Potential Enbridge Line 5 Closure:

Alternatives for Crude Oil Supply to

Ontario and Quebec Refineries

and

Associated Impacts on Ontario and Quebec Refined Product Markets

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About the author

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Executive Summary

Enbridge Energy's Mainline System connects crude oil producers in Western Canada to refineries in the US Midwest and Ontario. Additional pipelines connected to the Mainline System serve producers in areas such as the Bakken region of North Dakota, and refineries further to the south and east. Two pipelines in the Mainline System deliver crude oil to Sarnia, Ontario:

- Line 5, which runs from Superior, Wisconsin to Sarnia, Ontario
- Line 78, which runs from Flanagan, Illinois and also terminates in Sarnia, Ontario

Hydrocarbons carried on the Mainline System to Sarnia are delivered to refineries and a natural gas liquids (NGL) fractionation plant in Sarnia, and onward on additional pipelines to refineries further east in Ontario, Quebec and Pennsylvania. Crude oil transported on Lines 5 and 78 can also be delivered to refineries in Detroit, Michigan and Toledo, Ohio via additional pipelines connected to the Mainline System. In addition to crude deliveries on the Mainline System and associated pipelines, the refineries in Nanticoke, Ontario, Montreal, Quebec and Lévis, Quebec are also able to receive crude oil deliveries via rail car and marine tanker.

In the event of the potential closure of Line 5, the following changes to the crude oil logistics system serving refineries in Ontario and Quebec would enable continued reliable supply of crude oil to these refineries from the same sources that the refineries are currently processing:

- Expansion of Enbridge Energy's Line 78 to the ultimate design capacity of this pipeline, which is 800,000 bd on Line 78A from Flanagan, IL to Stockbridge, MI, and 525,000 bd on Line 78B from Stockbridge, MI to Sarnia
- Investment in additional rail car offloading facilities at refineries in Ontario and/or Quebec, allowing an increase of 119,000 bd in receipts of crude oil by rail from sources in western North America

The impact of these changes on consumer prices for refined petroleum products such as gasoline and diesel fuel in Ontario and Quebec would likely be very modest, to the point that such changes would likely go unnoticed. If the increase in crude oil transportation cost associated with these changes is averaged over the total volume of crude processed by refineries in Ontario and Quebec, average crude costs would rise by $2.01 US per barrel. This would translate into an increase in refined petroleum product cost at the refinery gate of $0.018 CDN per litre, averaged across all refinery liquid products. It is important to note that imports represent 23%-26% of domestic sales of motor gasoline in Ontario plus Quebec. Given this high level of refined product imports, it is possible that refined petroleum product prices could rise less than the increase in crude oil costs.

In the event that Line 5 were to experience a closure without completion of the modifications to expand Line 78 and add rail car unloading facilities as described above, there would be the potential for significant impacts on Ontario and Quebec refined products markets. With economic factors strongly favoring the processing of crude produced in Western Canada and/or North Dakota and delivered via the Mainline System by these refineries, Quebec and Ontario refiners would likely continue to nominate for capacity on the Mainline System to access these economically advantaged crudes. If this were to occur, it would likely result in apportionment of capacity on parts of the Mainline System, which could lead to shortfalls in crude availability for refineries in Ontario and Quebec. Such shortfalls, were they to occur, would likely result in constraints on the availability of refined products in these markets and the possibility of significant rises in consumer prices for refined petroleum products.

Currently existing crude oil logistics infrastructure could be used to deliver crude to the refineries in Quebec independent of the Enbridge Mainline System and without adding rail car unloading capacity. These facilities are the marine tanker unloading facilities at the Lévis refinery, and the Portland to Montreal pipeline and associated marine tanker receiving facilities in Portland, Maine. Indeed, this is the logistics infrastructure that delivered crude oil to these refineries from 1998 through 2015. However, Quebec refiners are unlikely to voluntarily give up their current access to favorably priced crude from western North America and shift back to the use of these facilities for all of their crude oil supply. Further, there may be community opposition in Portland which could prevent or delay the return to service of the Portland to Montreal pipeline system.

Table of Contents

List of Figures

List of Tables

1 Introduction

This report evaluates the impact of the potential closure of Enbridge Energy's Line 5 on refineries and refined products markets in Ontario and Quebec. Line 5 is a component of Enbridge's Mainline System connecting crude oil producers in Western Canada to Ontario and the US Midwest, and onward on additional pipelines to markets further south in the US and east in Canada. Line 5's route commences in Superior, Wisconsin and runs eastwards across Michigan's Upper Peninsula, crosses the Straits of Mackinac which connects Lake Michigan and Lake Huron, and then runs southward through Michigan's Lower Peninsula to Marysville before crossing under the Saint Clair River and terminating in Sarnia, Ontario.

The report starts by providing market context with respect to North American crude oil supply and associated crude oil logistics systems, with a focus on the producing areas and logistics systems that directly impact refineries and refined product markets in Ontario and Quebec. With this context established, options to maintain crude oil deliveries to Ontario and Quebec in the event of a Line 5 closure are described and the impact of these options on crude oil costs for Ontario and Quebec refiners is evaluated. The report also provides information on the infrastructure changes required for the implementation of these options.

The report continues with an assessment of the Ontario and Quebec refined petroleum product markets, starting with an overview of key demand trends and overall market structure. The report then evaluates the impact of the potential closure of Line 5 on refined petroleum product markets. The report concludes with an analysis of the impact of a potential Line 5 closure and the associated constraint on NGLs delivery to Ontario, with a focus on potential impacts on the Ontario petrochemical industry.

2 Crude Oil Supply and Logistics Systems

Changes in crude oil production across producing regions are a constant for the oil sector, and these changes inevitably lead to associated changes in crude oil logistics systems. For example, crude oil production from the Bakken region in North Dakota and from the oil sands in Alberta has risen very significantly over the last 15 years. These production increases have led to adjustments in the North American crude oil logistics system, as described in more detail below.

2.1 North American Crude Oil Logistics Systems

An extensive network of crude oil pipelines connects North American crude oil producers with refineries and crude oil export facilities[1]. These pipelines connect producing regions such as the Western Canadian Sedimentary Basin in Canada, the Permian Basin in Texas and New Mexico and the Bakken region in North Dakota to refineries in Central and Eastern Canada, the US mid-continent and the US Gulf Coast.

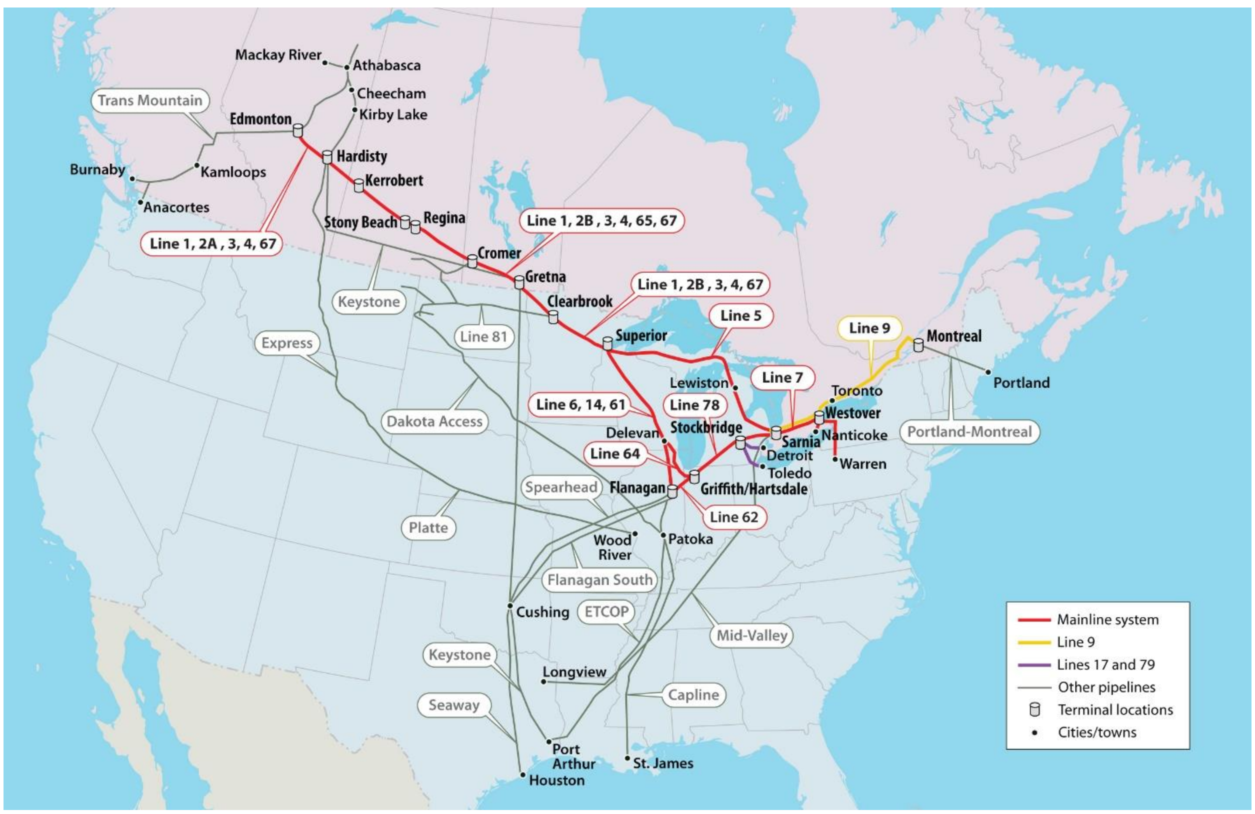

FIGURE 1: MAP OF MAJOR NORTH AMERICAN CRUDE OIL PIPELINES

Enbridge Energy's Mainline System is a major element of this network of pipelines. It connects crude oil production sites in Western Canada to markets in the US midcontinent and Ontario (see Figures 2 and 3). In addition, other pipelines can deliver crude oil from producing areas such as the Bakken region into the Mainline System, and transport crude oil shipped on the Mainline System onward to reach refineries as far east as Quebec and as far south as the US Gulf Coast.[2]

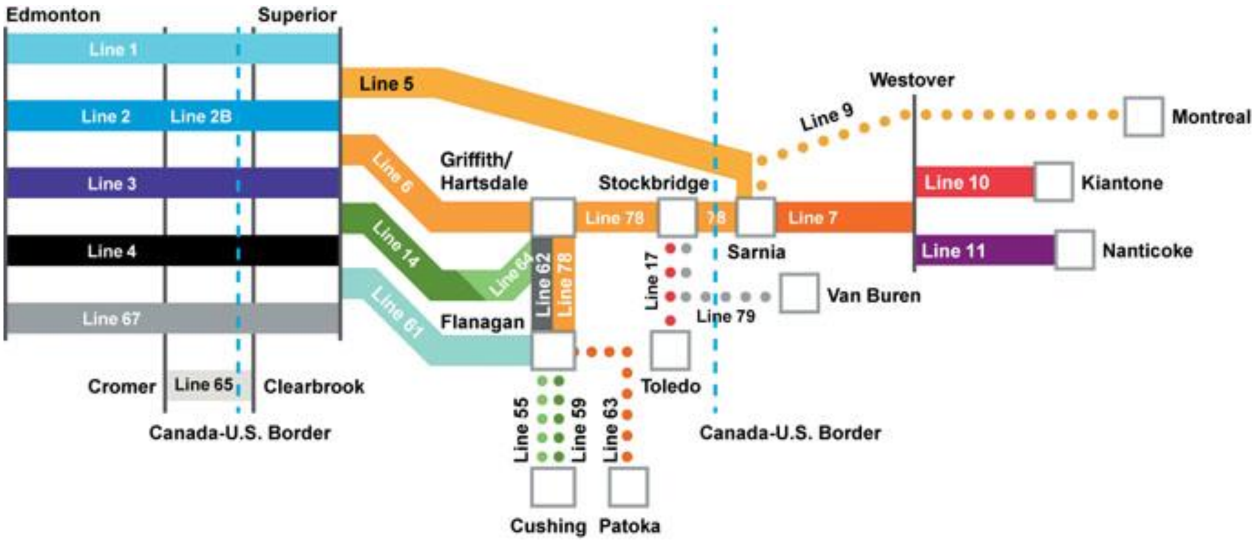

FIGURE 2: ENBRIDGE MAINLINE CRUDE OIL PIPELINE SYSTEM[3]

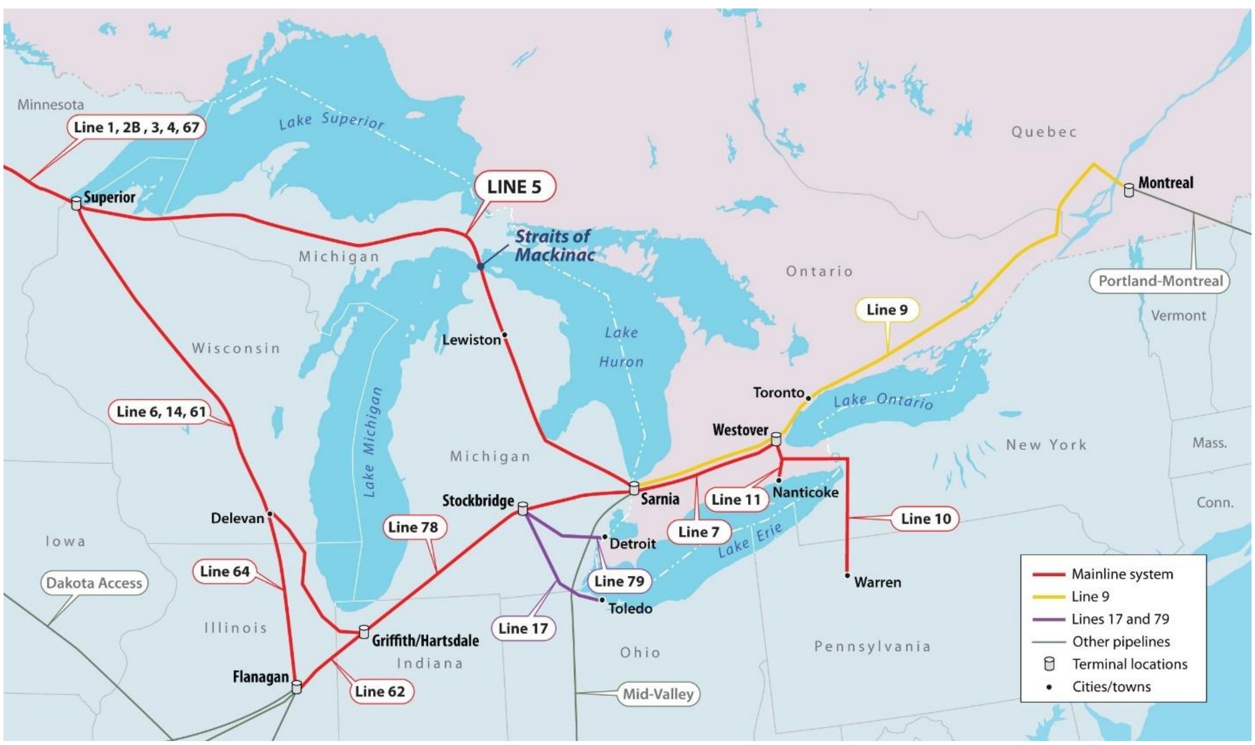

FIGURE 3: MAP OF LAKEHEAD SYSTEM AND LINE 9 CRUDE OIL PIPELINE ROUTES

2.2 Trends in North American Crude Oil Production

Crude oil production in North America has experienced significant growth over the last 15 years. Key trends include steady growth in production from the oil sands in Alberta and sharply rising output from tight shale oil fields in Texas, New Mexico and North Dakota since 2010. The result has been a 121%

increase in North American crude oil production from 7.7 million bd in 2005 to 17.0 million bd in 2019, as shown in Figure 4.

