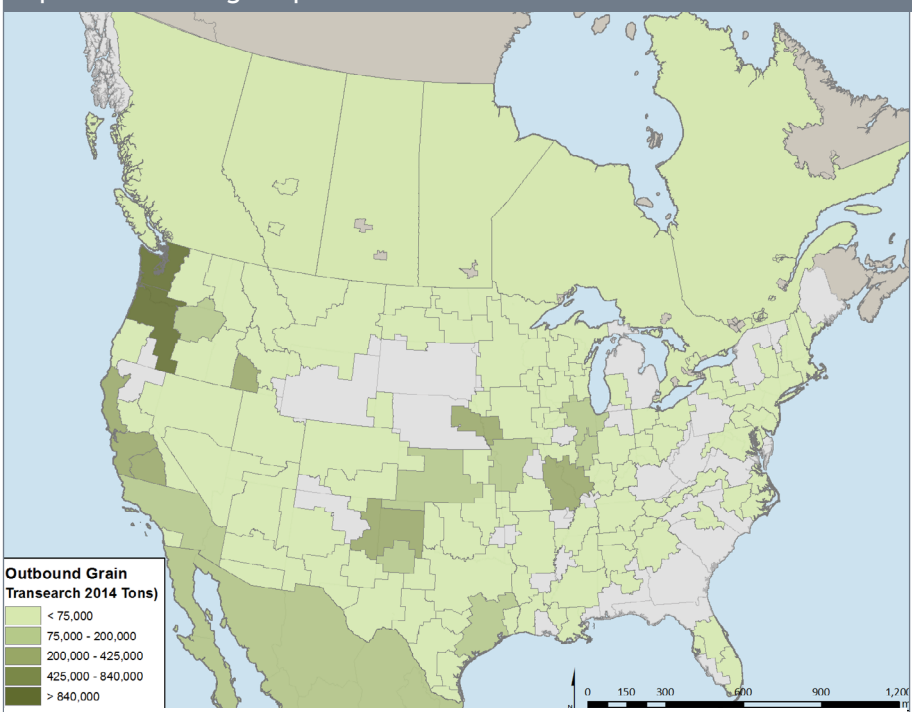
CAGR: compound annual growth rate

Source: IHS Transearch 2012

© 2015 IHS

US Northwest locations, such as Seattle and Portland, demonstrate a strong rail-based trade relationship with Minnesota, as a producer of agricultural products, and serve as a connective location for commodities ultimately destined for Asia. Trade flows from the Grand Forks, Fargo, and Minneapolis BEA economic areas to the Northwest are forecast to grow at more than 4% annually for several agricultural commodities.

Top rail outbound grain product destinations



Source: IHS Transearch 2012

The estimated tonnage of frac sand shipments originating in Minnesota is based on the IHS forecast for unconventional oil production in the Bakken/Three Forks formation. The largest tonnages of Minnesota frac sand are currently being shipped to Colorado, North Dakota, and Texas. Taken together, the Texas destinations receive substantially more frac sand than the Minot, North Dakota, BEA economic area. Shipments to the Dallas BEA economic area are forecast to grow at the highest rate (just over 6%) between 2012 and 2030, while those to the Grand Forks and Minot BEA economic areas are forecast to increase at average annual rates of 3.5% and 2%, respectively. Demand for frac sand will persist, despite the recent revision of oil production due to super fracking. Conceivably, this demand can be satisfied by frac sand originating in Minnesota as well as other locations. Frac sand shipments originating in Minnesota and destined for North Dakota could result in as many as one to two unit trains per day throughout the study period.

Top origin-destination pairs for outbound Minnesota frac sand

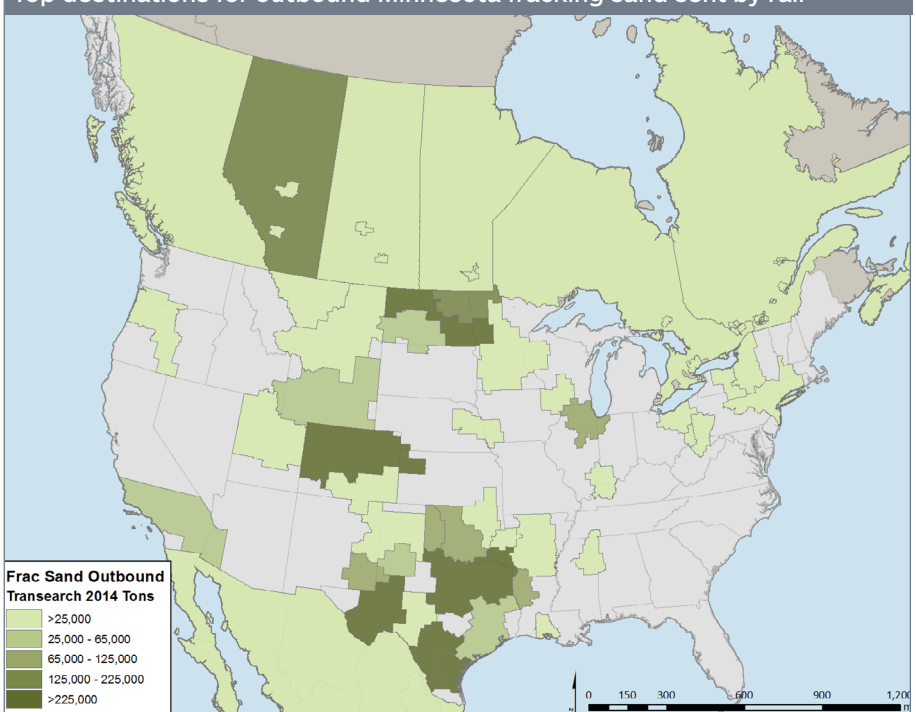
Origin BEA economic area	Destination BEA economic area	2012	2014	2015	2019	2030	CAGR 2012-30
			(Tons in thousands)				
Minneapolis, MN	Denver, CO	829	888	952	1,124	1,034	1.2%
Minneapolis, MN	Odessa, TX	630	634	652	725	789	1.3%
Minneapolis, MN	Minot, ND	479	487	493	584	685	2.0%
Minneapolis, MN	Dallas, TX	455	600	634	776	1,388	6.4%
Minneapolis, MN	San Antonio, TX	450	452	493	590	695	2.4%
Minneapolis, MN	Corpus Christi, TX	234	227	232	315	431	3.5%
Fargo, ND	Fargo, ND	232	227	231	261	285	1.1%
Minneapolis, MN	Grand Forks, ND	201	212	215	258	376	3.5%
Rochester, MN	Dallas, TX	190	172	196	199	178	-0.4%
Minneapolis, MN	Alberta, CA	124	126	132	152	199	2.7%

CAGR: compound annual growth rate

Source: IHS Transearch 2012

© 2015 IHS

Top destinations for outbound Minnesota fracking sand sent by rail



Source: IHS Transearch 2012

Minnesota outbound truck traffic

Grain constitutes the largest tonnage of commodities being shipped out of Minnesota by truck between 2012 and 2019, followed closely by sand and gravel. After 2019, annual grain tonnage is forecast to level out at around 30 million tons, resulting in an annual growth rate of

1% between 2012 and 2030. Additional agricultural shipments include miscellaneous field crops; dairy farm products; oil kernels, nuts, or seeds; and prepared or canned feed. The tonnage for all agricultural shipments should climb from about 36.8 million tons in 2012 to approximately 43.0 million by 2030, equivalent to a 1.5% average annual growth rate.

From 2012 to 2030, gravel and sand tonnage will grow 3.8% annually, exceeding the level of grain tonnage in 2030 by almost 35%. Annual growth rates in tonnage shipped between 2012 and 2030 are highest for cut stone and stone products and for broken stone, increasing 6.4% and 4%, respectively.

Top outbound Minnesota commodities carried by truck

Commodity	2012	2015	2019	2030	CAGR
		(Tons in thousands)			2012-30
Grain	25,179	29,426	29,692	30,259	1.0%
Gravel or Sand	20,948	24,65	29,646	40,728	3.8%
Warehouse & Distribution Center	5,999	6,747	7,427	10,317	3.1%
Misc. Field Crops	4,221	3,950	4,025	4,044	-0.2%
Broken Stone or Riprap	3,358	4,322	5,289	6,908	4.1%
Dairy Farm Products	2,861	2,888	3,117	3,488	1.1%
Oil Kernels, Nuts or Seeds	2,777	2,224	2,429	2,885	0.2%
Petroleum Refining Products	1,890	2,069	2,026	1,850	-0.1%
Cut Stone or Stone Products	1,851	2,302	2,685	5,666	6.4%
Prepared or Canned Feed	1,752	1,882	2,044	2,307	1.5%

CAGR: compound annual growth rate

Source: IHS Transearch 2012

© 2015 IHS

Grain, gravel and sand, and stone are the top commodities being shipped to destinations in the Upper Midwest. Annual growth rates for gravel and sand will be highest for shipments between Minneapolis and Des Moines, Fargo, Sioux Falls, and Sioux City, at 3.6%, 3.2%, 4.3%, and 4.7%, respectively.

Top origin-destination pairs for outbound Minnesota commodities carried by truck

Origin BEA	Destination BEA	Commodity	2012	2015	2019	2030	CAGR
				(Tons in thousands)			2012-30
Minneapolis, MN	Des Moines, IA	Grain	4,810	5,690	5,722	5,919	1.2%
Minneapolis, MN	Sioux, Falls, SD	Grain	2,986	3,426	3,364	3,071	0.2%
Minneapolis, MN	Des Moines, IA	Gravel or Sand	1,859	2,197	2,659	3,532	3.6%
Minneapolis, MN	Sioux, City, IA	Grain	1,851	2,234	2,251	2,370	1.4%
Minneapolis, MN	Omaha, NE	Grain	1,666	1,893	1,890	1,857	0.6%
Minneapolis, MN	Fargo, ND	Gravel or Sand	1,434	1,557	1,845	2,503	3.1%
Minneapolis, MN	Sioux Falls, SD	Gravel or Sand	1,372	1,618	2,006	2,901	4.2%
Minneapolis, MN	Fargo, ND	Broken Stone or Riprap	1,365	1,804	2,187	2,813	4.1%
Minneapolis, MN	Fargo, ND	Grain	1,323	1,586	1,600	1,619	1.1%
Minneapolis, MN	Sioux City, IA	Gravel or Sand	1,046	1,278	1,597	2,388	4.7%

CAGR: compound annual growth rate

Source: IHS Transearch 2012

© 2015 IHS

Minnesota inbound rail traffic

Coal by far represents the largest amount of tonnage being shipped. IHS forecasts that the annual tonnage of inbound coal shipped by rail will decrease from 12.3 million tons in 2012 to 9.6 million tons by 2030, yielding an average annual rate of decline of 1.4%. Intermodal shipments and fertilizers represent the next largest amount of tonnage shipments. Through 2030, industrial organic chemicals flows will grow 4.5% annually—the highest rate among the commodities in Table 13. As a result, 2030 industrial inorganic chemicals will rank third in terms of annual tonnage shipped.

Shipments of coal originate in Wyoming, while chemicals and lumber come from Saskatchewan and British Columbia, Canada. Intermodal shipments arrive from Chicago and Seattle, thus providing some indication of the Twin Cities' role as a national and regional intermodal hub.

Top inbound Minnesota commodities carried by rail

Commodity	Tons 2012	Tons 2015	Tons 2019	Tons 2030	CAGR 2012-30
		(Tons in thousands)			
Bituminous Coal	12,342	11,372	10,439	9,607	-1.4%
Intermodal Shipments	1,286	1,435	1,562	2,040	2.6%
Fertilizers	1,264	1,320	1,553	1,477	0.9%
Grain	1,208	1,506	1,573	1,771	2.1%
Primary Iron or Steel Products	1,190	1,265	1,388	1,601	1.7%
Potassium or Sodium Compound	1,118	1,122	1,183	1,259	0.7%
Misc. Industrial Inorganic Chemicals	972	984	1,052	1,166	1.0%
Misc. Industrial Organic Chemicals	899	977	1,209	1,966	4.4%
Lumber or Dimension Stock	886	1,041	1,153	1,369	2.4%
Nonmetal Minerals, Processed	767	953	1,118	1,459	3.6%

CAGR: compound annual growth rate

Source: IHS Transearch 2012

© 2015 IHS

Top origin-destination pairs for inbound Minnesota commodities carried by rail

Origin BEA	Destination BEA	Commodity	2012	2015	2019	2030	CAGR 2012-30
				(Tons in thousands)			
Casper, WY	Minneapolis, MN	Bituminous Coal	5,730	5,078	4,797	4,489	-1.3%
Billings, MT	Minneapolis, MN	Bituminous Coal	2,764	2,808	2,587	2,832	0.1%
Casper, WY	Duluth, MN	Bituminous Coal	2,614	2,351	2,038	1,526	-2.9%
Billings, MT	Duluth, MN	Bituminous Coal	966	894	813	619	-2.4%
Seattle, WA	Minneapolis, MN	Shipments - Intermodal	653	727	788	1,020	2.5%
Non-CMA, SK	Minneapolis, MN	Potassium or Sodium Compound	536	533	558	610	0.7%
Non-CMA, ON	Minneapolis, MN	Primary Iron or Steel Products	391	409	445	545	1.9%
Non-CMA, BC	Minneapolis, MN	Lumber or Dimension Stock	377	427	473	603	2.6%
Chicago, IL	Minneapolis, MN	Shipments - Intermodal	301	335	363	470	2.5%
Tampa, FL	Minneapolis, MN	Fertilizers	294	303	357	292	0.0%

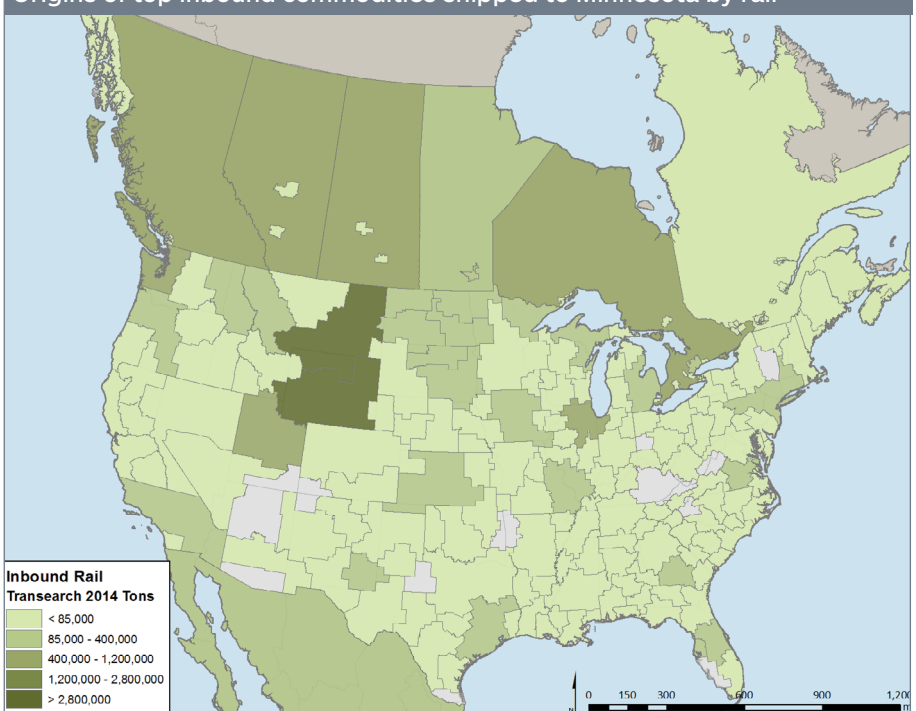
CAGR: compound annual growth rate

Source: IHS Transearch 2012

© 2015 IHS

The dark green area in Wyoming and Montana is the source of coal being sent to Minnesota as an inbound commodity shipped by rail.

Origins of top inbound commodities shipped to Minnesota by rail

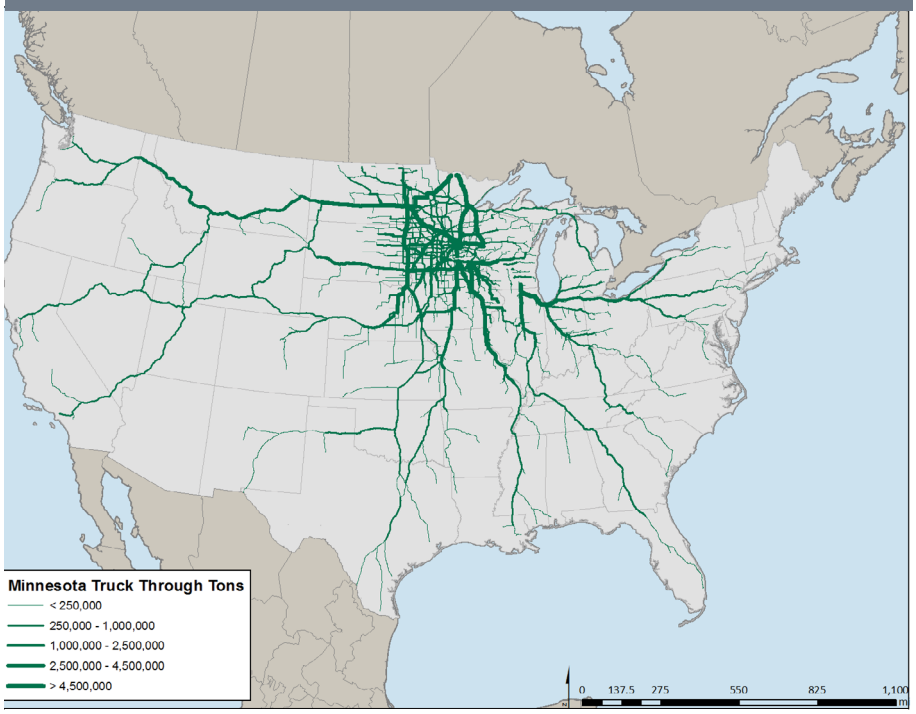


Source: IHS Transearch 2012

Minnesota inbound truck traffic

Broken stone, grain, and distilled or blended liquors constitute the largest flows of inbound tonnage for commodities with Minnesota destinations being shipped by trucks, followed by grain shipments. The average annual growth rates during 2012–30 for these commodities are comparable, ranging between 1% and 2%. Shipments of gravel and sand are forecast to grow 3.5% annually, compared with 2.8% for warehousing and redistribution commodities.

Trade truck flows with Minnesota destinations



Source: IHS Transearch 2012

Top origin-destinations pairs for inbound Minnesota commodities carried by truck

Origin BEA	Destination BEA	Commodity	2012	2015	2019	2030	CAGR
				(Tons in thousands)			2012-30
Des Moines, IA	Minneapolis, MN	Broken Stone or Riprap	3,659	4,475	5,553	5,723	2.5%
Rochester, MN	Minneapolis, MN	Broken Stone or Riprap	2,690	2,753	2,708	1,311	-3.9%
Des Moines, IA	Minneapolis, MN	Grain	2,257	3,066	3,209	3,689	2.8%
Fargo, ND	Minneapolis, MN	Grain	2,130	2,622	2,716	3,139	2.2%
Des Moines, IA	Duluth, MN	Distilled or Blended Liquors	2,044	2,251	2,517	3,438	2.9%
Sioux, Falls, SD	Minneapolis, MN	Grain	1,857	2,286	2,380	2,516	1.7%
Grand Island, NE	Duluth, MN	Distilled or Blended Liquors	1,751	1,888	1,846	1,543	-0.7%
Grand Forks, ND	Minneapolis, MN	Gravel or Sand	1,660	2,764	3,541	4,128	5.2%
Omaha, NE	Duluth, MN	Distilled or Blended Liquors	1,276	1,406	1,459	1,424	0.6%
St. Louis, MO	Minneapolis, MN	Broken Stone or Riprap	1,233	1,224	1,223	1,237	0.0%

CAGR: compound annual growth rate

Source: IHS Transearch 2012

© 2015 IHS

The market dynamics and shipment patterns of the Upper Midwest and Midwest highlight truck trade flows with Minnesota as the destination, illustrating the significance of the Twin Cities as an intermodal and warehousing hub for commodities moving by truck.

Top inbound Minnesota commodities carried by truck

Commodity	2012	2015	2019	2030	CAGR 2012–30
	(Tons in thousands)				
Broken stone or riprap	16,221	17,868	20,653	22,507	1.8%
Grain	15,247	19,075	19,574	21,374	1.9%
Distilled or blended liquors	15,245	16,819	17,644	19,875	1.5%
Gravel or sand	7,460	9,473	11,812	13,914	3.5%
Warehouse and distribution centers	3,613	3,957	4,395	5,911	2.8%
Misc. field crops	3,343	3,430	3,641	4,318	1.4%
Petroleum refining products	2,179	2,578	2,505	2,135	-0.1%
Oil kernels, nuts, or seeds	2,172	1,838	1,976	2,224	0.1%
Dairy farm products	1,980	2,088	2,128	2,201	0.6%
Livestock	1,503	1,561	1,727	1,996	1.6%

CAGR: compound annual growth rate

Source: IHS Transearch 2012

© 2015 IHS

Transportation summary

- Prior to the recent drop in crude oil prices per barrel, IHS estimated that rail shipments of crude petroleum produced in North Dakota and Canada passing through Minnesota would peak starting in 2015, decline slightly by 2019, and continue to fall through 2030. At that time, IHS estimated that the total number of unit trains per year carrying crude oil from the Bakken/Three Forks formations would decline from about 3,700 in 2019 to about 2,800 by 2030. With the revised alternative oil/barrel price scenarios that IHS developed, IHS developed new forecasts of unit trains through 2030, which are provided in the table below.

- Due to the recent price drops, IHS has produced estimates of rail shipments transiting Minnesota based on $90/barrel WTI, $70/barrel WTI, and $50/barrel WTI. The forecast of rail shipments at $90/barrel WTI is estimated to drop from about 9 unit trains in 2014 to 6, increasing to 15 in 2025 and eventually 17 in 2030. For the $70/barrel WTI price estimate, the forecast of unit trains drops from 9 in 2014 to 5 in 2015, then increases to 7 in 2020, 10 in 2025 and eventually 11 in 2030. At $50/barrel WTI the number of trains drops from 9 in 2014 to 3 in 2015 and then to 1 in 2020. By 2025, the forecast of the number of unit trains increases to 2 and then falls to 0 in 2030.

Revised unit train forecasts based on alternative oil price scenarios

Alternative prices	2014	2015	2020	2025	2030
$90/barrel WTI					
Annual	3,311	2,127	3,887	5,237	6,068
Daily	9	6	11	15	17
$70/barrel WTI without pipelines					
Annual	3,311	1,612	2,389	3,350	3,953
Daily	9	5	7	10	11
$70/barrel WTI with pipelines					
Annual	3,311	1,612	0	0	0
Daily	9	5	0	0	0
$50/barrel WTI					
Annual	3,311	836	148	571	863
Daily	9	3	1	2	0

Source: IHS

© 2015 IHS

- At $70/barrel WTI, which could be considered a more likely scenario, we expect approximately 1,600 unit trains per year, or about four to five per day, to transit Minnesota in 2015. Assuming no new major pipelines come on line, the number of unit trains could increase to 11 by 2030. However, with the completion of pipelines that have been proposed, rail crude petroleum shipments transiting Minnesota in 2020 could drop to close to zero. If all proposed pipelines are built, we anticipate that almost all oil shipments could divert to pipelines between 2017 and 2020.

- Our original estimate for unit trains carrying crude oil from Canada through Minnesota was approximately 428 in 2014, 441 in 2015, and 472 in 2030, equivalent to one to two unit trains per day. The majority of these through rail shipments are destined for the US East Coast, Midwest, and Gulf Coast and for locations in eastern Canada such as Montreal, Toronto, and Chicoutimi, Quebec. Based on new production estimates, the number of annual unit trains is estimated to be about 400, or about one per day, from 2015 through 2030.

- Based on new crude-oil production forecasts and the completion of planned and proposed pipelines through 2020, the number of unit trains carrying Bakken-related production could drop close to zero. Based on the revised Canadian crude-oil production estimates, the number of unit trains annually passing through Minnesota could fall slightly below 400 (compared with the original estimate of 428 and 472 units trains annually, depending on the year). This translates to about one train per day.

