UNITED STATES DISTRICT COURT

FOR THE WESTERN DISTRICT OF WISCONSIN

CASE NO. 3:19-CV-00602

BAD RIVER BAND OF THE LAKE SUPERIOR TRIBE OF CHIPPEWA INDIANS OF THE BAD RIVER RESERVATION

Plaintiff

V.

ENBRIDGE ENERGY COMPANY, INC. AND ENBRIDGE ENERGY, L.P.

Defendants

EXPERT REPORT OF

NEIL K. EARNEST, PRESIDENT
Muse, Stancil & Co.

January 31, 2022

MUSE
STANCIL

5080 Spectrum Drive
Suite 600E
Addison, TX 75001-6505

Phone: 214-954-4455
Fax: 214-954-1521

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1. INTRODUCTION

1.1 This Report is authored by Mr. Neil K. Earnest, President of Muse, Stancil & Co. ("Muse"), with assistance from Mr. Ken Y. Chow, Principal of Muse. Muse is an employee-owned consultancy founded in 1983 that specializes in providing a combination of technical and economic consulting services to the downstream sector of the energy industry. Muse is headquartered in Addison, Texas (a suburb of Dallas), with additional offices in London, Houston, and Singapore.

1.2 I hold a Bachelor of Science in Chemical Engineering from Michigan State University and a Masters of Business Administration from the University of Houston – Clear Lake. I am a Professional Engineer, in the discipline of Chemical Engineering, registered in the State of Texas. I have over 40 years of professional experience in the downstream sector of the energy industry. My expert qualifications are further set forth in my curriculum vitae, which is attached as Appendix 1. My curriculum vitae provides a list of my publications and presentations, and a list of all other cases in which I have testified as an expert.

1.3 I have never been a direct or contract employee of any of the parties in this dispute, and I have no ownership interest in any of the parties. The remuneration to Muse is at my standard hourly rate, which is $415.00 per hour, and is not connected to the outcome of these proceedings. I have exercised reasonable care and skill in order to be accurate and complete in preparing this report. The opinions I have expressed represent my true professional opinions on the matters to which they refer.

1.4 I have been assisted in the preparation of this report by Mr. Ken Chow, Senior Consultant of Muse. Mr. Chow has performed much of the analysis concerning the impact of closing Enbridge Line 5 pipeline ("Line 5") on the regional propane and butanes markets. Mr. Chow has never been a direct or contract employee of

any of the parties in this dispute and has no ownership interest in any of the parties. Mr. Chow's curriculum vitae is attached as Appendix 2.

1.5 Mr. Chow and I have read the Protective Order agreed to by the parties in this case and have agreed to be bound by it. The documents relied upon are detailed in Appendix 3.

1.6 I understand that the Bad River Band of the Lake Superior Tribe of Chippewa Indians of the Bad River Reservation (the "Bad River Band") filed this lawsuit against Enbridge Energy Company, Inc. and Enbridge Energy, L.P. ("Enbridge") in connection with the operation of Line 5 across a portion of the Bad River Reservation (the "Reservation") in Wisconsin.

1.7 I have been asked by Venable LLP ("Venable") and Steptoe & Johnson LLP ("Steptoe"), counsel for Enbridge, to act as an independent expert witness with regard to the impacts of shutting down Line 5 before the new section of Line 5, re-routed around the Reservation, is completed and operational. As of the date of this report, Enbridge anticipates that the reroute will be complete and operational at some point in 2023. A shutdown of the portion of Line 5 that transits the Reservation has been requested by the Bad River Band in this litigation, and that shutdown is sought regardless of whether or not a re-route is constructed and operational. The shutdown of the portion of Line 5 that transits the Reservation will also close the entirety of Line 5. Enbridge denies that this relief, or indeed any relief, is warranted. While I understand that Enbridge believes no such shutdown of Line 5 is required or appropriate here, I have been asked to address the effects of such a shutdown were it to occur without an operational re-route in place.

1.8 To be clear, I am not opining on the underlying merits of this dispute but only the impacts if Line 5 is shut down before the Line 5 re-route off the Reservation is complete and operational.

1.9 I have been specifically asked by Venable and Steptoe to provide an expert report addressing the following implications of shutting down Line 5 on:

1.9.1 The regional propane and butanes markets;

1.9.2 The regional crude oil markets; and

1.9.3 The regional refined product markets.

1.10 A summary of the opinions that I have reached to date appears in Section 2. I reserve the right to augment or otherwise modify my report should I learn of information that would have a material impact on my opinions.

2. SUMMARY OF OPINIONS

2.1 Based upon my educational and professional experience, independent analysis, and review of relevant materials in this case, I have reached the following opinions:[1]

OVERALL IMPACT OF A LINE 5 SHUTDOWN

2.2 If Line 5 is shut down without an operational re-route, there will be shortages in propane for a minimum of several years in the Upper Midwest and Ontario. During this period of shortages, consumer prices can be expected to be elevated and volatile. Moreover, the cost of building the infrastructure required to fully replace the propane currently supplied by the natural gas liquids ("NGLs") transported on Line 5 and the need to use more costly transportation modes can be expected to significantly increase consumer costs.

2.3 A Line 5 shutdown will also result in shortages of crude oil. The resultant decrease in crude oil deliveries by Enbridge to the Line 5 delivery area is estimated to be 334,700 barrels per day ("b/d"). The supply shortfall could potentially be reduced to 226,700 b/d, primarily via the reactivation of existing rail and crude oil tanker unloading facilities to make additional deliveries to Quebec. The impact of a Line 5 shutdown will be severe for refineries in western Pennsylvania and Ontario, and significant for refineries in Michigan, northern Ohio, and Quebec.

2.4 As a result of the shortfall in crude oil supply, shortages and price increases for gasoline, jet fuel, diesel, and asphalt will occur and there will be a need to obtain these refined products from more distant alternative sources, which will be more expensive. These shortages and cost impacts will be most acute in Michigan,

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[1] Footnotes concerning information sources have been omitted from the Summary of Opinions. Citations to all sources are found in the body of the report.

Ontario, and western Pennsylvania. Refined products shortages may lead to panic buying, creating additional shortages and prices increases, making a problematic situation even more difficult.

2.5 It is my opinion that shutting down Line 5 will result in the closure of a major NGLs fractionation facility in Ontario and two smaller NGLs fractionation facilities in Wisconsin and Michigan. There is also the potential for one or more refinery closures. Significant job losses and refined product shortages will result.

CONCLUSION ONE: IMPACT ON REGIONAL PROPANE AND BUTANES MARKETS

2.6 Line 5 is essential to meeting the demand for propane and butanes in Michigan and Ontario. In 2019, Line 5 transported approximately 80,300 b/d of NGLs to fractionators at Rapid River, Michigan, and Sarnia, Ontario. Once fractionated, the Line 5 NGLs produced approximately [redacted] of propane and [redacted] of butanes. Line 5 also enabled an additional approximately [redacted] of propane to be produced at an NGLs fractionator located at Superior, Wisconsin. The 2019 production volumes are regarded as being reasonably representative of the post-pandemic market and, accordingly, are being used for this analysis.

2.7 There is no practicable alternative to Line 5 for the supply of NGLs to the Superior, Rapid River and Sarnia NGLs fractionators, all of which are operated by Plains Midstream Canada ("Plains"). The Rapid River fractionator meets much of the propane demand in the Upper Peninsula of Michigan, and the Superior fractionator satisfies much of the propane demand in the northern counties of Minnesota and Wisconsin. The Sarnia fractionator is the largest producer of propane and butanes in the Midwest and Eastern Canada and is an essential source of supply for Ontario and the Lower Peninsula of Michigan. Plains has confirmed that all three fractionators will close if Line 5 is shut down. Propane and butanes supply shortages and resultant price increases will occur.

2.8 None of the other propane or butanes production sources in the Midwest or Eastern Canada are capable of significantly increasing their propane or butanes

supply to offset the lost production from the Plains fractionators, requiring propane and butanes supply to be delivered from outside of the region. Absent the Plains fractionators, rail transportation of propane and butanes will be needed to attempt to satisfy regional demand. However, the rail unloading facilities required to meet regional demand do not currently exist.

2.9 Substantial supply shortages will persist for several years until sufficient rail unloading capacity can be permitted and constructed. Until construction is completed, propane prices in particular can be expected to be well above their historical norms. As commonly observed following other significant refined product supply outages in the U.S., such as resulted from the Colonial Pipeline closure in 2021, hoarding behavior can be expected and prices will be very volatile.

2.10 Assuming sufficient rail unloading capacity is constructed, the increased costs for propane consumers are estimated to be $30 million per year in the Lower Peninsula and $33 million per year in Ontario. The cost increase for regional butane consumers is estimated to be $53 million per year. The propane cost increase for Wisconsin consumers will be at least $4 million per year, and $8 million per year in the Upper Peninsula.

CONCLUSION TWO: IMPACT ON REGIONAL CRUDE OIL MARKETS

2.11 Line 5 is a major source of crude oil supply for refineries in Michigan, northern Ohio, western Pennsylvania, Ontario, and Quebec.

2.12 Based upon my analysis of the regional crude oil consumption and supply patterns, the shutdown of Line 5 will reduce crude oil deliveries by Enbridge to the Line 5 delivery area by an estimated 334,700 b/d. There is the potential to reduce the supply shortfall to 226,700 b/d, primarily via the reactivation of existing rail and tanker unloading facilities to make additional crude oil deliveries to Quebec.

2.13 The estimated crude oil supply impact on refineries in western Pennsylvania and Ontario will be severe. The adverse impacts on refineries in Michigan, northern Ohio, and Quebec will be significant. Although the Quebec refineries may be able to replace the crude oil volumes delivered via Line 5 using alternative delivery options, these options are inferior to the use of Line 5. If using rail as the alternative delivery mode, transportation costs and greenhouse gas emissions are higher, operational complexity increases, and reliability of supply decreases. If using tankers, the crude oil grades available in Western Canada cannot be obtained, potentially degrading refinery yields and increasing costs.

2.14 Refineries require a minimum crude oil throughput to safely operate. It is possible that the crude oil supply shortfall for one or more refineries served by Line 5 will be such that they have to close unless and until alternative crude oil transportation capacity is constructed. There is no prospect for a new crude oil pipeline to take the place of Line 5, and even the construction of new rail unloading facilities will take years.

2.15 The closure of Line 5 will reduce the long-term competitiveness of regional refineries due to higher crude oil supply costs. As a consequence, the closure of one or more refineries is possible, which will translate to job losses.

2.16 The letters and declarations filed by U.S. and Canadian refiners about the impact of a Line 5 shutdown in another legal proceeding involving Line 5 support my conclusions.

CONCLUSION THREE: IMPACT ON REGIONAL REFINED PRODUCT MARKETS

2.17 The shutdown of Line 5 will significantly decrease regional refinery crude oil runs and, therefore, there will be shortages of refined products such as gasoline, jet fuel, diesel, and asphalt. The reduction in local refined product supply will be particularly acute in the Detroit/Toledo region, Ontario, and western Pennsylvania.

2.18 The estimated impact of a Line 5 shutdown on Wisconsin and Michigan gasoline, jet fuel, and diesel prices is an increase of 0.5 cents per gallon ("¢/gal"). The aggregate estimated cost increase due to a Line 5 shutdown on Wisconsin and Michigan consumers of gasoline, jet fuel, and diesel is $20 million and $30 million per year, respectively.

2.19 The estimated impact of a Line 5 shutdown on Ontario consumers of gasoline, jet fuel, and diesel is a price increase of 5 ¢/gal, which translates into an aggregate cost increase of approximately $300 million per year.

2.20 The shutdown of Line 5 will significantly reduce the local asphalt supply in the Detroit/Toledo region, western Pennsylvania, and Ontario. The reduction in asphalt supply is estimated to increase Michigan and Ontario asphalt user costs by $33 million and $44 million per year, respectively.

CONCLUSION FOUR: MICHIGAN CRUDE OIL PRODUCTION ISSUES

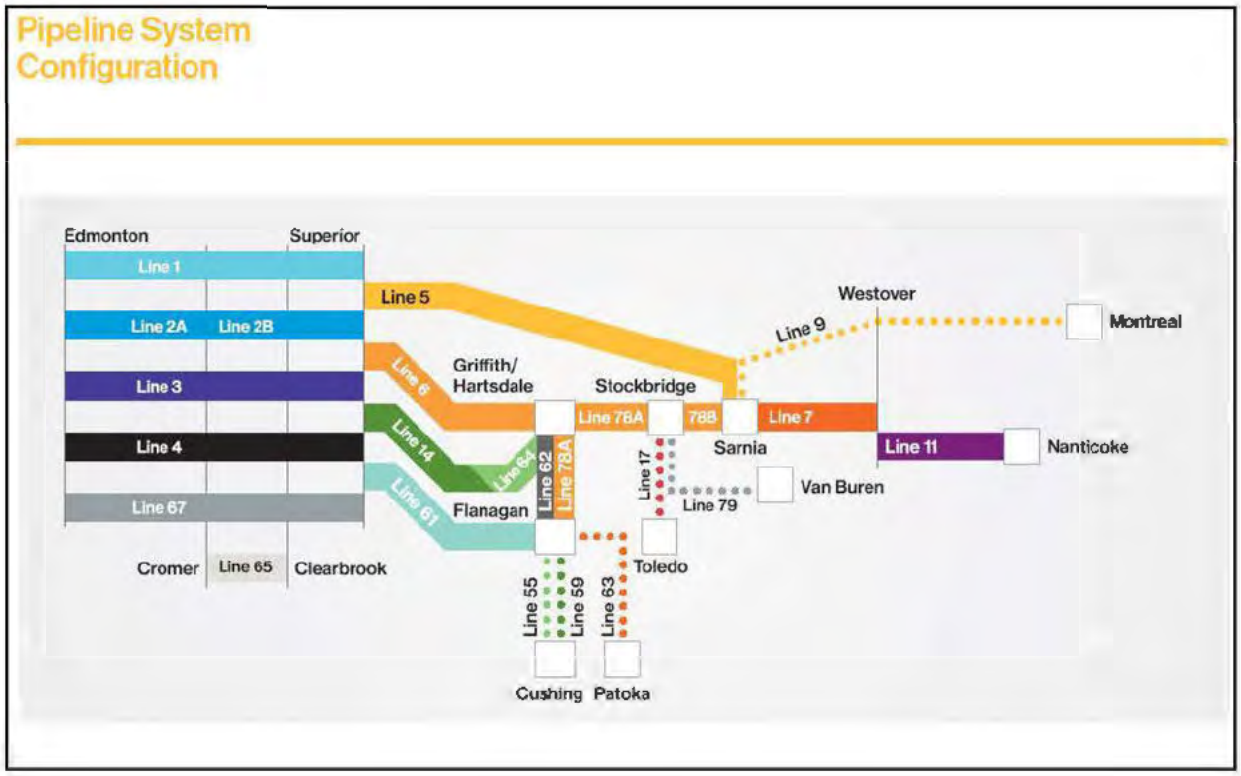
2.21 The shutdown of Line 5 will require much of the Michigan crude oil production in the Lower Peninsula to cease production or use more costly truck transport to reach refinery customers. The latter will both degrade the economics of crude oil production in Michigan and increase transportation-related greenhouse gas emissions.

3. OVERVIEW OF THE ENBRIDGE MAINLINE

INTRODUCTION

3.1. Line 5 is a pipeline within the Enbridge Mainline system. The Enbridge Mainline consists of multiple individual pipelines generally located in the same pipeline right-of-way. The Enbridge Mainline is one of the largest crude oil pipeline systems in the world and primarily connects the large crude oil resources of Western Canada with refineries located throughout the Upper Midwest and Ontario. Additional pipelines that connect to the Mainline enable Western Canadian crude oil to reach markets in the Lower Midwest, Midcontinent, Gulf Coast, and Quebec. Appendix 4 provides a schematic of the various pipeline segments of the Enbridge Mainline, Enbridge-owned connecting pipelines, and their individual capacities. Figure 1 shows the Enbridge pipeline system schematic that has been extracted from Appendix 4.

Figure 1



ENBRIDGE LINE 5

3.2. Line 5 originates at the large Enbridge Superior, Wisconsin, terminal and terminates in Sarnia, Ontario, where there are a number of refineries and connecting crude oil pipelines. Refineries in Michigan, Ohio, Pennsylvania, and Quebec also depend on Line 5 crude, which is transported to them on connected pipelines. In 2019, Line 5 transported approximately 446,000 b/d of crude oil.[2]

3.3. Line 5 also transports NGLs, which is unusual for a pipeline that primarily transports crude oil. Those NGLs originate in Western Canada and are transported to Superior on other Enbridge pipelines. In 2019, Line 5 delivered approximately 80,300 b/d of NGLs to fractionation facilities at Rapid River, Michigan, and Sarnia. The Rapid River facility is the primary propane supplier for the Upper Peninsula, and the Sarnia fractionator is a major supplier to Ontario, the Lower Peninsula, and regional petrochemical plants. Line 5 is the only Enbridge pipeline that can transport NGLs downstream of Superior.[3]

3.4. The nominal capacity of Line 5 is 540,000 b/d. In 2019, Line 5 transported a total of 526,000 b/d of NGLs and crude oil. The actual throughput of a pipeline and its nominal capacity may differ for various reasons, such as unscheduled maintenance activities. I use the 2019 throughput so as to incorporate actual historical data wherever possible in my analysis of the impact of closing Line 5. The impact of a Line 5 closure would be greater if I had used a throughput of 540,000 b/d for the analysis.

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[2] Enbridge provided the Line 5 throughput data.
[3] The Enbridge Line 1 transports NGLs from Western Canada to the Enbridge Superior terminal, where Line 1 terminates. See Figure 1.

4. LINE 5 SHUTDOWN IMPACT ON THE PROPANE AND BUTANES MARKETS

LINE 5 ROLE IN REGIONAL PROPANE AND BUTANES SUPPLY

4.1 In the Upper Midwest, propane is mostly consumed by the residential and agricultural sector. The former uses propane for heating and cooking, and latter uses it for crop drying and heating livestock housing. Demand is highly seasonal, with the largest consumption occurring in the fall and winter months. The term "butanes" refers to normal butane and isobutane. Normal butane is primarily blended directly into gasoline, particularly during the winter months, and isobutane is mostly processed by refineries into a high-octane gasoline blendstock.

4.2 Line 5 transports crude oil plus an NGLs product comprised primarily of propane (70 percent) and butanes (26 percent). By batching NGLs in the pipeline with crude oil, Line 5 offers transportation advantages that cannot be otherwise replicated. For example, the pipeline enables "just-in-time" deliveries of propane that would otherwise require a significant investment in storage for supply assurance. Line 5 delivers over 100,000 b/d of NGLs during some winter months.[4]

4.3 Before delivering the NGLs to Sarnia, a portion of the NGLs is delivered to the Plains fractionator facilities in Superior, Wisconsin, and Rapid River, Michigan. These facilities extract the propane fraction from the NGLs and return the unneeded butanes back to Line 5 for ultimate delivery to Sarnia. The propane

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[4] The numbers are approximate because, for reasons of customer confidentiality, the Enbridge Commodity Movement Tracking ("CMT") application is used to generate these numbers rather than custody transfer tickets. The CMT provides the volume of commodities that enter and exit each Enbridge origination and delivery point. NGLs inventory fluctuations and the lack of temperature compensation for the CMT measurements will create a difference between the volumes reported by the CMT and the custody transfer tickets.

that is extracted at Superior and Rapid River is distributed by propane marketers to customers in Wisconsin, Minnesota, and throughout the Upper Peninsula. The remaining NGLs are processed at the Plains Sarnia Fractionator, where the propane and butanes are separated and sold in Ontario, Michigan, and elsewhere in the Upper Midwest.[5]

4.4 The Superior fractionator is entirely reliant upon the continued operation of Line 5, because Line 5 is the means by which the Superior fractionator disposes of the unneeded butanes. Propane production at the Superior fractionator was approximately [redacted] of propane in 2019.[6] Because of the proximity of the Minnesota border to Superior, it is my opinion that a significant portion of the Superior propane output is also sold in northern Minnesota. The Superior fractionator is responsible for about 7 percent of the total propane supply for Wisconsin and Minnesota, and a much higher percentage of the propane supply for just northern Wisconsin and Minnesota.[7]

4.5 Figure 2 shows the annual average production volumes of propane at Superior for 2010 through 2019.[8] The facility has a demonstrated ability to surge its production to meet shortages in the local propane market. In 2014, the facility significantly increased its production and served a crucial role in supplying propane to Wisconsin and Minnesota during the severe 2013-2014 polar vortex winter event that caused propane shortages across the Midwest. Propane production at the Superior fractionator has remained elevated since the Cochin

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[5] Supplemental Submission of Interested Party Letters in Support of Defendants' Response to Plaintiff's Motion for Preliminary Injunction, Exhibit 1, PDF, pg. 5

[6] Enbridge CMT data. The Superior production estimate is calculated by subtracting the annual volume exiting the Superior terminal from the volume entering the terminal.

[7] State consumption data is extracted from the EIA State Energy Data System: https://www.eia.gov/state/

[8] Enbridge CMT data.

pipeline, formerly a major pipeline that transported propane from Western Canada to the Upper Midwest, permanently stopped delivering propane in 2014.[9]

Figure 2

4.6 Figure 3 illustrates the annual average propane volumes produced at Rapid River from Line 5 NGLs deliveries for 2010 through 2019. The Plains fractionator at Rapid River depends exclusively on Line 5 for its NGLs feedstock and produced approximately [redacted] of propane in 2019.[10] The Upper Peninsula is heavily reliant on the Rapid River facility for propane supply, as residential propane usage in the Upper Peninsula is estimated to be 1,750 b/d.[11] Details for just the Upper Peninsula are not available but, for all of Michigan, residential propane consumption is estimated to comprise 82 percent of total propane demand.[12] Assuming that the same percentage applies to the Upper Peninsula, total propane demand in the Upper Peninsula is about 2,130 b/d. Consequently,

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[9] Cochin Pipeline profile, Pipeline System and Key Points, June 2020, from Canada Energy Regulator: https://www.cer-rec.gc.ca/en/data-analysis/facilities-we-regulate/pipeline-profiles/oil-and-liquids/pipeline-profiles-kinder-morgan-cochin.html#key-points.

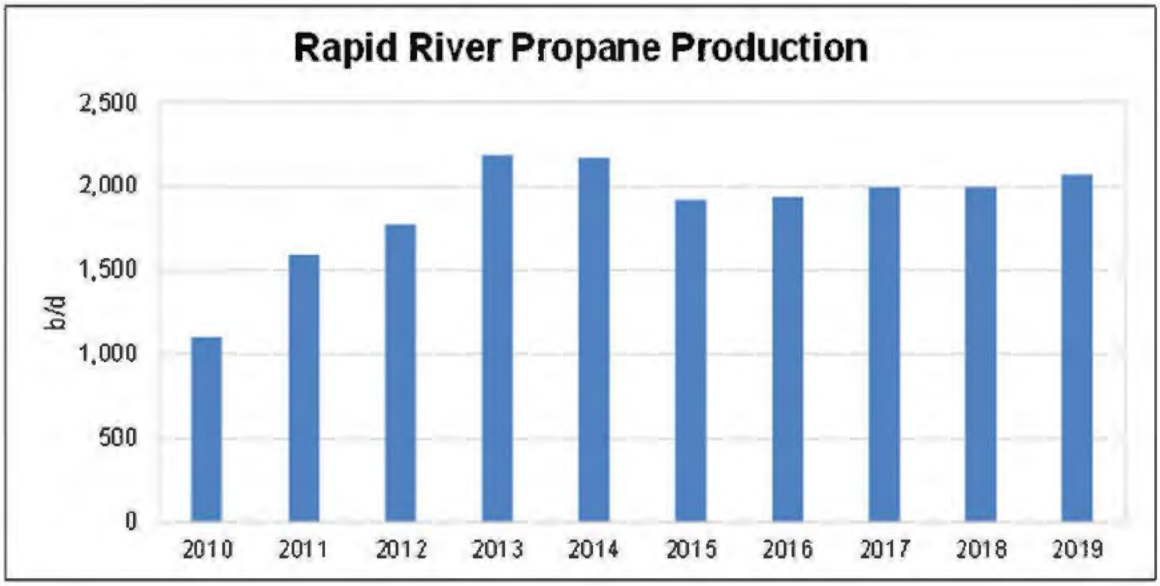
[10] Enbridge CMT data. The delivered propane volume equals the NGLs delivered at Rapid River minus the NGLs returned to Line 5.

[11] MPSC UP Propane System Presentation, August 5, 2019, PDF pg.10.

[12] EIA State Energy Data System: https://www.eia.gov/state/seds/seds-data-complete.php?sid=MI.

the Rapid River fractionator is reasonably believed to be responsible for most of the propane supply (residential and otherwise) for the Upper Peninsula.[13]

Figure 3



4.7 The Plains Sarnia fractionator receives all, or almost all, of its NGLs supply via Line 5 and separates the NGLs into propane and butanes for sale in surrounding markets.[14] The Sarnia fractionator produced approximately [redacted] of propane and [redacted] of butanes in 2019.[15] Data for Ontario indicates that 25,600 b/d of propane was consumed within the province in 2019 and 30,500 b/d was exported to the U.S.[16] Based on this supply/demand balance, it is my opinion that the Sarnia fractionator supplies virtually all of the propane consumed

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[13] There is also a small rail-supplied propane terminal at Kincheloe, located in eastern Upper Peninsula near the Canadian border, which supplies the local market as well as northern Ontario markets. This terminal has a propane storage capacity capable of accommodating about four rail cars.

[14] It is possible that the Sarnia fractionator receives a small amount of feedstock from the local refineries.

[15] Enbridge CMT data. The NGLs shipments have a buffer before and after each batch, and much of the buffer gets delivered to the Sarnia fractionator. Because the CMT data for Sarnia deliveries includes buffer, the Sarnia deliveries are reduced by 2,000 b/d to capture just the NGLs volume.

[16] Statistics Canada. Table 25-10-0026-01 Supply and demand of natural gas liquids, annual: https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=2510002601.

in Ontario. In addition, Plains has disclosed that it sells 13,000 b/d of propane from the Sarnia fractionator directly in Michigan.[17]

4.8 The annual demand for propane in Michigan was 25,000 b/d in 2019, so the Plains propane sales alone from the Sarnia fractionator supplied about 56 percent of the Lower Peninsula propane demand. In reality, the Sarnia fractionator meets an even greater percentage of the Lower Peninsula propane demand because Plains only disclosed its own direct sales, which does not include direct sales into Michigan by other companies with ownership interests in the Sarnia fractionator, such as Pembina[18] and Shell Canada,[19] as well as sales into Michigan by other marketing intermediaries that purchase propane from Sarnia. Over a 10-year period, Line 5 delivery volumes to Sarnia have been relatively consistent, as demonstrated by Figure 4. Propane volumes have averaged approximately [redacted] and butanes volumes have averaged approximately [redacted] over the 2015 to 2019 timeframe.

