

**MICHIGAN CRUDE OIL PRODUCTION:
ALTERNATIVES TO ENBRIDGE LINE 5 FOR
TRANSPORTATION**

Prepared for

National Wildlife Federation

By



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London Economics International LLC (“LEI”) was retained by the National Wildlife Federation (“NWF”) via a grant from the Charles Stewart Mott Foundation, to examine alternatives to Enbridge Energy, Limited Partnership (“Enbridge”) Line 5 for crude oil producers in Michigan.

About sixty-five percent of the crude oil produced in Michigan currently uses Enbridge Line 5 to reach markets. This production is located in the Northern and Central regions of the Lower Peninsula. Oil production from the Southern region of the Lower Peninsula does not use Enbridge Line 5 to reach markets.

LEI’s key findings are that the lowest-cost alternative to Enbridge Line 5 would be trucking from oil wells to the Marysville market area. LEI estimates that the increase in transportation cost to oil producers in the Northern region would be \$1.31 per barrel based on recent oil production levels and recent trucking costs. For the Central region, the cost increase on average would be less, as these producers are located closer to markets. There would be no impact on Southern region producers. The \$1.31 per barrel cost increase amounts to 2.6 percent of a crude oil price of \$50 per barrel. It is much smaller than typical monthly swings in Michigan crude oil prices, which have ranged from \$28 per barrel to over \$100 per barrel from 2014 through 2017.

Table of contents

1	INTRODUCTION AND EXECUTIVE SUMMARY.....	4
1.1	ENBRIDGE LINE 5.....	4
1.2	LEI’S APPROACH	5
1.3	KEY FINDINGS AND CONCLUSIONS	5
1.4	ROADMAP TO THIS REPORT	6
2	MICHIGAN CRUDE OIL PRODUCTION.....	8
2.1	OIL PRODUCTION IN MICHIGAN HAS BEEN FLAT FOR ALMOST 20 YEARS.....	8
2.2	OIL PRODUCTION HAS SHIFTED AWAY FROM THE NORTHERN REGION.....	8
2.3	CRUDE OIL TRANSPORTATION IN MICHIGAN	9
2.3.1	Enbridge Line 5 serves Northern and Central producers.....	10
2.3.2	Southern region producers do not use Enbridge Line 5	12
2.3.3	Rail could be an option for crude oil transport in Michigan	12
3	THE MICHIGAN UPSTREAM INDUSTRY WITH AND WITHOUT ENBRIDGE LINE 5	14
3.1	STEP ONE: LEI EXAMINED DATA FROM PUBLICLY-AVAILABLE SOURCES	14
3.1.1	Transportation cost data.....	14
3.2	STEP TWO: LEI REPLICATED DYNAMIC RISK’S CRUDE TRANSPORTATION COST RESULTS	18
3.2.1	Replicating Dynamic Risk’s methodology and assumptions	20
3.3	STEP THREE: LEI RE-CALCULATED DYNAMIC RISK’S ESTIMATE USING PUBLIC DATA	23
3.3.1	Option Two (trucking from Lewiston to Marysville).....	23
3.4	LEI EXAMINED TWO OTHER OPTIONS FOR PRODUCERS.....	24
3.4.1	Option Three: Trucking from Kalkaska to Marysville	24

3.4.2	<i>Option Four: Trucking from Kalkaska to Gaylord plus rail from Gaylord to Marysville</i>	25
4	CONCLUSIONS AND IMPLICATIONS	29
4.1	THE COST INCREASE WOULD BE SMALL COMPARED WITH THE VALUE OF CRUDE OIL	29
4.2	IMPACT ON MICHIGAN CRUDE OIL PRODUCERS COULD BE MINIMAL	30

Table of figures

FIGURE 1.	ENBRIDGE LINE 5.....	4
FIGURE 2.	LEI'S WEIGHTED AVERAGE ANNUAL COST OF CRUDE TRANSPORTATION TO MARYSVILLE (\$ PER BARREL)	7
FIGURE 3.	MICHIGAN FIELD PRODUCTION OF CRUDE OIL.....	8
FIGURE 4.	MICHIGAN OIL PRODUCTION BY REGION.....	9
FIGURE 5.	MICHIGAN ACTIVE OIL WELLS AND CRUDE PIPELINES	10
FIGURE 6.	MONTHLY CRUDE DELIVERIES AT LEWISTON (2015-2016)	11
FIGURE 7.	LARGEST CRUDE OIL PRODUCERS IN CENTRAL REGION BY COUNTY	12
FIGURE 8.	MICHIGAN'S RAILROAD SYSTEM	13
FIGURE 9.	PIPELINE TARIFFS FOR LIGHT CRUDE OIL (DOLLARS PER BARREL).....	15
FIGURE 10.	HOURLY WAGE FOR FUEL TANKER DRIVER, NOT INCLUDING BENEFITS, BONUSES, OR COMMISSIONS...16	
FIGURE 11.	PADD 2 RETAIL PRICE OF NO. 2 DIESEL, ULTRA-LOW SULFUR (0-15 PPM), INCLUDING TAXES	16
FIGURE 12.	CRUDE RAILCAR LEASE RATES, 2013 TO 2015.....	18
FIGURE 13.	DYNAMIC RISK ASSUMPTIONS FOR TRUCKING COST ANALYSIS	19
FIGURE 14.	DYNAMIC RISK'S OPTION TWO (TRUCKING FROM LEWISTON TO MARYSVILLE) ESTIMATES.....	20
FIGURE 15.	LEI'S REPLICATION OF DYNAMIC RISK'S OPTION TWO RESULTS (TRUCKING FROM LEWISTON TO MARYSVILLE) (NUMERICAL DATA)	22
FIGURE 16.	LEI'S REPLICATION OF DYNAMIC RISK'S OPTION TWO RESULTS (TRUCKING FROM LEWISTON TO MARYSVILLE).....	22
FIGURE 17.	LEI'S COST FOR OPTION TWO (TRUCKING FROM LEWISTON TO MARYSVILLE) BASED ON PUBLIC DATA	23
FIGURE 18.	COMPARISON OF TRUCKING COST ESTIMATES, LEWISTON TO MARYSVILLE (DOLLARS PER BARREL)....	24
FIGURE 19.	LEI'S COST FOR OPTION THREE (TRUCKING FROM KALKASKA TO MARYSVILLE).....	25
FIGURE 20.	LEI'S COST FOR THE FIRST LEG OF OPTION FOUR (TRUCKING FROM KALKASKA TO GAYLORD)	26
FIGURE 21.	LEI'S COST FOR THE SECOND LEG OF OPTION FOUR (RAIL TRANSPORT FROM GAYLORD TO MARYSVILLE).....	27
FIGURE 22.	LEI'S WEIGHTED AVERAGE ANNUAL COST OF CRUDE TRANSPORTATION TO MARYSVILLE (\$ PER BARREL)	28
FIGURE 23.	ANNUAL MAXIMUM, MINIMUM, AND AVERAGE PRICES FOR CRUDE OIL FIRST PURCHASE PRICES IN MICHIGAN (2015-2017)	29

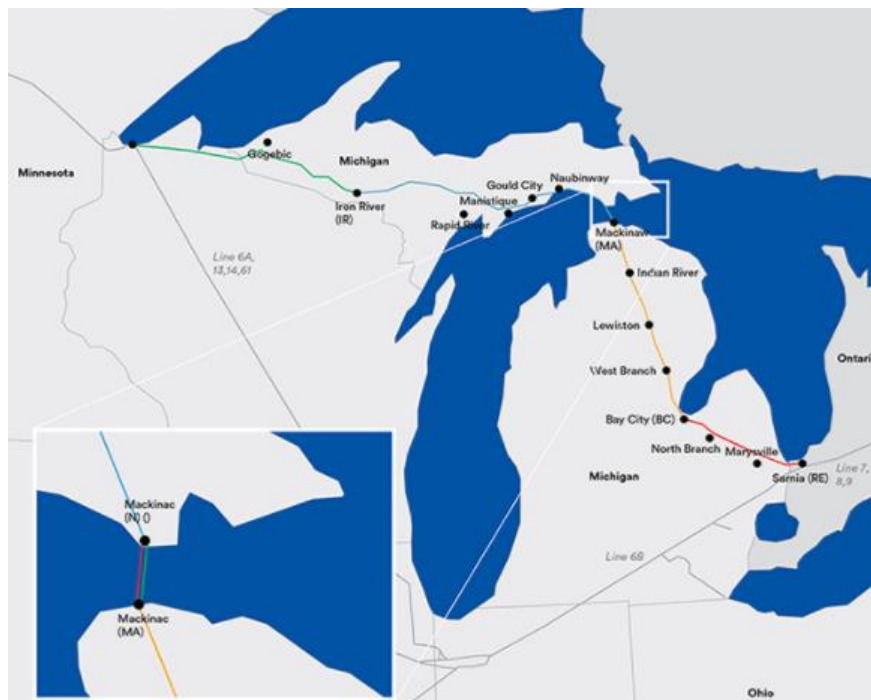
1 Introduction and executive summary

1.1 Enbridge Line 5

Enbridge Line 5 begins in Superior, Wisconsin (“WI”) and terminates in Sarnia, Ontario (“ON”). The pipeline’s capacity is 540,000 barrels per day.¹ It transports light crude oil, light synthetic crude, and natural gas liquids (“NGLs”).

Enbridge Line 5 was built in 1953. The pipeline runs for 645 miles from Wisconsin, at the bottom of the Straits of Mackinac, through Michigan to Sarnia. The 30-inch diameter pipeline splits into two 20-inch diameter lines where it crosses the Straits of Mackinac for 4.5 miles (see Figure 1).

Figure 1. Enbridge Line 5



Source: Enbridge²

LEI was engaged to assist in understanding the current and potential future role of Enbridge Line 5 from the perspective of Michigan crude oil producers. The CS Mott Foundation and NWF wished to understand the degree of reliance on Enbridge Line 5 by crude oil producers in Michigan, and if there are alternative options for transporting Michigan crude oil to markets.

¹ Enbridge. “The Straits of Mackinac crossing and Line 5.” September 2015. <http://www.enbridge.com/~media/Enb/Documents/Brochures/Brochure_Line5.pdf>

² Enbridge. “About Line 5.” Accessed on April 2018. <<https://www.enbridge.com/projects-and-infrastructure/public-awareness/line-5-michigan/about-line-5>>

In this report, LEI provides an independent view of the extent to which Enbridge Line 5 is needed for Michigan crude oil producers, and what the cost impact on oil producers would be if Enbridge Line 5 through Michigan did not exist.

A report by Dynamic Risk Assessments, Inc (“Dynamic Risk”) – funded by Enbridge Energy and overseen by the State of Michigan – also estimated the potential impact on transportation costs for Michigan crude oil producers. LEI did not perform a comprehensive critique of the Dynamic Risk report, which covers a wide variety of issues in addition to the impact on crude oil producers. However, Dynamic Risk provided specific assumptions about some elements of the pipeline, rail, and trucking costs, which LEI compared to publicly-available data and then used to evaluate the impact on the cost of transporting Michigan crude oil to market. Dynamic Risk’s assumptions and their resulting estimates for the cost of alternatives to Enbridge Line 5 provide a useful comparison to LEI’s, and this report refers to Dynamic Risk’s assumptions and results.