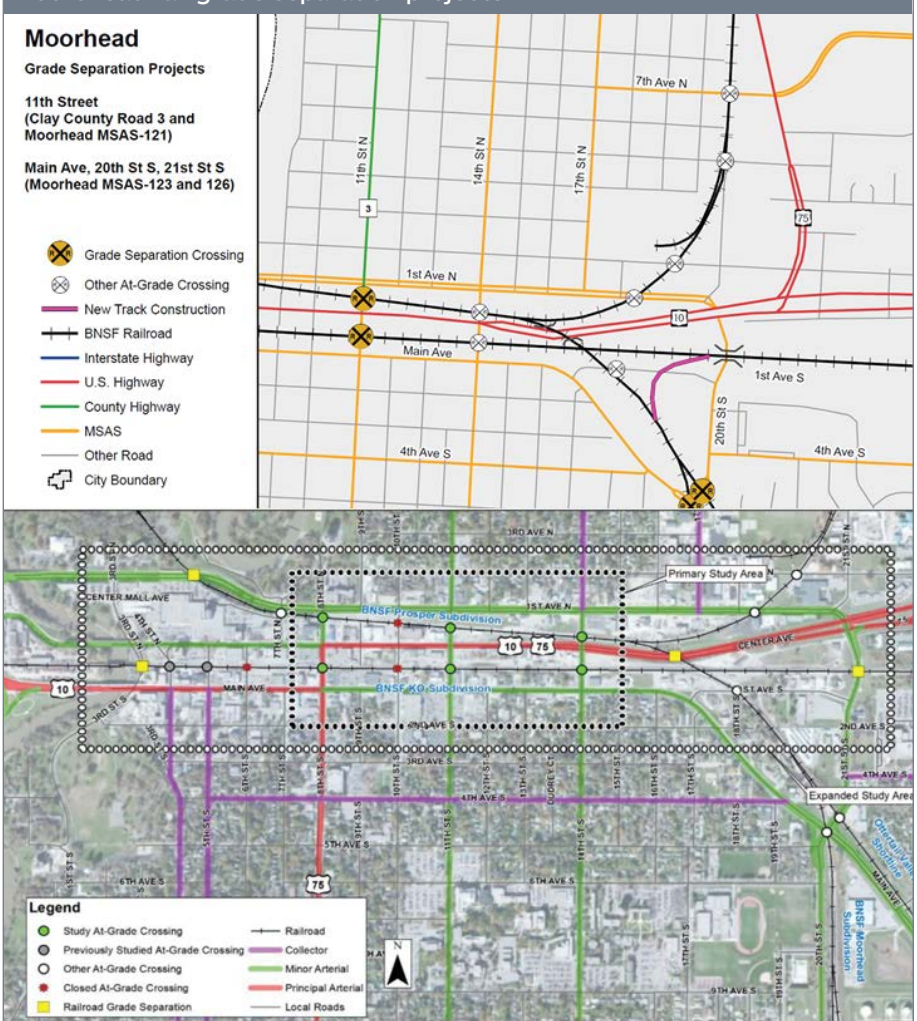
- Grain, along with other agricultural commodities (e.g., oil kernels, nuts, or seeds; soybean oil and by-products; and corn) and iron ore, will constitute high shares of Minnesota's outbound commodity shipments by rail and truck through 2030. Accommodating these demands, along with the continuing high demands for unit trains to carry crude oil, will require rail and highway system capacity expansions that ensure reliable and timely shipments of all commodity types.

- We anticipate growth of gravel and sand and stone-related commodities shipped by rail and truck to North Dakota as well as other Midwest locations. This reflects the US economic recovery and indicates a growing demand for frac sand and construction materials in North Dakota.

- The Twin Cities are a significant intermodal hub for national, interregional, and regional shipments and for warehousing. The North Dakota oil developments present an opportunity for the Twin Cities to leverage and maximize their role in providing intermodal connectivity and distribution services. This provides an opportunity for Border Cities to identify sites that would facilitate rail car maintenance, manufacturing and parts assembly, and supply chain management (e.g., warehouse and distribution centers).

- The planning and potential programming of investments to improve Moorhead's rail separations has been studied.[3] With the increasing train traffic and concerns for safety, this should be revisited to implement tactics and strategies that will alleviate congestion and ensure the safety of the city's citizens. Moorhead has two BNSF lines, the KO line and Prosper Lines, running parallel and in close proximity. Additionally, along a 17 block stretch from 20th Street to 3rd Street, the City has a limited number of at grade crossings. Governor Dayton's 2015 budget proposal calls for strategic investments in Minnesota rail safety improvements, to ensure the safety of Minnesotans living near railroads

Moorhead rail grade separation projects



Source: Minnesota Department of Transportation (top); Moorhead Downtown Grade Separation Study: Existing and Future Conditions Report

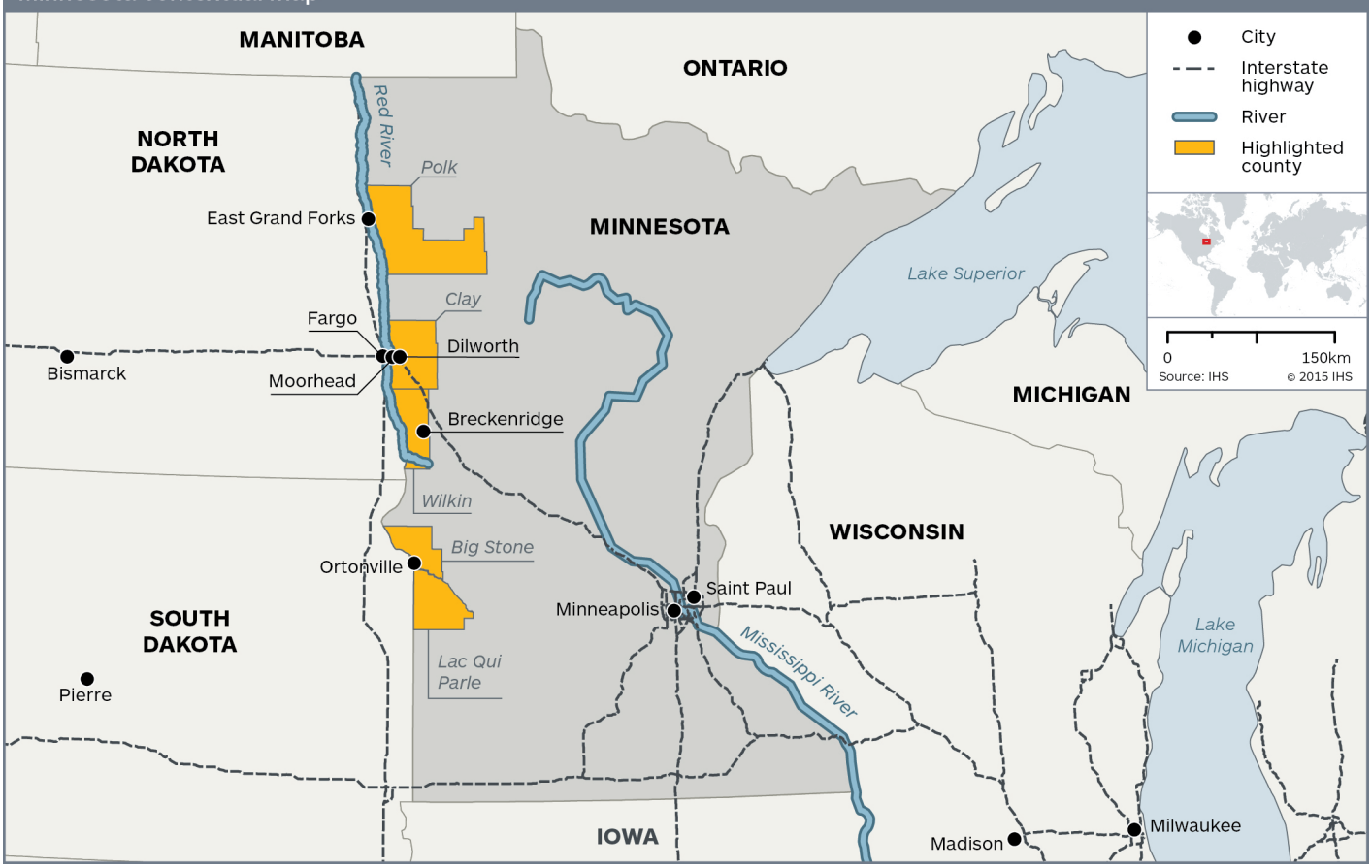
3 *Moorhead Downtown Grade Separation Study: Existing and Future Conditions Report*, Executive Summary, City of Moorhead and the Fargo-Moorhead Metropolitan Council of Governments, 2008, 2014

carrying hazardous materials. The proposal calls for funding 75 priority railway safety infrastructure improvements of which three are located in the City of Moorhead (11th Street S; Main Avenue and 30th Avenue S). Metropolitan wide planning provides the opportunity to advocate and prioritize transportation infrastructure investments. The Fargo-Moorhead Metropolitan Council of Governments provides a forum for North Dakota and Minnesota border communities (Fargo and Moorhead) to continue to elevate grade crossing improvements as investment priorities for incorporation in either state's Transportation Improvement Program.

Phase 3: Economic impacts

The purpose of this section is to present the economic impacts on the Minnesota economy generated by the oil production activity occurring in the Bakken formation of western North Dakota and eastern Montana. The proximity of Minnesota to the Bakken formation was shown above in the context map presented in the introduction. Impacts on the Five Border cities and the counties they are in will be discussed as appropriate. The Five Border Cities, shown in the accompanying map, are: 1) Breckenridge in Wilkin County; 2) Dilworth in Clay County; 3) East Grand Forks in Polk County; 4) Moorhead in Clay County; and 5) Ortonville in Big Stone and Lac qui Parle counties. The economic impacts occurring in Minnesota will be based on only those effects that can be directly attributed to the production of oil in the Bakken formation, such as purchases of goods and services from Minnesota companies, or changes in the basis price of agricultural commodities due to competition for scarce rail capacity.

Minnesota contextual map



On 9 May 2013, the *MinnPost* Business section ran an article with the headline, "New N.D. oil projections offer opportunities for Minnesota businesses" citing western North Dakota's need for "infrastructure like housing, hotels, retail stores and other services" as an opportunity for Minnesota businesses.[4] A year later, Jeff Johnson, publisher of the *Minnesota Real Estate Journal*, was quoted as saying, "The opportunities are almost limitless—and it is not too late to get involved [...] North Dakota and the Bakken are still in the early stages of growth and prosperity, and there are many opportunities to profit—either directly with business ventures in the region or by investing in the ventures already in place."[5] As of early 2015, decreased oil prices have begun to lower exploration and drilling activity in the Bakken oil field, local communities face increased health and safety risks because of a lack of preparedness for continued oil

4 http://www.minnpost.com/business/2013/05/new-nd-oil-projections-offer-opportunities-minnesota-businesses

5 http://www.rejournals.com/2014/05/28/opportunities-abound-in-north-dakotas-bakken-region-minnesota-real-estate-journal-to-hold-bakken-investing-conference-this-june/#sthash.4pYwxs3e.dpuf

train traffic, and local business owners complain of the Bakken "stealing qualified workers." Many are questioning the nature and extent of the long-term impact of North Dakota's Bakken oil production on the Minnesota economy. The economic impact assessment below considers the long-term economic impacts in Minnesota by analyzing four different years in which the composition of total direct spending in North Dakota for capital equipment (capex) and operating expenditures (opex) that support crude oil production changes as exploration and drilling activity declines.

As the level of oil production, and accompanying capex and opex spending, in North Dakota began to accelerate in 2007, its influence began to be seen in the counties of western Minnesota located along the border with North Dakota. Some of the Bakken crude oil started to be sent east on railroad unit trains through Minnesota to processing locations. Communities located along the main rail routes experienced increases in the number of unit trains passing through their communities. The increased rail traffic was especially significant in communities located along the main rail lines such as Moorhead. As oil production levels grew rapidly, large numbers of high-paying jobs were created in the Bakken, which began to attract nonresident workers, including those living in western Minnesota counties. The rapid economic growth in North Dakota increased the level of state tax revenues, enabling it to keep state-level tax rates low, spend money to improve infrastructure, and offer economic incentives for existing and new businesses.

The forecast of North Dakota oil production, phase 1 of this study, described the sudden and large drop in the price of crude oil that has occurred since early summer of 2014. The benchmark West Texas Intermediate (WTI) price for crude oil has fallen from $107 per barrel in the third week of June 2014 to $44 per barrel during the last week of January 2015, a decline of 59%. The price drop has begun to reduce the level of exploration and drilling activity in the Bakken formation, which will lead to lower levels of capital (capex) and operating (opex) spending in North Dakota over the next several years. The direct spending reductions, in turn, will affect the level of the economic impact on the Minnesota economy as fewer goods and services, as well as labor, will be obtained from Minnesota companies and households.

Economic structure and performance

The following section describes economic characteristics and recent performance of Minnesota and the five counties with Border Cities. Because more detailed socioeconomic data, such as employment, income, and gross county product, is available for counties than for cities and towns, the economic analysis below will present data for the five counties that have Border Cities. Information and analyses are used to: 1) derive the economic impacts, and 2) to identify, describe, and derive opportunities, problems, and expectations presented in the Phase 4 analysis.

Minnesota

Economic characteristics

According to IHS's Business Market Insights (BMI) data base, total 2014 nonfarm employment in Minnesota was 2.98 million jobs, having grown at a compound annual growth rate (CAGR) of 0.3% between 2004 and 2014. The largest employment growth between 2004 and 2014 occurred in education services; healthcare and social assistance; arts, entertainment, and recreation; and management of companies. Employment declined in eight sectors, with the largest declines in information and manufacturing at annual rates of -1.8% and -1.6%, respectively.

At the two-digit NAICS level, the largest employment sectors in 2014 were healthcare and social assistance, retail trade, and accommodations and food services. The goods-producing sector (e.g., agriculture, mining, construction, and manufacturing) accounted for 17.6% of total Minnesota employment in 2014, which is well above the US figure of 15.3%. By contrast, the private-services sector (i.e., all sectors excluding goods-producing and government) represented 68.5% of total Minnesota employment in 2014, slightly below the US share of 69.4%.

Employment growth and distribution

Sector	Minnesota 2014 Employment	Minnesota %	Minnesota CAGR 2000-14	Minnesota Location quotient - 2014	Border Cities and their respective counties 2014 Employment	Border Cities %	Border Cities CAGR 2000-14	Border Cities Location quotient - 2014
11 Agri., Forestry, Fishing and Hunting	93,888	3.2%	-1.0%	**1.43**	4,905	10.5%	-1.2%	**4.77**
21 Mining	6,109	0.2%	-1.2%	0.35	41	0.1%	-3.2%	0.15
22 Utilities	13,083	0.4%	0.1%	**1.17**	34	0.1%	-1.5%	0.19
23 Construction	108,485	3.6%	-0.6%	0.87	1,698	3.6%	-0.6%	0.87
31-33 Manufacturing	314,911	10.6%	-1.6%	**1.27**	2,529	5.4%	-1.0%	0.65
42 Wholesale Trade	134,762	4.5%	0.3%	**1.12**	2,284	4.9%	1.7%	**1.22**
44-45 Retail Trade	288,559	9.7%	-0.4%	0.92	4,539	9.7%	-1.6%	0.93
48-49 Trans. & Warehng.	135,862	4.6%	-0.7%	0.83	2,015	4.3%	0.4%	0.79
51 Information	53,409	1.8%	-1.8%	0.96	401	0.9%	-1.9%	0.46
52 Finance & Insurance	139,728	4.7%	0.6%	**1.17**	860	1.8%	0.4%	0.46
53 Real Estate, Rental & Leasing	40,602	1.4%	0.9%	0.96	457	1.0%	3.9%	0.69
54 Prof., Scientific, and Tech. Svcs.	136,988	4.6%	0.6%	0.81	1,104	2.4%	3.1%	0.41
55 Mgmt. of Companies	78,569	2.6%	1.3%	**1.81**	320	0.7%	5.6%	0.47
56 Admin. & Waste Mgmt. Services	138,067	4.6%	0.6%	0.78	909	2.0%	5.1%	0.33
61 Educational Services	69,013	2.3%	3.6%	1.00	2,474	5.3%	1.9%	**2.29**
62 Health Care & Social Assistance	433,310	14.6%	3.1%	**1.17**	7,316	15.7%	3.6%	**1.26**
71 Arts, Enter., & Recreation	42,007	1.4%	1.7%	**1.01**	259	0.6%	-2.3%	0.40
72 Accommodation & Food Svcs.	214,887	7.2%	0.9%	0.84	3,153	6.8%	-0.1%	0.78
81 Other Svcs.	118,826	4.0%	0.3%	**1.06**	1,920	4.1%	-0.9%	**1.09**
Federal Government	30,888	1.0%	-1.1%	0.56	300	0.6%	-3.5%	0.34
State Government	89,710	3.0%	0.6%	0.86	2,305	5.0%	0.0%	**1.41**
Local Government	295,366	9.9%	0.2%	**1.01**	6,731	14.5%	-0.5%	**1.47**
Total All Sectors	2,977,029	100.0%	0.3%		46,554	100.0%	0.2%	

CAGR: compound annual growth rate

Gray cells identify sectors with location quotients > 1.0

Source: IHS, Business Market Insights data base, 2014.

© 2015 IHS

The distribution of Minnesota employment by two-digit NAICS code shows the state's diverse economy. Nine private-sector industry groups had employment location quotients (LQs) above 1.0 in 2014. A location quotient is the ratio of an individual economic sector's share of total Minnesota employment divided by its share of total US employment. An LQ greater than 1.0 means Minnesota had an above-average concentration of employment, and likely economic activity, in that sector when compared with the US economy. Sectors with high LQs are those for which the state likely has competitive advantages. The five sectors with the highest employment LQs were management of companies; agriculture, forestry, and fisheries; manufacturing; utilities; and healthcare and social assistance. The lowest LQ was in mining at 0.35, indicating that mining, while important in Northeast Minnesota, doesn't have a strong presence statewide. There is no extraction of oil or natural gas in Minnesota, but silica sand, which is used in fracking, is an emerging mining industry in the southeastern part of the state.

Comparative performance

Minnesota's economy has outperformed most other states from 2007 to the present, excluding the unique situation that occurred in North Dakota as oil production in the Bakken formation began to increase rapidly. Minnesota's performance, and rank across the 50 states and the District of Columbia, based on the percent change between 2007 and 2014 is summarized here:

- Total employment: 1.9% increase; ranked 17th
- Manufacturing employment: 7.6% decline, ranked 17th
- Personal income: 22.5% increase, ranked 28th

- Gross state product per capita: 18.9% increase, ranked 12th
- Labor force: 3.0% increase, ranked 20th
- Population: 4.8% increase, ranked 29th.

By contrast, North Dakota ranked first in percent increases in employment, personal income, and gross state product per capita; second in population; and third in labor force. Minnesota's economic performance between 2007 and 2014 was generally higher than in Iowa, Wisconsin, and the United States as shown in the accompanying table.

Comparative economic performance from 2007 to 2014

Measure	Minnesota	North Dakota	Iowa	Wisconsin	South Dakota	US
Tota non-farm Employment						
2014 Level (thousands)	2,823.8	464.3	1,550.6	2,863.0	421.2	138,839.1
CAGR 2007 to 2014 (%)	0.3	3.8	0.3	(0.1)	0.5	0.1
% change 2007 to 2014	1.9	29.6	2.1	(0.6)	3.6	0.8
Rank for % change	17	1	15	32	8	NA
Manufacturing Employment						
2014 Level (thousands)	315.6	25.5	215.0	466.6	42.4	12,125.2
CAGR 2007 to 2014 (%)	-1.1	-0.3	-0.9	-1.0	0.1	-1.9
% change 2007 to 2014	-7.6	-2.3	-6.4	-6.9	0.8	-12.5
Rank for % change	17	4	10	13	2	NA
Personal Income						
2014 Level (thousands)	$265,386.3	$40,727.4	$140,668.6	$256,771.5	$39,669.0	$14,704,694.2
CAGR 2007 to 2014 (%)	2.9	8.1	3.5	2.8	4.4	3.0
% change 2007 to 2014	22.5	72.5	27.3	21.5	34.8	22.6
Rank for % change	28	1	12	33	5	NA
Gross State Product per capita						
2014 Level (millions of $)	$59,185	$81,936	$54,768	$50,563	$56,030	$54,376
CAGR 2007 to 2014 (%)	2.5	9.2	2.7	2.2	3.3	1.9
% change 2007 to 2014	18.9	85.1	20.1	16.1	25.6	13.9
Rank for % change	12	1	8	23	5	NA
Labor Force						
2014 Level (thousands)	2,991.8	410.0	1,698.5	3,081.6	452.2	155,831.9
CAGR 2007 to 2014 (%)	0.4	1.6	0.3	-0.1	0.4	0.3
% change 2007 to 2014	3.0	11.9	1.9	-0.5	2.9	2.4
Rank for % change	20	3	25	39	21	NA
Population						
2014 Level (thousands)	5,461.6	741.2	3,109.0	5,759.7	854.2	319,158.3
CAGR 2007 to 2014 (%)	0.7	1.8	0.5	0.4	1.1	0.8
% change 2007 to 2014	4.8	13.4	3.6	2.6	7.8	5.8
Rank for % change	29	2	35	40	16	NA

CAGR: compound annual growth rate

Sources: Employment: Bureau of Labor Statistics, Current Employment Statisticcs, 2015. Personal income: IHS, US Regional Service, 2015. Gross State Product: IHS, US Regional Service, 2015. Labor Force: Bureau of Labor Statistics, Local Area Unemployment Statistics, 2015. Population: IHS, US Regional Service, 2015. © 2015 IHS

Structural diversity

IHS measured the diversity of Minnesota using the Shannon-Weaver index of structure diversity.[6] The Shannon-Weaver index ranges from a maximum value of 1.0 for an economy with the highest level of structural diversity, as measured by employment shares by detailed economic sector, down to 0 for an economy with no diversity (i.e., an economy with only one industry sector). The state-level Shannon-Weaver index values in 2012 ranged between 0.610 for the District of Columbia to just over 0.761 for Wisconsin. The corresponding 2012 index values for Minnesota and North Dakota were 0.751 and 0.712, confirming that Minnesota's economy is substantially more diverse than North Dakota's, but slightly

6 The Shannon-Weaver index of structure diversity is calculated by the Minnesota IMPLAN Group (MIG) and is included in its state-level models.

less diverse than Wisconsin's. A higher diversity index value indicates two things when considering economic impacts: 1) the economy produces a wider range of goods and services, with economic activity being more equally distributed across the individual subsectors; and 2) the indirect and induced multiplier effects generated by new economic activity will be higher as more of the required intermediate inputs can purchased locally.

Border Cities and their respective counties

Border Cities legislation

Minnesota first passed legislation in 1987 to allow the establishment of enterprise zones (Minnesota Statutes 469.166 through 469.1735) in five Border Cities, and provided a variety of economic incentives that were available in the zones (e.g., disparity reduction property tax credits, debt financing for new construction, sales tax credits, and tax credits for new job creation). The five Border Cities and the counties they are in are 1) Breckenridge in Wilkin County; 2) Dilworth in Clay County; 3) East Grand Forks in Polk County; 4) Moorhead in Clay County; and 5) Ortonville in Big Stone and Lac qui Parle counties. Note that the enactment of the initial Border Cities legislation occurred well before North Dakota oil production began to grow rapidly in 2008, suggesting that concerns about the ability of the Border Cities and the counties they are in to compete economically with the adjacent cities and counties in North Dakota has been a concern for many years. The strong economic growth in North Dakota due to oil production, and accompanying high growth rate in state tax revenues that has enabled North Dakota to lower state and local taxes and to improve the quality of infrastructure and public services, has only heightened this concern.

The legislation specifies the number of development zones, and the maximum total acreage of the zones that be established in each Border City; for example Breckenridge and East Grand Forks may designate their entire city as a development zone. The location of the five Border Cities and the counties they are in are shown in the location map presented above. The five Border Cities are located approximately 300 miles from the Bakken; the one-way driving distance between Moorhead and Williston according to Google Maps is 394 miles. The long distance indicates that the five Border Cities and the counties they are in are located too far from the Bakken to be suppliers of goods and services where close proximity to the supplier is essential and too far for daily commuting by workers.

Economic characteristics

The economic structure of the five counties (e.g., Big Stone, Clay, Lac qui Parle, Polk, and Wilkin) that contain the five Border Cities is very different from the structure of the statewide economy. The combined economy of the five counties is quite small with a total 2014 employment of 46,554 jobs, or 1.6% of the statewide total. Their economy is not as diverse as the state's with only five private-sector industries having employment LQs above 1.0. As expected, the highest employment LQ was in agriculture at 4.72, followed by education services at 2.29, and healthcare and social assistance at 1.26. The lowest LQs were in mining; utilities; and administrative and waste management services. The LQs for manufacturing and for most of the private, services-providing sectors that would support business activity range between 0.3 and 0.8, suggesting that five counties that include Border Cities are unlikely to be major providers of goods and services used in the Bakken, especially if size, specialization, and wide range of products and services are required.