Figure 4

[17] Supplemental Submission of Interested Party Letters in Support of Defendants' Response to Plaintiff's Motion for Preliminary Injunction, Exhibit 1, PDF pg. 5.
[18] Supplemental Submission of Interested Party Letters in Support of Defendants' Response to Plaintiff's Motion for Preliminary Injunction, Exhibit 2, PDF pg. 10.
[19] Supplemental Submission of Interested Party Letters in Support of Defendants' Response to Plaintiff's Motion for Preliminary Injunction, Exhibit 8, PDF pg. 24.

4.9 The pipeline supply of propane via Line 5 has consistently kept the price of propane lower in Michigan than in its neighboring states to the south. Per the Energy Information Administration (the "EIA"), the wholesale price of propane in the states south and east of Michigan (Indiana, Ohio, and Pennsylvania) has consistently been higher than prices in Michigan.[20] This is the case even though the Marcellus/Utica Shale natural gas play in eastern Ohio and western Pennsylvania has developed into a major NGLs fractionation hub.[21] Despite this increase in propane production in the Marcellus/Utica Shale, the wholesale price for propane over the past four winters in Ohio and Pennsylvania has been on average 9 percent and 13 percent higher, respectively, than in Michigan. Indiana wholesale propane prices are 12 percent higher than that in Michigan.

LINE 5 SHUTDOWN IMPACT ON PROPANE AND BUTANES PRODUCTION

4.10 If the Plains Superior, Rapid River, and Sarnia fractionators were to lose their NGLs feedstock from Line 5, there is no immediate NGLs feedstock alternative. Furthermore, all three of the Plains facilities are designed to produce propane and butanes from NGLs comprised nearly entirely of propane and butanes. This is an unusual NGLs product type that is generally only available in Western Canada because the other components typically found in NGLs, such as ethane and natural gasoline, are removed in Canada for use there.

4.11 The Plains facilities cannot practically procure this unusual propane/butanes NGLs mix elsewhere. NGLs from the Marcellus/Utica Shale play, the closest alternative source, are the common "Y-grade" NGLs containing ethane, propane, butanes, and natural gasoline. All the Plains facilities would have to invest in additional processing equipment and storage facilities to process Y-grade NGLs.

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[20] EIA, Petroleum & Other Liquids, Wholesale Propane Prices, weekly, February 24, 2020 to March 30, 2020: http://www.eia.gov/dnav/pet/pet_pri_wfr_a_epllpa_pwr_dpgal_w.htm.

[21] The industry term "Marcellus/Utica Shale natural gas play" refers to the hydrocarbon resources found in the Marcellus and Utica formations, which underlie much of eastern Ohio and western Pennsylvania.

Table 1 compares the composition of the Line 5 NGLs to the Y-grade NGLs produced in the Marcellus/Utica Shale play.[22]

Table 1

2019 NGL Composition Comparison

(Volume Percent)

	Line 5	*Y-Grade*
Ethane	3.1%	38.9%
Propane	70.2%	35.1%
Butanes	26.1%	16.0%
Natural Gasoline	0.6%	10.0%
Total	**100.0%**	**100.0%**

4.12 Switching to Y-grade NGLs raises two other issues. First, new market outlets will be required for ethane, butanes, and natural gasoline at Superior and Rapid River. The lack of a local market for ethane, butanes, and natural gasoline will require the installation of truck and/or rail loading racks to enable the byproducts to be transported to some distant market outlet.

4.13 Second, the propane fraction in the Y-grade NGLs is only about 35 percent. This low propane content is a more substantial issue, as the Plains fractionators would have to double their NGLs processing capacity to match their historical propane production volumes. Based upon my process engineering experience, such an expansion would not be possible with just low-cost equipment modifications. The facilities would require sizable capital expenditures to double their NGLs processing capacity.

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[22] The Marcellus/Utica NGLs composition is estimated based on data from: EIA, Petroleum & Other Liquids, PADD 1 Natural Gas Plant Field Production, Monthly, December 2019 to May 2020: https://www.eia.gov/dnav/pet/pet_pnp_gp_dc_r10_mbbl_m.htm.

4.14 The Superior and Rapid River fractionators are small, simple facilities. Extensive modifications such as the addition of NGLs storage tanks, rail unloading facilities, butanes storage tanks, and either a truck or rail butanes loading system will be required if Line 5 is closed. Such modifications will be expensive, and it is my opinion that it is almost a certainty that Plains or any other owner would not make such an investment in these facilities, even in the circumstance where it is known that Line 5 would be taken out of service permanently. Furthermore, Plains has stated that a Line 5 shutdown would result in the closure of the Sarnia, Rapid River, and Superior fractionators.[23]

OVERVIEW OF POTENTIAL SUPPLY SOURCES

4.15 Once the Superior, Rapid River and Sarnia fractionators are forced to close following a Line 5 shut down, no single supply source will be able to replace the approximately [redacted] of propane and [redacted] of butanes produced from the NGLs delivered by Enbridge in 2019 to Superior, Rapid River, and Sarnia.[24] To provide some perspective on the magnitude of this supply shortfall, the lost propane supply exceeds the entire volume of propane consumed in Michigan and Ontario. A supply loss of this size can only be met from a number of supply sources, likely consisting of some combination of NGLs fractionation facilities located in Alberta, the Midcontinent, the Marcellus/Utica Shale area, and the Gulf Coast. This will result in a more logistically complex and costly supply chain for propane consumers in northern Wisconsin and Minnesota, Michigan, Ontario, and northern Ohio markets.

4.16 If Line 5 is shutdown, the NGLs now stranded in Western Canada do not disappear. They will be fractionated somewhere in North America and, therefore, incremental propane and butanes supply will be available at these fractionation locations. Another potential source of supply for the Midwest and Ontario is via a

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[23] Supplemental Submission of Interested Party Letters in Support of Defendants' Response to Plaintiff's Motion for Preliminary Injunction, Exhibit 1, PDF pg. 6.
[24] Enbridge CMT and Line 5 NGLs composition data.

reduction of propane and butanes exports from North America to overseas markets. In summary, the potential sources of propane and butanes supply, each discussed in more detail below, to replace the volumes lost due to a Line 5 shutdown are:

4.16.1 Alberta via the fractionation of a portion of the stranded Line 5 NGLs;

4.16.2 Alberta via the reduction of propane exports to the Asian markets;

4.16.3 Volumes from the Midcontinent via the fractionation of a portion of the stranded Line 5 NGLs and potentially greater volumes via a reduction of propane and butanes shipments via pipeline from the Midcontinent to the Gulf Coast;

4.16.4 The Marcellus/Utica Shale fractionation facilities via the reduction of propane and butanes exports to overseas markets; and

4.16.5 The Gulf Coast via the fractionation of the stranded Line 5 NGLs and/or the reduction of propane exports.

ALBERTA

4.17 With Line 5 shutdown, approximately 82,000 b/d of NGLs will be stranded in Western Canada. The total 2019 propane production in Alberta was 228,700 b/d.[25] Processing the stranded Line 5 NGLs in Alberta would require a 28 percent increase in propane production. The corresponding required increase in butanes production is about 16 percent, based upon a butanes production volume in 2019 of 131,600 b/d.[26] The capability of the existing Western Canadian fractionators to increase throughput is not known with precision, but it

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[25] Alberta Energy Regulator, Natural Gas Liquids, Production and Demand, Updated June 2020, Figure S6.2, Alberta propane supply from natural gas and demand: https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st98/natural-gas-liquids/natural-gas-liquids.html.

[26] Alberta Energy Regulator, Natural Gas Liquids, Production and Demand, Updated June 2020, Figure S6.3, Alberta butanes supply from natural gas and demand: https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st98/natural-gas-liquids/natural-gas-liquids.html.

is my assessment that it is unlikely that the entire volume of stranded Line 5 NGLs can be processed in Western Canada. The balance of the stranded NGLs that cannot be fractionated in Western Canada will have to be railed to NGLs fractionators elsewhere in North America.

4.18 Historically, Alberta propane producers had only had the U.S. market as a major market outlet via rail once local demand was met. However, other propane markets have recently emerged that provide market alternatives and more attractive (higher) prices for Alberta propane producers. These alternative propane markets will reduce the volume potentially available for export to anywhere in the U.S., including the Line 5 delivery area.

4.19 First, as part of an initiative to generate domestic demand for its NGLs commodities and attract private investment to the province, the Alberta Government created the Petrochemical Diversification Program. This program facilitated the construction of a propane dehydrogenation petrochemical plant that will consume 22,000 b/d of propane when completed in early 2022.[27] The plant is located in the Edmonton area, which is where rail shipments of propane to the U.S. generally originate.

4.20 Second, Alberta propane producers now have access to the premium Asian markets that offer higher prices. In 2019, the average price for propane at Edmonton was 30 ¢/gal, while the average landed import propane price in Japan was 87 ¢/gal. In addition to providing a higher price, the Asian propane markets are sizable. For example, in 2019 the U.S. exported 374,000 b/d of propane to Japan and 87,000 b/d to South Korea.

4.21 Alberta propane producers have obtained access to the Asian markets via new rail-to-ship transloading facilities. The AltaGas Ridley Island Propane Export Terminal in British Columbia was completed in mid-2019 with an export capacity

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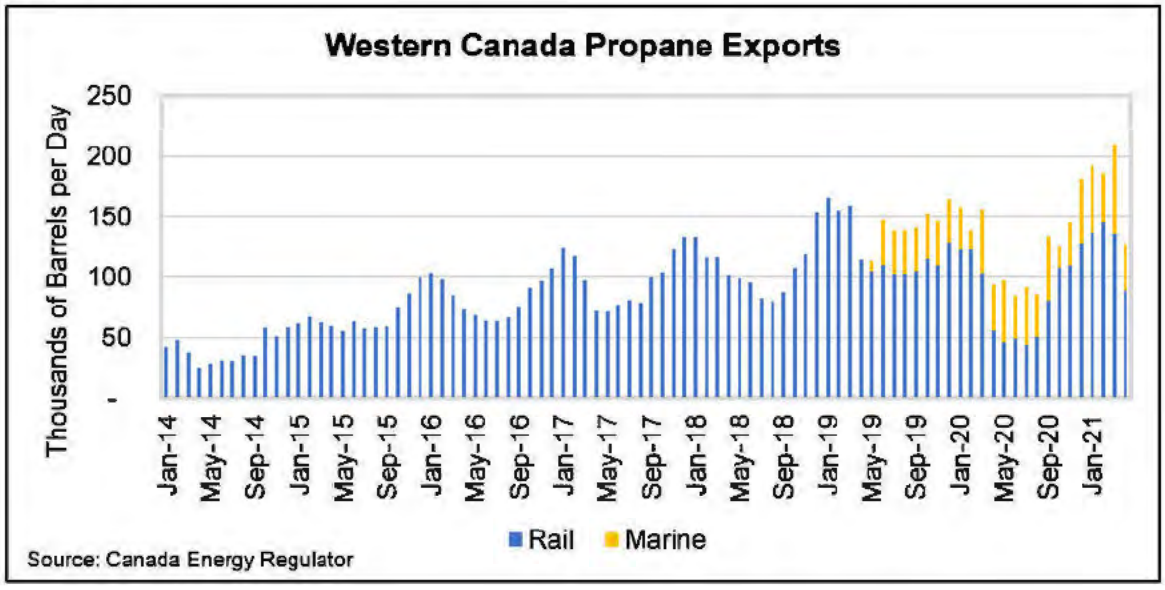
[27] Inter Pipeline, Delivering Energy, NGL Processing: https://www.interpipeline.com/operations/businesssegments/ngl-processing.cfm.

of almost 80,000 b/d.[28] In 2021, the Pembina Prince Rupert Terminal on Watson Island started up with a propane export capacity of 25,000 b/d.[29] An additional 86,000 b/d of propane export capacity is under various stages of development at two other West Coast locations at Ridley Island and Kitimat, facilitating additional Asian competition for Alberta propane supply in the coming years.[30] Figure 5 illustrates the degree to which the Western Canadian export patterns have recently shifted.[31] It is my assessment that the Asia-Alberta price differentials are wide enough such that propane exports to Asia from Alberta will continue and these volumes will not be available to supply the Midwest and Eastern Canada.

Figure 5



[28] AltaGas News Release, December 17, 2019: https://www.altagas.ca/newsroom/news-releases/altagas-announces-2020-guidance-suspension-its-dividend-reinvestment-program.
[29] Pembina, Operations, https://www.pembina.com/operations/projects/prince-rupert-terminal/.
[30] Canada Energy Regulator, Market Snapshot: New propane export terminal in British Columbia allows Canadian propane direct access to Asian markets, July 17, 2019: https://www.cer-rec.gc.ca/nrg/ntgrtd/mrkt/snpsht/2019/07-03nwprpnxprttrmnl-eng.html.
[31] Canada Energy Regulator, Commodity Statistics, Natural Gas Liquids, export data: https://apps.cer-rec.gc.ca/CommodityStatistics/Statistics.aspx?language=english.

MIDCONTINENT

4.22 The Midcontinent has NGLs fractionators at Bushton, Conway, and Hutchinson in Kansas, plus a fractionator at Medford, Oklahoma. Total capacity is about 575,000 b/d. These fractionators have historically supplied propane to the Midcontinent and Midwest markets plus shipped sizable volumes via pipeline to Gulf Coast petrochemical plants and propane export terminals. It is my assessment that the Midcontinent fractionation facilities are close to full utilization and have little capacity available to process any of the stranded Line 5 NGLs.[32] The ability of the Midcontinent fractionators to process the stranded Line 5 NGLs is further limited because these facilities are designed to process Y-grade NGLs, not the propane/butanes mixture shipped on Line 5.

4.23 In 2019, the Midcontinent fractionators shipped 260,507 b/d of propane and 143,348 b/d of butanes via pipeline to the petrochemical markets and export terminals on the Gulf Coast.[33] A portion of these propane and butanes volumes are potentially available for transportation by rail to the Upper Midwest and Ontario markets, since the Midcontinent fractionators have some rail loading capacity and currently ship some propane and butanes by rail. However, the incremental rail loading capacity available is not known, and it is my assessment that it is unlikely that Midcontinent fractionators have sufficient excess rail loading capacity to fully replace the Line 5 volumes.

MARCELLUS / UTICA SHALE

4.24 The Marcellus/Utica Shale gas play is located in eastern Ohio and western Pennsylvania, and it produces a sizable amount of natural gas and NGLs. The

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[32] EIA, Natural Gas Plant Field Production, Natural Gas Liquids, PADD 2, Oklahoma, Kansas, Missouri, 2014 to 2019: https://www.eia.gov/dnav/pet/pet_pnp_gp_a_EPL2_FPF_mbblpd_a.htm and EIA, Movements by Pipeline between PAD Districts, Natural Gas Liquids, PADD 4 to PADD 2, 2014 to 2019: https://www.eia.gov/dnav/pet/pet_move_pipe_dc_R20-R40_mbbl_a.htm.

[33] EIA, Movements by Pipeline between PAD Districts, Crude Oil and Petroleum Products, PADD 2 to PADD 3: https://www.eia.gov/dnav/pet/pet_move_pipe_dc_R30-R20_mbbl_a.htm. The EIA does not separately identify the volume of propane and butanes shipped as purity product versus the volume shipped in a Y-grade mix.

potential supply of replacement propane from the NGLs fractionators in the Marcellus/Utica Shale is assessed to be limited to approximately 17,000 b/d for the reasons described below. The Marcellus/Utica Shale play is unable to replace a larger amount of the propane and butanes lost due to a shutdown of Line 5 for two primary reasons.

4.25 First, the propane supplied from the Marcellus/Utica Shale fractionators to the local and Northeast markets cannot simply be redirected to Michigan and Ontario. Such actions would simply leave the local and Northeast markets without propane. Only the propane that is exported from the U.S. are potentially available for redirection to Michigan and Ontario.

4.26 Second, much of the propane and butanes production from these fractionators is dedicated to long-term contracts on the Mariner East pipeline system for delivery to the Marcus Hook, Pennsylvania export and distribution terminal on the Delaware River.[34] In 2019, the Marcus Hook terminal exported most of the 119,000 b/d of propane and all of the 37,000 b/d of butanes that left the East Coast.[35] The Mariner East pipeline is almost exclusively a contract carrier because Energy Transfer, the owner of the Mariner East pipeline system, received binding volume commitments from shippers prior to beginning pipeline construction.[36] The capacity on the Mariner East 2 pipeline is also fully contracted while the next expansion of the Mariner East pipeline system, Mariner East 2X, already has a significant portion of its capacity sold.[37]

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[34] Energy Transfer Investor Presentation, September 2019, PDF pg. 22.

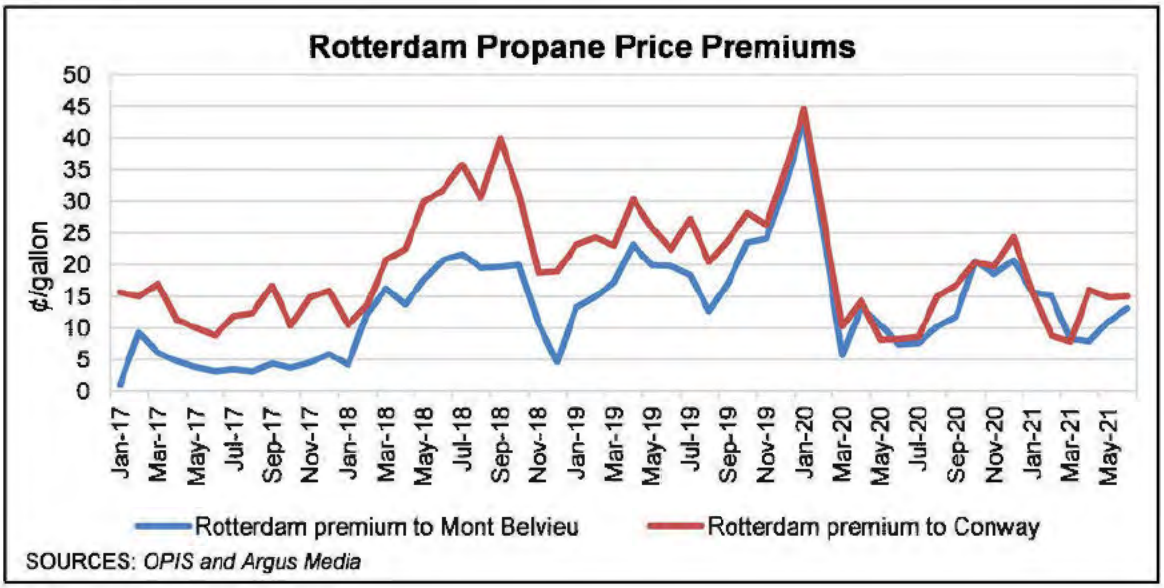
[35] EIA, Petroleum & Other Liquids, Propane exports from the East Coast (PADD 1), 2014 to 2019: https://www.eia.gov/dnav/pet/pet_move_expcp_a2_r10_EPLLPA_EEX_mbblpd_a.htm and EIA, Petroleum & Other Liquids, Normal Butane exports from the East Coast (PADD 1), 2014 to 2019: https://www.eia.gov/dnav/pet/pet_move_expcp_a2_r10_EPLLBAN_EEX_mbblpd_a.htm. In 2019, there were two operational terminals in PADD 1 capable of exporting propane, Marcus Hook and a small Plains terminal in Tampa, Florida.

[36] Sunoco Press Release, September 26, 2012: https://www.businesswire.com/news/home/20120926005959/en/Sunoco-Logistics-Partners-L.P.-Announces-Successful-Open.

[37] Energy Transfer Q4 2018 Earnings Conference Call Transcript: https://www.fool.com/earnings/call-transcripts/2019/02/21/energy-transferut-ltd-partn-int-et-q4-2018-earning.aspx.

4.27 These long-term pipeline transportation commitments are structured as take-or-pay obligations, which means that much of the transportation expense to reach the Marcus Hook export terminal is a sunk cost for the Mariner East shippers.[38] Consequently, the value/price for the volume of propane and butanes shipping under long-term contracts on the Mariner East pipeline buyers equals the value/price at the Marcus Hook terminal, which is high. Much of the propane at Marcus Hook is being shipped to Europe, and prices at Rotterdam, the key Northwest Europe marketing and pricing hub, trade at a premium to U.S. propane prices. As illustrated by Figure 6, Rotterdam propane prices were on average 20 ¢/gal higher than Mont Belvieu in 2019 and 16 ¢/gal in 2020. It is my assessment that contract producers will prefer to ship propane to Rotterdam and that, therefore, only the volume of propane and butanes shipped at a spot toll on the Mariner East pipeline is potentially available for redirection to the Michigan and Eastern Canadian markets.

Figure 6



[38] A sunk cost is one that has already been incurred and cannot be recovered. When deciding to ship to Marcus Hook, the sunk costs are ignored by shippers.

4.28 Based on volume commitments on the Mariner East pipeline system, propane movements from Petroleum Administration for Defense Districts ("PADD") PADD 2 to PADD 1, local demand, and propane production capability in the Marcellus/Utica Shale, I estimated that about 17,000 b/d of propane would be available for Michigan and Ontario. As reflected in Figure 7, this conclusion is based on the estimated disposition of the 272,000 b/d of propane produced from the Marcellus/Utica Shale in 2019.[39] Of this amount, Ohio, Pennsylvania, and West Virginia propane demand comprised 53,400 b/d[40] while rail movements of propane within PADDs 1 and 2 were 37,000 b/d.[41] An estimated 165,000 b/d of propane from the Marcellus/Utica Shale NGLs fractionators is transported by the Mariner East pipeline system to Marcus Hook.[42] It is expected that these pipeline movements to Marcus Hook will continue to rise because the original Mariner East pipeline has 35,000 b/d of committed propane transportation capacity.[43] The Mariner East 2 pipeline has approximately 192,500 b/d of propane transportation commitments.[44] This would leave approximately 17,000 b/d of propane shipping under the Mariner East spot toll available from the Marcellus/Utica Shale for the Line 5 delivery area, substantially less than would be needed to meet Michigan and Ontario market demand.

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[39] EIA, Natural Gas Plant Field Production: Propane, 2019: http://www.eia.gov/dnav/pet/pet_pnp_gp_a_epllpa_fpf_mbblpd_a.htm.

[40] EIA, Prime Supplier Sales Volumes, 2019: https://www.eia.gov/dnav/pet/pet_cons_prim_a_EPLLPA_P00_Mgalpd_a.htm.

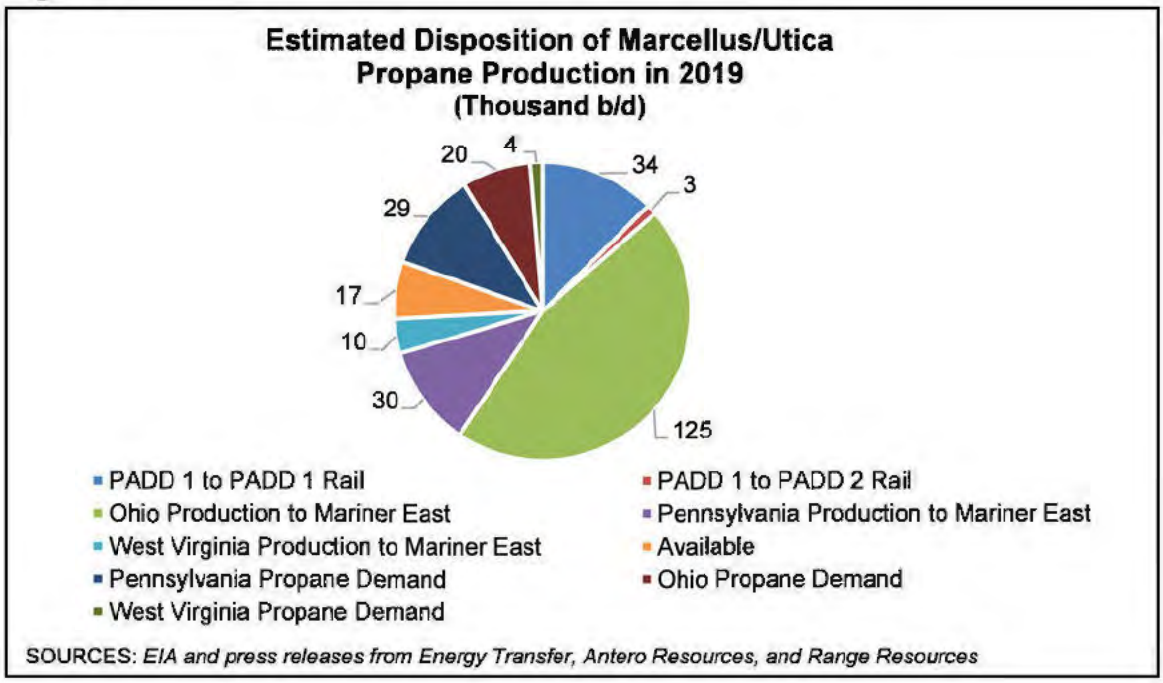
[41] EIA, Propane Movements by Rail: http://www.eia.gov/dnav/pet/pet_move_railna_a_epllpa_rail_mbbl_m.htm.

[42] EIA, Propane Movements by Pipeline: https://www.eia.gov/dnav/pet/pet_move_pipe_a_EPLLPA_LMV_mbbl_a.htm.

[43] Sunoco Press Release: https://www.businesswire.com/news/home/20120926005959/en/Sunoco-Logistics-Partners-L.P.-Announces-Successful-Open and Range Resources Press Release, https://www.sec.gov/Archives/edgar/data/315852/000119312512406402/d417826dex991.htm.

[44] Antero Resources Press Release: https://www.anteroresources.com/investors/news-events/press-releases/detail/167/antero-resources-reports-first-quarter-2019-financial-and and Energy Transfer Presentation, 2019 Goldman Sachs Global Energy Conference, January 8, 2019, PDF pg. 25: https://ir.energytransfer.com/static-files/502ded10-ef44-467d-9c4f-6fbb67046022.

