A WIN-WIN COLLABORATIVE INITIATIVE TO IMPROVE CANADIAN TRANSPORTATION EFFICIENCY THROUGH REGULATORY CHANGE

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Abstract

Transportation efficiency can be improved through regulatory changes in support of heavy haul corridors, transportation partnership programs, seasonal weight programs, etc. Transportation in Canada also is governed by heavy vehicle weights and dimensions legislation and regulations under the responsibility of the provincial and territorial governments. Recently FPInnovations conducted a national survey and analysis of all log truck configurations for each Canadian province. From this was identified the most efficient and top performing configurations as well as gaps and needed improvements for certain provinces as it relates to transportation efficiency. This paper highlights how FPInnovations collaborations helped improve transportation efficiency in provinces where a gap in transportation efficiency was identified. This paper also presents an overview of the implementation process for a higher efficiency truck in Ontario and its impacts as an illustration of a win-win collaborative approach to regulatory change.

Keywords: Transportation, efficiency, configurations, weights, dimensions, regulation

1. Introduction

The forestry industry is one of Canada's major economic pillars. The transportation of wood, which accounts for as much as 50% of the cost of fibre supply, typically is by log hauling trucks. These trucks utilize public roads whenever possible and, therefore, are subject to provincial or territorial weights and dimensions regulations. In addition, some provinces have industry-targeted transportation programs or seasonal load programs aimed at improving transportation efficiency and cost, while maintaining infrastructure integrity and public safety. This paper summarizes provincial regulations for log hauling vehicles as well as related interprovincial agreements. It also summarizes how these regulations have shaped current log hauling operations. The paper highlights the most efficient and top performing configurations, by province, and identifies disparities and needed improvements as they relate to transportation efficiency. Through a case study in Ontario, where a high efficiency log hauling configuration was implemented in 2023, this paper also illustrates how a win-win collaborative research approach between FPInnovations, universities, government and the log haul industry can improve lead to enhanced transportation efficiency.

2. Summary of the current state of transportation in Canada

2.1 Challenges to commercial truck transport: Case of forestry

Depending on the province, different configurations are typically used for forest products transportation in Canada. In some cases the load limits for these configurations have remained unchanged for years. In addition, some provinces have no transportation partnerships programs (TPP), heavy haul corridors, or winter weight premiums (WWP). A WWP is an additional payload granted by ministry of transport during wintertime. It is assumed that when frost reaches a specific depth, the pavement is insensible to added load. Figures 1 and 2 below illustrate, respectively, Canadian provinces and territories with WWP and those with targeted corridors or partnerships between government and the forestry industry.

Figure 1 – Provinces and territories with WWP

Figure 2 – Provinces and territories with provinces with targeted corridors or partnerships between government and the forestry industry

Log hauling challenges are accentuated by a growing shortage of drivers, an aging workforce, and ongoing increases in equipment, fuel, and labor costs. Climate change also has had an impact on fibre transportation, and causes shorter operating seasons, frequent access disruptions, reduced fiber availability, and higher infrastructure costs.

2.2 Configurations and maximum allowable loads in different provinces

Table 1 illustrates the different truck configurations used to transport roundwood in Canada's provinces and territories. The loads shown represent legal limits and additional loads such as WWP and TPP targeted to the forest industry.

Table 1 shows that there is a greater variety of configurations and higher allowable loads in provinces located in the west (British Columbia and Alberta) and the prairies (Saskatchewan and Manitoba), in comparison to the eastern provinces and the Maritimes.

When compared with the neighboring provinces of ON, NB, and NL, the heavy-duty vehicles used in Quebec are similar; however, the forestry industry in Quebec is subject to certain constraints (e.g., lower allowable loads). For example, the 7-axle tandem tractor / 4-axle semi-trailer is limited to 57.5 t in Quebec but enjoys over 62 t in Ontario.