Fargo, in Cass County, North Dakota, is located directly across the Red River from the city of Moorhead. Fargo is North Dakota's largest city with a 2013 population of 113,658 persons, compared with 39,398 persons for Moorhead. Clay County, Minnesota, and Cass County, North Dakota comprise the Fargo-Moorhead Metropolitan Statistical Area (MSA). An MSA is a single functional economic area defined primarily by commuting patterns, so the cost of living and wage levels are generally the same within it. Utility, land, and housing prices will vary based on locational attributes. Two main rail lines of the BNSF Corporation (formerly called the Burlington Northern and Santa Fe Railway) run north-south and east-west through the Fargo-Moorhead MSA.

Commuting

One of the issues raised during the workshop in Moorhead was the out-migration and out-commuting by resident workers of the five counties that include Border Cities to take high-paying jobs in the Bakken formation. IHS analyzed commuting and migration patterns by using the Census Bureau's On the Map database, which has commuting patterns

for 2011 and American Community Survey (ACS) data on out-migration from the five counties that include Border Cities to the Bakken counties between 2008 and 2012. We found that:

- There was comparatively little commuting from the five border counties to the Bakken counties in 2011, likely because of the long distances. The On the Map database showed only 155 persons commuting from Clay County to North Dakota's Bakken counties in 2011 and very few from the other four counties that include Border Cities. Local employers indicated the most common practice is for resident workers to work in the Bakken for 10 days or 2 weeks at a time, return home for a similar period, and then return. Unfortunately, the data in the On the Map database primarily captures daily commuting. The level of weekly or biweekly commuting has likely increased from 2012 onward as the production levels in the Bakken rose sharply.

- State-level analysis showed that 34,033 residents of Minnesota commuted to North Dakota in 2011, whereas only 1,096 workers traveled to the Bakken counties in North Dakota and Montana.

- According to the ACS, between 2008 and 2012 a total of 3,101 residents of the five counties that include Border Cities migrated to North Dakota; most went to Fargo and only 55 moved to the Bakken counties.

Given the atypical commutes of Minnesota residents who work in the Bakken, normal data sources may not capture their movements, nor are they captured in migration data as these workers typically do not change their place of residence. Minnesota has reciprocity with North Dakota for the personal income taxes; therefore, Minnesota's resident commuters do not affect the income taxes collected by Minnesota. If the commuting workers make more in North Dakota than they would have working in Minnesota, then income tax revenues received by Minnesota would increase.

The "edge" effect and differences between Minnesota and North Dakota

As the five Border Cities and the counties that include Border Cities are located directly across the Red River from North Dakota, they are most directly affected by differences in the levels of tax, cost of doing business, regulations, and range of available economic incentives that are determined by state policy. Differences in these variables can be the deciding factor in decisions by businesses and households to locate in Minnesota or North Dakota due to an "edge effect." For example, a business or a household could first decide that the Fargo-Moorhead MSA is the preferred location for them; differences in state-level variables would then be a factor in determining whether they select Minnesota or North Dakota. Other local factors will also influence their decision such as land and housing costs, local real property tax rates, amenities, quality of public services including education, and site characteristics. The edge effect is especially acute in Moorhead, which is located across the Red River from Fargo, North Dakota's largest city.

Comparative socioeconomic characteristics

IHS compiled a set of socioeconomic and demographic characteristics for Minnesota, North Dakota, Cass County in North Dakota, and five counties that include Border Cities in Minnesota, in the following table. The objective of this analysis is to identify differences and similarities across the eight geographies for key variables that describe the existing situation (i.e., the "S" in the SCOPE analysis), and the context (i.e., the "C" in the SCOPE analysis).

The urban character of Cass County, North Dakota, is evident when comparing its values with Clay County, Minnesota and the other four counties that include Border Cities, especially population density, education attainment, retail sales, and average annual wage. The effects of the strong economic growth in North Dakota are evident is its high employment and per capita personal income growth rates. It is interesting to note that per capita personal income is higher in North Dakota than Minnesota, while the median household income is higher in Minnesota. The high level of per capita personal income in North Dakota is indicative of a "wealth effect" in that its residents now have significant levels of disposable income. The wealth effect is further confirmed by the high level of retail spending per capita in North Dakota, suggesting that Minnesota has an opportunity to attract this spending, as it offers a wider array goods and services.

The five counties that include Border Cities and Cass County, North Dakota have a lower cost of living than in other large cities in Minnesota and North Dakota, and they are well below the statewide levels. Similarly, average wage levels are

lower in the five counties that include Border Cities than in Cass County, and in turn the six counties have wage levels well below their respective statewide figures.

Minnesota has a highly educated labor force as 32.6% of its residents 25 years and older have a bachelor's degree or higher, with 10.7% having advanced degrees; the corresponding figures for North Dakota are 27.2% and 7.6%, respectively. Cass County, North Dakota, and Clay County, Minnesota, also have above-average levels of educational attainment as 37.2% and 30.3%, respectively, of their residents 25 years and older have a bachelor's degree or higher.

Economic and social Indicators

Indicator	Big Stone, MN	Clay, MN	Lac qui Parle, MN	Polk, MN	Wilkin, MN	Cass, ND	MN	ND
Demographics								
Population	5,209	59,638	7,184	31,522	6,576	154,080	5,347,740	689,781
CAGR 2004 to 2013	-0.8%	1.3%	-0.8%	0.1%	-0.3%	2.0%	0.5%	0.9%
Population 16 years and older	4,264	47,252	5,867	24,986	5,141	123,691	4,212,737	553,026
% in labor force	58.4%	72.1%	62.8%	66.8%	67.6%	76.5%	70.3%	70.5%
Population 25 years and older	3,837	35,642	5,273	20,888	4,574	95,521	3,562,331	450,429
% high school graduate or higher	96.8%	94.9%	94.2%	94.6%	89.9%	96.8%	92.8%	95.4%
% Bachelor's degree or higher	17.6%	30.3%	17.6%	21.9%	16.5%	37.2%	32.6%	27.2%
% with advanced degrees	4.3%	8.5%	3.8%	6.9%	4.7%	11.3%	10.7%	7.6%
Number of Households	2,347	22,463	3,074	12,663	2,685	65,816	2,107,232	287,270
Population density (persons/sq. mile in 2010)	10.6	56.4	3.1	16.0	8.8	84.9	66.6	9.7
Housing								
% renter occupied housing units	19.9%	30.7%	17.4%	29.3%	22.7%	46.6%	29.5%	33.9%
Median housing value	$91,300	$155,200	$80,200	$128,100	$107,300	$158,900	$187,900	$132,400
Income and wages								
Median Household Income	$46,313	$52,410	$48,468	$50,695	$50,507	$52,590	$59,836	$53,741
Per capita personal income	$50,450	$39,180	$55,500	$44,350	$50,880	$46,720	$47,320	$53,040
CAGR 2003 to 2013	6.2%	4.1%	7.9%	4.8%	2.5%	3.9%	3.0%	6.0%
Average annual wage	$32,190	$37,360	$30,710	$35,400	$25,400	$44,920	$49,110	$46,990
CAGR 2003 to 2013	3.8%	1.9%	3.1%	2.9%	5.4%	3.8%	2.6%	5.7%
Number of business establishments	642	2,356	1,088	2,423	662	6,905	240,139	54,904
Retail sales (millions of $)	$41	$678	$75	$424	$76	$4,778	$80,567	$15,878
per capita	$7,936	$11,375	$10,415	$13,452	$11,568	$31,013	$15,066	$23,019
Employment and labor force								
Total non-farm Employment (2014)	3,047	21,631	3,783	14,744	3,349	116,660	2,977,029	521,566
CAGR 2004 to 2014	1.3%	0.5%	0.6%	0.1%	2.1%	2.5%	0.5%	3.2%
Labor force NSA, Nov. 2014	2,638	35,835	4,053	18,316	3,899	88,751	2,985,228	413,341
Change last 10 years	-132	5,276	65	1,274	255	8,344	95,690	65,468
% Change last 10 years	-4.8%	17.3%	1.6%	7.5%	7.0%	10.4%	3.3%	18.8%
Unemployment rate NSA	3.2%	2.2%	3.1%	3.2%	2.5%	2.2%	3.7%	2.8%
ACCRA Cost of Living 2014q3								
Fargo-Moorhead MSA		94.1				94.1		
Minneapolis,MN							107.0	
St. Paul, MN							105.8	
Bismarck, ND								100
Minot, ND								105.4

Average for all 264 metros = 100.0

CAGR: compound annual growth rate

NSA: not seasonally adjusted

All figures are for calendar year 2013 unless noted otherwise.

Sources: Demographics and housing, and median household income: Bureau of the Census, 2009-2013 American Community Survey, 2015. Per capita personal income, average annual wage, and retail sales: IHS, US Regional Service, 2015. Number of establisments: IHS, Business Market Insights database, 2015. Labor force and unemployment rates: Bureau of Labor Statistics, Local Area Unemployment Rates, 2015. ACCRA Cost of Living: ACCRA, 2015.

© 2015 IHS

Labor market characteristics

The accompanying table presents wage levels and growth rates in Minnesota and North Dakota for the oil and gas extraction sector, construction, selected manufacturing sectors that either provide inputs to oil and gas activities or are potential users of crude oil (e.g., petroleum and coal, chemicals), and selected service sectors that support oil and gas activity. The impact of the oil and gas production in the Bakken is clearly shown by the fact that the average annual growth rate in wages in North Dakota was higher than the growth rate in Minnesota for almost all of the economic sectors. For example, average annual pay in the natural resources and mining sector in North Dakota grew at an average annual rate of 8.6% compared with 3.6% in Minnesota. Similarly, average annual pay in construction rose at an annual rate of 6.8% in North Dakota compared with 1.3% in Minnesota. The level of average annual pay in the goods-producing sector in North Dakota in 2013 was 13.2% higher than in Minnesota. In virtually all of the sectors where the average annual pay in Minnesota in 2013 was still higher than in North Dakota, the percent differences declined over the six-year period.

Average annual pay in selected economic sectors

	2007		2013		CAGR 2007-13	
Sector	**Minnesota**	**North Dakota**	**Minnesota**	**North Dakota**	**Minnesota**	**North Dakota**
Goods-producing	$51,090	$42,551	$58,113	$66,981	2.2%	7.9%
Natural resources and mining	$35,621	$54,833	$44,150	$89,901	3.6%	8.6%
NAICS 211 Oil and gas extraction	NA	$79,186	NA	$111,427	NA	5.9%
Construction	$53,161	$40,533	$57,337	$60,220	1.3%	6.8%
Manufacturing	$52,300	$40,170	$59,579	$48,103	2.2%	3.0%
NAICS 324 Petroleum and coal	$85,266	NA	$109,077	NA	4.2%	NA
NAICS 325 Chemicals.	$68,695	$40,577	$72,955	$62,007	1.0%	7.3%
NAICS 333 Machinery	$54,931	$46,796	$62,295	$51,148	2.1%	1.5%
NAICS 336 Tran. Equip.	$50,281	$37,063	$49,757	$41,923	-0.2%	2.1%
Service-providing	$42,941	$30,503	$48,719	$42,811	2.1%	5.8%
Trade, transportation, and utilities	$38,333	$31,525	$43,684	$46,965	2.2%	6.9%
Information	$59,568	$47,410	$66,787	$55,795	1.9%	2.8%
Financial activities	$70,572	$39,403	$81,220	$53,798	2.4%	5.3%
Professional and business services	$60,495	$35,875	$69,386	$53,750	2.3%	7.0%
NAICS 541 Prof. & tech. svcs.	$69,863	$43,096	$81,106	$67,293	2.5%	7.7%
Leisure and hospitality	$15,683	$11,232	$17,826	$16,260	2.2%	6.4%
Total, all industries	$44,645	$32,815	$50,476	$48,740	2.1%	6.8%

CAGR: compound annual growth rate

Source: Bureau of Labor Statistics, 2015. Quarterly Census of Employment and Wages.

© 2015 IHS

IHS also analyzed trends in median hourly wage levels by occupation for the Fargo-Moorhead and Minneapolis-St. Paul MSAs, the far-western nonmetropolitan part of North Dakota where the Bakken is located, and the United States. Based on our recent work in other similar studies, we identified the detailed, core occupations that are used in either the extraction of oil and natural gas, or in its supply chain, and then determined changes in wage levels for the major occupational categories of which they were a part. The accompanying table further confirms the strong effect that North Dakota oil production has had on rising wage levels.

Between 2007 and 2013, the CAGR in the median hourly wage level for the far-western North Dakota region was higher in the seven major occupational categories for which data were available than it was in both the Fargo-Moorhead and Minneapolis-St. Paul MSAs. Median hourly wages in 2013 in the Fargo-Moorhead MSA were lower in six of the major occupational categories than they were in western North Dakota; the only exception was in business and financial operations, where they were very similar. Interestingly, the annual growth rate of median hourly wages in the Minneapolis-St. Paul MSA was lower across the major occupational categories than it was in the Fargo-Moorhead MSA and far-western North Dakota. One conclusion from this analysis is the counties that include Border Cities, including Cass County, North Dakota, have an advantage compared with the Bakken region in terms of wage costs, especially for construction and extraction; installation, maintenance, and repair; production; and transportation and material-moving occupations.

A recent study prepared by the Minneapolis Federal Reserve bank found that the high wages being paid in the Bakken formation increased average weekly wages out to a radius of 100 miles, and also reduced the unemployment rate. There was no effect on wages or the unemployment rate beyond this distance. As result, it is unlikely that the Bakken is having a significant impact on overall wage levels and the unemployment within the five Border Cities and the counties that include them.

Wage trends in occupations used in oil and natural gas extraction and its supply chain

Major SOC code and description	Fargo-Moorhead MSA	Far western ND, non-metropolitan	Minneapolis-St. Paul MSA	US
2007 Median hourly wage				
11-0000 Management	$35.36	$28.94	$46.26	$40.60
13-0000 Business and Financial Operations	$22.28	$21.01	$26.93	$26.87
17-0000 Architecture and Engineering	$23.71	$22.92	$30.52	$31.14
43-0000 Office and Administrative Support	$12.53	$11.15	$15.84	$13.91
47-0000 Construction and Extraction	$16.14	$17.86	$25.70	$17.57
49-0000 Installation, Maintenance, and Repair	$16.87	$16.91	$20.85	$18.04
51-0000 Production	$12.89	$13.42	$15.83	$13.53
53-0000 Transportation and Material Moving	$12.91	$14.32	$14.43	$12.65
2013 Median hourly wage				
11-0000 Management	$40.53	$44.29	$49.57	$45.96
13-0000 Business and Financial Operations	$26.57	$26.22	$30.75	$30.67
17-0000 Architecture and Engineering	$28.04	NA	$35.11	$35.83
43-0000 Office and Administrative Support	$14.34	$16.02	$17.51	$15.39
47-0000 Construction and Extraction	$18.39	$23.45	$27.39	$19.95
49-0000 Installation, Maintenance, and Repair	$18.65	$19.37	$19.37	$19.92
51-0000 Production	$14.72	$19.95	$16.89	$15.03
53-0000 Transportation and Material Moving	$14.79	$22.28	$16.10	$13.99
CAGR 2007 to 2013				
11-0000 Management	2.3%	7.3%	1.2%	2.1%
13-0000 Business and Financial Operations	3.0%	3.8%	2.2%	2.2%
17-0000 Architecture and Engineering	2.8%	NA	2.4%	2.4%
43-0000 Office and Administrative Support	2.3%	6.2%	1.7%	1.7%
47-0000 Construction and Extraction	2.2%	4.6%	1.1%	2.1%
49-0000 Installation, Maintenance, and Repair	1.7%	2.3%	-1.2%	1.7%
51-0000 Production	2.2%	6.8%	1.1%	1.8%
53-0000 Transportation and Material Moving	2.3%	7.6%	1.8%	1.7%

Note: the detailed occupations required in oil and gas production that are in the 8 major occupational categories above accounted for 86% of total US oil and gas employment in 2013.

CAGR: compound annual growth rate

Source: Bureau of Labor Statistics, Occupational Employment Statistics, 2015.

© 2015 IHS

Key economic sectors in Minnesota

IHS identified the key economic sectors in Minnesota using a shift-share analysis that decomposed employment growth between 2000 and 2014 by detailed economic sector. The shift-share analysis compares individual sectors' growth in Minnesota to the United States' overall level of performance. The shift-share analysis was performed at the three-digit NAICS level, except in manufacturing, where it was performed at the four-digit NAICS level to better identify forward- and backward-linkage sectors. The purpose of the shift-share analysis was to:

- Classify economic sectors into one of four categories based on their employment growth over the analysis period
- Identify the high-performing, most competitive economic sectors in the Minnesota economy
- Determine if Minnesota has high-performing sectors that are either: 1) suppliers of goods and services used in the production of crude oil (i.e., were backward linkage sectors), or 2) potential users of the crude oil being produced in North Dakota as an input (i.e., were forward-linkage sectors).

The shift-share analysis assigned each economic sector to one of four types as below:

A sectors: The sector's employment CAGR in Minnesota between 2000 and 2014 was higher than its employment CAGR at the US level, and it had a 2014 employment LQ greater than 1.0. These are the highest-performing sectors, and those for which Minnesota may have a competitive advantage.

B sectors: The sector's employment CAGR in Minnesota between 2000 and 2014 was higher than its employment CAGR at the US level, but it had a 2014 employment LQ less than or equal to 1.0. Emerging sectors are often found among B sectors.

C sectors: The sector's employment CAGR in Minnesota between 2000 and 2014 was below the sector's employment growth rate at the US level, but it had a 2014 employment LQ greater than 1.0. These sectors are the traditionally important sectors in a locality whose relative performance has declined, either because they are now slow-growth sectors at the US level or because Minnesota no longer has strong competitive advantages in them.

D sectors: the sector's employment CAGR in Minnesota between 2000 and 2014 was below the sector's employment growth rate at the US level, and it had a 2014 employment LQ less than or equal to 1.0. D sectors are the lowest-performing sectors as they have both below-average performance levels and comprise below-average shares of the Minnesota economy.

The following two tables summarize the results of the shift-share analysis by presenting the top-ten sectors in each shift-share type based on 2014 employment. The A sectors include some expected sectors such as crop production, food manufacturing, and education and healthcare. Also present are business-related services sectors such as insurance, credit intermediation, and waste management and remediation services. The B sectors include truck transportation, construction, telecommunications, general retail trade (possibly due to the presence of the Mall of America), and warehousing storage, which is consistent with the Minneapolis-St. Paul MSA's role as multi-state regional distribution center. Interestingly, the B sectors also include chemicals, a possible user of refined oil products as an intermediate input.

The C sectors also have some expected sectors, such as management, animal production, and securities. More analysis of the machinery sector is needed to see if it can provide the capital equipment required in oil production. Finally, the D sectors are dominated by retail trade sectors; the one surprise is the presence of the large professional, scientific, and technical services sector, which includes engineering design and environmental services.

Minnesota shift-share analysis	
Top 10 A sectors	**Top 10 B sectors**
721 Accommodation	238 Specialty Trade Contractors
611 Educational Services	452 Retail Trade - General Merchandise Stores
622 Hospitals	484 Truck Transportation
623 Nursing & Residential Care Fac.	236 Construction of Buildings
562 Waste Mgt. & Remed. Services	448 Retail Trade - Apparel & Acc.
423 Merchant Wholesalers, Durable	517 Telecommunications
524 Insurance Carriers & Related Activities	492 Couriers and Messengers
111 Crop Production	325 Chemical mfg.
522 Credit Intermed. & Related Activities	493 Warehousing and Storage
311 Food mfg.	331 Primary Metal mfg.
Top 10 C sectors	**Top 10 D sectors**
551 Management of Comp. & Ent.	541 Professional, Scientific, & Tech. Ser.
812 Personal & Laundry Services	621 Ambulatory Health Care Services
333 Machinery mfg.	445 Retail Trade - Food & Beverage
112 Animal Production	813 Religious, Civic, & Prof. Org.
712 Museums, Historical Sites	441 Retail Trade - Motor Vehicle & Parts
447 Retail Trade - Gasoline Stations	444 Retail Trade - Build. Mat. & Garden Eq.
425 Wholesale Electronic Markets	713 Amusement, Gambling, & Rec. Ind
523 Securities & Oth. Financial Invst.	722 Food Services & Drinking Places
485 Transit and Ground Passenger Transportation	453 Retail Trade - Misc. Stores
454 Retail Trade - Nonstore Retailers	446 Retail Trade - Health & Personal Care

Note: shares of private sector employment are: A - 35.6%; B - 10.2%; C - 15.6%; and D - 19.4%

Source: IHS, Business Market Insights database, 2015. Analysis by IHS.

© 2015 IHS

The manufacturing shift-share results are consistent with and confirm Minnesota's large medical device sector, and related capabilities in instruments. The B sectors also contain advanced manufacturing subsectors such as pharmaceuticals, other electrical equipment, aerospace, and engines. The C sectors contain, as expected, several subsectors involved in food production. The presence of the agricultural, construction, and mining machinery subsectors suggests the presence of a possible backward-linkage sector to support oil production; more analysis is needed to determine if companies in this sector are currently meeting capex demands coming from the Bakken.

Minnesota detailed manufacturing shift-share analysis	
Top 5 A sectors	**Top 5 B sectors**
3231 Printing and Related Support Activities	3254 Pharmaceutical and Medicine mfg.
3345 Navigational, Measuring, Electromedical, and Control Instruments mfg.	3359 Other Electrical Equipment and Component mfg.
3116 Animal Slaughtering and Processing	3262 Rubber Product mfg.
3391 Medical Equipment and Supplies mfg.	3364 Aerospace Product and Parts mfg.
3327 Machine Shops; Turned Product; and Screw, Nut, and Bolt mfg.	3336 Engine, Turbine, and Power Transmission Equipment mfg.
Top 5 C sectors	**Top 5 D sectors**
3344 Semiconductor and Other Electronic Component mfg.	3363 Motor Vehicle Parts mfg.
3331 Agriculture, Construction, and Mining Machinery mfg.	3273 Cement and Concrete Product mfg.
3115 Dairy Product mfg.	3121 Beverage mfg.
3114 Fruit and Vegetable Preserving and Specialty Food mfg.	3333 Commercial and Service Industry Machinery mfg.
3321 Forging and Stamping	3259 Other Chemical Product and Preparation mfg.

Note: the shares of mfg. employment are: A - 28.8%; B - 3.2%; C - 10%; and D - 3.7%

Source: IHS, Business Market Insights database, 2015. Analysis by IHS.

© 2015 IHS

Backward-linkage sectors

The sectors that supply goods and services used in the production of crude oil are referred to as backward linkages. When crude oil firms increase their levels of exploration, drilling, and production, they purchase the goods and services needed to support these activities from their vendors. The goods and services used in the production of output in any economic sector, such as crude oil, are also called intermediate inputs; they do not include labor compensation. The initial increase

in demands for goods and services from the backward-linkage sectors, and the subsequent purchases by suppliers from their suppliers generate the indirect multiplier effect. The induced effects are generated by the expenditures of the new directly hired workers, and the other workers hired by companies in the backward-linkage sectors.

A major objective of this study is to determine how the direct capex and opex spending levels under the three production scenarios in North Dakota affect the Minnesota economy. We first identify the backward-linkage sectors that support crude oil production, and then determine if they are present in Minnesota. These two steps determine the shares of the goods and services required by oil producers in North Dakota that could potentially come from Minnesota. IHS identified the backward-linkage sectors for crude oil production using several sources of information: 1) our work in other recent energy impact studies; 2) an analysis of US input/output table coefficients, especially the use table for oil and natural gas production; and 3) the expertise of our energy group. The accompanying table presents the backward-linkage sectors, with the corresponding shift-share type presented for each one.

