Railroad Strategy for Crude Oil Transport:
Considering Public Policy and Pipeline Competition

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Motivations

While crude oil is mainly transported by pipelines in North America, railroads have seen significant growth in this commodity, from just 9,500 carloads in 2008 to 234,000 in 2012 (AAR 2013)

The explosion of a crude oil unit-train in Lac-Mégantic, Québec on July 6, 2013, which killed 47 people, thrust the transport of crude oil by rail into the media spotlight, and highlighted the broader societal issues with the transport of crude oil by rail.

Growth of crude oil transportation by rail from the Alberta oil sands has been slower than the growth in the Bakken-formation region, providing a window to consider these issues

What should the railroad industry's strategy be, given these societal issues? This research identifies and describes some of the ***system drivers***, ***stakeholders***, **and** ***objectives*** for the bitumen transport system from the ***Alberta oil sands***, and reviews the performance of pipelines and railroads in satisfying these objectives.

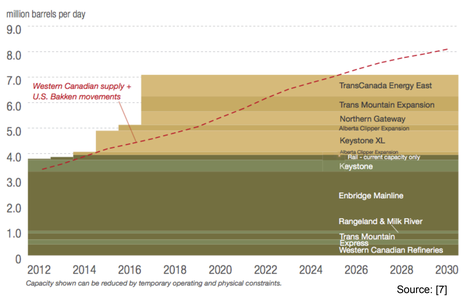
System Drivers and Stakeholders:

Economic Development

Canadian Government	US Government

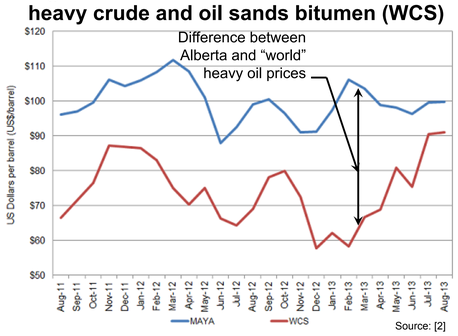
• Currently in Alberta, one out of 14 jobs is in the oil and gas sector [1]
• Over the next 25 years, given plausible oil sands growth (Fig. 1):
  ○ The Alberta Government could expect to receive **$455 billion** in tax revenue and royalties [14]
  ○ The Canadian government could expect to receive **$311 billion** in tax revenue [14]
• The above values are **highly dependent on oil prices**, which have been lower for bitumen due to limited pipeline capacity (Fig. 2) [14]
	• [14] estimates that direct, indirect, and induced jobs from new projects in the oil sands sector could contribute to the creation and preservation of **465,000 jobs** in the US in 2035, up from **21,000** in 2010.
	  ○ These are likely an upper bound estimate, as many jobs may be "preserved" regardless of growth in the oil sands.
	• [18] suggest anecdotally that projects like Keystone XL could actually **cause job losses** from the environmental impacts of spills.

Fig. 1: Predicted oil sands production growth and transportation capacity



Source: [7]

Fig. 2: Price differential between Maya heavy crude and oil sands bitumen (WCS)



Source: [2]

Environmental – Climate Change Policies

Canadian Government	US Government
• Canada has adopted the same climate change policy as the US for 2020 ("17% below the 2005 emission level by 2020") [11]. • Canada is currently not on track to achieve that target, particularly as a result of projected growth in the oil sand sector [11]. • There are currently no federal limits for GHG emissions from the oil sands sector [11]. • Aggressive carbon constraint policies would slow or reverse production from the oil sands [9].	• [20] predicts that "given implementation of programs and measures in place as of September 2012 and current economic projections, total gross US GHG emissions are projected to be 4.6 percent lower than 2005 levels in 2020." • California has implemented low-carbon fuel standards which could impact the import of fuel derived from the oil sands bitumen, due to its higher well-to-wheel emissions.

Safety

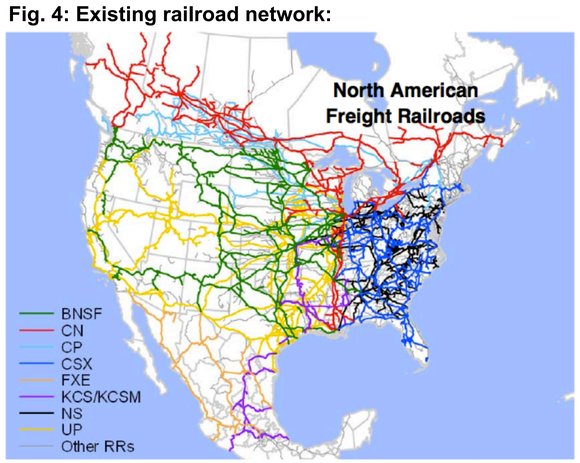
Canadian Government	US Government
• Governments in both the US and Canada have expressed concern over the environmental impacts of a dilbit spill (e.g. the rerouting of the Keystone XL in Nebraska). • The Government of British Columbia has been particularly concerned about the impact from a oil tanker spill off of the West Coast [16] • Rail safety regulators in both the US and Canada have issued emergency orders in response to the Lac-Mégantic accident; there has been a specific focus on tank car design and the packaging and labeling of the oil being shipped.	