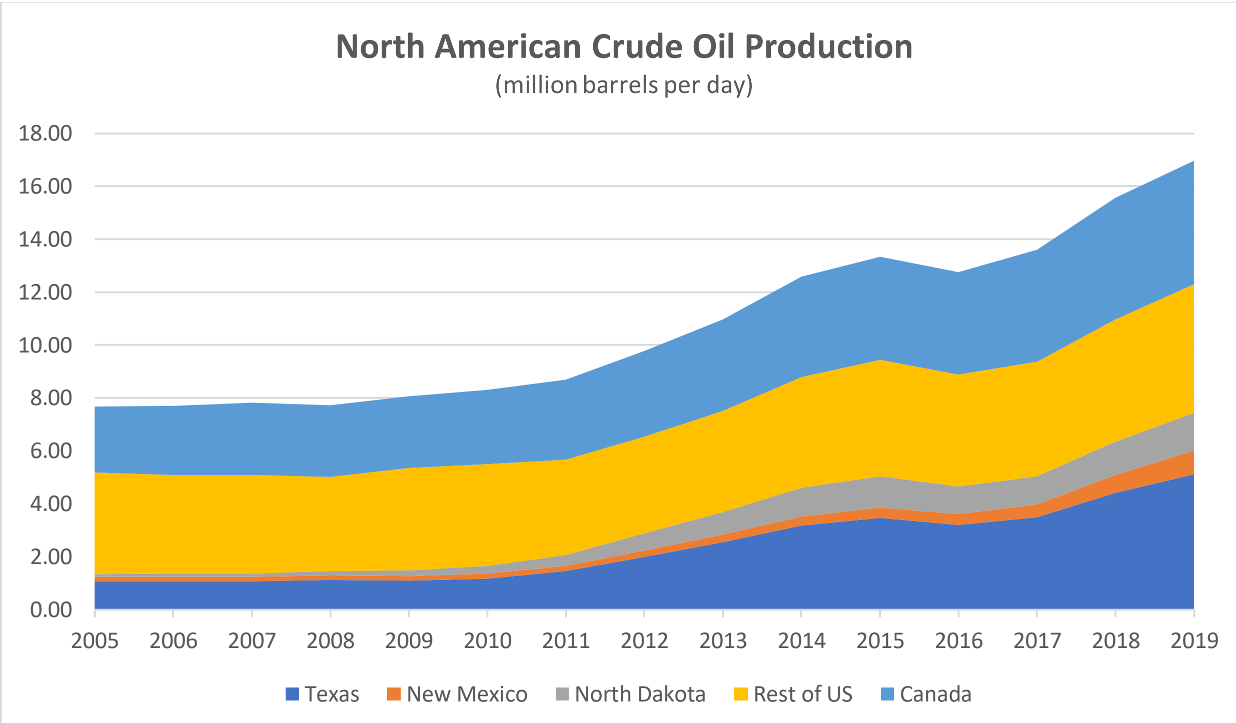

FIGURE 4: NORTH AMERICAN CRUDE OIL PRODUCTION[4]

This increase in North American crude oil production led to a significant decline in imports of crude oil into the US from countries other than Canada, and a gradual rise in imports from Canada, as shown in Table 1. Imports of crude oil into the US from countries other than Canada declined 73% from 8.5 million bd in 2005 to 2.3 million bd in 2019, while imports from Canada rose 134% from 1.6 million bd in 2005 to 3.8 million bd in 2019. Subsequently, crude oil exports from the US also rose very significantly, increasing one hundred-fold from 0.03 million bd in 2005 to 3.0 million bd in 2019. This growth in US crude oil exports was enabled by rising domestic crude oil production as described above, and permitted by the Consolidated Appropriations Act of 2016, which repealed a previous law that had effectively prohibited exports of crude oil from the US.

	Imports from Canada	**Imports from Other Countries**	**Exports**
	(barrels per day)		
2005	1,633	8,493	32
2010	1,970	7,243	42
2015	3,169	4,194	465
2019	3,814	2,987	2,982

TABLE 1: US CRUDE OIL IMPORTS AND EXPORTS[5,6]

2.3 Impact of Crude Oil Production Trends on North American Crude Oil Logistics Systems

The growth in crude oil production in Western Canada and North Dakota described above exceeded the capacity of pipelines to transport this production to refining markets. This led to allocation of capacity on the common carrier pipelines carrying crude oil away from these producing regions, a regulatory process also referred to as capacity apportionment[7], and to sharp declines in crude oil prices for producers in these producing regions. Given the time lags involved in developing, permitting, designing and constructing new pipelines[8], crude oil producers turned to shipping increasing volumes of crude by rail. This involved installing new railcar loading facilities to permit shipments of crude oil by rail, while refiners in Central and Eastern Canada and in the US East Coast, Gulf Coast and West Coast regions installed rail car unloading facilities.

Total shipments of crude oil by rail in the US rose from an average of 30,000 bd in the first quarter of 2010 to more than 1,000,000 bd during the period from April 2014 to January 2015. Although down from the 2014/2015 peak, total US rail shipments of crude oil remain significantly above 2010 levels, for example averaging 650,000 bd to 800,000 bd in the second half of 2019 (see Figure 5).

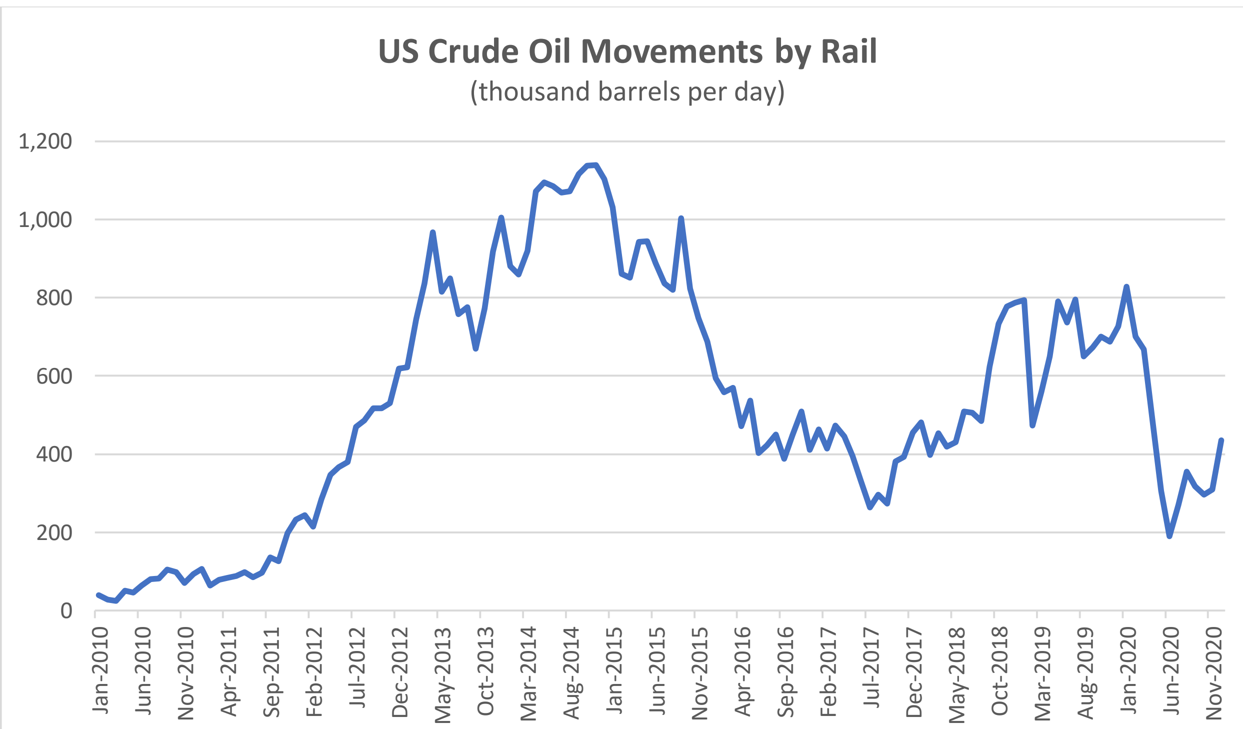

FIGURE 5: US CRUDE OIL MOVEMENTS BY RAIL[9]

Looking more closely at the Bakken region (see Figure 6), rail shipments out of North Dakota initially mirrored the rapid rise in crude oil production in the state from 2010 to 2014. This was a consequence of the constraints on pipeline takeaway capacity out of North Dakota at the time. Rail shipments out of North Dakota rose from an average of 44,000 bd in 2010 to an average of 754,000 bd in 2014. More recently, the completion of pipelines has resulted in significant declines in rail shipments, even as crude oil production has remained at or above 1,000,000 bd.

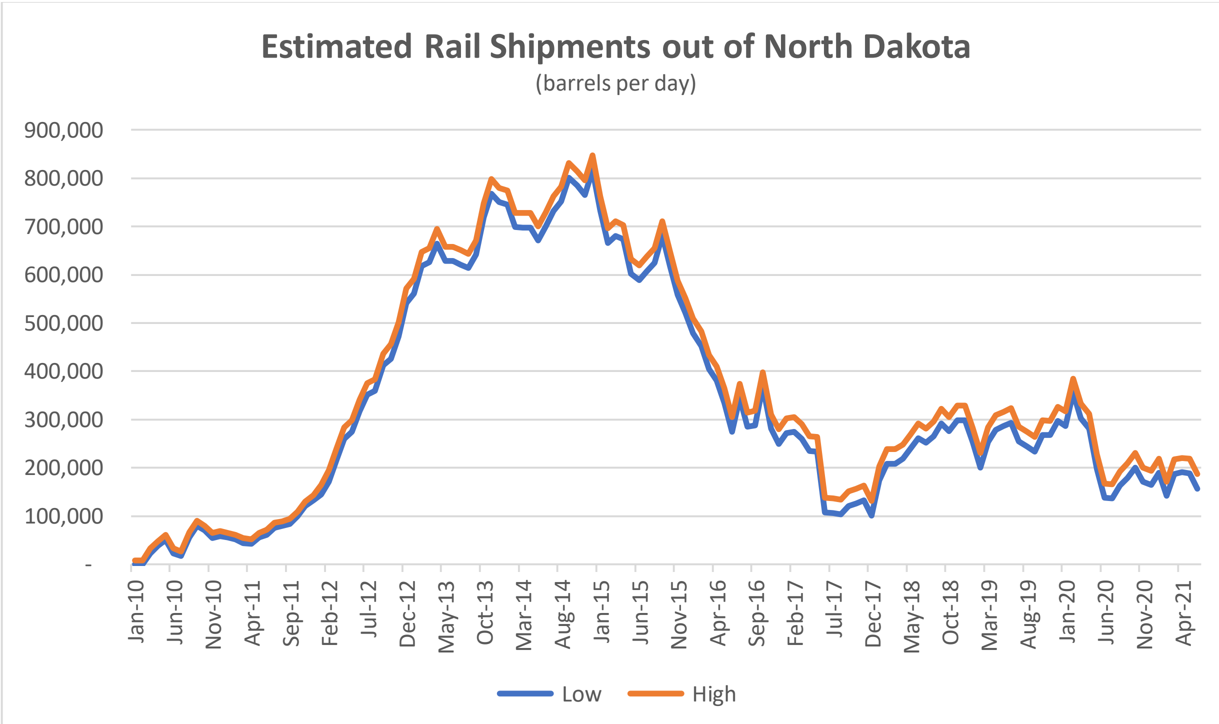

FIGURE 6: CRUDE OIL MOVEMENTS OUT OF NORTH DAKOTA BY RAIL[10]

In Canada, exports of crude oil by rail rose steadily during the 2010s as increasing crude oil production exceeded pipeline takeaway capacity. Monthly average crude oil exports by rail, which were in the range of approximately 10,000 bd to 35,000 bd in the first half of 2012, reached an average of 280,611 in 2019, with flows in some months reaching as much as 350,000 bd (see Figure 7). Domestic shipments of crude oil by rail from Alberta to Canadian refineries also rose, as evidenced by the additions in rail car receiving facilities at Canadian refineries in New Brunswick, Quebec, Ontario and British Columbia in 2013 and 2014[11]. However specific data on interprovincial movements of crude by rail are not publicly available.

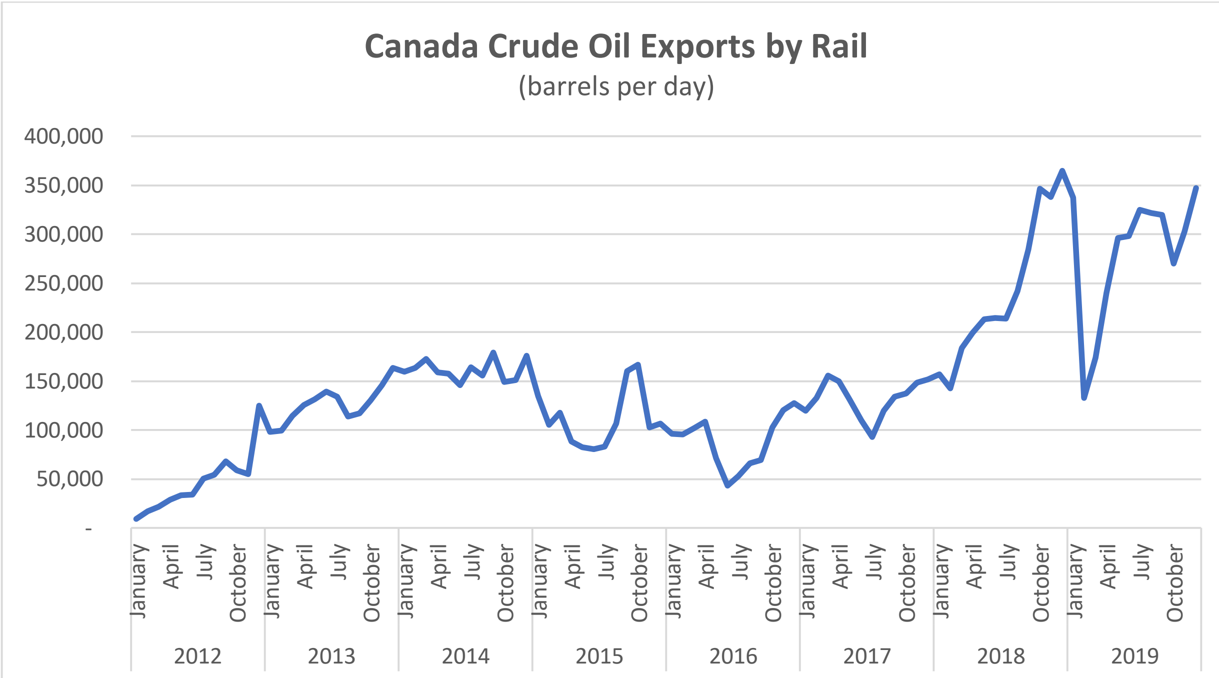

FIGURE 7: CRUDE OIL EXPORTS FROM CANADA BY RAIL[12]

The rise in crude oil production in the Bakken region and from the oil sands of Alberta led to many proposals for new and expanded pipelines to connect this growing supply to refining markets. A detailed assessment of these plans is beyond the scope of this report. However, it is worth noting that a number of pipeline expansions and new pipelines were built and became operational, while other proposed projects did not proceed. Together with the added capacity to ship by rail, these pipeline capacity additions have been an important component of the changes in the crude oil logistics system in response to the rise in Alberta and Bakken region crude oil production.

2.4 Ontario and Quebec Oil Refineries and the Enbridge Mainline System

There are six oil refineries in Ontario and Quebec, with a combined crude processing capacity of 765,000 bd. Four of the refineries are located in Ontario with a combined capacity of 393,000 bd, and two are in Quebec with a combined capacity of 372,000 bd. Locations, ownership and crude processing capacities for these refineries are provided in Table 2 below.

Province	Owner	Location	Capacity (bd)
Ontario	Imperial Oil	Sarnia	121,000
	Shell	Sarnia	75,000
	Suncor	Sarnia	85,000
	Imperial Oil	Nanticoke	112,000
Total			**393,000**
Quebec	Suncor	Montreal	137,000
	Valero	Lévis	235,000
Total			**372,000**

TABLE 2: CAPACITY OF REFINERIES IN ONTARIO AND QUEBEC[13]

Crude oil shipped on the Mainline System destined for refineries in Ontario and points east is delivered to Sarnia, Ontario via two branches:

- Enbridge Line 5, which runs from Superior, Wisconsin eastwards across the Upper Peninsula of Michigan, across the Straits of Mackinac and south through the Lower Peninsula of Michigan to Sarnia[14]
- Enbridge Line 78, which runs from Enbridge's Flanagan Terminal in Illinois eastwards through northwestern Indiana and across southern Michigan before also terminating in Sarnia[15]

Crude shipped to Sarnia on the Mainline System is directly available to the three refineries in Sarnia. Further volumes are shipped eastward to the Imperial Oil refinery in Nanticoke, Ontario, the United Refining refinery in Warren, Pennsylvania and the Suncor refinery and Valero crude oil terminal facilities in Montreal via additional pipelines:

- Crude destined for the Imperial Oil refinery in Nanticoke is shipped to Westover, Ontario on Enbridge Line 7 and on to Nanticoke on Enbridge Line 11 (these lines are both part of the Mainline System)
- Crude destined for the United Refining refinery in Warren, Pennsylvania is shipped to Westover, Ontario on Enbridge Line 7 (this line is part of the Mainline System), then to Buffalo, New York on the Westover Express Pipeline and then on the refinery on the Kiantone Pipeline[16]
- Crude oil destined for the Suncor refinery in Montreal is shipped from Sarnia to Montreal on Enbridge Line 9[17]
- Crude oil destined for the Valero refinery in Lévis, Quebec, is shipped from Sarnia to Montreal on Line 9, then on to Lévis on oil tankers on the St. Lawrence River[18]

Enbridge's Line 9, which runs between Sarnia, Ontario and Montreal, Quebec, provides an example of how crude oil infrastructure develops and evolves in response to changes in the economic and political environment.[19]

- Line 9 was built and completed in 1976 with the support of the Canadian federal government. The government's policy objective was to secure access to domestic crude oil supply for refineries in Quebec, by enabling the shipment of Western Canadian crude production eastward from Sarnia to Montreal.
- Shipments on Line 9 declined in the 1990s as imports of offshore crudes became economically more attractive for the refineries in Montreal, and Line 9 was reversed in 1998, flowing east to west. The line was primarily used by petrochemical manufacturers in Ontario to access offshore feedstocks.
- With the growth in production of crude oil in western North America since 2010 as described above, economic incentives shifted once more, and in 2012 Enbridge filed for approval from the National Energy Board to "re-reverse" Line 9 back to its original west to east flow, and to expand capacity to 300,000 bd. The re-reversal was approved by the NEB, and was completed in December, 2015.

Line 9 has been operating in west to east mode from Sarnia, Ontario to Montreal, Quebec since completion of the "re-reversal" at the end of 2015.