1.2 LEI’s approach

To provide a foundation for understanding the cost of alternatives to Enbridge Line 5, LEI began by laying out the facts that describe Michigan’s upstream oil activity (see Section 2).³ LEI examined the location of oil production compared to available transportation, including Enbridge Line 5. Then, LEI analyzed the cost of alternatives to Enbridge Line 5 for crude oil transportation for Michigan producers (see Section 3). These alternatives include trucking and rail shipment. First, LEI examined publicly-available data sources for published pipeline tariffs and public reports of current rail and truck shipment costs. Second, LEI re-produced the cost calculations provided by Dynamic Risk⁴ to understand to what degree Dynamic Risk’s cost results (in dollars per barrel) depended on their assumptions about key elements of cost. Third, LEI substituted publicly-available data for key cost elements, and applied the Dynamic Risk methodology, to arrive at new estimates of the additional cost per barrel to transport crude oil if Enbridge Line 5 did not exist. Finally, LEI examined two alternatives not considered by Dynamic Risk. These are discussed in detail in Section 3. These turned out to have lower incremental costs to producers than the alternative examined by Dynamic Risk.

1.3 Key findings and conclusions

LEI’s key findings were:

- 1 Not all oil producers in Michigan would pay more to transport their crude oil if Enbridge Line 5 was not in service. LEI divided Michigan oil production, all of which is from the Lower Peninsula, into three major regions: Northern, Central, and Southern and analyzed the alternatives for each region.

³ “Upstream” oil activity refers to exploration, development, and production of crude oil; “midstream” refers to transportation of oil; “downstream” refers to refining and marketing.




⁴ Dynamic Risk. “Final Report: Alternatives Analysis for the Straits Pipelines.” October 26, 2017. Prepared for the State of Michigan. October 26, 2017.

- 2 Production from the Northern region accounts for about 37 percent of Michigan crude oil production and has been flat for many years. In that region the least expensive transportation alternative to Line 5 is trucking from Northern oil wells to market (Marysville terminal) for an average cost of \$2.81 per barrel (Option Three in Figure 2). This is \$1.31 per barrel more than the cost of using Enbridge Line 5 (Option One). However, the trucking option is less expensive than the route examined by Dynamic Risk (Option Two) which relies on the MarkWest Michigan Pipeline and trucking from Lewiston to Marysville (which LEI estimates would cost \$3.72 per barrel). LEI estimated that the cost of using a combination of trucking and rail (Option Four) would be more expensive than trucking alone, but less expensive than continuing to use MarkWest Michigan Pipeline and trucking from Lewiston to Marysville.
- 3 The Central region accounts for about 28 percent of Michigan crude oil production, and production has also remained flat for years. The cost increase to producers would depend on their location but would likely be lower than the cost for Northern region producers because the Central region is closer to markets.
- 4 The Southern region accounts for about 35 percent of Michigan crude oil production. This region has experienced declining production since 2013, but production remains higher than in the previous decade. These oil producers do not use Enbridge Line 5 to transport their crude oil to market, so they would not be impacted.
- 5 An increase of \$1.31 per barrel is 2.6 percent of the value of a \$50-barrel of crude oil (the average price in 2017). It is small compared with the volatility of monthly average oil prices in Michigan, which have ranged from \$28 per barrel to over \$100 per barrel since 2014. The cost increase from using alternatives to Enbridge Line 5 would be lost in the noise of typical crude oil price volatility.
- 6 Michigan crude oil producers may be able to pass along some of the cost increase to refineries or other buyers of crude oil. In the absence of Line 5, if the added cost to replace the large quantities of crude oil that are typically shipped on Line 5 are higher than the \$1.31 per barrel which impacts the small volumes of Michigan crude oil, then the Michigan producers may be able to increase their prices and recover some of the increased shipping cost.

1.4 Roadmap to this report

This report begins with the basic facts which describe the upstream oil industry in Michigan and how the oil is transported to refineries; these are presented in Section 2. In Section 3, LEI examines the cost of different transportation alternatives. The conclusions and implications of LEI's analysis are in Section 4.

Figure 2. LEI's weighted average annual cost of crude transportation to Marysville (\$ per barrel)

Option	Option 1: MI Pipeline and Enbridge Line 5	Option 2: MI Pipeline and trucking from Lewiston	Option 3: Trucking only	Option 4: Trucking plus rail
Mode of transportation	Michigan Pipeline	Michigan Pipeline		
Cost of transportation (\$ per barrel)	\$0.92	\$0.92		
Terminal	Lewiston	Lewiston	Kalkaska	Kalkaska
Mode of transportation	Enbridge Line 5 Pipeline	Truck	Truck	Truck
Cost of transportation (\$ per barrel)	\$0.59	\$2.80	\$2.81	\$0.55
Terminal				Gaylord
Mode of transportation				Rail
Cost of transportation (\$ per barrel)				\$2.54
Destination	Marysville			
Total cost (\$ per barrel)	\$1.51	\$3.72	\$2.81	\$3.09
Difference compared to Option One		\$2.22	\$1.31	\$1.59

Note: The transportation costs in this table are typical costs. They are neither averages, nor maximums, nor minimums. For example, the \$0.92 per barrel cost for the Michigan Pipeline is the tariff for injection at Lewiston; which is the same as the incentive tariff rate at Michigan Pipeline's Kalkaska truck receipt point (see Section 3.1.1.1 for details). Thus, the \$0.92 is typical of the rate a shipper on Michigan Pipeline would pay to access the Lewiston injection point for Enbridge Line 5. Totals are rounded independently.

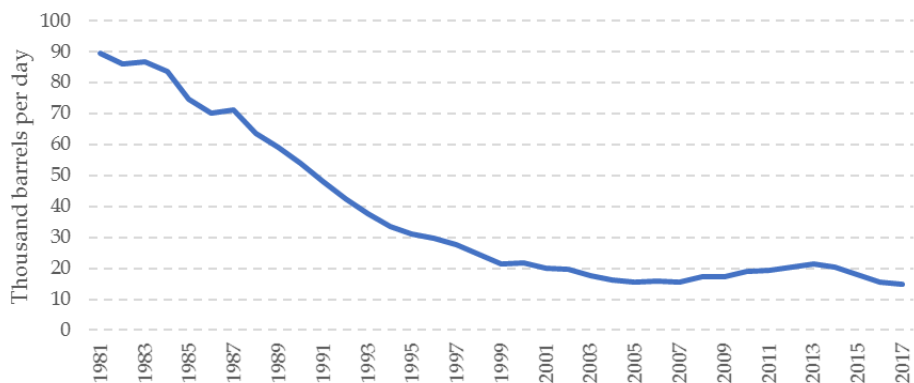
2 Michigan crude oil production

The state of Michigan is a small producer of crude oil, from wells dispersed across the Lower Peninsula. As discussed below, LEI estimates that 9,000 to 10,000 barrels per day (about two-thirds of total oil production in the state) uses Enbridge Line 5 to transport oil to market.

2.1 Oil production in Michigan has been flat for almost 20 years

Michigan is the 21st -largest oil producer in the United States, producing 15,000 barrels per day of crude oil in 2017. Production has declined significantly from early 1980s levels of about 90,000 barrels per day (see Figure 3). Production has been more-or-less flat for nearly 20 years.

Figure 3. Michigan field production of crude oil



Source: EIA⁵

Michigan's crude oil production amounts to a less than one percent of the over 400,000 barrels per day of refined products consumed in Michigan.⁶

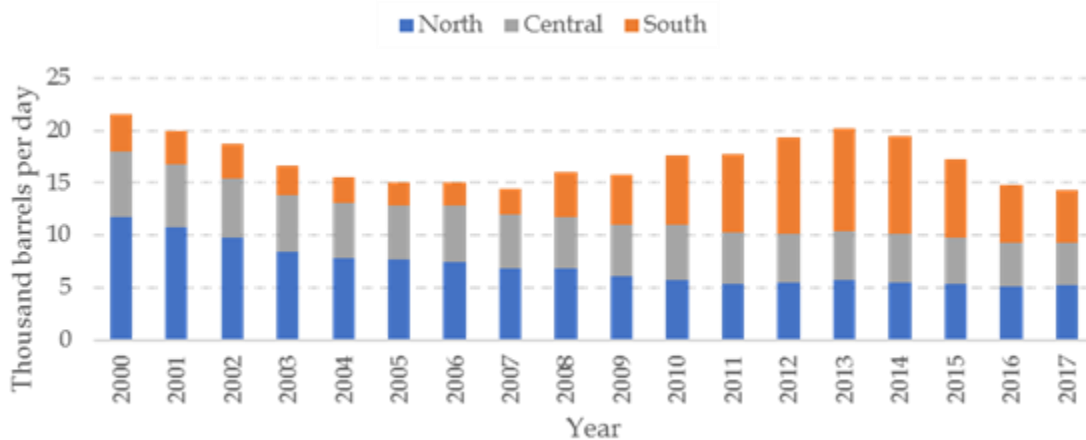
2.2 Oil production has shifted away from the Northern region

In 2017, 56 of Michigan's 83 counties produced oil. LEI grouped these counties into three geographic regions: Northern, Central, and Southern. The Northern region of the Lower Peninsula used to account for the largest portion of the state's total oil production. However, oil resources in that region are in decline and production levels are now more evenly spread across the state (see Figure 4). There is no crude oil production in Michigan's Upper Peninsula.

⁵ EIA. Petroleum & other liquids. Crude oil production. Accessed on June 20, 2018.
<https://www.eia.gov/dnav/pet/PET_CRD_CRPDN_ADC_MBBL_A.htm>

⁶ Michigan Public Service Commission. "About Petroleum Industry." Accessed on July 2018.
<https://www.michigan.gov/mpsc/0,4639,7-159-16389_59859---,00.html>

Figure 4. Michigan oil production by region



Source: Michigan DEQ⁷ (North, Central, and South regional oil production was compiled by LEI based on county data)

2.3 Crude oil transportation in Michigan

The Michigan Pipeline, owned and operated by MarkWest, crosses the northern part of Michigan’s Lower Peninsula. It is the largest crude oil gathering pipeline in Michigan, built in 1973, with a transportation capacity of 60,000 barrels per day^{8 9} (see Figure 5). It is about 250 miles long and connected to over 1,000 wells in the Northern region through 50 direct connects; the pipeline has four truck loading facilities and 15,000 barrels of storage.¹⁰

The Michigan Pipeline interconnects with Enbridge Line 5 at Lewiston, MI. From there, Enbridge Line 5 transports Michigan crude oil south to the Marysville terminal near Sarnia, Ontario. Sarnia provides an important market for crude oil as it is home to three refineries with about 280,000 barrels per day of capacity.¹¹ Marysville is interconnected to the Mid-Valley pipeline, which

⁷ Michigan Department of Environmental Quality. “Oil & Gas Well Production Database.” Accessed June 27, 2018.