Figure 7



SOURCES: *EIA and press releases from Energy Transfer, Antero Resources, and Range Resources*

GULF COAST

4.29 The Mont Belvieu fractionation complex on the Texas Gulf Coast is the largest NGLs hub in North America with over 3 million b/d of fractionation capacity. There are additional NGLs fractionation facilities located in Louisiana. Due to the amount of NGLs fractionation capacity available on the Gulf Coast, it is likely that much of the stranded Line 5 NGLs that are not fractionated in Alberta will ultimately be processed on the Gulf Coast. However, the ability of the Gulf Coast to replace the Line 5 volumes is limited by the available pipeline capacity between the Gulf Coast and the Midwest.

4.30 The Enterprise TE Products Pipeline (the "TE Products Pipeline") is the only pipeline that can deliver propane and butanes from the Gulf Coast to terminals in Indiana and Ohio, and it is frequently operating at capacity. The TE Products Pipeline also transports gasoline, jet fuel, diesel, and diluent in addition to propane and butanes through a complex pipeline batching and capacity allocation process. Due to the Enterprise allocation policy for shippers of refined products and propane/butanes, the TE Products Pipeline cannot prioritize

shipments of propane and butanes in the winter months absent an emergency order from the Federal Energy Regulatory Commission ("FERC").[45] The combined propane and butanes shipment volumes on the TE Products Pipeline were 71,000 b/d in 2018 and 63,000 b/d in 2019.[46] Furthermore, the existing volumes now shipped on the TE Products Pipeline are committed to local markets and cannot simply be diverted to supply the Line 5 markets.[47]

4.31 Moreover, the TE Products Pipeline terminals are generally small ones designed to supply the local market. For example, the closest TE Products Pipeline terminal to Michigan, located in Coshocton, Ohio, has just three propane storage tanks and what appears to be a two-bay truck rack.[48] This facility cannot meaningfully replace the volume of propane produced by the Sarnia fractionator even if the TE Products Pipeline had available capacity.

4.32 In summary, the TE Products Pipeline and its connected terminals do not have the capacity to replace the Line 5 NGLs volumes, particularly during peak winter propane demand periods. The only alternatives for additional volume from the Midcontinent and the Gulf Coast are by truck and rail. The issues with truck and rail transportation are addressed in detail in the William Rennicke report.[49]

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[45] FERC Order Extending Priority Treatment, Enterprise TE Products Pipeline Company, LLC; 146 FERC ¶ 61,085 (2014): https://www.ferc.gov/sites/default/files/2020-06/Enterprise%20TE%20Products%20Pipeline%20Company%2C%20LLC%2C.pdf.

[46] Enterprise Products Partners L.P. 2019 Form 10-K, PDF pg. 29. Enterprise does not separately disclose the propane and butanes volume. A number of years ago when this information was disclosed, propane was about 75 percent of the total volume of propane and butanes.

[47] Enterprise Products Partners L.P. 2019 Form 10-K, PDF pg. 29. Enterprise does not separately disclose the propane and butanes volume. A number of years ago when this information was disclosed, propane was about 75 percent of the total volume of propane and butanes.

[48] Google Maps: https://www.google.com/maps/place/Enterprise+Products/@40.1965049,-81.844859,275m/data=!3m1!1e3!4m8!1m2!2m1!1sCoshocton,+OH+enterprise!3m4!1s0x0:0x3cd86234dad49eb!8m2!3d40.1960285!4d-81.8450669, viewed on November 3, 2020.

[49] *See generally* Expert Report of William Rennicke, January 31, 2022.

REFINERY PROPANE PRODUCTION

4.33 The shortfall in propane supply that will follow from a shutdown of Line 5 cannot be replaced with propane produced by regional refineries. While refineries do produce some propane, their primary objective is to produce gasoline, jet fuel, and diesel. Propane is just a by-product, and refineries have no practical means to significantly increase (or decrease) propane production. Accordingly, the regional refineries have no ability to increase their propane production so as to replace the shortfall in propane supply due to a Line 5 shutdown. In addition, Midwestern refineries are net consumers of butanes, and thus have no ability to replace the butanes supplied by Line 5.

4.34 Further, the shutdown of Line 5 will also reduce the supply of propane due to crude oil run reductions at the refineries in the Line 5 delivery area. The estimated impact of these crude oil run reductions on refinery propane supply is shown in Table 2. Using the ratio of PADD-level refinery propane production to refinery crude oil capacity, the estimated propane volumes from the regional refineries is 24,080 b/d. The closure of Line 5 is estimated to reduce refinery propane supply by about 4,200 b/d. This will further exacerbate the propane supply shortfall in the Upper Midwest and Ontario.

Table 2

Estimated Refinery Propane Production

(Barrels per Day)

Refinery	*Adjusted 2019 Estimated Production*	*Production with Line 5 Shutdown*	*Line 5 Shutdown Impact*
Detroit/Toledo Region	9,300	8,100	1,200
Pennsylvania	80	40	40
Ontario	7,200	4,200	3,000
Quebec	7,500	7,500	-
Grand Total	**24,080**	**19,840**	**4,240**

OVERVIEW OF MIDWESTERN PROPANE DELIVERY OPTIONS

4.35 To replace the Line 5 propane supply, it is not enough to simply identify the locations at which propane could be potentially loaded onto rail cars for transport to the Midwest and Ontario. It is also necessary to identify where these rail cars potentially could be unloaded in the Midwest and Ontario. Figure 8 provides the location of the major terminals from which propane is currently distributed to Midwestern and Ontario consumers. These propane sites include facilities that produce propane from NGLs that are not transported by Line 5, refinery-connected terminals, and rail terminals. As discussed previously, the Superior, Rapid River, and Sarnia sites rely on Line 5 for propane supply and will have no propane available if Line 5 is shut down.

Figure 8

4.36 The Aux Sable Channahon facility near Chicago is the only NGLs fractionator in the area that does not rely upon Line 5 for NGLs supply. The Aux Sable facility processes raw natural gas transported on the Alliance Pipeline from Western Canada and North Dakota. One of the products produced by the facility is propane. However, the Alliance Pipeline is currently operating at capacity, leaving Aux Sable with no significant capability to increase propane production.[50]

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[50] Canada Energy Regulator, Natural Gas Pipeline Transportation System, Figure 21, 2020 Average Throughput and Capacity at Key Points: https://www.cer-rec.gc.ca/en/data-analysis/facilities-we-regulate/canadas-pipeline-system/2021/natural-gas-pipeline-transportation-system.html.

4.37 The Kalkaska, Michigan gas processing plant produces an estimated 1,100 b/d of propane and is operated by Lambda Energy Resources ("Lambda"), the largest producer of oil and natural gas in Michigan. The propane production at this facility is purely a function of the amount and propane content of the raw natural gas processed at the facility, and Lambda has no means to increase either one if Line 5 is shut down. In addition, the plant operator states that the facility will be closed if Line 5 is shut down, thereby eliminating the only producer of propane in the northern Lower Peninsula and exacerbating the shortages in propane supply.[51]

4.38 The Kincheloe rail terminal is located on the eastern edge of the Upper Peninsula near the Canadian border and supplies propane to the local markets as well as Sault Ste. Marie, Ontario. This small rail terminal only has 120,000 gallons of propane storage, which is about the volume of four propane rail cars.[52] Available satellite imagery indicates that the facility has a two rail car unloading rack, and may be capable of moving an additional two rail cars into position without assistance from the railroad.[53] It appears to be able to load one or two trucks at time from the onsite propane storage tanks, and it does not have a truck rack which would speed the truck loading process. Absent major investment, it appears that the Kincheloe terminal has little capacity to significantly increase propane supply.

4.39 The Woodhaven terminal stores propane produced at the Marathon Detroit refinery.[54] The Inkster terminal provides the same service for the PBF Energy

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[51] Supplemental Submission of Interested Party Letters in Support of Defendants' Response to Plaintiff's Motion for Preliminary Injunction, Exhibit 4, PDF pg.15.

[52] MPSC UP Propane System Presentation, August 5, 2019, PDF pg.14.

[53] Google Maps: https://www.google.com/maps/place/Kincheloe,+Kinross+Charter+Twp,+MI+49788/@46.2605339,-84.4752486,206m/data=!3m1!1e3!4m5!3m4!1s0x4d361052dd5584d5:0x46fd9ba8766b2464!8m2!3d46.2664445!4d-84.4663642 viewed on November 3, 2020.

[54] U.S. Federal Register, 33716, Vol. 77, No. 110 / Thursday, June 7, 2012 / Notices: https://www.govinfo.gov/content/pkg/FR-2012-06-07/pdf/2012-13861.pdf.

("PBF") Toledo refinery.[55] These storage terminals rely on propane production from their connected refineries and will not be able to increase supply if Line 5 is shut down.

4.40 The DCP Midstream Partners ("DCP") Marysville NGLs facility provides storage services to the Sarnia refining and petrochemical sector as well as the Sarnia fractionator through the Plains Sarnia Downstream System pipeline. The storage facility has a capacity of 8 million barrels to store ethane, propane, and butanes to serve regional refining and petrochemical demand and to act as a balancing mechanism to meet the seasonal demand for propane in the Midwest and Ontario markets. Since this facility obtains its propane via Line 5, it has no ability to address the propane supply shortfall created by a Line 5 shut down. The Plains St. Clair terminal is also supplied by the Sarnia fractionator.

4.41 The Plains Alto rail terminal, located in the Lower Peninsula, generally receives propane produced at facilities outside of the region. It is a relatively large facility with 1.4 million barrels of storage capacity.[56] Satellite imagery indicates that the Alto terminal has a four-bay truck loading rack and a rail unloading rack capable of unloading seven rail cars.[57] On-site rail car storage capacity appears to be limited to seven rail cars and, consequently, the ultimate capacity of the facility would be limited by the number of daily rail car switches provided by the local railroad. If three switches per day are possible, the facility capacity would be about 15,000 b/d on an annual average basis.[58] However, the key metric that is

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[55] Sunoco Logistics Partners Form 10-K for fiscal year ending, December 31, 2010, pg. 11: https://www.sec.gov/Archives/edgar/data/95304/000119312511050224/d10k.htm.

[56] Michigan and Plains – Propane Overview presentation, September 2019: https://www.michigan.gov/documents/egle/egle-exe-upetf-ENB_L5_Presentation_666520_7.pdf, Michigan: Plains Role in Propane Movements, PDF pg.4.

[57] Google Maps: https://www.google.com/maps/place/42%C2%B051'18.0%22N+85%C2%B021'57.6%22W/@42.8543258,-85.3663989,219m/data=!3m1!1e3!4m5!3m4!1s0x0:0x0!8m2!3d42.855!4d-85.366 viewed on November 2, 2020.

[58] An automated four-bay truck rack should be able to load more than 15,000 b/d if operating 24 hours a day. Therefore, the facility likely has the capability to load more propane during peak winter demand periods by drawing down inventory.

not known about the Alto terminal is the amount of unused capacity, as the facility is already suppling propane to the local market. Companies do not build expensive excess capacity unless there is some expectation of future demand growth, and propane demand in Michigan has been relatively constant in recent years. Nonetheless, even if the Alto terminal has hypothetically 100 percent excess capacity (7,500 b/d), it would still be able to replace less than 15 percent of the propane that Line 5 delivers to Sarnia.

4.42 In summary, none of the other propane producing facilities (red circles) on Figure 8 above have a significant capability to increase their propane production in the event that Line 5 is shut down. For many locations, the propane supply is simply a byproduct of refinery operations. As for the rail terminals, all of them are currently suppling their local markets, and the key uncertainty is the amount of surplus capacity available at each. It is my judgement that it is very unlikely that these rail terminals have sufficient excess capacity to accommodate the loss of the propane volume transported by Line 5.

LOGISTICAL ALTERNATIVES FOR PROPANE SUPPLY TO SUPERIOR

4.43 Historically, the Kinder Morgan Cochin Pipeline transported propane from Western Canada to the Upper Midwest, supplying propane to consumers in Minnesota, Wisconsin, Iowa, and Illinois. These states are all net importers of propane. Kinder Morgan announced in June 2012 that the Cochin Pipeline would stop shipping propane potentially as early as July 2014, thus giving industry about 2 years—a sharp contrast to the minimal lead time that will be available here—to respond and invest in other supply options, such as rail terminals, to mitigate supply disruptions.[59]

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[59] *Oil & Gas Journal*, "KMEP to reverse Cochin Pipeline, ship diluent to Alberta," June 6, 2012: https://www.ogj.com/pipelines-transportation/pipelines/article/17273959/kmep-to-reverse-cochin-pipeline-ship-diluent-to-alberta.

4.44 In anticipation of the loss of propane supply from the Cochin pipeline, CHS, a major propane wholesaler in the Upper Midwest, invested $24 million in four states to facilitate rail deliveries of propane, including the addition of 980 b/d of propane delivery capacity for Wisconsin.[60] To put this incremental supply volume by CHS in perspective, the loss of the Superior fractionator will require the replacement of [redacted] of propane supply, almost four times the amount the Cochin pipeline supplied to Wisconsin. Despite the investments in rail unloading facilities by CHS, Wisconsin still experienced a propane supply emergency during the winter of 2019-20. Propane had to be trucked into Wisconsin from Kansas and Texas to meet demand.[61] There is no reason to think the outcome in the winter of 2019-20 would have been better if Line 5 was shut down.

4.45 The Enterprise Mid-America Pipeline ("MAPL") system, which originates at Conway, has a pipeline segment that supplies Wisconsin. However, the terminus of this pipeline segment is at Janesville, near the southern border of Wisconsin, and is 357 miles away from Superior. The propane deliveries from this MAPL pipeline segment are understood to be currently absorbed by the markets in southern Wisconsin and northern Illinois. Since CHS built rail terminals in response to the end of propane deliveries by Cochin pipeline, rather than simply acquiring more propane from the MAPL system, it is my opinion that the MAPL segment connected to Wisconsin is already operating at capacity and is incapable of delivering additional propane.

4.46 To replace the [redacted] of lost propane supply, Superior will likely have to rely on truck deliveries from a number of propane rail terminals scattered across

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[60] Wisconsin Governor Scott Walker, Press Release for Executive Order #148, January 9, 2015, Relating to the Declaration of an Energy Emergency Due to Intermittent Propane Pipeline Supplies: http://homeenergyplus.wi.gov/docview.asp?docid=26353.

[61] Wisconsin Congressman Ron Kind, Letter to FERC on propane shortage, November 15, 2019: https://kind.house.gov/sites/kind.house.gov/files/Kind%20to%20Chairman%20Chatterjee%20on%20Propane%20Shortage.pdf.

Wisconsin and elsewhere in the Midwest.[62] It is noteworthy that Rapid River is one of the propane terminals that supplies Wisconsin.[63] I have assumed that rail terminals scattered across Wisconsin and the Midwest have sufficient capacity to handle the additional tank cars needed to replace the lost propane supply from the Superior fractionator, an assumption that, for the reasons set forth in the report of William Rennicke, may be optimistic.[64]

4.47 According to the American Transportation Research Institute ("ATRI"), the tanker truck marginal cost per mile was $2.155 in 2018. The marginal cost reflects the operational costs of the tanker truck, including fuel, truck lease payments, maintenance, insurance, driver wages, and driver benefits.[65] Based on the average distance between Superior and these rail terminals, I estimate that shutting down Line 5 will increase the cost of propane to Wisconsin consumers by $4 million per year. I regard this cost estimate to be conservative (i.e., low), because the trucking distance to the most distant rail terminal required to satisfy demand will generally establish the propane price in the Superior area. The calculation details can be found in Workpaper 1.

LOGISTICAL ALTERNATIVES FOR PROPANE SUPPLY TO THE UPPER PENINSULA

4.48 There is a strong seasonal component to propane demand in the Upper Peninsula. Figure 9 shows the seasonal variations in Line 5 propane deliveries to Rapid River. It should be noted that Line 5 enables the Upper Peninsula propane supply to be rapidly increased irrespective of the weather conditions. In contrast, increasing propane supply via other transportation modes requires obtaining additional equipment and personnel, such as trucks, drivers, and rail

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[62] Wisconsin Governor Scott Walker, Executive Order #268, Relating to the Declaration of an Energy Emergency Due to Intermittent Propane Supplies: https://docs.legis.wisconsin.gov/code/executive_orders/2011_scott_walker/2017-268.pdf.

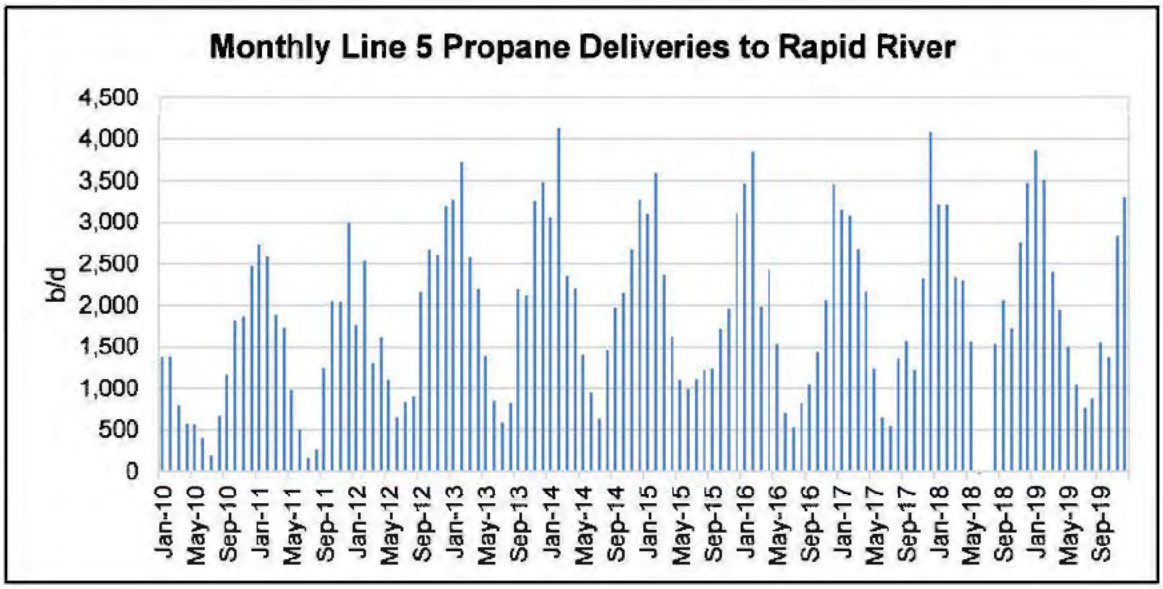
[63] Ibid.

[64] Rennicke Report at 32-66.

[65] American Transportation Research Institute; Operational Costs of Trucking, 2019, PDF pg. 36: https://truckingresearch.org/wp-content/uploads/2019/11/ATRI-Operational-Costs-of-Trucking-2019-1.pdf

cars, which takes time. Moreover, utilizing truck or rail transportation can be very difficult during severe weather.

Figure 9



4.49 With Line 5 shut down and the ensuing closure of the Rapid River fractionator, the potential alternative propane supply options are rail and truck. However, as discussed above, the Kincheloe rail terminal is assessed to have little unused capacity available, leaving long-distance trucking from Wisconsin and Lower Peninsula terminals as the only option. The closure of the Superior fractionator with the corresponding supply burden on the Wisconsin terminals further exacerbates the difficult supply situation for the Upper Peninsula. Moreover, the Rapid River fractionator has historically also supplied propane to Wisconsin so the rail terminals in Wisconsin may not have the capability to fulfill demand in the Upper Peninsula.[66] Shortages during peak winter demand periods are possible, even likely.

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[66] Wisconsin Governor Scott Walker, 2017 Executive Order #268, Relating to the Declaration of an Energy Emergency Due to Intermittent Propane Supplies: https://docs.legis.wisconsin.gov/code/executive_orders/2011_scott_walker/2017-268.pdf.

4.50 The optimum longer-term solution for the Upper Peninsula in the absence of Line 5 is not clear. The existing Rapid River fractionator with its propane storage tanks and truck loading rack is not particularly close to a rail line. Options include: building a rail spur to the existing facility and adding a rail unloading rack; building a remote rail unloading site with a pipeline connection to the existing Rapid River facility; or, relocating the existing storage tanks and truck rack to a new site convenient to a rail line somewhere in the Upper Peninsula. All of these options will take time and be expensive; none of these options will create an immediate, or even short-term, way to replace existing supply for the Upper Peninsula. Accordingly, closing Line 5 without an operational re-route would have immediate adverse impacts on Upper Peninsula propane supply resulting in shortages.

ALTERNATIVE PROPANE SUPPLY SOURCES FOR ONTARIO AND THE LOWER PENINSULA

4.51 It is theoretically possible to deliver Y-grade NGLs to Sarnia via the Utopia pipeline, which originates in the Marcellus/Utica Shale in Ohio and terminates at Windsor, Ontario, as show on Figure 10. The Utopia pipeline is currently designed to deliver ethane to Sarnia petrochemical customers.[67] However, the Sarnia fractionator is designed to process a mixed propane/butanes NGL. The Y-grade NGLs available in the Marcellus/Utica Shale, assuming that the NGLs could somehow be diverted from the local fractionators in the area, cannot be processed by the Sarnia fractionator.

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[67] ICIS, "*US Kinder Morgan starts up Utopia ethane pipeline to Canada*", January 23, 2018: https://www.icis.com/explore/resources/news/2018/01/23/10186000/us-kinder-morgan-starts-up-utopia-ethane-pipeline-to-canada/. The Utopia pipeline delivers ethane to the Windsor Sarnia Pipeline at Windsor, Ontario, which connects to Sarnia.

Figure 10

4.52 A second potential option is to transport the Line 5 stranded NGLs by rail from Edmonton to Sarnia. However, the multiple NGLs receipt points (Edmonton, Kerrobert, and Cromer) on the Enbridge Mainline significantly complicate the rail logistics.[68] Supplying about 80,000 b/d of NGLs to the Sarnia fractionator would require a unit train operation, about 110 cars every day, but the NGLs are not available at a single location to load unit trains.[69] Further, the Sarnia fractionator is understood to have very limited rail receipt capabilities because it relies on Line 5 for all of its feedstock. It is my assessment that the economics of operating a NGLs fractionator with rail-delivered feedstock will be marginal or negative, even assuming that a NGLs rail unloading facility could be permitted and built in the Sarnia area (a process that would be expensive and lengthy). I am not aware of any NGLs fractionator in North America that relies upon rail for

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[68] Enbridge: Line 5 Discussion U.P. Energy Task Force, September 20, 2019, PDF pg. 8.

[69] A unit train consists of rail cars transporting a single commodity from a single origination point to a single destination. Because a unit train requires less handling by the railroads, the rail transportation charges are lower than for a train transporting a mix of items and rail car types. Trains transporting a mix of items are referred to as manifest trains. Typical commodities transported by unit trains are agricultural products, coal, and crude oil.

its primary feedstock supply. Plains, the facility operator, asserts that the Sarnia fractionator will be closed if Line 5 is shut down.[70]

4.53 The butanes market in Michigan and Eastern Canada will be similarly affected by a Line 5 shutdown. I am not aware of butanes being railed into the Upper Midwest or Ontario, and it appears that local supply and TE Products Pipelines deliveries are sufficient to meet regional demand. However, the TE Products Pipeline is operating at, or close to capacity and, accordingly, it is my assessment that the butanes supply shortfall resulting from the shutdown of Line 5 will have to be met with rail.

PRICE IMPACTS IF LINE 5 IS SHUT DOWN

4.54 The shortfalls in propane and butane supply will be accompanied by increasing prices in Wisconsin, Michigan, and Ontario, a subject explored in greater detail in the expert report of Dr. Corbett Grainger. Historically, Michigan wholesale propane prices have been on average 12 percent lower than in neighboring Indiana and 9 percent lower than in Ohio.[71] I attribute this to the fact that Michigan has accessed lower-priced Western Canadian propane supply delivered via Line 5, while Indiana and Ohio were supplied by the TE Products Pipeline, the Marcellus/Utica Shale fractionators, and at times rail. Consequently, if Line 5 is shut down, Michigan wholesale propane prices can be expected to rise to at least the Indiana and/or Ohio wholesale price. The loss of the Rapid River fractionator will require the extensive use of trucks to meet Upper Peninsula demand. The resulting cost increase for propane consumers in the Upper Peninsula is estimated at $8 million per year. The calculation details are found in Workpaper 2.

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[70] Supplemental Submission of Interested Party Letters in Support of Defendants' Response to Plaintiff's Motion for Preliminary Injunction, Exhibit 1, PDF pg. 6.

[71] EIA, Wholesale Propane Weekly Heating Oil and Propane Prices (October - March): http://www.eia.gov/dnav/pet/pet_pri_wfr_a_epllpa_pwr_dpgal_w.htm.

4.55 I estimate the minimum cost increase for Lower Peninsula propane consumers to be approximately $30 million per year, as shown on Workpaper 3. This estimate is based upon Michigan propane prices trading at parity with the average Ohio/Indiana propane price. In practice, the Michigan propane price is likely to exceed the average Ohio/Indiana propane price because Michigan is farther from the incremental propane supply sources, such as the Gulf Coast.

4.56 Propane prices for Ontario are not available, but Michigan and Ontario are both supplied by the same Plains Sarnia fractionator. Accordingly, I make the reasonable assumption that the Ontario propane price would increase by the same amount as the Michigan propane prices (9 ¢/gal). This translates to about $33 million per year in higher propane costs for Ontario consumers. As is the case for Michigan, in practice the increase in Ontario propane prices is likely to be higher because it is farther from the incremental supply sources. Workpapers 3 and 4 contain the details for these calculations for the Lower Peninsula and Ontario, respectively.

4.57 The butanes cost increase is estimated to be $53 million for the Upper Midwest and Ontario, based upon the incremental cost to ship butanes by rail versus the TE Products Pipeline. The details for these calculations are contained in Workpaper 5.

SUPPLY OUTAGES AND CONSUMER BEHAVIOR

4.58 The U.S. occasionally experiences significant refined product supply shortfalls, and these events frequently prompt widespread hoarding by consumers. A recent example is the cybersecurity attack on the Colonial Pipeline that took place on May 7, 2021. Colonial is the largest U.S. refined product pipeline with a 5,500-mile network which can move up to 2.5 million b/d of gasoline, diesel, and jet fuel from refineries and importers in the Gulf Coast region to the East Coast states. Colonial estimates that its shipments represent approximately 45 percent of the transportation fuel consumed in the East Coast states.

