Evaluation of Minnesota Draft Scoping Decision Document for Sandpiper Pipeline Project

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1. Introduction

The purpose of this report is to comment on the Draft Scoping Decision Document (DSDD) prepared by the Minnesota Department of Commerce (MDOC) for the Sandpiper Pipeline Project (the Project). We begin by providing an overview of the Project and a brief description of the proponent's justification and rationale for the Project. In our discussion of need for the Project, we assess whether the stated purpose of the Project of shipping oil to an endpoint in Superior, Wisconsin is appropriate and whether other transportation projects that ship Bakken oil to other locations should be considered as alternatives to the Project. The implications of major changes in oil markets since 2014 (principally the decline in the price of crude oil and the prospect of new pipelines coming online in the near future) are analyzed. Finally, additional social, economic, and environmental impacts that should be addressed in the Environmental Impact Statement (EIS) for the Project, but are not referenced in the DSDD, are identified.

2. Overview of Sandpiper Project

The Sandpiper Project is a proposed 616-mile oil pipeline to be constructed and operated by North Dakota Pipeline Company LLC (NDPC), a joint venture between Enbridge Energy Partners, L.P. and Williston Basin Pipe Line LLC, a subsidiary of Marathon Petroleum Corporation. The Project would transport 225 thousand barrels per day (kbpd) of crude oil from Beaver Lodge Station, south of Tioga, North Dakota, to a new terminal facility at Clearbrook, Minnesota via a 24-inch pipeline. From Clearbook, the pipeline would transport 375 kbpd of Bakken crude oil a distance of 229 miles and terminate at a terminal and tank farm in Superior, Wisconsin. The Bakken crude can then be carried via the Enbridge Mainline for delivery to refineries in the Midwest and Eastern Canada. If approved, the Project will also include construction of a new oil terminal with two 150,000-barrel tanks and pump station near the existing terminal and storage tanks in Clearbrook as well as pipeline inspection gauge launcher and receiver types and mainline valve facilities at Pine River, Minnesota.

In August 2015, the Minnesota Court of Appeals ruled that Sandpiper requires a full EIS before the state can grant a certificate of need. The state's Public Utilities Commission had authorized Sandpiper without an EIS. This has delayed the proposed start-up date of the Project to 2019.

3. Rationale for Sandpiper

The rationale for the Sandpiper Project provided in the application and testimony of Paul Eberth,[1] Michael Palmer,[2] and Neil Earnest[3] includes the following points:

- Sufficient market demand exists for the crude oil to be delivered by Sandpiper.
- Sandpiper will operate at, or close to, capacity throughout the forecast period (2016 to 2035).
- Shipper commitments for 155 kbpd of the capacity on Sandpiper indicate demand for the Project and supports commercial viability of the Project.
- Sandpiper's transport of crude oil to the Midwest and Eastern Canada markets will displace rail transportation, which is generally more costly and less efficient than pipeline transportation.
- Improved market access and lower transport costs provided by Sandpiper would provide Bakken producers with pre-tax economic benefit of approximately $5 billion over the forecast period.

4. Assessment of Need for Sandpiper

In this section, the rationale and need for the Project are assessed. This assessment shows that there are significant issues regarding the DSDD's treatment of the project's need and rationale.

4.1 Purpose of the Project

The foremost deficiency associated with the assessment of the need for Sandpiper is the unreasonably narrow stated purpose of the Project. The DSDD states, "[t]he alternative must meet the underlying purpose of the project."[4] The DSDD adopts the proponent's definition of the Project from a public notice issued in June 2013, which is "to transport growing crude oil production from the Bakken Formation in North Dakota to the Superior, Wisconsin, terminal and