⁸ MarkWest. Northeast operations. Accessed on June 20, 2018. <<http://www.markwest.com/operations/northeast>>

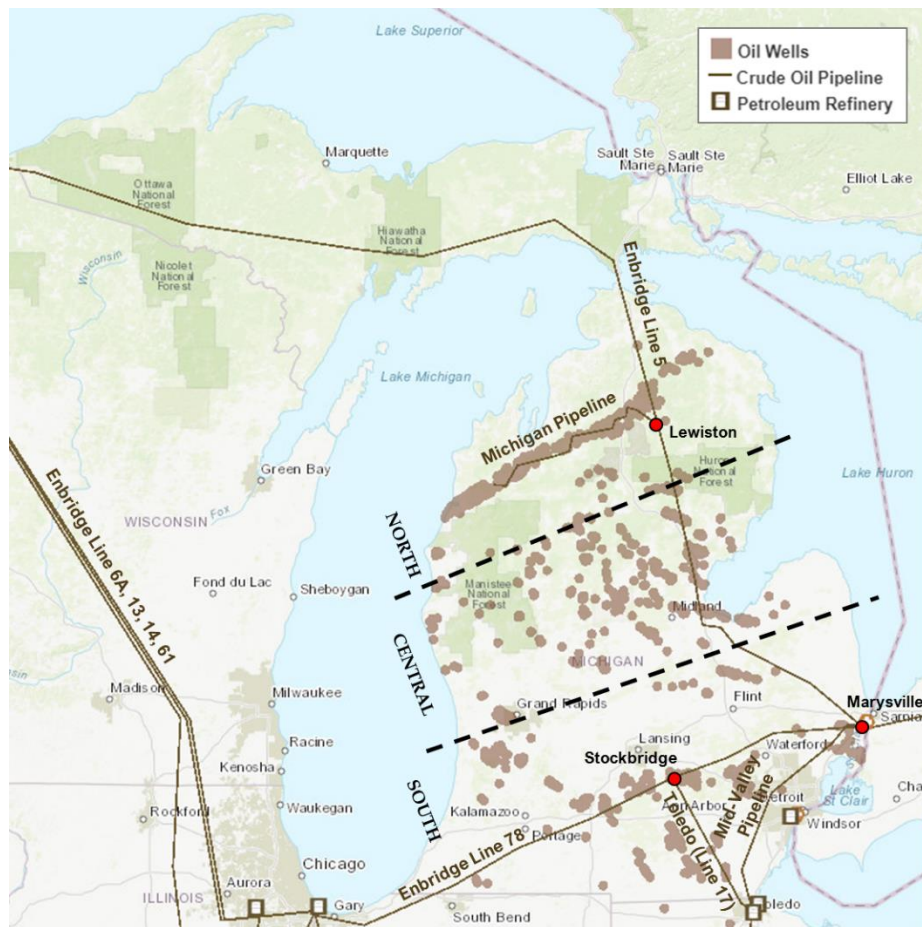
⁹MarkWest Energy Partners, L.P. Form 10-k. 2011.
<https://www.sec.gov/Archives/edgar/data/1166036/000104746912001759/a2207469z10-k.htm>

¹⁰MarkWest. <http://www.markwest.com/operations/ferc-pipelines/michigan-crude-pipeline-markwest-michigan-pipeline-company-llc/>

¹¹ Shell Canada, Imperial Oil, and Suncor Energy operate refineries in Sarnia. Company website accessed on July 13, 2018. <https://www.shell.ca/en_ca/about-us/projects-and-sites/sarnia-manufacturing-centre.html>; <<http://www.imperialoil.ca/en-ca/company/operations/refining-and-supply/sarnia>>; <<http://www.suncor.com/about-us/refining/sarnia-refinery>>

receives oil from the Enbridge system and ships it to refineries in Toledo and to a tank farm in Samaria, MI which supplies a refinery in Detroit.¹²

Figure 5. Michigan active oil wells and crude pipelines



Source: EIA¹³

2.3.1 Enbridge Line 5 serves Northern and Central producers

Crude oil injections at Lewiston into Enbridge Line 5 averaged 10,081 barrels per day in 2015 and 9,321 barrels per day in 2016 and (see Figure 6).¹⁴ This is equivalent to capacity utilization of about 17 percent of the total 60,000 barrel-per-day capacity on the MarkWest Michigan Pipeline.

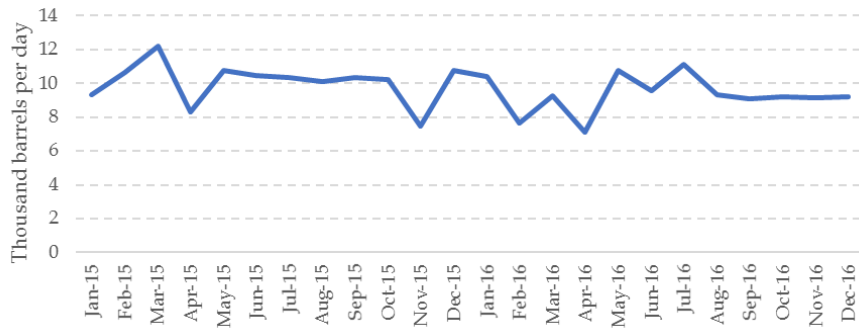
¹² Sunoco Logistics Partners, L.P. Form 10-k 2012.

<https://www.sec.gov/Archives/edgar/data/1161154/000119312513086930/d444720d10k.htm>

¹³ Source: EIA. U.S. Energy Mapping System. Accessed on June 20, 2018. <<https://www.eia.gov/state/maps.php>>

¹⁴ Dynamic Risk. "Final Report: Alternatives Analysis for the Straits Pipelines." Prepared for the State of Michigan. October 26, 2017. Appendix C.

Figure 6. Monthly crude deliveries at Lewiston (2015-2016)



Source: Dynamic Risk¹⁵

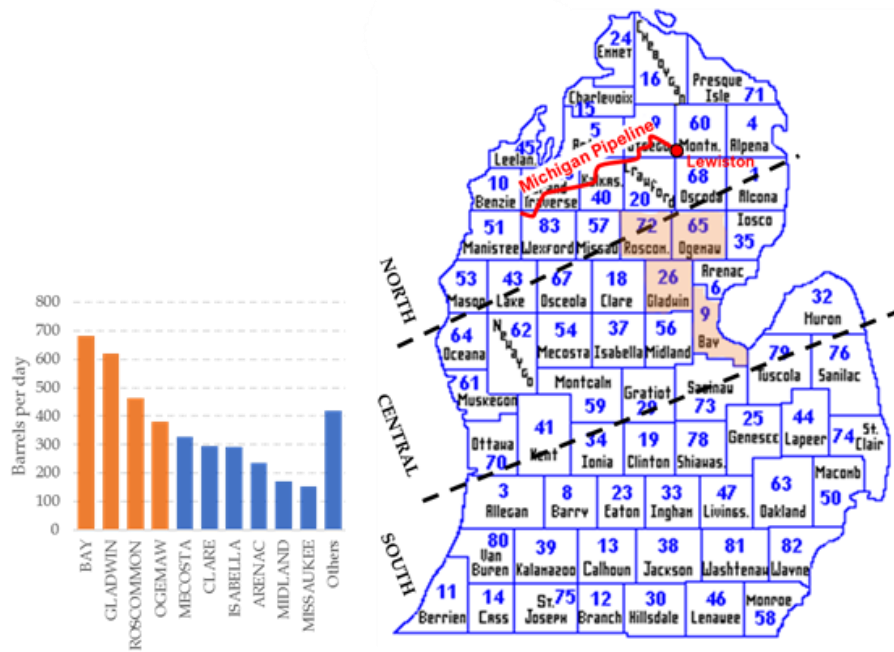
With throughput at Lewiston of 9,000-10,000 barrels per day, Enbridge Line 5 appears to be servicing most or all of the oil production in the Northern and Central regions. In 2016 when light crude injections at Lewiston were 9,321 barrels per day, production in the Northern and Central regions added up to 9,282 barrels per day.

Enbridge Line 5 does not appear to accept crude oil injections anywhere in Michigan except at Lewiston. Given the level of throughput at Lewiston relative to Northern and Central region production, and the lack of crude oil receipt points on Enbridge Line 5 other than at Lewiston, it appears that all oil production in the Northern and Central regions currently passes through the Lewiston terminal and into Enbridge Line 5.

Based on their location, producers in the four largest producing counties in the Central region (see orange bars in Figure 7) are most likely trucking crude oil to Enbridge Line 5 at the Lewiston injection point, or at the truck receipt point at Kalkaska, where the incentive rate is equal to the tariff rate at Lewiston. These are the lowest-cost receipt points on the MarkWest Michigan Pipeline, so they are the likely receipt points for trucked crude oil.

¹⁵ Ibid.

Figure 7. Largest crude oil producers in Central region by county



Source: Michigan DEQ¹⁶

2.3.2 Southern region producers do not use Enbridge Line 5

The lack of receipt points between Lewiston and Marysville implies that Southern region crude oil (about 4,000 barrels per day) does not end up in Enbridge Line 5. Oil producers in the Southern region may be trucking crude oil to terminals interconnected with pipelines (Enbridge Line 17, Enbridge Line 78, or the Sunoco Mid-Valley pipeline) which transit the southern portion of the state (see Figure 5 above) or to terminals connected to nearby refineries.

2.3.3 Rail could be an option for crude oil transport in Michigan

Railroad transport is usually more expensive than pipelines, but it has some advantages over a pipeline:^{17,18}

- rail offers more flexible destinations and shorter-term contracts;

¹⁶ Michigan Department of Environmental Quality. "Oil & Gas Well Production Database." Accessed June 27, 2018.

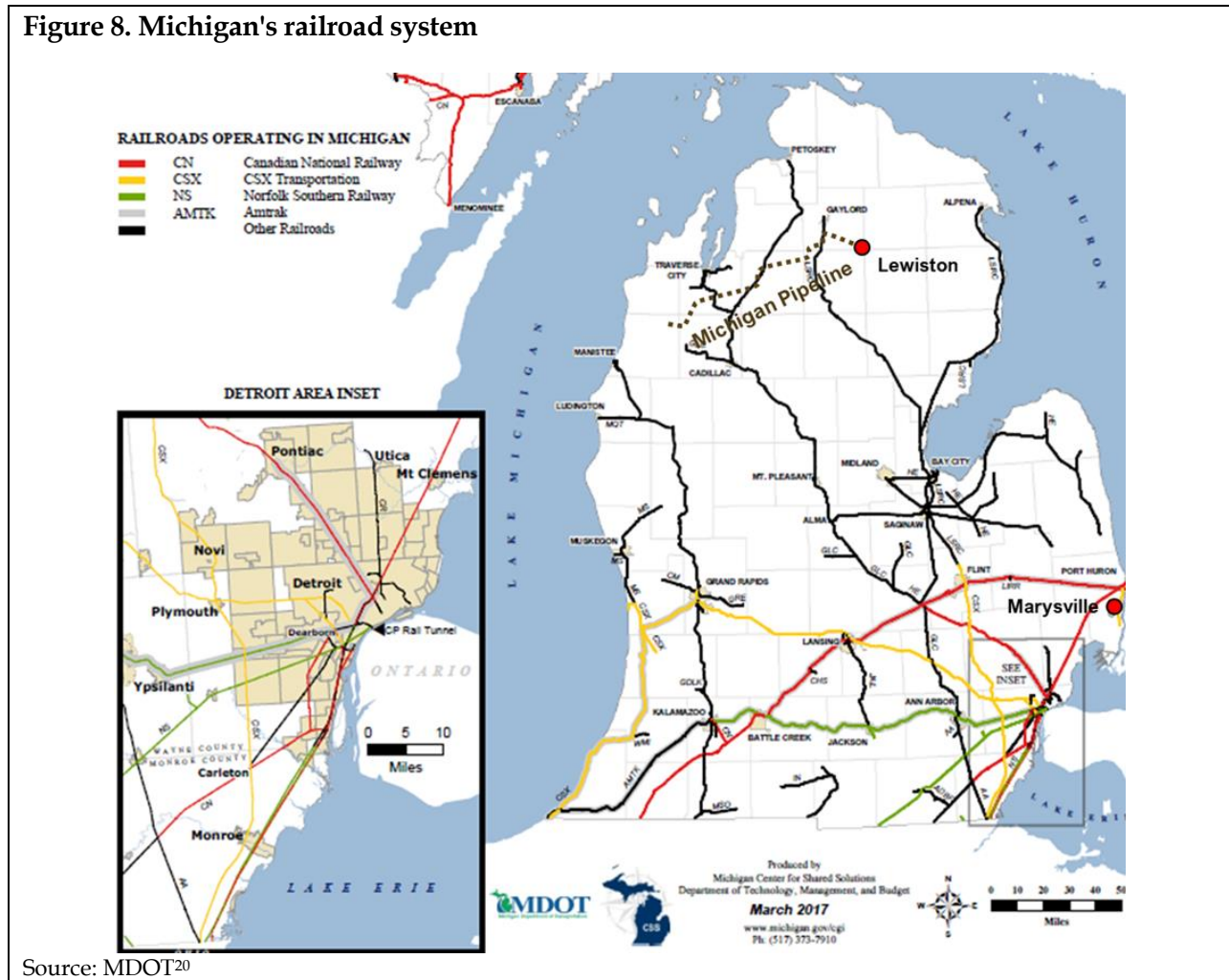
¹⁷ Congressional Research Service. "U.S. Rail Transportation of Crude Oil: Background and Issues for Congress." December 4, 2014.