Backward linkage sectors by NAICS codes

Description	NAICS Code	Shift-share class	Description	NAICS Code	Shift-share class
Capital goods			**Logistics**		
Agric., Construction, and Mining Machinery Mfg.	3331	C	General Freight Trucking	4841	B
Motor Vehicle and Motor Vehicle Parts wholesalers	4231	A	Secialized Freight Trucking	4842	B
Machinery, Equip, & Supplies Wholesalers	4238	A	Materials		
Power Boiler and Heat Exchanger Mfg.	332410	A	Building Material and Supplies Dealers	4441	B
Metal Tank (Heavy Gauge) Mfg.	332420	A	Steel Product Mfg. from Purchased Steel	3312	A
Cutting Tool and Machine Tool Accessory Mfg.	333515	A	Wholesale Lumber and Construction Materials	4233	A
Turbine and Turbine Generator Set Units Mfg.	333611	B	Wholesale Lumber and Construction Materials	4235	A
Speed Changer,High-Speed Drive, and Gear Mfg.	333612	B	Wholesale Electric Goods	4236	A
Mechanical Power Transmission Equipment Mfg.	333613	B	Wholesale Hardware, Plumbing and Heating Equip.	4237	A
Other Engine Equipment Mfg.	333618	B	Chemical and Allied Products Merchant Wholesalers	4246	D
Pump and Pumping Equipment Mfg.	333911	A	Construction Sand and Gravel Mining	212321	C
Air and Gas Compressor Mfg.	333912	A	Industrial Gas Manufacturing	325120	B
Conveyor and Conveying Equipment Mfg.	333922	A	Other Basic Inorganic Chemical Manufacturing	325180	B
Power-Driven Handtool Mfg.	333991	A	Cement Manufacturing	327310	A
Other Electronic Component Mfg.	334419	C	Ready-Mix Concrete Manufacturing	327320	A
Automatic Control Mfg.	334512	A	Concrete Block and Brick Manufacturing	327331	A
Instr. for Controlling Indust. Process Variables	334513	A	Iron and Steel Mills and Ferroalloy Manufacturing	331110	B
Totalizing Fluid Meter and Counting Device Mfg.	334514	A	Aluminum Sheet, Plate, and Foil Manufacturing	331315	B
Analytical Laboratory Instrument Mfg.	334516	A	Fabricated Pipe and Pipefitting Manufacturing	332996	C
Other Measuring and Controlling Device Mfg.	334519	A	**Professional and other services**		
Light Truck and Utility Vehicle Mfg.	336112	D	Water, Sewage and Other Systems	2213	A
Heavy Duty Truck Mfg.	336120	D	Warehousing and Storage	4931	B
Railroad Rolling Stock Mfg.	336510	D	Insurance Carriers	5241	A
Construction and well services			Constr., and Mining Machinery and Equip. Leasing	532412	D
Nonresidential Building Construction	2362	B	Architectural, Engineering, and Related Services	5413	D
Utility System Construction	2371	D	Mgmt. , Scientific, and Technical Consulting Svcs.	5416	D
Highway, Street, and Bridge Construction	2373	D	Other Prof. Scientific & tech. Services	5419	D
Other Heavy and Civil Engineering Construction	2379	D	Other Nonhazardous Waste Treatment & Disposal	562219	A
Foundation, Structure, and Building Exterior Contractors	2381	B	Comm. & Indust. Mach. & Equip. Repair & Maintenance	811310	D
Building Equipment Contractors	2382	B			
Other Specialty Trade Contractors	2389	B			
Drilling Oil and Gas Wells	213111	NA			
Support Activities for Oil and Gas Operations	213112	NA			

Source: IHS, Business Market Insights database, 2015.

© 2015 IHS

The backward linkages are presented for five functional groups: capital goods, construction and wells services, logistics, materials, and professional and other services. The shift-share classes as described above are presented for each individual subsector; they show how well it has performed in the Minnesota economy. For example, under the capital goods functional group, there are a number of potential backward-linkage sectors in durable manufacturing sectors (i.e., 3335, 3336, 3344, 3345, etc.) that are higher performers (i.e., are in shift-share classes A and B), suggesting that firms in these sectors may be capable of supporting oil production activity. A number of the subsectors under the professional and other services functional group are in shift-share class D; however, this does not mean that they are not capable of supporting oil and gas production, only their relative economic performance in Minnesota over the last 14 years has not been as high in other sectors. Selling services to support Bakken oil production could increase the relative performance of these sectors (i.e., move them from a D to a C or a B).

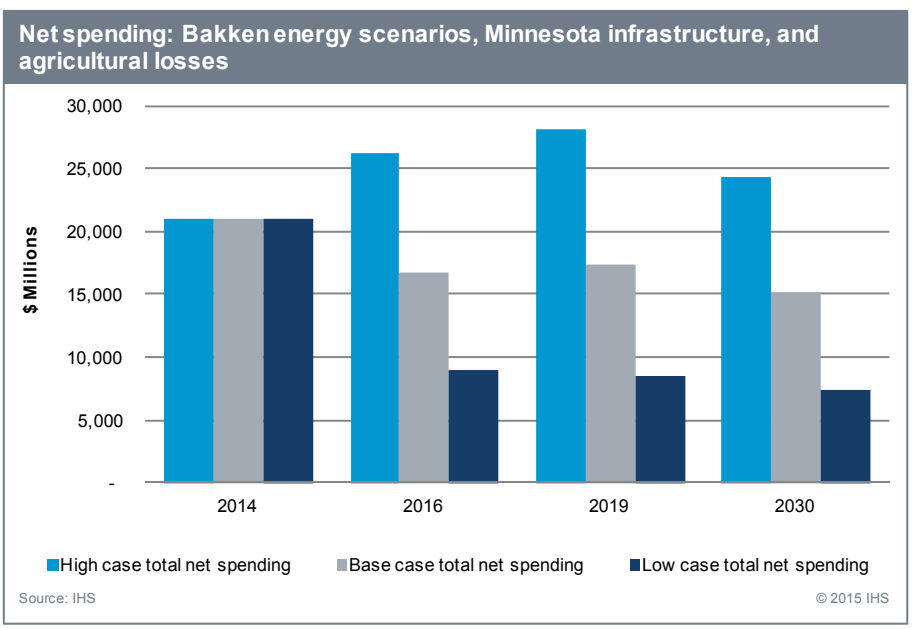
In the economic impact assessment that follows, we assigned the capex and opex spending in North Dakota to the appropriate backward-linkage sectors in the IMPLAN model.

Economic impacts of backward linkages

Methodology

IHS estimated the economic impacts of the oil production in North Dakota on Minnesota's economy using three identifiable and quantifiable spending effects:

- The directed spending in North Dakota for capital investment (capex) and operating investment (opex) needed to support crude oil production. Some portion of the capex and opex spending will be used to purchase goods and services from Minnesota companies. Investment and operations spending in North Dakota and Minnesota associated with the support of oil production
- Infrastructure spending in Minnesota to support the movement of crude oil coming from the Bakken
- Agricultural losses incurred as a result of lower basis prices, which in turn are due to increased competition and higher costs for rail capacity. The issue of the adverse effect on the basis price for agricultural commodities produced in Minnesota due to competition with crude oil shipments for rail capacity was discussed at both workshops.



IHS analyzed the economic impacts of three different oil production scenarios in North Dakota based on three different oil price scenarios developed by the IHS Energy group. The production scenarios are described in detail in the Phase 1 report—Oil production forecasts for North Dakota. For example, IHS forecasts that in 2016 total direct spending in North Dakota under the high scenario for capex and opex would be approximately $26.2 billion, compared with $16.7 billion and $8.9 billion under the base and low-price scenarios. One of the challenges of this study was estimating oil production levels in North Dakota as energy prices continued to fall throughout the second half of 2014. The Bakken formation was especially difficult to forecast as global oil prices, such as the West Texas Intermediate price measure, fell below the break-even price at which it was profitable to extract oil from the Bakken formation.

Study area

IHS used the IMPLAN input/output model to evaluate the regional economic impacts of direct spending from the Bakken activities on the Minnesota economy. We complemented and adjusted, as appropriate, the model's interstate purchasing relationship (i.e., what share of goods and services needed for oil production in the Bakken would come from Minnesota economic sectors) with expert knowledge of Bakken purchasing behavior. The IMPLAN model is based on an input-output accounting of commodity flows within a regional economy that flow from producers to intermediate users to final consumers. The model establishes a matrix of supply chain relationships between industries, households, and producers of household goods and services.[7] We generated a multi-region IMPLAN model using the following regions:

- North Dakota
- Minnesota
- A separate aggregated model for the five counties that include Border Cities: Big Stone, Clay, Lac qui Parle, Polk, and Wilkin. This model was used as a proxy for the five Border Cities because the IMPLAN model builds regions from individual counties.

Years considered

IHS estimated economic impacts for the following four years based upon annual forecasts and events in energy, infrastructure, and agriculture. The purpose of analyzing the four years was to show how the impacts in Minnesota would vary according to the level and composition (i.e., shares for capex and opex) of direct spending in North Dakota for oil production.

- **2014**: Base year of analysis. Agricultural basis prices experience their largest anticipated impact in 2014. Oil prices were volatile throughout 2014. Future Bakken investment and production trends were established. Railway operator BNSF makes substantial investment in rail upgrades to accommodate the combined demand from crude oil and agriculture.
- **2016:** High level of infrastructure spending as energy delivery company Enbridge is proposing to build the Sandpiper pipeline across Minnesota to carry Bakken crude oil to Superior, Wisconsin.
- **2019**: Bakken oil production growth peaks and the level of capital investment spending in North Dakota starts to level off; by this time the agriculture pricing impacts are largely gone as infrastructure spending in prior years reduces competition for rail capacity.
- **2030:** Long-term view: North Dakota oil production has leveled off; capital expenditures taper off to about one-third of current levels, while operations expenditures peak as a large number of producing wells reach their maximum output.

The economic analysis was conducted using nominal prices as all cost and revenues values for the years after 2014 were escalated using an inflation rate of 2% to account for increases in nominal prices over time.

Bakken oil production scenarios

The IHS Energy group closely followed the rapidly changing oil prices over the past six months and modeled three oil production scenarios in North Dakota based on the price of oil, cost of production in the Bakken region, and transportation prices from October 2014 through February 2015. Three scenarios of capital investment spending and operations and maintenance spending were assessed based on total number of wells drilled, completed, and maintained from 2010 through 2030. Bakken spending in the low and base scenarios is expected to have peaked in 2014 at $21.1 billion of combined capital and operations spending in North Dakota. Total spending in both the low and base price scenarios is expected to decline at a compound annual growth rate of -6% and -2%, respectively, so that by 2030 low scenario spending is expected to fall to $7.3 billion and base scenario spending is expected to drop to $15.1 billion. Spending under the high scenario is expected to peak in 2019 at a total of $28.2 billion of combined capital and operations

7 Further details are available at www.implan.com.

spending in North Dakota. By 2030, high scenario is expected to fall slightly from the 2019 peak to $24.3 billion, a compound annual growth rate of -1% from 2014.

Average daily oil production is expected to grow over time in the high and base scenarios, and decline slightly in the low scenario. Correspondingly, the levels of operations and maintenance expenditure are expected to change at compound annual growth rates of -0.9%, 1.9%, and 3.4% for the low, base, and high scenarios, respectively, through 2030.

Growth of production and O&M spending though 2030

Scenarios	CAGR: Annual Operations Spending	CAGR: Average Daily Oil Production
Low Case	-0.9%	-0.4%
Base Case	1.9%	2.1%
High Case	3.4%	3.4%

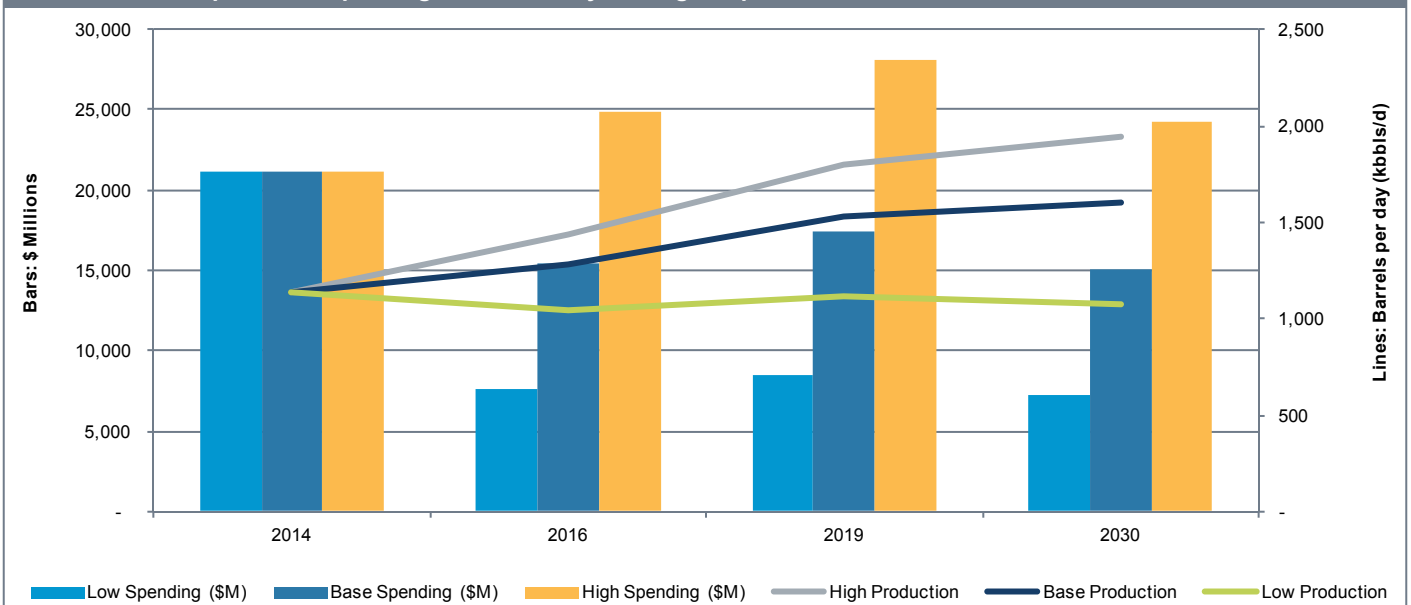
Source: IHS Energy © 2015 IHS

Our energy experts identified a representative set of backward-linkage economic sectors based on their work in recent, similar studies, and then determined the respective shares of capex and opex spending by sector. We then compared the IMPLAN model's data for the backward-linkage sectors such as: the appropriate IMPLAN final demand sector (i.e., sectors where the direct opex and capex occur), trade flows between North Dakota and adjacent states including Minnesota, and regional purchasing (RPC) coefficients. Data from IHS Business Market Insights (BMI) and Transearch databases (see the discussion of Transearch in the transportation analysis) were also used to vet the trade flows in the IMPLAN model for reasonableness, and adjust them where necessary. Finally, capital and operations expenditures were entered into the appropriate IMPLAN final demand sectors to derive the multiplier effects that oil production purchases in North Dakota have on the Minnesota economy through the backward linkages.

Infrastructure investment

As noted in the transportation analysis, a significant share of North Dakota's crude oil production is being sent eastward through Minnesota, primarily by rail, while inputs for oil production are being sent to the Bakken by highway and rail. The increased flow of crude oil, combined with the existing flows of agricultural commodities, has meant that infrastructure improvements are needed in Minnesota to accommodate the increased traffic flows, especially to the rail system. Crude oil pipeline and rail infrastructure projects are being implemented by private sector firms to address the concerns over insufficient infrastructure capacity within Minnesota, and to provide additional capacity to move crude

Investment and operations spending and total daily average oil production in Bakken, North Dakota



Source: IHS © 2015 IHS

oil by pipeline. The Minnesota Department of Transportation is planning highway improvements, such as eliminating at-grade railroad crossings and construction of bypasses, to reduce congestion.

Sandpiper pipeline

Enbridge, an energy delivery company based in Alberta, Canada, has three infrastructure projects under development in Minnesota with construction activity occurring between 2014 and 2017. Enbridge has submitted applications to the Minnesota Public Utilities Commission for a certificate of need and a pipeline route permit for the Sandpiper pipeline. The Public Utilities Commission is currently reviewing the two applications; as of early March 2015 Enbridge had not yet received approval to proceed with the project in Minnesota, although they have received approval to proceed from the North Dakota Public Utilities Commission. IHS included the Sandpiper pipeline development in this study as the pipeline's main purpose is to transport crude oil from North Dakota to Enbridge's oil storage terminal in Superior, Wisconsin; from there, the crude oil will be sent via pipeline to refineries in the US Midwest and eastern Canada. The Sandpiper pipeline project will have a total cost of $2.6 billion over a three-year period. Approximately 300 miles of pipeline, or about half its total length, will be constructed in Minnesota. If the project is approved by the Minnesota Public Utilities Commission, it will produce substantial, short-term, positive economic impacts in Minnesota because of the estimated $1.3 billion in construction spending. Enbridge expects to use local workers and suppliers to the maximum extent possible. Operation expenditures for the entire pipeline are estimated be $30 million per year. We apportioned the expenditures by length to allocate about $1.3 billion worth of construction spending that would occur in Minnesota in 2016 if the project is approved.

We excluded Enbridge's two other Minnesota projects from our estimate of economic impacts—the Line 67 upgrade and the Line 3 replacement—as they are not directly attributable to Bakken activities. We acknowledge that both these projects will produce positive economic impacts in Minnesota during their construction and operation phases.

Rail infrastructure improvements

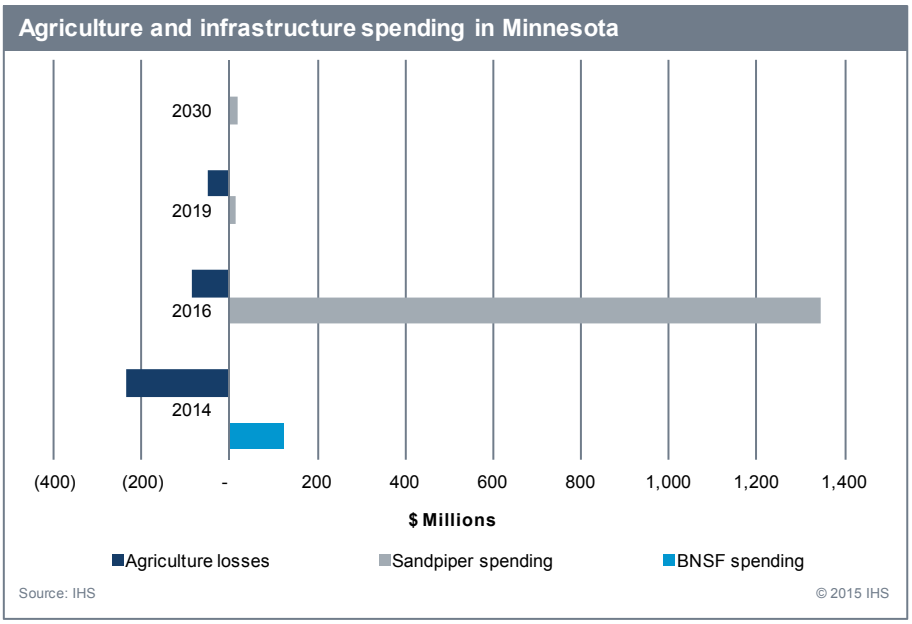
Burlington North Santa Fe (BNSF) is one of the largest freight railroads in the United States and has been highlighted as a major rail transportation provider in Minnesota and North Dakota. BNSF reported investments of $120 million in Minnesota during 2014 to expand rail capacity, replace and maintain the network, and continue implementation of positive train control (PTC) technology. We acknowledge that BNSF rail services will continue to have a significant impact as a transportation provider in the region, but excluded annual maintenance expenditures from the scope of this analysis as the rail lines serve a variety of freight needs in addition to the movement of crude oil. BNSF will be investing $326 million in 2015 in Minnesota due to rail traffic demands including crude oil and oil field supply demands[8]. Three other railroads - Canadian National, Canadian Pacific, and Union Pacific - will also be investing over $200 million in the state, with the spending by the Canadian Pacific and the Union Pacific due to crude oil and oil field supply demands. Spending associated with Canadian crude oil was excluded from the scope of this analysis, as they are not directly attributed to Bakken production.

Agriculture impacts

In July 2014 the Minnesota Department of Agriculture released a study[9] describing how transportation problems during the winter and spring of 2014 affected the shipments of grains in Minnesota. This then led to a decline in the basis price (i.e., cash price relative to the futures price) and a drop in the market value of Minnesota grains. The study said local cash prices for crops are affected by three factors: 1) transportation costs and availability; 2) local supply and demand conditions; and 3) availability of local storage capacity. The Department of Agriculture then concluded that the primary reason for the decline in the basis price had been the lack of available transportation capacity to ship the grain to market, due in significant part to the simultaneous demand for rail capacity for Bakken crude oil being transported across the State. During the two workshops held in November 2014, several participants also commented on the decline in the grain basis price that had occurred earlier in the year, attributing it to a shortage of rail capacity that could not accommodate both the demands from a bumper agricultural crop and the movement of North Dakota crude oil through Minnesota. As a result of these comments, IHS included direct agricultural effects in the economic impact analysis.

8 http://www.bnsf.com/media/news-releases/2015/february/2015-02-05a.html.

9 Minnesota Department of Agriculture, Minnesota Basis Analysis, July 2014.



Current global projections by IHS reflect the changing dynamic across the agriculture sector. The last decade in agriculture was driven by strong growth in China with the opening of trade barriers along with the advent of biofuel policies. The decade had periods with historical price levels seen across many of the major agriculture commodities. IHS projections mark an expected slowdown to the global agriculture commodity market growth. As an example, the world-level corn production grew nearly 21% between crop years 2005/06 and 2010/11, 15% between 2010/11 and 2015/16 and is projected at 7–8% between 2015/16 and 2020/21. Over the next five years, global demand is slower at the same time competing global producers have expanded to fulfill the global supply. In this global context, agriculture producers are projected to work within an environment of tightened margins. Crop producers are expected to put constraints on costs for inputs: machinery, seed, chemicals, etc.

The advent of lower crop prices offers the opportunity for animal agriculture producers to see better returns and expand production. There are positive benefits of a lower marginal cost of feed for animal production centers, which are significant for Minnesota agriculture, as it is the largest producer of turkey in the United States. Minnesota animal production centers benefit from lower crop prices through reduced feed prices, which results in an increased return for animals though a possible increase in the marginal dress weight of the animals. As mentioned with grains, the majority of the benefit of lower commodity prices has been because the global supply of feed that has increased more than the discounts caused by the transportation issues. The losses that affect the crop producers are larger than the off-set of positive benefits to the animal producers as the in-state users. The turkey producers are generally found in Central Minnesota and pork producers are Southern Minnesota, which is part of the reason that basis prices widened less in those two regions than in Northwest Minnesota. Unfortunately, the lower global macroeconomic growth may limit the export opportunities that could otherwise be gained.

Minnesota area planted is a normal part of the IHS global agriculture quarterly forecast. The US-level projections include the supply and demand of major agriculture commodities along with expected US farm income. The projections of the US level along with the Minnesota specifics set the baseline expectations for this study. The historical state-level farm price was correlated with the US national season average price for the selected commodities. The level of historical discount or premium was accounted for within the price transmission. Minnesota historical farm cash receipts were taken directly from the US Department of Agriculture/Economic Research Service (USDA/ERS). The historical calculation was correlated to a combination of state-level commodity production and state prices. Carry-over production and prices were taken into account to create baseline expectations of unadjusted projected returns. We considered the following types of direct agricultural effects:

- **Negative regional-specific crop basis price reaction:** The basis prices, which are the difference between futures prices and local prices of commodities, widened in 2014, resulting in lower prices received by crop producers, which in turn lowered their income. However, the lower local commodity prices mean lower costs for end users (e.g., biofuels, feed users, and food users).

- **Increased carryover cost of stocks on hand:** The delays in moving supply increase the time in storage.

- **Decreased volume moved through supply chain:** Lower volumes lead to decreased revenue for supply chain, specifically elevators.

Changes to Minnesota cash receipts for corn, wheat, and soybean were quantified to garner the change due to limited supply chain resources for input to the IMPLAN model. The state-level commodity price was discounted by a negative impact on basis pricing during the projection period. The basis-level discount was quantified based on the spatial distribution of state-level crop production and reported discounts seen in price levels across various locations. Seasonal mitigation of supply chain availability across the state was taken into account. The level of production associated with a decreased level of area planted was quantified as the crop mix shifts across the state separately from the overriding global supply and demand impacts. The new discounted price and discounted production were used to calculate the affected level of commodity cash receipts. Our agricultural experts anticipate that crop farm revenue declines will be short lived, with the largest impacts having occurred in 2014 when grain farming cash receipts fell $164 million and soybean cash receipts fell $69 million. The agricultural losses in cash receipts are expected to gradually decline through 2019 due to a combination of declining oil production in North Dakota and the addition of new crude oil pipeline capacity, specifically the completion of the Sandpiper project previously described.

Estimating total economic impacts

IHS was able to estimate total annual economic impacts that the Bakken oil play in North Dakota has on the Minnesota economy. Total economic impacts in Minnesota are estimated for three variables described below.

- **Employment:** The total number of jobs generated by the direct spending, not the change in number of employed persons. The job figure includes both nonfarm positions at business establishments with payrolls, and also self-employed persons and sole proprietors. The employment figure consists of full- and part-time positions, so it is not presented on a full-time equivalent (FTE) basis.

