

Alberta to Alaska Railway Pre-Feasibility Study



THE VAN HORNE INSTITUTE

2015

Table of Content

Executive Summary	i
Infrastructure and Operating Requirements.....	ii
Environmental Considerations and Permitting Requirements	ii
Capital and Operating Cost Estimates.....	iii
Business Case	iii
Mineral Transportation Potential.....	iii
First Nations/Tribes and Other Contacts.....	iv
Conclusions.....	iv
1 Introduction.....	1
This Assignment.....	1
This Report	2
2 Infrastructure and Operating Requirements.....	3
Route Alignment.....	3
Fort McMurray to Delta Junction.....	4
Tidewater Access Options	4
Environmental Considerations.....	7
Infrastructure and Operations	9
Infrastructure and Facility Requirements	10
Capital and Operating Cost Estimates.....	12
Conclusions.....	15
3 Business Case.....	16
Discounted Cash Flow	16
Sensitivity Analysis	17
Estimate Cost per Barrel Required	18
4 Mineral Transportation	20
Mineral Potential.....	20
Freight Revenue and Cash Flow Potential.....	21
Conclusions.....	22
5 First Nations Engagement	23
First Nations/Tribes and Other Contacts.....	23
Information Sharing Program.....	23
Conclusions.....	23
6 Conclusions.....	24

EXECUTIVE SUMMARY

Resource development has been key to Canada's economic growth and prosperity. In recent years, oil and gas, especially in Alberta, have been primary drivers of the nation's economy. Historically, expansion of pipeline capacity kept pace with resource development but increasingly this is no longer the case. Capacity of existing pipelines serving Alberta is constrained and proposed new pipelines face long delays due to significant opposition that has impacted their regulatory approval and implementation. The lack of transportation capacity and limited access to coastal refineries and overseas markets also results in a considerable price discount on Western Canada crude oil relative to world oil prices.

In March 2013, G7G and AECOM approached Alberta Energy with a funding request to investigate the feasibility of building a railway capable of carrying bitumen and petroleum products between northern Alberta (Fort McMurray) and tidewater at the Port of Valdez, Alaska. This project was inspired by and built on a 2006 study by the State of Alaska and Yukon Government to connect the Alaska Railroad from its eastern terminus at Delta Junction to the North American rail network at Fort Nelson, BC. The Port of Valdez was selected as the endpoint for oil export as it has been in operation for almost 40 years. A further objective of the G7G/AECOM proposal was that First Nations be engaged throughout the planning and design process and acquire 50% profit share/equity ownership as well as employment opportunities in building and operating the new railway and oil shipment facilities.

In considering this request, Alberta Energy conferred with the Van Horne Institute (VHI) of Calgary, which had participated in the 2006 study, and asked that the VHI structure and manage the proposed study. VHI recommended the inclusion of mineral freight potential as this was a major underpinning of the 2006 study and of economic development interest to both the Yukon and Alaska. The resulting study examines at a high level the feasibility of building a railway capable of carrying bitumen, petroleum and other products between northern Alberta (Fort McMurray) and the terminus of the Alaska Railroad at Delta Junction, with bitumen/petroleum transferred to tidewater at the Port of Valdez, Alaska. Minerals and other freight traffic are assumed to continue via the Alaska Railroad to reach Anchorage or Port MacKenzie or CN Rail at Fort Nelson to reach other Canadian or US destinations.

This study includes:

- A conceptual engineering and business case assessment of the railway and oil transport requirements by AECOM;
- Information sharing and solicitation of support from First Nations by G7G; and,
- An assessment of mineral volumes and transport revenue potential by the University of Alaska and Michigan Tech.

Infrastructure and Operating Requirements

The proposed railway between Fort McMurray and Delta Junction, Alaska comprises 2,440 kilometres of single, standard gauge, bi-directional heavy haul track. The track is upgradable to a double track configuration that would add substantial capacity. Included are a railway operations centre; loading/unloading, maintenance and refueling facilities at the Fort McMurray and the western terminus located at either Delta Junction or Glennallen, Alaska; and, intermediate support facilities for track and signal maintenance and train crew changes. The study also identified rolling stock, equipment and manpower requirements for both a 1.0 million barrel per day (mbpd) and 1.5 mbpd petroleum volume.

As extending the railway to the Port of Valdez was concluded to be economically infeasible, three tidewater options were identified:

- negotiating the transfer of bitumen/petroleum products to the Trans Alaska Pipeline System (TAPS), if this is agreeable to its owners, and undertaking or reimbursing the cost of any necessary upgrades to the pipeline and/or marine terminal either through a lump sum capital cost payment or the oil transmission toll rate;
- building a new 430 km pipeline parallel to TAPS from Delta Junction to Valdez along with a new marine terminal; or
- building an additional 50 km of rail spur from Tok to Glennallen to move the rail terminal closer to tidewater, a shorter new 185 km pipeline from Glennallen and a new marine terminal at Valdez.

Environmental Considerations and Permitting Requirements

The study indicated that the proposed railway passes through, or comes in close proximity to, a number of areas that are environmentally protected, support migratory and/or sensitive or endangered species, or are important for wildlife and biodiversity, especially along major river valleys which have fishery values. Extensive studies and data collection are required to better identify these environmental issues and risks to enable route refinements as well as mitigation measures, seasonal limitations for construction and other intrusive or disruptive activities, as well as other considerations.

The Environmental Approval and Permitting process will be extensive and complex. It includes the need for multi-jurisdictional environmental assessments and specific agency permits at the federal, provincial, territorial and state levels in Canada and the US, including a Presidential Permit prior to commencement of any construction. It will also need to meet all requirements for consultation and respect First Nations and US Tribal legislative and constitutional rights.

Capital and Operating Cost Estimates

The pre-feasibility study estimated the project's capital cost for the new railway as well as tidewater access and oil handling facilities¹ to be between \$28 and \$32 billion for 1.0 mbpd and \$30 to \$34 billion for 1.5 mbpd (\$2013 CAD).² Annual operating costs are estimated to be \$1.9 to \$2.3 billion per year for 1.0 mbpd and \$2.7 to \$3.5 billion for 1.5 mbpd. However, this does not include the cost of necessary prior studies and design, including a full feasibility study, preliminary and potentially detailed engineering, financial studies and funding submissions, environmental studies and preparation of formal Canadian EA and US EIS submissions, surveys, mapping and other preparatory activities.

Business Case

The business case used a Discounted Cash Flow (DCF) analysis to determine the cost per barrel to fully repay all capital and operating costs and provide reasonable rate of return for both debt and equity investors over 25 years, assuming an accelerated and aggressive implementation schedule (2 years for environmental approval and 3 years of construction), or 29 years, based on recent precedent (5 years for environmental approval and 4 years of construction). The DCF indicated that between \$15.44 and \$21.41 per barrel for 1.0 mbpd would have to be charged to fully recover the project and operating costs. For 1.5 mbpd, \$12.46 to \$18.01 per barrel would be required. These figures are consistent with published Canadian Association of Petroleum Producers' (CAPP) estimates for railway transport of bitumen and oil products to the West Coast.

Mineral Transportation Potential

Metallic mineral potential within the project corridor is known to be high, and has a 90% certainty of generating expected in-place gross metal values between \$333 and \$659 billion over 30-years of operation. Based on known mineral occurrences, high potential for non-metallic minerals and coal can be inferred. The analysis has generated estimates of the mineral and coal tonnage that are likely to result over 30 years. While the timing and distribution of these revenues over 30 years are unknown, the anticipated mineral freight is expected to generate a pre-tax net present value cash flow of approximately \$10 to \$11 billion. This revenue could either substitute for bitumen tonnage should there be a reduction in this volume and thereby reduce the railway's financial risk, or offset at least part of capital repayment required from bitumen shippers.

¹ This includes the railway from Fort McMurray to Delta Junction, Alaska and all associated oil handling and rail operation and maintenance facilities and equipment as well as either the rail spur to Glennallen, pipeline and marine terminal or the pipeline from Delta Junction and marine terminal facilities.

² Estimated land costs are discounted by \$0.5 billion to reflect expected equity participation.

First Nations/Tribes and Other Contacts

Consultation and meaningful involvement and participation of First Nations are essential to the success of this project. There are twenty-five directly affected First Nations communities and eleven Native Corporations and Traditional Councils with interest in the corridor. G7G made contact with all First Nations leadership and tribes directly affected by the project. They held 59 information sharing and project presentation meetings with First Nations' leaders or groups as well as Alaska Legislature representatives, the Mayor of Valdez and Chairman of the Port of Valdez, Alaska; Mayor and Chamber of Commerce of Fairbanks, Alaska; Yukon Economic Development officials; and, Mayor and Council of Watson Lake, BC.