¹⁸ Philips, M. "Amid U.S. Oil Boom, Railroads Are Beating Pipelines in Crude Transport." *Bloomberg*. June 13, 2013. <<http://www.businessweek.com/articles/2013-06-13/amid-u-dot-s-dot-oil-boom-railroads-are-beating-pipelines-in-crude-transport>>

- rail can respond more quickly to short-term changes in supply and demand; and
- rail infrastructure can quickly expand by extending track and building terminals.

Michigan has a robust railroad system with almost 4,000 miles of track.¹⁹ Some rail lines are situated near oil production centers and refineries. The Lake State Railway Company (“LSRC”) operates a line that interconnects to Gaylord in the northern part of the Lower Peninsula 30 miles away from the Lewiston crude facility (see Figure 8). It is equipped with truck to rail transloading services. LSRC interconnects at Flint with CSX transportation which can transport crude oil directly to refineries in Detroit and Toledo, or interconnect with Canadian National Railway (“CN”) which has access to Marysville.

Figure 8. Michigan's railroad system



¹⁹ Michigan Department of Transportation. “Rail & Transit Facts.” Accessed on July 2019. <https://www.michigan.gov/mdot/0,4616,7-151-9623_11154-129688--,00.html>

²⁰ Michigan Department of Transportation. “Michigan's Railroad System.” March 2017. Accessed on July 2019. <https://www.michigan.gov/documents/mdot/MI_Rail_Map_Printable_553910_7.pdf>.

3 The Michigan upstream industry with and without Enbridge Line 5

LEI examined the cost of alternative transportation routes for oil producers in the Northern and Central regions of the Lower Peninsula. This section begins with LEI's three-step approach which examines the analysis of the transportation option provided by Dynamic Risk:

- 1 **LEI examined public supply and transportation cost data.** To the extent public data were available, LEI compared the data to the cost assumptions that underpinned Dynamic Risk's analysis of Option Two (trucking from Lewiston to Marysville). Section 3.1 provides a review of those costs.
- 2 **LEI replicated Dynamic Risk's computations.** Using Dynamic Risk's own assumptions and their cost model, LEI replicated Dynamic Risk's calculations of the cost of Option Two. This step ensured that LEI understood Dynamic Risk's methodology and used their model correctly but does not imply LEI agrees with their conclusions. This is presented in Section 3.2.
- 3 **LEI found Dynamic Risk's computations essentially correct, but their fundamental assumption about available alternatives was flawed.** LEI used the publicly-available data from Step 1 in the Dynamic Risk model and calculated the results. LEI concluded that Dynamic Risk's trucking cost estimates were consistent with public sources of data (Section 3.3). However, Option Two assumed both the Northern region and Central region oil producers would continue to use the MarkWest Michigan Pipeline to ship oil to Lewiston and then truck the oil from Lewiston to Marysville. This is a flaw in Dynamic Risk's analysis because crude oil producers have other options.

LEI examined two other options: i) trucking crude directly to Marysville (Option Three), and ii) trucking plus rail transport to Marysville (Option Four). These alternatives do not involve using the MarkWest Michigan Pipeline.

LEI's results, discussed in detail in this section, show that Option Two is not the lowest-cost alternative to Enbridge Line 5 available to Northern or Central region producers. Option Three is the lowest-cost alternative to Enbridge Line 5. LEI did not perform any analysis for Southern region crude oil producers because the region does not rely on Enbridge Line 5 for delivery of crude oil to markets.

3.1 Step one: LEI examined data from publicly-available sources

LEI examined a broad array of public data sources to collect information on the key components of transportation costs for Michigan crude oil.

3.1.1 Transportation cost data

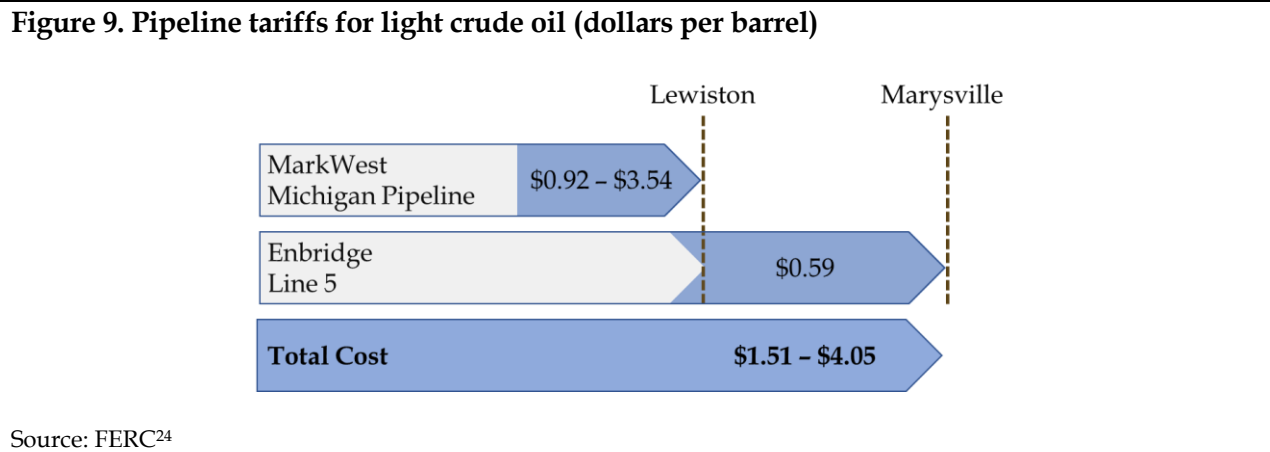
Pipeline tariffs for crude oil transport are publicly available. Rail and trucking cost have many cost elements which are not publicly available and are not simple to estimate, but some cost information is available in the public domain. This section covers key elements of pipeline, trucking, and rail costs for crude oil transportation.

3.1.1.1 Costs by pipeline

Pipelines are the favored option for transporting large volumes of oil. Crude oil contracted for delivery via a pipeline usually pays for transportation costs at a published tariff for a specific route, with an injection point near where the oil is produced, to a delivery point near a refinery or interconnection to a terminal.

The tariff on Enbridge Line 5 effective July 1, 2018, is \$0.59 per barrel for the 221 miles from Lewiston to Marysville.²¹

The tariff on the MarkWest Michigan Pipeline to Lewiston effective July 31, 2017 ranges from \$0.9195 per barrel for injection at Lewiston to \$3.54 per barrel for injection at Manistee.²² The tariff currently offers an incentive rate for injection at the Kalkaska truck facility (more-or-less in the middle of the pipeline) for deliveries of at least 50 barrels. This rate is \$0.9195 per barrel, the same as the Lewiston rate.²³ LEI assumed producers who are not directly interconnected with the pipeline would take advantage of this incentive tariff, as it would be a straightforward matter to ensure that any crude oil delivery truck (which can hold 250 barrels) would arrive with at least a 50-barrel cargo.



²¹ FERC. "ICA Oil Tariff No. 43.25.0." Issued May 30, 2018. Effective July 1, 2018.

²² FERC. "Local Pipeline Tariff No. 8.20.0." Issued July 31, 2017. Effective July 31, 2017.

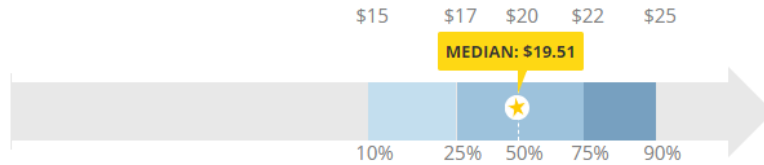
²³ This rate is set to expire at the end of July 2018. For the purposes of our analysis, LEI assumed it would be renewed at the same rate.

²⁴ MarkWest Michigan Pipeline FERC No. 8.20.0 and Enbridge Lines 5/78 FERC No. 43.25.0

3.1.1.2 Elements of trucking costs

Oil trucking has two major cost components: driver’s salary and the cost of diesel fuel. The hourly pay for a fuel tanker driver is reported to range from about \$15 per hour to about \$25 per hour, not including benefits, bonuses, or commissions (see Figure 10).²⁵

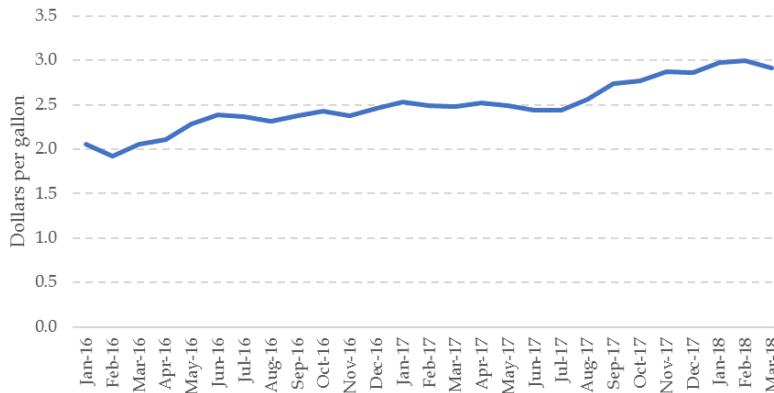
Figure 10. Hourly wage for fuel tanker driver, not including benefits, bonuses, or commissions



Source: PayScale²⁶

The retail price of diesel fuel in the Petroleum Administration for Defense District (“PADD”) 2 (the district which includes Michigan) including taxes ranged from \$2.00 per gallon to slightly under \$3.00 per gallon in 2016/17 (see Figure 11).