Table 1 - Popular log hauling truck configurations by province

Province	Number of axles	Configuration	Max. legal loads (t)	Add. program loads (t)	
				TPP	WWP
Quebec	7	Tandem tractor / 4-axle semi-trailer	57.5	-	-
	8	B-Train	62.5	-	-
British Columbia	6	Tandem tractor / tridem tractor	47.1	-	-
	8	B-Train	63.5	-	-
	8	Tridem tractor / B-Train	63.5	-	-
	8	Tridem tractor / 4-axle trailer	63.5	-	-
	9	Tridem tractor / B-Train	72.3	-	-
Alberta	8	Tridem tractor / 4-axle semi-trailer	63.4	-	4.6
	8	B-Train	63.5	-	4.6
	9	Tandem tractor / 6-axle B-Train	70.5	-	7.0
	9	Tridem tractor / B-Train	71.3	-	7.0
	10	Tridem tractor / 6-axle B-Train	78.3	-	10.0
Saskatchewan	7	Tridem tractor / tridem semi-trailer	66.3	-	-
	8	B-Train	63.5	5.0	3.0
	9	Tridem tractor / B-Train	69.5	5.5	3.0
	9	Tandem tractor / 6-axle B-Train	69.5	5.5	3.0
Manitoba	8	B-Train	63.5	-	-
	8	Tridem tractor / B-Train	63.3	-	-
Ontario	7	Tandem tractor / 4-axle semi-trailer	59.1	3.0	3.0
	8	Tridem tractor / 4-axle semi-trailer	62.5	2.8	2.8
	8	B-Train	63.5	3.2	3.2
	9	Tandem tractor / 6-axle B-Train	72.5	-	-
New Brunswick	6	Tandem tractor / tridem semi-trailer	49.5	-	2.0
	7	Tandem tractor / 4-axle semi-trailer	55.5	-	2.0
	8	Tridem tractor / 4-axle semi-trailer	62.3	-	-
	8	B-Train	62.5	-	-
Nova Scotia	6	Tandem tractor / tridem semi-trailer	49.5	-	-
	7	Tandem tractor / 4-axle semi-trailer	55.5	-	-
	8	B-Train	62.5	-	-
Newfoundland and Labrador	7	Tandem tractor / 4-axle semi-trailer	55.5	2.0	-
	8	B-Train	62.5	3.0	-

2.3 Comparative analysis of Canadian forestry truck performance by province

A comparative analysis of log hauling truck performance in each province was carried out to quantify the impact of differences caused by legal load limits and the availability of seasonal weight programs, permitted heavy haul corridors, and targeted TPPs. Performance was ranked based on three main criteria: the number of trips required to transport the same volume, transportation costs, and greenhouse gas emissions. Figure 3 illustrates this comparison of best performing trucks for each province. Only those configurations that had relatively high payloads and had the greatest populations were considered. For example, in Quebec, the 7-axle tandem drive/ 4-axle semi-trailer is the top performer because no other configurations are used for log hauling; the 62.5 t 8-axle B-train is a legal QC configuration but is rarely used for log hauling.