2.5 Alternatives to the Mainline System for Crude Oil Supply to Ontario and Quebec Refineries

There are three existing alternatives to the Enbridge Mainline System that can physically deliver crude oil to Ontario and Quebec refineries:

- Rail: The Imperial Oil refinery in Nanticoke, the Suncor refinery in Montreal and the Valero refinery in Lévis all have rail car unloading facilities with a combined capacity of 110,000 bd, with details provided in Table 3 below. These rail receiving facilities enable receipt by rail of crude oil produced in Western Canada and the US Upper Midwest.
- Marine tanker direct: The Valero refinery in Lévis has the ability to receive direct deliveries of crude oil via tanker from a wide range of supply sources. This was the sole mode of crude oil delivery to this refinery from the start of operations until the mid-2010s. More recently, Valero has indicated that it has received crude oil deliveries of crude produced in the US and shipped from the US Gulf Coast by crude oil tanker. These facilities have the capacity to receive at least 235,000 bd of crude, based on previous operations. [20]
- Marine tanker and pipeline: The Suncor refinery in Montreal is able to receive crude oil from offshore sources delivered by crude oil tanker to Portland, Maine and then on to Montreal on the Portland-to-Montreal pipeline. This was the primary mode of crude oil delivery to this refinery from the start of operations until the completion of Line 9 in 1976. Flows of crude oil through this system have essentially stopped since 2016, because the delivered cost is not competitive with crude oil sourced from western North America.[21]

Province	Owner	Location	Capacity (bd)
Ontario	Imperial Oil	Nanticoke	20,000
Quebec	Suncor	Montreal	30,000
Quebec	Valero	Lévis	60,000
Total			110,000

TABLE 3: CRUDE OIL RECEIVING CAPACITY BY RAIL AT ONTARIO AND QUEBEC REFINERIES[22]

2.6 Current Crude Oil Deliveries to Ontario and Quebec Refineries

As described above, the Enbridge Mainline System is the primary component of the crude oil logistics system serving refineries in Ontario and Quebec. The large majority of crude the crude shipped to Ontario and Quebec on the Mainline System is sourced from Western Canada. From 2016 through 2019, 71% to 79% of the total volume shipped to Sarnia consisted of crude oil and NGLs from Canada, with the remaining 21% to 29% of the total consisting of crude oil produced in the US (see Figure 8).

Total shipments of crude oil and NGLs to Sarnia on the Mainline System were 724,000 bd in 2018, up from 450,000 bd to 510,000 bd from 2012 to 2015. The increase in volume starting in 2016 coincided with the re-reversal and expansion of Enbridge Line 9 in late 2015, which allowed the shipment of crude oil eastward from Sarnia to Montreal.

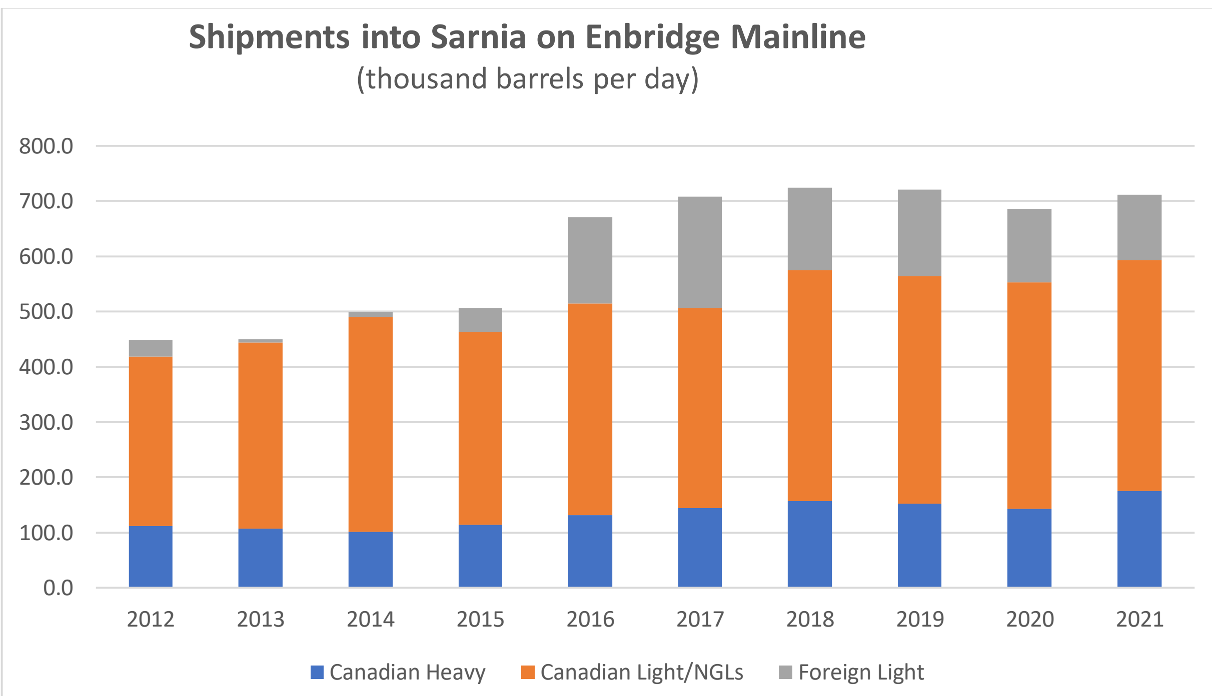

FIGURE 8: SHIPMENTS INTO SARNIA ON ENBRIDGE MAINLINE SYSTEM[23]

As shown in Figure 8, data on deliveries to Sarnia on the Mainline System are broken down into three categories; Canadian heavy crude, Canadian light crude and NGLs, and imported light crude. A publicly released report authored by Dynamic Risk Advisors (DRA) provides historic data on the specific share of NGLs in this mix[24]. Specifically, Appendix C of the DRA report shows data provided by Enbridge indicating that deliveries of NGLs into Sarnia on Line 5 averaged 76,802 bd in 2015 and 81,221 bd in 2016. Assuming a typical annual average NGL delivery rate of 80,000 bd based on these historic data, this implies that crude oil deliveries into Sarnia on the Mainline System were 644,000 bd in 2018.

This crude oil delivery rate of 644,000 bd into Sarnia in 2018 was destined for refineries in Ontario and Quebec and the 65,000 bd United Refining refinery in Warren, Pennsylvania. Table 4 below provides an analysis of the allocation of these crude oil deliveries, and enables the calculation of the additional volumes of crude supplied to Ontario and Quebec refineries via alternate logistics:

- If we assume the United Refining refinery operates at 60,000 bd on average (a 92% capacity utilization rate), then refineries in Ontario and Quebec received 584,000 bd of crude shipped on the Mainline System.
- Crude runs by Ontario and Quebec refineries in 2018 totaled 684,000 bd.
- This implies that Ontario and Quebec refineries received 100,000 bd of crude oil via other means.

	Thousand barrels per day
Total volume delivered to Sarnia on Mainline	724
NGL delivered to Sarnia (estimate)	80
Crude oil delivered to Sarnia on Mainline	644
United Refining crude oil runs (estimate)	60
Crude delivered to Sarnia on Mainline processed by Ontario and Quebec refineries	584
Ontario refinery crude oil runs	357
Quebec refinery crude oil runs	327
Total Ontario and Quebec crude oil runs	684
Crude oil delivered to Ontario and Quebec refineries by rail or marine tanker	100

TABLE 4: ONTARIO AND QUEBEC CRUDE OIL BALANCE - 2018[25]

Based on the crude oil logistics systems serving these refineries, we can conclude that the large majority of this volume consisted of shipments by rail and/or by marine tanker to the Lévis refinery in Quebec.

3 Impact of a Potential Line 5 Closure on Crude Oil Supply and Logistics Systems

As described above, refineries in Ontario receive the large majority of their crude oil supply via the Enbridge Mainline system. As also described previously in this report, since the re-reversal of Line 9 in late 2015, the large majority of crude oil processed in Quebec refineries is likewise shipped to Sarnia on the Enbridge Mainline System, and then onwards to Quebec on Line 9. Accordingly, this assessment of the impact of a potential closure of Line 5 on Ontario and Quebec refineries starts with an evaluation of the potential to maintain deliveries via the Mainline System by increasing flows in Line 78, the remaining portion of the Mainline System that delivers crude oil to Sarnia. Once the potential to increase Line 78 deliveries has been fully evaluated, other options to increase crude oil deliveries using existing and/or expanded logistics infrastructure will also be considered.

3.1 Options to Maintain Pipeline Deliveries of Crude to Ontario and Quebec Refineries

On April, 16 2012, Enbridge submitted an application to the Michigan Public Service Commission (Case No. U-17020) requesting approval to replace segments of what is now known as Line 78.[26] This application was part of an undertaking by Enbridge to fully replace all the pipeline elements of what was previously known as Line 6B, and is now referred to as Line 78, running from Griffith, Indiana to Sarnia, Ontario. The line replacement program came after a significant spill of crude oil occurred in Calhoun County, Michigan in July 2010, which was caused by pipeline failure.[27]

Enbridge's application provides important information on the potential to expand Line 78. Specifically, the application includes a table on Page 5 of Exhibit A-2 of the application document that provides information regarding the "current" and "ultimate" capacities of Line78A, which runs from Griffith, Indiana to Stockbridge, Michigan, and of Line 78B, which runs from Stockbridge to Sarnia upon completion of the requested replacements of pipeline segments. These capacities are presented in Table 5 below. This table indicates that the Ultimate Annual Capacity of Lines 78A and 78B are 800,000 bd and 525,000 bd, respectively. The current capacities for these pipeline segments are indicated to be 570,000 bd and 500,000 bd, respectively, on Enbridge's website.[28]

	Line 78A	Line 78B
Current Annual Capacity (bd)	570,000	500,000
Ultimate Annual Capacity (bd)	800,000	525,000

TABLE 5: CURRENT AND ULTIMATE ANNUAL CAPACITY LINES 78A AND 78B[29]

Two important conclusions regarding Line 78 capacity and the capacity of Mainline System to deliver crude oil into Sarnia in the event of a potential closure of Line 5 can be drawn from details provided in the application document and associated testimony by Enbridge executives[30]:

- Bringing Lines 78A and 78B up to their ultimate capacity requires additions to pumping capacity, but does not require replacement of any pipeline elements
- If Lines 78A and 78B are brought up to their ultimate capacity, the Mainline System would have the capacity to deliver 525,000 bd of crude oil to Sarnia

With respect to the first conclusion, the application document makes clear that once the modifications described in the application are complete, the pipeline components of Lines 78A and 78B will be fully consistent with pipeline operation at ultimate capacity. Quoting from page 5 of exhibit A-2 of the application document:

"Upon completion of the Project (and the 75-mile replacement project filed with this Commission in MPSC Case Nos. U-16838 and U-16856), Enbridge will have replaced Line 6B in its entirety from Griffith, Indiana to the St. Clair River in Marysville, Michigan. This will enable Enbridge to restore Line 6B to its original ultimate pipeline capacity and along with certain facility installations at existing station sites, to provide the pipeline capacity necessary to meet its shippers' current and future transportation requirements."

In other words, with the completion of the modifications outlined in the application, the only additional changes required to the pipeline to its ultimate annual capacities of 800,000 bd for Line 78A and 525,000 bd for Line 78B are modifications to "… certain facility installations at existing station sites …". This indicates that the changes required would be limited to modifications to increase pumping capacities at some or all of the existing pump stations on Line 78.

The second conclusion is that once the modifications to bring Lines 78A and 78B up to their ultimate capacities are complete, the Mainline System will have the capacity to deliver 525,000 bd of crude to Sarnia. This based on the following:

- The ultimate annual capacity of Line 78A, which runs from Griffith, Indiana to Stockbridge, Michigan is 800,000 bd
- At Stockbridge, two existing crude lines with a combined capacity of 181,000 bd, Enbridge Line 17 and Enbridge Line 79, split off from Line 78
- These pipelines enable delivery of crude off the Mainline System to refineries in Detroit, Michigan and Toledo, Ohio
- Hence even if flows on Lines 17 and 79 are at maximum rates, there would be more than sufficient capacity on Line 78A to deliver 525,000 bd to Stockbridge, and then on to Sarnia on Line 78B

In summary, any consideration of the impact of a potential closure of Line 5 should take account of the fact that Line 78 will have the capacity to deliver 525,000 bd of crude oil into Sarnia once modifications to its pumping capacity have been completed.

3.2 Other Existing Options for Crude Oil Delivery to Ontario and Quebec Refineries

Crude oil deliveries to Sarnia on the Mainline System totaled 644,000 bd in 2018. This is 119,000 bd more than the ultimate design capacity of Line 78 to deliver crude into Sarnia of 525,000 bd. Hence if we assume a potential closure of Line 5 has taken place and Line 78 is expanded to its ultimate design capacity, an additional 119,000 bd in crude deliveries would be required to maintain total crude deliveries to refineries in Ontario, Quebec and Warren, Pennsylvania at the 2018 rate of 644,000 bd.

As described earlier in this report, three existing logistics systems have the potential to provide this additional crude delivery capacity in the event of a Line 5 shutdown:

- Rail: Increased deliveries by rail to multiple refineries in Ontario and Quebec
- Marine tanker: Increased deliveries by crude oil tanker to the Valero refinery in Lévis
- Marine tanker plus pipeline: Resumption of crude oil deliveries by tanker to Portland, Maine and then on to the Suncor refinery in Montreal on the Portland to Montreal pipeline

These options are evaluated in more depth in the following sections of the report.

3.2.1 Increased Deliveries by Rail

There are four elements of infrastructure required to ship crude oil by rail from producing regions to refineries:

- Tank car loading facilities in proximity to the crude oil production and gathering facilities
- A sufficient number of tank cars to transport the crude oil by rail
- Access to a railroad network that enables shipment by rail from the tank car loading facilities to unloading facilities in proximity to the destination refinery
- Tank car unloading facilities at or proximate to the refinery that will process the crude oil

As described earlier in this report, crude oil shipments by rail from Alberta and the Bakken region have declined from recent highs over the last several years:

- Monthly average crude oil exports by rail from Canada to the US were consistently above 250,000 bd from the third quarter of 2019 to the first quarter of 2020, with most months above 320,000 bd and some months exceeding 400,000 bd. In 2021, exports from Canada by rail have been much lower, in the 110,000 bd to 195,000 bd range (see Figure 7 above).
- Shipments of crude oil out of US PADD 2 by rail have declined from a range of 623,000 bd to 715,000 bd during 2013 to 2015, to 232,000 bd to 314,000 bd during 2018 to 2020 (see Figure 9).

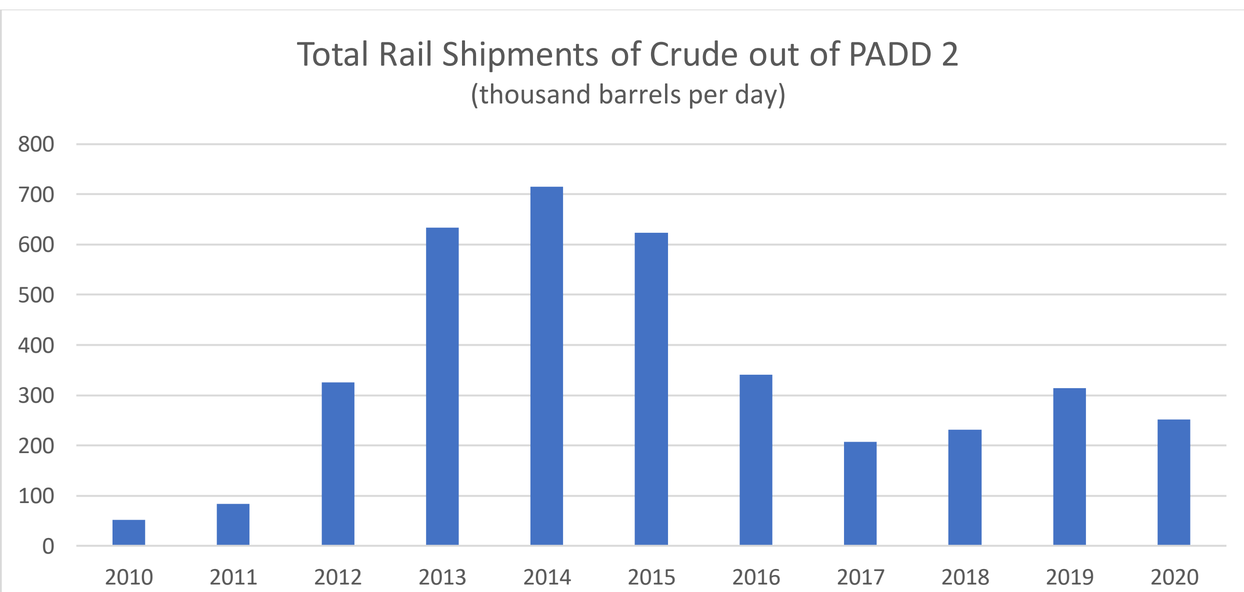

FIGURE 9: CRUDE OIL SHIPMENTS BY RAIL OUT OF US PADD 2[31]

These declines in shipments of crude oil by rail from Alberta and PADD 2 in recent years indicate there is significant under-utilized capacity in the first two of the four key elements required to ship crude by rail. As a result, there is more than sufficient existing loading and rail car capacity to enable a 120,000 bd increase in crude oil shipments by rail from Alberta and/or the Bakken region to refineries in Ontario and Quebec. Likewise, based on these recent declines in shipments by rail, we can conclude that there is sufficient rail system takeaway capacity from Alberta and North Dakota.