[1] See Direct Testimony of Paul Eberth, on behalf North Dakota Pipeline Company LLC, MPUC Docket No. PL-6668/CN-13-473, August 8, 2014.
[2] See Direct Testimony of C. Michael Palmer, on behalf North Dakota Pipeline Company LLC, MPUC Docket No. PL-6668/CN-13-473, August 8, 2014.
[3] See Direct Testimony of Neil E. arnest on behalf North Dakota Pipeline Company LLC, MPUC Docket No. PL-6668/CN-13-473, August 8, 2014.
[4] MDOC 2016, p. 6.

then connect to various other pipelines expanding access to refinery markets in the US Midwest and beyond."[5]

This definition of the purpose of the Project does not capture the Project's broader reason for being proposed, which is to transport Bakken oil to viable market destinations. By using the narrow definition of specifying Superior as a destination for Bakken oil shipments as the Project's purpose, other viable transportation alternatives that meet Sandpiper's primary objective of transporting Bakken oil to markets may be omitted from consideration.

Currently, Bakken oil is also shipped south of the Williston Basin via pipelines and rail in addition to the North Dakota Pipeline System that carries crude east to Clearbrook and then to Superior, Wisconsin. For example, the Bridger, Butte, and Belle Fourche pipelines serve refineries in Cheyenne, Wyoming, and Denver, Colorado. Further, the Palermo Rail Terminal project, designed to have an initial capacity of 100 kbpd with the flexibility to be expanded to 200 kbpd, will have direct access to the Sacagawea Pipeline and facilitate access to the East and West Coast once construction is completed. There are alternative routing options available for transporting Bakken oil to markets that do not include Superior. Therefore, the DSDD should require that the assessment of the Project take into account all current, proposed, and planned Bakken oil transportation capacity capable of shipping Bakken oil to markets instead of relying on a narrow definition of market access that excludes viable options.

Second, existing and planned Bakken transportation capacity must be compared to forecasted Bakken oil shipments in the assessment of need and rationale for the Project. A comprehensive analysis of the supply and demand for Bakken oil transportation services is essential to assess the need for Sandpiper, the existence of reasonable and prudent alternatives to Sandpiper, and whether the consequences of approving Sandpiper are more favourable than not approving it. This analysis of supply and demand for Bakken oil transportation services should be included in the Special Studies referenced in the DSDD,[6] but most critically, the results of this analysis must inform the selection of alternatives analyzed in the EIS, including the No Action Alternative.

The data on Bakken supply and demand for transportation services show why a comprehensive supply and demand analysis of Bakken transportation capacity is important. Current transportation capacity in the Bakken region exceeds oil production, and this gap is

[5] MDOC 2016, p. 6.
[6] MDOC 2016, p. 30.

expected to grow (Table 1). Even if rail capacity is excluded, there is still expected to be surplus transportation capacity of between 516 and 866 kbpd in 2020. If rail is included, the surplus capacity could exceed 2,400 kbpd.

While some degree of surplus capacity is inevitable as new pipeline projects come into operation and is beneficial to provide some degree of flexibility in the oil transportation system, the forecast surplus capacity if all projects are built is excessive: it is equivalent to about ten Sandpiper projects of unused capacity. Surplus capacity, on Sandpiper or other pipelines serving the Bakken, could impose a significant cost on the oil sector and on economies of the states the pipeline traverses, like Minnesota. Clearly not all proposed projects are needed or prudent and an evaluation of all the alternatives is necessary to determine whether Sandpiper is needed and the negative consequences of approving Sandpiper in terms of contributing to surplus transportation capacity.[7]

Table 1. Oil Transportation Supply and Demand, Bakken Region

	2016 (kbpd)	**2020 (kbpd)**
Pipeline/Refinery Capacity	851	1,541
Sandpiper	0	225
Rail Capacity	1,590	1,590
All Transportation Total	2,441	3,356
Production (March 2016)	1,109	900 – 1,250
Surplus Transportation Capacity Without Rail	**-258**	**516 – 866**
All Surplus Transportation Capacity	**1,332**	**2,106 – 2,456**

Sources: North Dakota Pipeline Authority (NDPA) (2016a; 2016b); Kringstad (2016).