4.59 As a result of the attack, Colonial Pipeline halted all of its pipeline operations. At the time, it was not known how long the shutdown would last. To reduce the impact of the massive supply shortfall, officials at state and federal levels almost immediately issued emergency orders temporarily relaxing certain transportation and environmental regulations to stretch current supplies and speed up the delivery of additional supply to the affected areas.[72]

4.60 Notwithstanding these mitigation actions by the authorities, the supply crisis quickly escalated as consumers began panic buying and thousands of retail gasoline outlets across multiple states ran out of supply. The states most affected were those with few alternative sources of fuel, including Georgia, North Carolina, South Carolina, and Virginia.[73] Industry representatives, analysts, and government officials expressed concern about the panic buying. In some areas, there were supplies available at terminals but the stations were selling gasoline faster than the trucks could resupply them.[74]

4.61 Bart Fletcher, president of the Petroleum & Convenience Marketers of Alabama, said, "*We don't have a 'supply' problem, we have a 'delivery problem' exacerbated by panic buying.*"[75] Tom Kloza, head of energy analysis at OPIS, shared that there was about 26 or 27 days of local gasoline supply in the affected states before Colonial shut down; and in his opinion the panic buying "*catalyzed what would have been an annoyance or an inconvenience into sort of a crisis in some places.*"[76]

4.62 Further examples of panic buying were observed in Florida, which experienced stations running out of gasoline even though only about 3 percent of its supply was delivered by Colonial because most of the state is supplied via ocean-going

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[72] Argus US Products, May 14, 2021.
[73] Collin Eaton, Amrith Ramkumar and Jennifer Smith, U.S. Gas Prices Hit $3 a Gallon as Shortage Sets in Amid Colonial Pipeline Shutdown, Wall Street Journal, May 12, 2021.
[74] Argus Media News Release, May 12, 2021.
[75] Ibid. Quotations in the original.
[76] Tom Kloza, 'Panic buying' is driving the fuels shortage after Colonial Pipeline hack, expert says," Interview by Amna Nawaz, PBS News Hour, May 11, 2021.

tankers. AAA spokesman Mark Jenkins said: "*Essentially you have people who are seeing reports about the Colonial Pipeline outage and are rushing to the pump to fill their tanks. They're actually creating the shortage of gasoline there in Tallahassee and other regions around the state.*"[77] On May 12, the restart of the pipeline was initiated and on May 17 Colonial reported that its volumes were back up to normal levels.

4.63 The precise behavior of propane consumers cannot be predicted if Line 5 were to be abruptly shut down. Nonetheless, it is predictable that many consumers will react to the event by seeking to acquire all of the propane that they can find and store, irrespective of their short-term need for propane. Such behavior will exacerbate the supply shortfall and create a very volatile pricing environment. As observed in Florida during the Colonial Pipeline outage, there is the real possibility that panic buying and hoarding of propane with extend into regions that are not physically supplied by Line 5.

SUMMARY OF OPINION

4.64 In 2019, Line 5 enabled the delivery of approximately 84,000 b/d of propane and butanes to the Upper Midwest and Eastern Canada. Line 5 is essential to meet the existing demand for propane and butanes in this region. To put the criticality of Line 5 for regional propane supply in perspective, the volume of propane delivered by Line 5 exceeds the total combined propane demand in Michigan and Ontario.

4.65 None of the alternative propane production sources in the Midwest or Eastern Canada are capable of increasing propane supply to offset the loss of the Line 5 volumes, forcing propane supplies to be delivered from farther afield.

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[77] Karl Etters, Alicia Devine and Tori Lynn Schneider, 'Fuel up responsibly': Industry officials say panic buying in Florida is causing gas shortage, Tallahassee Democrat, May 11, 2021.

4.66 Superior will have to rely on a number of Wisconsin rail terminals that receive propane by rail from Alberta and elsewhere. The increase in costs for propane for Wisconsin consumers will be at least $4 million per year, depending on the ultimate trucking distance required to reach the most distant rail terminal needed to replace the capacity of the Superior fractionator.

4.67 The Upper Peninsula will also have to depend on rail deliveries and truck deliveries from terminals in the Lower Peninsula to meet its propane demand. The increased cost of propane in the Upper Peninsula is estimated to be $5 million annually.

4.68 The absolute size of the Ontario and Lower Peninsula markets requires that some combination of the Alberta, Marcellus/Utica, Midcontinent, and the Gulf Coast fractionators become the incremental suppliers of propane and butanes via rail. Irrespective of the availability of propane at these various supply sources, the existing transportation infrastructure is not currently capable of moving the required volumes if Line 5 is shut down prior to completion of the re-route. Moreover, industry will require several years to expand the transportation infrastructure to meet demand. Once the necessary transportation infrastructure is built, the estimated annual cost to consumers of propane will increase by at least $33 million in Ontario and by $30 million in the Lower Peninsula. The cost impact on the regional butanes consumers is estimated to be $53 million per year.

5. OVERVIEW OF CRUDE OIL PIPELINE INFRASTRUCTURE

INTRODUCTION

5.1 In 2019, Midwestern refineries processed 3,803,000 b/d of crude oil.[78] Of this amount, about 99 percent of all refinery crude oil receipts were delivered by pipeline, with the balance delivered by barge and truck.[79] The proportion delivered via rail was negligible. Moreover, the proportion delivered via pipeline has changed little over the years. Consequently, pipelines are the essential transportation mode that delivers crude oil to Midwestern refineries, thus enabling them to produce the refined products used by consumers throughout the Midwest.

5.2 The Enbridge Mainline is one of the largest crude oil pipeline systems in the world and connects the large crude oil resources of Western Canada with refineries located throughout the Midwest and Eastern Canada. In 2019, the Enbridge Mainline transported almost a billion barrels of crude oil across the international border into the U.S.[80] This volume of crude oil is far too great to be transported by a single pipeline and, therefore, the Enbridge Mainline consists of multiple individual pipelines generally located in the same pipeline right-of-way. For convenience, I provide again as Figure 11 the Enbridge Mainline schematic provided earlier in this report that has been extracted from Appendix 4.

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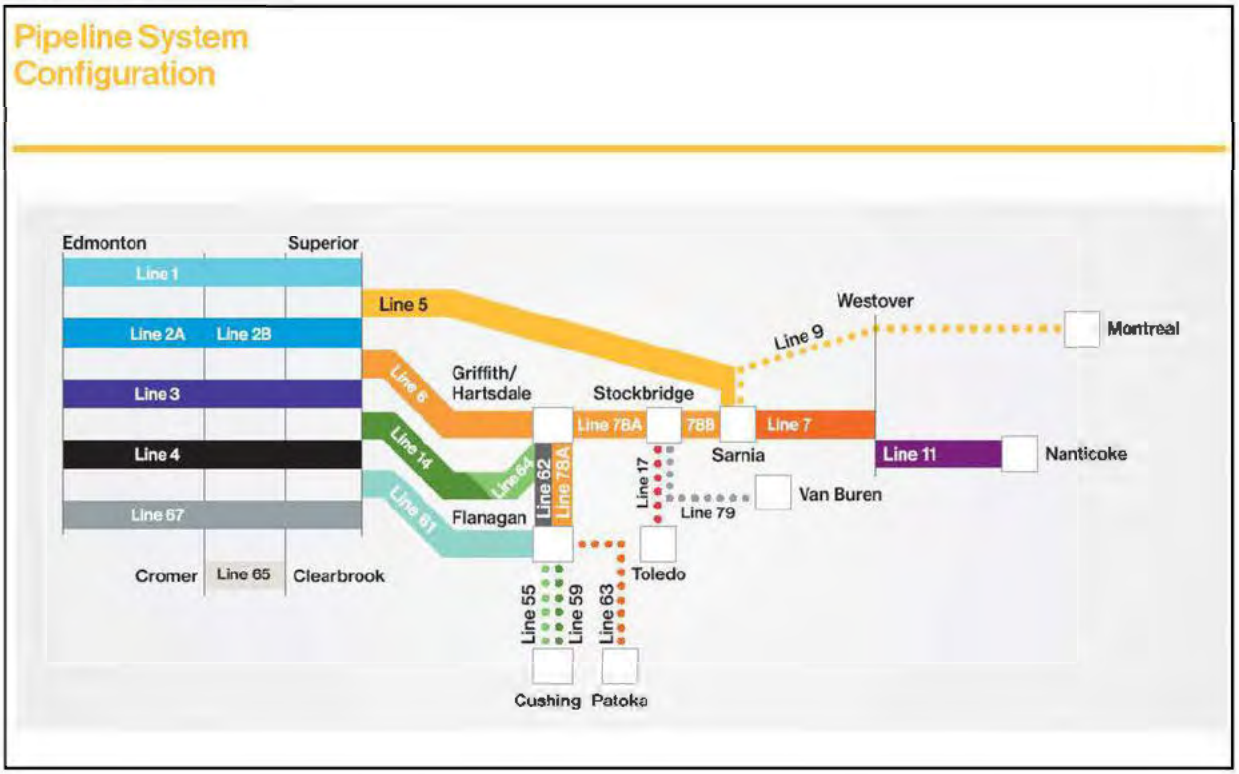
[78] U.S. EIA, Refinery Net Input; Area: PADD 2: https://www.eia.gov/dnav/pet/pet_pnp_inpt2_dc_r20_mbblpd_a.htm.

[79] In 2019, 98.4 percent of Midwestern crude oil was delivered by pipeline. Source: EIA, Refinery Receipts of Crude Oil by Method of Transportation: https://www.eia.gov/dnav/pet/pet_pnp_caprec_dcu_nus_a.htm.

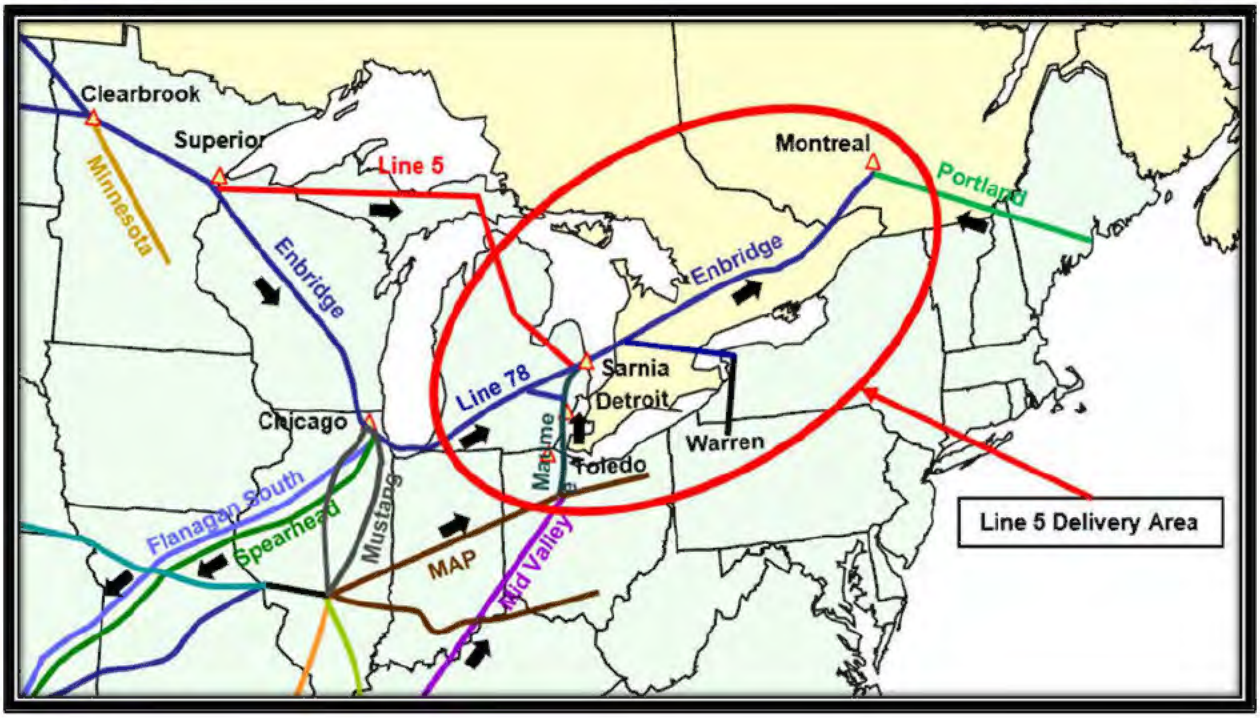
[80] Enbridge 2019 FERC Form 6, PDF pg. 70.

Figure 11



5.3 Compared to a typical North American crude oil pipeline, Line 5 is a relatively large pipeline. It is a key pipeline by which refineries in the Detroit/Toledo area, western Pennsylvania, Ontario, and Quebec receive their crude oil. Figure 12 provides an overview of all of the crude oil pipelines that are connected to the geographical region supplied by Line 5 (the "Line 5 delivery area"). There are three crude oil pipelines that currently supply crude oil to this region. These are Line 5, Enbridge Line 78 ("Line 78"), and Maumee Pipeline ("Maumee").

Figure 12



5.4 A fourth pipeline, the Portland Pipe Line Company (the "Portland Pipeline"), originates in Portland, Maine, and terminates at Montréal, Quebec. Pipelines above a certain revenue threshold are obligated to report a variety of financial and operational data to the FERC, using the FERC Form 6 ("Form 6"). A review of the Portland Pipeline Form 6 filings indicates that this pipeline has not transported significant volumes of crude oil in recent years.[81] Suncor Energy ("Suncor"), the owner of the Portland Pipeline, stated that the pipeline had been idled with the exception of shipping occasional volumes for inspection and pipeline integrity purposes.[82] Nonetheless, it appears that the Portland Pipeline can be restarted, and I have assumed that this is the case and would be able to supply the Suncor Montréal refinery if necessary.

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[81] Portland Pipelines 2017, 2018, 2019 and 2020 FERC Form 6, Statistics of Operations.
[82] Enbridge Pipelines Inc., Canadian Mainline Contracting Application to CER, E101-2019-02. Response to Information Request No. 1, Suncor Energy Inc. to Enbridge Pipelines Inc., pg. 3.

ENBRIDGE LINE 5

5.5 Line 5 originates at the large Enbridge Superior, Wisconsin, terminal and terminates in Sarnia, Ontario, where there are a number of refineries and connecting crude oil pipelines. There is a single intermediate receipt point at Lewiston, Michigan, where local Michigan crude oil is collected. In 2019, 9,500 b/d of Michigan crude oil was received at Lewiston.[83]

5.6 The Line 5 crude oil delivery points are at Marysville, Michigan, and several sites in Sarnia. At Marysville, the three refineries in the Detroit/Toledo area can be accessed via third-party pipelines. In addition to supplying three Canadian refineries located in Sarnia, Line 5 is also connected to Enbridge Line 7 and Line 9 at Sarnia. Enbridge Line 7 connects to the Imperial Oil Company ("Imperial") refinery in Nanticoke, Ontario, and a third-party pipeline that delivers crude oil to the United Refining Company ("United") Warren refinery in western Pennsylvania. Enbridge Line 9 transports crude oil from Sarnia to Montréal. Suncor has a refinery located in Montréal and Valero Energy Corporation ("Valero") ships crude oil by water from Montréal to its refinery in Lévis, Quebec.

ENBRIDGE LINE 78

5.7 Line 78 originates at the Enbridge Flanagan terminal located in the Chicago area and terminates in Sarnia. The Flanagan terminal primarily receives crude oil deliveries from Superior via Enbridge Line 61. Line 78 has the capability to transport light, medium, and heavy crude oil, and has a capacity of 570,000 b/d. The Line 78 delivery points are at Stockbridge, Michigan, Marysville, and Sarnia. From Stockbridge, the three refineries in the Detroit/Toledo area can be accessed via a combination of Enbridge (Lines 17 and 79) and third-party pipelines. Line 78 cannot transport NGLs.

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[83] Enbridge 2019 FERC Form 6, PDF pg. 70.

MAUMEE PIPELINE

5.8 Maumee originates at Lima, Ohio, and terminates at the Samaria Station, Michigan. From Samaria, the Marathon Detroit refinery can be accessed via a third-party pipeline. There is also a delivery point at Toledo from which the PBF Toledo and the BP-Husky Toledo refineries can be reached. Maumee cannot transport NGLs.

5.9 Maumee is an undivided joint interest pipeline with two owners. Mid Valley Pipeline Company LLC ("Mid Valley") owns 73.97 percent, and Hardin Street Holdings LLC ("Hardin Street") holds the balance of 26.03 percent.[84] While there is just a single pipe, each owner establishes their own transportation rates and other commercial arrangements. Mid Valley, the operator of Maumee, is owned by Energy Transfer Operating LP ("Energy Transfer"). Harding Street is owned by Marathon Petroleum Company ("Marathon").

5.10 Recent public information regarding the capacity of Maumee is not available. A news article from 2009 suggest that the capacity of Maumee is 142,000 b/d.[85] An analysis of the throughput of Maumee, discussed later in this report, indicates that Maumee transported 159,700 b/d of crude oil in 2019. Maumee has a relatively low maximum operating pressure of 788 pounds per square inch ("psi").[86] This low operating pressure limits the maximum capacity of Maumee. For analytical purposes, I use a Maumee capacity of 159,700 b/d.

OVERVIEW OF REGIONAL REFINERIES

5.11 Table 3 lists the refineries and their capacities that can receive crude oil via Line 5 and, based upon my industry knowledge, it is likely that all of these refineries receive some portion of their crude oil supply via Line 5. The non-pipeline crude oil delivery options for these refineries are also very limited. As a

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[84] Mid Valley 2019 FERC Form 6, PDF pg. 14.
[85] UPDATE 2 - Sunoco shuts Midwest crude pipeline after spill, April 19, 2009.
[86] PHMSA Pipeline Failure Investigation Report, February 18, 2009.

practical matter, only the Valero Lévis refinery has the option of receiving sizable volumes of crude oil directly by tanker. The capability of the Suncor Montréal refinery to receive waterborne crude oil receipts is constrained by water depth and maximum vessel width. Either small tankers of about Panamax size or short-loaded Aframax vessels must be used to deliver crude oil to Montréal, and for a portion of the year ice class vessels are needed.[87] Due to the small vessel size (or short-loading) and time-consuming route up the St. Lawrence River to Montréal, waterborne crude oil deliveries are expensive.

Table 3

REGIONAL REFINERY CAPACITY

(Thousands of Barrels per Day, Unless Noted)

	Refinery Capacity
Detroit/Toledo Region	
BP-Husky Toledo	155.0
Marathon Detroit	140.0
PBF Toledo	172.8
Subtotal/Average	**467.8**
Pennsylvania	
United Warren	65.0
Ontario	
Imperial Nanticoke	113.0
Imperial Sarnia	119.0
Shell Sarnia	78.0
Suncor Sarnia	85.0
Subtotal/Average	**395.0**
Quebec	
Suncor Montréal	137.0
Valero Lévis	235.0
Subtotal/Average	**372.0**
Grand Total	**1,299.8**

[87] Panamax tanker can transport up to about 600,000 barrels of crude oil, and a fully loaded Aframax tanker can transport up to about 900,000 barrels.

5.12 To the best of my knowledge, there are three refineries with dedicated crude oil rail unloading facilities among the refineries detailed in Table 3. The Imperial Nanticoke refinery has a crude oil rail unloading facility with a capacity of 20,000 b/d.[88] The Suncor Montréal and the Valero Lévis refineries have crude oil rail unloading facilities with indicated capacities of 30,000 and 60,000 b/d, respectively.[89] Suncor has stated that the rail unloading facility has been idled, and that it would require two to three months to return the facility to service.[90] It is possible that one or more of the other regional refineries has the capability to unload a few rail tank cars per day.

5.13 There also is a rail terminal in Toledo that has the capability to unload rail tank cars directly into trucks using portable equipment.[91] The capacity of this facility is not known, but loading two tank trucks an hour over a 12-hour shift translates to an unloading capacity of about 5,000 b/d. This type of unloading procedure is time-consuming and labor intensive, and is, therefore, costly. Furthermore, any receiving refineries must have the capability to unload crude oil trucks to use this rail car unloading facility. Only the PBF Toledo refinery is known to have a sizable crude oil truck unloading capability. It has a dedicated crude oil truck unloading rack with a capacity of 22,500 b/d.[92] It appears that this rack is primarily used to unload crude oil obtained from local Ohio sources.

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[88] CAPP 2018 Crude Oil Forecast, Markets & Transportation, PDF pg. 23.
[89] CAPP 2018 Crude Oil Forecast, Markets & Transportation, PDF pg. 23.
[90] Response to Information Request No. 1, Suncor Energy Inc. to Enbridge Pipelines Inc., pg. 3.
[91] Midwest Terminals website: https://www.midwestterminals.com/ironville/.
[92] PBF Energy, Inc. 2018 Annual Report, PDF pg. 25.

6. IMPACT OF LINE 5 SHUTDOWN ON REGIONAL REFINERIES

INTRODUCTION

6.1 In 2019, Line 5 transported 446,000 b/d of crude oil to the refineries in the Line 5 delivery area. I estimate that the total crude oil demand in this same area to be 1,188,400 b/d.[93] Therefore, Line 5 supplies about 38 percent of all of the crude oil demand in Michigan, northern Ohio, western Pennsylvania, Ontario, and Quebec. This section evaluates the ability of the refining industry to replace 38 percent of the crude oil supply to a sizable area of North America with existing logistical infrastructure. Due to the relatively short period of time required to complete the Line 5 re-route, it is my opinion that it is highly unlikely that the refining industry will have the time for or any interest in significant investments in new logistical infrastructure.

6.2 Since pipelines are almost the exclusive means by which Midwestern refineries received their crude oil, the shutdown of a large pipeline like Line 5 will have significant impacts on the refineries it supplies if the outage extends beyond about a week. Because crude oil deliveries via pipeline are usually very reliable, inland refiners do not hold much crude oil inventory at the refinery itself over and above that required for operational requirements. The existing crude oil pipelines that remain cannot be easily expanded. If technically possible, as limited by the maximum permissible pipeline operating pressure and other considerations, the capacity of a pipeline can be increased by installing higher capacity pumps at existing pump stations, or by adding more pump stations. These measures are costly and generally require approval from various regulatory agencies. These measures are time consuming, particularly if a revised operating permit must be

[93] The calculation details for this estimate are provided later in this report.

obtained, and are unlikely to be pursued to bridge the gap for the short period until the Line 5 re-route is completed.

6.3 The construction of a new crude oil pipeline requires years of effort. The permitting process is typically a multi-year exercise with uncertain outcomes, and a large, long-distance pipeline will usually require a construction period of 2 or more years. Moreover, the total cost for new pipelines is extremely high. The prospects for a new crude oil pipeline to replace the capacity lost via a Line 5 closure are essentially zero.

6.4 Finally, replacing the lost capacity of Line 5 with truck or rail transport is problematic as explained in more detail in the Report of William Rennicke.[94] Both are more costly and have substantially higher greenhouse gas emissions per barrel of crude oil transported. The crude oil volume that can be transported by a truck is only about 200 barrels, making truck transport expensive and practical only over short distances. Using trucks to replace the lost capacity of Line 5 would require a huge number of trucks and drivers and is utterly impractical. Rail transport is capable of higher volumes and greater distances but requires obtaining the necessary number of rail cars via purchase or lease and the construction of an expensive rail unloading facility. Rail unloading facilities require a sizable section of land and many refineries lack sufficient space. The permitting requirements for rail unloading facilities tend to be onerous, time-consuming, and in some locations simply unobtainable. As noted above, only about 1 percent of the crude oil used by Midwestern refineries is transported by means other than pipeline.

PIPELINE CAPACITY ALLOCATION OVERVIEW

6.5 Usually before about the 16th day of the month, shippers have to nominate to the pipeline operator the volume of crude oil that they desired to ship during the

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[94] *See generally* Rinnicke Report.

following month.[95] Thus, nominations for February shipments are usually due by January 16. It is possible, and for some pipelines a routine circumstance, for the total nominations to exceed the capacity of the pipeline. Thus, all regulated pipelines must have some policy set forth in their tariffs to allocate the available capacity among the shippers when the total nominations exceed the pipeline capacity. The term used for the allocation process varies between pipelines, but most refer to the process as either apportionment or proration. I use the term apportionment for the allocation process for the balance of this report.

MAUMEE APPORTIONMENT

6.6 Because Maumee is the only non-Enbridge pipeline that could possibly replace any portion of the stranded Line 5 volumes, the capacity and apportionment policies of Maumee matter in terms of how much alternative supply is potentially available and which refinery receives the supply. Maumee is an undivided joint-interest pipeline, and the two owners are free to establish their own commercial arrangements with their shippers for the portion of the pipeline that they own. The apportionment policies of the two owners differs somewhat, but both owners fundamentally apportion the pipeline capacity on the basis of the shipping history of their shippers.

6.7 Energy Transfer (73.97 percent owner) allocates 95 percent of its share of the Maumee capacity to its regular shippers, which is any shipper that had a record of movements during at least 9 months out of the last 12 months.[96] The available capacity is apportioned to the regular shippers on the basis of the proportion of each regular shipper's volume to the total volume shipped by the regular shippers over the last 12 months. I estimate that the Energy Transfer's ownership share is equivalent to about 118,000 b/d of the total Maumee capacity.

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[95] The precise day varies slightly from month-to-month depending upon the timing of the weekends and the specific nomination policy of the pipeline.

[96] Mid Valley Pipeline Company, Local Pipeline Tariff FERC No. 482.2.0, PDF pp. 9-12.

6.8 Marathon (26.03 percent owner) also allocates 95 percent of its share of Maumee to its regular shippers, which are defined as any party that shipped crude oil on Maumee during the prior 24 months. I estimate that the Marathon ownership share is equivalent to about 42,000 b/d of Maumee capacity. Marathon apportions its capacity on the basis of the proportion of each regular shipper's volume to the total volume shipped over the last 24 months.[97]

6.9 The identity of the regular shippers of either Energy Transfer or Marathon is not publicly known, but it appears to be limited to parties shipping to just the three refineries in the Detroit/Toledo area. There is no connection between Maumee and the Sarnia refineries. Typically, the parties shipping on Maumee would be the refinery owners themselves, but crude oil is also sold on a delivered basis, in which case the regular shipper would not be the refinery owner. In the circumstance of a shutdown of Line 5, even a temporary closure for a few months, the apportionment procedures of both Energy Transfer and Marathon have substantial implications for the three Detroit/Toledo area refineries because they appear to have significantly different shipping histories. Since the shippers that have historically shipped on Maumee effectively control 95 percent of the Maumee capacity, these shippers will decide which of the three Detroit/Toledo refineries receives the crude oil transported by Maumee if Line 5 is shut down.[98] There can be no expectation that Maumee capacity will be made available to the refinery that experiences the greatest shortfall of crude oil supply if Line 5 is shut down. *See* Workpaper 6.

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[97] Hardin Street Holdings LLC, Local Tariff FERC No. 2.6.0, PDF pg. 7.