G7G requested both feedback and, if possible, indications of support that resulted in a number of letters of support in principle for the pre-feasibility study. G7G have cautioned that, while the information sharing process has, for the most part, been positively received, it does not constitute "consultation" as legally required nor First Nations support for the project.

Conclusions

The Alberta to Alaska Railway and tidewater access project will clearly be challenging to build. However, projects similar to this, although not exactly the same in magnitude and scope, have been completed in other areas. The project's estimated capital cost, which ranges from \$28 billion to \$34 billion depending on the volume of petroleum product shipped, tidewater access option selected and final cost and schedule, would be one of the largest infrastructure projects ever in Canadian history and involves substantial risk. Further study is required to better delineate these challenges and seek ways to reduce and either defray or diversify project cost and risk.

Furthermore, while the estimated cost per barrel of bitumen/petroleum products required to recoup total capital and operating costs over the project life is somewhat higher than potential or equivalent pipeline tolls to reach West Coast tidewater, the project has the advantage of:

- being able to carry other commodities, such as minerals, construction supplies and other materials, and generating revenues that both defray financial risk to the railway and partly offset its capital cost;
- potentially offering more economic development opportunities; and,
- being an additional option to the current West Coast pipeline proposals.

1 | INTRODUCTION

Resource development has been key to Canada's economic growth and prosperity. In recent years, oil and gas, especially in Alberta, have been primary drivers of the nation's economy. Spurred by high prices and growing global demand, investment and output has increased rapidly, with Alberta's crude oil production up nearly 10% over the last year alone. In June 2014, the *Canadian Association of Petroleum Producers* (CAPP) projected that oil production would increase from 3.2 million barrels per day (mbpd) to 6.4 mbpd by 2030, with over 90% of this growth attributed to increased oil sands production.³ While the recent drop in oil prices due to oversupply and slowed economic growth may lower or delay these expectations, most analysts agree that this does not alter the long term increased demand and production outlook.

Historically, expansion of pipeline capacity kept pace with resource development but increasingly this is no longer the case. Capacity of existing pipelines serving Alberta is constrained and proposed new pipelines, notably Northern Gateway and Kinder Morgan, face long delays due to significant opposition that has impacted their regulatory approval and implementation. Both the lack of transportation capacity and limited access to coastal refineries and overseas markets has also resulted in a considerable price discount on Western Canada crude oil relative to world oil prices that affects the viability of production expansion as well as Alberta and Canada's economies as a whole.

Existing pipelines serving Alberta have a total capacity of 3.7 mbpd.⁴ Proposed expansions would add another 3.4 mbpd⁵, bringing total export capacity to 7.1 mbpd, which is in line with current oil production projections but requires virtually all proposed pipelines to be implemented. However, the timing and certainty of these projects may not be aligned with oil production and financial return requirements. These questions give rise and support to the development of alternative transportation solutions whether in the interim or long term.

This Assignment

In March 2013, G7G and AECOM approached Alberta Energy with a funding request to investigate the feasibility of building a railway capable of carrying bitumen and petroleum products between northern Alberta (Fort McMurray) and tidewater at the Port of Valdez, Alaska. This project was inspired by and built on a 2006 study by the State of Alaska and Yukon Government to connect the Alaska Railroad from its eastern approved terminus at Delta Junction to the North American rail network at Fort Nelson, BC. The Port of Valdez was selected as the endpoint for oil export as it has been in operation for more

³ Canadian Association of Oil Producers, *2014 Crude Oil: Forecasts, Markets and Transportation*, June 2014.

⁴ Ibid.

⁵ Ibid.

almost 40 years and has extensive infrastructure, fully trained personnel and experience in intermodal oil transportation and safety. A further objective of the G7G/AECOM proposal was that First Nations be engaged throughout the planning and design process and acquire 50% profit share/equity ownership as well as employment opportunities in building and operating the new railway and oil shipment facilities.

In considering this request, Alberta Energy conferred with the Van Horne Institute (VHI) of Calgary, which had participated in the 2006 study, and asked that the VHI structure and manage the proposed study. VHI recommended the inclusion of mineral freight potential as this was a major underpinning of the 2006 study and of economic development interest to both the Yukon and Alaska. Accordingly, the pre-feasibility study included the following components:

- A conceptual engineering and business case assessment of the railway and oil transport requirements by AECOM;
- Information sharing and solicitation of support from First Nations by G7G; and,
- An assessment of mineral volumes and transport revenue potential by the University of Alaska and Michigan Tech.

This Report

This report presents a high level summary of the findings from the pre-feasibility study components. Information in this report draws principally from reports produced by the three study teams, and reflects their professional assertions and opinions. The study team reports are posted on the Van Horne website and should be considered appendices to this overview report.

2 | INFRASTRUCTURE AND OPERATING REQUIREMENTS

AECOM was commissioned to complete a preliminary feasibility study of building and operating a railway to transport bitumen and petroleum products between Northern Alberta (Fort McMurray) and Alaska, including all oil loading/unloading facilities and any other transport requirements needed to reach tidewater at the Port of Valdez. The infrastructure and operating requirements identified are capable of carrying 1.0 to 1.5 mbpd of bitumen and petroleum products as well as other commodities (eg., minerals) for export. The study's objectives were to:

- identify a feasible corridor and indicative alignment based on existing mapping, aerial photography, data and information derived from the 2006 Alaska-Canada Rail Link study as well as AECOM's prior experience on projects of similar scale and location;
- identify high risk areas for environmental and permitting purposes for future consideration in optimizing the alignment and estimating the complexity, cost and time required to acquire environmental and permitting approvals;
- develop a conceptual operating plan, including facilities, equipment and manpower requirements, to operate the railway, load/unload oil and annually transport 1.0 to 1.5 mbpd of bitumen and petroleum products between Northern Alberta and the Port of Valdez, Alaska;
- develop preliminary cost estimates of material, labour and other requirements for construction and operation of the railway as input to the business case analysis (see Section 3); and
- establish an initial understanding of construction challenges and further studies required to more accurately define existing conditions, refine the alignment and profile, as well as other infrastructure requirements to improve the accuracy of the cost estimate and implementation schedule.

Route Alignment

AECOM's objective was to identify the most efficient rail route from Northern Alberta in the vicinity of Fort McMurray to Delta Junction, Alaska, the currently approved endpoint of the Alaska Railroad, as well as the best means to access tidewater at the Port of Valdez, Alaska. To do so, required the following key factors to be balanced:

- the shortest distance;
- the lowest rail grades, not exceeding 1% in the westward, loaded, direction; and,
- the lowest cost of construction (ie., avoiding excessive river crossings, tunnels, and quantities of cut and fill materials as well as adverse ground conditions).

An initial rail alignment was identified based on the above criteria, followed by a single high level iteration of design optimization that looked for opportunities to avoid perceived areas of environmental significance and substantial grades and earthworks. The resulting proposed alignment represents a balance between operating and engineering requirements and the cost of earthworks.

Fort McMurray to Delta Junction

Starting from an eastern endpoint approximately 50 km northwest of Fort McMurray, which offered a suitable area for a railway yard and bitumen/petroleum product loading facility, various alignment variations were identified as illustrated in Figure 1. The first and most direct route via Peace River was rejected because it exceeded maximum allowable grades and resulted in a diversion that impacted numerous farms. A second alignment via Fort Vermillion was determined to be optimal but also required diversions to avoid impact to Birch Mountains Wildland Park and excessive grades through the Birch Mountains. Even with these constraints, this alignment proved to be favourable to the Peace River alignment, as it is 156 km shorter, with comparable earthwork quantities per kilometer. This alignment also proved to be flatter and 64 km shorter west of Peace River, with fewer curves, and avoided a difficult water crossing at Fort Nelson.

The next segment of the route from Fort Nelson to Watson Lake is particularly challenging, traversing the most difficult, undulating and mountainous terrain of the entire corridor. The optimal alignment shifts 64 km north of the Liard Provincial Park and is relatively straight and flat for the first 145 km but then winds to avoid excess earthworks. The profile climbs to a peak of 920 m where a 7 km tunnel is proposed and then includes eight bridges with heights over 30 m, after which the alignment follows a major river and is relatively flat.

From Watson Lake to the Alaska border, two route options were considered; one via the Ladue River to Carmacks, Yukon and the Alaska border; and, the other via Beaver Creek through Whitehorse to the Alaska border. Based on topography and design constraints, the Carmacks route was determined to be the optimum alignment. West of Carmacks, a route following the Yukon, White, Ladue, Tok and Robertson Rivers was chosen as its profile is generally rolling, with only one major peak (elevation of 645 m) where a 3 km long tunnel is proposed. The western endpoint of the railway is Delta Junction where it links with the Alaska Railroad.