Figure 11. PADD 2 retail price of No. 2 diesel, ultra-low sulfur (0-15 ppm), including taxes



Source: EIA²⁷

²⁵ PayScale. “Fuel Tanker Driver Salary.” Accessed on July 2018.
https://www.payscale.com/research/US/Job=Fuel_Tanker_Driver/Hourly_Rate

²⁶ PayScale. “Fuel Tanker Driver Salary.” Accessed on July 2018.
https://www.payscale.com/research/US/Job=Fuel_Tanker_Driver/Hourly_Rate

²⁷ EIA. “Midwest No 2 Diesel Ultra Low Sulfur (0-15 ppm) Retail Prices Dollars per Gallon.” Accessed on April 2018.
https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2DXL0_PTE_R20_DPG&f=M

As discussed in more detail in Section 3.2, LEI used this public information to test the reasonableness of Dynamic Risk's crude oil trucking cost estimates.

3.1.1.3 Elements of rail costs

Transportation by rail is an alternative to crude pipeline transportation. A typical railcar can hold between 670 and 750 barrels of crude oil depending on the density of the crude.²⁸ Heavy crude oil requires heating and/or insulation, with less room left over for the oil; lighter crude oil, such as that produced in Michigan, does not require heated or insulated rail cars.

Railroads offer tariffs in the form of "walk-up" rates which apply to the equivalent of a last-minute transaction. Many shippers do not pay walk-up rates. Instead, they pay discounted rates by providing their own equipment such as tanker cars, and/or committing to shipping large or fixed volumes. In 2015, the average freight revenue in the United States for Class I rail was \$0.0395 per ton-mile, equivalent to \$0.00593 per barrel-mile of crude oil.²⁹ Freight rates charged for crude oil specifically are not publicly available.

The cost to lease railcars is another important component of the cost of transporting crude by rail. For light crude oil this cost was about \$500 per car per month in 2016, down from about \$2,000 per car per month in 2014 (see Figure 12). Lease rates are usually fixed under a leasing agreement for a specific period, which can vary from 2 years to 20 years, depending on the type of lease.³⁰

²⁸ Canadian Association of Petroleum Producers. "Transporting Crude Oil by Rail in Canada." March 2014.

²⁹ United States Department of Transportation. "Average Freight Revenue per Ton-Mile." Accessed on July 2018.
<<https://www.bts.gov/content/average-freight-revenue-ton-mile>>

³⁰ Market Insider. Global Railcar Leasing Market 2017-2021. Press Release PR Newswire. September 2017.
<<http://markets.businessinsider.com/news/stocks/global-railcar-leasing-market-2017-2021-1002359341>>

Figure 12. Crude railcar lease rates, 2013 to 2015



Source: Genscape³¹ “30k” refers to 30,000 gallons, or about 715 barrels; “31.8k” refers to 31,800 gallons, or about 750 barrels; “29k” refers to 29,000 gallons, or about 690 barrels.

3.2 Step two: LEI replicated Dynamic Risk’s crude transportation cost results

Dynamic Risk examined the cost of one alternative for crude oil producers in Michigan if Line 5 were not in service: they examined the cost of using tanker trucks rather than Line 5 to transport oil from the Lewiston terminal to Marysville (Option Two). They assumed that producers would continue to truck oil to MarkWest Michigan Pipeline (if they were already doing so), then ship by MarkWest to Lewiston, then offload from MarkWest into trucks for the remainder of the journey to Marysville. Thus, for oil which is not directly interconnected to the MarkWest Michigan Pipeline, Dynamic Risk implicitly assumed two legs of the journey by truck: one from the field to the Michigan Pipeline, then another from Lewiston to Marysville.

Dynamic Risk concluded that it would cost \$3.05 per barrel to truck oil from Lewiston to Marysville.³² Dynamic Risk based this on an assumed tanker truck capacity of 248 barrels³³ but did not provide all the other detailed assumptions or calculations to support this conclusion.

³¹ Genscape. “Tank-Car Lease Rates Plummet on Weak Crude-By-Rail Demand, Low Crude Prices.” November 11, 2015. <<https://www.genscape.com/blog/tank-car-lease-rates-plummet-weak-crude-rail-demand-low-crude-prices>>

³² Dynamic Risk. “Final Report: Alternatives Analysis for the Straits Pipelines” Prepared for the State of Michigan. October 26, 2017. P ES-23.

³³ Dynamic Risk. “Final Report: Alternatives Analysis for the Straits Pipelines” Prepared for the State of Michigan. October 26, 2017. P 7-1

Therefore, LEI examined its plausibility based on other assumptions which Dynamic Risk provided for its propane transportation cost analysis (see Figure 13).³⁴ LEI's replication of Dynamic Risk's crude oil results were based on the assumptions in Figure 13 (except for the tanker truck volume), so LEI did not expect to arrive at precisely the same results as Dynamic Risk, for its analysis of Option Two.

Figure 13. Dynamic Risk assumptions for trucking cost analysis

General				
Volume of Propane per Tractor Trailer	10,400		gal	
Terminal Load/Unload Time	1		h	
Operating Hours Per Day	24		h/d	
Truck Fuel Mileage	7.9		mpg	
Driver Wage	\$35		\$/h	
Diesel Fuel Costs	\$3.00		\$/gal	
Capital Costs of Tractor Truck	\$120,000		\$/Unit	
Capital Cost of Propane Trailer	\$145,000		\$/Unit	
Insurance/License Fees/Permits	\$0.09		\$/Mile	
Truck/Trailer Repairs	\$0.16		\$/Mile	
Truck/Trailer Tires	\$0.04		\$/Mile	
Truck Tractor Life	7		Years	
Propane Trailer Life	15		Years	
Incremental Overhead	0.45		Man Years	
Incremental Storage	270,000		gal	
Incremental Transload Equipment	2		Units	
Capital Cost Storage Tanks (90,000 gal)	\$350,000		\$/Unit	
Capital Cost Transload Equipment	\$100,000		\$/Unit	
Useful Life (Storage Tank/Transloader)	20		Years	
Amortization Rate	15%		Per Annum	
Cost of Overhead	\$80,000		\$/Annum	
Terminal Specific	Distance mi. (km)	Transit Time (h)	Cycle Time (h)	Fleet (#)
Kincheloe, MI	150 (241)	3	8	5
Owen, WI	240 (386)	5	12	8
Superior, WI	290 (467)	6	14	9
Sarnia, ON	427 (688)	8	18	12
Lewiston, MI	221 (356)	4	10	21

Source: Dynamic Risk Appendix J³⁵

³⁴ Dynamic Risk. "Final Report: Alternatives Analysis for the Straits Pipelines." Appendix J. Prepared for the State of Michigan. October 26, 2017.

³⁵ Dynamic Risk. "Final Report: Alternatives Analysis for the Straits Pipelines." Appendix J, P. J-4. Prepared for the State of Michigan. October 26, 2017.

3.2.1 Replicating Dynamic Risk’s methodology and assumptions

LEI wanted to ensure we were performing the cost calculations in the same way that Dynamic Risk did. Once that was established, LEI could change the assumptions and examine the impact on the results.

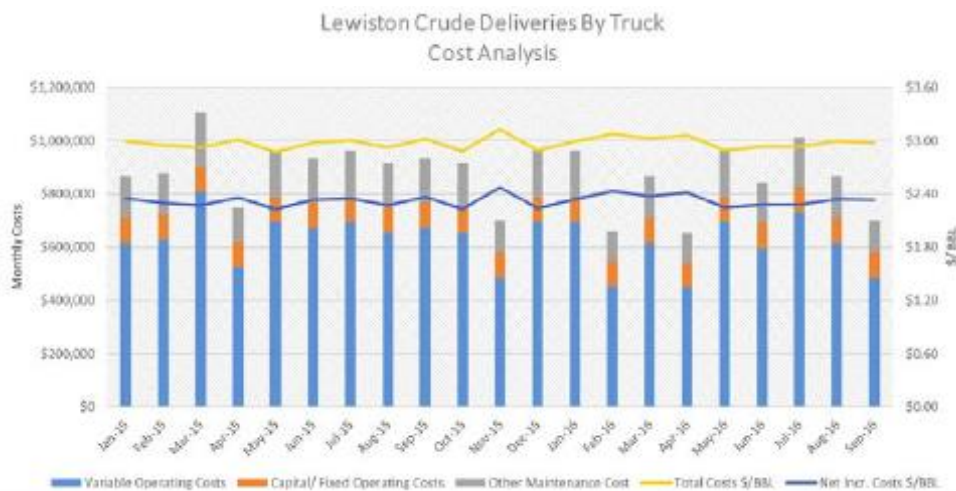
3.2.1.1 Verifying pipeline shipping costs

LEI compared the pipeline costs used by Dynamic Risk to Enbridge Line 5’s and MarkWest Michigan Pipeline’s published tariffs. Dynamic Risk used a rate of \$0.65 per barrel for Lewiston to Maryville for Enbridge Line 5, which was the rate that was in place for the time period for which they conducted their analysis.³⁶ The current rate, as mentioned previously, is \$0.59 per barrel. Dynamic Risk did not conduct any cost analysis related to the MarkWest Michigan Pipeline.

3.2.1.2 Replicating tanker truck shipping costs

LEI examined Dynamic Risk’s total cost to ship crude oil by truck from Lewiston to Maryville. As mentioned above, Dynamic Risk did not provide the numerical assumptions for all its cost components, but they did provide a visual representation of costs in their Final Report, in Figure 4-10, page 4-17 (see Figure 14). Dynamic Risk arrived at a transport cost by tanker truck from Lewiston to Maryville of \$3.05 per barrel by dividing these total monthly costs by the monthly volumes of oil transported.

Figure 14. Dynamic Risk’s Option Two (trucking from Lewiston to Maryville) estimates



Source: Dynamic Risk. Figure 4.10³⁷

³⁶ FERC. “ICA Oil Tariff No. 43.21.0.” Issued May 31, 2016.

³⁷ Dynamic Risk. “Final Report: Alternatives Analysis for the Straits Pipelines.” Prepared for the State of Michigan. October 26, 2017. P 4-17.

LEI used this visual representation and Dynamic Risk's total cost estimate of \$3.05 per barrel as a "target" for its replication of Dynamic Risk's analysis of Option Two.

Dynamic Risk's monthly variable operating costs had two components: fuel cost and driver wages. LEI calculated the monthly diesel fuel cost using the diesel fuel cost and the truck fuel mileage used by Dynamic Risk (see Figure 13 above), multiplied by the mileage from Lewiston to Marysville (Dynamic Risk Final Report page 4-14) and by the number of truckloads. LEI calculated the monthly driver wage cost based on driver hourly wage used by Dynamic Risk (\$35 per hour) multiplied by the estimated round-trip cycle time of 10 hours (see Figure 13 above).

LEI calculated the monthly capital and fixed operating costs, including three separate components: overhead cost, incremental overhead cost (both based on the same data used by Dynamic Risk (see Figure 13 above) and assuming a 2,000-hour work year); and fixed cost recovery. To replicate fixed cost recovery, LEI used the average annual fixed cost recovery charge of \$0.20 per barrel which it appeared that Dynamic Risk used.