[98] My analysis of crude oil deliveries on Maumee is based on the Statistics of Operations reported by Mid Valley and Hardin Street in their respective 2019 FERC Form 6s. While volumes shipped by Mid Valley on Maumee are not shown, Mid Valley's Form 6 reports total barrel miles for Mid Valley and Maumee along with delivery volumes for Mid Valley at various destinations. The mileage to Mid Valley delivery points is either provided by or can be estimated using the 2019 Mid Valley FERC Form 7 at pdf pp 70-71 and 2019 Harding Street FERC Form 7 at pdf pp 72-73. These data permit me to calculate the portion of the total barrel*miles that moved on just Mid Valley, and the remainder that must have been shipped on Maumee. Using this information, I estimate the 2019 volumes shipped by Mid Valley and Hardin Street to Maumee is 115,700 b/d and 44,100 b/d for an aggregate total of 159,700 b/d.

ENBRIDGE MAINLINE APPORTIONMENT OVERVIEW

6.10 The Canadian section of the Enbridge Mainline has been in apportionment for some time, and Enbridge has developed an elaborate apportionment policy to allocate capacity among its shippers. Unlike the owners of Maumee, Enbridge does not use historical shipping history to allocate capacity. Rather, Enbridge apportions all verified shipper nominations on a *pro rata* basis without regard to the historical movements of the shippers.[99] Enbridge does verify that the nominations are reasonable. There are two major elements to the verification procedure for the nominations: 1) a requirement that shippers verify that they have sufficient crude oil supply to fill their nominations ("upstream verification") and, 2) a requirement that shippers verify that they have sufficient downstream refinery, storage, and/or capacity on connecting pipelines to accept their nominations ("downstream verification"). Each destination facility, i.e., refinery, connected to Enbridge is required to submit an affidavit to Enbridge stating the capacity of the destination facility. In practice, it is the downstream verification element (or capacity) that limits the volume that a shipper can nominate on Enbridge.

6.11 For each refinery, the downstream verification procedure makes a comparison of certain metrics. First, the refinery capacity, working storage capacity, and movement of crude oil out of the refinery to a different location (by pipeline, barge, etc.) is summed. Second, the sustainable and on-going movement of crude oil into the refinery on the pipeline that is connected to Enbridge is assessed. The lessor of the two equals the total capacity of the refinery for the purposes of downstream verification.

6.12 Enbridge defines the refinery capacity to be equal to stream day capacity. For U.S. refineries, this equals the stream day capacity reported by the refiner to the EIA in their Annual Refinery Report, which are public data. The equivalent is

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[99] Enbridge FERC 41.5.0 Appendix A – Destination Verification Procedure.

also required for Canadian refineries, although the Canadian refineries do not have a similar reporting obligation to the Canadian government. The working storage capacity and the movement of crude oil out of the refinery are self-reported by the refiner to Enbridge for the downstream verification process, and public data generally are not available to assess these metrics. NGLs have a somewhat different apportionment procedure, but as a practical matter NGLs are rarely apportioned.

6.13 In the circumstance where Line 5 is shut down, all crude oil must first be transported south from Superior to Chicago, before getting onto Enbridge Line 78 for further transport to Detroit/Toledo and Sarnia. There are two possibilities for the volume of crude oil that can be transported via Line 78 to Detroit/Toledo and Sarnia. The first possibility is that the volume transported via Line 78 to Detroit/Toledo and Sarnia will be limited by the capacity of Line 78 itself. The second possibility is that the volume transported will be limited by the apportionment procedure for the Superior-to-Chicago segment, and the flows on Line 78 will be less than its capacity. I evaluate the second possibility immediately below.

ENBRIDGE MAINLINE APPORTIONMENT: SUPERIOR-TO-CHICAGO SEGMENT

6.14 The analysis of allocation of crude oil on the Superior-to-Chicago segment relies upon the Statistics of Operations reported by Enbridge in its 2019 Form 6.[100] The Statistics of Operations reports the volume received, by state or at international borders, from connecting carriers (i.e., other pipelines) and crude oil gathering systems into Enbridge. The Form 6 also reports deliveries, generally by state, to connecting carriers and the number of barrels terminated out on Enbridge trunk lines. Workpaper 7 provides the origination and delivery volumes for the Enbridge Mainline in 2019.

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[100] Enbridge 2019 FERC Form 6, PDF pg. 71-72.

6.15 Using the 2019 Form 6, I can determine the Enbridge deliveries to the following locations:

6.15.1 The Chicago area refineries and the connected pipelines that transport crude oil south to other markets (Illinois deliveries), net of a relatively small amount of crude oil received from connected carriers;

6.15.2 Deliveries to Ontario and Line 9 (International Border);

6.15.3 Deliveries to Michigan, which would be the Detroit/Toledo refineries via the connecting pipelines originating at Stockbridge and Marysville; and

6.15.4 Deliveries to the United Warren refinery in Pennsylvania.

6.16 Since the Enbridge Mainline was in apportionment in 2019, I reasonably assume that the deliveries to the indicated locations are reflective of the aggregate downstream verification capacities for each location.[101] In 2019, the Enbridge crude oil deliveries to the refineries and connecting pipelines in the Line 5 delivery area (the International Border and Michigan) were 861,200 b/d, which is 35.6 percent of the total crude oil volume exiting Superior. The total capacity of the pipelines in the Enbridge Superior-to-Chicago segment is currently 2,006,000 b/d, and I assume that a planned expansion of Line 61 of approximately 158,000 b/d proceeds.[102] Consequently, the Line 5 delivery area would be allocated 35.6 percent of the Superior-to-Chicago segment capacity, which is 769,700 b/d, if Line 5 is shut down.

6.17 However, the capacity of Line 78 is only 570,000 b/d. Therefore, the maximum volume of crude oil that can be transported by Enbridge to the Line 5 delivery

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[101] See Canada Energy Regulator, Pipeline Throughput and Capacity Data, CER apportionment dataset.xls for apportionment statistics for Canadian crude oil export pipelines.

[102] The expansion is related to the recent completion of the Enbridge Line 3 Replacement Project upstream of Superior, which will add additional inbound crude oil capacity to Superior from Western Canada. See Exhibit 4 for the pre-expansion capacities of the individual Enbridge Mainline segments.

area is limited to the Line 78 capacity, i.e., the first possibility, rather than the apportionment allocation on the Superior-to-Chicago segment. Workpaper 8 provides the calculation details.

ENBRIDGE MAINLINE APPORTIONMENT: CHICAGO-TO-STOCKBRIDGE / SARNIA SEGMENT (LINE 78)

6.18 With Line 5 shut down, the supply of crude oil by Enbridge to the Detroit/Toledo, western Pennsylvania, and the Canadian refineries will be limited to the Line 78 capacity, which is 570,000 b/d. Enbridge will have to apportion the crude oil volume shipping on Line 78, and this allocation will be controlled by the downstream verification capacity of either refineries or the pipelines that connect the Mainline to the refineries. The downstream verification capacity of a refinery is usually the sum of: 1) its crude oil distillation capacity; 2) working crude oil storage capacity; and, 3) the movement of crude oil out of the refinery to a different location (by pipeline, barge, etc.). The exception is when downstream verification capacity of the refinery itself is greater than the capacity of the pipeline (or pipelines) that connect the refinery to the Enbridge Mainline. In this instance, the capacity of the connecting pipelines establishes the downstream verification capacity for the refinery.

6.19 The refinery capacities in Line 5 delivery area are public information. The working storage capacities at the refineries are not public data but, in my experience, refinery crude oil storage capacity is directly correlated with the refinery crude oil capacity. Therefore, I use the known refinery crude oil capacity to assess the proportion of the total downstream verification capacity held by each refinery. None of these refineries are connected to a major crude oil pipeline or loading facility that could move sizable volumes of crude oil out of the refinery to a different location, and therefore, I ignore the third component of the downstream verification capacity procedure. Moreover, to the extent that individual refineries in the Line 5 delivery area have a crude oil storage capacity that differs from the norm, or access to outbound crude oil transportation

capacity, this only shifts the crude oil allocation among the refineries. It does not change the overall volume of crude oil that can be delivered by Enbridge to the refineries in the Line 5 delivery area, which is limited by the capacity of Line 78 to 570,000 b/d in all circumstances.

6.20 I start the analysis by estimating the crude oil runs at each region (Detroit/Toledo, Pennsylvania, Ontario, and Quebec) in the Line 5 delivery area on Workpaper 9. This workpaper also estimates the crude oil delivery volume to each region by the various transportation options, i.e., Enbridge, Maumee, truck, rail, and tanker. Details concerning the information sources are provided on Workpaper 9.

6.21 Workpaper 10 provides the analytical details of the downstream verification capacities. As required by the Enbridge downstream verification procedure, I use the stream day capacities for the U.S. refineries as reported in the EIA 2019 Annual Refinery Capacity report.[103] For the Canadian refineries, I obtain the refinery capacities from various public sources.[104] Since these Canadian refinery capacities are understood to be reported in terms of calendar day capacities, I divide them by 0.95 to convert them to stream day capacities.

6.22 It is my opinion that the Quebec refineries will continue to seek to ship Western Canadian crude oil on Line 9 without Line 5 in operation. Western Canadian crude oil generally represents their lowest cost supply of crude oil and for this reason alone they can be expected to continue to nominate crude oil volumes for shipment via Enbridge. In addition, three refiners in eastern Canada executed 10-year Transportation Service Agreements ("TSAs") with Enbridge whereby

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[103] EIA, Petroleum & Other Liquids, Refinery Capacity Report, with data as of January 1, 2020: https://www.eia.gov/petroleum/refinerycapacity/archive/2020/refcap2020.php.

[104] Sources: Imperial Sarnia and Nanticoke refineries, Imperial Oil Limited Form 10-K 2020, pg. 17; Suncor Sarnia and Montréal refineries, Suncor website, https://www.suncor.com/en-ca/about-us/refining; Shell Sarnia refinery, Royal Dutch Shell plc Investors' Handbook, https://reports.shell.com/investors-handbook/2019/; Valero Lévis refinery, Valero website, https://www.valero.com/en-us/Pages/JeanGaulin.aspx.

they committed to ship 275,000 b/d in aggregate on Line 9 or pay a penalty.[105] In exchange for these long-term financial commitments to ship on Line 9, the shippers receive a lower committed toll on Line 9 than uncommitted shippers.[106] Thus, these TSAs provide another incentive for refiners to ship on Line 9.

6.23 As shown on Workpaper 10, the aggregate capacity of the three refineries in the Detroit/Toledo region is 495,000 b/d, whereas the aggregate capacity of the three pipelines that connect the Mainline with these refineries is 372,000 b/d.[107] Accordingly, the downstream verification capacity of the Detroit/Toledo refineries is limited by the capacity of the connecting pipelines. The situation is similar for the Quebec refineries, where the aggregate capacity of the two Quebec refineries exceeds the capacity of the connecting Enbridge Line 9.

6.24 I calculate the percentage of the total downstream verification capacity available in each region, and then use these percentages to allocate the 570,000 b/d of capacity available via Line 78. I add the Maumee deliveries as estimated in Workpaper 9 and assume that the Michigan crude oil production that is currently being transported to the regional refineries by Line 5 from Lewiston will be delivered via truck. The alternative is to shut-in the Michigan production.

6.25 To be conservative with my analysis, I assume that the Valero Lévis refinery can make up any shortfall in crude oil receipts with crude oil delivered by rail or tanker. It appears that Suncor has the capability to restart its rail facility and the Portland Pipeline, and I have assumed that this would be the case. I limit the throughput of the Suncor rail facility to 90 percent of its indicated capacity, and the remaining supply shortfall is met by the Portland Pipeline. In addition, the Portland Pipeline is currently capable of transporting only one grade of crude oil,

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[105] Line 9B Reversal and Line 9 Capacity Expansion Project Application to the NEB, PDF pg. 51. The penalty is waived in the circumstance where the shippers' Line 9 nominations cannot reach the origin of Line 9 due to Enbridge apportionment or other reasons.

[106] Enbridge Pipelines Inc. (Canadian Mainline and Line 9) International Joint Rate Tariff FERC No. 1.16.0.

[107] The connecting pipelines are Enbridge Line 17, Enbridge Line 79, and the Sunoco pipeline that originates at Marysville.

which limits the operational flexibility of the refinery.[108] It should be understood that these alternative delivery options for the Quebec refineries are inferior to the use of Line 5, and impose higher costs and may degrade refinery yields and reduce crude oil throughput. If these alternative delivery options were superior, the Quebec refiners would be using them today.

6.26 In addition, crude oil runs at the Imperial Sarnia and Nanticoke refineries were reduced in 2019 because of a fire damage at the Sarnia refinery that limited operations.[109] The utilization of the two Imperial refineries in 2019 was about 73 percent, substantially less than the utilization rates of the other refineries in the Line 5 delivery area. To remove the one-time effect of the fire, I adjust the utilization of the two Imperial refineries to 92 percent, which is approximately the current refinery utilization level in Ontario and similar to the 2018 Imperial utilization levels.[110] This adjustment acts to increase the aggregate crude oil runs at the Imperial refineries by [redacted] Workpaper 11 provides the revised shortfall assessment with the Imperial refinery utilization adjustment.

6.27 Table 4 provides a summary of the full analysis provided on Workpaper 11. The overall reduction in crude oil supply via Enbridge to the Line 5 delivery area would be 334,700 b/d. I estimate that it is likely possible to reduce the shortfall to 226,700 b/d in a relatively short period of time, primarily by the reactivation of existing rail and tanker unloading facilities for crude oil deliveries to Quebec. However, some of these existing facilities require refurbishment before they can be utilized, and the time and cost to do so is not known. The lessened shortfall still equates to a 19 percent reduction in total crude oil supply for the Line 5 delivery area. It is possible that some regional refiners may have supply options

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[108] Enbridge Pipelines Inc., Canadian Mainline Contracting Application to CER, E101-2019-02. Response to Information Request No. 1, Suncor Energy Inc. to Enbridge Pipelines Inc., pg. 3. The refinery crude oil rail unloading facility is capable of handling only light crude oil.

[109] Imperial Oil Limited 2019 Form 10-K, pg. 14. The Imperial Sarnia and Nanticoke refineries are operationally interconnected and share some process facilities. Therefore, it appears that the fire damage at the Sarnia refinery also acted to reduce throughput at the Nanticoke refinery.

[110] Ibid.

available that involve higher costs and more complex logistics. There have been indications in the press that Imperial has additional supply options, the nature and cost of which are not clear.[111]

Table 4

CRUDE OIL SUPPLY IMPACT OF LINE 5 SHUTDOWN

(Thousands of Barrels per Day, Unless Noted)

	Adjusted 2019 Crude Runs	*Enbridge Deliveries*	*Maumee Deliveries*	*Rail, Truck and Tanker Deliveries*	*Total Deliveries*	*Crude Oil Supply Shortfall*	*Shortfall as Percent of Crude Runs*
Detroit/Toledo Region	426.6	183.1	159.7	26.9	369.7	(56.9)	13.3
Pennsylvania	64.5	34.5	-	-	34.5	(30.0)	46.5
Ontario	372.4	204.7	-	28.0	232.7	(139.7)	37.5
Quebec	324.7	147.7	-	177.0	324.7	-	-
Grand Total/Average	**1,188.4**	**570.0**	**159.7**	**231.9**	**961.7**	**(226.7)**	**19.1**

6.28 In terms of individual refinery crude oil runs, while all refineries will incur higher crude oil delivery costs if Line 5 is shut down, for some refineries the impact of shutting down Line 5 is severe. The Pennsylvania refinery is estimated to lose 47 percent of its crude oil supply, and the four Ontario refineries are estimated to lose in 38 percent of their crude oil supply, as shown on Table 4 above. Refineries have a limited degree of turndown capability, and at this level of crude oil supply shortfall these refineries will struggle to maintain stable operations. It is quite possible that one or more of these refineries will have to close until alternative crude oil supplies somehow could be arranged.

6.29 In another proceeding involving Line 5, letters or declarations describing the impact of a Line 5 shutdown were submitted by the following refiners: United Refining; Imperial Oil; Suncor Energy; Valero Energy; Shell Canada; and PBF Energy.[112] All of these refiners stated that shutting Line 5 would reduce

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[111] Financial Post, *Suncor, Imperial scramble to make contingency plans in case Michigan's order cuts off Ontario's oil supply*, February 4, 2021.

[112] Defendant's Supplemental Submission of Interested Party Letters in Support of Defendant's Response to Plaintiff's Motion for Preliminary Injunction, June 29, 2020 [Imperial Oil, Suncor

their crude oil supply volumes and negatively impact their refinery operations. Several refiners warned of possible refinery shutdowns. Almost all of the refiners assert that shutting Line 5 would reduce the supply of refined product to the region and may result in higher refined product prices. The Ohio attorney general also filed a brief on behalf of the States of Ohio, Indiana, and Louisiana describing the negative impacts of closing Line 5 on the regional economies, refined product supply, and refined product prices.[113] The conclusion of the brief is also supported by the analysis of Dr. Corbett Grainger.[114]

SUMMARY OF OPINION

6.30 My key conclusions are:

6.30.1 If Line 5 is closed before the reroute is operational, the resultant decrease in crude oil deliveries by Enbridge to the Line 5 delivery area is estimated to be 334,700 b/d. I estimate that it is possible to reduce the shortfall to 226,700 b/d by reactivating existing rail and tanker unloading facilities to supply the Quebec refineries. However, some of these existing facilities require refurbishment before they can be utilized, and the time and cost to do so is not known.

6.30.2 The crude oil shipments by rail required to replace Line 5 are 290,000 b/d. This volume is greatly in excess of the existing rail unloading capacity in the Line 5 delivery area. In addition, crude oil shipments by truck from Lewiston will increase by 9,500 b/d due to the loss of Line 5.

Energy, Valero Energy, Shell Canada, and PBF Energy]; Declaration of John R. Wagner in Support of Enbridge Energy, Limited Partnership's Opposition to Plaintiff's Motion of Preliminary Injunction, June 26, 2020 [United Refining].

[113] Oho Attorney General Dave Yost's *Amicus Curiae* Brief on Behalf of the State of Ohio, the State of Indiana, and the State of Louisiana Regarding Economic Harm Resulting from a Line 5 Shutdown, June 29, 2020.

[114] *See generally* Expert Report of Dr. Corbett Grainger.

6.30.3 The impact of closing Line 5 on following regions will be severe: Detroit/Toledo; western Pennsylvania; and Ontario.

6.30.4 It is quite possible that one or more refineries will have to close unless alternative crude oil supplies somehow could be arranged.

6.30.5 Closing Line 5 will cause refined product shortages in the Line 5 delivery area.

6.30.6 The letters and declarations filed by U.S. and Canadian refiners in another legal proceeding involving Line 5 support my conclusions.

7. LINE 5 SHUTDOWN IMPACT ON REFINED PRODUCT SUPPLY AND PRICES

INTRODUCTION

7.1. Line 5 is a major source of crude oil supply for refineries in Michigan, northern Ohio, Ontario, western Pennsylvania, and Quebec. As the analysis of regional crude oil flows has demonstrated, the loss of Line 5 will significantly decrease regional refinery crude oil runs and, therefore, the local supply of refined products such as gasoline, jet fuel, and diesel. The reduction in local refined product supply will be particularly acute in Michigan, Ontario, and western Pennsylvania. This section of the report examines the available options to replace the lost refined product supply and the anticipated impact on prices.

7.2. The EIA subdivides the U.S. into five PADDs. The Midwest is in PADD 2, which consists of the states between North Dakota to Ohio in the north and those south to Oklahoma and Tennessee.[115] The EIA provides a great deal of supply and demand information at the PADD level.

7.3. The preponderance of regional refinery output is gasoline, jet fuel, and diesel, which comprise about 88 percent of the total refinery runs of crude oil and other feedstocks on average in PADD 2.[116] Accordingly, this analysis primarily focuses on these three refined products, collectively labeled "transportation fuels." Asphalt is also considered because several of the refineries most affected by the shutdown of Line 5 are major asphalt producers.

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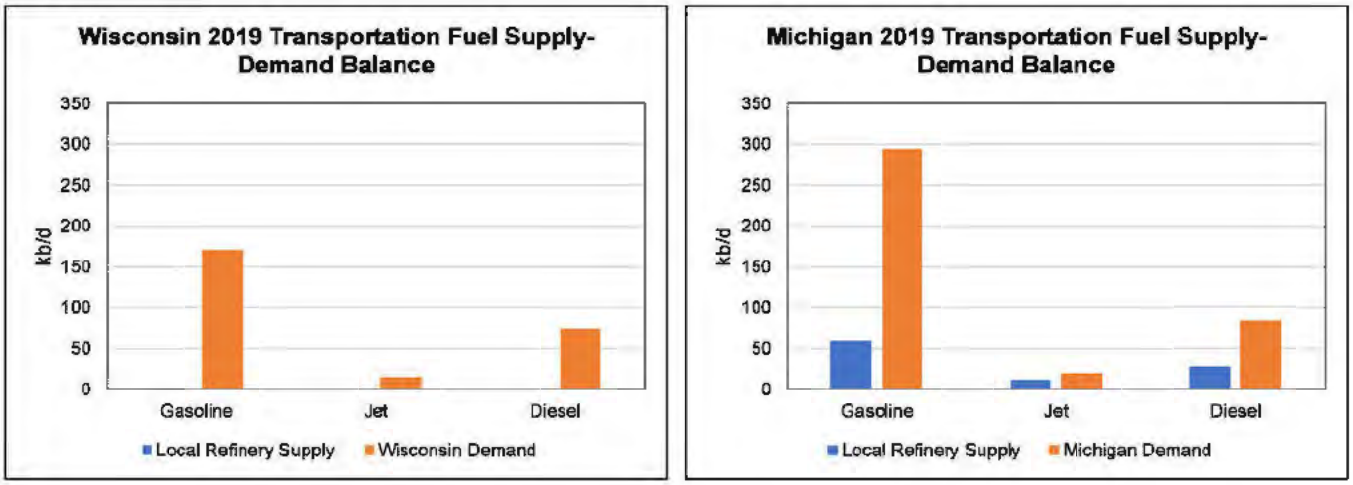
[115] A map of the U.S. PADDs can be found at: https://www.eia.gov/petroleum/supply/monthly/pdf/append.pdf.

[116] EIA, Petroleum & Other Liquids, Refinery Yield, Area PADD 2, Annually, 2014 to 2019: https://www.eia.gov/dnav/pet/pet_pnp_pct_dc_r20_pct_a.htm.

7.4. Figure 13 provides an overview of the transportation fuel supply-demand balances for Wisconsin and Michigan. Both states rely upon large transfers of refined product from adjacent states to meet local demand. In 2019, Wisconsin relied upon adjacent states for all of its transportation fuel supply because the state's single small refinery in Superior was closed for fire-related repairs. Workpapers 12 and 13 provide more detail on the supply-demand balances for Wisconsin and Michigan, respectively.

Figure 13



7.5. Most of Wisconsin's demand is met by pipeline transfers from Minnesota refineries and from the Chicago area. The bulk of the transportation fuel shortfall in Michigan is met by pipeline transfers from the Chicago area, with some contribution from the two Toledo refineries.

7.6. Figure 14 illustrates the transportation fuel supply-demand balances for Ontario and Quebec. Most of the shortfall in Ontario is satisfied by transfers from Quebec by pipeline with a more limited contribution from barge transportation, also originating in Quebec.[117] There are also some transfers by truck and barge from Michigan into Ontario. Workpapers 14 and 15 provide more detail on the

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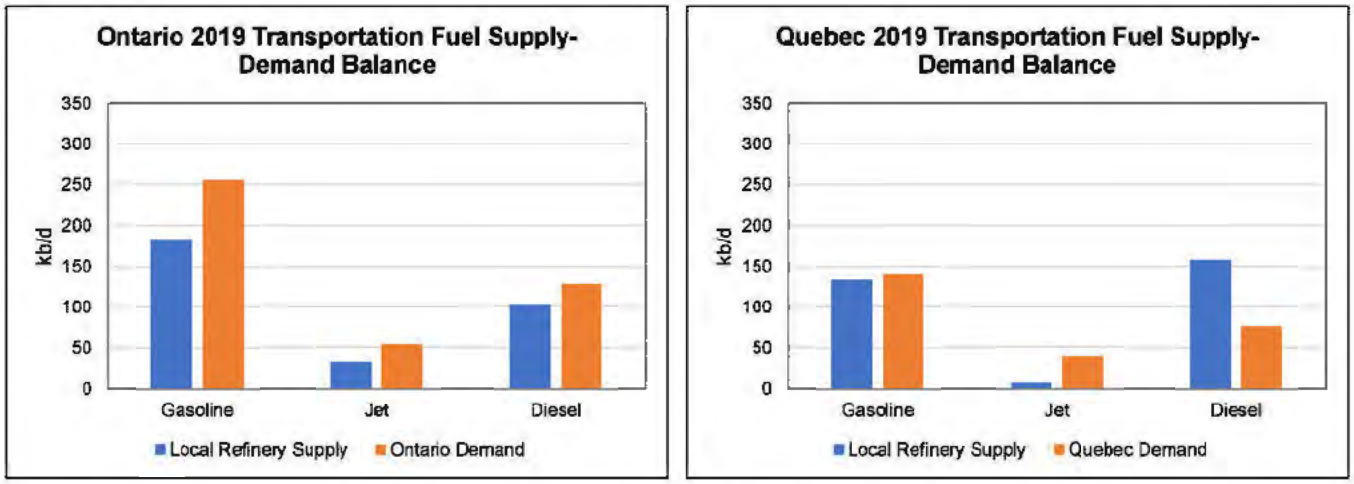
[117] Since Quebec itself is relatively balanced without a sizable surplus to transfer to Ontario, the transfers from Quebec are, in effect, backfilled by transfers to Quebec from Atlantic Canada and imports.

supply-demand balances for Ontario and Quebec, respectively. Transportation fuel demand in western Pennsylvania is met by local supply (the United Warren refinery) and refined product pipelines originating in eastern Ohio and the Philadelphia area.

Figure 14



7.7. These estimates of the transportation fuel supply-demand balances are generated with a Muse transportation fuel distribution model. The model uses data from the EIA to generate the local demand and refinery production estimates and incorporates information from various pipeline companies about transportation costs.

LINE 5 SHUTDOWN IMPLICATIONS FOR MICHIGAN TRANSPORTATION FUEL PRICES

7.8. The crude oil supply analysis indicates that the Detroit /Toledo region will experience approximately 57,000 b/d crude oil supply shortfall, representing

about 13 percent reduction in refinery crude oil runs. The PADD 2 transportation fuel supply-demand balance can provide some insight on the likely price effects of a Line 5 shutdown on transportation fuel prices in Michigan and elsewhere in the Midwest. Workpaper 16 provides the supply-demand balances for gasoline, jet fuel, and ultralow sulfur diesel.