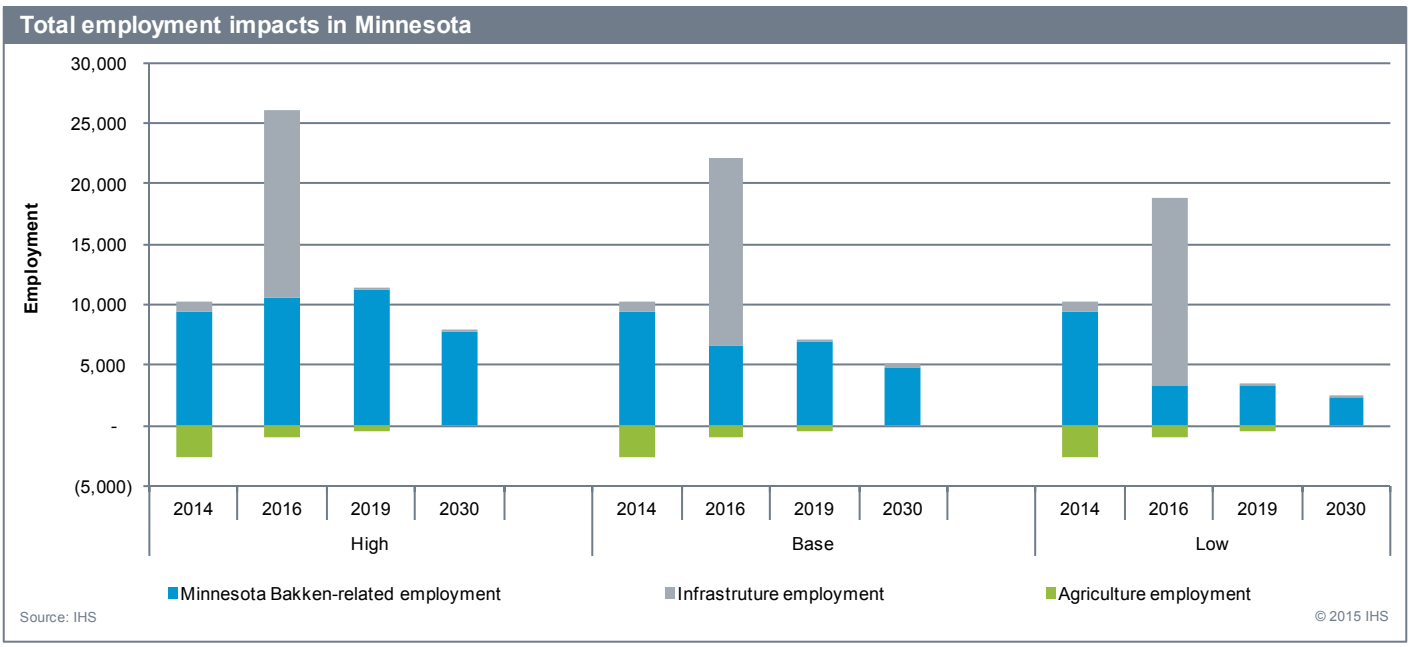
- **Gross regional product (GRP):** The total change in value added generated by the direct spending. GRP is conceptually the same type of measure as gross domestic product (GDP), which is also a measure of value added and indicates the market value of goods and services, at purchaser prices, produced by all economic resources located in the United States. As a result, GRP measures the change in value added that occurs in a regional economy, so it is essentially GDP at the regional local level. Value-added is the concept most commonly used to measure the size of an economy. In our analysis, the terms value added and gross regional product or GRP will be used interchangeably.

- **Labor income:** Total labor compensation received by the employed persons, based on the definition presented, generated by the direct spending. Labor compensation includes wages and salaries paid to workers at establishments with payrolls, income received by self-employed persons and sole proprietors, and the value of fringe benefits received by workers.

The IMPLAN model also provides economic effects in terms of the change in output, which is defined as value added plus the costs of intermediate inputs (i.e., raw materials, supplies, equipment, etc. used in producing a good or service). Output can also be understood as a measure of sales or revenues received by businesses. IHS decided to use value added in the form of gross state product (GSP) or gross metro product (GMP) instead of output in our analysis because most persons are more familiar with the term GDP and thus the concept of value added.

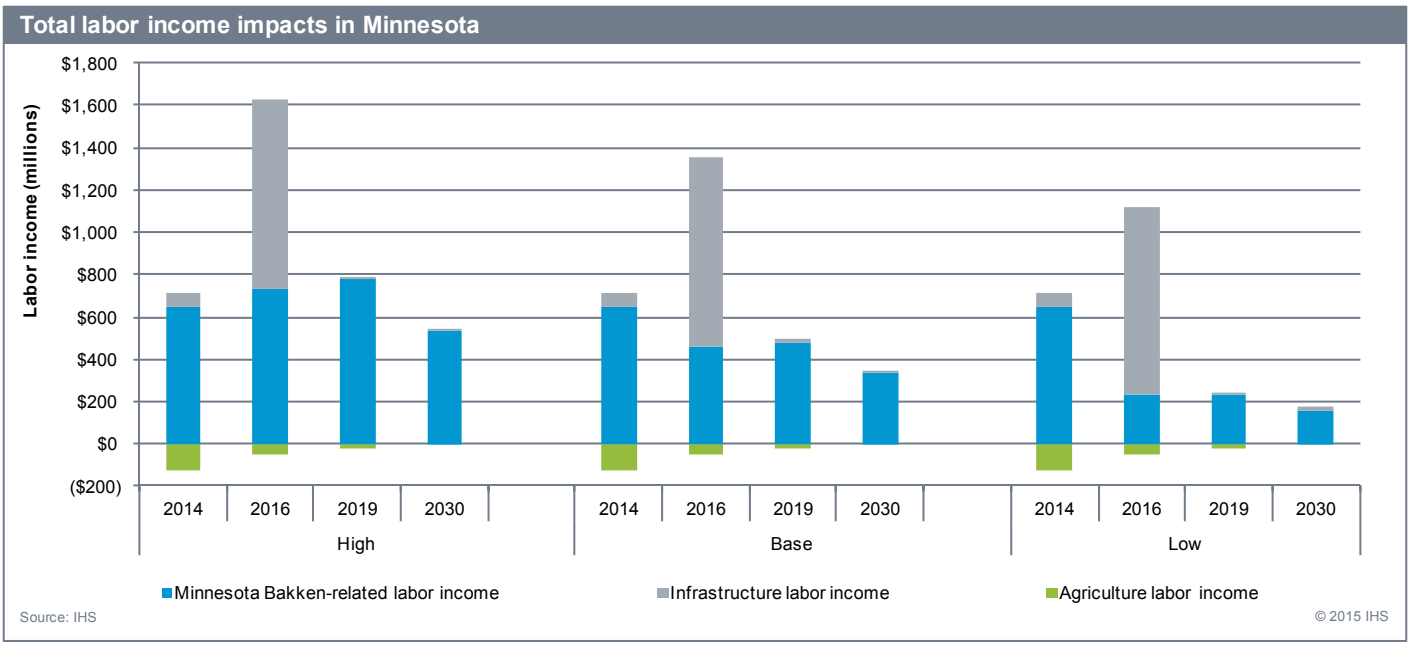
Results: Total economic impacts

Total economic impacts in Minnesota from North Dakota oil production varied based on capital investment and operations spending patterns across the three energy spending scenarios. All North Dakota spending scenarios decline over time and Minnesota benefits also decrease over time. The accompanying two charts present the total changes in employment and labor income in Minnesota under the three scenarios disaggregated into the three direct effects: 1) energy spending in North Dakota; 2) infrastructure spending in Minnesota; and 3) changes in agriculture income in Minnesota.



Minnesota gains a net of 7,749 jobs in 2014 across all energy growth scenarios. As expected, higher spending scenarios correspond with higher employment, labor income, output, and value-added. Over time, the largest job growth occurs in high-scenario employment, with an increasing compound annual growth rate of 0.2% from 2014 through 2030. All other energy scenarios demonstrate overall employment declines. Base scenario employment declines at a compound annual rate of -2.6% from 2014 through 2030, while low scenario employment falls at rate of -6.7% over the same time period. The employment declines over time are due to the falling level of Bakken spending, and resulting decline for goods and services provided by Minnesota companies. In 2014, the decrease in Minnesota employment of 2,586 jobs from the decline in agricultural income more than offsets the rise in employment of 916 jobs generated by infrastructure spending. In 2016, the situation is reversed as the drop in employment of 923 jobs due to losses of agriculture income are more than offset by the increased employment of 15,497 jobs from the construction of the Sandpiper pipeline. Finally, by 2019 the agricultural income losses are minimal, and infrastructure spending in Minnesota attributable to North Dakota oil production is also at a low level, so that the change in total employment is due to overwhelmingly to spending on oil production in North Dakota as shown in the two accompanying charts.

Labor income follows employment trends across scenarios and over time, but demonstrates slightly stronger sensitivity to overall declines in spending. Labor income does not experience the same overall growth as employment in the high scenario, declining from 2014 through 2030 at a compounded annual growth rate of -0.4%. In the base scenario labor income declines with a compound annual growth rate of -3.2% from 2014 through 2030, while for the low scenario labor income declines at a rate of -7.3% in the same period. The lower growth rates in labor income, compared to employment, under the three scenarios, likely occurs because the composition of goods and services being supplied to support North Dakota will shift over time from capex, where skilled workers are highly paid, to opex where more inputs will come from the service sector where wage levels are lower.



Infrastructure investments, such as the Sandpiper pipeline, generate significant economic benefits in Minnesota as they produce direct, indirect, and induced increases in employment, rather than the indirect and induced jobs due to Bakken spending. At the same time, the declines in agriculture income lead to losses of direct, indirect, and induced jobs in Minnesota.

The percent changes in employment and labor income in Minnesota attributable to North Dakota oil production over our baseline economic forecast for the state are small, even during the peak year of impacts in 2016. The increases in employment range between 0.6% and 0.9% across the three scenarios, while those for labor income are from 0.5% to 0.7%.

Largest net employment gains in Minnesota, base-case 2016 ranking

		Base	High	Low
36	Construction of other new nonresidential structures	5,139	0	0
356	Securities, commodity contracts, investments, and related activities	1,333	202	-92
381	Management of companies and enterprises	1,002	443	-162
413	Food services and drinking places	908	202	-167
201	Fabricated pipe and pipe fitting manufacturing	840	0.3	-280
319	Wholesale trade businesses	535	126	-87
382	Employment services	525	107	-89
369	Architectural, engineering, and related services	463	17	-31
365	Commercial and industrial machinery and equipment rental and leasing	415	52	-3
360	Real estate establishments	370	52	-80
397	Private hospitals	349	70	-61
394	Offices of physicians, dentists, and other health practitioners	327	72	-57
425	Civic, social, professional, and similar organizations	302	94	-48
335	Transport by truck	293	54	-57
398	Nursing and residential care facilities	286	61	-64
354	Monetary authorities and depository credit intermediation activities	264	77	-43
329	Retail Stores - General merchandise	262	77	-67
357	Insurance carriers	254	59	-63
324	Retail Stores - Food and beverage	227	62	-44
388	Services to buildings and dwellings	215	56	-40
230	Other general purpose machinery manufacturing	189	74	-36
367	Legal services	188	42	-47
368	Accounting, tax preparation, bookkeeping, and payroll services	176	53	-39
414	Automotive repair and maintenance, except car washes	165	58	-37
39	Maintenance and repair construction of nonresidential structures	160	46	-35

Source: IHS, IMPLAN

© 2015 IHS

The largest overall industry employment gainers in 2016 will be in construction industries supporting the pipeline project. The second- and third-largest gainers in the base-scenario were among Minnesota cluster industries: IMPLAN 356 (securities, commodity contracts, investments and related activities) and IMPLAN 381 (management of companies and enterprises); each are expected to gain over 1,000 jobs during Sandpiper construction.

We removed infrastructure and agriculture effects to see which Minnesota industries played a role in the Bakken unconventional supply chain and its ripple effects. The largest employment gains in Minnesota resulting from capital investment and operations spending in the Bakken were in business service and consumer service industries. The largest employment gains across energy scenarios were in IMPLAN 381 *Management of companies and enterprises*, with an increase in 885 jobs in the 2016 base scenario. IMPLAN 413 *Food services and drinking places* and IMPLAN 319 *Wholesale trade businesses* have the second- and third-largest employment gains in 2016 Bakken scenarios.

Top-25 energy employment gainers in Minnesota: 2016 base-case rankings

Rank	IMPLAN		High	Base	Low
		Total	**10,637**	**6,636**	**3,328**
1	381	Management of companies and enterprises	1,419	885	444
2	413	Food services and drinking places	537	335	168
3	319	Wholesale trade businesses	330	203	99
4	230	Other general purpose machinery manufacturing	289	188	102
5	356	Securities, commodity contracts, investments, and related activities	294	182	90
6	382	Employment services	287	180	92
7	360	Real estate establishments	261	164	84
8	425	Civic, social, professional, and similar organizations	257	161	81
9	357	Insurance carriers	225	140	69
10	354	Monetary authorities and depository credit intermediation activities	221	137	69
11	389	Other support services	204	127	63
12	397	Private hospitals	197	123	62
13	394	Offices of physicians, dentists, and other health practitioners	185	115	58
14	398	Nursing and residential care facilities	162	101	51
15	329	Retail Stores - General merchandise	135	84	42
16	388	Services to buildings and dwellings	127	79	40
17	368	Accounting, tax preparation, bookkeeping, and payroll services	126	79	40
18	403	Spectator sports companies	127	78	39
19	39	Maintenance and repair construction of nonresidential structures	123	78	40
20	335	Transport by truck	123	76	37
21	377	Advertising and related services	119	75	38
22	324	Retail Stores - Food and beverage	116	73	36
23	367	Legal services	114	71	36
24	380	All other miscellaneous professional, scientific, and technical services	102	64	33
25	358	Insurance agencies, brokerages, and related activities	95	59	29

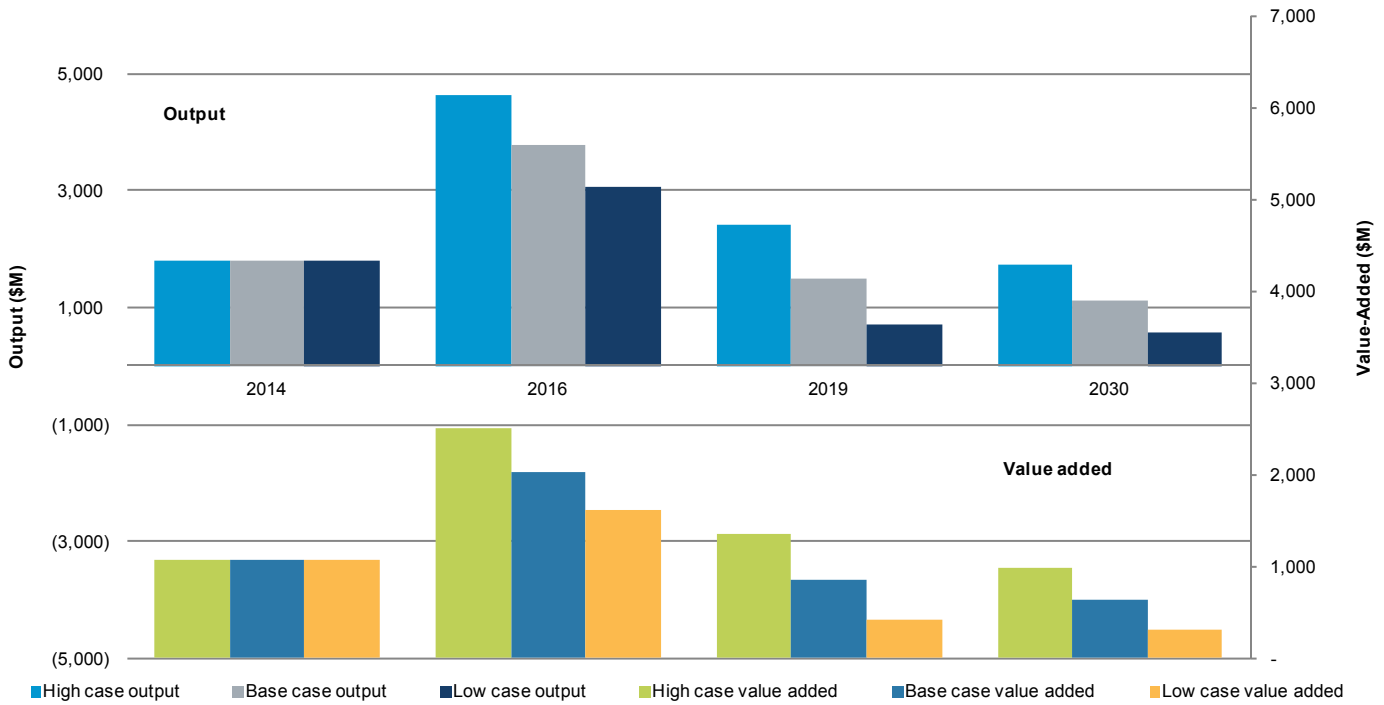
Source: IHS, IMPLAN

© 2015 IHS

Overall, output and value-added impacts follow similar trends to employment and spending scenarios, with the largest gains occurring in 2016 and growth tapering off through 2030. Output and value-added declined in the high scenario over the analysis period, falling at a compound annual growth rate of -0.3% and -0.6%, respectively, from 2014 through 2030. Output declines in the base and low scenarios over the analysis period at a compound annual growth rate of -3% and -7%, respectively, from 2014 through 2030. Value added declines at similar rates in the base and low scenarios, declining at a compound annual growth rate of -3.3% and -7.3%, respectively, from 2014 through 2030.

The percent increases in value added and output in Minnesota attributable to North Dakota oil production over our baseline economic forecast for the state in 2016 are similar in size to those noted for employment and labor income. During 2016, the increases in value added vary from 0.5% and 0.8% across the three scenarios, while the rises in output range from 0.4% to 0.6%.

Output and value-added impacts in Minnesota



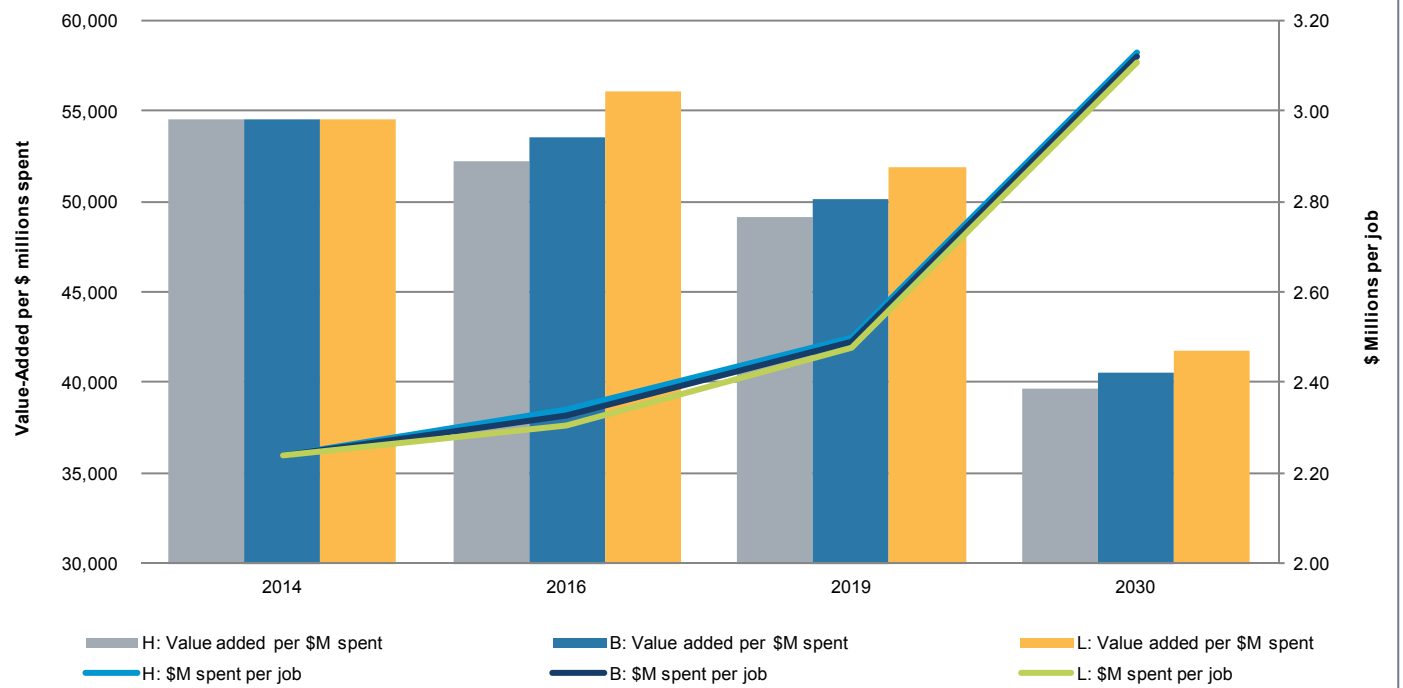
Source: IHS, IMPLAN

© 2015 IHS

To better grasp the significance of North Dakota oil production activities on Minnesota, IHS created two separate measures: 1) million dollars spent per job created and 2) change in Minnesota's gross state production (GSP), or value-added, per million dollars spent. These two measures were created using North Dakota spending and Minnesota benefits alone, without taking into consideration agriculture and infrastructure activities. With the first measure, we see that for every $2.24 million spent in North Dakota's oil industry, one job in Minnesota was created in 2014. In 2030, slightly over $3 million of spending in North Dakota's Bakken is required to create one Minnesota job.

The second measure provides a better sense of direct business gains for Minnesota industry. Many stakeholders and businesses have expressed an increase in business, but perhaps have not been able to isolate their gains from the Bakken relative to other economic factors. The value-added gains in Minnesota relative to millions of dollars spent in North Dakota approximates the ripple effects the dollars spent in the Bakken have on Minnesota businesses. In 2014, the change in Minnesota's gross state product per million dollars spent for oil production in North Dakota was slightly above $54,000. The value-added benefits decline over time, as 1) spending shifts with time from capital investment to operations, and 2) the backward linkages become more complete so that a higher share of the goods and services used in oil production can be obtained from within North Dakota as opposed to other states.

Impact of spending on Minnesota value-added and employment



Source: IHS

© 2015 IHS

Tax impacts

IHS estimated the changes in major state-level tax revenues that would be generated by the increases in economic activity under each of the three scenarios, and for each of the four years, as presented. Our basic approach was to use time series data on state tax revenue collections in Minnesota back to 2002, and historical data on the four variables provided by the IMPLAN model—employment, value added, output, and labor income—to derive a set of effective tax rates. These rates were then multiplied by the results of the economic impact assessment presented in this report to derive revenue estimates. The effective tax rates took into consideration whether the rates for major state-level taxes such as individual income, corporate net income, and sales and use taxes had changed over time. In fiscal year 2013 Minnesota obtained 74.7% of its total state tax revenues from just three sources: individual income tax, 44%; corporate income tax, 6.3%: and sales and use taxes, 24.4%. By comparison, that same year North Dakota obtained 42.8% of its tax revenues from the same three sources: individual income tax, 12%; corporate income tax, 3.6%: and sales and use taxes, 27.2%; but 46.6% of its revenues from oil extraction and gross production

State-level tax revenues by scenario

Scenarios and tax types	2014	2016	2019	2030
October high				
State corporate income	$3.6	$8.8	$4.7	$3.4
Individual income	$27.5	$73.9	$35.9	$25.7
General sales and use	$13.2	$33.8	$17.5	$12.7
All other taxes and fees	$16.0	$39.0	$20.7	$14.9
Total	$60.3	$155.5	$78.8	$56.7
December base				
State corporate income	$3.6	$7.2	$2.9	$2.2
Individual income	$27.5	$61.0	$22.1	$16.3
General sales and use	$13.2	$27.6	$10.8	$8.1
All other taxes and fees	$16.0	$31.7	$12.9	$9.6
Total	$60.3	$127.4	$48.7	$36.1
February low				
State corporate income	$3.6	$5.8	$1.4	$1.1
Individual income	$27.5	$50.3	$10.5	$8.2
General sales and use	$13.2	$22.4	$5.2	$4.1
All other taxes and fees	$16.0	$25.6	$6.2	$4.8
Total	$60.3	$104.0	$23.3	$18.3

Note: the major components of all other taxes are: motor vehicles sales, motor fuels excise, motor vehicle registration, alcoholic beverage, cigarettes, tobacco, insurance premiums, health care surcharges, MinnesotaCare, and state property taxes

Note: all revenues are in millions of current dollars.

Sources: IHS, US Regional Service, 2015. Minnesota IMPLAN Group, Input/output model for Minnesota, 2015. Wolters Kluwer, CCH 2015 State Tax Handbook, 2015. Minnesota Department of Revenue, Table 1. Minnesota State Tax Collections (FY 1974 - 2013). http://www.revenue.state.mn.us/research_stats/Pages/State_Tax_Collections_by_Type_of_Tax.aspx

taxes. As with economic impacts, the maximum levels of tax revenues will be generated in 2016 due to the combination of still-high levels of capex and opex spending in North Dakota and infrastructure spending.

We estimate that in 2016 the total additional state-level tax revenues in Minnesota generated by increases in economic activity from North Dakota oil production will range from approximately $155.5 million under the October high scenario down to $104 million under the February low scenario. The annual tax revenue increase will gradually decline thereafter as infrastructure spending declines, along with the levels of direct capex and opex spending in North Dakota.