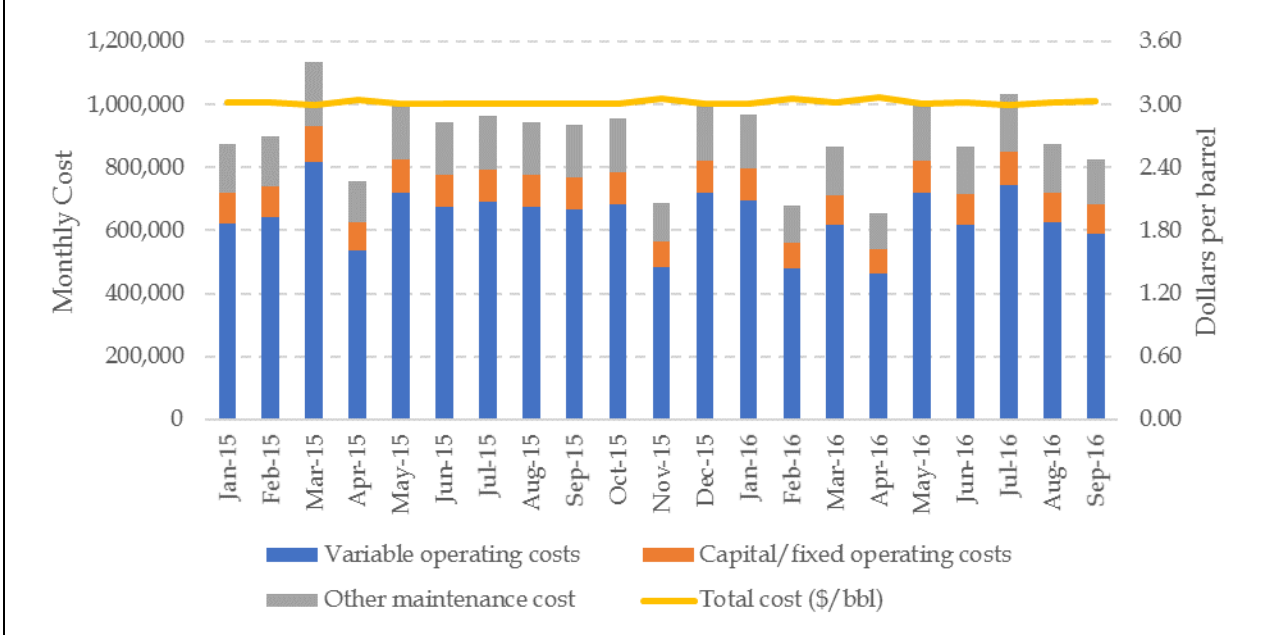
To replicate "Other maintenance costs," LEI used the following inputs provided by Dynamic Risk: Insurance/License/fees/permits, truck/trailer repairs, and truck/trailer tires (see Figure 13 above). LEI multiplied these costs by mileage and truckload as appropriate.

To replicate Dynamic Risk's costs per barrel, LEI used monthly light crude oil injections into Line 5 at Lewiston (from Appendix C, pages C-2 and C-3 of the Dynamic Risk Report). LEI arrived at a weighted average total cost of \$2.93 per barrel (see Figure 15 and Figure 16). This is within four percent of Dynamic Risk's \$3.05 per barrel results. This confirms that LEI understood Dynamic Risk's approach and used their assumptions correctly.

Figure 15. LEI’s replication of Dynamic Risk’s Option Two results (trucking from Lewiston to Marysville) (numerical data)

Year	Month	Light crude deliveries to Lewiston (barrels)	Number of truck delivery trips needed in the month	Miles per round trip	Fuel cost per month	Driver wage cost per month	Insurance, license, fees, permits, and repair cost per month	Overhead cost	Incremental overhead cost	Fixed cost recovery	Total cost per barrel
2015	Jan	289,170	1,166	442	\$ 195,712	\$ 408,103	\$ 149,459	\$ 6,667	\$ 31,500	\$ 57,834	\$2.94
2015	Feb	297,995	1,202	442	\$ 201,685	\$ 420,558	\$ 154,020	\$ 6,667	\$ 31,500	\$ 59,599	\$2.93
2015	Mar	379,061	1,528	442	\$ 256,551	\$ 534,965	\$ 195,919	\$ 6,667	\$ 31,500	\$ 75,812	\$2.91
2015	Apr	248,895	1,004	442	\$ 168,454	\$ 351,264	\$ 128,643	\$ 6,667	\$ 31,500	\$ 49,779	\$2.96
2015	May	334,408	1,348	442	\$ 226,330	\$ 471,947	\$ 172,840	\$ 6,667	\$ 31,500	\$ 66,882	\$2.92
2015	Jun	313,808	1,265	442	\$ 212,387	\$ 442,874	\$ 162,193	\$ 6,667	\$ 31,500	\$ 62,762	\$2.93
2015	Jul	320,954	1,294	442	\$ 217,224	\$ 452,959	\$ 165,886	\$ 6,667	\$ 31,500	\$ 64,191	\$2.92
2015	Aug	312,764	1,261	442	\$ 211,681	\$ 441,401	\$ 161,654	\$ 6,667	\$ 31,500	\$ 62,553	\$2.93
2015	Sep	309,845	1,249	442	\$ 209,705	\$ 437,282	\$ 160,145	\$ 6,667	\$ 31,500	\$ 61,969	\$2.93
2015	Oct	317,444	1,280	442	\$ 214,848	\$ 448,005	\$ 164,072	\$ 6,667	\$ 31,500	\$ 63,489	\$2.93
2015	Nov	224,364	905	442	\$ 151,851	\$ 316,643	\$ 115,964	\$ 6,667	\$ 31,500	\$ 44,873	\$2.98
2015	Dec	332,848	1,342	442	\$ 225,274	\$ 469,745	\$ 172,034	\$ 6,667	\$ 31,500	\$ 66,570	\$2.92
2016	Jan	321,928	1,298	442	\$ 217,883	\$ 454,335	\$ 166,390	\$ 6,667	\$ 31,500	\$ 64,386	\$2.92
2016	Feb	222,358	897	442	\$ 150,493	\$ 313,811	\$ 114,927	\$ 6,667	\$ 31,500	\$ 44,472	\$2.98
2016	Mar	286,440	1,155	442	\$ 193,865	\$ 404,250	\$ 148,048	\$ 6,667	\$ 31,500	\$ 57,288	\$2.94
2016	Apr	213,797	862	442	\$ 144,699	\$ 301,730	\$ 110,502	\$ 6,667	\$ 31,500	\$ 42,759	\$2.98
2016	May	332,848	1,342	442	\$ 225,274	\$ 469,745	\$ 172,034	\$ 6,667	\$ 31,500	\$ 66,570	\$2.92
2016	Jun	286,824	1,157	442	\$ 194,124	\$ 404,792	\$ 148,246	\$ 6,667	\$ 31,500	\$ 57,365	\$2.94
2016	Jul	344,742	1,390	442	\$ 233,324	\$ 486,532	\$ 178,182	\$ 6,667	\$ 31,500	\$ 68,948	\$2.92
2016	Aug	289,755	1,168	442	\$ 196,108	\$ 408,929	\$ 149,761	\$ 6,667	\$ 31,500	\$ 57,951	\$2.94
2016	Sep	273,049	1,101	442	\$ 184,801	\$ 385,351	\$ 141,127	\$ 6,667	\$ 31,500	\$ 54,610	\$2.94
Weighted average											\$2.93

Figure 16. LEI’s replication of Dynamic Risk’s Option Two results (trucking from Lewiston to Marysville)



3.3 Step three: LEI re-calculated Dynamic Risk's estimate using public data

For the final step, LEI tested the impact on Dynamic Risk's Option Two cost estimate of using the public data for several key assumptions.

3.3.1 Option Two (trucking from Lewiston to Marysville)

For Option Two (trucking from Lewiston to Marysville) LEI's analysis of publicly available data showed different values than those used by Dynamic Risk. Diesel fuel prices have been somewhat below Dynamic Risk's \$3.00 per gallon; LEI used \$2.90 per gallon. Public data for driver wages was lower than the \$35 per hour used by Dynamic Risk, but did not include benefits, bonuses, or commissions. Based on the public data noted previously, LEI assumed an average pay of \$19.51 per hour (from Figure 10), a 2,000-hour working year, \$18,000 per driver per year for health insurance, and \$8,000 per driver per year for bonuses and commissions, for a total cost of \$32.51 per hour. Substituting public data (a \$2.90 per gallon diesel price, and a wage cost of \$32.51 per hour) into the Dynamic Risk model resulted in a cost of \$2.80 per barrel (see Figure 17). This is somewhat lower than the Dynamic Risk's result (see Figure 18).

Figure 17. LEI's cost for Option Two (trucking from Lewiston to Marysville) based on public data

Year	Month	Light crude deliveries to Lewiston (barrels)	Number of truck delivery trips needed in the month	Fuel cost per month	Driver wage cost per month	Insurance, license, fees, permits, and repair cost per month	Overhead cost	Incremental overhead cost	Fixed cost recovery	Total cost per barrel
2015	Jan	289,170	1,166	\$ 189,189	\$ 378,953	\$ 149,459	\$ 6,667	\$ 29,250	\$ 57,834	\$2.81
2015	Feb	297,995	1,202	\$ 194,962	\$ 390,518	\$ 154,020	\$ 6,667	\$ 29,250	\$ 59,599	\$2.80
2015	Mar	379,061	1,528	\$ 247,999	\$ 496,753	\$ 195,919	\$ 6,667	\$ 29,250	\$ 75,812	\$2.78
2015	Apr	248,895	1,004	\$ 162,839	\$ 326,173	\$ 128,643	\$ 6,667	\$ 29,250	\$ 49,779	\$2.83
2015	May	334,408	1,348	\$ 218,785	\$ 438,236	\$ 172,840	\$ 6,667	\$ 29,250	\$ 66,882	\$2.79
2015	Jun	313,808	1,265	\$ 205,308	\$ 411,240	\$ 162,193	\$ 6,667	\$ 29,250	\$ 62,762	\$2.80
2015	Jul	320,954	1,294	\$ 209,983	\$ 420,604	\$ 165,886	\$ 6,667	\$ 29,250	\$ 64,191	\$2.79
2015	Aug	312,764	1,261	\$ 204,625	\$ 409,872	\$ 161,654	\$ 6,667	\$ 29,250	\$ 62,553	\$2.80
2015	Sep	309,845	1,249	\$ 202,715	\$ 406,047	\$ 160,145	\$ 6,667	\$ 29,250	\$ 61,969	\$2.80
2015	Oct	317,444	1,280	\$ 207,686	\$ 416,005	\$ 164,072	\$ 6,667	\$ 29,250	\$ 63,489	\$2.79
2015	Nov	224,364	905	\$ 146,790	\$ 294,026	\$ 115,964	\$ 6,667	\$ 29,250	\$ 44,873	\$2.84
2015	Dec	332,848	1,342	\$ 217,765	\$ 436,192	\$ 172,034	\$ 6,667	\$ 29,250	\$ 66,570	\$2.79
2016	Jan	321,928	1,298	\$ 210,621	\$ 421,882	\$ 166,390	\$ 6,667	\$ 29,250	\$ 64,386	\$2.79
2016	Feb	222,358	897	\$ 145,477	\$ 291,396	\$ 114,927	\$ 6,667	\$ 29,250	\$ 44,472	\$2.84
2016	Mar	286,440	1,155	\$ 187,403	\$ 375,375	\$ 148,048	\$ 6,667	\$ 29,250	\$ 57,288	\$2.81
2016	Apr	213,797	862	\$ 139,876	\$ 280,178	\$ 110,502	\$ 6,667	\$ 29,250	\$ 42,759	\$2.85
2016	May	332,848	1,342	\$ 217,765	\$ 436,192	\$ 172,034	\$ 6,667	\$ 29,250	\$ 66,570	\$2.79
2016	Jun	286,824	1,157	\$ 187,654	\$ 375,878	\$ 148,246	\$ 6,667	\$ 29,250	\$ 57,365	\$2.81
2016	Jul	344,742	1,390	\$ 225,547	\$ 451,779	\$ 178,182	\$ 6,667	\$ 29,250	\$ 68,948	\$2.79
2016	Aug	289,755	1,168	\$ 189,571	\$ 379,719	\$ 149,761	\$ 6,667	\$ 29,250	\$ 57,951	\$2.81
2016	Sep	273,049	1,101	\$ 178,641	\$ 357,826	\$ 141,127	\$ 6,667	\$ 29,250	\$ 54,610	\$2.81
Weighted average										\$2.80

Figure 18. Comparison of trucking cost estimates, Lewiston to Marysville (dollars per barrel)

Dynamic Risk estimate for Option Two	\$ 3.05
LEI replication of Dynamic Risk's estimate, using Dynamic Risk's assumptions	\$ 2.93
LEI estimate of Option Two using public data	\$ 2.80

3.4 LEI examined two other options for producers

Gaylord, a rail terminal with transloading services, is located about 30 miles from the Lewiston terminal. Crude oil could be trucked directly from Northern region wells to Gaylord, so LEI felt the combination of trucking to Gaylord followed by rail from Gaylord to Marysville was an option worth examining for cost-effectiveness (LEI's Option Four). LEI compared this to trucking crude oil from the Northern region all the way to Marysville (LEI's Option Three).