With respect to rail car unloading capacity, three refineries in Ontario and Quebec have a combined tank car unloading capacity of 110,000 bd, as described above in this report (see Table 3). This indicates that crude deliveries by rail are considered to be a potentially viable option for Ontario and Quebec refiners. It also indicates that making up all of the 120,000 bd delivery shortfall described above by rail deliveries would require some increase in offloading capacity. The specific amount of capacity increase, and the location of these offloading capacity increases, would depend on how much of the current 110,000 bd capacity is in use, and on which refineries would decide to add unloading capacity.

3.2.2 Increased Deliveries by Crude Oil Tanker to Lévis

For the majority of its existence, the Valero refinery in Lévis, Quebec received all of its crude oil from a range of offshore sources by crude oil tanker and delivered to its proprietary dock facilities on the St. Lawrence River. These facilities are currently operational, receiving crude oil shipments by tanker from Montreal that arrived from Western Canada on the Mainline System and Line 9, as described earlier in this report. The facilities also remain available to receive additional waterborne crude deliveries, and press reports and statements from Valero indicate that in recent years Valero has at times shipped crude oil to the Lévis refinery from the US Gulf Coast region.[32]

3.2.3 Return to Operation of Portland, Maine to Montreal Pipeline

The Portland to Montreal crude oil pipeline system was a key component of Canada's crude oil logistics system for many years. Before the completion of Line 9 in 1976 as described above, refineries in Montreal processed offshore crude delivered by tanker to Portland, Maine and then on to Montreal on the Portland to Montreal pipeline. With the reversal of Line 9 at the end of 2015 flows on the Portland to Montreal pipeline have slowed almost to a complete standstill.[33] Nevertheless, the pipeline remains operational, and the pipeline plus associated tanker unloading facility in Portland and associated tankage in Portland and Montreal that comprise the system could be reactivated for crude oil deliveries to Montreal. The capacity of the Portland to Montreal system would be more than sufficient to fully supply the Suncor refinery in Montreal.[34]

It is worth noting that there may be local resistance to restarting operations of the Portland to Montreal pipeline. The city of South Portland, Maine has passed an ordinance prohibiting the export of crude oil from facilities within the city[35]. With crude oil receiving operations having stopped for the last five years, it is possible there would be local resistance to the resumption of such operations. The age of the pipeline system (it was completed in 1941)[36] may also be raised as a point of concern.

3.3 Crude Oil Transportation Costs

Shipping crude oil by pipeline is widely recognized as being the lowest cost method of overland, long-distance transportation of significant volumes of crude oil.[37] Crude oil transportation costs on common carrier pipelines such as the Enbridge Mainline System are set by the National Energy Regulator (NER) in Canada and the Federal Energy Regulatory Committee (FERC) in the US. These tariffs are in the public domain. For example, the current tariff to ship light crude from Edmonton, Alberta to Sarnia, Ontario on the Mainline System is $36.9758 US per m3 (equivalent to $5.87 US per barrel),[38] while the cost to ship the same grade of crude from Edmonton to Montreal is $47.0800 US per cubic meter (equivalent to $7.49 US per barrel).[39]

The cost of shipping crude oil by rail is generally higher and more volatile than pipeline tariffs.[40] Factors that have a significant impact on the cost of shipping crude by rail include the freight rates charged by railroads,[41] and the lease rates for tank cars.[42] Shippers willing to make longer term commitments to shipping crude by rail can address some of this variability by entering into longer term contracts with railroads that can include minimum volume commitments, and by either owning or entering into long term lease arrangements for rail cars. Rates for shipping crude oil by rail are also less transparent than pipeline tariffs, particularly since shippers typically enter into contracts with railroads for transportation services that reflect their particular requirement for transportation services.[43]

Research published by Thomas Covert and Ryan Kellogg in a September 2017 Working Paper for the National Bureau of Economic Research provides insight into the variability of freight rates for shipping crude oil by rail[44]. Their analysis indicates that freight rates for crude by rail were US$4 per 1,000 barrel-miles in 2016, down from $5 US per 1,000 barrel-miles in 2011-2014, with roughly one half of the decline attributable to a decline in fuel costs for the railroads (see Figure 10).

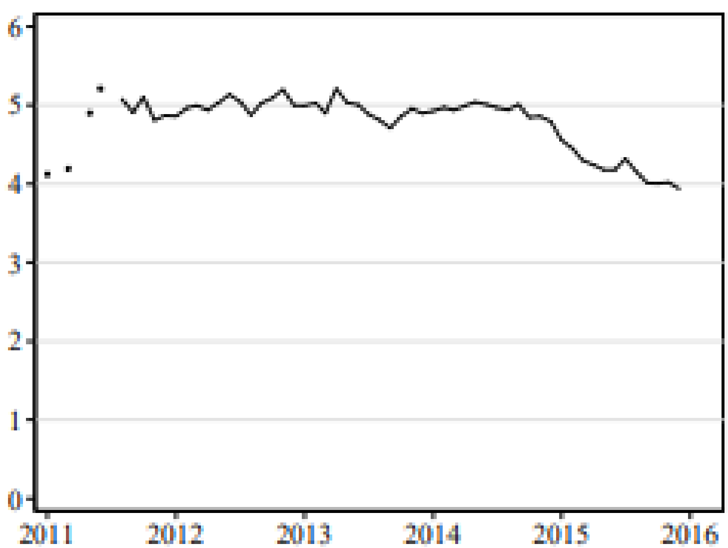

FIGURE 10: CRUDE BY RAIL COSTS - SHIPMENTS FROM PADD 2 TO PADD 1 IN $ PER BARREL[45]

Another important component of the cost of shipping crude oil by rail is the cost of ownership of the tank cars. Shippers typically own or lease their own rail cars and hence this cost is borne directly by the shipper and not by the railroad. As documented in the September 2017 Working Paper referenced above, during the rapid rise in crude production from the Bakken region and the attendant sharp increase in demand for tank cars, lease rates for large crude oil tank cars rose sharply and were reported to approach $2,500 per month in 2014/2015 (see Figure 11). Lease rates collapsed to under $500 per month in 2016, before more recently recovering to $750 per month.

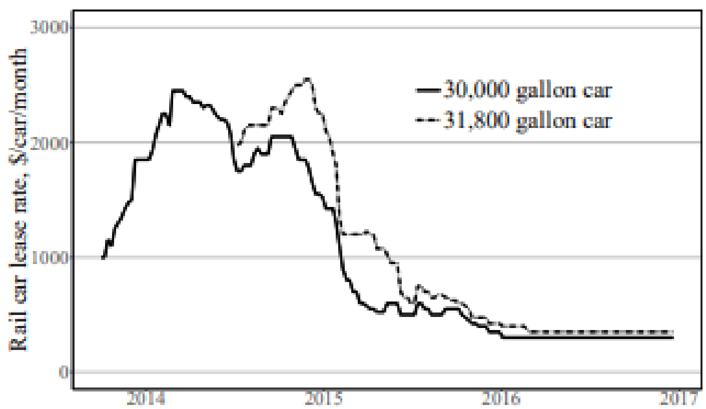

FIGURE 31: ASSESSMENT OF RAIL CAR LEASE RATES BY GENSCAPE[46]

Notwithstanding the significant increase in shipments by rail documented previously in this report, it is important to place this in context. Pipelines remain the lowest cost mode of overland shipping of large volumes of crude oil over long distances. The sharp rise in shipments by rail documented above took place in response to the crude oil production increases and constraints in pipeline capacity to bring these production increases to market, as described earlier in this report. As stated in the December 2014 report "US Rail Transportation of Crude Oil: Background and Issues for Congress" by the nonpartisan Congressional Research Service, "… refiners found it profitable to utilize the North Dakota oil delivered by rail even though the rail transportation cost is perhaps $5 to $10 per barrel higher than pipeline costs."[47] Indeed, even with the significant rise in crude oil shipments by rail in the US during the 2010s, deliveries of crude oil to US refineries by rail continued to be dwarfed by the deliveries by pipeline, as shown in Figure 12:

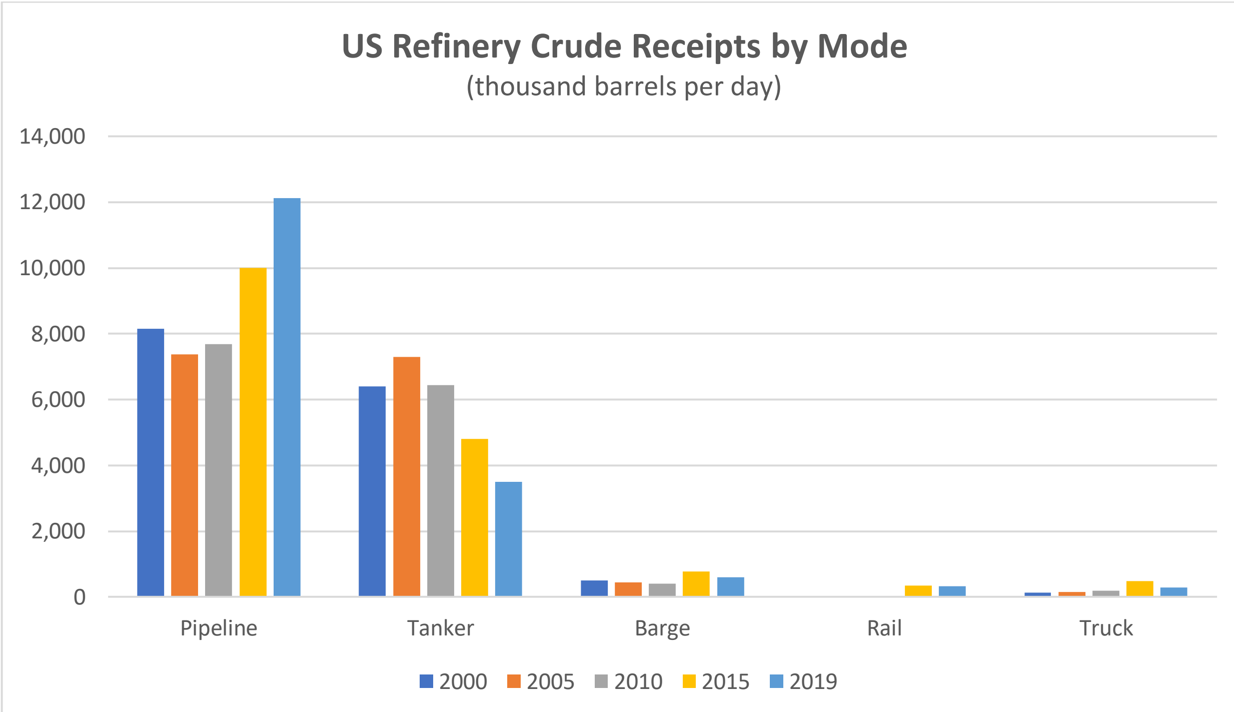

FIGURE 42: US REFINERY RECEIPTS OF CRUDE OIL BY MODE[48]

3.4 Assumptions for Ontario and Quebec Crude Oil Supply in Event of Potential Line 5 Closure

An assumed crude oil supply basis for Ontario and Quebec refiners in the event of a potential Line 5 closure can be constructed based on this analysis of available crude oil supply options, the relative transportation costs for these options, and the economic drivers these refiners face. Specifically, a crude supply mix can be built based on the assumptions that these refiners will:

- Maximize their purchases of supply delivered via the Mainline System
- Maintain their current non-Mainline supply
- Supplement with 119,000 bd of crude by rail to meet the total crude requirement

This volume balance is compared to the crude oil supply mix with Line 5 in operation below in Table 6:

	2018 Actual (thousand barrels per day)	Line 5 Shut Down
Crude deliveries on Mainline	584	465
Crude deliveries by other means	100	100
Added crude deliveries by rail		119
Total crude runs	684	684

TABLE 6: ONTARIO AND QUEBEC CRUDE BALANCE WITH AND WITHOUT LINE 5

Source: Canadian Energy Regulator[49] and Meyers Energy Consulting analysis

3.5 Crude Oil Cost Impacts of a Potential Line 5 Closure on Ontario and Quebec Refiners

The transportation cost impact on refiners in Ontario and Quebec from the potential closure of Line 5 would consist of two components:

- Higher costs associated with shipping 119,000 bd of crude to Ontario/Quebec by rail instead of by pipeline as discussed in section 3.3 above, with this differential largely reflecting the cost differential between the two transportation modes
- A potential increase in Mainline System tariffs to reflect the reduction in total system flows that would result from Line 5 closure, and an allowance to compensate Enbridge for the removal of Line 5 from its rate base

3.5.1 Crude Oil Transportation Cost Impact of Increased Shipments by Rail

As indicated in the research report by the US Congressional Research Service on the increased use of rail to transport crude oil in the US referenced earlier, the cost of shipping crude oil the Bakken region to US refiners was an estimated to be $5 US per barrel to $10 US per barrel higher than shipping by pipeline.[50] We can then make a conservative estimate of the transportation cost impact of shipping 119,000 bd of crude to Ontario or Quebec refineries by rail instead of on the Mainline System, by assuming that

- All 119,000 bd of crude shipped by rail car would be sourced from the same location it is currently injected into the Mainline System
- This volume shipped by rail would carry a transportation cost penalty of $10 US per barrel above the pipeline tariff

3.5.2 Crude Oil Transportation Cost Impact of Potential Tariff Increase

As described above, the second element of a crude oil transportation cost increase resulting from a potential Line 5 closure would be the possible increase in tariff on the Mainline System to compensate Enbridge for the abandonment of Line 5, and for the reduction in overall capacity on the Mainline System. This potential tariff increase has previously been estimated to total $0.40 US per barrel by Dynamic Risk Associates in its September 2017 report.[51] This increase in tariff would be applied to the 465,000 bd delivered to Ontario and Quebec refineries on the Mainline as part of the assumed crude oil mix described above and summarized in Table 6.

3.5.3 Average Crude Oil Transportation Cost Impact of Potential Line 5 Closure

The overall transportation cost impact on Ontario and Quebec refiners can be estimated by calculating the volume-weighted average impact of these transportation cost increases for the different elements of the assumed crude oil mix. This estimate is based on the assumption that refiners in Ontario and Quebec continue to source crude oil from Western Canada and the US Upper Midwest and ship the crude via the Mainline System and by rail car. This calculation is summarized in Table 7 below:

	Crude Volume (thousand bd)	Transportation Cost Increase (US$/bbl)
Crude to Ontario and Quebec refineries on Mainline System	465	$0.40
Incremental crude to Ontario and Quebec refineries by rail	119	$10.00
Crude currently delivered to Ont & Que refineries by rail/marine	100	$0.00
Total Ontario & Quebec crude runs	**684**	**$2.01**

TABLE 7: TRANSPORTATION COST INCREASE FOR ONTARIO AND QUEBEC REFINERS FROM POTENTIAL LINE 5 SHUTDOWN

Source: National Energy Regulator[52], Meyers Energy Consulting analysis

As indicated in the Table, the weighted average cost increase for the total volume of crude delivered to and processed by the refineries in Ontario and Quebec would be $2.01 US per barrel ad indicated in Table 7. If we assume an average liquid product yield of 90% for these refineries, this would translate into a refined product cost increase of $2.24 US per barrel. At an assumed exchange rate of $1.00 US to $1.25 US, this would be equivalent to a refined product cost increase of $2.79 CDN per barrel, or CAD0.018 per litre. In other words, the assumed increase in refined product cost of 1.8 cents per litre would be very modest in the context of the typical volatility in prices experienced by consumers.

This analysis makes the conservative assumption that refiners do not make any changes to the mix and location of their crude purchases in response to a potential Line 5 closure. Refiners typically optimize their crude oil selections on an ongoing basis, taking into account factors such as crude oil prices, transportation costs, refinery yields, anticipated offtake volume requirements and refined petroleum product prices and using a wide range of sophisticated planning tools.[53] It is likely that Ontario and Quebec would reoptimize their crude oil diet and associated crude oil transportation options if faced with a potential closure of Line 5, which could result in an even lower impact on refined product cost.

4 Changes Required to Expand Line 78 and Add Rail Car Unloading Capacity

As described previously in this report, crude oil logistics systems are highly adaptable over time, often through modifications to elements of the existing logistics system. It is also important to recognize that the complexity of such modifications can vary widely, depending on multiple factors including:

- The scope of the changes required
- The ability to make use of existing infrastructure
- Permitting requirements
- Specific equipment requirements

As highlighted previously, the modifications to the crude oil logistics system that would permit continued reliable supply of crude oil to the Ontario and Quebec refineries from current crude oil sources, and hence reliable supply of refined products to these markets, consist of the expansion of Line 78 and the addition of rail car unloading capacity at Ontario and/or Quebec refineries. The following sections provide some general comments on the complexity of these modifications.