Minnesota has reciprocity agreements for individual income taxes with North Dakota and Michigan. Tax reciprocity is an agreement where if a Minnesota resident works in either of the other two states, their tax obligation to Minnesota is no different than it would be if the job was located in Minnesota. The effect of tax reciprocity means that there is no reduction of individual income tax revenues to Minnesota when a resident worker takes a job in North Dakota; if the North Dakota job pays more than the worker was earning in Minnesota, then individual income tax revenues received in Minnesota would increase, and vice versa.

There would be some small increases in tax revenues in those counties in southeastern Minnesota that produce frac sand. Section 298.75 of Minnesota Statutes permits counties to levy a tax of 21.5 cents per cubic yard or 15 cents per ton on aggregate material excavated in the county. The revenues are required to be used for local transportation improvements—42.5%, general fund revenues—42.5%, and deposited into a reserve fund to pay for restoration of mined areas—15%. Based on current estimates of between 4.0 million[10] and 5.0 million[11] tons per year of frac sand production in Minnesota, this tax would produce between $600,000 and $750,000 in additional county tax revenues, but less than 20% of this revenue can be attributed to oil production activity in North Dakota at the present time.

Economic impacts in the Border Cities and their respective counties

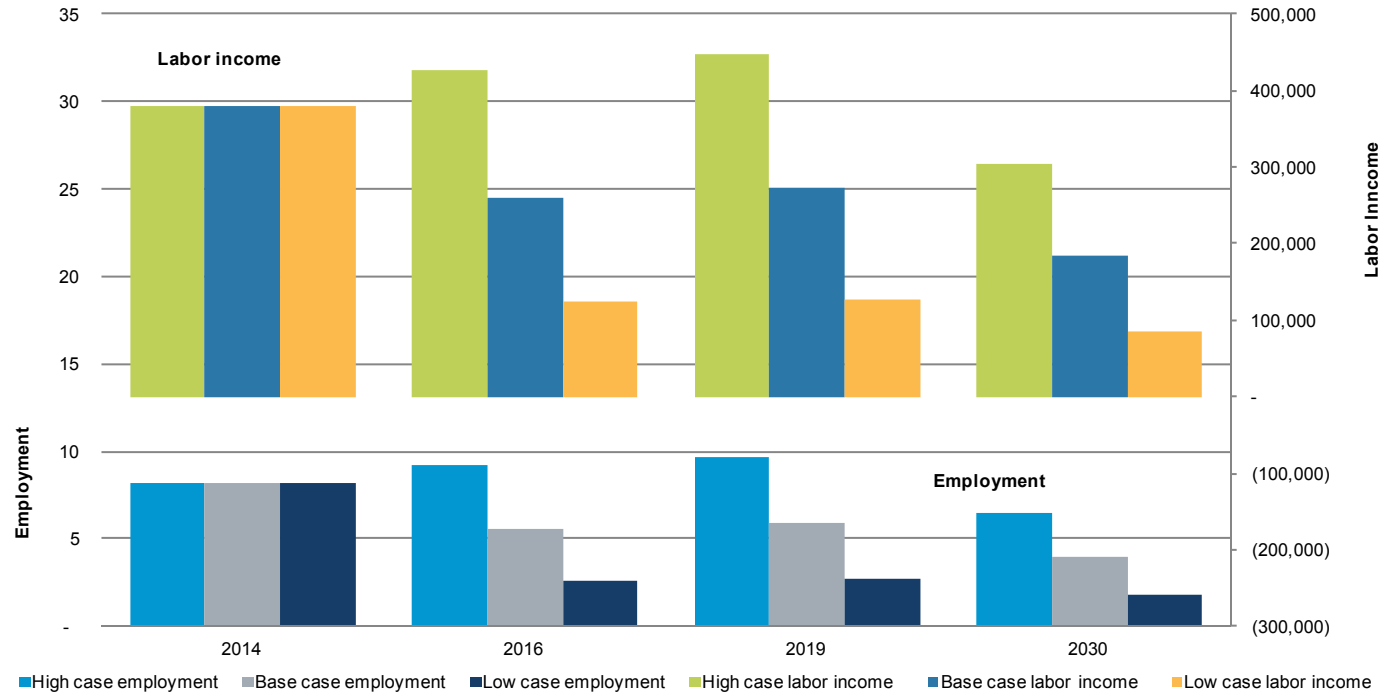
IHS considered the overall economic impact that capital investments and operations spending in the Bakken has on the five Border Cities of Minnesota. Given the relatively modest size of the economy and populations of the Border Cities, IHS constructed an IMPLAN region composed of an aggregation of the five counties in which the affected Border Cities are located. Infrastructure and agricultural impacts were excluded from the aggregated county impacts due to the structure of the IMPLAN model we used and our efforts to avoid double counting.

The overall economic impacts were modest throughout the period of analysis. Employment gains are expected to peak in 2019 for the high-growth scenario, and are expected to have already peaked in 2014 for the base- and low-growth scenarios. Employment effects are expected to decline at a compound annual growth rate of -1.4% in the high scenario from 2014 through 2030. Employment impact declines are projected to be steeper for the base and low scenarios, declining at a compound annual growth rate of -4.4% and -8.9%, respectively, from 2014 through 2030. Labor income follows employment growth through each year of analysis for each forecasted trend. The relative sizes of labor income impacts are limited to a range of $120,000 to a maximum of $448,000, with employment impacts in levels of 10 or fewer new jobs.

10 IHS, Transearch database, 2015.

11 Heather Arends, Minnesota Department of Natural Resources, personal conversation, March 16, 2015.

Employment and labor income impacts of Bakken activities: Aggregated 5 counties



Source: IHS, IMPLAN

© 2015 IHS

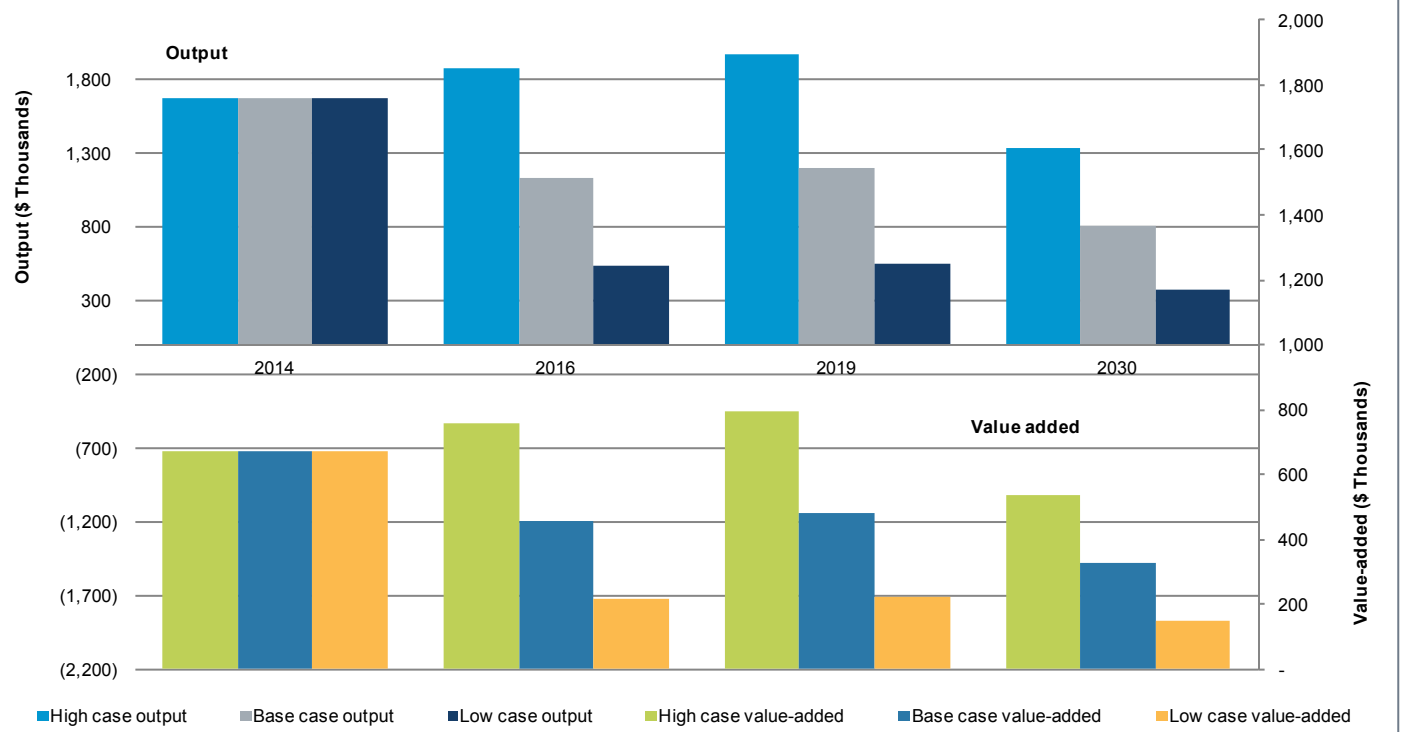
Output and value-added impacts in the aggregated five-county IMPLAN region are comparable to employment effects. In 2014, the Bakken capital investment and operations spending attributed to $1.68 million of increased output and $672,000 in increase value-added in the five-county region across all three scenarios. The annual increases of output and value added in the five counties declines over time as the direct spending falls.

The primary reasons for the minimal backward linkage economic impacts in the Border Cities and the counties that include Border Cities are:

- **Proximity:** the cities and counties are located too far from the Bakken to be local suppliers. It is at least 200 miles driving distance from Moorhead to the eastern edge of the Bakken formation near Bismarck, which is too far to provide any proximity benefits to companies located in the five counties.

- **Economic structure:** the economy of the five counties that include Border Cities is small, with a total employment of 46,554 jobs in 2014. As rural economies with a large agricultural sector and a lack of structural diversity, many of the specialized goods and services used in the production of crude oil are not produced there. The five counties also lack, for the most part, larger firms that are able to offer the range of specialized services required by oil producers at the scale they require. Responses to the interviews performed during the SCOPE process indicated that the companies selling goods and services into the Bakken tend to be either: 1) large full-service firms, or 2) those that offer high-level, specialized goods and services, especially those in the professional and business services, finance, equipment leasing, insurance, and construction sectors. The supplier firms tend to be located further to the east around near the Twin Cities, and they have the scale to establish branch offices in the Bakken, supported by activities in other offices.

Output and value-added impacts of Bakken activities: Aggregated 5 counties



Source: IHS, IMPLAN

© 2015 IHS

Given the geographic location and the industrial mix of the aggregated five county regions' economy, we anticipate the benefits of Bakken spending to be minimal. Agriculture impacts were excluded in this level of detail of the impact analysis, as were benefits from the Sandpiper pipeline project. Approximately 60 miles, or one-fifth of the Sandpiper pipeline's total length in Minnesota, will be constructed in Polk County, which would produce positive, short-term economic benefit in 2016.

Economic development and forward linkages

Forward linkages are economic sectors that use the output of another sector as an input in providing other types of goods and services. As an example, refineries use crude oil as input to produce refined products such as gasoline, diesel fuel, and other similar products. In turn, the petrochemical sector would use some of the refined products, such as distillates, to make basic chemicals. The gasoline and diesel fuel produced by the refinery would be used by businesses and households present with their market area. If crude oil from North Dakota passes through Minnesota by rail (i.e., it is currently being sent by rail to Philadelphia for processing) or by the Sandpiper pipeline and is not used as an input in the state, the forward linkage economic development benefits will be minimal. In other words, the extent to which the Minnesota economy benefits over the long-term from the increased supply of North Dakota crude oil that passes through it will depend in the ability of the forward linkage sectors to use the crude as an input. Most importantly, in order for the most of the forward linkage sectors to benefit from the increased supply of crude, it will first have to be refined into products they can use.

Other forward linkage sectors in Minnesota will potentially benefit from North Dakota's oil production by providing transportation and storage services for the crude oil passing through the State to processing and storage locations, such as to the Enbridge oil terminal in Superior, Wisconsin. Crude oil from the Bakken is currently being sent on unit trains to a large refinery on the Schuylkill River in Philadelphia, resulting in higher demand for rail services provided by rail companies such as CSX and BNSF. Currently, two unit trains per day carrying about 160,000 barrels of crude oil travel from the Bakken field to Philadelphia, passing through Minnesota and six other states. A recent IHS report issued in December 2014 estimates that the cost of shipping Bakken crude oil by rail to the US east coast averages $14.75 per barrel, compared to the cost of sending it by pipeline to the US Gulf Coast of $9.50 per barrel. Pipeline companies such

as Enbridge will experience an increase in sales for the services they provide in shipping North Dakota crude oil to the Superior, Wisconsin facility.

When firms like BNSF and Enbridge ship crude oil across multiple states, it is difficult to precisely assign the share of their increase in sales and economic activity that will occur in a single state such as Minnesota, but it is reasonable to assume that the impact is generally proportional to the share of the trip that is located in an individual state. Rail and pipeline companies will purchase goods and services, and hire some workers to maintain their facilities that are located in Minnesota; these operating and maintenance costs were considered in economic impact assessment presented above. The size of the economic impacts from purchasing transportation services will also be affected by where the payments are made. BNSF's corporate headquarters are in Dallas, Texas, while Enbridge's are in Toronto, Canada. To the extent that payments made for rail services provided by BNSF flow to Dallas, as opposed to Minneapolis where they have an office, the local economic impacts will be less and vice versa.

IHS identified potential forward linkage sectors from our work in other recent studies, the shift-share analysis of the Minnesota economy described above, and an analysis of the US input/output table to identify economic sectors that use crude oil as an intermediate input. The accompanying table presents the potential forward linkage sectors that we identified, along with their shift-share type. The largest potential forward linkage sector is petroleum refining, with Minnesota having two refineries. Under the right circumstances, these refineries could be potential users of the Bakken crude, especially if their current refining processes allow them to use the light, sweet crude oil coming from the Bakken instead of the heavier crude oil coming from Canada. After petroleum refining, all of the other forward linkage sectors on the list will require that the crude oil first be processed to generate the refined petroleum products that can be directly used as an intermediate input. Other forward linkage sectors that rank high on the list include transportation services (e.g., air, truck, and rail), grain farming, other basic organic chemicals, iron ore mining, various agriculture activities, construction, and wholesale trade.

Since the underlying input/output table combines crude oil and natural gas into a single sector, additional analysis of the potential forward linkage sectors would need to be done to identify the economic sectors that can use either unrefined crude oil, or refined petroleum products, as an input. This analysis would be especially important for the two chemical manufacturing sectors—other basic inorganic chemicals or plastics and resins—that appear on the list.

Refinery forward linkages

Minnesota is geographically advantaged to potentially benefit from rising crude oil supplies in North Dakota and Canada because it has access to the key rail and pipeline routes to market further east and south. Bakken crude and Canadian crude volumes move through the state via pipeline and rail to markets in Minnesota, Wisconsin, Illinois and markets further east and south. Bakken oil production has increased at a rate greater than the supporting pipeline infrastructure, resulting in a significant use of rail as noted in the recent IHS report "Crude by Rail" released in December 2014[12].

There are two refineries in Minnesota, both located in the Minneapolis-St. Paul MSA.

- Flint Hills/Pine Bend, located in Rosemount, which processes heavy Canadian crude oil and produces gasoline, diesel, jet fuel, asphalt, heating fuels, sulfur for fertilizer, and other products with a capacity of 339,000 barrels per day
- Northern Tier, located in St. Paul Park, processes a mix of crude oils, but requires lighter crude oils than Pine Bend and produces gasoline, diesel, jet fuel, and asphalt, with a capacity of 89,500 barrels per day.

Both refineries provide fuel to Minnesota and the adjacent states. Canadian heavy crude oil fueled refinery expansions in Minnesota and the Chicago area. Bakken crude oil has now emerged with similar logistical benefits to Minnesota refiners as Canadian heavy.

12 IHS, *Crude by Rail: The new logistics of tight oil and oil sands growth*. December 2014. http://press.ihs.com/press-release/energy-power/transportation-crude-oil-rail-expected-peak-between-2015-2016-will-remain

Top-30 forward linkage sectors

NAICS	Description	% of oil and natural gas output used*	Shift-share class
32411	Petroleum refineries	58.1%	A
2211	Electric power generation, trans. & distribution	7.7%	A
2212	Natural gas distribution	5.8%	A
481	Transport by air	2.4%	C
484	Transport by truck	2.2%	B
11113-6, 11119	Grain farming	2.1%	A
2362	Const. of other new nonresidential structures	1.7%	B
32519	Other basic organic chemical mfg.	1.7%	B
42	Wholesale trade businesses	1.5%	A
21221	Mining iron ore	1.1%	C
n.a.	Other state and local government enterprises	1.0%	NA
5617	Services to buildings and dwellings	1.0%	B
2362	Maint. & repair of nonresidential structures	0.8%	B
11111-2	Oilseed farming	0.7%	A
722	Food services and drinking places	0.7%	D
32212	Paper mills	0.6%	C
531	Real estate establishments	0.6%	A
492	Couriers and messengers	0.5%	B
n.a.	State and local government passenger transit	0.5%	NA
2361	Construction of other new residential structures	0.5%	B
2362	Const. of new nonresid. Comm. & health care structures	0.5%	B
482	Transport by rail	0.5%	NA
622	Private hospitals	0.4%	A
55	Management of companies and enterprises	0.4%	C
325211	Plastics material and resin mfg.	0.4%	B
2361	Const. of new residential structures	0.3%	B
324122	Asphalt shingle and coating materials mfg.	0.3%	A
1122, 1124-5, 1129	Animal production, except cattle and poultry and eggs	0.3%	C
311313	Beet sugar mfg.	0.3%	A
32552	Adhesive mfg.	0.3%	B

* The 30 sectors above account for 95% of oil & natural gas output used as an intermediate input, excluding use by the oil & natural gas extraction sector itself.

Minnesota refining capabilities can process some Bakken light sweet crude oil, but to fully benefit from logistical cost advantages, additional capital investments and refinery reconfiguration and logistic capacity may be required. We find that Minnesota may have a logistical advantage to capture a greater proportion of the crude shipments and increase production of higher value refined products, such as gasoline/fuels or refined chemicals with more flexible use, such as polypropylene and butane.

The opportunity for refinery expansion clearly exists, as is evident by refinery capabilities located in markets further from Bakken than Minnesota, and by Northern Tier's public intent to take advantage of Bakken crude sources. Potential expansion opportunities will be defined by investment costs and comparative market benefits to other refinement locations.

There is currently one operating refinery in North Dakota, the 60,000 barrel per day Tesoro facility in Mandan near Bismarck. Two other smaller refineries, each with a capacity of 20,000 barrels per day, are currently under construction: the Dakota Prairie plant near Dickinson which is expected to open this year, and the Trenton refinery; both of which will produce diesel fuel to meet local demand. Finally, two additional 20,000 barrel per day refineries have been proposed, one near Devils Lake and the other near Mondak; both of these would also produce fuels for local consumption. Because their small sizes and local orientation, the eventual operation of all these refineries would not affect the decision-making by the two Minnesota refineries on whether to start processing crude oil coming from North Dakota.

Other economic effects

In addition to the backward and forward linkage economic impacts described above, the Minnesota economy will benefit in two other ways as described below.

The wealth effect

As we noted above, the rapid economic growth that has occurred in North Dakota since oil production began in the Bakken formation has significantly increased the average level of per capita personal income to $53,040 in 2014, above the figure of $47,320 in Minnesota. Between 2007 and 2014, total personal income in North Dakota rose at a compound annual growth rate of 8.1%. This is by far the highest rate increase for total personal income among the 50 states and the District of Columbia, while total disposable income in North Dakota grew by 7.6% annually. Personal income is the appropriate metric for measuring this increase in income and wealth, as it includes both earned income (i.e., wages and salaries, and proprietor's income received from working) and unearned income (i.e., dividends, interest, rent, transfer payments, fringe benefits, pension payments, etc.). Payments made to North Dakota residents in the form of royalties, leases, and purchases of land or drilling rights would show up as unearned income. The high per capita personal income figure in North Dakota is due to the combination of high growth rates in earned and unearned income divided by a small population. Simply put, North Dakota residents have a lot more disposable income to spend.

As Minnesota has a much larger, more diversified economy than North Dakota; it offers specialized goods and services of all types that are not available in North Dakota. As examples, Minnesota offers specialized and high-end retail facilities such as the Mall of America; health care services like the Mayo Clinic; recreation opportunities; arts and culture facilities; and professional and business services that are not present in North Dakota. As a result, North Dakota residents with their higher levels of income are purchasing some of these services in Minnesota. In some cases, they are visiting Minnesota to purchase these services, in other instances they are purchasing high end goods and services and taking them back to, or having them installed in North Dakota. While in the short-term the income growth rate in North Dakota may slow due to the reduction in oil exploration and drilling caused by the recent drop in the price of crude oil, over the long-term income will continue to grow at a high rate in North Dakota, so that the wealth effect will continue. IHS forecasts that over the next five years, disposable income in North Dakota will grow at an annual rate of 2.1% compared to 1.7% in Minnesota. The implication for Minnesota businesses is that they should take steps, which many are already doing, to attract and sell to North Dakota residents.

The infrastructure effect

The rapid growth in oil production in North Dakota has also resulted in high growth rate in state-level tax revenues in North Dakota. As noted above, total state-level taxes in North Dakota grew at a compound annual growth rate of 20.8% between 2007 and 2013. North Dakota currently imposes a 5% tax on the gross value of oil at the well and an extraction tax of 6.5% on the gross value of the oil extracted. However, the extraction tax is subject to a trigger price so that the extraction tax is reduced to 4% if the average price of crude oil for any consecutive 5-month period falls below the trigger price. The current trigger price is $52.59 per barrel. The State of North Dakota recently (February 2015) reduced its revenue forecast for the biennium lasting from July 1, 2015 to June 30, 2017 by $4.05 billion; even so, it still expects to collect $4.3 billion in oil and gas revenues over the biennium.

As the level of oil related tax revenues began to surge in 2009 and 2010, North Dakota established a legacy fund, similar to Alaska's permanent fund, to be used pay for programs to benefit the state; however money from the Legacy fund cannot be used until 2017. By law, 30% of the revenues from the extraction and production taxes are deposited in the Legacy Fund. As of February 15, 2015, the Legacy fund had a total value of $3.65 billion. Shares of the oil and gas tax revenues are distributed to local governments and school districts throughout the state. At the same time, North Dakota established a series of trust and dedicated funds to use the oil tax revenues for a variety of purposes, including:

- Oil and Gas Impact fund
- Resources Trust fund
- Common Schools Trust fund

- Foundation Aid Stabilization fund
- Oil and Gas Development fund
- Strategic Investment and Improvement fund
- Property Tax Relief fund
- Disaster Relief fund
- Oil and Gas Research fund.

A relatively small share of the oil and gas tax revenues are given to the North Dakota general fund; during the current biennium that ends on 30 June 2015, this figure is estimated to be $300 million. The largest of the funds listed above is the Strategic Investment and Improvement fund, whose balance on 30 June 2015 is estimated to be about $1.189 billion by the North Dakota Legislative Council. The purpose of the Strategic Investment and Improvement fund is to pay for improvements to state infrastructure or programs to improve the efficiency of state government. The high level of oil and gas tax revenues has enabled, and will continue to enable, the state of North Dakota to spend substantial amounts to improve the quality of its public services, such as education and infrastructure, and to mitigate the impacts of oil and gas development on the infrastructure of the directly affected communities. The combined spending presents a significant opportunity for Minnesota companies to provide the necessary goods and services. The point made above about Minnesota's ability to provide specialized goods and services, including delivering them at a large scale, also applies to infrastructure spending.

Economic summary

Principal findings are that the overall net impact of North Dakota oil production on the Minnesota economy is positive, but will produce small percent increases in statewide economic activity. As the annual levels of spending for oil exploration and drilling in North Dakota rose steadily from 2007 onward, demand also grew for goods and services that could be provided by companies from Minnesota and in other states. Over the same period, increasing volumes of crude oil were being sent eastward through Minnesota, affecting communities located along the transportation corridors, but also creating opportunities for economic sectors to use the crude oil as an input.

The extent to which significant portions of the total capital and operations spending would flow to Minnesota, as opposed to other states, depends on a variety of factors such as: 1) the types of goods and services needed to support crude oil production; 2) the ability of Minnesota companies to meet the specific needs of oil producers, 3) the size and diversity of Minnesota's economy; 4) existing relationships oil producers have with suppliers in other states; and 5) proximity. IHS estimated the total economic impacts on the Minnesota economy for three direct effects: 1) the annual levels of capital and operations spending in North Dakota for oil production and the resulting indirect spending that would flow to Minnesota through the backward linkages; 2) declines in agricultural commodity basis prices and accompanying decline in farm income due to competition with crude oil for scarce rail capacity; and 3) infrastructure investment in Minnesota directly attributable to the Bakken oil production.