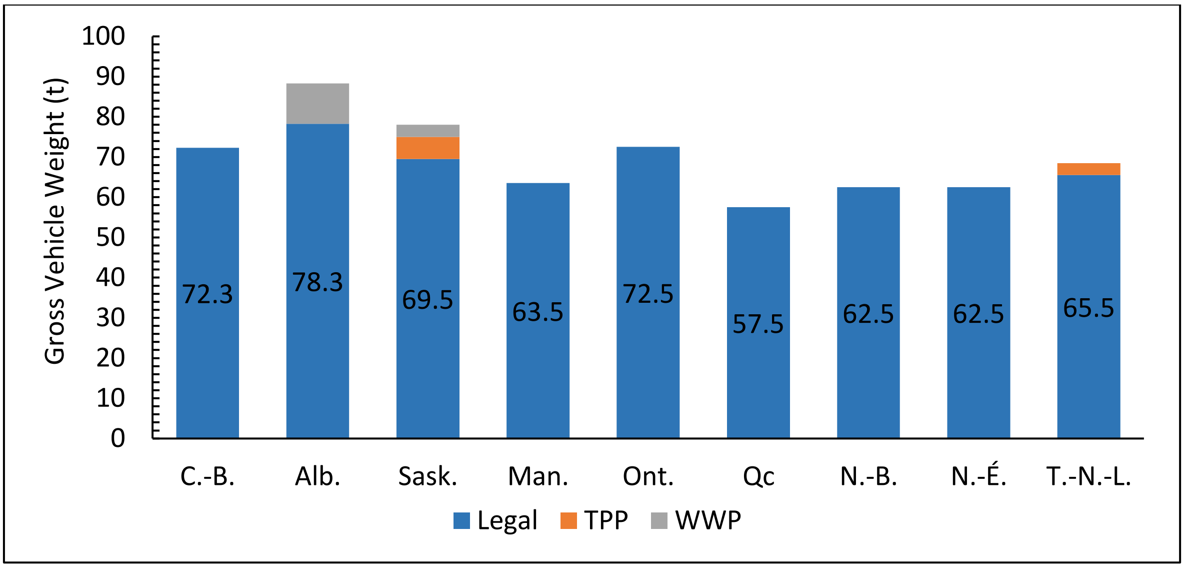

Figure 3 – Comparison of best performing trucks by province

Figure 4 compares the number of trips required to transport 1 million tonnes of logs with the best performing truck from each province. Given that logging is limited to set annual harvest levels an increase in log truck payload will generate a reduction in number of trips needed to transport the annual harvest.

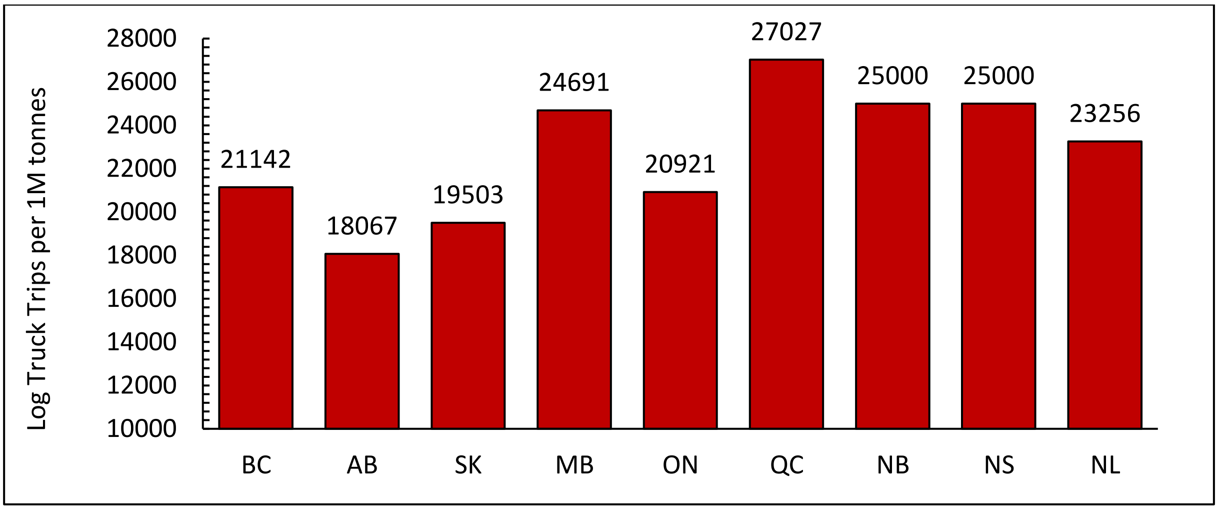

Figure 4 – Comparison of the number of trips required to transport 1M tonnes of wood by the best performing log hauling configuration in each province

The number of trips needed ranged from a low of 18067 (in AB) to a high of 27027 (in QC) with a difference of about 33%. The number of trips per a set volume is an important criterion because it illustrates the impact of truck productivity on public road congestion and crash risk, driver shortages and fleet size, and on road infrastructure impacts. Infrastructure impacts are strongly influenced by reductions in the number of heavy truck trips. Based on FPInnovations' estimates, figures 5 and 6 present a comparison of transportation costs and environmental impacts for the best-performing configurations in each province.