4.1 Expansion of Line 78

As described above in this report, Enbridge indicates in its application to the Michigan Public Service Commission and in subsequent testimony that the pipe components of Lines 78A and 78B are consistent with the Ultimate Annual Capacity for these lines. The changes required to expand these pipelines to the Ultimate Annual Capacity consist of adding pumping horsepower to existing pumping units and/or additional pumping units at existing pump stations. A general assessment can be made based on the four factors listed above:

- **Scope of the changes.** The scope of changes required to expand Lines 78A and 78B to their Ultimate Annual Capacity is likely well understood by Enbridge, and consists of the addition of pumping horsepower and/or the addition of higher capacity pumping units at existing pumping stations.
- **Use of existing infrastructure.** The modifications required make use of key elements of existing infrastructure, most importantly the existing pipeline elements and the existing pump stations of Lines 78A and 78B.
- **Permitting requirements.** Given the absence of any need to lay new pipe or build new pumping stations, combined with the fact that the expanded pipeline would operate within already approved pressure constraints, it is likely permitting would not be a major time constraint.
- **Specific equipment requirements.** The specific equipment requirements for the expansion are not known, but could consist of items such as new electric motor drivers and/or new pumps, piping elements at the pumping stations to permit the installation of new pumping units if required, modifications to the control and monitoring systems at the pumping stations, and electrical hardware to permit the operation of higher power pumping capacity.

Overall, this indicates relatively low complexity to execute the expansion of Line 78, relative to for example the construction of a new pipeline system.

4.2 Addition of Refinery Tank Car Unloading Capacity

The time requirement to add refinery tank car unloading capacity will vary across refineries. As with the case of expanding Line 78, an outside-in assessment of the complexity of adding rail car unloading facilities for the six refineries in Ontario and Quebec is limited by the lack of detailed public information of the changes required at each refinery. That said, some general comments can be made as follows:

- **Scope of the changes.** The scope of the changes will likely vary significantly by refinery, with more extensive scope likely required for refineries that do not have existing crude oil tank car receiving facilities. Factors that will impact refinery-specific scope include existing connections to rail systems and the availability and location of land to be used for new facilities, among others.
- **Use of existing infrastructure.** Factors such as existing access to rail systems, the presence of existing tank car unloading facilities including the required connections to refinery crude oil handling systems will affect the time required.
- **Permitting requirements.** Permitting requirements to expand crude oil unloading facilities may vary across refineries, but are not considered to be a likely cause of significant delays in implementation.
- **Specific equipment requirements.** The specific hardware required to add rail unloading capacity at a particular refinery will vary from case to case, but the typical components required do not generally require extended lead times for delivery.

Similar to the expansion of Line 78, this indicates relatively low complexity to execute the expansion of Line 78, relative to for example the construction of a new pipeline system.

5 Potential Impact of Line 5 Closure Without Line 78 Expansion/Rail Car Unloading Additions

This section of the report provides a qualitative assessment of what could happen in the event that Line 5 would be shut down without completion of Line 78 expansion and addition of rail car unloading facilities. This assessment takes into account existing crude oil logistics infrastructure that could enable the refineries in Quebec to be physically supplied with crude oil in the event of a Line 5 closure without completion of the Line 78 expansion and addition of rail car unloading capacity. Specifically:

- The Suncor refinery in Montreal has the ability to access offshore crude, delivered by tanker to Portland, Maine and then by pipeline to Montreal. This system has the physical capacity to meet all of the refinery's volumetric crude oil requirement. The refinery also has the capacity to receive up to 30,000 bd of crude oil by rail.
- The Valero refinery in Lévis has the ability to receive all its crude requirement by tanker over its own wharf facilities, and in addition has 60,000 bd of rail car unloading capacity.

Notwithstanding this existing infrastructure, economic incentives strongly favor the processing of North American crudes delivered to the Montreal area on Line 9 and, in the case of the Valero refinery, also by a mix of rail and/or marine tanker.

If Ontario and Quebec refiners faced closure of Line 5 without Line 78 expansion and addition of rail car unloading facilities being in place, there would be the potential for significant disruption to crude oil supply to Ontario and Quebec refineries. Such an interruption in crude oil supply would likely impact Ontario and Quebec refined product markets, as described below:

- All refineries currently receiving crude transported on Enbridge's Line 5 and/or Line 78 would face capacity apportionment[54]
  - This mechanism is designed to ensure the impacts of a disruption are shared equitably among the parties making use of a common carrier pipeline
  - The reduction in a pipeline system's capacity is shared equitably across the parties shipping on the system
- Refiners in Ontario and Quebec would continue their nominations to ship crude from the west to their refineries on the Mainline System, since this is their most economically attractive feedstock choice as evidenced by their current crude oil purchasing patterns[55]
- As a result of capacity apportionment, all the refineries in Ontario and Quebec (as well as the refineries in the Detroit/Toledo area and in western Pennsylvania) would experience reduced crude oil deliveries on the Mainline System
- Lower crude oil deliveries would lead to reduced refinery output and hence reduced refined product supply
- Refined product prices in Ontario and Quebec would rise sharply in response, leading to increases in refined product imports into Quebec and increased product shipments from Quebec to Ontario
- Product imports by tank truck into Ontario would be a possible additional source of supply, but the refiners in Detroit and Toledo would also be on allocation and potentially operating at reduced rates, limiting potential surplus supply available for export to Ontario

- There would be potential for periods of constrained refined product supply as a result of reduced refinery production and limits on the ability to access alternate sources of supply
- Refiners in Quebec would likely act to re-activate the currently inactive logistics options to meet their crude supply requirements
- Refiners in Ontario would have very limited short-term options to access additional crude oil supplies based on the existing infrastructure, with the exception of the 20,000 bd rail car unloading capacity at the Imperial Oil refinery in Nanticoke

Government(s) could consider intervening to try to mitigate the potential disruptive effects of such a scenario if it (they) believes such an intervention would be in the national and/or provincial interest. There is certainly precedent for government intervention in the oil and gas sector in Canada, with multiple examples including the building of Enbridge Line 9,[56] the formation of PetroCanada,[57] the Ontario government's investment in Suncor,[58] and most recently the federal government's purchase of Trans Mountain Pipeline.[59] Indeed, the "Great Pipeline Debate" in the mid-1950s was with regard to the federal government's role in facilitating the construction of the TransCanada natural gas pipeline.[60] That said, given the likelihood of federal and multiple provincial governments being involved, this would likely be a complex endeavor.

6 Refined Product Markets in Ontario and Quebec

Crude oil and oil refining markets are tied directly to the demand for finished refined petroleum products such as gasoline, jet fuel, diesel fuel and light heating oil, among others. Accordingly, it is necessary to understand key trends in refined product demand and the existing structure of refined product supply in a given market to assess the implications of changes in crude oil supply to refineries in that market. The following sections of this report provide that background.

6.1 North American Refined Product Demand

The economy in North America has become less oil-intensive since the 1970s as a result of structural changes such as rising efficiency in the transportation sector and a general shift in the economy away from energy intensive industries.[61] As demonstrated in Figures 13 and 14, respectively, this phenomenon has continued since 2000 in both the US and Canada.

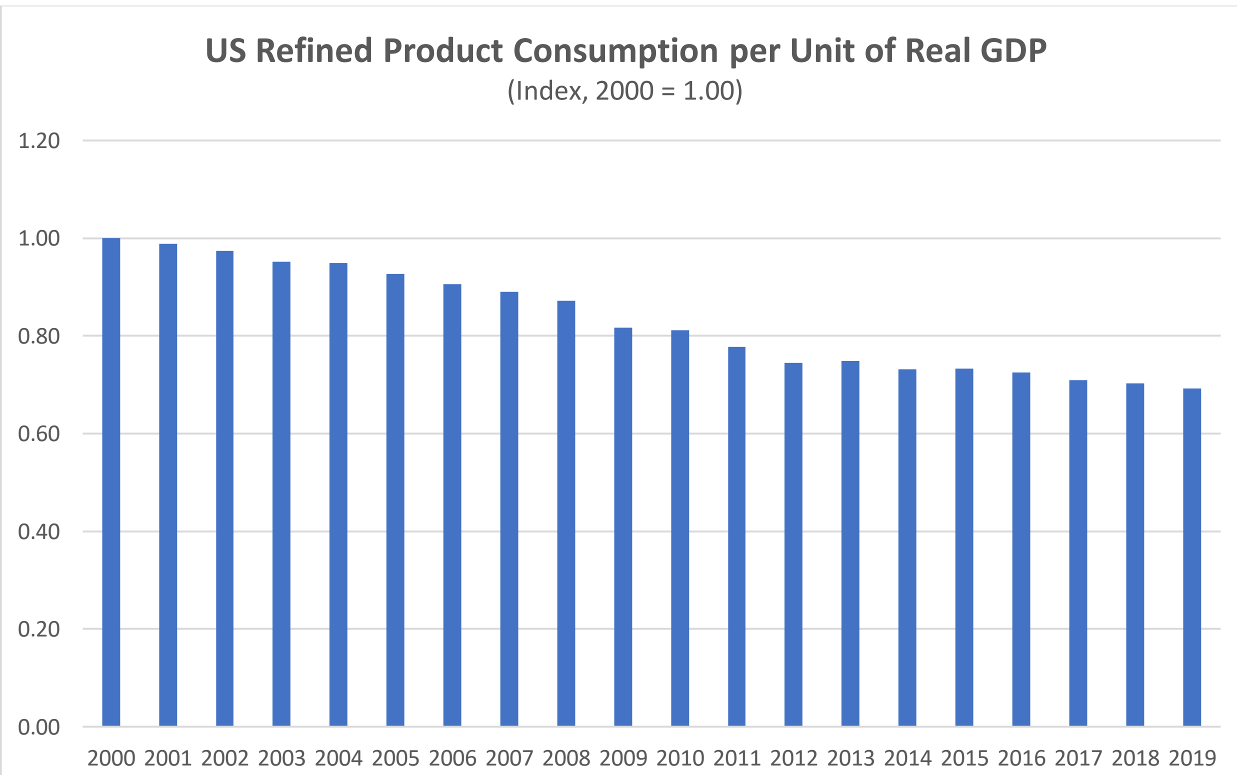

FIGURE 135: US REFINED PRODUCT CONSUMPTION PER UNIT OF REAL GDP[62]

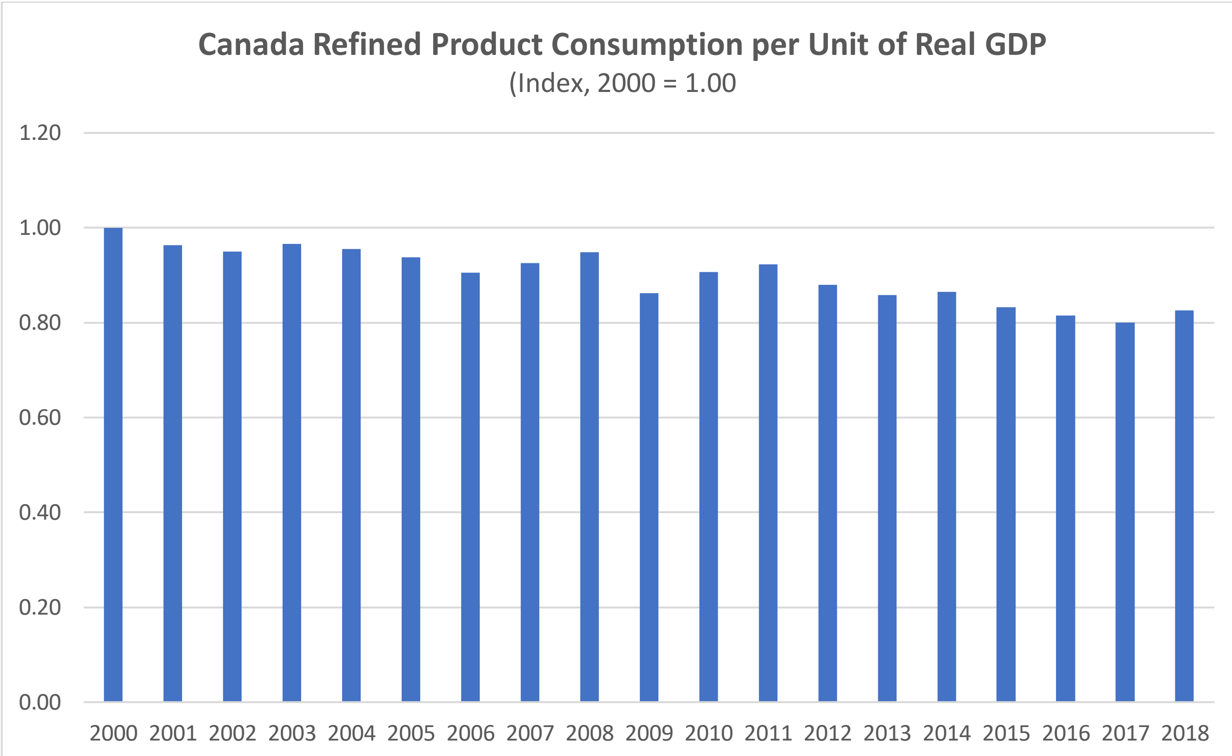

FIGURE 64: CANADA TOTAL REFINED PRODUCT DOMESTIC SALES PER UNIT REAL GDP[63]

As shown in Figures 15 and 16 below, the result has been stagnant or very slow growth in the consumption of refined products in the United States. US total refined product consumption peaked in 2004-2005 at approximately 18.5 million bd. Consumption declined sharply during the 2008/2009 economic crisis, falling to a low of 16.1 million bd in 2011. Consumption recovered starting in 2012, reaching 17.3-17.4 million bd in 2017-2019, but remained below the previous peak.

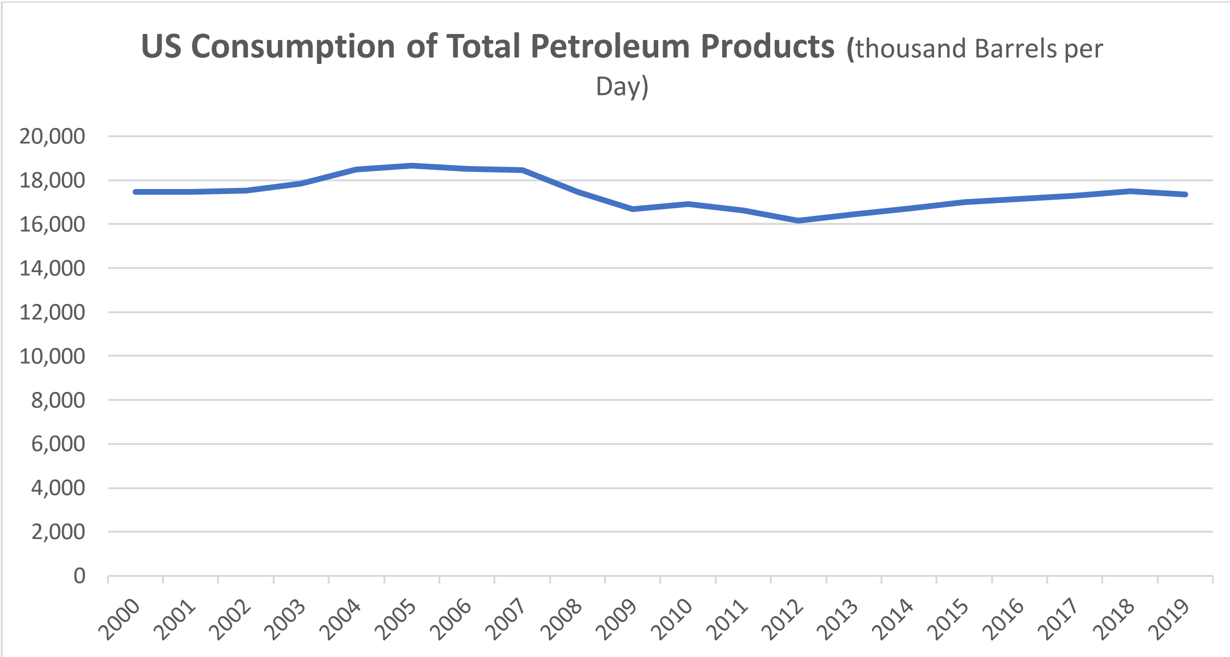

FIGURE 15: US CONSUMPTION OF TOTAL REFINED PRODUCTS[64]

Consumption of motor gasoline and diesel fuel, which together represent 76%-78% of total US refined product consumption since 2010, followed broadly similar trends (see Figure 16). The compound annual growth rate for consumption of total refined products, gasoline and diesel in the US from 2000 to 2019 were 0.0%, 0.5% and 0.5%, respectively.

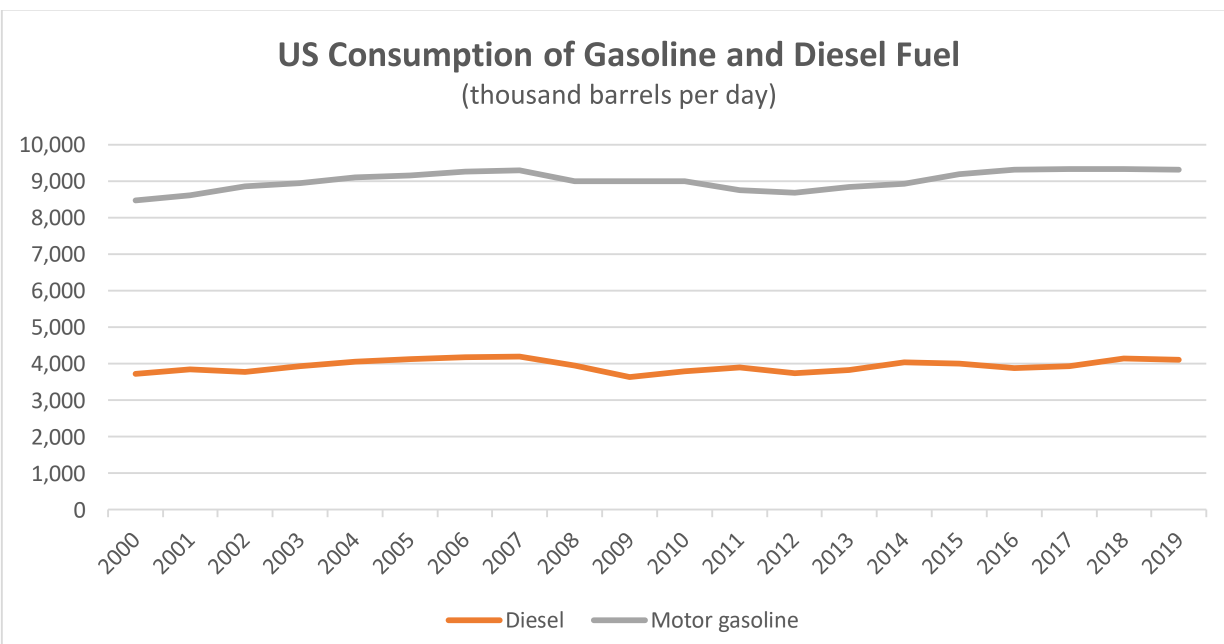

FIGURE 16: US CONSUMPTION OF MOTOR GASOLINE AND DIESEL[65]

As indicated in Figure 17 below, trends have been broadly similar in Canada, but with slightly higher growth rates. Domestic sales of total refined products rose at a compound annual growth rate of 0.9% from 1,629,000 bd in 2000 to 1,920,000 bd in 2018.