3.4.1 Option Three: Trucking from Kalkaska to Marysville

Kalkaska, as noted previously, is a trucking receipt point on the MarkWest Michigan Pipeline about halfway along the pipeline, with an incentive tariff rate equal to the rate at Lewiston. LEI assumed this halfway point would represent the average distance a Northern producer would have to truck their oil (233 miles) to get to Marysville, if they did not use MarkWest and Enbridge Line 5. This distance implies a 10-hour cycle time; and given the transport volume and truck size, a fleet of 21 trucks (based on assumptions shown in Figure 13 previously). Using the same methodology as above, LEI calculated that the cost to producers for trucking from Kalkaska to Marysville would be \$2.81 per barrel (see Figure 19).

Figure 19. LEI's cost for Option Three (trucking from Kalkaska to Marysville)

Year	Month	Light crude deliveries to Lewiston (barrels)	Number of truck delivery trips needed in the month	Fuel cost per month	Driver wage cost per month	Insurance, license, fees, permits, and repair cost per month	Overhead cost	Incremental overhead cost	Fixed cost recovery	Total cost per barrel
2015	Jan	289,170	1,166	\$ 199,718	\$ 379,069	\$ 157,777	\$ 3,667	\$ 16,092	\$ 57,834	\$2.82
2015	Feb	297,995	1,202	\$ 205,813	\$ 390,638	\$ 162,592	\$ 3,667	\$ 16,092	\$ 59,599	\$2.81
2015	Mar	379,061	1,528	\$ 261,802	\$ 496,906	\$ 206,823	\$ 3,667	\$ 16,092	\$ 75,812	\$2.80
2015	Apr	248,895	1,004	\$ 171,902	\$ 326,274	\$ 135,802	\$ 3,667	\$ 16,092	\$ 49,779	\$2.83
2015	May	334,408	1,348	\$ 230,962	\$ 438,371	\$ 182,460	\$ 3,667	\$ 16,092	\$ 66,882	\$2.81
2015	Jun	313,808	1,265	\$ 216,735	\$ 411,367	\$ 171,220	\$ 3,667	\$ 16,092	\$ 62,762	\$2.81
2015	Jul	320,954	1,294	\$ 221,670	\$ 420,734	\$ 175,119	\$ 3,667	\$ 16,092	\$ 64,191	\$2.81
2015	Aug	312,764	1,261	\$ 216,013	\$ 409,998	\$ 170,651	\$ 3,667	\$ 16,092	\$ 62,553	\$2.81
2015	Sep	309,845	1,249	\$ 213,998	\$ 406,172	\$ 169,058	\$ 3,667	\$ 16,092	\$ 61,969	\$2.81
2015	Oct	317,444	1,280	\$ 219,246	\$ 416,133	\$ 173,204	\$ 3,667	\$ 16,092	\$ 63,489	\$2.81
2015	Nov	224,364	905	\$ 154,959	\$ 294,116	\$ 122,418	\$ 3,667	\$ 16,092	\$ 44,873	\$2.84
2015	Dec	332,848	1,342	\$ 229,885	\$ 436,326	\$ 181,609	\$ 3,667	\$ 16,092	\$ 66,570	\$2.81
2016	Jan	321,928	1,298	\$ 222,343	\$ 422,012	\$ 175,651	\$ 3,667	\$ 16,092	\$ 64,386	\$2.81
2016	Feb	222,358	897	\$ 153,574	\$ 291,486	\$ 121,323	\$ 3,667	\$ 16,092	\$ 44,472	\$2.84
2016	Mar	286,440	1,155	\$ 197,833	\$ 375,491	\$ 156,288	\$ 3,667	\$ 16,092	\$ 57,288	\$2.82
2016	Apr	213,797	862	\$ 147,661	\$ 280,264	\$ 116,652	\$ 3,667	\$ 16,092	\$ 42,759	\$2.84
2016	May	332,848	1,342	\$ 229,885	\$ 436,326	\$ 181,609	\$ 3,667	\$ 16,092	\$ 66,570	\$2.81
2016	Jun	286,824	1,157	\$ 198,098	\$ 375,994	\$ 156,497	\$ 3,667	\$ 16,092	\$ 57,365	\$2.82
2016	Jul	344,742	1,390	\$ 238,100	\$ 451,918	\$ 188,099	\$ 3,667	\$ 16,092	\$ 68,948	\$2.80
2016	Aug	289,755	1,168	\$ 200,122	\$ 379,836	\$ 158,096	\$ 3,667	\$ 16,092	\$ 57,951	\$2.82
2016	Sep	273,049	1,101	\$ 188,584	\$ 357,936	\$ 148,981	\$ 3,667	\$ 16,092	\$ 54,610	\$2.82
Weighted average										\$2.81

3.4.2 Option Four: Trucking from Kalkaska to Gaylord plus rail from Gaylord to Marysville

For the first leg of Option Four, LEI assumed the average distance a producer would have to truck crude to get to Gaylord would be 40 miles, the distance from Kalkaska to Gaylord. The 40 miles implies a 1.8-hour cycle time and requires four trucks (based on the assumptions shown in Figure 13). Based on this, LEI estimated that average trucking cost for the 40 miles to Gaylord would be \$0.55 per barrel (see Figure 20).

Figure 20. LEI's cost for the first leg of Option Four (trucking from Kalkaska to Gaylord)

Year	Month	Light crude deliveries to Lewiston (barrels)	Number of truck delivery trips needed in the month	Fuel cost per month	Driver wage cost per month	Insurance, license, fees, permits, and repair cost per month	Overhead cost	Incremental overhead cost	Fixed cost recovery	Total cost per barrel
2015	Jan	289,170	1,166	\$ 34,242	\$ 68,610	\$ 27,051	\$ 3,667	\$ 16,092	\$ 10,468	\$0.55
2015	Feb	297,995	1,202	\$ 35,287	\$ 70,704	\$ 27,877	\$ 3,667	\$ 16,092	\$ 10,787	\$0.55
2015	Mar	379,061	1,528	\$ 44,887	\$ 89,938	\$ 35,461	\$ 3,667	\$ 16,092	\$ 13,722	\$0.54
2015	Apr	248,895	1,004	\$ 29,473	\$ 59,054	\$ 23,284	\$ 3,667	\$ 16,092	\$ 9,010	\$0.56
2015	May	334,408	1,348	\$ 39,599	\$ 79,343	\$ 31,283	\$ 3,667	\$ 16,092	\$ 12,105	\$0.54
2015	Jun	313,808	1,265	\$ 37,160	\$ 74,456	\$ 29,356	\$ 3,667	\$ 16,092	\$ 11,360	\$0.55
2015	Jul	320,954	1,294	\$ 38,006	\$ 76,151	\$ 30,025	\$ 3,667	\$ 16,092	\$ 11,618	\$0.55
2015	Aug	312,764	1,261	\$ 37,036	\$ 74,208	\$ 29,259	\$ 3,667	\$ 16,092	\$ 11,322	\$0.55
2015	Sep	309,845	1,249	\$ 36,691	\$ 73,515	\$ 28,986	\$ 3,667	\$ 16,092	\$ 11,216	\$0.55
2015	Oct	317,444	1,280	\$ 37,590	\$ 75,318	\$ 29,696	\$ 3,667	\$ 16,092	\$ 11,491	\$0.55
2015	Nov	224,364	905	\$ 26,568	\$ 53,234	\$ 20,989	\$ 3,667	\$ 16,092	\$ 8,122	\$0.57
2015	Dec	332,848	1,342	\$ 39,414	\$ 78,973	\$ 31,137	\$ 3,667	\$ 16,092	\$ 12,049	\$0.54
2016	Jan	321,928	1,298	\$ 38,121	\$ 76,382	\$ 30,116	\$ 3,667	\$ 16,092	\$ 11,654	\$0.55
2016	Feb	222,358	897	\$ 26,331	\$ 52,758	\$ 20,801	\$ 3,667	\$ 16,092	\$ 8,049	\$0.57
2016	Mar	286,440	1,155	\$ 33,919	\$ 67,962	\$ 26,796	\$ 3,667	\$ 16,092	\$ 10,369	\$0.55
2016	Apr	213,797	862	\$ 25,317	\$ 50,726	\$ 20,000	\$ 3,667	\$ 16,092	\$ 7,739	\$0.58
2016	May	332,848	1,342	\$ 39,414	\$ 78,973	\$ 31,137	\$ 3,667	\$ 16,092	\$ 12,049	\$0.54
2016	Jun	286,824	1,157	\$ 33,964	\$ 68,053	\$ 26,832	\$ 3,667	\$ 16,092	\$ 10,383	\$0.55
2016	Jul	344,742	1,390	\$ 40,823	\$ 81,795	\$ 32,250	\$ 3,667	\$ 16,092	\$ 12,479	\$0.54
2016	Aug	289,755	1,168	\$ 34,312	\$ 68,749	\$ 27,106	\$ 3,667	\$ 16,092	\$ 10,489	\$0.55
2016	Sep	273,049	1,101	\$ 32,333	\$ 64,785	\$ 25,543	\$ 3,667	\$ 16,092	\$ 9,884	\$0.56
Weighted average										\$0.55

For the second leg of Option Four, LEI calculated the cost of rail transport from Gaylord to Marysville. This is a distance of 234 miles, which implies a 10.2-hour cycle time (based on rail cost and performance assumptions shown in Dynamic Risk's Appendix J).³⁸ The cycle time combined with the needed monthly deliveries and the volume of a railcar (660 barrels) requires a fleet of eight railcars. Based on LEI's research of public sources discussed in Section 3.1 above, LEI assumed tanker lease costs of \$750 per car per month. The freight rate for crude hauling in Michigan is not publicly available, as noted previously. The average freight rate in the United States for all types of freight in 2015 was \$3.95 per ton-mile; the equivalent of \$0.00593 per barrel-mile.³⁹ This amounts to \$1.39 per barrel for the 234-mile trip. LEI assumed this average freight rate in its analysis.