Tidewater Access Options

To reach tidewater from Delta Junction, several alternatives were considered. Due to the coastal mountain range, it was not deemed economically feasible to extend the railway to the Port of Valdez. Potential alternatives identified, as illustrated in Figure 2, include:

- negotiating the transfer of bitumen/petroleum products to the Trans Alaska Pipeline System (TAPS), if this is agreeable to its owners, and undertaking or reimbursing the cost of any necessary upgrades to the pipeline and/or marine terminal either through a lump sum capital cost repayment or the oil transmission toll rate;
- building a new 430 km pipeline parallel to TAPS from Delta Junction to Valdez along with a new marine terminal; or
- building a new 50 km rail spur from Tok to Glennallen to move the rail terminal closer to tidewater, a shorter new 185 km pipeline from Glennallen and a new marine terminal at Valdez.

Depending on which option is chosen, a large area with flat grades will be required either at Delta Junction or Glennallen to allow the construction of an unloading and transfer terminal, as well as associated railyards and facilities.

The reader should note that the concept of transferring oil to TAPS was based on the understanding that the pipeline has not been operating at capacity and has experienced problems due to low volume flows. However, more recently, the Government of Alaska enacted tax concessions with the aim of increasing North Slope oil production that may result in increased pipeline use. To date, there have been no discussions with the pipeline and marine terminal owners (BP, ConocoPhillips, ExxonMobil and Unocal) regarding the feasibility and/or acceptability of this proposal.

In addition, the other options were not examined at the level of detail used for the Fort McMurray to Delta Junction railway alignment. Instead, they were only considered at a high level for costing purposes.

It is assumed that minerals and other freight would use the Alaska Railroad to access either the Anchorage or Port MacKenzie or CN Rail at Fort Nelson to reach other Canadian or US destinations.