System Definition:

Fig. 3: Existing and proposed pipelines:

Source: [7]

Fig. 4: Existing railroad network:



Source: Association of American Railroads

Some products shipped:

Term	Definition
Bitumen	Also referred to as "raw" bitumen, bitumen is "a thick, sticky form of crude oil that is so heavy and viscous that it will not flow unless it is heated or diluted with lighter hydrocarbons." (Alberta Oil Sands Glossary)
Dilbit	More formally referred to as diluted bitumen, dilbit is bitumen that has been mixed with a diluent for transport, such as condensate (heavier hydrocarbons from natural gas that liquify once the gas is recovered). A typical ratio of bitumen to diluent is 70:30
Railbit	Similar to dilbit, but having only approximately 15 percent condensate in the mix.

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System Objectives and Performance:

Shipping Economics

	Unit Train	Pipeline
Shipping cost	$7.20/bbl to $31.00/bbl	$7.00/bbl to $25.75/bbl

(Alberta to US Gulf Coast [USGC])	• Estimates vary significantly depending on what components of total logistics cost are included (e.g. value of time)
	• The cost estimates to ship by pipeline tend to be smaller than to ship by rail; however, rail becomes more competitive if:
	  ○ Value of time considered (rail takes 8 – 15 days from Alberta to USGC, whereas pipeline takes 40 – 50 days) [8, 17]
	  ○ Less diluent is used to ship bitumen by rail (diluent represents a "deadweight loss" and there are inadequate supplies in Western Canada [6]
	  ○ Small shippers are considered: pipeline rates are higher for them [6]
	  ○ Rail is used to ship diluent on the backhaul (8]
	• Unit train economics, particularly of shipping raw bitumen, have not been tested from Alberta (Fielden 2013b)	

Capacity Scalability	• One train start per day can ship 63,000 to 78,000 bbl/d [5] • Terminals can be economically built in the 50,000 – 100,000 bbl/d range • Unclear whether rail could handle all of the projected growth from the oil sands [5]	• Pipeline expansion typically in the 120,000 bbl/d to 850,000 bbl/d range • Proposed projects are shown in Fig. 3.
Geographical flexibility	• *With new terminals:* rail can serve most destinations in the US and Canada • Flexibility allows producers to seek higher prices in multiple markets, closing the differential in Fig. 4	• *Without new infrastructure:* limited to serving markets in the US Midwest (PADD II and IV) and USGC (PADD III), as shown in Fig. 3
Agility	• It takes 12 – 18 months to build a new terminal [8] • Tank car production: ~16,000 to 24,000 cars per year; backlog until mid-2015 [15]	• Pipelines projects take several years (e.g. ~5 years for the original Keystone) to complete

Environmental – Transportation GHG Emissions

	Unit Train	Pipeline
Alberta to BC:	5,000 gCO2/bbl	3,000 gCO2/bbl
Alberta to USGC:	13,000 gCO2/bbl	46,000 gCO2/bbl

- Pipelines are generally more energy efficient and produce fewer GHG emissions than unit trains; however, a power grid that relies on fossil fuels (in the US Midwest), and the ability to ship bitumen with <30% diluent means that unit trains produce less GHG emissions for shipping the Alberta to the USGC [19]

Safety

	Unit Train	Pipeline
Frequency:	0.81 – 2.08 incidents per billion ton-miles	0.56 – 0.58 incidents per billion ton-miles
Magnitude:	16.4 - 65.7 bbl per incident	266 – 269 bbl per incident

- Overall, pipelines have fewer incidents but larger spills than rail *on average*, although the rail accident in Lac-Mégantic released a similar amount of crude oil as other major pipeline spills
- Limited information is available on the behavior of dilbit following a release [10]
- The diluent can be highly flammable and appeared to cause adverse health impacts following a pipeline release in Michigan [10]
- Some in the rail industry have hypothesized that shipping raw bitumen is safer, as the product will not flow, e.g. [12]; little evidence is available to support of disprove this hypothesis
- A study by the National Academy of Sciences found that oil sands diluted bitumen does not have any properties that make it any more likely to damage pipelines than conventional crude oil [4]

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