The evaluation of transportation alternatives to Sandpiper should be based on a comprehensive benefit cost analysis of each option that includes all economic, social and environmental costs. It is also important that the cost comparison of existing and proposed pipelines and rail capacity be based on the marginal cost of transporting Bakken oil. To do this, it is important to distinguish between variable cost and fixed cost. For existing projects, the

[7] The proponent states that they have shipper contracts for Sandpiper that will ensure Sandpiper capacity is used. The likelihood of fulfillment of these contractual obligations depends on the terms of the contracts, which should be assessed in the project review. However, even if the contracts ensure Sandpiper is used, the costs of surplus capacity created by Sandpiper will still exist and will be imposed on other shippers who will lose the shipments diverted to Sandpiper.

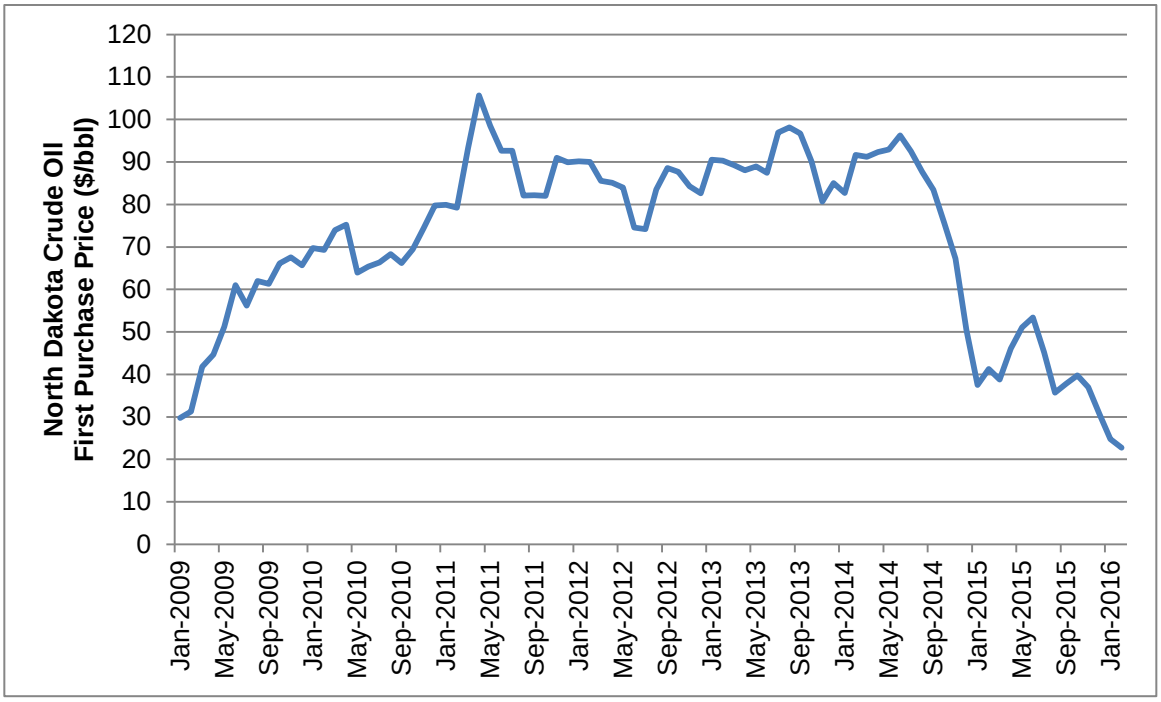
marginal cost of shipments is just the variable cost (capital has already been invested and the capital costs are sunk costs), while for a proposed project not yet constructed the marginal cost is variable cost plus the fixed costs required to provide a return to the new capital investment. The variable cost of operating pipelines is significantly less than the fixed cost so the marginal cost of shipments on an existing pipeline will be much lower than the marginal costs for a proposed pipeline like Sandpiper[8]. The cost comparisons of alternatives provided in the proponent's application prepared by Muse, Stancil & Co. ("Muse") do not make this distinction and therefore overstate the cost of existing transportation capacity relative to proposed new capacity, such as Sandpiper. The result is that the relative benefits of the Sandpiper Project are overstated. Furthermore, the analysis of the Project does not assess the costs of any surplus capacity that Sandpiper may create. The absence of an analysis of the costs of surplus capacity as a requirement by the DSDD is a deficiency that should be remedied. Estimates of surplus capacity costs should be included in the DSDD as part of the benefit cost analysis (BCA) for the Project.