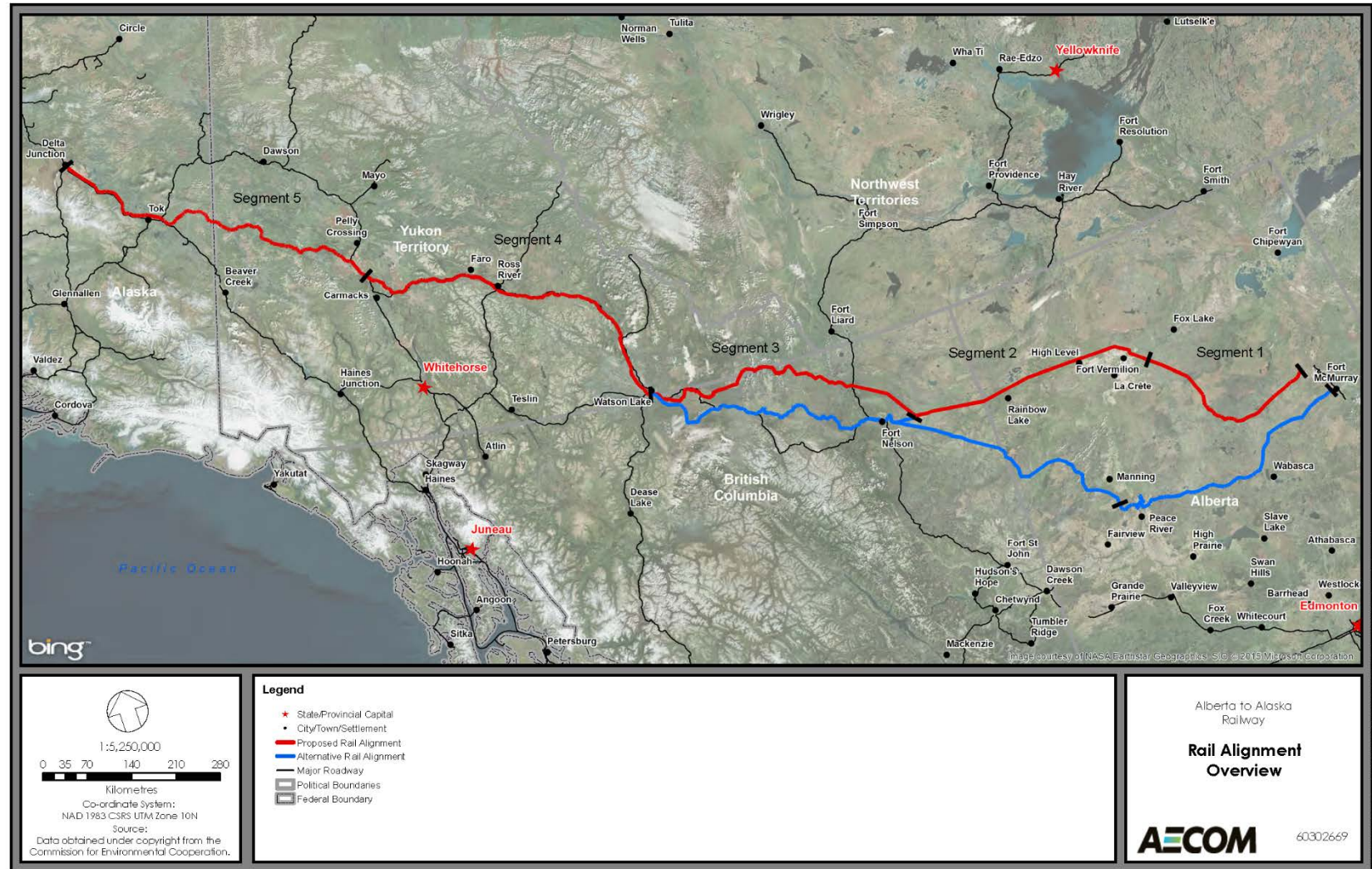


Figure 1 – Route Alignment Options

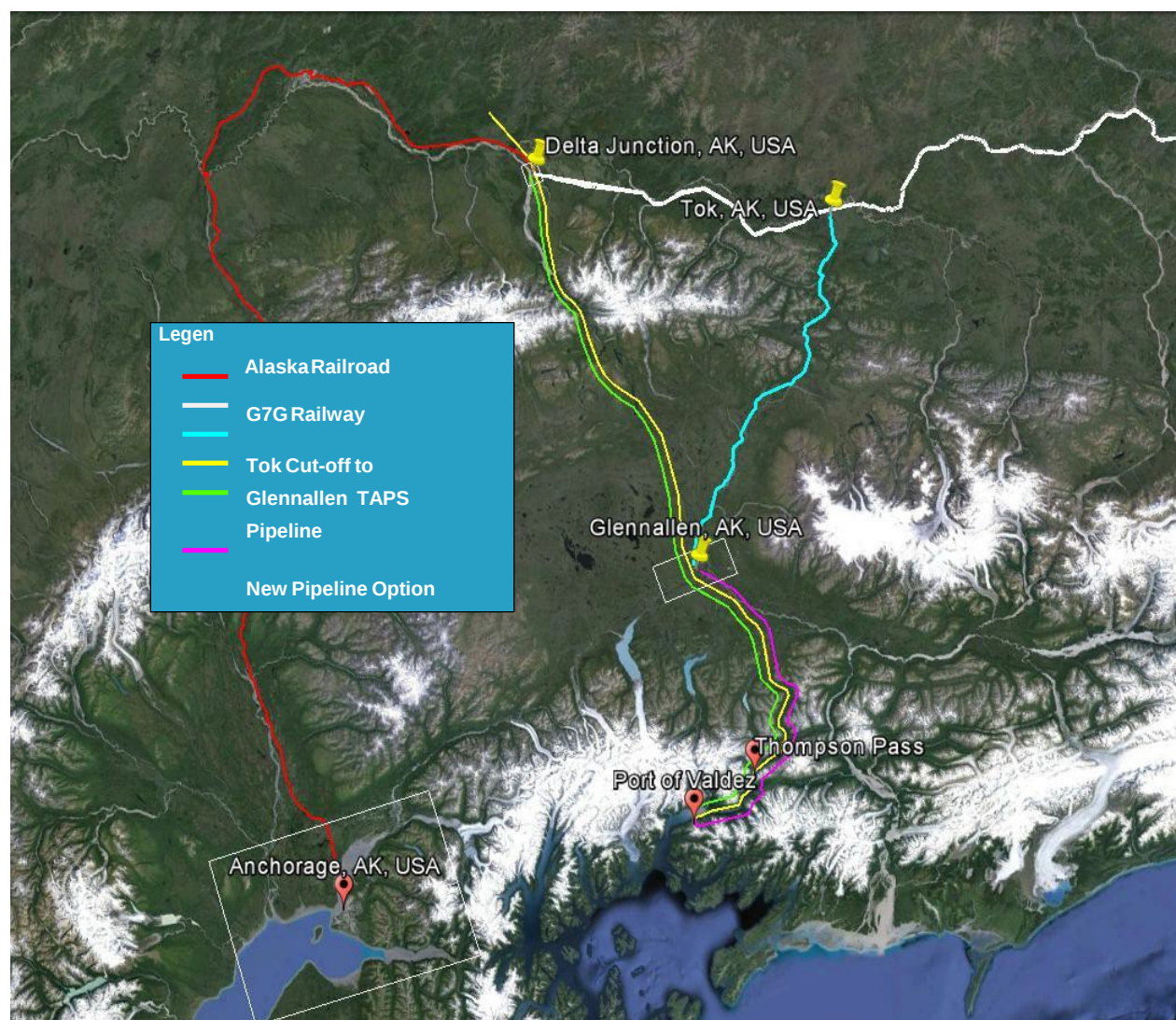


Figure 2 – Tidewater Access Options

Environmental Considerations

Environmental Issues

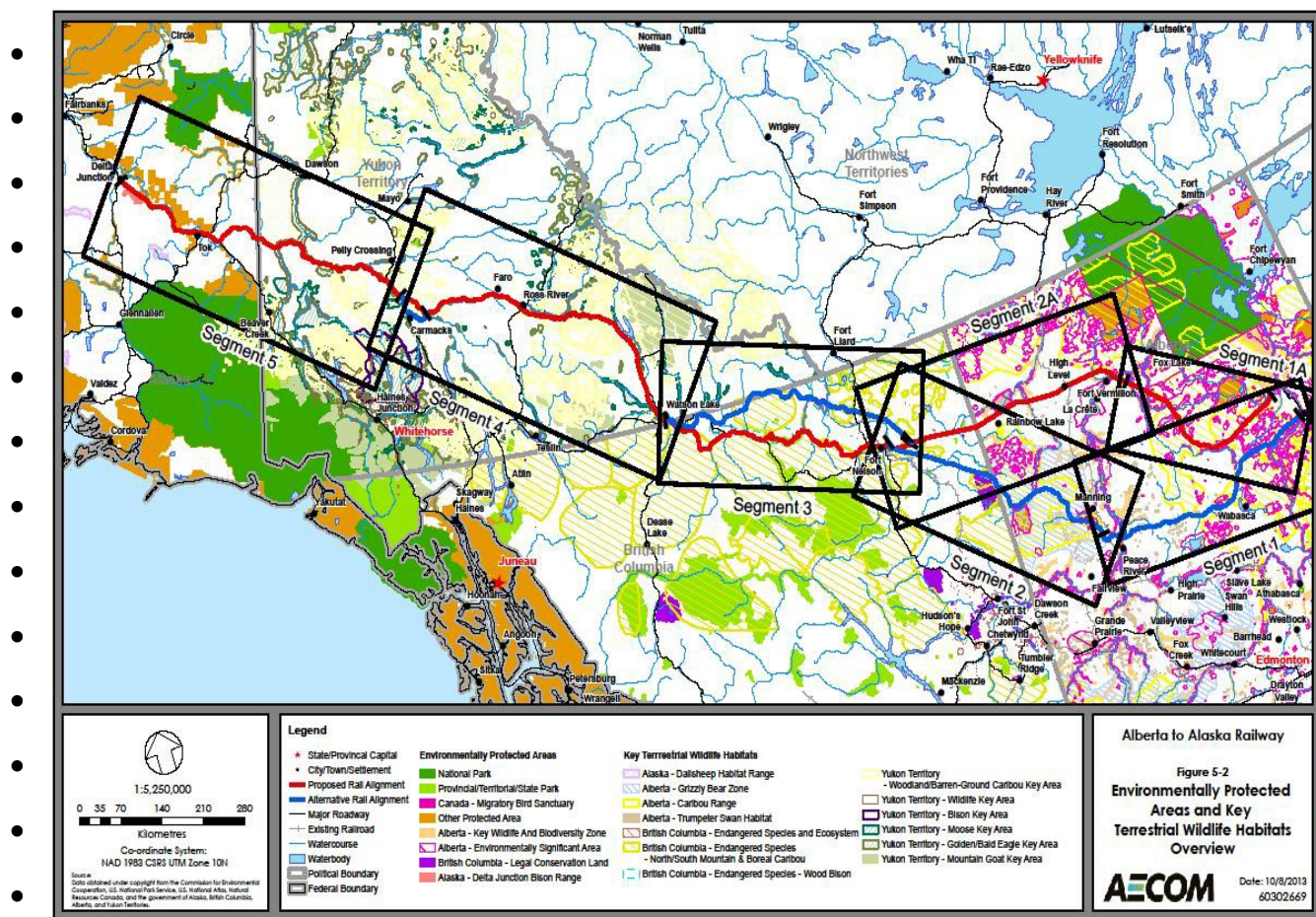
A preliminary review of the proposed railway alignment was carried out to identify key environmental issues as well as risks and permitting requirements for the proposed railway. “Risk” was defined as the potential for a significant delay and/or additional cost, up to and including route realignment, which can be triggered at any point in the Environmental Assessment and subsequent permitting processes.

The review indicated that the proposed railway passes through, or comes in close proximity to, a number of environmentally protected areas, including the Caribou River Natural Area northeast of Fort Vermillion, Alberta; BC’s Etthithun Lake Bison Management Area, Liard River Corridor Provincial Park, Smith River

Falls-Fort Halkett Provincial Park, and Portage Brule Rapids Ecological Reserve; and Alaska's Tanana Valley State Forest, Delta Junction State Bison Range and Haines-Fairbanks Pipeline Corridor, which is presently subject to an on-going environmental contamination investigation. In addition, key wildlife and biodiversity areas, especially along major river valleys, fishery values as well as areas that support migratory and/or sensitive or endangered species have been noted in the railway corridor.

Extensive studies and data collection are required to better identify environmental attributes, issues and risks throughout the railway corridor as well as route refinements, mitigation measures, seasonal limitations on construction (eg., January 15 to April 30 for ungulates in the Alberta section), and other considerations. Completion of these studies is an essential pre-requisite in developing the necessary environment assessment and permit submissions required for regulatory approval of the railway as well as a new pipeline and marine terminal, if these are necessary. At this time, it is not possible to estimate the time or cost required for these studies. Figure 3 below identifies environmentally protected areas and key terrestrial habitats relative to the railway corridor and alignment.

Figure 3 – Environmentally Protected Areas & Key Terrestrial Habitats



Permitting Requirements

The review concluded that the Environmental Approval and Permitting process for the project will be extensive and complex. It includes the need for multi-jurisdictional environmental assessments (EA in Canada and EIS in the US) and Provincial, Territorial, State and Federal approvals, including Alberta, BC, the Yukon, Alaska, Canada and the US, as well as a Presidential Permit prior to commencing any construction. It will also require multiple additional subsequent permit applications and approvals at each of these jurisdictional levels. In addition, it will need to meet all requirements for consultation and respect First Nations' and US Tribal legislative and constitutional rights, including the possible negotiation and completion of multiple impact/benefit agreements.

In Canada, as the project falls within multiple jurisdictions, it will be subject to a Federal EA carried out in cooperation with Alberta, BC and the Yukon. Two levels of review are possible at the discretion of the Federal Minister of Environment; a Comprehensive EA to be complete within one year; or, the more complex, EA by a Review Panel to be complete within 2 years once a project submission is received. Either process is subject to additional time extensions to allow provision of additional studies or information. Given the physical and geographic magnitude of the project, the associated potential to encounter contentious issues, the involvement of multiple jurisdictions and its international security and trade implications, it is highly likely that the railway will require an EA by a Review Panel.

In the US, the previous extension of the Alaska Railway from Fairbanks to Delta Junction underwent an EIS. Accordingly, the present proposal will undoubtedly follow this precedent. The time required to receive a decision is two years or more. However, in the case of the 129 km Delta Junction extension, environmental approval took five years to complete. The current proposal also requires a Presidential Permit, which needs the concurrence of the US Secretaries of State and Defense that can result in significant delays even after EA approval. At this stage of study, it seems apparent that there is significant risk for this project to encounter significant delay and/or additional resource allocation beyond estimates, up to and including route realignment. These risks apply to any point in the EA and subsequent permitting processes.

Infrastructure and Operations

A railway operating plan was developed, and railway operations were simulated to confirm the suitability of the infrastructure and operation for the movement of 1.0 and 1.5 mbpd of bitumen from Fort McMurray to Delta Junction or Glennallen. Using the latest available railway technology, every aspect from cars to locomotives, to track structure, alignment grades and terminals, was tailored to make the railway the most efficient and safe for hauling bitumen and other petroleum products. Once completed, it was then used to determine the specifications for the alignment, facilities, equipment and manpower from which both capital (CAPEX) and operating (OPEX) expenditures were estimated.