Major findings of the economic impact assessment include:

- Minnesota benefits from the oil production activity in North Dakota, but because of the size and diversity of the state's economy, the incremental impact is small. Minnesota's economy is only minimally affected by the level of oil production activity in North Dakota, which is not necessarily a bad thing given the historic volatility of state economies that are dependent on the prices of natural resources.
- IHS determined that overall net economic impact of North Dakota oil production on the Minnesota economy is positive, but generates only a small percent increase in the level of economic activity. During 2016, when the combined capex and opex spending in North Dakota, plus infrastructure spending in Minnesota directly attributable to North Dakota oil production, are at their peaks, total employment would rise by 25,210 jobs under the high scenario, and

generate an additional $2.5 billion in gross state product. The increases in economic activity in 2016 are between 0.4% and 0.9% over IHS's forecast baseline for Minnesota. For the other years, the increases would be much smaller as gross state product rise between 0.1% and 0.3% in 2019, and by 0.1% or less in 2030.

Economic impacts in Minnesota by scenario and year

Scenario and measure	2014	2016	2019	2030
October high scenario				
Output	$1,813.8	$4,643.3	$2,400.3	$1,740.9
Employment	7,748	25,211	10,950	7,984
Value Added	$1,065.0	$2,492.6	$1,355.8	$974.9
Labor income	$585.4	$1,574.9	$765.3	$547.6
December base scenario				
Output	$1,813.8	$3,789.1	$1,483.5	$1,112.5
Employment	7,749	21,210	6,671	5,068
Value Added	$1,065.0	$2,019.0	$845.7	$623.3
Labor income	$585.4	$1,299.2	$470.6	$346.7
February low scenario				
Output	$1,813.8	$3,077.9	$709.2	$567.7
Employment	7,749	17,902	3,089	2,569
Value Added	$1,065.0	$1,621.8	$411.1	$315.0
Labor income	$585.4	$1,071.3	$223.9	$174.7

Note: all dollar amounts are in millions, employment in total jobs

Sources: Minnesota Implan Group, IMPAN input/output models for Minnesota and North Dakota, 2014. Analysis performed by IHS.

© 2015 IHS

- The primary reason for the modest percent effects presented above is that significant shares of the capex inputs will come from other states, especially durable manufacturing inputs such as steel, pumps, compressors, etc. In addition, while Minnesota is relatively close to the Bakken compared to other states, it is not close enough to benefit from being a supplier of locally consumed inputs and construction labor, with the exception of frac (silica) sand. As the level of capital and operations spending in North Dakota, and infrastructure outlays in Minnesota, decline in future years, the increases in statewide economic become smaller as shown in the table above. Increases of $104 million, $127.4 million and $155.5 million in Minnesota state-level tax revenues in 2016 under the three price scenarios. The increases in subsequent years will be smaller as the total economic impacts decline. According to our analysis, the percent increases in state-tax revenues over current levels would be the same as the percent increases in economic activity.

- The adverse effects on agriculture income due to the decline in crop basis prices that resulted from competition with crude oil for scarce rail capacity will be largely short term, between 2014 and 2016. Pipeline and other infrastructure improvements, such as the completion of the Sandpiper pipeline and BNSF rail expansion, in the near term will help to shift crude oil from rail to pipeline, thus creating additional rail capacity for agricultural and types of commodities, such as coal.

- The economic impacts in the five Border Cities and the counties that include Border Cities from the backward linkages will be minimal. They are not located close enough to the Bakken for their companies to benefit by being local suppliers, or to provide significant amounts of labor. The rural economies of the five counties lack the structural diversity to provide the goods and services used in crude oil production, and the larger, full service firms that can meet the specific demands oil producers. Finally, based on research done by the Minneapolis Federal Reserve Bank, the overall wage levels in the Five Border cities and the counties they are in have not been increased by demands for skilled workers in the Bakken region.

- Minnesota's economy is diverse and is potentially positioned to benefit from its logistical advantages, especially the lower delivered price of Bakken crude oil in the Twin Cities when compared to other refining locations in the US Midwest. The extent to which the Minnesota economy can benefit over the long-term from the increased supply of North Dakota crude oil will depend on the ability of the two refineries to use the crude as an input to produce the refined products that in turn can be used by other forward linkage sectors such as chemicals.

- The wealth and infrastructure spending effects described above are currently generating positive economic impacts in Minnesota that are in addition to increases in economic activity produced by the backward linkages. These two effects will create long-term opportunities for Minnesota businesses to either attract more North Dakota residents to visit the state and spend, or to expand the level of goods and services they sell in North Dakota to support its consumption and infrastructure spending.

Phase 4: SCOPE Analysis

Methodology

Similar to the typical SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis, IHS used the SCOPE (Situation, Core Competencies, Obstacles, Prospects, and Expectations) framework to evaluate a broad set of factors that has influenced (and will continue to influence) Minnesota's ability to leverage North Dakota oil production for statewide economic development. The SCOPE analysis relies on our findings from three prior phases of the study: oil production forecast in North Dakota, transportation analysis, and the economic impact assessment.

- **S**ituation today
- **C**ore industry and economic development competencies
- **O**bstacles for achieving the desired impact from ND oil production
- **P**rospects for deriving economic development and employment opportunities from the oil production and development occurring in North Dakota, and
- **E**xpectations for achieving the projected economic growth and industrial development outcomes.

The three preceding chapters of this report—North Dakota oil production forecast, transportation, and the economic impact assessment—contain detailed information about Minnesota, the five Minnesota Border Cities (Breckenridge, Dilworth, East Grand Forks, Moorhead and Ortonville) and their respective counties, and North Dakota. The first two sections below—Situation today and Core Competencies - summarize the findings of the other three chapters, and present other material, to provide context for more detailed discussions of Obstacles, Prospects, and Expectations.

Situation today

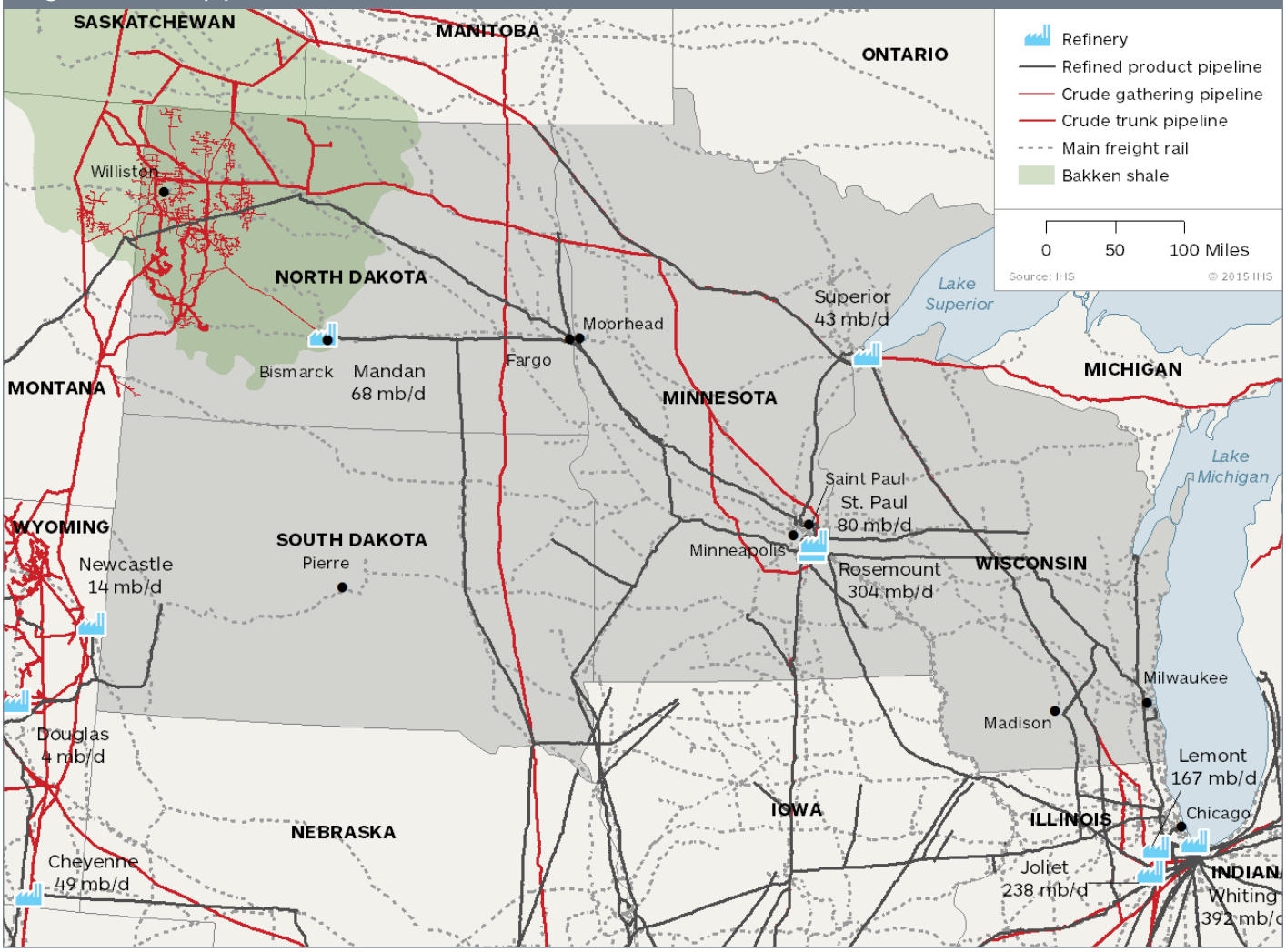
As this study is assessing the economic impacts of oil production in North Dakota on the Minnesota economy, it is essential to understand Minnesota's proximity to the Bakken formation, and its connectivity to the rail and oil infrastructure that serves the states of the upper Midwest. The accompanying map presents the locational context of Minnesota, showing the distance to the Bakken formation, the routes of the major rail lines and oil pipelines that pass through the states of the upper Midwest, and distances to refineries. The features on the map influence Minnesota's ability to:

- Provide goods and services to support Bakken oil production and development
- Receive economic benefits from the movement, processing, and consumption of Bakken crude oil, and the refined products derived from it.

The Minneapolis-St. Paul metropolitan statistical area (MSA), including the two refineries located there, are closer to the Bakken formation than the other large metro areas and refining centers of the upper Midwest offering Minnesota an advantage in the form of a lowered delivered cost for crude oil. There is one operating refinery in North Dakota, the 60,000 barrel per day Tesoro facility in Mandan. Two 20,000 barrel per day refineries are under construction, and two more with the same capacity have been proposed. All of these refineries have been designed to produce fuels to meet local demand within North Dakota. Because of their small sizes and their local market areas, their operation would not affect the decisions by the two Minnesota refineries to consider using crude oil from North Dakota.

The map shows Minnesota's position directly east of the Bakken formation and the routes of rail lines and pipelines carrying Bakken crude through Minnesota to processing facilities in the Midwest and East Coast.

Freght rail and oil pipeline connections



Minnesota

- The Bakken formation is located in western North Dakota and extends into eastern Montana and southern Canada. North Dakota and Minnesota share a 424-mile long border. The driving distance from Moorhead, Minnesota to Bismarck, North Dakota (located at the extreme eastern edge of the Bakken formation) is approximately 200 miles. Travel distances from other locations in Minnesota to the center of the Bakken formation are even farther, as noted in the previous chapters of this study.

- Since 2007, when annual oil production levels in the Bakken began to accelerate, North Dakota has had the highest economic growth rates among the 50 states and District of Columbia, so the Great Recession never occurred there. Over the same period, Minnesota's economy performed comparatively well, generally ranking comfortably in the top half among the states, in terms of percent changes in major economic measures.

- Since 2007, annual wage growth rates in occupations and economic sectors that support crude oil production have been between two and four times higher in North Dakota than in Minnesota due to the demands for skilled workers in the Bakken.

- North Dakota's oil production has created opportunities for Minnesota businesses to supply the required goods and services including: professional and business services, (e.g. engineering, architecture, staffing agencies, environmental consulting), transportation (e.g. rail, pipeline, trucking, crew transport, and storage and distribution services),

hospitality (e.g. hotels and restaurants along the interstate highways and roads connecting the two states) and a broad range of other inputs (e.g. frac sand, heating equipment for drilling sites, construction, concrete, building materials, and other services).

Five Border Cities and their respective counties

- The counties containing the five Minnesota Border Cities have experienced above-average economic growth since 2007. IHS estimates that the compound annual growth rate of total employment in the five counties between 2007 and 2014 was 0.5%, compared to 0.3% and 0.1% respectively for the Minnesota and the US. Similarly, the annual growth rate of output in the five counties was 3.6%, again above the corresponding rates for Minnesota and the US of 3.1% and 2.6%, respectively. Finally, the unemployment rate (not seasonally adjusted) in the five counties has been lower than the Minnesota rate by an average of 1.3 percent points from January 1, 2007 through October 2014. In our judgment, the above-average economic growth has been due primarily to the structure of the economy, especially favorable conditions in its largest sectors, and only minimally to the effects of North Dakota oil production.

- There is some commuting by workers from the Border Cities to the Bakken, but the long distances mean that most commuting is done on a weekly or bi-weekly basis (i.e., work for two weeks in the Bakken, return home for 1-2 weeks, and then go back) as opposed to daily commuting. Similarly, there was little permanent migration by residents of the five counties to the Bakken region between 2008 and 2012.

- In 2013, wage levels for major occupational categories in oil production supply chain industries were substantially lower in the Fargo-Moorhead MSA than in either far western North Dakota or the Minneapolis-St. Paul MSA. The aggregate economy of the five Border Cities and the counties that include Border Cities is small and structurally uniform, and therefore, does not offer many of the specialized goods and services needed in the production of crude oil. Similarly, the presence of larger, full-service firms in the Border Cities and their respective counties has been insufficient to meet the needs of oil and gas producers. The largest industry concentrations of employment in 2014 in the aggregate economy of the Border Cities and their respective counties are in healthcare, education services, agriculture, and wholesale trade. The aggregate economy of the five Border Cities and the counties that include Border Cities has below average shares of activity in the manufacturing sector and, in several service-sectors, such as information, financial activities, and professional and business services.

- The North Dakota part of the Fargo-Moorhead MSA, Cass County, is much larger than the Minnesota part, Clay County. In 2014 IHS estimated the following shares of MSA-wide activity in Cass County: 85.7% of total employment; 88.7% of gross county product; and 74.6% of business establishments. The shares for population and personal income, which are compiled on a place of residences basis, were 73.4% and 76.3% respectively. According to Census Bureau's On the Map database, in 2011 53% of the employed residents of Clay County worked in Cass County. As confirmation of this spatial distribution, of the 220 primary sector companies served by the Greater Fargo-Moorhead EDC (GFMEDC), about 90% are located on the North Dakota side of the river.

Core competencies

Economy

- Minnesota's economy and population are considerably larger than North Dakota's as noted above. In 2014 Minnesota's total population, non-farm employment, and gross state product were approximately eight, six, and five times respectively greater than the North Dakota totals. In all industry sectors except mining, Minnesota has at least double the workforce of North Dakota, and, of the industries involved in the oil and gas supply chain, many have a more significant presence in Minnesota than in North Dakota. The size effect is visible across a range of economic sectors. In 2014, the number of people involved in management of companies in Minnesota was more than 15 times that number in North Dakota. The number of manufacturing jobs in Minnesota was 12 times greater than that of North Dakota. Even in the construction industry, which accounts for nearly twice the share of statewide employment in North Dakota as it does in Minnesota, the number of people employed in Minnesota was more than three times that of the employment base in North Dakota.

- The large size of the Minnesota economy means that it has a wide degree of economic diversity, as shown by the Shannon-Weaver diversity index presented in the economic impact analysis. Minnesota's diverse economy was one reason for its above-average economic performance since 2007; others include the national competitiveness of its key economic sectors, a highly skilled labor force, and access to national markets.

- Approximately 60% of Minnesota's total employment in 2014 was in 2-digit NAICs sectors that had location quotients (LQs) greater than 1.0, showing that employment is concentrated in sectors where the state appears to have competitive advantages. The high LQ sectors are: agriculture; utilities; manufacturing; wholesale trade; finance and insurance; management of companies; health care and social assistance; arts, entertainment, and recreation; other services; and local government.

- Minnesota's key economic sectors are identified by the shift-share analysis presented in the economic impact analysis chapter. Approximately 46% of its total employment and 32% of its manufacturing employment in 2014 were in the high performing A and B sectors; this indicates that high-performing sectors account for significant shares of Minnesota's economic activity. The shift-share analysis identifies sectors that have potential competitive advantages for providing goods and services to support North Dakota oil production and related spending for infrastructure such as professional and business services, insurance, wholesale trade, financial activities, transportation and logistics, selected durable manufacturing and specialty construction.

- Minnesota houses the headquarters of many national and international firms. In 2014, there were 18 Fortune 500 companies whose headquarters were in Minnesota, and Minneapolis-St. Paul ranks first among the largest US MSAs based on the number of Fortune 500 companies per capita.

Market Access

- Minnesota has a strong intermodal and multimodal transport system that facilitates passenger & freight movement, including an international airport, the Port of Duluth, several interstate highways, and multiple freight rail lines. Further, the Minnesota DOT and the Metropolitan Council for Greater Minneapolis-St. Paul have been recognized for forward-thinking transportation planning and programming, especially regarding Intelligent Transportation Systems.

- Minnesota provides access to a much larger market than can be served from most locations in North Dakota. The Hoover's database lists 633,207 business establishments located within a 200-mile radius of St. Paul (zip code 55155) compared to 113,681 establishments within the same distance from Bismarck (zip code 58505). By comparison, 387,008 establishments are located within a 200-mile radius of Moorhead (zip code 56561). These figures include establishments located in the United States and Canada.

Workforce

- In 2014, Minnesota had the 3rd highest employment/population ratio among the 50 states, behind only North Dakota and Nebraska, two much smaller states. This finding is consistent with the below-average unemployment rate in Minnesota for February 2015 of 3.7%, well below the US rate of 5.5%.

- In 2014, Minnesota's gross state product per capita was 14th highest among the 50 states and the District of Columbia. North Dakota ranked second, but this is attributed to a combination of the high value of crude oil production and its low population.

- Minnesota has a highly educated labor force as shown in the educational attainment figures presented in economic impact analysis chapter. Higher levels of educational attainment lead to increased worker productivity and are a very attractive factor for expanding or relocating businesses. The 2012 proportions of Minnesota's population aged 25 years and older with either a Bachelor's degree or higher, or an advanced degree, were 32.6% and 10.7%; both levels were above the shares in North Dakota and the US. In the Fargo-Moorhead MSA, both Cass and Clay counties have above-average levels of educational attainment, whereas the educational attainment in the other counties containing Border Cities is below the US average.

- Minnesota's public elementary and secondary school systems have significantly above-average performance levels when compared to other US states, which, over the long-run, results in a more productive workforce. Minnesota ranked in the top 10 among all states and the District of Columbia on the four 2013 National Assessment of Education Progress (NAEP) tests listed below:
  - 4th grade reading: MN score: 227, ranked 9th; US score: 222
  - 4th grade math: MN score: 253, ranked 1st; US score: 242
  - 8th grade reading: MN score: 271, ranked 10th; US score: 268
  - 8th grade math: MN score: 295, ranked 5th; US score: 285.
- Minnesota's NAEP scores were also higher than those for North Dakota on all four tests listed above, but North Dakota's scores for all were also above the US average, ranking in the top 10 on the two math tests.
- The cost of living in the Fargo-Moorhead MSA in the third quarter of 2014 was significantly lower than in Bismarck, Minneapolis, St. Paul, and Williston.

Border Cities and their respective counties

- The five Border Cities are well served by highway, rail, and pipeline infrastructure, as shown in the context map presented above.
- One of the Fargo-Moorhead MSA's primary competitive advantages is that it has a lower cost of doing business than in other metros in Minnesota and North Dakota, and its costs are competitive with those in other comparably sized metros in the upper Midwest. IHS's business cost index value in the third quarter of 2014 for the Fargo-Moorhead MSA was 92.6 compared to 102.3 in Minneapolis-St. Paul, and it was competitive with levels for other smaller MSAs in the upper Midwest. Similarly, *Competitive Alternatives 2014*, a study by KPMG which considered a wide range of location-sensitive business costs (e.g., labor compensation, facility, transportation, and taxes), offers the following overall cost index results:
  - Chicago, IL—99.1;
  - Minneapolis, MN—98.2;
  - Madison, WI—96.8;
  - Fargo, ND—95.1;
  - Sioux Falls, SD—94.5; and
  - Cedar Rapids, IA—94.

While the costs of doing business in the Fargo-Moorhead are low and very competitive with those in other MSAs, the decision by firms to locate on either the Minnesota or North Dakota side of the border varies on a case by case basis.

Obstacles

The section below describes the significant obstacles faced by Minnesota in trying to maximize the potential economic development benefits of North Dakota oil production.

Distance to the Bakken

Typically, oil field exploration and production brings service opportunities for local businesses and workers associated with both the capex phase (e.g. rigs-drilling; casing/cement crews; perforating; logging; installation of pumps, compressors and artificial lift systems; and construction of gathering systems) and, to a lesser extent, the servicing of drilling rigs. While many national oil field service companies are headquartered in Texas or Louisiana, they usually establish a local office in areas where oil extraction is occurring, from which they hire local crews and procure equipment such as trucks, pumping units, and mobile rigs that can move from well to well or job-to-job.

For Minnesotan suppliers of these types of services, the state's location, despite its shared border with North Dakota, is not close enough to serve as a primary source of competitive advantage. The map presented above shows the distances from locations in Minnesota to the Bakken. The majority of all the locations permitted for drilling in the Bakken over the past two years have been in the upper Northwest corner North Dakota, more than 175 miles due west of Grand Forks, the nearest city on the Minnesota/ North Dakota border. As a point of reference, the one-way driving distance from Moorhead to Bismarck is 200 miles. Current activity is occurring further away, at more than 240 miles from Grand Forks. The one-way driving distances from Moorhead and St. Paul to Williston, the center of the recent drilling activity, are 424 miles and 663 miles, respectively. Other support offices servicing wells in the Williston basin are located in Dickenson or Minot, all within 100 miles or less from the current wells and within 150 miles of permitted locations.

In addition to the oil and gas (O&G) service opportunities that stem from drilling operations are often business opportunities for relevant manufacturing sectors. However, proximity is even less of a determining factor in the oil & gas industry's choice of equipment suppliers. Rather, the materials used in drilling, production, and related construction are industry-specific, with established manufacturing centers providing equipment and materials tailored to those needs and relationships previously established between exploration and production companies and their vendors. In fact, even some of the Minnesota firms working in the Bakken today got their first opportunities to provide equipment or services to the oil and gas industry through work in other oil-producing states in the East or Western US.

A 2013 study by the Federal Reserve Bank of Minneapolis further confirms the limited reach of the Bakken impact. It found that the significant impact of the Bakken oil production activity on increasing wage levels and reducing unemployment rates occurred within a 100-mile radius. While annual wage rates in the Fargo-Moorhead MSA rose over the last seven years, on an overall basis, they were not directly affected by activity in the Bakken.

Workforce issues

The low current unemployment rates in Minnesota, the Minneapolis-St. Paul, and Fargo-Moorhead MSAs indicate tight labor markets, and possible upward pressure on wages in occupations that are in short supply. The labor force in the five counties that include Border Cities is small with only 64,700 workers in November 2014, while unemployment rate is even lower than for Minnesota and the Minneapolis-St. Paul MSA.

While North Dakota oil production may have been a draw for professionals and skilled laborers across the state, the Bakken is just one of many factors contributing to a tight labor market in Minnesota. Other factors include the state's above-average economic performance, high skill level of the labor force, high employment/population ratio, and its above-average labor force participation rate.

Increase in North Dakota's oil and gas tax revenues

The economic impact analysis noted North Dakota's total state revenues rose at a compound annual growth rate of 20.8% between 2007 and 2013. North Dakota has been using this revenue windfall for a variety of purposes, including tax reductions, infrastructure spending and business incentives, among other spending.[13,14] Between 2007 and 2013, the commercial loan portfolio of the Bank of North Dakota, which provides business participation loans, grew from $0.7

13 North Dakota Department of Revenue, *North Dakota Oil and Gas Revenue Allocations 2011-1023 Biennium*, 2014. http://www.ndoil.org/image/cache/wardner.pdf.