4.2 Oil Market Changes

Since the Project application and the Muse benefits analysis were submitted in 2013-14, there have been important changes in the market that impact the economic prospects for Sandpiper. The steep decline in oil prices that started in summer 2014 has lead to an enduring low oil price scenario for Bakken crude. As shown in Figure 1, North Dakota oil prices have fallen from an average of $96 per barrel (bbl) in June 2014 to about $38/bbl in January 2015. There has not been any indication of a rebound either as prices averaged less than $23/bbl in February 2016. This has led oil analysts to lower their oil price forecasts, with some forecasting that oil will remain in the $50/bbl to $70/bbl range for the next several decades (Wolak 2015). The International Energy Agency (IEA) has also recently reduced their longer-term forecasts and included a long-term low price scenario (IEA 2015).

[8] For example, Enbridge mainline pipeline variable costs average about 23% of the total pipeline cost, while the remaining 76% is required to cover fixed costs (calculated from data in Enbridge 2014). This means that the marginal cost of shipments on an existing pipeline with a toll of $3.00 per barrel would be $.69 per barrel while the marginal cost of a proposed pipeline with a toll of $3.00 would be $.69 per barrel to cover variable cost plus $2.31 per barrel to cover fixed costs of the new capital investment. The ratio of variable to fixed costs will vary among pipelines and between pipelines and other modes of transportation such as rail. Variable costs for rail shipments, for example, will be a higher proportion of total costs than for pipelines. Therefore the marginal cost analysis will need to examine the specific costs of each transportation option.

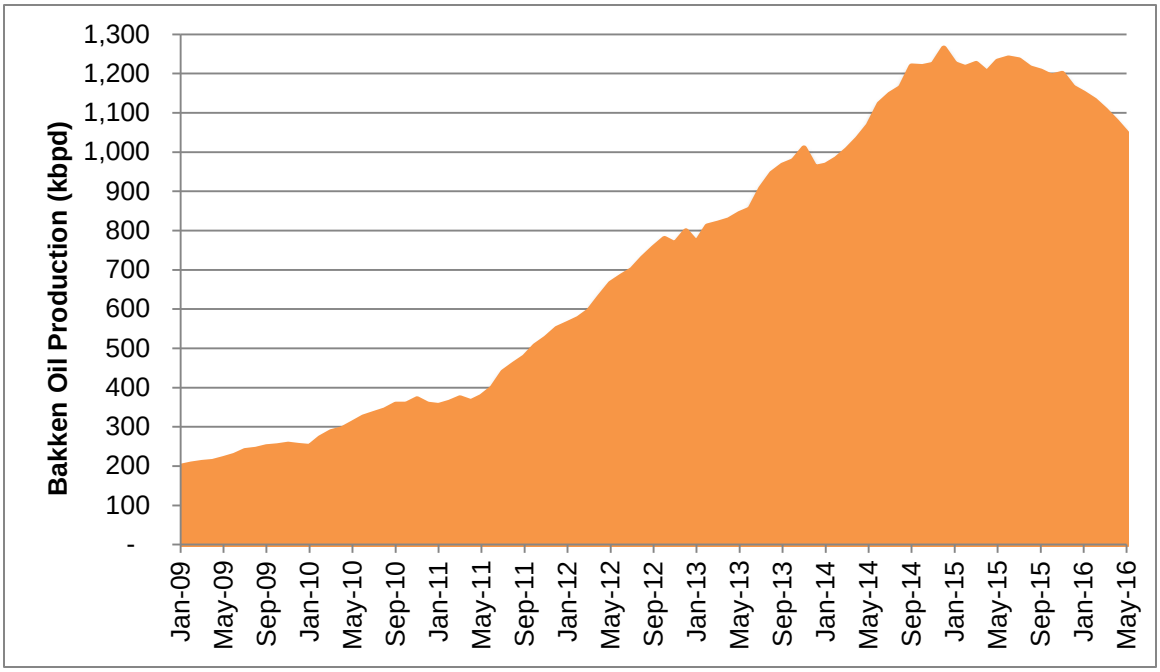
Figure 1 North Dakota Oil Price (Jan 2009 - Feb 2016)