LEI added all the monthly costs and divided by the monthly crude oil delivered to Lewiston. LEI arrived at an average of \$2.54 per barrel to ship by rail from Gaylord to Marysville (see Figure 20).

³⁸ Dynamic Risk, "Final Report: Alternative Analysis for the Straits Pipelines." Appendix J, P. J-2. Prepared for the State of Michigan. October 26, 2017.

³⁹ <https://www.bts.gov/content/average-freight-revenue-ton-mile>.

Figure 21. LEI's cost for the second leg of Option Four (rail transport from Gaylord to Marysville)

Year	Month	Light crude deliveries to Lewiston (barrels)	Number of railcar deliveries needed in the month	Round trip time (days)	Trip days required	Number of cars required	Freight charge	Railcar lease cost	Transloading cost	Overhead plus incremental overhead cost	Fixed capital recovery	LEI rail cost per barrel
2015	Jan	289,170	438.1	0.4	186.9	6.2	\$400,923	\$ 4,671	\$ 306,696	\$ 8,167	\$ 14,696	\$2.54
2015	Feb	297,995	451.5	0.4	192.6	6.4	\$413,158	\$ 4,814	\$ 316,055	\$ 8,167	\$ 15,144	\$2.54
2015	Mar	379,061	574.3	0.4	244.9	8.2	\$525,552	\$ 6,123	\$ 402,034	\$ 8,167	\$ 19,264	\$2.54
2015	Apr	248,895	377.1	0.4	160.8	5.4	\$345,083	\$ 4,021	\$ 263,980	\$ 8,167	\$ 12,649	\$2.55
2015	May	334,408	506.7	0.4	216.1	7.2	\$463,643	\$ 5,402	\$ 354,675	\$ 8,167	\$ 16,995	\$2.54
2015	Jun	313,808	475.5	0.4	202.8	6.8	\$435,082	\$ 5,069	\$ 332,827	\$ 8,167	\$ 15,948	\$2.54
2015	Jul	320,954	486.3	0.4	207.4	6.9	\$444,989	\$ 5,185	\$ 340,405	\$ 8,167	\$ 16,311	\$2.54
2015	Aug	312,764	473.9	0.4	202.1	6.7	\$433,634	\$ 5,052	\$ 331,719	\$ 8,167	\$ 15,895	\$2.54
2015	Sep	309,845	469.5	0.4	200.2	6.7	\$429,588	\$ 5,005	\$ 328,624	\$ 8,167	\$ 15,746	\$2.54
2015	Oct	317,444	481.0	0.4	205.1	6.8	\$440,123	\$ 5,128	\$ 336,683	\$ 8,167	\$ 16,132	\$2.54
2015	Nov	224,364	339.9	0.4	145.0	4.8	\$311,072	\$ 3,624	\$ 237,962	\$ 8,167	\$ 11,402	\$2.55
2015	Dec	332,848	504.3	0.4	215.1	7.2	\$461,480	\$ 5,377	\$ 353,021	\$ 8,167	\$ 16,915	\$2.54
2016	Jan	321,928	487.8	0.4	208.0	6.9	\$446,341	\$ 5,200	\$ 341,439	\$ 8,167	\$ 16,360	\$2.54
2016	Feb	222,358	336.9	0.4	143.7	4.8	\$308,290	\$ 3,592	\$ 235,834	\$ 8,167	\$ 11,300	\$2.55
2016	Mar	286,440	434.0	0.4	185.1	6.2	\$397,138	\$ 4,627	\$ 303,800	\$ 8,167	\$ 14,557	\$2.54
2016	Apr	213,797	323.9	0.4	138.1	4.6	\$296,421	\$ 3,454	\$ 226,755	\$ 8,167	\$ 10,865	\$2.55
2016	May	332,848	504.3	0.4	215.1	7.2	\$461,480	\$ 5,377	\$ 353,021	\$ 8,167	\$ 16,915	\$2.54
2016	Jun	286,824	434.6	0.4	185.3	6.2	\$397,670	\$ 4,633	\$ 304,207	\$ 8,167	\$ 14,576	\$2.54
2016	Jul	344,742	522.3	0.4	222.8	7.4	\$477,971	\$ 5,569	\$ 365,636	\$ 8,167	\$ 17,520	\$2.54
2016	Aug	289,755	439.0	0.4	187.2	6.2	\$401,734	\$ 4,681	\$ 307,316	\$ 8,167	\$ 14,725	\$2.54
2016	Sep	273,049	413.7	0.4	176.4	5.9	\$378,571	\$ 4,411	\$ 289,597	\$ 8,167	\$ 13,876	\$2.54
Weighted average												\$2.54

The total for the truck-plus-rail option from Kalkaska to Marysville is $\$0.55 + \$2.54 = \$3.09$ per barrel. This is more than the $\$2.81$ per barrel cost for trucking-only from Kalkaska to Marysville (see Figure 22). Therefore, although rail options exist, this rail route would be more expensive assuming the crude oil freight charge is $\$1.39$ per barrel.

LEI's analysis demonstrated that the single option (Option Two) examined by Dynamic Risk – trucking along the Lewiston – Marysville route while continuing to use the MarkWest Michigan Pipeline – is not cost effective compared to simply trucking crude oil to Marysville (Option Three). The trucking option LEI examined costs $\$1.31$ per barrel more than the MarkWest-Enbridge Line 5 option (Option One) that Northern region producers currently use. The truck-plus-rail option (Option Four), though not as cost-effective as the truck-only option, was still cheaper than the option examined by Dynamic Risk, because it does not involve using the MarkWest Michigan Pipeline.

For producers located in the Central region, the cost of trucking directly to market in Marysville could be lower than the cost for Northern producers. The Central region is physically closer to Marysville (though the distance varies depending on the county). For Central region producers, it would make more sense to truck crude oil south or southeast directly to Marysville, rather than north to Kalkaska then south to Marysville.

Figure 22. LEI’s weighted average annual cost of crude transportation to Marysville (\$ per barrel)

Option	Option 1: MI Pipeline and Enbridge Line 5	Option 2: MI Pipeline and trucking from Lewiston	Option 3: Trucking only	Option 4: Trucking plus rail
Mode of transportation	Michigan Pipeline	Michigan Pipeline		
Cost of transportation (\$ per barrel)	\$0.92	\$0.92		
Terminal	Lewiston	Lewiston	Kalkaska	Kalkaska
Mode of transportation	Enbridge Line 5 Pipeline	Truck	Truck	Truck
Cost of transportation (\$ per barrel)	\$0.59	\$2.80	\$2.81	\$0.55
Terminal				Gaylord
Mode of transportation				Rail
Cost of transportation (\$ per barrel)				\$2.54
Destination	Marysville			
Total cost (\$ per barrel)	\$1.51	\$3.72	\$2.81	\$3.09
Difference compared to Option One		\$2.22	\$1.31	\$1.59

Note: The transportation costs in this table are typical costs. They are neither averages, nor maximums, nor minimums. For example, the \$0.92 per barrel cost for the Michigan Pipeline is the tariff for injection at Lewiston; which is the same as the incentive tariff rate at Michigan Pipeline’s Kalkaska truck receipt point (see Section 3.1.1.1 for details). Thus, the \$0.92 is typical of the rate a shipper on Michigan Pipeline would pay to access the Lewiston injection point for Enbridge Line 5. Totals are rounded independently.

4 Conclusions and implications

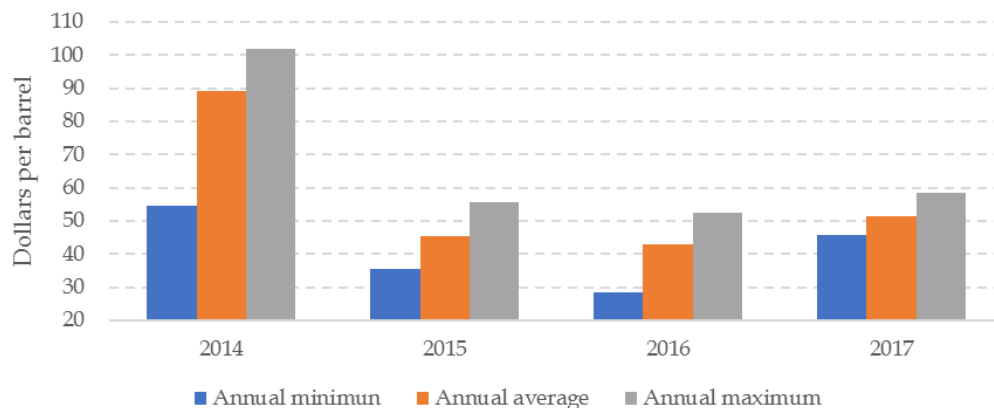
If Enbridge Line 5 was not in service, the three regions in Michigan which produce crude oil would each face different impacts:

- **Northern region:** Without access to Enbridge Line 5, Northern region oil producers would seek the least-expensive alternative. The cheapest option is trucking to Marysville, without using the MarkWest Michigan line. LEI estimates this would add \$1.31 per barrel to the weighted average annual cost of transporting oil.
- **Central region:** Oil producers in the Central region would likely pay less than Northern producers to transport oil to market, as they are generally closer to Marysville. The impact on these producers would probably be less than \$1.31 per barrel.
- **Southern region:** Oil producers in the Southern region will not be impacted as they do not use Enbridge Line 5 to transport their crude oil to market.

4.1 The cost increase would be small compared with the value of crude oil

The average price of crude oil in Michigan was just over \$50 per barrel in 2017. A transportation cost increase of \$1.31 per barrel amounts to 2.6 percent of that average price. Higher crude oil prices for 2018 imply an even lower percentage for the cost impact in terms of the value of crude oil. Also, monthly average crude oil prices in the past four years have been as low as \$28 per barrel and as high as \$100 per barrel (see Figure 23). A \$1.31 per barrel difference in transport cost is small compared with such large changes in the value of Michigan crude oil.

Figure 23. Annual maximum, minimum, and average prices for crude oil first purchase prices in Michigan (2015-2017)



Source: EIA⁴⁰

⁴⁰ EIA. "Domestic Crude Oil First Purchase Prices by Area - Michigan." Accessed on July 2018.
<https://www.eia.gov/dnav/pet/pet_pri_dfp1_k_a.htm>

4.2 Impact on Michigan crude oil producers could be minimal

The volume of crude oil the Michigan producers have been shipping on Line 5 (about 10,000 barrels per day) is tiny compared to the over 700,000 barrels per day used by nearby Detroit, Toledo, and Sarnia refineries. If Line 5 were not in service, these refineries would need other options for sourcing the rest of the 414,000 barrels per day that Line 5 has typically delivered.⁴¹ Without Line 5, refiners and other purchasers of crude oil would have to find alternatives to a portion of the 414,000 barrels per day. Michigan's production of 15,000 barrels per day would account for only a small fraction of this. Rail could carry large volumes from distant supply regions such as North Dakota but could cost more than trucking Michigan-produced crude oil. This would give Michigan producers headroom to increase their delivered prices to refineries and other purchasers; the impact on the profitability of Michigan crude oil producers may therefore be minimal.

⁴¹ Average Line 5 deliveries of light crude oil 2015/16. Dynamic Risk. Dynamic Risk, "Final Report: Alternative Analysis for the Straits Pipelines." Appendix C. Prepared for the State of Michigan. October 26, 2017.