



Nichols
APPLIED MANAGEMENT INC.

Cost-Benefit Analysis of Highway 40 Twinning

Submitted to:
County of Grande Prairie

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1. Introduction

1.1 Background to the Report

Traffic safety along Highway 40 is an ongoing concern in the region due in part to traffic volumes, road configuration, truck traffic, and weather. Recognizing these concerns and the role of Highway 40 as the primary roadway that connects the region to the wider highway network in the south, the provincial government has committed funding to twin the first 19 kilometers of Highway 40 south from the City of Grande Prairie. The Tri-Municipal Industrial Partnership – involving the City of Grande Prairie, County of Grande Prairie, and M.D. of Greenview – is interested in better understanding and quantifying the net benefits of twinning this portion of Highway 40.

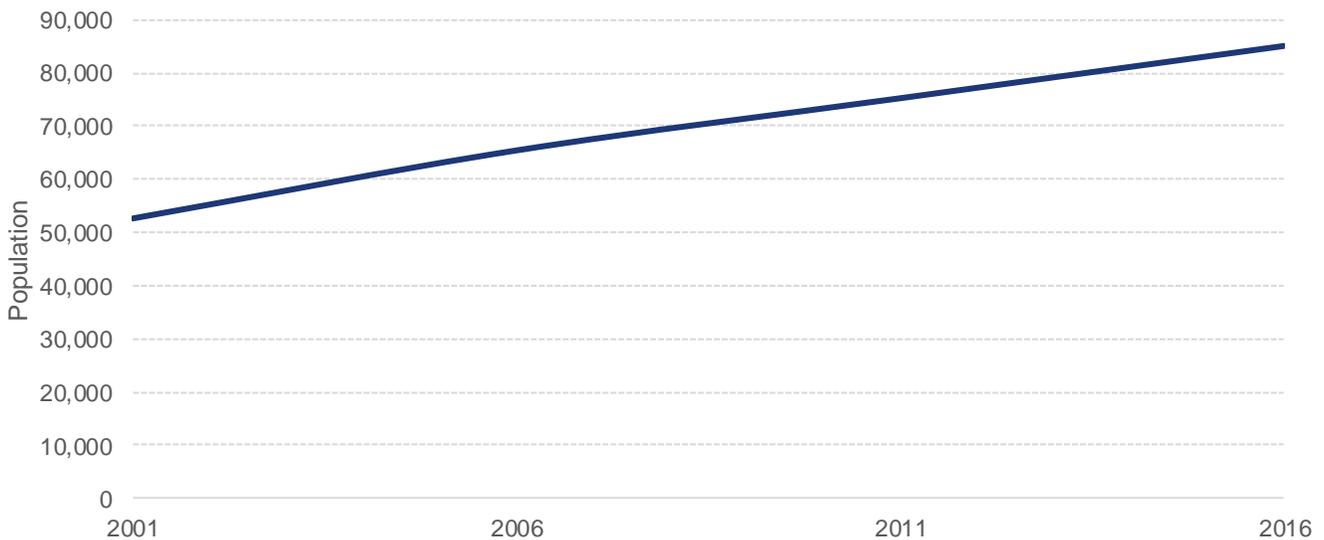
Nichols Applied Management Inc. (Nichols) has conducted a cost-benefit analysis (section 3) of the proposed highway twinning to support the Tri-Municipal Industrial Partnerships’ decision-making process.

1.2 Regional Setting

1.2.1 Population

In 2016, the regional population – which includes the City of Grande Prairie and approximately 40 kilometers on either side of Highway 40 south to Highway 16 – was approximately 85,097 (Environics 2016). As shown in Figure 1-1, the population grew by approximately 3% annually between 2001 and 2016, higher than the provincial growth rate of roughly 2% over that same time period (Statistics Canada 2006, 2016). The majority of this growth occurred in the City of Grande Prairie.

Figure 1-1 Population



Source: Environics 2016. Population is reported for census years only.

The region is also home to a non-permanent population that fluctuates seasonally and with the level of industrial activity. Mobile workers, who reside permanently outside of the region but work in the region, typically reside in temporary accommodations such as work camps, hotels/motels, or campgrounds. Mobile workers with longer-term employment arrangements might also make use of rental accommodations. Although there is no official

estimate of the mobile workforce in the region, it is still an important contributor to the population of the region overall.