Source: EIA (2016)

The decline in oil prices has fundamentally altered the economics of investment in oil development. The U.S. Energy Information Administration (EIA) forecasts total U.S. crude oil production to decline by 800 kbpd in 2016 and 600 kbpd in 2017 (EIA 2016). In the Bakken, drilling activity has slowed as a result of the price decline from a high of 194 rigs in September 2014 to only 32 active rigs in March 2016 (Kringstad 2016). The corresponding reduction in Bakken oil production is evident from Figure 2. The sharp decline in oil prices precedes the peak in Bakken oil production, and production has since declined by approximately 216 kbpd. This downward pressure on production reduces forecast shipments and further aggravates the potential for excess transportation capacity. These changes in oil markets show that the forecast used in the Muse market analysis for the Project, which is based on pre-2014 oil prices, is no longer valid.

Figure 2 - Bakken Region Oil Production



Source: EIA (2016)

The marginal cost of production relative to oil prices is an important consideration for forecasting future Bakken production levels, and therefore for evaluating transportation alternatives. It is also a critical factor in assessing the environmental and socioeconomic impacts of the No Action Alternative. If declining production levels reduce the need for transportation capacity, then the No Action Alternative addresses the same need as the proposed project: delivering appropriate volumes of Bakken crude to the refineries that demand it.

The Bakken oil formation is host to about 6,288 wells capable of producing a minimum of 400 bpd. The completed well costs of these wells are in the range of $6-8 million. However, according to Kringstad (2016), at a $35/bbl oil price and a 20% internal rate of return (after production taxes and royalties), none of the wells in the Bakken region would be economical at production levels below 600 bpd. In fact, when oil prices are $35/bbl, wells completed at a cost of $7 million must be capable of producing more than 1,000 bpd to earn greater than a 20% IRR. Only about 8% of the $6-8 million wells in the Bakken region can produce more than 1,000 bpd. In other words, the breakeven wellhead price for the majority of Bakken wells is much higher than $35/bbl (in the $45-75/bbl range). Since the North Dakota crude oil price is currently

below even the $35/bbl mark, a major rise in oil prices would be required for Bakken production to return and surpass mid-2014 levels as projected in the Muse analysis.

While our assessment points to lower Bakken production in the near term, Sandpiper could contribute to higher Bakken production volumes under certain conditions. If oil prices recover and/or producers are able to achieve deep cuts in their costs that make new investments in the Bakken region viable again, it is possible Sandpiper could result in incremental oil production by providing lower transportation costs.

4.3 New Projects Not Considered

Several of the major new projects included in the North Dakota Pipeline Authority transportation analysis summarized in Table 1 are not included in the Muse analysis submitted by the proponent in support of Sandpiper. The new projects, their expected in-service dates, and the changes in capacity omitted from the Muse analysis are shown in Table 2. All are scheduled to be in operation before Sandpiper, with the exception of the TransCanada Upland Pipeline. In total, the Muse analysis omits 608 kbpd of transportation capacity and regional refinery expansion. The largest change is due to the 450 kbpd of capacity expected to be available through the Energy Transfer Partners Bakken Pipeline in 2017. These new projects that have been proposed since the Muse analysis was completed are additional alternatives to Sandpiper that need to be assessed.