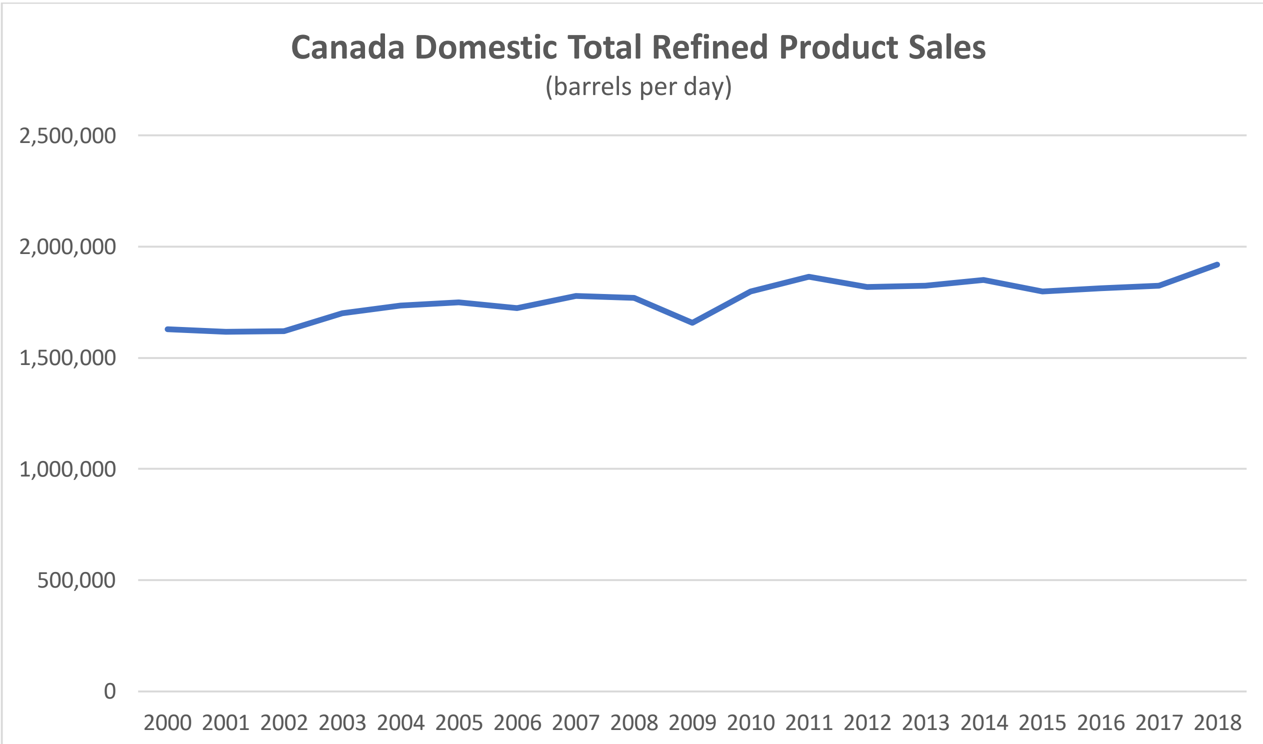

FIGURE 77: CANADA DOMESTIC SALES OF TOTAL REFINED PRODUCTS[66]

6.2 Ontario and Quebec Refined Product Demand

Figure 18 demonstrates that consumption of petroleum refined products in Ontario and Quebec has largely mirrored the trends of the Canadian market overall. In both Ontario and Quebec, refined product demand has been largely stagnant from 2010 through 2018, with some noise in the data from year to year. Overall, for the period 2010 to 2018 Statistics Canada data show a 1.3% CAGR in total refined product consumption in Quebec, and a -0.6% CAGR in the same metric for Ontario.

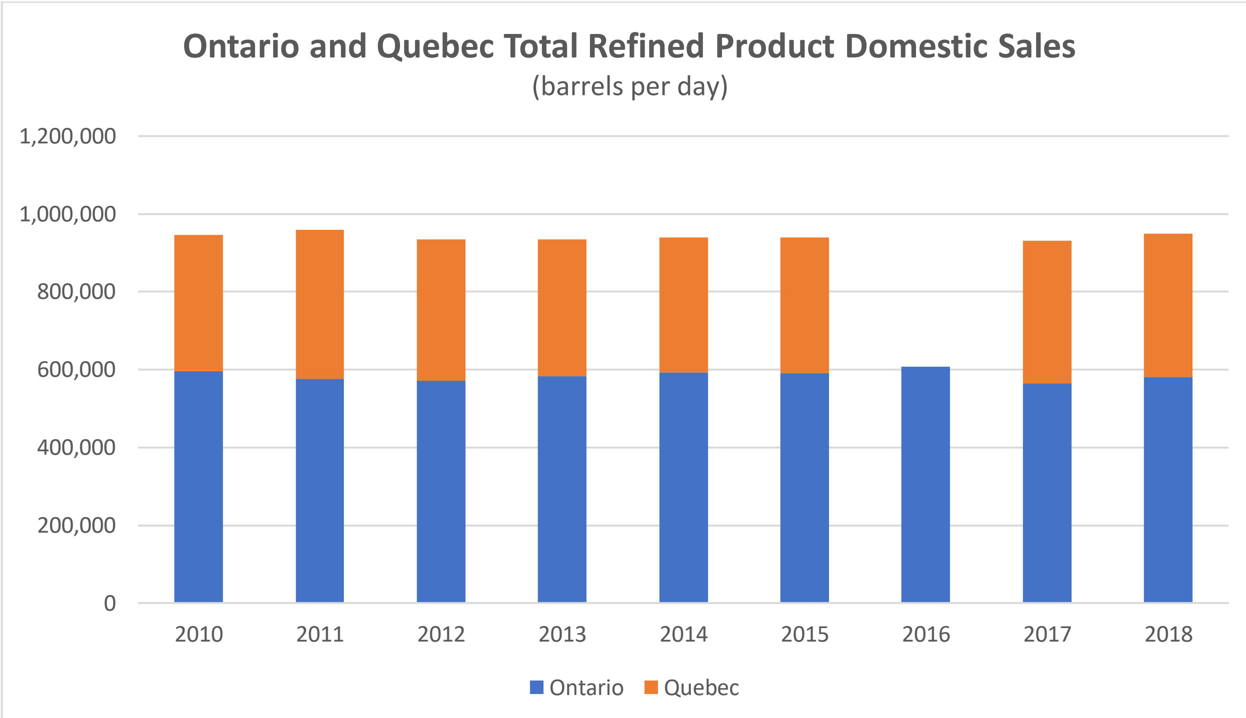

FIGURE 88: ONTARIO AND QUEBEC* TOTAL DOMESTIC REFINED PRODUCT SALES[67]

*Data for Quebec for 2016 suppressed to meet the confidentiality requirements of the Statistics Act

6.3 Refined Product Exports and Imports

As highlighted above in section 2.2 of this report, rising crude oil production in the US and Canada resulted in increased crude oil exports from Canada to the US, and starting in 2016, a sharp rise in crude oil exports from the US. The rising US crude production and attendant decline in the relative price of crude oil for US refiners led to sharply rising exports of refined products from the US, as indicated in Figure 19. US refined product exports increased modestly from 863,000 bd in 2000 to 1,010,000 bd in 2005, before doubling in five years to 2,025,000 bd in 2010 and reaching 2,353,000 bd in 2019.

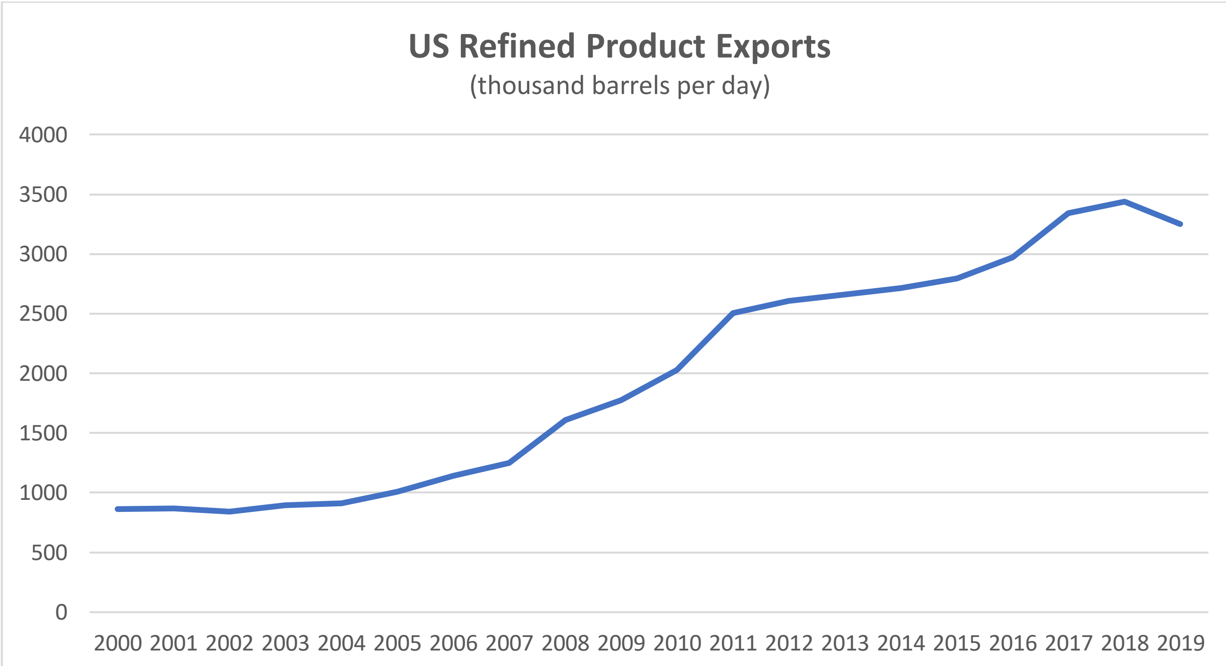

FIGURE 99: US EXPORTS OF REFINED PRODUCTS[68]

Figure 20 demonstrates that refined products exports from Canada were much more stable during this period. Exports rose modestly from 302,000 bd in 2000 to 447,000 bd in 2018, with the large majority of that increase taking place from 2000 to 2002. This increase was the result of the expansion and upgrade of the Irving Oil refinery in Saint John, N.B. which was completed in 2000.[69]

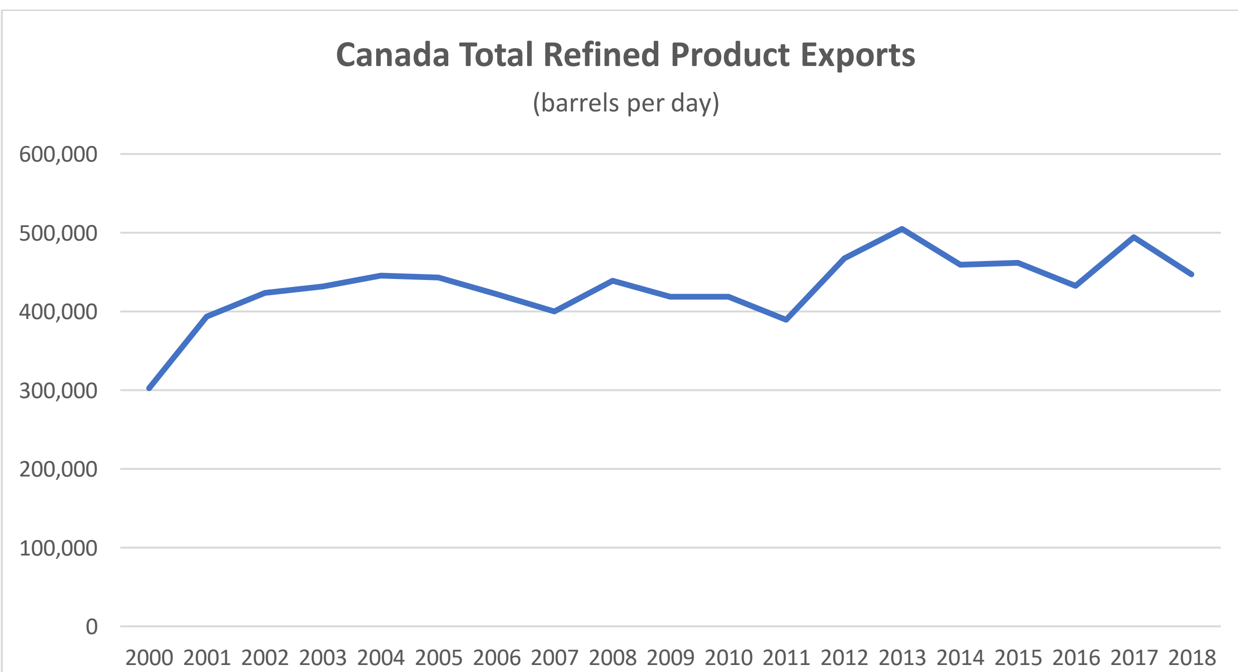

FIGURE 20: CANADA REFINED PRODUCT EXPORTS[70]

As described in Figure 21, Ontario and Quebec represent a significant contrast to the picture for Canada, with Total refined product imports exceeding exports for Ontario and Quebec combined every year from 2014 to 2018. Also notable is the import/export balance for motor gasoline, jet fuel and diesel fuel, the key light products that represent the large majority of refined product demand. Net imports for the two provinces of motor gasoline and jet fuel alone averaged 144,000 bd during this period.

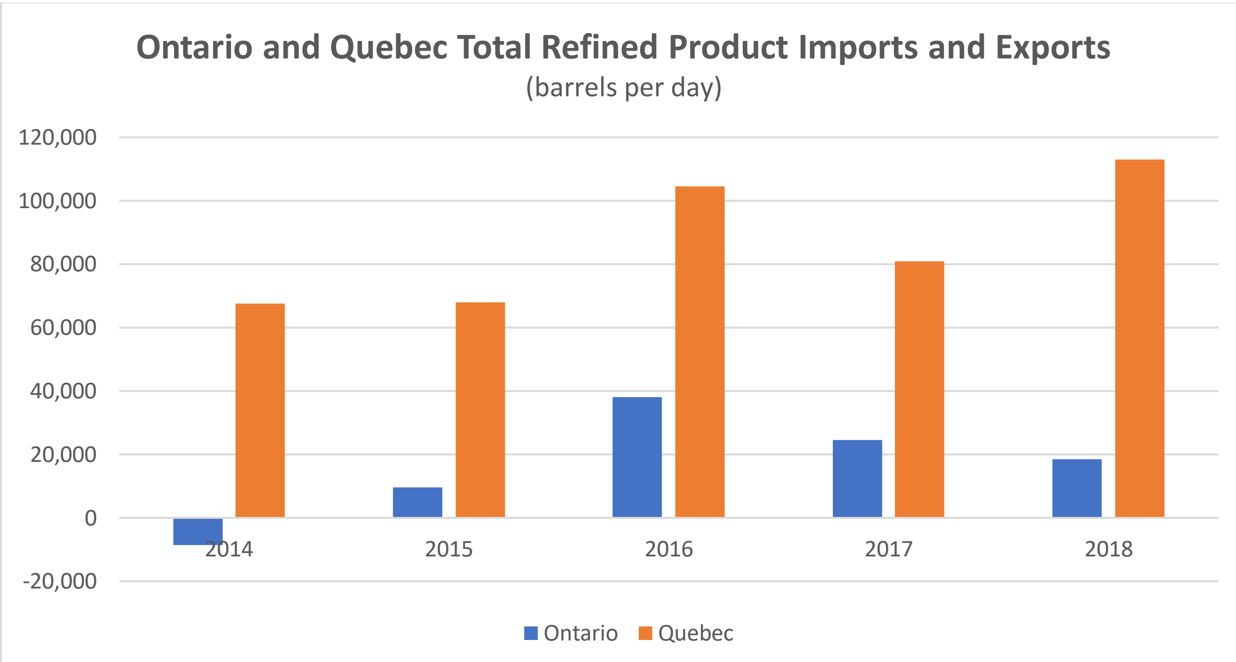

FIGURE 101: ONTARIO AND QUEBEC TOTAL REFINED PRODUCT IMPORTS AND EXPORTS[71]

The linkage between refined petroleum product imports into Quebec and inter-provincial transfers into Ontario is also noteworthy. For example, in 2018 Quebec was a significant importer of motor gasoline, jet fuel and diesel fuel, averaging 158,000 bd of imports of these three products.[72] During the same period, Ontario was a significant recipient of inter-provincial transfers for the same three products, averaging 128,000 bd.[73] This flowrate is consistent with capacity information provided by Trans Northern Pipeline Incorporated, which runs a product pipeline connecting Quebec and Ontario. As the company states on its website:[74]

"We operate 850 kilometres of pipeline in Ontario-Quebec. The pipeline flows east to west, linking Montreal, Quebec and Oakville, Ontario and west to east between Nanticoke and Toronto, Ontario. There are also branch lines which connect Toronto's Pearson International Airport, Montreal's Pierre Elliott Trudeau International Airport, as well as Clarkson and Ottawa, Ontario. This pipeline safely transports an average of 27,500m^3 or approximately 172,900 barrels of refined fuel products daily."