7.9. In 2019, PADD 2 gasoline demand, net of fuel ethanol additions, exceeded the gasoline supply from PADD 2 refineries. The proportion of PADD 2 gasoline produced by PADD 2 refineries was about 85 percent, with the shortfall primarily supplied by Gulf Coast refiners. The situation was similar for jet fuel and diesel, with PADD 2 refineries producing about 90 percent of PADD 2 demand, per Workpaper 16.

7.10. Consequently, refined product supply reductions in Michigan will require additional transfers of gasoline, jet fuel, and diesel into the Midwest, primarily from the Gulf Coast. The existing northbound refined product pipelines are believed to have sufficient available capacity to accommodate the reduction in Michigan transportation fuel supply, so the transportation costs between the Gulf Coast and the Midwest will not substantially increase. Nonetheless, additional demand will apply upward pressure on Midwestern fuel prices. I estimate that a Line 5 shutdown will have a small impact on Michigan gasoline, jet fuel, and diesel prices, likely less than 1 ¢/gal.

7.11. Nonetheless, a small increase in fuel prices still translates into a significant increase in end-user costs due to the volumes involved. The total 2019 Michigan demand for gasoline (net of fuel ethanol), jet fuel, and diesel is estimated at 398,000 b/d. If the increase in Michigan transportation fuel prices due to a Line 5 shutdown is 0.5 ¢/gal, this results in a cost increase for Michigan consumers of gasoline, jet fuel, and diesel of over $30 million per year.

7.12. The price impact of a Line 5 shutdown will also be influenced by the degree to which transportation fuels are exported from the Detroit and Toledo area into Ontario. The reduction in crude oil runs at the Ontario refineries averages about

38 percent, assuming that all four of the Ontario refineries can still operate safely at these low rates. Transportation fuel exports from PADD II to Canada, which are believed to be primarily from the Detroit area, averaged 25,000 b/d in 2019, although they have been higher in previous years.[118] Due to the severity of the supply reduction in Ontario, higher truck exports from Detroit into southern Ontario can be expected to significantly increase. In addition, barge and rail shipments from the Detroit area to Toronto also can be expected to rise. These flows will also apply upward pressure on Michigan transportation fuel prices.

LINE 5 SHUTDOWN IMPLICATIONS FOR WISCONSIN TRANSPORTATION FUEL PRICES

7.13. In 2019, the local supply of transportation fuel in Wisconsin was zero, because the only refinery in Wisconsin, the Husky Superior refinery, was shut down for the entire year for repairs.[119] Nonetheless, even if the small Husky Superior refinery had been operating in 2019, Wisconsin would still be heavily reliant on transportation fuel supply from Minnesota and the Chicago area. Due to its large refineries and high-capacity inbound transportation fuel pipelines, the Chicago area is also a key source for meeting any transportation fuel shortfall in Michigan. Additional transfers of transportation fuel to Michigan act to increase prices in Chicago, and, therefore, Wisconsin. My estimate of the increase in Wisconsin transportation fuel prices is the same as that for Michigan gasoline prices, i.e., approximately 0.5 ¢/gal. This translates into an increase in transportation fuel costs for Wisconsin consumers of approximately $20 million per year.

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[118] For example, in 2015, transportation fuel exports from PADD II to Canada averaged 45,000 b/d. See EIA: https://www.eia.gov/dnav/pet/pet_move_exp_dc_R20-Z00_mbblpd_a.htm for details on exports. All exports from PADD 2 of transportation fuels are believed to go to Canada.

[119] Since 2019, Husky has been acquired by Cenovus.

LINE 5 SHUTDOWN IMPLICATIONS FOR ONTARIO TRANSPORTATION FUEL PRICES

7.14. Ontario is currently net short refined product and this shortfall is primarily met by shipments on the Trans-Northern pipeline. This pipeline originates at Montréal and terminates in the Toronto area. A segment of the Trans-Northern pipeline also connects the Imperial Nanticoke refinery with Toronto.

7.15. Shutting down Line 5 will reduce the production of transportation fuels by the Ontario refineries by over 100,000 b/d. This greatly exceeds the available capacity on the Trans-Northern pipeline, and this shortfall will have to be met with sizable barge movements from Montréal and Detroit.[120] The shortfall will also likely result in additional shipments via truck from Detroit into southern Ontario.

7.16. The supply problem for Ontario will be particularly acute in the winter months when the Great Lakes and St. Lawrence Seaway close for shipping. It is not clear that there is sufficient transportation fuel storage capacity in Ontario to enable the fuel distributors to inventory enough transportation fuel prior to the close of the shipping season to last through the winter. In addition, the availability of the additional tugs and barges required to transport the additional volumes likely will be an issue.

7.17. Barge and truck transport are considerably more costly than pipeline shipments, which will act to increase transportation fuel prices. Average transportation fuel inventory levels will also have to increase to accommodate loss of waterborne supply during the winter period, which also imposes a working capital cost on Ontario fuel suppliers. I estimate that transportation fuel prices in Ontario will increase by 4 to 6 ¢/gal due to the higher transportation costs, higher inventory levels, and greater logistical complexity. Using a 5 ¢/gal price change, the cost

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[120] See the Canada Energy Regulator pipeline system portal for details on Canadian pipeline activity at: https://www.cer-rec.gc.ca/en/data-analysis/facilities-we-regulate/pipeline-profiles/oil-and-liquids/pipeline-profiles-trans-northern.html.

increase for Ontario transportation fuel consumers will be over $300 million per year.

LINE 5 SHUTDOWN IMPLICATIONS FOR REGIONAL ASPHALT MARKET

7.18. Asphalt is something of a specialty refined product and many refineries do not make it. Table 5 provides the details of the asphalt production capabilities of the 10 refineries in the Line 5 delivery area.[121] Six of the refineries in the region produce asphalt.

Table 5

REGIONAL ASPHALT PRODUCTION CAPACITY

(Thousands of Barrels per Day)

	Crude Oil	*Asphalt Capacity*
Detroit/Toledo Region	467.8	41.0
Pennsylvania	65.0	22.0
Ontario	395.0	15.2
Quebec	372.0	30.0
Grand Total	**1,299.8**	**108.2**

[121] EIA Table 4 – Production Capacity of Petroleum Refineries is the information source for the U.S. refinery asphalt production capacity, and Oil & Gas Journal Worldwide Refining Survey 2020 is the information source for the Canadian refineries.

7.19. Assuming that none of the asphalt refineries are shut down outright by a Line 5 closure, I estimate that the regional asphalt production capacity will be reduced by 20 percent. The shortages will be particularly acute in Ontario and western Pennsylvania. Table 6 provides a summary of the analysis of the impact of closing Line 5 on regional asphalt production capabilities.

Table 6

LINE 5 SHUTDOWN IMPACT ON ASPHALT PRODUCTION

(Thousands of Barrels per Day, Unless Noted)

	Nominal Asphalt Capacity	*Post-Line 5 Shutdown Asphalt Capacity*	*Percent Asphalt Yield Reduction*
Detroit/Toledo Region	41.0	35.5	*13.3*
Pennsylvania	22.0	11.8	*46.5*
Ontario	15.2	9.5	*37.5*
Quebec	30.0	30.0	-
Grand Total	**108.2**	**86.8**	***19.8***

7.20. Asphalt can only be transported by truck, rail, or barge using specialized equipment that is insulated and fitted with steam coils to re-liquify the asphalt once it reaches its destination. Such requirements translate into high costs to transport asphalt, particularly over long distances. Consequently, the reduction in local asphalt supply can be expected to increase asphalt prices in Michigan, northern Ohio, western Pennsylvania, and Ontario. I assess the increase in Michigan asphalt prices to be about 10 percent, or approximately $8.00/bbl. In 2019, the estimated asphalt demand in Michigan was 4.1 million barrels.[122] A $8.00/bbl price increase equates to a higher asphalt cost of $33 million per year

[122] EIA: https://www.eia.gov/opendata/qb.php?category=40243&sdid=SEDS.ARTCP.MI.A.

for Michigan consumers. End-users in northern Ohio and western Pennsylvania can also expect higher asphalt prices.

7.21. For Ontario, a comparison of asphalt production capacity (15,200 b/d) and asphalt demand (14,900 b/d) indicates that asphalt supply and demand are closely balanced.[123] Consequently, the estimated 38 percent reduction in Ontario asphalt production capacity, per Table 6 above, will result in a shortfall in Ontario asphalt supply. Using an asphalt price increase of $8.00/bbl, the resultant increase in cost for Ontario consumers is $44 million per year.

IMPACT ON REFINERY COMPETITIVENESS

7.22. It is my opinion that the closure of Line 5 before a re-route is operational will affect the competitiveness of the regional refineries. The average crude oil run reductions for the Pennsylvania and Ontario refineries are estimated at 47 and 38 percent, respectively. The first issue that these refineries will face is whether or not they can safely operate at these low throughputs. Based upon my refining expertise, it is my judgment that there is a significant probability that at least one of the regional refineries will not be able to operate at these low rates.

7.23. Refinery economics are also characterized by relatively high fixed costs that do not change with crude oil throughput. If the crude oil throughput drops, the per-barrel fixed cost burden increases. Consequently, a 30 percent decrease in crude oil throughput due to Line 5 closing will act to increase the per-barrel fixed cost burden for a refinery by 43 percent. Translated to dollar terms, if a refinery has a fixed cost that is $2.50/bbl, then its fixed cost burden will be $3.58/bbl if Line 5 is closed. This is significant increase in the per-barrel cost of operating a refinery.

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[123] See Table 5 above for the estimate of Ontario asphalt production capacity. Ontario asphalt demand data obtained from Statistics Canada: https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=2510004401.

7.24. This degree of per-barrel cost increase may make some of these refineries unprofitable. Accordingly, it is my assessment that the impact of shutting down Line 5 on the long-term competitiveness of these refineries will be severe, and may result in the closure of one or more of the refineries. The social and economic effects of such closures are detailed in the expert report of Dr. Corbett Grainger.[124]

7.25. Finally, even in Quebec where the refineries are believed to have some alternative crude oil delivery options that may enable them to avoid sizable crude oil throughput reductions, the closure of Line 5 will have significant cost and operational consequences. Reactivating the Portland Pipeline and existing rail unloading facilities is clearly a less desirable option for the Quebec refineries than using Line 5. If these options were superior, the Quebec refineries would be using them today, rather than Line 5. Reactivation will require investment in facilities that will be used only until a Line 5 re-route around the Reservation is completed. If using rail, transportation costs and greenhouse gas emissions are higher, operational complexity increases, and the reliability of supply decrease. If using tankers, the crude oil grades available will not duplicate the attributes of the crude oil grades available in Western Canada, potentially degrading refinery yields and increasing costs.

SUMMARY OF OPINION

7.26. My key conclusions are:

7.26.1. The shutdown of Line 5 even for a short-term period (even for as long as 2 years) will significantly decrease regional refinery crude oil runs and, therefore, reduce the local supply of refined products such as gasoline, jet fuel, diesel, and asphalt. The reduction in local refined

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[124] *See generally* Expert Report of Dr. Corbett Grainger.

product supply will be particularly acute in Detroit/Toledo, Ontario, and western Pennsylvania.

7.26.2. The estimated impact of a Line 5 shutdown on Wisconsin and Michigan gasoline, jet fuel, and diesel prices is an increase of 0.5 ¢/gal.

7.26.3. The estimated impact of a Line 5 shutdown on Wisconsin and Michigan consumer costs for gasoline, jet fuel, and diesel is $20 and $30 million per year, respectively.

7.26.4. The estimated impact of a Line 5 shutdown on Ontario consumers of gasoline, jet fuel, and diesel is a price increase of 5 ¢/gal, which translates into a cost increase of approximately $300 million per year.

7.26.5. The shutdown of Line 5 will act to significantly reduce asphalt supply in Michigan, northern Ohio, western Pennsylvania, and Ontario.

7.26.6. The reduction in asphalt supply is estimated to increase Michigan and Ontario asphalt costs by $33 and 44 million per year, respectively.

7.26.7. The closure of Line 5 will have a severe impact on the long-term competitiveness on some regional refineries, and may result in the closure of one or more refineries with consequential job losses.

8. ADDITIONAL LINE 5 SHUTDOWN ISSUES

LOSS OF MICHIGAN-PRODUCED CRUDE OIL TRANSPORTATION CAPACITY

8.1 In 2019, Michigan produced approximately 14,000 b/d of crude oil, mostly in the northern portion of the Lower Peninsula. The Lambda Energy Gathering, LLC Michigan pipeline collects crude oil in the north and central regions of Michigan and delivers it to Lewiston, in Montmorency County, where there is a pump station and injection point on Line 5. In 2019, Line 5 transported approximately 9,500 b/d from Lewiston.[125]

8.2 I estimate that the distance from Lewiston to Marysville, the closest delivery point on Line 5, to be approximately 200 miles. Line 5 is a 30-inch diameter pipeline.[126] Therefore, approximately 920,000 barrels of crude oil is required to fill Line 5 between Lewiston and Marysville. Thus, in the circumstance where only the segment of Line 5 between Lewiston and Marysville remained in operation, it would take about 42 days for a barrel of crude oil injected at Lewiston to reach Marysville.

8.3 However, a pipeline designed to transport 540,000 b/d cannot be operated at 9,500 b/d (the Lewiston injection rate). To accommodate the low flow rate, the Line 5 pipeline segment will have to be operated in a start-stop mode of operation, i.e., the pipeline is started up and operated for a day or so, and then shut down until it is needed again. If Enbridge can operate Line 5 at a minimum rate of 270,000 b/d, which is half the design capacity, then Enbridge will be operating Line 5 for about 1 day out of every 28 days. Such an operation would be extremely impractical from an operational perspective, and also expensive on

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[125] Enbridge 2019 Form 6, PDF pg. 70.
[126] Ibid, PDF pg. 72.

a per-barrel basis due to the ongoing need for personnel, materials, and equipment to operate and maintain this pipeline segment.

8.4 Moreover, this mode of operation will require crude oil storage capacity at Lewiston to be at about 300,000 barrels, as at least 270,000 barrels will have to be accumulated at Lewiston to enable Line 5 to be operated for a day. Due to the massive misfit between the required crude oil transportation capacity from Lewiston and the Line 5 capacity, I conclude that operating Line 5 only between Lewiston and Marysville is infeasible. Consequently, the Michigan crude oil producers that rely upon Line 5 for transportation services must find an alternative transportation mode, mostly likely truck, or cease production.

9. EXPERT DECLARATION

EXPERT DECLARATION:

9.1. I understand that my duty in giving evidence in this expert proceeding is to assist the court and the jury to decide the issues in respect of which expert evidence is adduced. I have complied with, and will continue to comply with, that duty.

9.2. I confirm that this is my own, impartial, objective, unbiased opinion which has not been influenced by the pressures of the dispute resolution process or by any party to the proceeding.

9.3. I confirm that all matters upon which I have expressed an opinion are within my area of expertise.

9.4. I confirm that I have referred to all matters which I regard as relevant to the opinions I have expressed and have drawn to the attention of the court all matters, of which I am aware, which might adversely affect my opinion;

9.5. I confirm that, at the time of providing this written opinion, I consider it to be complete and accurate and constitute my true, professional opinion.

9.6. I confirm that if, subsequently, I consider this opinion requires any correction, modification, or qualification I will notify the parties to this proceeding and the court forthwith.

January 31, 2022
Dallas, Texas

Neil K. Earnest, President
Muse, Stancil & Co.

APPENDIX 1: EARNEST CURRICULUM VITAE

NEIL K. EARNEST

SUMMARY OF EXPERIENCE:

Mr. Earnest has over 35 years of experience focused on the downstream sector of the energy business, and has played key roles in major international arbitrations, multi-billion-dollar downstream asset acquisitions, and Canadian crude marketing and upgrading programs totaling hundreds of thousands of barrels per day. As a consultant, he has worked on a broad range of assignments around the world with an emphasis on asset acquisition and divestitures, crude and refined product marketing analyses, expert testimony in support for highly complex arbitrations and major pipeline projects, and project feasibility assessment. Mr. Earnest began his career at Phillips Petroleum Company, where he spent 11 years in a variety of roles at Phillips' largest refinery and petrochemical plant and in corporate planning/engineering. Mr. Earnest is currently the President of Muse.

REPRESENTATIVE CONSULTING EXPERIENCE:

Asset Acquisition and Divestitures

Mr. Earnest has frequently headed Muse's teams that have assisted clients contemplating downstream acquisitions or divestitures. Over the years, dozens of detailed valuations of North American refineries for a variety of clients have been completed. Representative engagements follow:

1. Provided a detailed technical and economic assessment of the range of options available to a Canadian heavy crude producer commencing a downstream integration strategy. Assistance included board-level presentations and assistance negotiating the purchase-sales agreements and the joint-venture operating agreements.

2. Developed a detailed valuation of the combined sales value of the European downstream assets of a major oil company. Included projecting refinery cash flow considering the evolving environmental, product demand, and product specification issues in Europe.

3. Provided economic, technical, and LP modeling assistance to a corporate team considering entry into the Asia-Pacific refining industry.

4. Conducted due diligence of, and assessed the potential for, investment in four state-owned African refineries.

5. Assisted a U.S. client considering the merger of their refining assets with another refiner. The assistance included an assessment of the competitive position of the potential merger partner and potential synergies.

Market, Strategic, and Competitive Analysis

Have provided a broad range of market and competitive analyses in support of client strategy objectives. Clients include pipeline companies, refiners, and crude producers. Representative examples include:

1. Assisted a number of Canadian crude producers with their long-range investment and market development strategies, including detailed market and potential customer assessments, for their synthetic and heavy sour crude programs.

2. For several refiner clients, provided a detailed assessment of their refinery competitive position versus domestic and foreign competition.

3. Generated a detailed assessment, considering multiple market scenarios, of the expected prices for a range of potential synthetic crude formulations that was instrumental in finalizing the design basis for a multi-billion-dollar Canadian oil sands upgrader.

4. Provided the market analysis in support of a new proposed product pipeline in the Rockies.

5. Assisted several clients with quantifying the value of their equity crude to specific purchasers. The purchasers were either being considered for term contracts or were large volume buyers.

6. Provided the Government of Alberta, Ministry of Energy, detailed analysis of the technical attributes, from the refiner's perspective, of extra-heavy crude oil blends as well as an assessment of their value in potential markets.

Project Feasibility and Technology Assessment

Representative project and technology assessment analyses include:

1. Provided a detailed assessment of the value of a biomass-sourced, partially upgraded feedstock to the refining industry on behalf of the biofuel manufacturer. This assistance included extensive analysis of the suitability and value of the individual fractional components of the bio-feedstock to the typical Gulf Coast refiner, and assessing the economic benefits to the biofuel manufacturer of adding additional desulfurization

and hydrogen-addition process technologies. The client ultimately constructed a commercial-scale plant.

2. Provided a detailed technical and economic assessment of a heavy crude partial upgrading technology on behalf of a potential investor in the technology company. Later acted as the independent engineer to certify the performance tests for the commercial demonstration plant. The certification was one of the pre-conditions for the sale of the technology company to the investor.

3. Provided a technology assessment of six extra-heavy crude oil partial-upgrading technologies. The technologies ranged from variations on fairly conventional refinery process technologies to super-critical water cracking schemes and sodium-based desulfurization technologies. The engagement included a ranking of the technologies on an economic, technical feasibility, and readiness for commercialization basis.

4. Assisted a major Canadian heavy crude oil producer with the selection of the process technology for the conversion of extra-heavy crude oil to light synthetic crude oil. The engagement included the detailed technical and economic assessment of competing process technologies.

5. In-depth evaluation of resid upgrading options for a large Middle East refinery. The assistance included the detailed LP modeling of the alternatives.

6. Assisted a South American client with process optimization in connection with a major upgrade of their lube manufacturing facilities.

7. Performed the detailed technical and economic analysis of the overall merits of constructing a new resid FCC unit on behalf of a South American refiner.

Expert Testimony

1. Private Arbitration (1998): Koch Shipping Inc., Koch Supply & Trading Company, and Koch Refining Company, L.P. v. Mobil Shipping and Transportation Company.

2. Provided expert report, in 2006, on behalf of Enbridge Pipelines regarding the market demand for Canadian crude oils and quantified the benefits that would flow to Illinois and other U.S. consumers regarding the Southern Access Pipeline. Report filed with the Illinois Commerce Commission.

3. Provided expert report and direct testimony before the National Energy Board (Canada) regarding the Southern Lights Project, on behalf of Enbridge Pipelines, Inc., with hearings held in Calgary, Alberta, in 2007.

4. Expert report and direct testimony before the National Energy Board (Canada) regarding the Alberta Clipper Project, on behalf of Enbridge Pipelines, Inc., with hearings held in Calgary, Alberta, in 2007.

5. Provided expert report, in 2007, on behalf of Enbridge Pipelines to the National Energy Board (Canada) regarding the crude supply and demand for Ontario and Montréal refineries.

6. Provided expert reports, in 2007, to the U.S. Federal Energy Regulatory Commission on behalf of Enbridge Pipelines regarding the expected utilization of the Southern Access Extension pipeline, as well as other non-rate shipper benefits that ensued from the commissioning of the pipeline. Also provided written affidavit in response to intervener's expert.

7. Provided direct testimony, in 2008, before the Minnesota Public Utilities Commission regarding the Alberta Clipper Project, on behalf of Enbridge Pipelines, Inc.

8. Direct testimony, in February 2008, before the International Court of Arbitration, with hearings held in Zurich, Switzerland, on behalf of Louis Dreyfus S.A.S. (Respondent) against Ronald W. de Ruuk, as Bankruptcy Administrator for Holding Tusculum B.V., (Claimant). Testifying expert at hearings on behalf of the respondent regarding the value of the Wilhelmshaven, Germany, refinery. Also, co-authored valuation report and responses to claimant's experts.

9. Provided expert report, in May 2009, and oral testimony to the International Court of Arbitration on behalf of Mobil Cerro Negro, Ltd (Claimant) against Petroleos de Venezuela, SA regarding the expropriation of assets.

10. Expert report and direct testimony before the National Energy Board (Canada) regarding the Keystone XL Project, on behalf of Enbridge Pipelines, Inc., with hearings held in Calgary, Alberta, in 2009.

11. Provided expert and reply report, in 2009, on behalf of Enbridge Pipelines to the National Energy Board (Canada) regarding the medium-term prospects for Line 9 in westbound service.

12. Provided expert and reply reports, in 2010 and 2011, to the International Centre for Settlement of Investment Disputes on behalf of Venezuelan Holdings B.V., et.al. (Claimant) against the Bolivarian Republic of Venezuela, and oral testimony at the hearing held in Paris in 2012 regarding the expropriation of assets.

13. Provided expert oral testimony in 2011 on behalf of Enbridge Inc. to the National Energy Board (Canada) regarding the Southern Lights Pipeline.

14. Provided expert report, in 2011, on behalf of Enbridge Bakken Pipeline Company to the National Energy Board (Canada) regarding the market prospects for North Dakota crude oil.

15. Submitted export report in January 2012 to the Michigan Public Service Commission regarding the public need and local economic benefits of Enbridge Line 17, on behalf of Enbridge Pipelines (Toledo) Inc.

16. In 2011, submitted expert and rebuttal reports to the U.S. Federal Energy Regulatory Commission on behalf of Enbridge Pipelines regarding the Southern Lights Pipeline followed by oral testimony at the hearing in Washington, D.C., in 2012.

17. Provided expert and rebuttal reports to the Joint Review Panel (Canada) regarding the Northern Gateway Pipeline project, followed by oral testimony at hearing held in Edmonton, Alberta in September 2012, on behalf of the Northern Gateway Pipeline.

18. Provided expert report to the National Energy Board (Canada) regarding the market prospects for the Enbridge Edmonton-to-Hardisty pipeline project in November 2012, followed by direct testimony in October 2013, on behalf of Enbridge Pipelines.

19. Provided expert report, rebuttal, and surrebuttal testimony in 2013 and 2014 before the Minnesota Public Utilities Commission regarding the Line 67 Station Expansion Project – Phase 2, on behalf of Enbridge Pipelines, Inc.

20. Provided expert report and rebuttal testimony in 2014 to the U.S. Federal Energy Regulatory Commission on behalf of North Dakota Pipeline Company LLC regarding the Sandpiper pipeline.

21. In June 2014, provided written and oral expert testimony in the English High Court of Justice – Commercial Court, on behalf of Innospec Inc. versus Jalal Bezee Mejel Al-Gaood & Partner regarding issues in the Iraqi refining sector.

22. Provided expert and rebuttal testimony to the National Energy Board (Canada) regarding Trans Mountain Pipeline nomination verification procedures in 2014, on behalf of Tesoro Canada.

23. Provided expert reports and oral testimony in August 2014 through January 2015 before the Minnesota Public Utilities Commission regarding the Sandpiper Pipeline Project on behalf of North Dakota Pipeline Company LLC.

24. Provided expert report and rebuttal report, followed by oral testimony at trial in February, 2016, in the U.S. District Court for the Central District of California, on behalf of Southern California Edison Company versus ExxonMobil Oil Corporation. The dispute concerned an electrical outage at a refinery.

25. Provided reply report in October 2014, followed by oral testimony in February 2017, to the International Centre for Settlement of Investment Disputes on behalf of ConocoPhillips Petrozuata B.V., et.al. (Claimant) against the Bolivarian Republic of Venezuela regarding the expropriation of assets.

26. Provided an expert report in November 2014 to the National Energy Board (Canada) regarding the expected utilization of the Enbridge Mainline for the Enbridge Line 3 Replacement Program.

27. Provided expert report and oral testimony in June and December, 2015 to the ICC International Court of Arbitration on behalf of Wallis Trading Inc. versus SGS Societe Generale de Surveillance SA for a case regarding issues relating to a collateral management agreement at an Albanian storage facility.

28. Provided expert report in September 2015 to the National Energy Board (Canada) regarding the expected utilization of and the Canadian crude oil producer benefits from the Trans Mountain Expansion Project.

29. Provided expert report to the U.S. Federal Energy Regulatory Commission in November 2015 on behalf of Colonial Pipeline Company regarding revisions to its Rules and Regulations tariff.

30. Provided an expert report and oral testimony in May and December 2016 to the ICC International Court of Arbitration on behalf of ConocoPhillips Petrozuata B.V., et.al. (Claimant) versus Petróleos de Venezuala, S.A. regarding the expropriation of assets.