Table 2. Williston Basin Crude Oil Export Capacity Not Included in Muse Analysis

Project	In-service date	Change in Capacity from Muse (kbpd)
Butte Expansion	Q3 2014	-10*
Keystone XL Pipeline	Permit denied	-100*
Kinder Morgan Double H Pipeline	Q1 2015	+8*
Energy Transfer Partners Bakken Pipeline	Late 2016	+450
TransCanada Upland Pipeline	2020	+220
Dakota Prairie Refinery	Q2 2015	+20
Thunder Butte Refinery	2018	+20
Pipeline/Refining Total		**+608**

Source: NDPA (2016a)

*Included in Muse analysis, but capacity has changed. Difference in capacity shown.

4.4 Summary

In summary, changes in oil markets, Bakken production, and the forecast potential transportation capacity since the Muse analysis was conducted impact the rationale for Sandpiper. As discussed, the price of oil has not recovered since its collapse in 2014. A lower oil price has lead to a downturn in Bakken oil production, and as a result, the production forecast used in the Muse analysis is now too high. In addition, new proposed transportation and refinery projects could mean that, if approved, the capacity provided by Sandpiper in 2019 will contribute to costly surplus capacity. At the scoping stage, this implies that the current transportation needs for Bakken crude may be met by either No Action at all, or by alternative projects that are expected to be in operations before Sandpiper. Constructing unneeded pipeline infrastructure would impose long-term costs on the oil and gas sector, as well as costs to government in the form of lower tax revenue. For these reasons, it is essential that the DSDD include a re-evaluation of the need for the Project, a comprehensive assessment of alternatives, and an estimate of the costs of any surplus capacity created by the Project.

5. Other Issues in Scoping

We identify the following three additional omissions in the DSDD that should be required as part of the EIS for the Sandpiper Project[9]:

1. The DSDD needs to include an assessment of damage costs for a worst-case scenario oil spill. The Enbridge Kalamazoo River spill, which is estimated to have cost $1.21 billion (Enbridge 2014), shows that the magnitude of spill damages can be substantial and consequently it is important to assess the financial capacity of NDPC (insurance and assets) to cover the costs associated with a worst-case spill and its legal obligation to pay damage costs and compensate third parties.

2. The DSDD needs to include a review of the spill response capacity of NDPC. The importance of assessing spill response is again illustrated by the Kalamazoo River spill near Marshall, Michigan in July 2010. Enbridge's emergency response was characterized by the National Transportation Safety Board (NTSB) as being

[9] It is important to note that the DSDD stipulates that the EIS will also analyze the potential impacts of the Line 3 Replacement (L3R) Project as part of the EIS's cumulative impacts discussion given the L3R route parallels the Sandpiper route between Clearbrook, Minnesota, and Superior, Wisconsin. Although our assessment of need focuses on Sandpiper, the omissions in scoping we have identified also apply to the environmental assessment for the L3R Project.

"not sufficiently focused on source control and demonstrated a lack of awareness and training in the use of effective containment methods" (2012, p. 119). The pipeline ruptured for over 17 hours despite monitoring systems and after the spill was detected, Enbridge experienced considerable difficulties locating contractors and other necessary resources to contain the spill (NTSB 2012).

3. The DSDD needs to include an assessment of upstream impacts of the Project. If, as Muse concludes, Sandpiper will provide Bakken producers with pre-tax economic benefits through higher netback prices for their product, the impacts of any incremental production need to be included in the EIS. The Canadian Government has developed a methodology to assess the upstream greenhouse gas (GHG) emissions from projects under review (Department of Environment and Climate Change 2016). In their definition, the upstream includes all industrial activities from the point of resource extraction, which are generally the extraction, processing, handling and transportation of the product. The assessment of upstream GHGs should consist of both a quantitative estimation of the GHG emissions released as a result of upstream production associated with Sandpiper, and a discussion of the projects' potential impact on national and global GHG emissions.