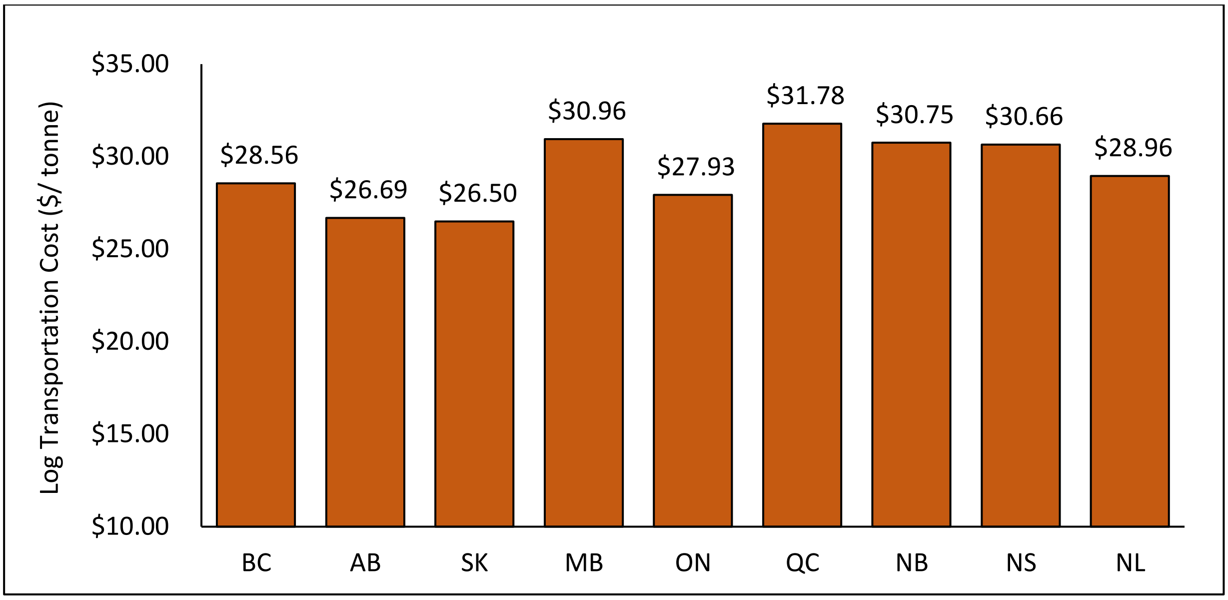

Figure 5 – Comparison of top performing truck costs, by province

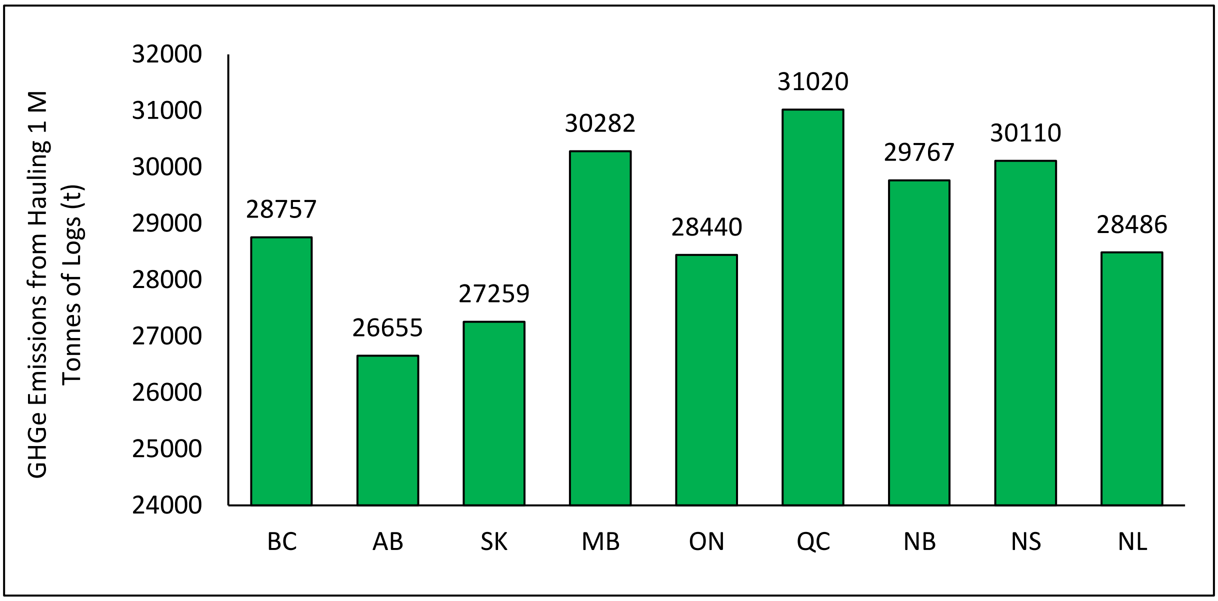

Figure 6 – Comparison of GHG emissions from transporting 1M tonnes of logs with each province's top performing log truck

Figures 5 and 6 show that, compared with Alberta, the province with Canada's most efficient log hauling configurations, transportation costs and GHG emissions are approximately 20% and 14% higher in Quebec, respectively. From figures 4, 5, and 6 it can be concluded that there are numerous opportunities to improve the efficiency of forest transportation, especially in the eastern provinces. Opportunities include the implementation of winter weight programs or Trucking Partnership Programs, permitted load increases for current legal configurations, and the introduction of new higher efficiency configurations. These improvements are likely to reduce greenhouse gas (GHG) emissions while also supporting local industry's competitiveness and productivity. Transporting a greater volume of wood with fewer trucks would reduce congestion and associated risks to other road users. Finally, measures to

improve transport efficiency also typically prolong the lifespan and reduce costs of transportation infrastructure.
It's worth noting that the best-performing configurations in most provinces are the result of close collaboration between industry, government and FPInnovations. Results presented in figures 3 to 6 were generated from FPInnovations' truck costing model.

3. Overview of the process to improve transportation efficiency in a province: case study of the introduction of 9-axle B-trains to a haul corridor in Ontario

As stated earlier, there is a need for transportation competitiveness to ensure the sustainability of truck-based industries in each province. Proven approaches to increasing transport efficiency include introducing higher capacity truck configurations; allowing over-dimension and(or) over-weight trucks to operate under permit on designated haul corridors; and refining seasonal weight programs to be less restrictive and more responsive to climate change and new truck technologies. This section focuses on the first of these approaches - implementing high efficiency truck configurations - and describes the strategy and general process used in Canada.