31. Provided an expert report in August 2017 in the U.S. District Court for Montana, on behalf of Northwestern Energy versus ExxonMobil Oil Corporation. The dispute concerned an electrical outage at a refinery.

32. Provided expert, rebuttal, surrebuttal, and supplemental surrebuttal reports in 2015 and 2017, followed by oral testimony, to the Minnesota Public Utilities Commission regarding the utilization and market impact of the Enbridge Mainline for the Enbridge Line 3 Replacement Program, on behalf of Enbridge Pipelines, Inc.

33. Provided expert and rebuttal reports in 2017 to an AAA Arbitration proceeding on behalf of NARL Refining Limited Partnership versus BP

Products North America regarding technical and economic issues related to a crude oil toll processing contract.

34. Provided an expert report, reply report, and oral testimony in 2017-2019 to the ICC International Court of Arbitration on behalf of the Republic of Turkey versus the Republic of Iraq regarding a dispute concerning Kurdish crude oil exports.

35. Provided an expert report in 2018 to the ICC International Court of Arbitration on behalf of Phillips 66 Company versus PDVSA. The dispute concerns the appropriate valuation methodology for a Venezuelan heavy sour crude oil.

36. In 2019 and 2020, provided an expert and reply report in a private expert proceeding regarding the appropriate protocol to value the crude oils shipped on a North Sea crude oil pipeline, followed by oral testimony. The parties involved included a number of North Sea crude oil producers.

37. In 2019, provided an expert report in the Superior Court of the State of Washington on behalf of the City of Tacoma, Washington – Department of Public Utilities versus U.S. Oil & Refining. The dispute concerned an electrical outage at a refinery.

38. In 2019, provided an expert report in the High Court of Justice Business and Commercial Courts of England and Wales – Commercial Court on behalf of JSC Antipinsky Refinery versus VTB Commodities Trading DAC. The dispute concerned a toll processing agreement at the Antipinsky refinery.

39. In 2019, provided an expert and rebuttal reports, followed by oral testimony, to the Canada Energy Regulator on behalf of Enbridge Pipelines, Inc., regarding the Canadian Mainline Contracting Application.

40. In 2020, provided an expert report and oral testimony to the Federal Energy Regulatory Commission on behalf of Colonial Pipelines Company versus a number of its shippers. The report and testimony addressed various industry issues in a market-based rate proceeding.

41. In June 2020, provided an affidavit in support of Enbridge Energy, LP versus Dana Nessel, Attorney General of the State of Michigan in the Circuit Court for the 30th Judicial Circuit, Ingham County. The affidavit addressed various issues concerning the potential shutdown of a pipeline.

42. In 2020, provided expert and reply reports in the United States District Court, Eastern District of Pennsylvania, in support of the Eddystone Rail Company, LLC versus Bridger Logistics LLC, et al. The dispute concerned a number of issues about a crude oil rail unloading and transloading facility.

43. In 2021, submitted rebuttal testimony to the Michigan Public Service Commission on behalf of Enbridge Energy Limited Partnership regarding an application to replace and relocate the segment of Enbridge Line 5 crossing the Straits of Mackinac. Oral testimony was provided in January 2022.

44. In December 2021, provided written testimony to the Board of Review of Madison County, Illinois, on behalf of WRB Refining LP regarding a tax dispute. Oral testimony was provided in January 2022.

WORK EXPERIENCE:

Muse, Stancil & Co. 1991 - Present
Current Position: President

Phillips Petroleum Company 1981-1991
Positions:
Process Senior Engineer
Economics Engineer
Staff Process Engineer

EDUCATION: B.S. Chemical Engineering - 1981
Michigan State University
M.B.A. - 1986
University of Houston – Clear Lake

PROFESSIONAL REGISTRATION: Chemical Engineer, Texas, #75398

PUBLICATIONS/PRESENTATIONS:

1. *"Refinery-Profitability Statistics Begin"*
Oil & Gas Journal
January 2001

2. *"Canadian Crude Market Outlook"*
Alberta Department of Energy Workshop #2
March 2002

3. *"View from the Market: The Refiner's Perspective"*
CERI 2003 World Oil Conference
January 2003

4. *"Traditional Markets and New Opportunities"*
CERI 2004 World Oil Conference
March 2004

5. *"Independent Views on Markets for Oil Sands and Pipeline Capacity"*
TD Newcrest Oil Sands Forum 2004
July 2004

6. *"Independent Views of Markets for Oil Sands and Pipeline Capacity"*
2004 National Petrochemical & Refiners Association
July 2004

7. *"The Canadian Crude Market"*
2005 Canadian Crude Oil Conference
September 2005

8. *"The Canadian Crude Market"*
3rd Annual Canadian Oil Sands Summit
January 2006

9. *"Bigger is Better"*
4th Annual Oil Sands Forum – Oil Sands Market Overview
July 2006

10. *"U.S. Market for Canadian Crude – Oil Sands Market Overview"*
Crude Oil Quality Group General Meeting
November 2006

11. *"Future Markets for Canadian Crude"*
4th Annual Canadian Oil Sands Summit
January 2007

12. *"Canadian Crude Market Outlook"*
3rd Annual Enbridge Mid-Continent Shippers Conference
January 2007

13. *"New Market Outlook for Canadian Crude"*
42nd Annual Enbridge Jasper Conference
June 2007

14. *"Canadian Oil Market – Opportunities and Challenges"*
5th Annual Canadian Oil Sands Summit
January 2008

15. *"Canadian Crude Market and Outlook"*
Argus US/Canada Asphalt Conference 2008
April 2008

16. *"Oil Sands Integration with the U.S. Market – A Revised Perspective"*
20th Annual Canadian Crude Oil Conference
September 2008

17. *"The Economy and Oil Demand: Where are They Taking the Oil Market?"*
CERI 2009 Oil Conference
April 2009

18. *"Oil Sands Integration with the Global Markets – A Revised Perspective"*
TD Newcrest London Oil Sands Forum 2009
January 2009

19. *"Oil Sands Integration with the Global Markets"*
TD Newcrest Canadian Unconventional Oil Forum 2009
July 2009

20. *"Implications of Expanding Canadian Pipeline Infrastructure"*
Argus Americas Crude Summit 2010
January 2010

21. *"Counter-Party Risk"*
TD Newcrest – Unconventional Oil & Gas Forum
July 2010

22. *"U.S. Downstream in the New Economic Reality"*
Annual Canadian Crude Oil Conference
September 2010

23. *"The Road to Recovery"*
Argus 4th Annual Americas Asphalt Summit
March 2011

24. *"Crack Spreads are Back: Which PADDs Stand to Benefit and How Long Will It Last?"*
TD Securities – Unconventional Energy Conference
TD Newcrest – 2011 Calgary Unconventional Energy Conference
July 2011

25. *"Overall Market Landscape for Canadian Crude Oil"*
Argus – Americas Crude Summit 2012
January 2012

26. *"Canadian Crude Landscape and Market Expansion Prospects"*
Argus – Americas Asphalt Summit 2012
March 2012

27. *"The Changing Crude Supply Landscape – The Refiner's Perspective"*
TD Securities
July 2012

28. *"Rail vs. Pipeline: What Projects are Being Developed to Accommodate Growing Shale Crude Production?"*

Argus Americas Crude Summit
January 2013

29. *"Implications of the North American Oil Renaissance"*
American Fuel & Petrochemical Manufacturers
January 2013

30. *"Implications of the Evolving North American Crude Supply Outlook"*
TD Securities – 2013 TD Calgary Energy Conference
July 2013

31. *"Implications of the Evolving North American Crude Supply Outlook"*
AICHE –5th Southwest Process Technology Conference
October 2013

32. *"Renaissance of the North American Energy Sector"*
Lloyds Register – Energy Conference
October 2013

33. *"Changing Topography of U.S. Crude"*
Argus – Americas Crude Summit 2014
January 2014

34. *"Canadian Tidewater Access – Implications for the U.S."*
American Fuels & Petrochemical Manufacturers Annual Meeting 2014
March 2014

35. *"Dealing with an Oversupply of Light Crudes in a World of Heavy Crude Refineries"*
Canadian Energy Research Institute 2014 Oil Conference
April 2014

36. *"Update on Market Access by Pipeline"*
Argus Canadian Crude Summit 2015
June 9, 2015

37. *"North American Crude Market Outlook"*
Enbridge 50th Annual Liquids Pipelines Conference 2015
June 11, 2015

38. *"Crude Oil Market Dynamics for 2016"*
Canadian Heavy Oil Association Annual Luncheon
January 7, 2016

39. *"Survival Outlook for Canadian Oil"*
8th Argus Americas Crude Summit
January 21, 2016

40. *"Light Transportation Fuels – Supply-Demand Outlook and Implications for Logistical Infrastructure"*
Argus Americas Motor Fuels Summit
January 17, 2018

41. *"Headwinds for the Russian Refining Industry"*
IP Week Conference – *Re-Engineering the Oil and Gas Operating Models: An Industry in Transition*
February 22, 2018

42. *North American Shale and Heavy Barrel Competition – The Latin American Competition*
Argus Canadian Crude Summit
May 1, 2018

APPENDIX 2: CHOW CURRICULUM VITAE

KENNETH CHOW

EDUCATION:

McGill University - Montreal, Quebec, Canada
Bachelor of Engineering, Mechanical Engineering, 1999

EXPERIENCE:

Muse, Stancil & Co. May 2014 – Present
Position: Senior Consultant

NextEra Energy Resources - Houston, Texas January 2013 – May 2014
Position: Manager, Midstream

Purvin & Gertz - Houston, Texas July 2011 – January 2013
Position: Senior Consultant (7/2011 – 1/2013) May 2001 – July 2004
Associate (5/2001 to 7/2004)

The Williams Companies - Tulsa, Oklahoma March 2010 - July 2011
Position: Senior Environmental Specialist

Wal-Mart Stores - Bentonville, Arkansas July 2008 - March 2010
Position: Manager, Global Energy Development

Tyson Foods - Springdale, Arkansas August 2004 – November 2007
Position: Senior Analyst, Supply Chain Planning and Strategy

Enron - Houston, Texas July 1999 - May 2001
Position: Analyst Rotation Program

PUBLICATIONS/PRESENTATIONS:

- "*LPG supply growth outstripping demand, infrastructure*", The Oil & Gas Journal, April 6, 2020
- "*North American propane market adapts to supply surge*", The Oil & Gas Journal, November 5, 2018
- "*Pipeline Safety & Regulation*", Argus North American Petroleum Transportation Summit, June 2015

- "*Benchmarking GHG emissions from cryogenic gas processing*", Gas Processing Magazine, November/December 2014 issue

REPRESENTATIVE INDUSTRY AND CONSULTING EXPERIENCE

Industry Experience

1. **Natural Gas Storage Development:** Led the planning, sizing, and vendor selection of 42,000 horsepower of compression for Houston Pipeline Bammel storage expansion project. Performed analysis of basis differentials to justify construction of a storage header project to connect to multiple interstate and intrastate pipeline systems.

2. **Producer Services:** Marketed joint venture Barnett Shale gas production by negotiating contracts for gas gathering, gas processing, and gas purchases with midstream companies. Coordinated the timing of well connects with the drill schedule and estimated availability of gas infrastructure during lease acquisitions.

3. **Commercial Operations:** Oversaw contract administration and monthly gas settlement statement process for natural gas gathering system and processing plant in the Bakken. Responsible for nomination process on company's North Dakota crude oil pipeline that delivered crude oil to an Enbridge pipeline.

4. **Facility Planning:** Analyzed natural gas pipeline flows to support Gas Control and Gas Marketing in understanding limitations to physical gas flow due to operating conditions. Advised Gas Control on available pipeline capacity for scheduling purposes. Identified opportunities to increase pipeline capacity and reduce compressor fuel consumption.

Independent Technical/Market Consultant

1. **Bolivian Natural Gas Pipeline Technical Review:** On behalf of the lender for project refinancing, participated on Independent Engineer assignment for a natural gas pipeline system in Bolivia. Responsibilities included the evaluation of the system design, planned expansions, operating capability, project economics, and cash flows.

2. **Indonesia LNG Plant Expansion:** For the independent engineer's construction cost estimate of a liquefaction train addition, Mr. Chow was responsible for major equipment pricing, vendor quotations, bulk material takeoffs, cost estimating models, and development of Monte Carlo simulations to determine the project cost risk profile. This investment assessment formed the basis for final negotiations with the LNG train construction contractors.

3. **Mexico Ethane Cracker Feedstock Analysis:** Acted as Ethane Market Consultant on behalf of the Project Lenders for development of a greenfield petrochemical complex in Coatzacoalcos. Responsibilities included the evaluation of ethane production, forecasting the regional ethane and natural gas supply/demand balances, ethane supply contract and pricing analysis, and capital investment review.

Commercial Contracts

1. **Surety Bond Coverage for Firm Transportation Pipeline Agreements:** On behalf of the reinsurance company considering providing surety bond coverage for pipeline transportation agreements to a Marcellus gas producer in bankruptcy, provided analysis to assure that the pipeline transportation would be utilized. As part of this process, reviewed firm and interruptible transportation agreements in place, analyzed producer's gas flow projections, and estimated pipeline utilization for the pipelines for which reinsurance company will provide surety bond coverage.

2. **Natural Gas Settlement Statement Disputes:** On behalf of producers and royalty owners, reviewed monthly settlement statements from midstream companies and identified discrepancies with contractual terms. Quantified discrepancies for clients and provided assistance to resolve disputes.

3. **Midstream Business Interruption Claim:** On behalf of client involved in one of multiple allision incidents at a midstream company's marine terminal, reviewed business interruption claims and company's efforts to mitigate damages. Evaluated storage contract terms and shipping records to assist in the assessment of the business interruption claims made by the midstream company.

Natural Gas Infrastructure Development

1. **Pipeline Tariffs for Arctic Gas Development:** On behalf of several provincial governments, developed pipeline transportation rates for proposed pipelines to move Arctic gas through the provinces. Responsible for the development of pipeline, compressor, and routing requirements for input into pipeline economic model.

2. **Natural Gas Pipeline Economics:** For various pipeline M&A, financing, and development projects, performed a review and benchmark of operating costs and capital costs for transmission pipeline systems. Developed pipeline cost models and calculated natural gas transportation costs. Validated expansion plans by assessing pipeline capacity, compressor horsepower requirements, and planned capital expenditures.

3. **Offshore Gas Monetization:** On behalf of the producer consortium, led the economic analysis for development of offshore natural gas reserves. Responsibilities included the calculation of netback natural gas prices and developing transportation economics for pipelines and CNG. Sensitivity analysis was performed to assist the consortium in determining project viability and timing.

LNG Project Development

1. **Indonesia LNG Plant Expansion:** For the independent engineer's construction cost estimate of a liquefaction train addition, Mr. Chow was responsible for major equipment pricing, vendor quotations, bulk material takeoffs, cost estimating models, and development of Monte Carlo simulations to determine the project cost risk profile. This

investment assessment formed the basis for final negotiations with the LNG train construction contractors.

2. **U.S. Gulf Coast Regasification Terminal Due Diligence:** On behalf of an investor, evaluated the commercial contracts and the design and construction of a Gulf Coast regasification terminal. Responsibilities included the review of contractor scopes of work, construction progress reports, commissioning reports, and terminal use agreements.

3. **U.S. Gulf Coast Offshore LNG Plant Siting Assistance:** On behalf of a major oil and gas producer, assessed the pipeline take-away capacity for a potential floating LNG terminal in the Gulf of Mexico. Prospective sites were identified for the client based on a thorough study of offshore pipeline infrastructure, pipeline diameters, operating pressures, available capacity, and pipeline operators.

4. **Africa LNG Value Chain Analysis:** Worked as part of the team on behalf of a major international gas producer in the evaluation of development projects related to stranded gas activities in West Africa. Responsibilities included the calculation of LNG liquefaction, shipping, and regasification costs to determine cost of LNG supplies as they related to natural gas markets in the U.S. East and Gulf Coasts.

Acquisitions

1. **Petrochemical Asset Acquisition:** Participated on team tasked with due diligence review of European petrochemical assets for acquisition. Responsibilities included data room records management, plant yields benchmarking, and a review of operational performance, capital plans, and O&M costs.

2. **Crude Oil Pipeline Acquisition:** Performed technical due diligence of crude oil pipeline system for potential acquisition. Responsibilities included site visits and inspections, conducting interviews with company personnel, assessment of planned capital expenditures, and a review of asset utilization rates.

APPENDIX 3: DOCUMENTS CONSIDERED

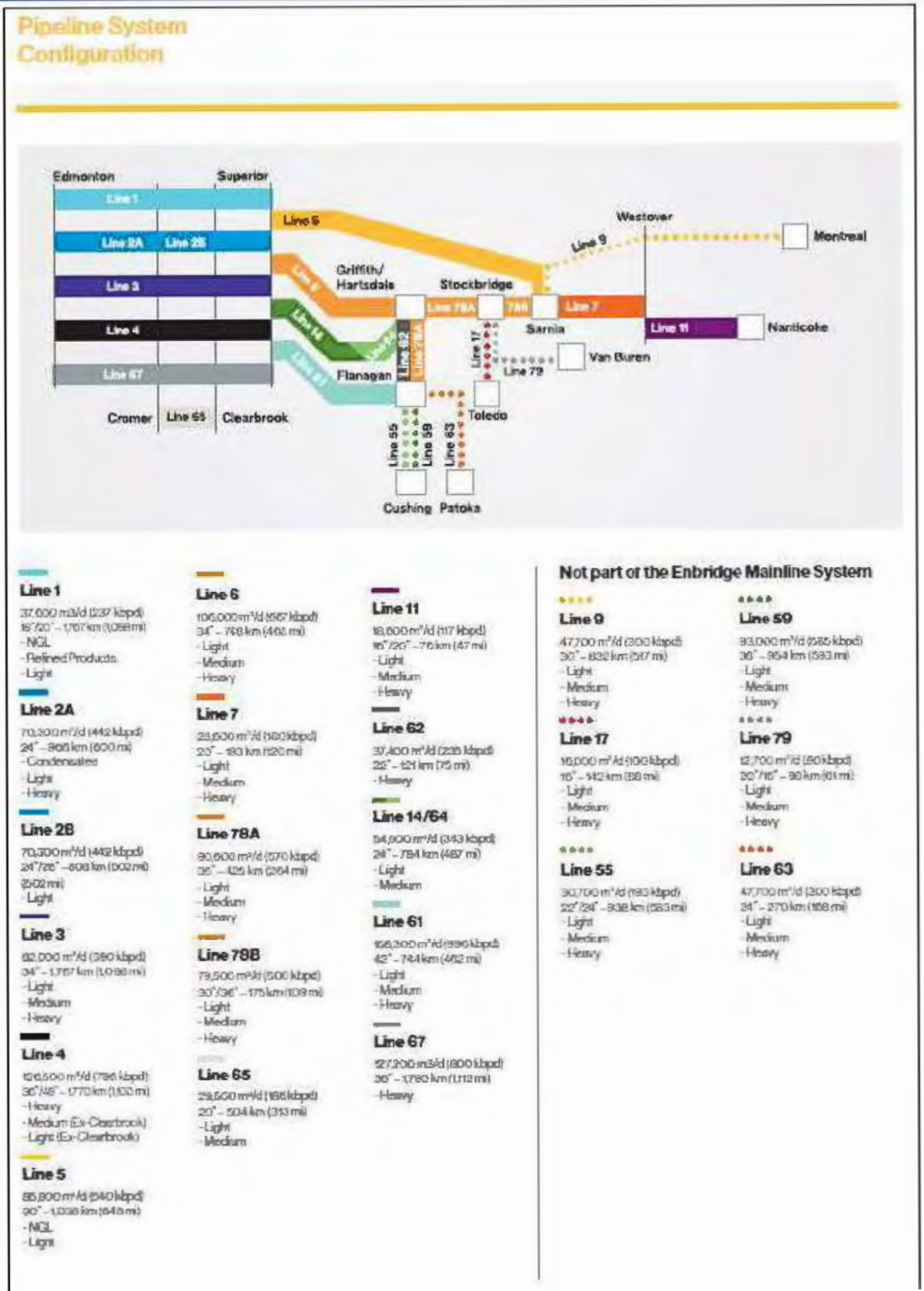
AER Figure S6.2 Alberta Propane Supply from Natural Gas and Demand.pdf
AER Figure S6.3 Alberta Butanes Supply from Natural Gas and Demand.pdf
Alliance Pipeline Project Overview -Capacity Expansion Project.pdf
Argus Media article -AltaGas could double Ridley volumes in 2020.pdf
ATRI An Analysis of the Operational Costs of Trucking: 2019 Update.pdf
Aux Sable Description from company website pdf.
Canada Energy Regulator Commodity Statistics propane exports by rail and marine.xls
CER Apportionment Dataset.xlsx
Cochin Pipeline profile, Pipeline System and Key Points, June 2020, from Canada Energy Regulator: https://www.cer-rec.gc.ca/en/data-analysis/facilities-we-regulate/pipeline-profiles/oil-and-liquids/pipeline-profiles-kinder-morgan-cochin.html#key-points
Crude-by-Rail Terminals Oil Sands Magazine May 2020 pdf
Dakota Access - FERC Financial Report Form No.6 Annual Report of Oil Pipeline Co 2019. pdf
Declaration of John R. Wagner State of Michigan Circuit Court pdf
EIA East Coast (PADD 1) Normal Butane Exports 2014 to 2019.pdf
EIA East Coast (PADD 1) Propane Exports. 2014 to 2019 pdf
EIA PADD 1 Natural Gas Plant Field Production.2014 to 2019 pdf
EIA PADD2 Oklahoma, Kansas, and Missouri Natural Gas Plant Field Production.xls
EIA Prime Supplier Sales of Propane (Consumer Grade).xls
EIA Wholesale Propane Weekly Heating Oil and Propane Prices (October to March).xls
ENB Mainline Pipeline System Configuration.pdf
Enbridge Destination Verification Procedure.pdf
Enbridge Energy - FERC Financial Report Form 6 Annual Report of Oil Pipeline Co 2019. pdf
Enbridge Flanagan South-FERC Financial Report Form 6 Annual Report of Oil Pipeline Co 2019.pdf
Enbridge Line 5 Data % Composition of NGL's on Line 5 by simple average for 2019-c2.docx
Enbridge Line 5 Data NGL Actual Injection and Delivery Data from 2010 to 2015.xlsx
Enbridge Line 5 Data NGL Injection Delivery Info - 2016 to 2020 Mar-c2.xlsx
Enbridge Toledo FERC Financial Report Form 6 Annual Report of Oil Pipeline Co 2019.pdf

Energy Transfer September 2019 Investor Presentation Highlighting Well Positioned Assets, Growth from Organic Investments, and Solid Financials.pdf

FERC Order to Enterprise TE Products Pipeline Extending Priority Treatment.pdf
Hardin Street Holdings-FERC Financial Report Form 6 Annual Report of Oil Pipeline Co 2019.pdf
Hardin Street Lima to Toledo Local Tariff.pdf
Hardin Street Local Tariff containing Rate, Rules & Regulations.pdf
Illinois Extension Pipeline FERC Financial SAE Form 6 Annual Report of Oil Pipeline CO 2019.pdf
Imperial Oil Limited Annual Report.pdf
Inter Pipeline NGL Processing- website description of PDH project.pdf
Line 9B Reversal and Line 9 Capacity Expansion Project. Pdf
Liquids Pipelines Customer Handbook 2020. pdf
Magnolia Pipeline.pdf
Marathon Petition for DC on Patoka to Lima.pdf
Marathon Pipeline Local Tariff - Martinsville to Lima Tariff.pdf
Marathon Pipeline Local Tariff - Patoka to LimaTariff.pdf
Michigan and Plains -Propane Overview Presentation -michigangov website.pdf
Mid Valley Pipeline Co - FERC Financial Report Form 6 Annual Report of Oil Pipeline Co2019.pdf
Mid Valley Pipeline Co - Pipeline Failure Investigation Report 2009-02-18 508.pdf
Mid-Valley Pipeline Local Tariff containing Rate, Rules & Regulations. FERC No 482.2 pdf
Mid-Valley Pipeline Local Tariff containing Rate, Rules & Regulations.pdf
MPLX Energy Logistics Investor Presentation Web Site August 2015.pdf
MPSC UP Propane System 05AUG2019.pdf
Mustang Pipeline - FERC Financial Report Form 6 Annual Report of Oil Pipeline Co 2019.pdf
Oil & Gas Journal Article - Cochin Pipeline Reversal -KMEP to reverse Cochin Pipeline.pdf
Patoka to Lima Expansion News Release.pdf
PBF Energy 2018 Annual Report.pdf
PBF Logistics Investor Presentation May 2019 .pdf
Pipeline Commodity Movement Map Quarter 1, 2019 .pdf
Port InfoExpress Publication - Large Aframax Tanker Calls Port of Montreal.pdf
Portland Pipeline - FERC Financial Report Form 6 Annual Report of Oil Pipeline Co 2017.pdf
Portland Pipeline - FERC Financial Report Form 6 Annual Report of Oil Pipeline Co 2018.pdf
Portland Pipeline - FERC Financial Report Form 6 Annual Report of Oil Pipeline Co 2019.pdf

Sarnia Refinery - Suncor Sarnia Refinery Communications.pdf
Spearhead CCPS - FERC Financial Report Form 6 Annual Report of Oil Pipeline Co 2019.pdf
Statistics Canada Table 25-10-0026-01 CANSIM -128-0012 Supply and demand of natural gas liquids, annual.pdf
Suncor Montreal Refinery Description.pdf
Sunoco Logistics Partners LP Form 10-K for FYE 2010-12-31.pdf
Sunoco Shuts Midwest Crude Pipeline After Spill - Reuters. Feb. 2019 pdf
Supplemental Submission of Interested Party Letters in Support of Defendants' Response to Plaintiff's Motion for Preliminary Injunction-c2-c2.pdf
The St. Lawrence Seaway 2019 Traffic Report 2019.pdf
US Federal Register Notice for Marathon Petroleum Company in Detroit, MI. pdf
Wisconsin Congressman Kind- Letter on behalf of constituents and farmers to Federal Energy Regulatory Comm. Regarding Propane Shortage in the Midwest. pdf
Wisconsin Governor Scott Walker Declares Energy Emergency as Precaution Measure for Propane Customers during Cold Weather-Press Release 2015-01-09.pdf
Wisconsin Governor Walker 2017 Executive Order 268. Relating to the Declaration of an Energy Emergency Due to Intermittent Propane Supplies.pdf
BP Products North America Inc. vs Sunoco Pipeline L.P., FERC Docket No. OR15-25, Prepared Direct Testimony of Steven H. Levine, January 26, 2016
Oil & Gas Journal Worldwide Refining Survey 2020