Infrastructure and Facility Requirements

The proposed railway between Fort McMurray and Delta Junction comprises 2,440 kilometres of single, standard gauge, bi-directional heavy haul track with 38 sidings to accommodate fueling, crew changes and train meets for 1.0 mbpd operation expanding to 59 sidings for 1.5 mbpd. The track is upgradable to a double track configuration that would add substantial capacity.

Operational design constraints necessitate two major tunnels that are 7 km and 3 km in length, with a possible five additional shorter tunnels, if costly and impractical deep earth cuts cannot be avoided through alignment refinement. It also requires 70 bridges, including major structures over the Crow, Beaver, Liard, Lapie and White Rivers, as well as more than 4,100 culverts with varying dimensions throughout its length.

The main railway yard facility is proposed to be located at the Fort McMurray terminus. The plan includes an office building to house the railway's administration and support functions and the Operations Control Centre, train fueling and service facilities, maintenance facilities for locomotives and cars (excluding overhauls which are assumed to be completed offsite) and storage of track, signal and communications maintenance supplies and equipment as well as emergency response equipment to respond to accidents and railway emergencies, such as derailments. Light maintenance facilities and train fueling facilities are also included in the western terminus.

An intermediate fueling facility is located near Liard River. Other facilities at intermediate points to support track and signal maintenance functions, as well as train crew change points, with crew rest houses, and potentially permanent accommodation facilities have also been included at five locations along the rail line.

Bitumen loading/unloading facilities have been included at both railway endpoints (Fort McMurray and Delta Junction or Glennallen). The loading/unloading infrastructure will consist of a covered loading facility, with 48 car loading/unloading tracks, in sets of two tracks on either side of a loading/unloading island platform. Two sets of two tracks are sufficient to load a 192 unit car train. Up to 18 - 250,000 barrel heated storage tanks are included in each yard to provide a buffer between the varying rates of production and delivery of raw bitumen to the railhead yard and the actual loading and transportation of bitumen on trains. They will also enable uninterrupted flow of bitumen in case of temporary shut downs either at the production end, or on the railway. Both the tanks and associated piping are to be insulated.

Depending on the tidewater access option selected, either upgrades to TAPS and the existing Port of Valdez marine terminal or construction of a new pipeline and marine terminal will also be required. As discussions have yet to occur with TAPS' owners, any necessary modifications to the pipeline or the marine terminal facilities have not been identified.

Railway Operations

The railway is proposed to operate 24 hours per day, using industry standards with the latest proven technologies in safety and efficiency. Bitumen will be collected and brought to the Fort McMurray railhead yard and loaded into insulated heated storage tanks and then transferred into insulated tank cars. To be as efficient as possible, and to maximize the volume of bitumen carried in each car, a dedicated fleet of tank cars specifically designed to take advantage of the latest technology and heaviest North American rail standards – 315,000 lbs. gross weight per car has been assumed with three cars permanently coupled to form one unit or a 3-pak.

A standard insulated double shell tank car has been identified to ensure heated bitumen from load to unload for 60 hours at the corridor's coldest temperatures. As the trip from Fort McMurray to Delta Junction is estimated to be approximately 42 hours, bitumen should not require reheating but, if for any reason, this is necessary, heating coils have been included. The tank car capacity in volume is 29,300 gallons. By moving heated bitumen, no addition of diluents to retain the viscosity of the bitumen is required. This means that the shipped product while on rail will be 100% bitumen, as compared to pipeline transportation where diluent is mixed with bitumen, and can typically be as much as 30% of its volume.

In addition to cost savings and higher efficiency, the absence of diluent offers a significant environmental benefit as without it, bitumen hardens as it cools, potentially limiting the risk of spill dispersion and contamination from an accident site. Furthermore, bitumen without diluent has very low flammability and low vapor pressure compared to other crude oils.

Bitumen trains are proposed to use distributed power, consisting of 192 tank cars (64 3-paks) and the three sets of paired locomotives (six in total) in the following train configuration:



2 Locomotive + 96 cars + 2 Locomotives + 96 cars + 2 Locomotives

Each train would carry 122,500 barrels of bitumen. Loaded trains would be operated at a maximum speed of 80 km per hour and empty trains at 100 km per hour. While these are not the highest speed limits for heavy freight rail in North America, they are based on balancing operating and infrastructure costs for an efficient heavy haul unit train operation. Based on the above, eight loaded trains per day (16 in total) would be required to transport 1.0 mbpd, and 12 loaded trains (24 in total) for 1.5 mbpd. Allowing 5% for locomotive spares and 2% for tank cars spares results in a fleet requirement of 208 locomotives and 6,072 tank cars for 1.0 mbpd, and 309 locomotives and 9,205 tank cars for 1.5 mbpd.

Capital and Operating Cost Estimates

The capital and operating costs for constructing the railway from Fort McMurray to Delta Junction were estimated based on the preliminary engineering and rail operations plans along with AECOM's recent rail construction experience in similar environments. As design progress is limited at this pre-feasibility stage, the estimate is a CIQS Class D estimate to provide an order of magnitude cost. A significant portion of the estimate is based on assumptions and allowances. Actual costs will depend on a number of factors, including alignment conditions, labour availability and cost, environmental mitigation, schedule changes, etc.

Estimated Railway Capital and Operating Expenditures

AECOM used PERT analysis, a probabilistic technique, to estimate the cost to construct the railway between Fort McMurray and Delta Junction. Starting from a base project cost estimate derived from best estimates of work quantities and unit prices for similar projects, AECOM developed a range of project cost from a low with a 5% likelihood of actual construction cost being at or below this figure to a high with a 95% likelihood. The median within this range was identified as the "Expected Cost" with an expected accuracy of approximately +30% to -25%.

For comparison purposes at the request of VHI, AECOM also developed a project cost estimate using a conventional costing model. This approach used the base project cost estimate and then added a contingency for unforeseen or changed assumptions, conditions, etc., omissions or excluded items and other unpredictable factors that varied by potential risk for each area of work (e.g, track, earthwork, etc.). The resulting contingency added to the base project estimate represents 25% of the base estimate total, which is consistent with the Canadian standard for CIQS Class D estimates.⁶

The following table presents the construction cost estimates using both approaches.

Figure 4 – Total Estimated Capital Cost for Fort McMurray to Delta Junction Railway⁷

	PERT "Expected Cost"	Conventional Model	PERT Variance to Conventional	% PERT Variance to Conventional
1.0 mbpd	\$19.4 billion	\$23.4 billion	-\$4.0 billion	-17%
1.5 mbpd	\$20.6 billion	\$24.6 billion	-\$4.0 billion	-16%

Railway operating cost components were estimated based on railway industry average unit rates, applied to the infrastructure and operating models developed for this operation. PERT analysis was again applied. The "Expected" annual operating costs for the railway between Fort McMurray and Delta Junction were

⁶ Joint Federal Government/Industry cost Predictability Taskforce, 2012.

⁷ Estimated land costs are discounted by \$0.5 billion to reflect expected equity participation.

estimated to be approximately \$1.2 billion for 1.0 mbpd and \$1.7 billion for 1.5 mbpd with a predicted accuracy of +/- 10%.

Pipeline and Marine Terminals

Unlike the detailed cost estimates for the railway mainline from Fort Mc Murray to Delta Junction, those for the three alternatives to access tidewater were developed at a high level only.

For the potential pipelines proposed, the currently projected cost per kilometer for the Northern Gateway project was used for estimating purposes. Based on this, the option of constructing a 430 km pipeline parallel to TAPS between Delta Junction and the Port of Valdez would cost approximately \$2.4 billion, whereas the shorter pipeline from Glennallen would cost approximately \$1.0 billion.

For the rail spur from Tok to Glennallen, a high level review of the terrain was conducted and values were applied for construction and operations derived from other locations along the Fort McMurray to Delta Junction main alignment that appear to have similar terrain. Based on this approach, the capital cost of the rail spur is estimated to be \$1.1 billion.

Potential costs for constructing a new marine terminal for oil export at the Port of Valdez were estimated based on the actual construction cost for the existing Valdez Marine Terminal escalated to 2013 dollars.⁸

However, it should be noted that the environmental review and permitting costs and schedule for both the pipeline and marine terminal facilities have not yet been identified due to substantial variations that may arise. Pipeline permitting may follow existing processes for the TAPS system or may include a different regulatory protocol. The specific tidewater site will also shape a unique permitting process.