6. Benefit Cost Evaluation

The best method to assess the costs and benefits of the Project and whether the consequences of approving Sandpiper are more favourable than the consequences of not approving it is benefit cost analysis (BCA). BCA is a standard requirement for approval of many major projects in the United States and should be used to assess projects such as Sandpiper. The objective of BCA is to identify all the positive and negative consequences of a project and to assess the relative significance of these consequences to determine whether a project generates a net gain or net loss to society. BCA is based on a well-developed theoretical foundation, its methodology and application is outlined in numerous publications, and it is required for various types of approvals in many jurisdictions. Since potential environmental effects associated with the Line 3 Replacement (L3R) Project must be incorporated in the cumulative impacts analysis of the EIS for Sandpiper, costs and benefits associated with L3R should factor into a BCA for Sandpiper too. Therefore, the Final Scoping Decision Document

should require a BCA of Sandpiper, the L3R Project, and alternatives as part of its "Special Studies or Research" identified in part 5 of the DSDD.

7. Conclusion

In this report, we have examined the purpose of the Sandpiper Pipeline Project and the proposed scope of the DSDD. Subsequent to the submission and review of the application for Sandpiper there have been major changes in oil markets that impact the need for and potential costs and benefits of Sandpiper. The dramatic decline in oil prices has reduced current and forecast Bakken oil production. At the same time, there are more new oil transportation projects proposed for the Bakken region, which increase the number of alternatives to Sandpiper and the likelihood of building costly excess transportation capacity that could exceed over 2 million bpd by 2020. These developments require a comprehensive reassessment of the need for and costs and benefits of approving Sandpiper. To ensure the Project is needed and in the public interest, the final scoping decision document needs to:

- Expand the objective of Sandpiper from the narrow definition of shipping oil to Superior, Wisconsin to the primary objective of shipping Bakken oil to market and consider all other viable options that meet this primary objective.
- Require a comprehensive oil transportation supply and demand analysis for the Bakken region that incorporates major changes that have occurred since the original application (additional projects, lower production forecasts).
- Evaluate all the alternative projects for transporting Bakken oil to market by conducting a benefit cost analysis.
- Estimate the costs of any surplus capacity created by building Sandpiper.
- Assess the terms of shipper service transportation agreements for Sandpiper to identify provisions or factors that allow shippers to abrogate terms of the contract.
- Assess other potential impacts of the Project, specifically:
    - Damage costs for worst-case oil spills.
    - The financial capacity of the proponent (insurance and assets) to cover the costs associated with a worst-case spill and its legal obligation to pay damage costs and compensate third parties.
    - Estimate of upstream emissions and environmental impacts.

Again we emphasize the importance of undertaking a comprehensive BCA as part of the EIS to quantitatively estimate the costs and benefits of the Project with potential L3R impacts incorporated. This approach would allow for a comparison of all viable transportation options and help identify the option or mix of options that meets the transportation needs of the Bakken oil sector in the most cost-effective social, environmental, and economic manner.

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Resume

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Summary

Dr. Gunton is currently Professor and Director of the Resource and Environmental Planning Program at Simon Fraser University, which is recognized as one of the leading international schools providing advanced interdisciplinary training for resource professionals. Dr. Gunton has had extensive professional experience including holding the positions of Deputy Minister of Environment, Lands and Parks, Deputy Minister of Cabinet Policy Secretariat and Deputy Minister of Finance (Treasury Board) for the Government of British Columbia. He has also held senior positions with the Government of Manitoba, including Assistant Deputy Minister of Energy and Mines where he was in charge of major natural resource project development and evaluation, Senior Economic Analyst in the Ministry of Economic Development and was visiting professor in resource and environmental economics at the University of Manitoba.