3.1 Strategy and general process for introducing high efficiency truck configurations in Canada

In general, a successful strategy for introducing new truck configurations is to take a collaborative approach that seeks a win-win outcome. The collaborative approach utilizes an evidence-based and accepted assessment process and recognizes the priorities of the stakeholders at the table. Figure 7 represents 4 common pillars of trucking policy change.

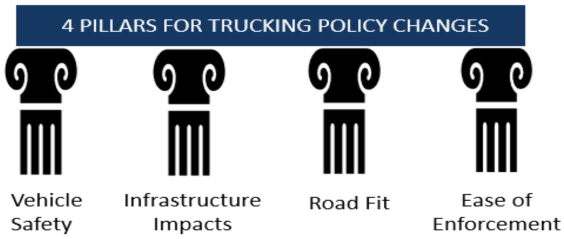

Figure 7 – 4 pillars of trucking policy change

Safety of truck drivers and the traveling public is a top priority for industry and transportation agencies. Agencies typically are willing to consider a proposal for a safer truck configuration.
A second priority, especially for the agencies, is that new configurations have equivalent or preferably smaller pavement and infrastructure impacts than regulation truck configurations. This is important because approving a new configuration that causes more damage than conventional trucks represents an unfair subsidy of a special interest group or industry. Further, a vehicle that increases infrastructure damage is a concern because budgets for maintenance are often tightly constrained.
A third priority is to ensure that the new configuration fits the geometry of the highway network. Turning, passing, overhead clearance, lane room, acceleration, and grade climbing – all should be considered.
A fourth priority is that it should be inexpensive and easy to enforce compliance with the terms and conditions of the operating permit.
Additional priorities may include the promotion of local jobs and competitiveness or solving specific logistical problems of industry. Understandably, this may be more important to

industry proponents and to government departments focused on economic growth than to transportation regulators.