APPENDIX 4: ENBRIDGE PIPELINE SYSTEM CONFIGURATION



MUSE STANCIL

WORKPAPERS

WORKPAPER 1

COST INCREASE FOR PROPANE IN SUPERIOR

	Units	*Amount*
Driving Distance from Propane Rail Terminals to Superior, WI		
Proctor, MN	Miles	8
Tomahawk, WI	Miles	187
Owen, WI	Miles	187
Hixton, WI	Miles	188
Junction City, WI	Miles	249
Waupaca, WI	Miles	291
Average Driving Distance to Superior, WI	Miles	**185**
Average Round Trip Propane Trucking Cost to Superior, WI		
ATRI tanker truck marginal cost	$/mile	2.155
multiplied by Average Round Trip Distance	Miles	370
equals Average Truking Cost Per Round Trip	$	797.35
Propane Tanker Truck Capacity	Barrels	248
Propane Tanker Truck Capacity	Gallons	10,416
Propane Trucking Cost to Superior	$/gallon	**0.077**
Propane Cost Increase		
Superior propane production, 2019 daily average	b/d	[redacted]
Superior propane production, 2019 total	gallons	[redacted]
Total Annual Propane Cost Increase at Superior	$	**4,317,377**

WORKPAPER 2

COST INCREASE FOR PROPANE CONSUMERS IN UPPER PENINSULA

	Units	Amount
Propane Cost Increase By Sourcing from Marysville		
Average Round Trip Propane Trucking Cost to Rapid River		
Driving distance from Marysville to Rapid River	Miles	422
Round trip distance from Marysville to Rapid River	Miles	844
multiplied by ATRI tanker truck marginal cost	$/mile	2.155
equals Trucking cost per round trip	$	1818.82
Propane Tanker Truck Capacity	Barrels	248
Propane Tanker Truck Capacity	Gallons	10,416
Propane Trucking Cost	$/gallon	0.175
Rapid River propane production, 2019 daily average	b/d	2071
Rapid River propane production, 2019 total	gallons	31,748,430
Annual propane cost increase to truck from Marysville	**$**	**5,543,844**
Propane Price Increase to Reach Parity with Prices in Indiana and Ohio		
EIA Propane Wholesale Prices % Higher in Indiana	Percent	12.0
EIA Propane Wholesale Prices % Higher in Ohio	Percent	9.0
Average % Higher EIA Propane Wholesale Prices than Michigan	Percent	10.5
EIA Average Propane Wholesale Price in Michigan (2016-2019)	$/gallon	0.82
Propane price increase in Michigan to reach IN/OH parity	$/gallon	0.09
Annual propane cost increase for Indiana/Ohio price parity	**$**	**2,733,540**
Total annual propane cost increase by sourcing from Marysville	$	**8,277,384**

WORKPAPER 3

COST INCREASE FOR PROPANE IN LOWER PENINSULA

	Units	Amount
Propane Cost Increase By Switching Supply Source to Mont Belvieu		
Michigan propane demand, 2019 daily average	b/d	25,014
less Michigan Upper Peninsula propane demand	b/d	2,130
equals Michigan Lower Peninsula propane demand	b/d	22,884
Michigan Lower Peninsula annual propane demand	gallons	350,811,720
Transportation cost for propane by rail from Mont Belvieu to Marysville	$/gallon	0.26
less Transportation cost for propane on TEPPCO from Mont Belvieu to IN/OH	$/gallon	0.1324
equals Incremental transportation cost to change propane supply logistics	$/gallon	0.1276
Annual propane cost increase by changing Mont Belvieu supply logistics	**$**	**44,763,575**
Propane Price Increase to Reach Parity with Prices in Indiana and Ohio		
EIA Propane Wholesale Prices % Higher in Indiana	Percent	12.0
EIA Propane Wholesale Prices % Higher in Ohio	Percent	9.0
Average % Higher EIA Propane Wholesale Prices than Michigan	Percent	10.5
EIA Average Propane Wholesale Price in Michigan (2016-2019)	$/gallon	0.82
Propane price increase in Michigan to reach IN/OH parity	$/gallon	0.09
Annual propane cost increase for Indiana/Ohio price parity	**$**	**30,204,889**
Total annual propane cost increase for Lower Peninsula	$	**74,968,465**

WORKPAPER 4

COST INCREASE FOR PROPANE IN ONTARIO

	Units	Amounts
Propane Cost Increase By Switching Supply Source to Mont Belvieu		
Ontario propane demand, 2019 daily average	b/d	25,380
Ontario annual propane demand	gallons	389,075,400
Transportation cost for propane by rail from Mont Belvieu to Marysville	$/gallon	0.26
less Transportation cost for propane on TEPPCO from Mont Belvieu to IN/OH	$/gallon	0.1324
equals Incremental transportation cost to change propane supply logistics	$/gallon	0.1276
Annual propane cost increase by changing Mont Belvieu supply logistics	**$**	**49,646,021**
Propane Price Increase to Reach Parity with Prices in Michigan, Indiana, and Ohio		
EIA Propane Wholesale Prices % Higher in Indiana than Michigan	Percent	12
EIA Propane Wholesale Prices % Higher in Ohio than Michigan	Percent	9
Average % Higher Propane Wholesale Prices to reach regional price parity	Percent	10.5
EIA Average Propane Wholesale Price in Michigan (2016-2019)	$/gallon	0.82
Propane price increase in Ontario to reach MI/OH/IN price parity	$/gallon	0.09
Annual propane cost increase for regional price parity	**$**	**33,499,392**
Total annual propane cost increase for Lower Peninsula	$	**83,145,413**

WORKPAPER 5

COST INCREASE FOR BUTANE IN GREAT LAKES REGION AND EASTERN CANADA

	Units	*Amount*
Butane Cost Increase By Switching Supply Source to Mont Belvieu		
Sarnia butane production, 2019 daily average	b/d	[redacted]
Sarnia annual butane production	gallons	[redacted]
Transportation cost for butane by rail from Mont Belvieu to Marysville	$/gallon	0.26
less Transportation cost for propane on TEPPCO from Mont Belvieu to IL/IN	$/gallon	0.0972
equals Incremental transportation cost to switch butane supply source	$/gallon	0.1628
Annual butane cost increase by switching to Mont Belvieu supply source	**$**	**53,435,947**
Total annual butane cost increase	**$**	**53,435,947**

WORKPAPER 6

ANALYSIS OF MID VALLEY AND HARDIN STREET 2019 FORM 6

(Units as Noted)

	Units		*kb/d*
Texas			
Origination	Barrels	77,658,285	212.8
Louisiana/Arkansas			
Louisiana Deliveries	Barrels	8,801,045	24.1
Louisiana Receipts	Barrels	(149,914)	(0.4)
Net Louisiana Deliveries	Barrels	8,651,131	23.7
Arkansas Deliveries	Barrels	1,289,079	3.5
Longview, TX to Haynesville, LA	Miles	110	
To Louisiana	Barrel*Miles	1,093,423,100	
Delhi, LA to Haynesville, LA	Miles	44	
To Louisiana	Barrel*Miles	6,596,216	
Haynesville, LA to Magnolia, AK	Miles	20	
To Arkansas	Barrel*Miles	25,781,580	
Mississippi			
Deliveries	Barrels	1,670,093	4.6
Receipts	Barrels	(395,116)	(1.1)
Net Deliveries	Barrels	1,274,977	3.5
Longview, TX to Mayersville, MS	Miles	227	
To Mississippi	Barrel*Miles	289,419,779	
Kentucky			
Deliveries		9,541,260	26.1
Receipts		(259,896)	(0.7)
Net Deliveries		9,281,364	25.4
Longview, TX to Lebanon Junction, KY	Miles	691	
To Kentucky	Barrel*Miles	6,413,422,524	
Ohio			
Deliveries from Texas	Barrels	57,161,734	156.6
Longview, TX to Lima, OH	Miles	913	
To Ohio	Barrel*Miles	52,188,663,142	
Total Mid Valley	**Barrel*Miles**	**64,028,163,255**	
Net to Detroit/Toledo Deliveries	Barrel*Miles	4,010,856,914	
Lima, OH to Detroit/Toledo	Miles	95	
Deliveries to Detroit/Toledo	**Barrels**	**42,219,546**	**115.7**
Hardin Street Holdings			
Ohio Receipts	Barrels	16,082,987	44.1
Estimated Maumee Throughput	**Barrels**	**58,302,533**	**159.7**

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WORKPAPER 7

ANALYSIS OF ENBRIDGE 2019 FORM 6

(Units as Noted)

	Barrels	*kb/d*	*Comments*
International Border			
Origination	986,922,286	2,703.9	Includes NGLs
Deliveries	235,195,048	644.4	To Ontario/Quebec
Minnesota			
Deliveries	112,694,524	308.8	Minnesota refineries
Receipts	(40,577,575)	(111.2)	Net Line 81 receipts
Net Deliveries	72,116,949	197.6	
Wisconsin			
Deliveries	1,321,470	3.6	NGLs. Husky Superor was shutdown in 2019
Receipts	-	-	
Net Deliveries	1,321,470	3.6	
Illinois			
Deliveries	463,656,710	1,270.3	Chicago refineres plus outbound pipelines
Receipts	(1,792,051)	(4.9)	Chicap receipts
Net Deliveries	461,864,659	1,265.4	
Indiana			
Deliveries	109,215,270	299.2	
Receipts	-	-	
Net Deliveries	109,215,270	299.2	
Michigan			
Deliveries	87,592,274	240.0	Stockbridge and Marysville deliveries
Receipts	(3,461,156)	(9.5)	Lewiston receipts
Net Deliveries	84,131,118	230.5	
International Border			
Origination	-	-	
Deliveries	24,482,298	67.1	Pennsylvania deliveries
Flows Downstream of Superior	914,888,393	2,506.5	Lines 5, 6A, 14, 61
Line Capacities			
Line 5		540.0	
Line 6		667.0	
Line 14		343.0	
Line 61 (pre-expansion)		954.0	
Subtotal		**2,504.0**	
Excess Capacity with Line 5		**(2.5)**	
Excess Capacity without Line 5		(542.5)	
NGL Adjustment		80.0	
Adjusted Excess Capacity without Line 5		**(462.5)**	

WORKPAPER 8

ENBRIDGE SUPERIOR-TO-CHICAGO APPORTIONMENT ANALYSIS

(Thousands of Barrels per Day, Unless Noted)

	2019 Barrels	2019 Rate	Percent of 2019 Total	Apportionment Allocation	Initial Supply Shortfall	Line 78 Excess Re-allocation	Final Supply	Final Supply Shortfall	Comments
Line Capacities									
Line 5		-							
Line 6		667.0							
Line 14		343.0							
Line 61 (with expansion)		1,154.0							
Subtotal		**2,164.0**							
2019 Deliveries Downstream of Superior									
Illinois									
Deliveries	463,656,710	1,270.3							Chicago refineries plus outbound pipelines
Receipts	(1,792,051)	(4.9)							
Net Deliveries	461,864,659	1,265.4	52.1	1,127.6	(137.7)	161.5	1,289.2	23.8	
Indiana									
Deliveries	109,215,270	299.2							
Receipts	-	-							
Net Deliveries	109,215,270	299.2	12.3	266.6	(32.6)	38.2	304.8	5.6	
International Border									
Deliveries	235,195,048	644.4							To Ontario and Quebec
NGL Adjustment	(28,543,000)	(78.2)							
Net Deliveries	206,652,048	566.2	23.3	504.5	(61.6)	(130.9)	373.6	(192.5)	
Michigan									
Deliveries	87,592,274	240.0							Stockbridge and Marysville deliveries
Receipts	(3,461,156)	(9.5)							
Net Deliveries	84,131,118	230.5	9.5	205.4	(25.1)	(53.3)	152.1	(78.4)	
International Border									
Origination	-	-							
Deliveries	24,482,298	67.1	2.8	59.8	(7.3)	(15.5)	44.3	(22.8)	Pennsylvania deliveries
Total Net Deliveries	**886,345,393**	**2,428.3**	**100.0**	**2,164.0**	**(264.3)**	**-**	**2,164.0**	**(264.3)**	
Total Illinois/Indiana	571,079,929	1,564.6	64.4	1,394.3	(170.3)	199.7	1,594.0	29.4	
Line 5 Delivery Area		**863.7**	**35.6**	**769.7**	**(94.0)**	**(199.7)**	**570.0**	**(293.7)**	
Line 78 Capacity				570.0					
Line 78 Capacity Shortfall				**(199.7)**					
Surplus to SAE, Mustang								29.4	

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WORKPAPER 9

2019 LINE 5 DELIVERY AREA CRUDE OIL SUPPLY-DEMAND ANALYSIS

(Thousands of Barrels per Day, Unless Noted)

	Refinery Capacity Bbl/CD	Utilization	Refinery Throughput Total	Canadian Heavy	Canadian Light	U.S.	Enbridge Canadian Heavy	Enbridge Canadian Light	Enbridge U.S. Light	Enbridge Total	Maumee Canadian Heavy	Maumee U.S. Light	Maumee Total	Deliveries Rail	Enbridge Lewiston	Tanker	Truck	Total Deliveries	Refinery Comments	Delivery Comments
Detroit/Toledo Region	467.8	91.2	426.6	137.5	88.5	200.6	109.3	88.5	32.7	230.5	28.2	131.5	159.7	-	9.5	-	28.0	426.6	Utilization per EIA Refining Dataset Data	Canadian receipts per EIA, truck by difference
Pennsylvania	65.0	99.3	64.5	61.6	-	2.9	61.6	-	2.9	64.5				-		-	-	64.5	Utilization per EIA	Canadian receipts per EIA
Ontario	395.0	83.3	329.0							328.5				-	-	-	0.5	329.0	Per CER Ontario Total	Truck volume is Ontario production
Quebec	372.0	87.3	324.7							237.7				-		87.1	-	324.7		
Grand Total	**1,299.8**	**88.1**	**1,144.9**							**861.2**			**159.7**	**-**	**9.5**	**87.1**	**27.4**	**1,144.9**		
Alternative Transportation Capacity Estimates																				
Toledo Truck	22.5																	-		PBF Annual Report
Nanticoke Rail	20.0																	-		CAPP 2018 Report
Montréal Rail	30.0																	-		CAPP 2018 Report
Quebec Waterborne	235.0																	-		To balance
Portland Pipeline	Unknown																	-		
Subtotal																		-		
Pipeline Capacity																				
Enbridge Line 5										460.0										
Enbridge Line 78										570.0										
Maumee										159.7										
Subtotal										**1,189.7**										
Net Surplus (Deficient) Supply Capacity										**197.0**										

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WORKPAPER 10

ENBRIDGE APPORTIONMENT ESTIMATE USING ACTUAL 2019 CRUDE OIL DELIVERIES

(Thousands of Barrels per Day, Unless Noted)

	Refinery Capacity	*Effective Downstream Verification Capacity*	*Percent of Total DV Capacity*	*Enbridge Deliveries*	*Maumee Deliveries*	*Truck Deliveries*	*Rail Deliveries*	*Tanker Deliveries*	*Line 5 Lewiston Redirection*	*Total Deliveries*	*2019 Crude Runs*	*Supply Shortfall*	*Shortfall as Percent of 2019 Crude Runs*	*Refinery Comments*
Detroit/Toledo Region	495.0	372.0	*32.1*	183.1	159.7	26.9	-	-	-	369.7	426.6	(56.9)	*13.3*	Connecting pipelines limiting DSV capacity
Pennsylvania	70.0	70.0	*6.0*	34.5	-	-			-	34.5	64.5	(30.0)	*46.5*	
Ontario	415.8	415.8	*35.9*	204.7	-	0.5	18.0	-	9.5	232.7	329.0	(96.3)	*29.3*	Assumed usage of rail unloading facility
Quebec	391.6	300.0	*25.9*	147.7	-	-	45.3	131.7	-	324.7	324.7	-	-	Connecting pipelines limiting DSV capacity
Total	**1,372.4**	**1,157.8**	***100.0***	**570.0**	**159.7**	**27.4**	**63.3**	**131.7**	**9.5**	**961.7**	**1,144.9**	**(183.2)**	***16.0***	

NOTE: Total Reduction in Enbridge Deliveries **291.2**

WORKPAPER 11

ENBRIDGE APPORTIONMENT ESTIMATE USING ADJUSTED 2019 CRUDE OIL DELIVERIES

(Thousands of Barrels per Day, Unless Noted)

	Refinery Capacity	*Effective Downstream Verification Capacity*	*Percent of Total DV Capacity*	*Enbridge Deliveries*	*Maumee Deliveries*	*Truck Deliveries*	*Rail Deliveries*	*Tanker Deliveries*	*Line 5 Lewiston Redirection*	*Total Deliveries*	*Adjusted 2019 Crude Runs*	*Supply Shortfall*	*Shortfall as Percent of Crude Runs*	*Refinery Comments*
Detroit/Toledo Region	495.0	372.0	*32.1*	183.1	159.7	26.9	-	-	-	369.7	426.6	(56.9)	*13.3*	Connecting pipelines limiting DSV capacity
Pennsylvania	70.0	70.0	*6.0*	34.5	-	-	-	-	-	34.5	64.5	(30.0)	*46.5*	
Ontario	415.8	415.8	*35.9*	204.7	-	0.5	18.0	-	9.5	232.7	372.4	(139.7)	*37.5*	
Quebec	391.6	300.0	*25.9*	147.7	-	-	45.3	131.7	-	324.7	324.7	-	-	Connecting pipelines limiting DSV capacity
Total	**1,372.4**	**1,157.8**	***100.0***	**570.0**	**159.7**	**27.4**	**63.3**	**131.7**	**9.5**	**961.7**	**1,188.4**	**(226.7)**	***19.1***	
NOTE: Total Reduction in Enbridge Deliveries											**334.7**			

WORKPAPER 12

2019 Wisconsin Supply - Demand Balance

(Thousands of Barrels per Day)

			CBOB	RBOB	Jet	ULSD	Total
Supply							
Refinery Production			-	-	-	-	-
Inbound Pipeline	**Origin**	**Destination**					
Flint Hills	Minneapolis	Wisconsin	41.7	21.3	0.3	31.8	95.0
West Shore	Chicago	Milwaukee, Madison	83.2	29.0	14.4	42.0	168.6
Magellan	Minneapolis	Wasau, Superior	14.2	-	-	6.2	20.3
Subtotal Pipeline			**139.0**	**50.3**	**14.7**	**79.9**	**283.9**
Imports	Canada	Upper Wisconsin	-	-	-	-	-
Total Supply			**139.0**	**50.3**	**14.7**	**79.9**	**283.9**
Demand							
Wisconsin Demand			**120.2**	**50.3**	**14.5**	**73.0**	**258.1**
Outbound	**Origin**	**Destination**					
Magellan	Superior	Duluth, MN	9.7	-	-	4.0	13.6
Magellan	Superior	Minneapolis	-	-	-	0.0	0.0
Truck	Green Bay	Michigan Upp. Pen	9.1	-	0.1	3.0	12.2
Subtotal Outbound			**18.8**	**-**	**0.1**	**6.9**	**25.8**
Exports	Duluth	Canada	-	-	-	-	-
Total Demand			**139.0**	**50.3**	**14.7**	**79.9**	**283.9**

WORKPAPER 13

2019 Michigan Supply - Demand Balance

(Thousands of Barrels per Day)

			CBOB	RBOB	Jet	ULSD	Total
Supply							
Refinery Production			59.5	-	11.6	27.4	98.5
Inbound Pipeline	Origin	Destination					
BP	Whiting	Detroit	0.0	-	-	-	0.0
Buckeye	Toledo/Lima	Detroit	90.6	-	-	-	90.6
Buckeye	Chicago	Detroit	0.0	-	-	-	0.0
Marathon	Chicago	Muskegon	23.5	-	1.5	-	25.0
Sun	Toledo	Taylor (Detroit)	13.5	-	16.6	9.9	40.0
Wolverine	Chicago	Grand Rapids, Marshall, Jackson, Lansing, Bay City	125.8	-	0.9	44.0	170.8
Subtotal Pipeline			253.5	-	19.0	53.9	326.5
Truck	Green Bay	Michigan Upper Peninsula	9.1	-	0.1	3.0	12.2
Imports	Canada	Detroit	-	-	-	-	-
Total Supply			322.1	-	30.7	84.3	437.1
Demand							
Michigan Demand			294.4	-	19.4	84.3	398.1
Outbound	Origin	Destination					
Truck	Detroit	Windsor	9.9	-	1.1	-	11.0
Truck	Detroit	Sarnia	-	-	-	-	-
Barge	Detroit	Toronto	17.7	-	10.3	-	28.0
Barge	Detroit	Montreal	-	-	-	-	-
Subtotal Outbound			27.7	-	11.3	-	39.0
Total Demand			322.1	-	30.7	84.3	437.1
Balance Check			-	-	-	-	-

MUSE STANCIL

WORKPAPER 14

2019 Ontario Supply - Demand Balance

(Thousands of Barrels per Day)

			CBOB	RBOB	Jet	Diesel	Total
Supply							
Refinery Production			183.0	-	33.1	101.7	317.9
Inbound	**From**	**To**					
Trans-Northern	Montreal	Kingston	5.0	-	0.5	2.5	7.9
Trans-Northern	Montreal	Ottawa	29.7	-	8.2	12.7	50.5
Trans-Northern	Montreal	Belleville	3.7	-	-	1.8	5.6
Trans-Northern	Montreal	North Toronto	-	-	-	-	-
Subtotal Pipeline			38.3	-	8.7	17.0	64.0
Waterborne	Montreal	Toronto	-	-	-	-	-
Truck/Rail	Winnipeg	NW Ontario	6.1	-	0.3	8.6	15.0
Truck	Detroit	Windsor	9.9	-	1.1	-	11.0
Truck	Detroit	Sarnia	-	-	-	-	-
Barge	Detroit	Toronto	17.7	-	10.3	-	28.0
Barge	Toledo	Toronto	-	-	-	-	-
Subtotal Water/Truck			33.8	-	11.6	8.6	54.0
Total Supply			255.1	-	53.4	127.4	435.9
Demand							
Ontario Demand			255.1	-	53.4	127.4	435.9
Outbound Flow			-	-	-	-	-
Total Demand			255.1	-	53.4	127.4	435.9

WORKPAPER 15

Quebec Supply - Demand Balance

2019

(Thousands of Barrels per Day)

			CBOB	RBOB	Jet	ULSD	Total
Supply							
Refinery Production			133.1	-	7.7	157.6	298.4
Inbound	**From**	**To**					
Tanker	Atlantic Canada	Montreal	-	-	-	-	-
Tanker	Atlantic Canada	Quebec/St. Lawrence	12.3	-	16.0	-	28.3
Tanker	Imports	Montreal	32.7	-	24.4	-	57.1
Barge	Detroit	Montreal	-	-	-	-	-
Barge	Toledo	Montreal	-	-	-	-	-
Subtotal Water			45.0	-	40.4	-	85.4
Total Supply			178.1	-	48.1	157.6	383.8
Demand							
Quebec Demand			139.8	-	39.4	77.1	256.2
Outbound	**From**	**To**					
Trans-Northern	Montreal	Kingston	5.0	-	0.5	2.5	7.9
Trans-Northern	Montreal	Ottawa	29.7	-	8.2	12.7	50.5
Trans-Northern	Montreal	Belleville	3.7	-	-	1.8	5.6
Trans-Northern	Montreal	Toronto	-	-	-	-	-
Subtotal Pipeline			38.3	-	8.7	17.0	64.0
Barge	Montreal	Toronto	-	-	-	-	-
Truck	Quebec	Atlantic Canada	-	-	-	-	-
Truck	Montreal	Vermont	-	-	-	13.5	13.5
Tanker	Montreal	Export	-	-	-	-	-
Tanker	Quebec City	Export	-	-	-	-	-
Tanker/Barge	Quebec	Portland	-	-	-	-	-
Tanker/Barge	Quebec	Boston	-	-	-	50.0	50.0
Tanker/Barge	Quebec	Linden	-	-	-	-	-
Tanker/Barge	Quebec	Providence	-	-	-	-	-
Tanker/Barge	Quebec	New Haven	-	-	-	-	-
Tanker/Barge	Quebec	Philadelphia	-	-	-	-	-
Subtotal Water/Truck			-	-	-	63.5	63.5
Total Outbound			38.3	-	8.7	80.5	127.6
Total Demand			178.1	-	48.1	157.6	383.8

WORKPAPER 16

2019 PADD 2 TRANSPORTATION FUEL SUPPLY

(Thousands of Barrels per Day, Unless Noted)

	Gasoline	*Jet*	*Diesel*	*Total*
PADD 2 Product Supplied	2,666	306	1,265	4,237
Fuel Ethanol/Biodiesel	(249)	-	(16)	(265)
Imports	-	-	6	6
Exports	6	2	-	8
Net Receipts from other PADDs	(13)	(33)	(76)	(122)
Net Receipts of Motor Gasoline Blend Components	(288)	-	-	(288)
Adjustments	(60)	-	(36)	(96)
Stock Change	2	(2)	(7)	(7)
Supplied by PADD 2 Refiners	**2,064**	**273**	**1,136**	**3,473**
Portion Produced in PADD 2	85.4%	89.2%	91.0%	87.4%

SOURCE: EIA: https://www.eia.gov/dnav/pet/pet_sum_snd_d_r20_mbblpd_a_cur.htm

WORKPAPER 17

IMPACT OF LINE 5 SHUTDOWN ON ASPHALT SUPPLY

(Thousands of Barrels per Day, Unless Noted)

	Adjusted 2019 Crude Runs	*Final Supply Shortfall*	*Post-Line 5 Shutdown Crude Runs*	*Percent Crude Run Reduction*	*Nominal Asphalt Capacity*	*Post-Line 5 Shutdown Asphalt Capacity*	*Asphalt Yield Reduction*	*Percent Asphalt Yield Reduction*
Detroit/Toledo Region	426.6	(56.9)	369.7	*13.3*	41.0	35.5	5.5	*13.3*
Pennsylvania	64.5	(30.0)	34.5	*46.5*	22.0	11.8	10.2	*46.5*
Ontario	372.4	(139.7)	232.7	*37.5*	15.2	9.5	5.7	*37.5*
Quebec	324.7	-	324.7	-	30.0	30.0	-	-
Total/Average	**1,188.4**	**(226.7)**	**961.7**	***19.1***	**108.2**	**86.8**	**21.4**	***19.8***

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