Dr. Gunton regularly provides advice to private sector and public sector clients. His work includes evaluation of resource development projects, regional development strategies and negotiation and collaborative models for resolving resource and environmental conflicts. While working for the BC government he managed a number of major initiatives including: a new Environmental Assessment Act, a new Forest Practices Code, a forest sector strategy, a new regional land use planning process, a major expansion of the provincial parks system, a redesign of the regulatory and royalty system for oil and gas development and new air pollution regulations. He was also the chief negotiator for the province on a number of major resource development projects including Kemano completion and oil and gas royalties. Dr. Gunton has been an expert witness for various regulatory agencies including the National Energy Board, the Ontario Energy Board, and the Manitoba Public Utilities Commission. He has also been an expert witness before the BC Arbitration Panel providing evidence on natural resource markets and pricing.

Dr. Gunton's works on management issues in a number of resource sectors including forestry, land use, energy, mining and fisheries. He is Chair of the Sustainable Planning Research Group and heads a research team providing advice to First Nations on impacts and risk assessment of oil and gas development and pipeline proposals including the Enbridge Northern Gateway project (NGP). He was senior supervisor of recently completed (2014) PhD research evaluating risk assessment and benefit-costs for the Enbridge Northern Gateway Pipeline. Dr. Gunton also recently prepared a draft of the Federal Sustainable Development Act for the Suzuki Foundation that was passed unanimously by the Parliament of Canada in 2008. Dr, Gunton has published over 80 refereed articles in scientific journals and over 100 technical reports for private and public sector clients on resource and environmental issues and project development. He was

recently awarded (2014) a large four year Mitacs research grant ($400,000) to assess social, environmental and economic impacts of natural resource development on First Nations in BC. Dr. Gunton has been working with First Nations for over 15 years to assess the impact of major projects on First Nations interests and to help negotiate impact benefit agreements between project developers and First Nations. He is currently assessing the impacts of the Kinder Morgan Pipeline for First Nations and is acting as an expert witness for First Nations in the NEB hearings on the Kinder Morgan Pipeline.

Current Employment

Professor and Director of the Resource and Environmental Planning Program, School of Resource and Environmental Management, Simon Fraser University. (1980-present).

Responsibilities

Teaching graduate courses in public policy analysis, regional resource development, dispute resolution. (courses include: environmental impact assessment, cost-benefit analysis, economic impact assessment, multiple accounts evaluation (social, environmental, fiscal, economic assessment techniques), conflict resolution techniques, regional development.) Senior Superviser of over 40 graduate theses on resource and environmental management

Previous Employment

1. Deputy Minister, Cabinet Policy Secretariat, Government of British Columbia, 8/96 to 8/00.

2. Deputy Minister, Ministry of Environment, Lands and Parks, Government of British Columbia, 10/93 to 7/96.

3. Deputy Minister, Treasury Board Secretariat, Ministry of Finance and Corporate Relations, and Secretary to Treasury Board. 08/92 to 10/93.

4. Director, School of Resource and Environmental Management, Simon Fraser University, 08/88 to 12/91.

5. Assistant Deputy Minister, Department of Energy and Mines, Province of Manitoba, Policy Planning and Project Development Division, 8/86 to 8/88

6. Senior Economic Analyst. Department of Energy and Mines, Province of Manitoba, Policy Planning and Project Development, 1984. (project and policy evaluation)

7. Visiting Professor, Department of Economics 1983, University of Manitoba, (teaching senior course in resource and environmental economics).

8. Senior Economic Analyst, Department of Economic Development, Province of Manitoba, 1983

9. Consultant to private and public sector clients 1980-present including. Major activities include: economic and environmental evaluation of major resource and energy projects and markets, participation as expert witness before agencies including NEB, OEB, MPUC, BC Arbitration Panel (on resource pricing and energy markets).

Refereed Publications over 80
Professional Reports Prepared over 100
Research Funding $1,668,000

Education

University of Waterloo BA, MA (Planning). (Field: regional planning and natural resource analysis and policy including law, ecology, economics and public policy)

University of British Columbia, Ph.D., Planning (Field: Natural resource policy, regional development planning, planning theory and public policy).