The process used to improve transportation efficiency while preserving road user safety and the integrity of affected roads and infrastructure involves nine steps:

1. **Project definition**. Define the need for increased transportation efficiency. Identify a champion and stakeholders and estimate the economic impacts to all parties involved.
2. **Feasibility study and approval strategy**. Study transportation regulations, government priorities, etc. to define potential configurations, ranges of weights and dimensions, and a strategy for approval and implementation (e.g., special programs for permitting new configurations can occur rapidly but have costs and compliance requirements and may be area constrained; adding a new configuration to regulations may take a long time but it allows the truck to operate freely throughout the province).
3. **Engage the regulators**. Identify regulators responsible for new truck policy creation and enlist a project champion from the agency's compliance and enforcement division. Establish the regulator's approval process for new configurations and the terms of reference to use for the technical evaluations.
4. **Dynamic performance**. Analyze the configuration's low- and high-speed performance. Adjust vehicle loading and(or) dimensions to make its dynamic performance measures meet provincial safety standards.
5. **Infrastructure impacts**. Analyze the configuration's impacts on bridges, culverts, and pavements. Typically, this is a relative comparison versus those impacts from regulation vehicles; however, detailed structural evaluations of specific or representative bridges also may be needed to ensure sufficient bridge capacity exists. Truck loading may need to be reduced from that established in step 4 if the infrastructure impacts are judged excessive.
6. **Road fit**. This analysis checks agreement with provincial dimensional limits (overall length, overall height, vehicle width), and room needed to negotiate low- and high-speed curves. Gradeability and acceleration from a stop also may need to be checked.
7. **Field testing**. If the vehicle is novel or there are concerns about its performance and safety, the regulator may require field testing to learn more about it under real life operating conditions.
8. **Regulation or policy development**. Once the agency is satisfied, regulations or policies are developed, reviewed, and approved by the agency. This may involve consultation with other stakeholders and District staff.
9. **Implementation**. Implementation involves the agency creating a special program or getting the new configuration voted into provincial regulations. Vehicle manufacturers will have to prepare designs and may have to tool up. Contractors must evaluate the economics of the new vehicle and whether they can afford to purchase the new configuration.

3.2 Case study of the introduction of 9-axle B-trains to a haul corridor in Ontario

The following case study of a recently completed project in Ontario illustrates how a new high efficiency log truck configuration was implemented using the process described in the preceding section. The proposed configuration was a high efficiency 9-axle tandem-drive log B-train with wide-spread tridem axles on the trailer. The proposed maximum axle loads were 5,500 kg on the steering axle, 17,800 kg on the tandem drive-axle group, and 24,600 kg on both the lead and rear trailer tridem-axle groups (Figure 8). The configuration's allowable gross vehicle weight (AGVW) would be 72,500 kg (711 kN) with no additional increases for winter weights or for participation in the Northern Ontario Log Truck Association agreement. The 9-axle B-train's maximum payload was expected to be about 51,000 kg.