14 National Conference of State Legislatures, *State Revenues and the Natural Gas Boom: An Assessment of State Oil and Gas Production Taxes*, June 2013. http://www.ncsl.org/documents/energy/pdf_version_final.pdf

billion to $3.5 billion.[15] Even with the projected decline in oil tax revenues over the next several years, North Dakota will still be able to offer economic development incentives and pay for programs to improve the quality of infrastructure and government services as many of the dedicated funds currently have substantial balances. North Dakota forecast in January 2015 that it will collect $300 million in oil and gas production and extraction taxes during both the 2013-15 biennium that ends June 30, 2015 and during the 2015-17 biennium.[16]

Local delays caused by unit trains

Some stakeholders expressed concerns that the high numbers of unit trains passing through the Border Cities each day were creating bottlenecks at at-grade rail crossings, resulting in delays inhibiting business and daily life. Approximately nine unit trains per day, or just over 3,300 for the entire year, carrying North Dakota crude oil passed through Minnesota in 2014. IHS forecasts the following levels of unit trains carrying crude oil from North Dakota that will travel through Minnesota under the three crude oil price scenarios considered in this report.

- $90/barrel for West Texas Intermediate: six trains per day in 2015-2016, rising to 11 per day by 2020 and 17 per day by 2030
- $70/barrel for West Texas Intermediate: five trains per day in 2015-2016, rising to seven per day by 2020, and then 11 per day by 2030. If the proposed new pipelines, such as the Sandpiper are completed, the levels will be five trains per day in 2015, declining to zero starting in 2020
- $50/barrel for West Texas Intermediate: three trains per day in 2015, falling to one per day by 2020, and to zero by 2030.

One unit train per day carrying Canadian crude will also cross Minnesota from 2015 onward under all three oil price scenarios.

There are 28 public at-grade railroad crossings in Moorhead, and 120 in Clay County[17], about 30 of which are located along the main BNSF rail line that goes through Fargo and Moorhead in an east-west direction. By comparison, there are a total of 4,291 public at-grade rail crossings in Minnesota, many of which are on low-traffic spur lines that serve industrial plants and parks, and agricultural storage and processing facilities. One direct effect of unit trains when they pass through cities such as Moorhead is to temporarily disrupt local traffic patterns, unless alternative routes are available such as tunnels under or bridges over the rail line. While delays associated with train traffic can best be eliminated through the removal of at-grade rail crossings, conversations with the Minnesota DOT did not confirm how many (if any) of the 10 rail crossings targeted for improvement by the MnDOT in 2015 are in Moorhead.

Minnesota Governor Mark Dayton recently proposed spending $330 million over the next 10 years to make at-grade rail crossings safer from passing trains carrying crude oil.[18] A total of 71 high priority rail improvement projects were presented, including three in Moorhead.

The "edge effect" and business costs

Minnesota's Border Cities and Fargo, North Dakota are almost equally distant from the Bakken, so firms seeking opportunities associated with North Dakota oil production can choose to locate in either state within the Fargo-Moorhead MSA. In an MSA like Fargo-Moorhead that straddles two states, differences in state and local tax rates can be a decisive factor for a firm's location decision, even if the levels for other variables are similar such as wages, land costs, utility rates, transportation accessibility, and quality of local services. In these situations, the value of the economic development incentive package can also be a determining factor[19].

15 Bank of North Dakota, *Annual Reports for 2007 through 2013*, March 2015. http://banknd.nd.gov/lending_services/business_financing_programs/commercial_bank_participation_loan_program.html.

16 North Dakota Legislative Council, 2015-17 *Biennium Revenue Forecast Adjustments—General Fund and Oil Tax Collection*, January 2015.

17 Federal Railroad Administration, Office of Safety Analysis, Public At-grade Vehicle Rail Crossings in the State of Minnesota by City, County, and Principal Warning Device, March 16, 2015. http://safetydata.fra.dot.gov/OfficeofSafety/publicsite/Query/PublicGradeCrossingInventoryByStateCounty.aspx

18 *Minnesota Star Tribune*, "Dayton proposes spending $330 million to upgrade rail safety", March 13, 2015. http://www.startribune.com/local/296219451.html

19 Moran, Stahl & Boyer. *Industrial Park Positioning Strategy*. October 2014. http://apps.cityofmoorhead.com/sirepub/cache/2/wyxz4s550jdppxeaiyjion55/13786403242015040603857.PDF

Prospects

As was mentioned in the IHS economic impact analysis, the overall increases in economic activity in Minnesota directly attributable to North Dakota oil production and related activities (i.e., infrastructure spending and agriculture price effects) will be small; in proportional terms the increases will range between 0.4% and 0.9% over the IHS forecast baseline for Minnesota during the peak year of spending in 2016. The increases in economic activity in the five Border Cities and their respective counties from the backward linkages will also be small in both absolute and percent terms because companies located there are not major suppliers of goods and services used in the production of crude oil. However, a number of policies or programs could help the state and the Border Cities address existing challenges and derive additional economic development opportunities from the oil production occurring in North Dakota.

Statewide opportunities include:

Educate Minnesota firms about North Dakota opportunities

While the major suppliers of goods and services to North Dakota oil producers tend to be larger, full-service firms with national reach and established experience working with the oil and gas industry, there are opportunities for Minnesota businesses to meet the specific demands of firms operating in the Bakken oil field. These include examples from across the state including frac sand from southeastern Minnesota, engineering and technical services from the Twin Cities; heating equipment from Alexandria, crew transport services from Fergus Falls, garage doors for maintenance buildings and specialized equipment for transporting pipe from Bemidji, professional services from Moorhead, and many others.

As such, statewide Minnesota economic development organizations, chambers of commerce, and other business associations have an opportunity to make their business members aware of North Dakota oil production opportunities and the risks and requirements of serving this industry and its corresponding supply chain.

Minnesota may also wish to replicate the success of other states who have undertaken significant work to educate local businesses about opportunities to participate in nearby oil and gas production activities. One example is the Canton Regional Chamber of Commerce in Canton, Ohio. There, the Chamber hosts an annual Utica Summit to evaluate the potential business, manufacturing and transportation opportunities created by natural gas extraction in the Utica Play.[20] With over 200 attendees, participants gain updated information on the Utica gas field development and discuss the opportunities stemming from the downstream use of Utica energy, from chemicals and plastics manufacturing to CNG commercial transportation.[21]

The Allegheny Conference on Community Development in Pittsburgh, Pennsylvania provides another example. There, in addition to working with oil and gas industry employers to create training programs to prepare the local workforce for participation in upstream, downstream, and midstream opportunities associated with the Marcellus Shale unconventional energy resources, the Allegheny Conference has also worked with industry to put on several supply chain seminars for local manufacturers and providers of technical services. Through these, they identified 325 small manufacturing and technical companies that have the capacity to be suppliers, including companies who could haul wastewater, repair fracking equipment that had previously been sent back to Texas for repair, and provide auto and truck bodies.

While such efforts have taken place in these other oil producing states, to date, relatively few concentrated efforts have been taken have been undertaken in Minnesota to expose local businesses to opportunities associated with the Bakken oil production and its corresponding supply chain. However, two organizations have played a role in exposing local Minnesota businesses to opportunities in the Bakken. The first is the Highway 2 West Manufacturers' Association (H2WMA), which held its first meeting on the topic in December 2012 with the former Executive Director of Williston Economic Development. Just over a year later, in February 2014, H2WMA was invited to hold a meeting at The Bakken/Three Forks Shale Oil Innovation Conference & Expo in Grand Forks, ND[22] and drew over 200 people to this session. During the meeting, titled "What Can H2W Members Offer to the Bakken Region?", H2WMA member companies who

20 http://www.cantonrep.com/article/20131022/News/310229818

21 http://www.cantonrep.com/article/20131022/News/310229818#ixzz3QauRPnip to see examples from Ohio, PA—

22 See http://thebakkenconference.com/ema/DisplayPage.aspx?pageId=Home for more info on this annual conference, occurring again in July 2015.

saw their products as potentially relevant to Bakken oil production held table-top displays and had an opportunity to explain more about their company's products in five minute presentations. In addition, the H2WMA has set up a webpage titled "Manufacturing Opportunities with the North Dakota Bakken Oil Patch" although the page serves more to recap H2WMA events on this topic than to offer information relevant to becoming a supplier.[23] Unfortunately, the H2WMA also does not have information on the end results of these activities thus far.

In another example, Fergus Falls Economic Improvement Commission staff traveled to the Bakken oil fields in summer 2012 to find opportunities for local businesses as well as promote Fergus Falls to those residents that no longer wished to live in the Bakken. Meetings were held with the Williston Rotary Club, the Williston Economic Commission, and selected business leaders and identified opportunities in housing (including supplying electrical, plumbing, and service sector support) as well as trucking and other repair services for the oil industry. Subsequently, the Fergus Falls EIC organized a bus trip to the region to provide local businesses with an opportunity to explore opportunities in the Bakken oilfields and the corresponding regional development in Western North Dakota.

Evaluate forward linkage opportunities

The economic impact assessment identified a list of downstream economic sectors that use crude oil or refined products as inputs. Minnesota's location puts it in a position to potentially benefit from North Dakota and Canadian oil production as the delivered cost of crude oil is lower there than in other places in the Midwest. The state is also well connected to the regional rail and oil pipeline networks as shown in the context map in the description of Minnesota's situation, so that refined petroleum products from the Twin Cities can be sent to the large markets to the south and east. There are two refineries in the Minneapolis-St. Paul MSA that are potential users of the Bakken and Canadian crude oil which provide fuel to Minnesota and the adjacent states. Both refineries are designed primarily to refine the heavier Canadian crude oil, but can process some Bakken light sweet crude oil. To fully benefit from increased supply of Bakken crude that will occur if the Sandpiper pipeline is completed as projected by 2017, additional capital investments and refinery reconfiguration may be required. The expansion opportunities will be defined by investment costs and potential market benefits compared to other refining locations. The potential future development of other forward linkage sectors in Minnesota, such as petrochemicals and energy-intensive industries such as food manufacturing, will depend on increasing the supply of refined petroleum products used as inputs by these other sectors that are available at a competitive cost.

Provide transportation infrastructure improvements

As both governments and private sector companies work to improve transportation infrastructure to accommodate the additional demands North Dakota oil shipments place on the inter and intra-state roads, railways, and pipelines, economic opportunities abound for Minnesota planners, engineering firms, maintenance workers, and other companies offering transportation related products or expertise. These opportunities are due, in large part, to BNSF's recent record levels of capital spending, of which $150 million was spent in Minnesota alone in 2014.

In the years ahead, the economic development opportunities associated with Bakken oil-influenced rail transportation infrastructure investments in Minnesota will come primarily from BNSF and Canadian Pacific, as MnDOT has indicated it has not assessed or calculated any incremental costs/expenditures associated with Bakken oil shipments and the State of Minnesota only has allocated limited funding for rail service improvements ($5 million out of a total of $4.594 billion for State Transportation Improvement Funding for 2015-17) including the elimination of 10 at-grade rail crossings throughout the state. Meanwhile, BNSF has planned 2015 capital investments of $120 million in rail capacity, network replacement and maintenance, and implementation of Positive Train Control technology in Minnesota and $400 million in North Dakota. Despite recent record levels of spending on capital improvements, as a private company, BNSF's level of investment in rail infrastructure will be determined by the overall level of demand for its services (which will be impacted by both the level of overall oil production occurring in the Bakken as well as the amount of oil shipped by pipeline rather than rail.)

In addition, cities near the planned Sandpiper pipeline which, if approved, will deliver Bakken light crude oil to North American refineries in the Midwest and along the East Coast can expect a boost to their local economy throughout the planning and construction process.

23 http://www.h2wma.com/Pages/MfgOpportuntywithBakken.aspx

Benefit from the wealth effect

With oil production creating a large North Dakota budget surplus and contributing to a per capital personal income growth rate of more than 6% (almost double that of Minnesota's) between 2003 and 2013, Minnesota has an opportunity to take advantage of the overall income and wealth effects occurring in North Dakota by providing retail, recreation, construction, and hospitality services. As noted in the economic impact analysis table on economic and social indicators, North Dakota's per capita personal income expanded at a compound annual growth rate of 6% between 2004 and 2014, compared to 3% in Minnesota. To determine how best to take advantage of North Dakota's oil-generated wealth, additional analysis should be undertaken to further investigate North Dakota's demand for luxury goods, what products or services are not available in North Dakota (or either in limited supply or more expensive there than in Minnesota), tourism destinations for shopping or outdoor recreation, and the reasons why North Dakotans visit neighboring states.

Support investments in infrastructure and public services

Some of the 'indirect' impacts on Minnesota businesses are not directly associated with North Dakota oil production, but rather the income effects and corresponding tax revenue that have resulted in North Dakota city and state investments in civil infrastructure and public services. Examples include upgrades to city buildings, water and wastewater treatment plants, and schools. With North Dakota's plans to use a substantial share of its tax revenues from oil and gas to improve infrastructure and increase the quality of its public services, Minnesota companies will have opportunities to provide a range of the goods and services required; many of which may not be available in North Dakota due its smaller size and lower economic diversity. In February 2015, North Dakota approved a $1.1 billion "surge" funding bill to pay for infrastructure improvements in the cities and counties in the western part of the State that have been most significantly affected by oil production in the Bakken formation.

Provide workforce education and skills training

As work opportunities in North Dakota continue to make competition for skilled labor even tougher in Minnesota, they should also increase statewide awareness of the need to prioritize investments in relevant technical education and training programs on Science, Technology, Engineering & Math (STEM) and other skills required by Minnesota employers. For example, the Manufacturing Day program undertaken by the Fargo-Moorhead Economic Development Corporation for the past two years to provide students with hands-on manufacturing experience through a tour of local manufacturing facilities including American Crystal Sugar, Cardinal IG, Fargo Automation and Swanson Health Products could be replicated or expanded. Meanwhile, the Valley Prosperity Partnership could play a lead role in "Developing Trades, STEM, and Other Career Awareness, Pathway, and Promotion Campaigns" as workforce attraction, development and retention was also called out as one of the next steps for improving the economic future of the Red River Valley, which includes regions of both North Dakota and Minnesota.[24]

Another example of the type of education program that is being developed in Minnesota to support local industry and could be expanded or replicated elsewhere is the Academies of Alexandria learning academy that launched in the fall of 2014 at Alexandria Area High School in Alexandria, MN. At this senior high school, the nationwide concept of Small Learning Communities (SLCs) is being applied to prepare Alexandria area students for college and career opportunities. In addition to requiring students to undertake a core curriculum of English, Math, Science, Social Studies, PE/Health, and General/Global Electives, students are provided with project-based, interdisciplinary learning that gives them 'real world' experience and provides connections with local businesses and professionals. The Academies of Alexandria provide students with curriculum informed by local employers, links schoolwork and real life work skills to provide students with employable skills, and plans for all students to have the opportunity to undertake an internship before graduation.[25]

Outside Minnesota, Colorado provides an example of a state that has designed workforce initiatives to increase the supply of skilled workers to meet the growing energy industry's needs. As part of this, the Colorado Online Energy Training Consortium (COETC), founded with a grant for $17.3 million from the Trade Adjustment Assistance Community College and Career Training (TAACCCT) program of the US Department of Labor, brings together 15 community

24 http://www.valleyprosperitypartnership.com/cooperating-beats-competing/

25 http://www.alexandria.k12.mn.us/domain/589

colleges across Colorado, the Colorado Department of Labor & Employment with its ten regional workforce centers, and many local energy employers to redesign curricula and upgrade the equipment used in training facilities to equip unemployed and under-employed workers with the skills required for placement in some of Colorado's most in-demand energy industry jobs. At the university and graduate levels, the Colorado School of Mines, Colorado State University, University of Colorado, and University of Denver are also playing a role. The Global Energy Management (GEM) Program at the University of Colorado Denver Business School offers a hybrid-online Master of Science (MS) degree program including graduate business courses (accounting, finance, strategic management, marketing, economics, etc.) exclusively designed to develop future leaders in the energy industry. The Colorado School of Mines is in the top ten schools graduating petroleum engineers and, in addition to serving the energy industry's demand for skilled workers; Colorado State University and the University of Denver provide students with research opportunities that enable them to go into Research & Development (R&D) positions within the energy industry.

Form cross border initiatives

Despite the perception by some that there is a cultural divide between North Dakota and Minnesota, there are a number of areas where bi-state or cross-border collaboration initiatives are already underway that could be strengthened or expanded to improve both states' economic development opportunities associated with the Bakken oil field production. Two of these include:

Building Transportation Infrastructure

As noted in the transportation analysis, the Sandpiper oil pipeline, if completed as planned by 2017, will divert a substantial volume of crude oil from rail to pipeline, reducing the demand for rail capacity. Even with the reduction in rail demand, units trains carrying crude will still continue to move eastward across Minnesota. Therefore, a second area where cross-state collaboration will be essential is the coordination of transportation infrastructure planning, regulation, and improvement. MnDOT would benefit from coordinated statewide planning to support goods movement and consideration of public private partnerships to accelerate infrastructure investments. Metropolitan Planning Organization (MPO), the Fargo-Moorhead Metropolitan Council of Governments (Metro COG)[26] provides the opportunity for multi-state coordination to identify rail transportation projects and funding needs. This is an important step to establish a programming timeline for investments and coordination with each state's department of transportation as they formalize State Transportation Implement Plans. Coordination will be essential to increasing the regional transportation system capacity and ensuring system-wide maintenance consistent with goods movement demand. MetroCOG has an opportunity to advance projects that support the region's economic well-being, safety, health and environment.

Educating & training the local workforce

A focus on workforce development and education should not be limited to Minnesota and, in fact, there are many existing collaborative efforts taking place across the border at various levels of education and workforce development. Examples include:

- At the high school level, the Northern Valley Career Expo exposes nearly 1500 sophomores from 27 high schools in Grand Forks, North Dakota and East Grand Forks, Minnesota area annually to opportunities in business on both sides of the border. The Manufacturing Day program undertaken by the Greater Fargo-Moorhead EDC (mentioned above) also involved both Minnesota and North Dakota high school students and toured companies in both states.

- The Northland Community & Technical College, with campuses in East Grand Forks and Thief River Falls, offers community college education and technical skills training programs for students on both sides of the border that include commercial vehicle operations, construction electricity and plumbing, sales marketing and management, supervisory leadership, and welding. Such programs have the potential to provide Minnesota and North Dakota employers as well as the North Dakota oil and gas industry and its supply chain with qualified workers.

26 http://www.fmmetrocog.org/new/index.php?id=22

- At the university level, the Tri-College Consortium brings Concordia College and Minnesota State University-Moorhead in Minnesota and North Dakota State University (NDSU) in Fargo, North Dakota together to prepare the local workforce with the technical skills required by companies operating in both states. North Dakota and Minnesota universities already have reciprocity agreements that allow residents to pay a special tuition rate that is lower than the normal non-resident rate when attending a state institution of higher learning in the neighboring state.

By expanding programs and initiatives such as these to include a focus on the shared skills required both by North Dakota and Minnesota employers serving the North Dakota oil production industry and its supply chain (e.g. construction, engineering, and business), the current skilled worker shortage can be addressed through a collaborative bi-state approach. For example, the Shale NET program initially started by Westmoreland County Community College in Youngwood, Pennsylvania to create an effective and efficient entry level training program to meet the local oil and gas industry's workforce needs has now expanded to include 20 recognized training providers in four states, and provides an example of a multi-state, public-private initiative focused on training the highly skilled workforce demanded by the unconventional energy industry.[27]

Maintain competitiveness of Border Cities

In addition to the opportunities mentioned above to support statewide economic development corresponding with a recent increase in North Dakota oil production, the current situation also raises the opportunity to take actions that will specifically benefit the Border Cities and Northwest Minnesota. These include:

Help Border Cities to mitigate the "edge effect"

As noted in the economic impact assessment, the "edge effect" predates the recent increase in North Dakota oil production as the original version of the Border Cities legislation was enacted in 1987. However, North Dakota's recent tax revenue windfall produced by increase in crude oil production has made it possible to reduce a variety of state and local taxes and make improvements in civil infrastructure and public services, making the edge effect all the more significant. The Border Cities legislation addresses this issue by allowing the five Border Cities (Breckenridge, Dilworth, East Grand Forks, Moorhead, and Ortonville) to establish Border-Cities Enterprise Zones which can provide a variety of economic development incentives, such as disparity reduction property tax credits, low cost debt financing for new construction, tax credits for new job creation and sales tax credits for purchases of certain types of equipment. As these incentives help to mitigate the "edge effect" by providing business tax credits to qualifying businesses that are the source of investment, development, and job creation or retention, policies such as these can continue to play a role in supporting Border Cities as Northwest Minnesota's economy adjusts to reflect recent developments in the Bakken.[28]

Before recommendations can be made for either expanding these incentives or increasing marketing about the value and equity of existing policies, Minnesota's economic development practitioners should seek more detailed information about what businesses considering investment in the region to take advantage of the Western North Dakota oil production see as the primary differences between the pros and cons of locating on each side of the border.

Supporting bi-state efforts for business attraction & retention

As mentioned earlier, ND's influx of wealth and planned investments in infrastructure and public services make it all the more essential for the two states to collaborate on economic development initiatives that benefit both sides of the border. The Greater Fargo Moorhead Economic Development Corporation provides one example of an organization that is already marketing the cross-border area and combining data from both states to produce a combined list of job openings, incentives, available sites/ commercial real estate, available capital, R&D activity, and cultural attractions, recreational facilities, and other factors that contribute to quality of life.[29] The Grand Forks-East Grand Forks Chamber of Commerce also works to 'Inform, Promote, Advocate, Connect and Educate' businesses and community members across both states about opportunities for business expansion, education, and residential living. Meanwhile, representing the economic centers of Fargo-Moorhead, Grand Forks-East Grand Forks, and Wahpeton-Breckenridge, the Valley Prosperity

27 https://www.shalenet.org/about

28 http://mn.gov/deed/business/financing-business/tax-credits/border-cities/

29 http://gfmedc.com/

Partnership has been formed to identify common strategic economic development opportunities throughout the Red River Valley spanning the borders of Minnesota and North Dakota. All of these organizations already play a role in facilitating cross border economic development initiatives and could play the additional role of educating local businesses in both states about the opportunities associated with Bakken oil production and the corresponding opportunities.

Expectations

Despite the recent fall in oil prices and projected relatively lower level of oil related revenues, the energy production forecast included in this report indicates that North Dakota will continue to be a major player in US oil production. However, sentiment regarding the opportunities versus challenges this will impose on the Minnesota economy varies by industry, personal experience, and location within the state.

In order to create a cohesive vision to maximize opportunities and mitigate the challenges associated with North Dakota oil production, Minnesota DEED, the Minnesota Chamber, and other statewide groups might take a lead role in getting this issue on the agenda of local and bi-state economic and business development organizations. Specifically, the state has an opportunity to:

- Make local businesses aware of the opportunities to get involved in the crude oil production supply chain—what standards or qualifications are required, contracting requirements, timeframes, risks, permitting requirements, insurance, certifications and training required for workers, etc.
- Alert local businesses about the opportunities to get involved in supplying both states with relevant transportation and civil infrastructure and other goods and services that will be required in North Dakota as it continues to invest heavily in expanding the capacity and quality of its infrastructure and government services.
- Evaluate opportunities to take advantage of North Dakota's increasing wealth and per capita incomes and supply products or services that are not available within North Dakota.
- Design education and training programs that produce workers with the STEM skills required not only by the oil and gas industry but also with other local employers.
- Seek legislative appropriations to undertake transportation infrastructure upgrades to reduce bottlenecks and improve transportation efficiency along public transportation corridors and work collaboratively with the privately owned railways to expedite the planned rail upgrades.
- Proactively seek areas for collaboration with North Dakota on economic development, transportation infrastructure, education and workforce development, and other areas of mutual interest.
- Assess the feasibility and value of expanding the set of economic development incentives that can be offered in the development districts under the Border Cities legislation in order to mitigate the "edge effect." Increasing the incentive package could include increasing maximum levels of grants and loans that can be made, lengthening the period of time over which tax credits and exclusions are available, reducing interest rates on loan programs, expanding the types of purchases for which tax credits or refunds are available, and ensuring that developable greenfield or brownfield sites have the required types and sizes of buildings, utility services, and access to critical transportation infrastructure.

In this report, the IHS forecasts on oil production, transportation, and statewide economic impacts provide background material and justification for initiating future conversations regarding opportunities for Minnesota businesses to benefit from oil production occurring in the Bakken formation. Groups such as the Minnesota Department of Employment and Economic Development, the Minnesota Chamber of Commerce, local chambers of commerce along the North Dakota-Minnesota border and pipeline/ rail corridors, the Greater Fargo-Moorhead EDC, the Red River Valley Prosperity Partnership, and Enterprise Minnesota might all play a role, building on the areas where they are already focused or well positioned to work with businesses and local supporting institutions. As appropriate, other economic development initiatives targeting specific regions of the state or industries (e.g. the Minneapolis-St. Paul Regional Cluster Initiative, Greater MSP, and other industry-specific trade associations) might also be engaged.

With proactive effort to engage and support local supplier businesses, and ongoing monitoring of North Dakota oil production activity, Minnesota can expect to make the most of the modest impacts that IHS forecasts will be associated with continued Bakken oil production through 2030 and the additional opportunities associated with forward linkages, the wealth effect, and cross border collaboration.