Pipeline and marine terminal operating costs were extrapolated from TAPS's publicly reported current tariff rates. However, no provision has been included to the supply diluent for use in the pipeline, as it is unclear whether the pipeline tariff rate includes this or not. With the new pipeline options, it is possible that diluent use could be avoided if the pipeline were to be heated but whether this would increase the capital cost estimate or decrease the operating cost estimate is unclear.

Option 1 – Transfer to TAPS at Delta Junction

As no discussions have occurred with the owners of the existing TAPS and marine terminal facilities at Valdez to determine the potential feasibility, capacity or upgrading requirements, required modifications or improvements, if feasible and agreed to, are unknown and have not been estimated.

⁸ As there are no land value comparables at the Port of Valdez, the escalated cost for the original terminal were assumed to include and represent current land cost. However, as land cost tends to appreciate more than construction costs, the terminal cost may be underestimated.

However, it may be reasonable to assume that these costs would be less than the construction of new facilities for this purpose. Therefore, cost estimates for the alternatives can be deemed a conservative and reasonable substitute.

Option 2 – Parallel Pipeline to TAPS from Delta Junction to Valdez

The total estimated capital cost for accessing tidewater from Delta Junction to the Port of Valdez, independent from the existing TAPS pipeline and marine terminal facilities is \$8.9 billion. Estimated annual operating costs are estimated to be \$0.7 billion.

Option 2 – Rail Spur from Tok to Glennallen and Pipeline to Valdez

The estimated cost for the railway spur, pipeline and new marine terminal is \$8.8 billion. Estimated annual operating costs are estimated to be \$0.7 billion.

Total Capital and Operating Cost Estimates

The following table summarizes the estimated capital and annual operating costs for the project from Fort McMurray to tidewater at the Port of Valdez.

Figure 5 – Total Estimated Capital and Annual Operating Costs

	1 mbpd		1.5 mbpd	
(\$ billions 2013 CAD)	Capital Cost	Op Cost/Yr	Capital Cost	Op Cost/Yr
Railway from Fort McMurray to Delta Junction ¹	\$19.4 - \$23.4 ²	\$1.2	\$20.6 - \$24.6 ²	\$1.7
Pipeline from Delta Junction to Valdez	\$2.2	\$1.1	\$2.2	\$1.8
Marine Terminal at Port of Valdez	\$6.7	\$0.03	\$6.7	\$0.03
Total Cost	\$28.3 to \$32.3	\$2.3	\$29.5 to \$33.5	\$3.5
Railway from Fort McMurray to Delta Junction ¹	\$19.4 - \$23.4 ²	\$1.2	\$20.6 - \$24.6 ²	\$1.7
Rail Spur from Tok to Glennallen	\$1.1	\$0.04	\$1.1	\$0.05
Pipeline from Glennallen to Valdez	\$1.0	\$0.6	\$1.0	\$0.9
Marine Terminal at Port of Valdez	\$6.7	\$0.03	\$6.7	\$0.03
Total Cost	\$28.2 to \$32.2	\$1.9	\$29.4 to \$33.4	\$2.7

¹ Estimated land costs are discounted by \$0.5 billion to reflect expected equity participation.

² Lower cost is PERT "expected Cost" and higher cost reflects project cost derived using conventional cost model.

The above does not include the cost for prior studies and design, including a full feasibility study, preliminary and potentially detailed engineering, financial studies and funding submissions, environmental studies and preparation of formal Canadian EA and US EIS submissions, surveys, mapping and other preparatory activities.

Conclusions

The pre-feasibility study has generated an indicative alignment, identified critical structures and high risk areas for environmental and permitting purposes, and developed a detailed albeit preliminary railway operating plan. Based on these outputs, the study provides an indicative base-case of the scale as well as the expected capital and operating costs for the proposed railway and tidewater access options. It also offers an initial understanding of the construction challenges ahead. Further studies will be required to gather much more focused information regarding the existing conditions, refine the alignment and profile and other infrastructure requirements, and develop a more accurate estimate of capital and operating cost as well as implementation schedule.

3 | BUSINESS CASE

In addition to identifying and costing the technical requirements for rail and tidewater access conveyance of bitumen and petroleum products between Northern Alberta and the Port of Valdez, AECOM was charged with assessing the economic feasibility and developing a business case for this project. To do so, AECOM conducted a Discounted Cash Flow (DCF) analysis to determine the cost per barrel necessary to fully repay all capital and operating costs over the life of the project (25 or 29 years depending on schedule assumptions) at reasonable rate of return for both debt and equity lenders.

Discounted Cash Flow

The DCF analysis includes all capital and operating costs, for loading and unloading of bitumen and oil products at the rail terminals, the haulage of these products in rail tank cars from Alberta to an unloading facility in Alaska, and the return haulage to Alberta of the empty cars. It also includes high level estimates for pipeline transmission of bitumen from the rail terminus to the Port of Valdez.

The analysis addresses two scenarios:

- ShipperCo – this scenario includes the cost to purchase and maintain a fleet of railway tank cars.
- RailCo – this scenario excludes the cost to purchase and maintain a fleet of railway tank cars, which is consistent with current railway practice, wherein large volume suppliers require a dedicated fleet of specialty railway cars and supply their own.

The DCF analysis is based on:

- a debt to equity ratio of 65:35, which is dependent on securing long term oil contract supply commitments (i.e., 10 to 20 years);
- a debt interest rate of 6% and return on equity of 12.2%, resulting in a weighted average cost of capital (WACC) of 8.2%, which is assumed to be a reasonable return to investors;
- a project life of 25 years assumes:
 - an optimistic best case of two years for environmental approval that requires a simplified and accelerated approval process (i.e., no panel review and expedited US Presidential approval);
 - the feasibility of an aggressive three year construction schedule without mitigating seasonal, labour shortage or other potential delays; and,

- o 20 years of railway operation of which the first two are a ramp-up period followed by 18 years transporting 100% of the targeted bitumen volume (ie., either 1.0 million bpd or 1.5 million bpd).
- Inclusion of a salvage value⁹ for track, signals and communication, rolling stock and equipment and facilities;
- 3.0% per year capital and operating costs escalation for inflation; and,
- 2.0% per year escalation on the base rate per barrel for inflation over the life of the project.

Based on the above assumptions, the DCF model yields estimates of the cost per barrel that must be charged to recoup 100% of capital and operating expenditures over 25 years. These estimates were calculated on a pre-interest and pre-tax basis.

Sensitivity Analysis

As the assumptions in the DCF drive the model's results as to the cost per barrel that needs to be charged, the analysis also looked at the impact of:

- higher/lower capital and operating costs;
- higher/lower WACC;
- higher/lower inflation on costs and the transport cost per barrel of oil;
- zero salvage value;
- higher capital cost risk (ie., a 50% increase in capital cost vs. a 27.5% increase in the higher capital cost scenario above); and,
- higher operating cost risk (ie., 50% increase in fuel cost).

In addition to the above, the impacts on costs of a longer environmental approval process (ie., 5 years instead of 2) and construction duration (ie., 4 years instead of 3) were examined. These latter analyses concluded that capital cost would increase by 6.0% to 6.4%.

The risk resulting from the absence of long term contractual supply commitments, which underlie the debt/equity ratio of the DCF analysis, as well as swings in market demand for bitumen were not analyzed.

⁹ The net salvage value is based on the remaining portion of the total economic life of the assets as prescribed by the Canadian Transportation Agency.

Market risk assessment involves a multitude of factors that will be necessary for investment decision but was well beyond the scope of this pre-feasibility study.

Of these analyses, higher capital costs and risk have the most significant impact on the price per barrel required to break even over the project life, adding approximately \$2 to \$3 per barrel. The results of these analyses are particularly relevant due to the risk of higher capital costs, longer environmental approval timelines and slower construction that have been identified. Conversely, lower capital and operating costs are extremely unlikely given the challenging environment and many other factors involved. Similarly, interest rate, cost and price inflation are at historic lows, making these factors, albeit of less impact in the sensitivity analyses, unlikely to be lower.

Estimate Cost per Barrel Required

The estimated per barrel cost to ship undiluted bitumen from Alberta to Alaska are shown below.