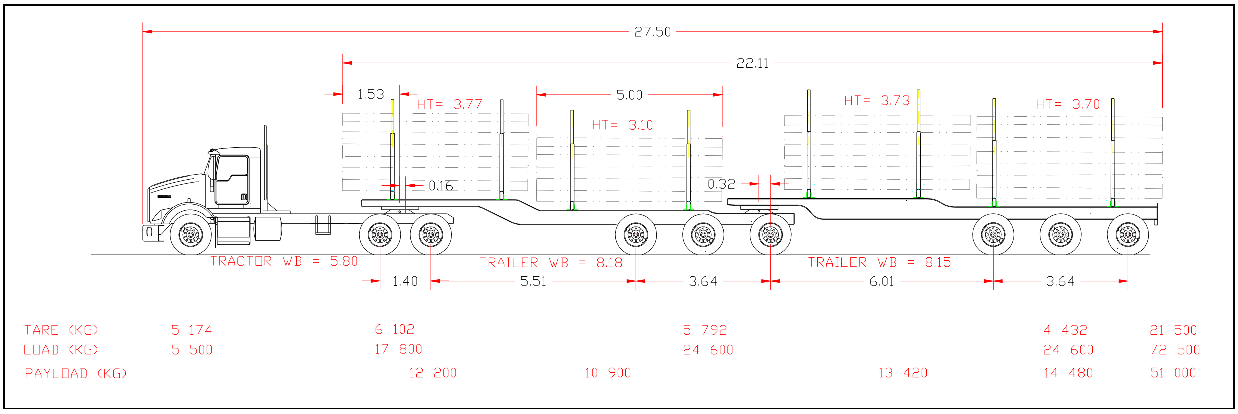

Figure 8 – Proposed 9-axle tandem-drive log B-train

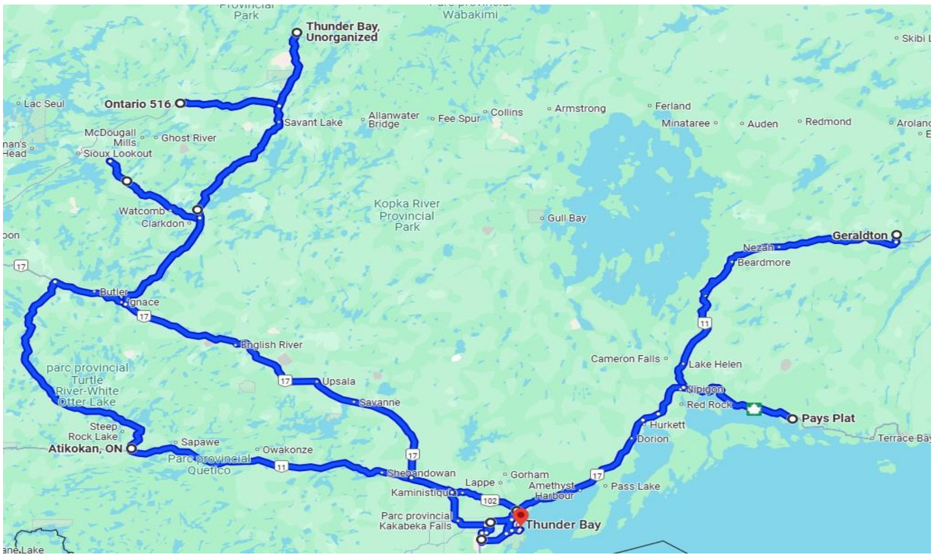

Figure 9 – Corridor haul routes

A series of technical analyses were conducted to assess 9-axle dynamic performance, and the expected pavement and infrastructure impacts to the proposed 9-axle corridor routes north-west and north-east of Thunder Bay (Figure 9). The vehicle dynamics, pavement, and bridge analyses are summarized in the following sections and described in more detail in (Bonsi and Parker 2021), (Thiam and Bober 2021), and (Bradley 2021), respectively.

Vehicle dynamics

FPInnovations evaluated the dynamic performance of the 72.5-t tandem drive 9-axle log B-train per standard performance measures. For comparison to the status quo, the dynamic performance of a reference configuration was also evaluated. The reference configuration was representative of the heaviest log hauling trucks currently used in the Thunder Bay region—a 63.5-t tandem-drive 8-axle B-train. Results showed that the proposed 9-axle configuration compared favorably to the 63.5-t 8-axle log B-train. The proposed 9-axle configuration exhibited both increased stability and improved dynamic performance. The 9-axle B-train did exhibit increased Low-Speed Off-Tracking (LSOT) and High-Speed Off-Tracking (HSOT) compared to the reference vehicle; however, all results met the provincial performance thresholds except for the HSOT at 110 km/h and the Friction Demand (FD). Overall, the proposed 9-axle configuration compared favorably with the reference 8-axle B-train configuration.