In summary, key conclusions from this section of this report are that:

- In contrast to the growth in refined product exports from the US since 2010, exports from Canada have been more stable

- Ontario and Quebec combined are net importers of refined products, with the large majority of imports flowing into Quebec, and a significant portion of that import volume subsequently being shipped westward to Ontario via refined product pipeline

7 Impact of Potential Line 5 Closure on Quebec and Ontario Refined Product Prices

In previous sections of this report, the following has been established with respect to the impact of a potential closure of Enbridge Line 5:

- Enbridge Line 78 can be expanded to enable delivery of 525,000 bd of crude oil to Sarnia on the Mainline System
- Assuming an expanded Line 78, 119,000 bd of crude would have to be delivered via alternate means to maintain crude oil deliveries to refineries in Ontario and Quebec,
- The economically preferred approach to meeting this 119,000 bd requirement would most likely be delivery of crude by rail to selected refineries in Ontario and/or Quebec
- The volumes delivered on the Mainline System could be subject to an estimated tariff increase of $0.40 US per barrel
- The deliveries by rail would carry a unit transportation cost increase over the Enbridge pipeline tariff in the order of $10 US per barrel
- The resulting increase in crude transportation cost, averaged over the total volume of crude processed by refineries in Ontario and Quebec, would amount to $2.07 US per barrel
- Assuming an average refinery liquid yield of 90%, this crude oil cost increase would translate into an average product cost increase of $2.30 US per barrel, equivalent to $0.018 CDN per litre

How this increase in average refined product cost could translate into changes in refined petroleum product prices depends very much on the current mechanism by which the market sets these prices. It is important to recognize that refined product imports represent a significant share of refined petroleum product consumption in Quebec and Ontario. For example, Table 8 shows combined Ontario and Quebec imports and domestic sales of motor gasoline. The figure indicates that imports represent 23%-26% of combined Ontario and Quebec motor gasoline domestic sales.

	2017	**2018**
Imports (bd)	101,040	120,104
Domestic Sales (bd)	449,018	453,599
Imports Share of Sales (%)	23%	26%

Table 8: Ontario and Quebec Gasoline Imports and Domestic Sales[75]

This high level of refined petroleum product imports suggests that wholesale refined product prices are likely significantly influenced by the price of imported product. If this is indeed the case, an increase in refinery crude oil costs could have little or no impact on wholesale refined product prices, and hence on retail prices. If on the other hand Ontario and Quebec refiners were able to pass the average increase in crude costs described above in section 3.5.3 of this report on to the wholesale market for refined petroleum products, and the cost increase was distributed equally across all products, wholesale prices would rise by $2.30 US per barrel, equivalent to approximately $0.018 CDN per litre. And if wholesale price increases translate directly into a retail price increase, this would also imply a retail price increase of $0.018 CDN per litre.

8 Natural Gas Liquids and Petrochemicals

As described above in this report, one component of the mix of hydrocarbon liquids shipped on Line 5 is a stream of NGLs consisting of a mixture of ethane, propane and mixed butanes. Closure of Line 5 would result in this stream not being delivered to Sarnia. This section of the report examines the implications of this change, including how the petrochemicals sector could be impacted.

8.1 Natural Gas Liquids Deliveries on Line 5

NGLs account for an estimated 80,000 bd of the hydrocarbon liquids currently delivered to Sarnia on Line 5, as described earlier in this report. This NGL stream consists primarily of propane with some butane content.[76] The large majority of the ethane in the natural gas produced in Alberta is recovered from the natural gas in field gas processing plants and large straddle plants in Alberta, for use as feedstock in that province's petrochemical industry.[77]

The NGL stream shipped to Sarnia on Line 5 is delivered to an NGL fractionator in Sarnia, which is owned and operated by Plains Midstream Canada.[78] This facility has a capacity of up to 130,000 bd.[79] Closure of Line 5 would stop the delivery of this NGL stream, and hence would leave the Plains Midstream fractionator without feedstock. Unless alternate means of feedstock supply were to be made available at economically attractive pricing, the closure of Line 5 would result in closure of the fractionator. In addition, current customers of the product streams from the fractionator would have to find alternate sources of supply.

8.2 Natural Gas Liquids Production in US PADDs 1 and 2

As documented in Figures 22 and 23 below, NGL production increased by 527,000 bd in PADD 1 and by 760,000 bd in PADD 2 from 2000 to 2019. This dramatic increase is the result of the commercialization of fracturing and directional drilling technologies, which have enabled the production of natural gas and associated NGLs from the tight shale resources. Examples of such resources include the Marcellus Shale[80] and Utica Shale[81] formations. Production from these formations is primarily located in eastern Ohio, western Pennsylvania and West Virginia, which are in PADDs 1 and 2. In addition, the rising crude oil production from the Bakken formation in North Dakota in PADD 2 described previously in this report has led to a significant increase in the production of associated NGLs in this region.[82]

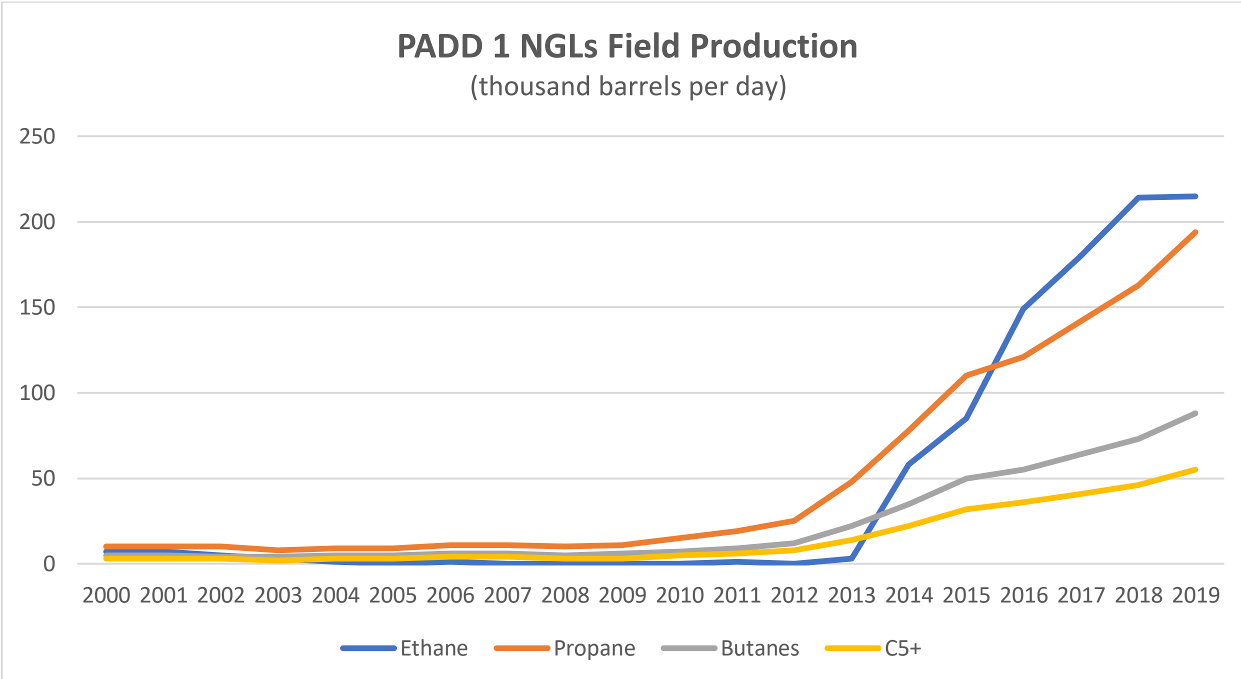

FIGURE 112: FIELD PRODUCTION OF NGLS IN PADD 1[83]

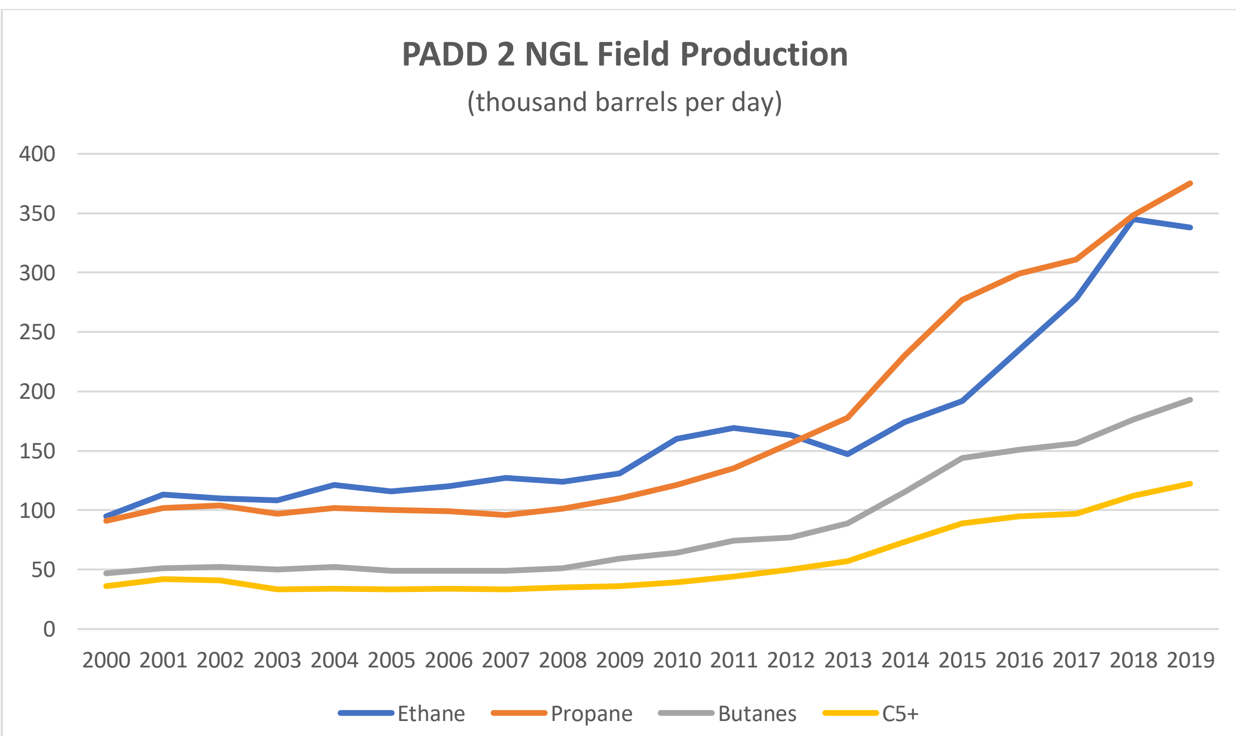

FIGURE 123: FIELD PRODUCTION OF NGLS IN PADD 2[84]

This rise in PADD 1 and PADD2 NGL production has led to significant investments in infrastructure to enable this increasing production to find markets. Among these investments are:

- **Petrochemical production complexes.** Shell is building a world scale petrochemical complex in western Pennsylvania based on local NGL feedstocks, and other petrochemical producers are considering such investments.[85]
- **Pipelines to ship NGL to the Philadelphia area.** The Mariner East pipeline projects enable the transportation of NGLs produced from the Marcellus and Utica Shale regions to the Philadelphia area, for both local consumption and export.[86]
- **Pipelines to ship NGLs to southwestern Ontario.** The Mariner West[87] and Utopia[88] pipelines permit the delivery of ethane and ethane/propane mix to southwestern Ontario and the petrochemical production plants in the Sarnia region, as described in more detail below.

8.3 Petrochemicals in Ontario

In the early 1970s a number of petrochemical producers in Sarnia jointly developed the Petrosar complex (initially referred to as the Sarnia Olefins and Aromatics Plant), an integrated refining and petrochemicals complex designed to produce base petrochemicals and fuel products from the processing of western Canadian crude oil.[89] The goal of this investment was to increase the competitiveness of the Ontario petrochemicals sector by increasing scale and accessing cost competitive feedstock. However as shown in Figure 23, when the complex started operations in 1977 crude oil prices were in the midst of a massive structural increase. This increase was the result of a tightening in the global oil supply-demand balance and actions taken by OPEC, the Organization of Oil Exporting Countries.[90] As indicated in Figure 24, by 1977 the average price in nominal terms of crude oil imported into the US had risen almost five-fold versus 1970, and by 1980 had exceeded an eleven-fold increase.

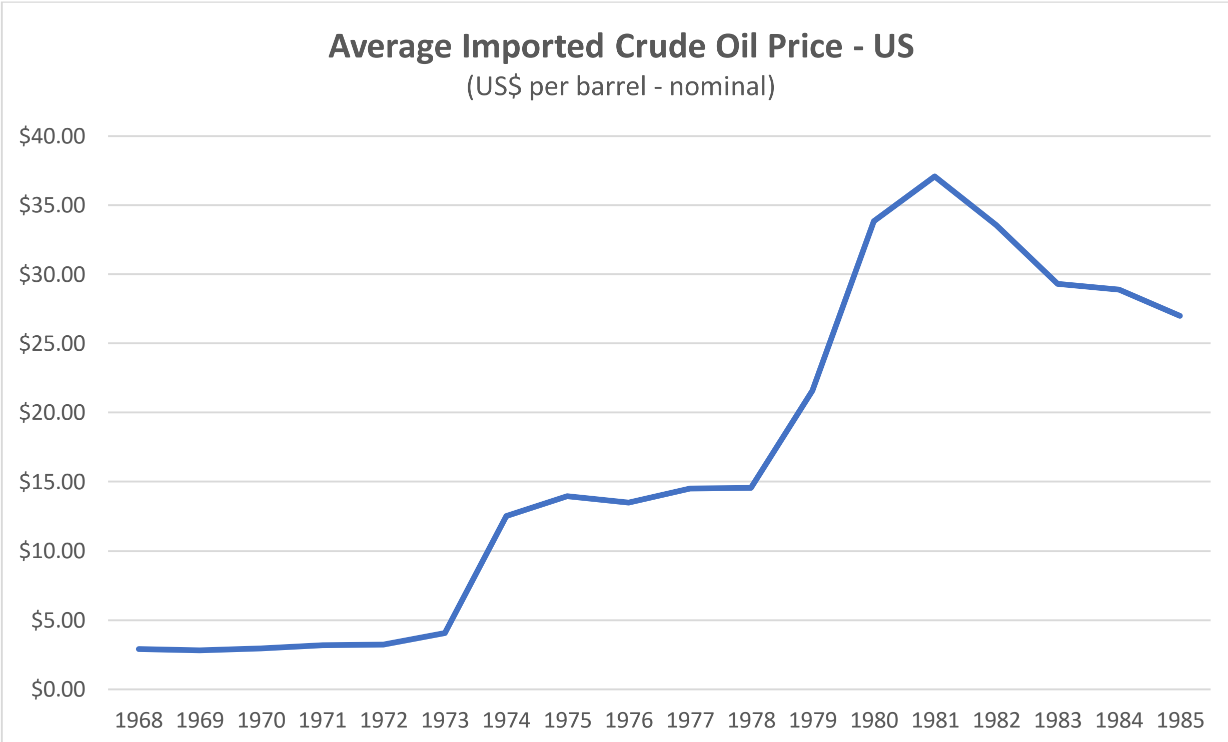

FIGURE 134: AVERAGE IMPORTED CRUDE OIL PRICE - US[91]

Ownership of the Petrosar complex has evolved, and it is currently owned by NOVA.[92] Feedstock for the complex now consists primarily of NGLs, and in particular of ethane sourced from rising production of NGLs in western PADD 1 and eastern PADD 2, as mentioned above in Section 8.2. As described above in Section 8.2, the Mariner West pipeline transports ethane produced from the Marcellus Shale to the Sarnia area. Section 8.2 above also describes how the Utopia pipeline ships ethane and an ethane/propane mix produced from the Utica Shale to the Cochin Pipeline which then delivers these products to petrochemical facilities in the Sarnia area. This access to ethane feedstock from the Marcellus Shale and Utica Shale appears to be sufficiently attractive that NOVA has undertaken a number of significant capacity expansions of the former Petrosar complex, now based on ethane feedstock.[93]

8.4 Implications of a Potential Line 5 Closure on NGL Supply and Petrochemicals

A potential Line 5 closure would result in the loss of access to the mixed NGL stream from Western Canada to Ontario that is the current feedstock of the Plains Midstream Canada fractionator. Given rising NGL production in nearby parts of US PADDs 1 and 2 as described above and the potential for further such production increases, this region could provide an alternate source of mixed NGL feedstock for the fractionator. If this does not occur and the NGL fractionator is shut down, the nearby parts of PADDS 1 and 2 could provide an alternate source of supply of liquified petroleum gas (LPG) products such as propane and butanes. Likewise, petrochemical feedstocks based on NGLs currently processed by the Sarnia fractionator and used locally could potentially be sourced from the nearby US regions, as has been the case for the NOVA plant as described above.