Figure 5 – Required Transport Cost per Barrel

(\$2013 CAD pre-tax)	1.0 mbpd	1.5 mbpd
Railway from Fort McMurray to Delta Junction	\$9.96 - \$11.19	\$8.14 - \$8.99
Pipeline from Delta Junction to Valdez	\$4.38	\$4.09
Marine Terminal at Port of Valdez	\$2.84	\$1.93
5 to 9 yrs project implementation	\$0 - \$3.00	\$0 - \$3.00
Total Cost	\$17.18 - \$21.41	\$14.16 - \$18.01
Railway from Fort McMurray to Delta Junction	\$9.96 - \$11.19	\$8.14 - \$8.99
Rail Spur from Tok to Glennallen	\$0.49	\$0.37
Pipeline from Glennallen to Valdez	\$2.15	\$2.02
Marine Terminal at Port of Valdez	\$2.84	\$1.93
5 to 9 yrs project implementation	\$0 - \$3.00	\$0 - \$3.00
Total Cost	\$15.44 - \$19.67	\$12.46 - \$16.31

By comparison, Kinder Morgan's proposed toll rate for its Trans Mountain expansion has been reported to be \$4.15 to \$5.48 per barrel.¹⁰ Northern Gateway's proposed tolls have yet to be confirmed as costs are still in flux. Pro rating this cost on a kilometer basis, the equivalent toll over the 2,440 km distance from Fort McMurray to Port Valdez, Alaska, would be \$11.26 per barrel. The estimated required range of transport cost per barrel of oil calculated above is clearly higher than either the proposed pipeline toll rate or equivalent toll, which is consistent with the research findings of the *Canadian Association of*

¹⁰ The Financial Post, August 1, 2014.

Petroleum Producers (CAPP).¹¹ CAPP cited a cost of \$9.83 to \$18.93 per barrel to ship oil by rail to the West Coast, which is in line with the above estimates.

Notwithstanding this transport cost differential, the current proposal has two offsetting advantages. First, the ability to carry other commodities, such as minerals, construction supplies and other materials, generating revenues that both defray financial risk to the railway and partly offset capital cost repayment. Second, it may promote more economic development opportunities and be an alternative to the current pipeline proposals.

¹¹ CAPP, *Transporting Crude Oil by Rail in Canada*, March 2014.

4 | MINERAL TRANSPORTATION

The University of Alaska at Fairbanks (UAF) and Michigan Tech Research Institute at Michigan Technological University (MTRI) were tasked with identifying mineral potential within the railway corridor and then estimating the value of these resources as well as both the potential freight tonnage for mineral transport and mining supplies, and revenues that could result for the railway over 30 years of operation. To complete this task, UAF and MTRI:

- compiled, digitized and analysed metallic mineral occurrences within a 160 km wide corridor of the railway derived from existing data bases and records, including the US Geological Survey's Mineral Deposit Model, British Columbia Mine File System, the Yukon Territory Mine File System, and the Alaska Resource Data Files System;
- used the Mineral Occurrence Revenue Estimation and Visualization (MOREV) Tool, which was developed by MTRI based on research and methodology developed by Metz and Dixon (1988) to generate expected rail metallic mineral in-place gross values at published metal prices in 2005, 2007, 2009, 2011, and 2013 and tonnages;
- estimated inbound freight loads of fuel and materials as well as non-metallic minerals and coal associated with metallic mineral extraction based on global industry experience; and
- estimated expected annual freight revenues and net present value before-tax cash flows to the railway for mineral, coal and supplies based on current rates and costs for the Alaska Railroad Corporation (ARRC).

Mineral Potential

Within the 160 km railway corridor, 1,717 metallic mineral occurrences are known. These occurrences are located primarily in a 1,760 km section of the corridor between Fort Nelson, BC and Delta Junction, Alaska. There is also much larger potential tonnage of industrial non-metallic minerals and coal within the corridor. These resources are less well defined but can be inferred based on estimated metallic mineral values based on global industry experience. However, this estimate is conservative as it:

- applies to mineral prospects that are in the early stage of exploration and evaluation;
- does not reflect the potential for additional mineral development as a consequence of new exploration activities that are likely to occur after a bulk transportation system is operational;

- does not include the potential freight from very large mineral occurrences outside the corridor that could support the development cost of longer supply infrastructure, such as the Crest Iron Ore occurrence in central Yukon Territory for which the estimated output is 5.5 billion tons¹²; and
- does not include the shipment of low grade bog iron deposits from northwestern Alberta.

Metallic Mineral Values and Freight Tonnage

Based on the above, metallic mineral potential within the 160 km corridor has a 90% certainty of generating expected in-place gross metal values of \$333-\$659 billion over 30-year's operation. This is equivalent to the gross metal value of one to two large porphyry copper deposits. By comparison, the Pebble Porphyry Copper Project in south central Alaska has a measured in-place gross metal value of \$350 billion. The expected rail freight concentrate tonnage is approximately 296 million tons, which is equivalent to five medium to large size base-metal mines over 30 years.

For base-metal and ferro-alloy metal mines, inbound freight loads range from 5-10% of outbound freight. The range reflects the need for larger quantities of fuel and materials for remote mines without grid power and a local labor force. Thus, the total rail freight requirements for the 160 km corridor are estimated to be 326 million tons (296 x 1.1) over a 30 year time period or approximately 11 million tons per year.

Non-Metallic Mineral and Coal Values and Freight Tonnage

Worldwide, basis metallic minerals only constitute 25% of total mineral resource value produced annually. Industrial minerals (non-metallic minerals) and coal account for 75% of the value of annual mineral resource production (petroleum and natural gas excluded). The latter are generally low unit value commodities that must be transported on rail or on water.

Experience shows that as mines and communities develop along the rail corridor, demand for energy and local industrial minerals will increase. Based on the gross metal value of metallic minerals, non-metallic minerals and coal generally results in four times the tonnage of metallic mineral tonnages. Applying this precedent, the total estimated rail freight for the 160 km corridor is 1.3 billion tons (4 x 326 million) over a 30-year time period or 43 million tons annually.

Freight Revenue and Cash Flow Potential

Based on an expected annual mineral and coal freight load of 43 million tons, the expected annual rail freight revenue can be estimated using a single or range of freight rates. Assuming that the average

¹² Operating at 50 million tons per year, Crest could provide this rail freight load for 100 years.

haulage distance for mineral and coal transport is 880 km and a freight rate of \$0.06 per ton-mile, the expected annual gross revenue would be \$1.42 billion. Assuming an operating cost of \$0.03 per ton-mile, the expected annual net cash flow before taxes would be \$710 million. This freight rate and operating cost are based on current rates and costs for the Alaska Railroad Corporation (ARRC). The current cost of capital to ARRC is estimated at five percent. At this interest rate and assuming a project life of 30 years, the expected net present value of the above net cash flow would be approximately \$10.9 billion.

Converting AECOM's calculations on revenue required per barrel to recoup the total capital and operating costs (see Section 3) to the tariff needed on a per tonne of mineral concentrates, the tariff would need to be \$0.04 per tonne-mile based on the 1.0 million bpd scenario and \$0.03 per tonne-mile for the 1.5 million bpd scenario. However, as the value of mineral concentrate is several times higher than the unit value of bitumen (\$2,040.00/short-ton for mineral concentrate vs \$552 for bitumen), minerals could support a slightly higher tariff rate of \$0.07 per tonne-mile. If this were the case, minerals could be expected to generate annual gross revenues of \$1.65 billion and an expected annual net cash flow before taxes would be \$917 million. Using AECOM's WACC of 8.2%, this represents an expected net present value net cash flow of \$10.1 billion over 30 years.

Conclusions

Unlike bitumen and oil products, the timing of development of expected mineral resources is uncertain. Furthermore, without better knowledge as to the location, number of mines and shipment volumes, the need for additional infrastructure to serve mainline capacity, the expected net present value total cash flow, although significant, cannot be integrated into the DCF model to determine how the cost per barrel of bitumen might be affected. What can be concluded is that mineral freight tonnage may be able to substitute for bitumen tonnage should there be a reduction in this volume, thus reducing the railway's financial risk. Furthermore, even if additional capital investment is required, added mineral revenue should offset at least part of capital repayment required from bitumen shippers.

5 | FIRST NATIONS ENGAGEMENT

Consultation and meaningful involvement and participation of First Nations are essential to the success of this project. Legally, the Crown, in making any decision that could potentially affect Aboriginal and treaty rights, has a duty to consult with First Nations, minimize infringement on Aboriginal and treaty rights, and address the potential effects through accommodation. With this in mind, G7G carried out a comprehensive information sharing program as part of this study.

First Nations/Tribes and Other Contacts

There are twenty-five directly affected First Nations communities throughout the corridor. Seven are situated in Alberta, two in British Columbia, five in the Yukon and up to eleven in Alaska. The uncertainty in Alaska will be addressed once the final route is confirmed. In addition, eleven Native Corporations and Traditional Councils are also involved.

Information Sharing Program

Over the course of the study, G7G made contact with all of the elected Leadership of the First Nations and Tribes directly affected by this project. They held 59 information sharing and project presentation meetings with First Nations' leaders or groups.