Pavement impacts

FPInnovations conducted two comparative pavement analyses to characterize and quantify impacts from the proposed 9-axle configuration. First, a load equivalency factor (LEF) analysis was performed to estimate long-term pavement impacts in terms of equivalent single axle loads (ESALs). Secondly, advanced pavement modelling was performed to quantify the spontaneous responses and long-term impacts to the various pavement structures within the corridor (both surface-treated and asphalt concrete pavements). The 9-axle tandem-drive B-train results were compared to those from two log truck configurations currently operating in the corridor (the 63.5-t 8-axle B-train and a 62-t 7-axle tractor/ 4-axle semi-trailer).

The load equivalency comparison found that the 9-axle B-train was more pavement-friendly than the current log hauling configurations. Using TAC's load equivalence formulae (Thiam and Bober 2021), the 9-axle tandem-drive B-train generated 16% and 24% fewer ESALs per tonne of payload than the reference 8-axle B-train and 7-axle tractor/ 4-axle semi-trailer. Of the 750,000 tonnes of logs to be hauled annually in the 9-axle's operating corridor, 78%, on average, will be hauled under unfrozen conditions and these truck loads will generate approximately 98,130 ESALs. If the fleet were to be replaced with tandem-drive 9-axle B-trains, the result would be an ongoing annual reduction of 16,790 ESALs (17%). Although advanced pavement modeling results (Thiam & Bober, 2021) are not presented in this paper, trends were like those from the ESAL analysis. The 9-axle B-train generated lower critical strains, and this theoretically would result in longer pavement life (climate and other traffic not withstanding). Considering the sensitivity analysis results, the lives of the surface-treated pavements in the corridor were predicted to be extended by 24% - 38% while the life of asphalt pavement structures would be extended by 2% - 6%. These results indicated that, with the introduction of the new truck configuration, pavement damage rates in the corridor should be reduced and should generate considerable pavement maintenance benefits on King's highways and, especially, surface-treated secondary highways.

Bridge and culvert impacts

FPInnovations conducted a general bridge impact analysis using the MTO equivalent base-length methodology applied to the proposed 72.5-t 9-axle B-train and to the 8-axle B-train reference at winter and summer loading. To gain additional insight other analyses also were completed: a screening evaluation of each corridor bridge and at-grade culvert, and an assessment of forces acting on buried culvert structures.

Compared to the 8-axle B-train, the 9-axle B-train had a comparable number of values exceeding the Ontario Bridge Formula curve and the amounts by which they exceeded the Ontario Bridge Formula curve also were comparable.

The screening evaluation identified a potential concern for long span bridges. In consultation with the MTO two of the longest bridges in the corridor were selected to represent worst-case structures and detailed evaluations of these structures were undertaken by TBT Engineering (Bradley & Sinnett, 2020), a Thunder Bay-based bridge consultant. These evaluations were taken as representative test cases to determine whether the longest corridor bridges would have sufficient capacity to withstand the additional demands caused by the 72.5-t 9-axle B-train. Both structures were found to have sufficient capacity to withstand the demands of the 72.5-t 9-axle B-trains.

Road fit

Given the gentle terrain within the hauling corridor and comparable turning requirements of the 9-axle tandem-drive B-train and the 8- and 7-axle trucks currently in use it was judged that no formal evaluations of road fit were needed.

4. Conclusion

Canada is a very large country blessed with abundant natural resources; however, these natural resources are located far from markets. Governments and industry in Canada must work together to create safe, reliable, and efficient transportation systems that help ensure industry competitiveness and stability and the economic sustainability of communities reliant on resource extraction. FPInnovations works closely with governments and the forest industry towards this goal. The subject of this paper has been the general process followed by project proponents, industry, and government to introduce new, large, high efficiency, truck configurations. High efficiency trucks that can safely and reliably carry larger payloads are a proven way to reduce transportation costs and create significant economic investment and development. Necessarily, the needs and concerns of affected stakeholders and public infrastructure must be safeguarded. Regulators ensure this by including in their approval processes and terms of reference requirements for robust technical analyses, consultation, and field testing/ monitoring/ pilots where appropriate. Further, where high efficiency trucks have been specially permitted for use program participation is treated as a privilege and registrants may be required to demonstrate enhanced levels of safety, maintenance, and compliance.

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