Endnotes:

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[1] "Major Canadian and U.S. Crude Oil Pipelines and Refineries", Enbridge Energy, Retrieved from: https://www.enbridge.com/~/media/Enb/Documents/maps/2021_RB_Crude_Pipelines_and_Refineries_Map.pdf?la=en

[2] "Infrastructure Map", Enbridge Energy, Retrieved from: https://www.enbridge.com/Map#map:infrastructure

[3] "Pipeline System Configuration", Enbridge Energy, Retrieved from: https://www.enbridge.com/~/media/Enb/Documents/Infographics/ENB%20Mainline%20Pipeline%20System.pdf

[4] "Crude Oil Production", Energy Information Administration, Retrieved from: https://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_m.htm

[5] "US Imports by Country of Origin", Energy Information Administration, Retrieved from: https://www.eia.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbbl_m.htm

[6] "US Exports of Crude Oil", Energy Information Administration, Retrieved from: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=mcrexus2&f=m

[7] "Definition of apportionment", Canadian Energy Regulator, Last modified February 26, 2021, Retrieved from: https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2018/market-snapshot-what-is-pipeline-apportionment.html#:~:text=Apportionment%20occurs%20when%20demand%20for%20uncommitted%20capacity%20exceeds,is%20reduced%20because%20of%20maintenance%20on%20the%20pipeline.

[8] "TC Energy – Life Cycle of a Pipeline", TC Energy, Retrieved from: https://www.tcenergy.com/about/explore-energy/understanding-how-it-works/life-cycle-of-a-pipeline/

[9] "US Movements of Crude Oil by Rail", Energy Information Administration, Retrieved from: https://www.eia.gov/petroleum/transportation/

[10] "US Williston Basin Rail Export Estimates", North Dakota Pipelines, Retrieved from: https://northdakotapipelines.com/

[11] "Crude Oil Forecast, Markets and Transportation", CAPP, 2017 Market Report, 2017, Retrieved from: http://www.oscaalberta.ca/wp-content/uploads/2017/06/CAPP-2017-Crude-Oil-Forecast.pdf

[12] "Canadian Crude Oil Exports by Rail", Canadian Energy Regulator, Last modified January 25, 2022, Retrieved from: https://www.cer-rec.gc.ca/en/data-analysis/energy-commodities/crude-oil-petroleum-products/statistics/canadian-crude-oil-exports-rail-monthly-data.html#:~:text=Canadian%20Crude%20Oil%20Exports%20by%20Rail%20%E2%80%93%20Monthly,%20%20128%2C006%20%2041%20more%20rows%20

"Canadian Refineries", [13] Oil Sands Magazine, Last modified January 6, 2022, Retrieved from: https://www.oilsandsmagazine.com/projects/canadian-refineries

[14] "Infrastructure Map", Enbridge Energy, Retrieved from: https://www.enbridge.com/Map#map:infrastructure

[15] Enbridge Energy, "Infrastructure Map".

[16] "Pipeline Operations", United Refining, Retrieved from: https://www.urc.com/pipelines

[17] "The Suncor Montreal Refinery", Suncor, 4, Retrieved from: https://sustainability-prd-cdn.suncor.com/-/media/project/suncor/files/about-us/montreal-refinery/suncor-montreal-refinery-en.pdf?la=en&modified=20210902045819&hash=DB9A0FBA800F588B05BA1D3B286D495E671181BE

[18] Nicolas Van Praet, "Valero Moves to Source all Crude for Quebec Refinery from North America by end of 2014", *Financial Post,* March 20, 2014, Retrieved from: https://financialpost.com/commodities/energy/valero-strikes-deal-to-ship-line-9-crude-from-montreal-to-quebec-city-by-tanker

[19] Rowland J. Harrison, "Enbridge Line 9 Reversal", *Energy Regulation Quarterly,* July 2014, Retrieved from: https://energyregulationquarterly.ca/case-comments/enbridge-line-9-reversal

[20] "Jean Gaulin Refinery", Valero, 2018, Retrieved from: https://www.energievalero.ca/en-ca/Operations/JeanGaulinRefinery

[21] "Pipeline Profiles: Montreal", Canada Energy Regulator, Last modified June 2020, Retrieved from: https://www.cer-rec.gc.ca/en/data-analysis/facilities-we-regulate/pipeline-profiles/oil-and-liquids/pipeline-profiles-montreal.html

[22] CAPP, "Crude Oil Forecast, Markets and Transportation"

[23] "Pipeline Profiles: Enbridge Mainline", Canada Energy Regulator, Retrieved from: https://www.cer-rec.gc.ca/en/data-analysis/facilities-we-regulate/pipeline-profiles/oil-and-liquids/pipeline-profiles-enbridge-mainline.html

[24] "Alternatives Analysis for the Straits Pipelines", Dynamic Risk Assessment Systems, Inc., 2017, Retrieved from: https://drive.google.com/drive/folders/10WIKtCb0Vq69K_xcjxfirjhmLKZCG8Xq

[25] Canada Energy Regulator, "Pipeline Profiles: Enbridge Mainline"

[26] "MPSC Case No. U-17020 In Re Enbridge Energy, Limited Partnership", Enbridge Energy, April 16, 2012, Retrieved from: https://mi-psc.force.com/sfc/servlet.shepherd/version/download/068t0000000wdBtAAI

[27] "Enbridge Incorporated Hazardous Liquid Pipeline Rupture and Release", National transportation Safety Board, July 25, 2010, Retrieved from: https://pstrust.org/wp-content/uploads/2013/05/NTSB-Marshall-report.pdf

[28] Enbridge Energy, "Infrastructure Map"

[29] Enbridge Energy, "MPSC Case No. U-17020 In Re Enbridge Energy, Limited Partnership"

[30] "Transcript of Testimony and Cross Examination of Mr. Thomas D. Hodge, Project Director, Enbridge Energy, LP before the Michigan Public Service Commission, Case Number U-17020", November 13, 2012, 385-386, Retrieved from: https://mi-psc.force.com/sfc/servlet.shepherd/version/download/068t0000000wdYQAAY

[31] "US Movements of Crude Oil by Rail", U.S. Energy Information Administration, Retrieved from: https://www.eia.gov/petroleum/transportation/

[32] Sandy Fielden, "Take A Pipe On The East Side – Feeding Crude To Quebec Refineries", RBN Energy LLC, March 9, 2014, Retrieved from: https://rbnenergy.com/take-a-pipe-on-the-east-side-feeding-crude-to-quebec-refineries

[33] Robert Tuttle, "Biden Backs Maine Town's Opposition to Suncor's Montreal Pipeline Reversal Proposal", *Financial Post*, June 29, 2021, Retrieved from: https://financialpost.com/commodities/energy/biden-backs-maine-town-saying-no-to-wwii-era-canada-oil-pipeline

[34] Canadian Energy Regulator, "Pipeline Profiles: Montreal"

[35] "City of South Portland Clear Skies Ordinance", South Portland City Council, July 21, 2014, Retrieved from: https://www.southportland.org/files/8114/0580/7459/08_-_ORDINANCE___1-14-15.pdf

[36] "Montreal Pipeline Limited", Portland Pipeline Corporation, Retrieved from: http://www.pmpl.com/

[37] Tortoise, "Transporting Oil: Why Pipelines Still Rule", *Forbes,* May 13, 2016, Retrieved from: https://www.forbes.com/sites/tortoiseinvest/2016/05/13/transporting-oil-why-pipelines-still-rule/?sh=3a9439d912dc

[38] Enbridge Energy LP International Joint Rate Tariff CER No. 492 FERC No. 45.27.01.20.0. Retrieved from: https://www.enbridge.com/~/media/Enb/Documents/Tariffs/2021/L9%20CER%20493%20FERC%201200%20LKH%20CDMN.pdf

[39] "Enbridge Energy LP International Joint Rate Tariff CER No. 493 FERC No. 1.20.0.", Enbridge Energy, Retrieved from: https://www.enbridge.com/~/media/Enb/Documents/Tariffs/2021/L9%20CER%20493%20FERC%201200%20LKH%20CDMN.pdf

[40] John Frittelli, Anthony Andrews, Paul Parmomak, Robert Pirog, Jonathan L. Ramseur, and Michael Ratner, "U.S. Rail Transportation of Crude Oil: Background and Issues for Congress", Congressional Research Service, December 4, 2014, Retrieved from: https://sgp.fas.org/crs/misc/R43390.pdf

[41] "Freight Rail Service and Rates; A Guide", Canadian Transportation Agency, Last modified March 8, 2021, Retrieved from: https://otc-cta.gc.ca/eng/publication/freight-rail-service-and-rates-a-guide

[42] Thomas R Covert and Ryan Kellogg, "Crude by Rail, Option Value, and Pipeline Investment", National Bureau of Economic Research, September 2017, Retrieved from: https://www.nber.org/system/files/working_papers/w23855/w23855.pdf

[43] Frittelli, Andrews, Parmomak, Pirog, Ramseur, and Ratner, "U.S. Rail Transportation of Crude Oil"

[44] Covert and Kellogg "Crude by Rail, Option Value, and Pipeline Investment"

[45] Ibid

[46] Ibid

[47] Frittelli, Andrews, Parmomak, Pirog, Ramseur, and Ratner, "U.S. Rail Transportation of Crude Oil"

[48] "Refinery Receipts of Crude Oil by Method of Transportation", U.S. Energy Information Administration, Retrieved from: https://www.eia.gov/dnav/pet/pet_pnp_caprec_dcu_nus_a.htm

[49] Canada Energy Regulator, "Pipeline Profiles: Enbridge Mainline"

[50] Frittelli, Andrews, Parmomak, Pirog, Ramseur, and Ratner, "U.S. Rail Transportation of Crude Oil"

[51] Dynamic Risk Assessment Systems, Inc., "Alternatives Analysis for the Straits Pipelines"

[52] Canada Energy Regulator, "Pipeline Profiles: Enbridge Mainline"

[53] "Energy Insights", McKinsey&Company, Retrieved from: https://www.mckinseyenergyinsights.com/resources/refinery-reference-desk/optimization/

[54] "Market Snapshot: What is Pipeline Apportionment?", Canada Energy Regulator, August 15, 2018, Retrieved from: https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2018/market-snapshot-what-is-pipeline-apportionment.html#:~:text=Apportionment%20occurs%20when%20demand%20for%20uncommitted%20capacity%20exceeds,is%20reduced%20because%20of%20maintenance%20on%20the%20pipeline.

[55] "Market Snapshot: Crude Oil Imports Decreased in 2020, and so did the Cost", Canada Energy Regulator, April 14, 2021, Retrieved from: https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2021/market-snapshot-crude-oil-imports-decreased-in-2020-and-so-did-the-cost.html#:~:text=Generally%2C%20imported%20oil%20is%20more,cost%20was%20%2418.9%20billion%202.

[56] "Our History", Enbridge Energy, Retrieved from: https://www.enbridge.com/about-us/our-history

[57] Sasha Yusufali and Larry R. Pratt, "Petro-Canada", *The Canadian Encyclopedia*, Last modified December 16, 2013, Retrieved from: https://www.thecanadianencyclopedia.ca/en/article/petro-canada

[58] James Wilt, "A Brief History of the Public Money Propping up the Alberta Oilsands", May 16, 2018, Retrieved from: https://thenarwhal.ca/brief-history-public-money-propping-alberta-oilsands/#:~:text=In%201981%2C%20the%20Government%20of%20Ontario%20bought%20a,a%2030%20per%20cent%20stake%20%E2%80%94%20pulled%20out.

[59] "Canada's purchase of the Trans Mountain Pipeline – Financial and Economic Considerations". Office of the Parliamentary Budget Officer, February 12. 2019, Retrieved from: https://pbo-dpb.gc.ca/web/default/files/Documents/Reports/2019/Transmountain/Trans_Mountain_Report_EN_FINAL2.pdf#:~:text=In%20August%202018%2C%20the%20Government%20of%20Canada%20purchased,Project%20%28TMEP%29%20and%20related%20assets%20for%20%244.4%20billion.

[60] Anon, "The Great Pipeline Debate: The Minister of Everything". *Oilweek Magazine,* 2008, Retrieved from: https://inis.iaea.org/search/search.aspx?orig_q=RN:40000020

[61] Stuart Staniford, "Why Oil Intensity Changed in the US Economy", *The Oil Drum*, October 21, 2005, Retrieved from: http://theoildrum.com/story/2005/10/21/4937/9542

[62] Federal Reserve Bank of St. Louis, Retrieved from: https://fred.stlouisfed.org

[63] Federal Reserve Bank of St. Louis

[64] U.S. Energy Information Administration, "Petroleum Supply Annual

[65] Ibid

[66] "Supply and Disposition of Refined Petroleum Products, Monthly", Statistics Canada, September 4, 2020, Retrieved from: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510004401

[67] Ibid

[68] U.S. Energy Information Administration, "Petroleum Supply Annual"

[69] "$1-Billion Upgrade Prepares Canadian Refinery for Future Specs", Oil & Gas Journal, March 27, 2000. Retrieved from: https://www.ogj.com/home/article/17215903/1billion-upgrade-prepares-canadian-refinery-for-future-specs#:~:text=The%20refinery%20opened%20on%20July%2020%2C%201960%2C%20with,capacity%20to%20250%2C000%20b%2Fd%2C%20where%20it%20stands%20today.

[70] Statistics Canada, "Supply and Disposition of Refined Petroleum Products, Monthly"

[71] Ibid

[72] Ibid

[73] Ibid

[74] "Our Pipelines". Trans Northern Pipeline, Retrieved from: https://tnpi.ca/our-pipelines/

[75] Statistics Canada, "Supply and Disposition of Refined Petroleum Products, Monthly"

[76] "About Line 5", Enbridge Energy, Retrieved from: https://www.enbridge.com/projects-and-infrastructure/public-awareness/line-5-michigan/about-line-5

[77] "Pipelines and Other Infrastructure", Alberta Energy Regulator, Retrieved from: https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st98/pipelines-and-other-infrastructure

[78] "Report to Stakeholders and Communities", Plans Midstream Canada, Retrieved from: http://www.plainsmidstream.com/sites/default/files/8597%20PM_CSR_FINAL.PDF

[79] "National Energy Board Hearing Number RH-002-2016", National Energy Board, 6, February 17, 2017, Retrieved from: https://docs2.cer-rec.gc.ca/ll-eng/llisapi.dll/fetch/2000/90465/92837/813094/3028317/3027987/3027765/3186731/A81773%2D2_Written_Evidence_of_Pembina_Resource_Services_Canada_%2D_A5I8Y3.pdf?nodeid=3185622&vernum=-2

[80] "The Marcellus Shale, Explained", State Impact Pennsylvania, Retrieved from: https://stateimpact.npr.org/pennsylvania/tag/marcellus-shale/

[81] Hobart King, "Utica Shale: The Giant Below the Marcellus", Geology.com. Retrieved from: https://geology.com/articles/utica-shale/

[82] Energy Information Administration "US natural gas plant liquid production continues to hit record highs" March 22, 2019 https://www.eia.gov/todayinenergy/detail.php?id=38772

[83] "Petroleum Supply Annual", U.S. Energy Information Administration

[84] Ibid

[85] "Pennsylvania Petrochemical Complex", Shell, Retrieved from: https://www.shell.com/about-us/major-projects/pennsylvania-petrochemicals-complex.html

[86] "Pennsylvania Relies on energy. We Deliver it Safely", Energy Transfer, Retrieved from: https://marinerpipelinefacts.com/#:~:text=The%20Mariner%20East%20pipeline%20system%20provides%20the%20needed,Mariner%20East%202%20and%20Mariner%20East%202X%20pipelines.

[87] "U.S. Purity Ethane Ships to Canada for the First Time in 25 Years", U.S. energy Information Administration, May 6, 2014, Retrieved from: https://www.eia.gov/todayinenergy/detail.php?id=16151

[88] "Utopia Pipeline Project: Ohio", NS Energy, Retrieved from: https://www.nsenergybusiness.com/projects/utopia-pipeline-project-ohio/#

[89] "Petrochemical Unit Planned for Canada", *New York Times,* April 9, 1974, Retrieved from: https://www.nytimes.com/1974/04/09/archives/petrochemical-unit-planned-for-canada.html

[90] "The Oil Shocks of the 1970s", Yale University Energy History, Retrieved from: https://energyhistory.yale.edu/units/oil-shocks-1970s

[91] "U.S. Crude Oil Imported Acquisition Cost by Refiners", U.S. Energy Information Administration, Retrieved from: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=r1300 3&f=m

[92] "General Information". Nova Chemicals, Retrieved from: https://www.novachem.com/locations/sarnia-lambton-on-canada/

[93] "Nova Chemicals Surpasses 65% Completion of its Growth Projects in Ontario, Targets 2022 Start-Up", Nova Chemicals, April 12, 2021, Retrieved from: https://www.novachem.com/media-center/news-releases/nova-chemicals-surpasses-65-completion-of-its-growth-projects-in-ontario-targets-2022-start-up/