In addition, G7G met with and presented project information to the Alaska State Legislature representatives; the Governor of Alaska's Deputy Chief of Staff; Alaska Legislature Joint Committee on Transportation and Economic Development; Mayor of Valdez; Chairman and legal counsel for the Valdez Port Authority; Mayor and Chamber of Commerce of Fairbanks, Alaska; Assistant Deputy Minister and staff of Yukon Economic Development; and, Mayor and Council of Watson Lake, BC

Response to the Program

G7G requested both feedback and, if possible, indications of support. They report receiving a number of letters of support in principle for the pre-feasibility study. They also reported concerns raised by three First Nations regarding development within their traditional territory, namely Fort Nelson First Nation, Selkirk First Nation and Little Salmon/Carmacks Creek First Nation.

Conclusions

G7G have cautioned that, while the information sharing process has, for the most part, been positively received, it does not constitute "consultation" as legal required nor First Nations support for the project.

6 | CONCLUSIONS

The Alberta to Alaska Railway and tidewater access project will clearly be challenging to build. The challenges include:

- extreme cold weather and a long winter season, which clearly affects the cost of construction and operations;
- isolation and limited access affecting the supply of material and supply and retention of labour;
- sensitive environmental areas in this undeveloped natural environment; and
- complex regulatory and approval and permitting processes with multiple governments, international considerations and interested stakeholders.

However, projects similar to this, although not exactly the same in magnitude and scope, have been completed in other areas.

The pre-feasibility study identified an indicative route alignment and facilities, rolling stock and equipment, construction requirements and operating plan for a new railway between Fort McMurray and Delta Junction, Alaska as well as options to access tidewater at the Port of Valdez, Alaska. However, many issues have not been addressed in detail or to the degree necessary to specifically delineate the full requirements and challenges in engineering design, construction and operations; environmental mitigation and approvals, including First Nations consultation and impact/benefit negotiations; scheduling and costs; and, optimal corporate structuring and financing. Further study and effort is required to address these questions.

The pre-feasibility study estimated the project's capital cost for the new railway as well as tidewater access and oil handling facilities¹³ to be between \$28 and \$32 billion for 1.0 mbpd and \$29 to \$33 billion for 1.5 mbpd (\$2013 CAD).¹⁴ Annual operating costs are estimated to be \$1.9 to \$2.3 billion per year for 1.0 mbpd and \$2.7 to \$3.5 billion for 1.5 mbpd. However, this does not include the cost of necessary prior studies and activities, which have yet to be determined.

A best case optimistic estimate to obtain environmental approval and construct the project is five years but this would require a simplified and accelerated environmental process (ie., no panel review and expedited US Presidential approval) and the feasibility of an aggressive construction schedule (ie., no mitigating seasonal stoppages, labour shortages or other potential delays). Based on similar project

¹³ This includes the railway from Fort McMurray to Delta Junction, Alaska and all associated oil handling and rail operation and maintenance facilities and equipment as well as either the rail spur to Glennallen, pipeline and marine terminal or the pipeline from Delta Junction and marine terminal facilities.

¹⁴ Estimated land cost is discounted by \$0.5 billion to reflect expected equity participation.

precedents, nine years is more realistic. Again, this does not include time required for prior studies and activities for which three to five years would not be unprecedented.

The pre-tax cost per barrel to recover all capital and operating cost cited above over the project life, whether 25 years based on the accelerated and aggressive implementation program¹⁵ or extended to 29 years based on recent project precedent¹⁶ range from \$15.44 to \$21.41 per barrel for 1.0 mbpd to \$12.46 to \$18.01 per barrel for 1.5 mbpd. These figures are consistent with CAPP estimates for railway transport of bitumen and oil products to the West Coast.¹⁷

Mineral and coal potential within the corridor is high, although timing associated with the realization of this potential is uncertain. The study estimated the in-place gross value of metallic minerals alone to be \$333 to \$659 billion over 30-years of operation. The study's assessment predicted that the combined expected total freight tonnage from minerals and coal over 30-years of operation could be in the order of 130 billion tons or 43 million tons per year, resulting in \$10.1 to \$10.9 billion in net present value cash flow. Unfortunately, as this cash flow cannot be predicted and may vary considerably over time, it cannot be factored into the base per barrel cost estimates. However, it does potentially mitigate the railway's financial risk as a result of revenue diversification and offset at least part of the common capital debt repayment.

Finally, while the transport cost per barrel of bitumen/petroleum products is somewhat higher than potential or equivalent pipeline tolls to reach West Coast tidewater, the project has the advantage of:

- being able to carry other commodities, such as minerals, construction supplies and other materials, and generating revenues that both defray financial risk to the railway and part offset its capital cost;
- potentially offering more economic development opportunities; and,
- offering an alternative to the current pipeline proposals.

¹⁵ Assumes 2 years for environmental approval resulting from a simplified and accelerated process and the feasibility of an aggressive 3 years for construction without seasonal, labour shortage or other delays.

¹⁶ Assumes 5 years for environmental approval, and 4 years of construction which is more in line with recent projects, including the Alaska Railway's extension to Delta Junction.

¹⁷ CAPP, *Transporting Crude Oil by Rail in Canada*, March 2014.

ABOUT THE PROJECT TEAM

The Van Horne Institute

The Van Horne Institute is recognized within Canada and internationally as a leading institute of public policy, education, and research in transportation, supply chain and logistics, and regulated industries. The Van Horne Institute was established to assist industry, governments, and the public in addressing issues affecting transportation, supply chain management/logistics and regulated industries that are relevant to the well-being and growth of industry and commerce. Efficient and low-cost transportation and logistics services are essential to both industry and the public in our geographically large country, so the evolution of sound industrial strategy, public policy, and progressive legislation and regulations are increasing in importance as business moves further towards globalization. Industry needs to be innovative to compete. The Institute will contribute to this competitive challenge through its education and public policy research activities. The Institute was incorporated federally in 1991 as a not-for-profit organization, and is affiliated with the University of Calgary, the University of Alberta, SAIT Polytechnic, and with Athabasca University.

Shirocca Consulting

Shirocca Consulting is an independent consulting practice established in 1998. The firm offers strategic advice and consulting services in project development, management, planning and economic evaluation in the fields of transportation, land development and resource management. Since its inception, the firm has completed a variety of railway projects in Canada and the US, including the Alaska-Canada Rail Link, Calgary-Edmonton High Speed Rail, revitalization of Vancouver Island's Southern Railway, Whistler Passenger Rail and Fort McMurray Rail as well as various commuter and urban rail projects. In recent years, the firm's activities have increasingly focused on project management and providing strategic and technical advice and review of major projects for senior management, boards and oversight agencies, such as the Auditor General of British Columbia, to ensure both value for money and appropriate risk management.

AECOM

AECOM (NYSE: ACM) is built to deliver a better world. We design, build, finance and operate infrastructure assets for governments, businesses and organizations in more than 150 countries. As a fully integrated firm, we connect knowledge and experience across our global network of experts to help clients solve their most complex challenges. From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our work is transformative, differentiated and vital. A Fortune 500 firm, AECOM companies had revenue of approximately US\$19 billion during the twelve months ending June 30, 2015. See how we deliver what others can only imagine at aecom.com and @AECOM.

G7G

G Seven Generations Ltd. (G7G) is a partnership of four like-minded entrepreneurs that seek “alternative solutions for the benefit of all” with the well-being of all people and of the environment foremost in the decision making. Therefore, G7G always recognizes the wants and needs of others, builds relationships with the stakeholders, in particular First Nations, and above all works to earn their trust by being open and honest from the very beginning of a concept to the completion of a project and beyond. After years of research and information sharing with potentially affected the stakeholders, G7G is pursuing the construction of a purpose-built railway, with designed safety that will be capable of transporting all of Western Canada’s resources to Pacific tidewater.

University of Alaska (Fairbanks)

The University of Alaska Fairbanks is a Land, Sea, and Space Grant university and an international center for research, education, and the arts, emphasizing the circumpolar North and its diverse peoples. UAF integrates teaching, research, and public service as it educates students for active citizenship and prepares them for lifelong learning and careers. The University’s core themes are: to educate undergraduate and graduate students and lifelong learners; to conduct research in order to create and disseminate new knowledge, insight, technology, artistic and scholarly works; to prepare Alaska’s career, technical, and professional workforce; to connect: Alaska native, rural, and urban communities by sharing knowledge and ways of knowing; and to engage Alaskans through outreach for continuing education and community and economic development.

Michigan Tech Research Institute

MTRI is a research center of Michigan Technological University with a focus on education, research, and development of technology to sense and understand natural and manmade environments. We are a recognized leader in the research, development and practical application of sensor and information technology to solve critical problems in national security, protecting and evaluating critical infrastructure, bioinformatics, earth sciences, and environmental processes. Founded in 2006, MTRI has 58 employees, with an Environmental Sciences Lab, a Sensor/Signal Processing Lab, a biomedical informatics research program, and a transportation research program.