1.2.2 Economy

Major industries in the region include (CPG 2018):

- Oil and gas extraction. The oil and gas industry is a major contributor to the local economy, not only in terms of direct employment in the oil and gas sector but also in terms of spinoff employment in the local transportation, manufacturing, and professional services (e.g., engineering) sectors. The City of Grande Prairie is a regional hub for oilfield services, especially for the Duvernay and Montney plays.
- Retail. The City of Grande Prairie serves a trade area of over 280,000 people from northeastern British Columbia, northwestern Alberta, and into the Northwest Territories. It is positioned as a hub for retail services, including convenience stores, department stores, entertainment, and automotive services and supplies.
- Forestry. Northwestern Alberta is an important source for much of Alberta's timber, pulp, and panel board. Several large forestry-related operators are located in the area including: Weyerhaeuser Canada Ltd., which operates a lumber mill; International Paper, which operates a pulp mill; Norbord Inc., which operates an oriented strand board plant; and Canadian Forest Products Ltd., which operates both a sawmill and green energy plant.
- Agriculture. The region is part of the Peace Country region, one of Alberta's highest crop producing regions. Major crops in the area include canola, wheat, barley, and alfalfa.
- Tourism. The region is situated on the route to the Alaska Highway and, due to Grand Prairie's size and associated amenities and services (e.g., hotels, dining, shopping, recreation), is able to host a variety of sports and entertainment events. Sports tourism is expected to continue being a major driver for the local tourism industry.

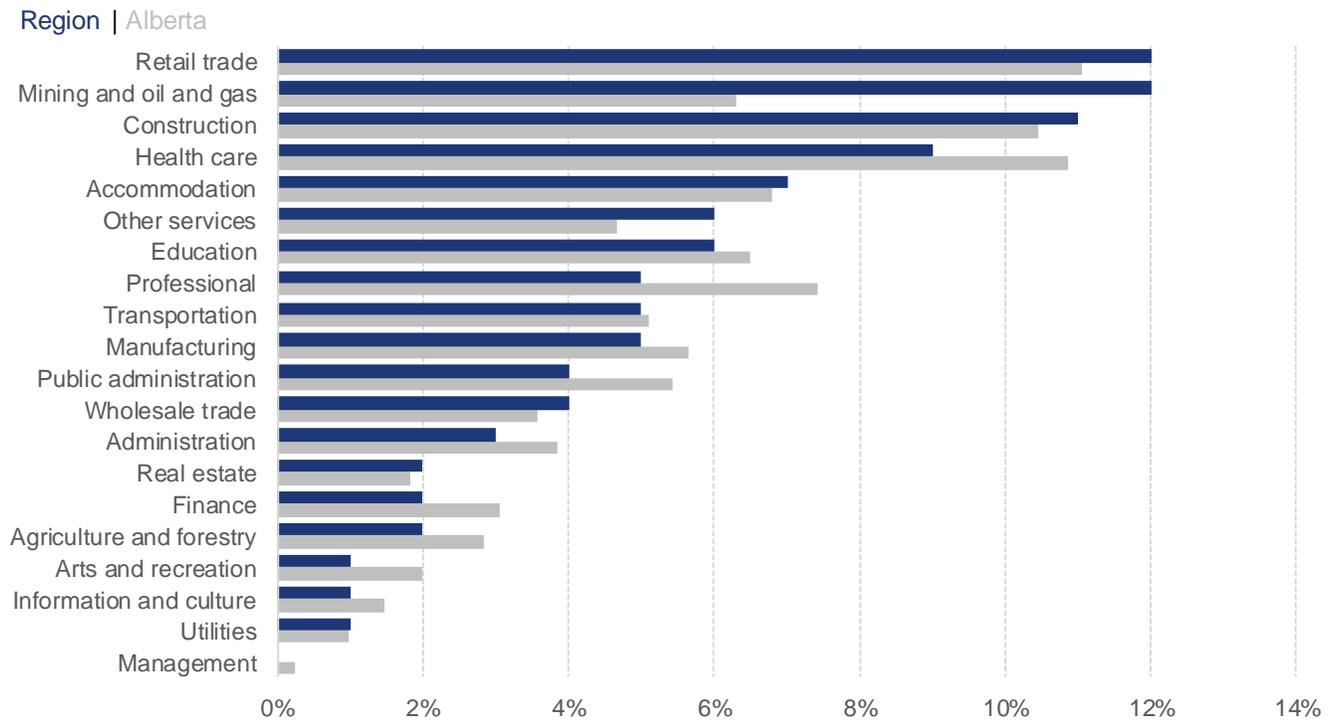
Along with the aforementioned industries, the City of Grande Prairie also acts as a regional centre for a number of public sector (e.g., health, education) amenities and services.

1.2.3 Labour Force

An examination of the local labour force demonstrates the predominance of the oil and gas sector in the regional economy. As shown in Figure 1-2, approximately 12% of the labour force in the region is devoted to the oil and gas extraction sector, including contract drilling and servicing, compared to the provincial average of 6% (Environics 2016). This sector is especially prominent in Greenview County.

It's also interesting to note that although the agriculture and forestry sector represents a relatively small proportion of the region's overall labour force (2%), approximately 15% of the total provincial labour force employed in the forestry sector and a further 14% of the total provincial labour force employed in the forestry manufacturing sector is located in this region (Environics 2016, Statistics Canada 2016).

Figure 1-2 Labour Force Composition by Industry



Source: Environics 2016.

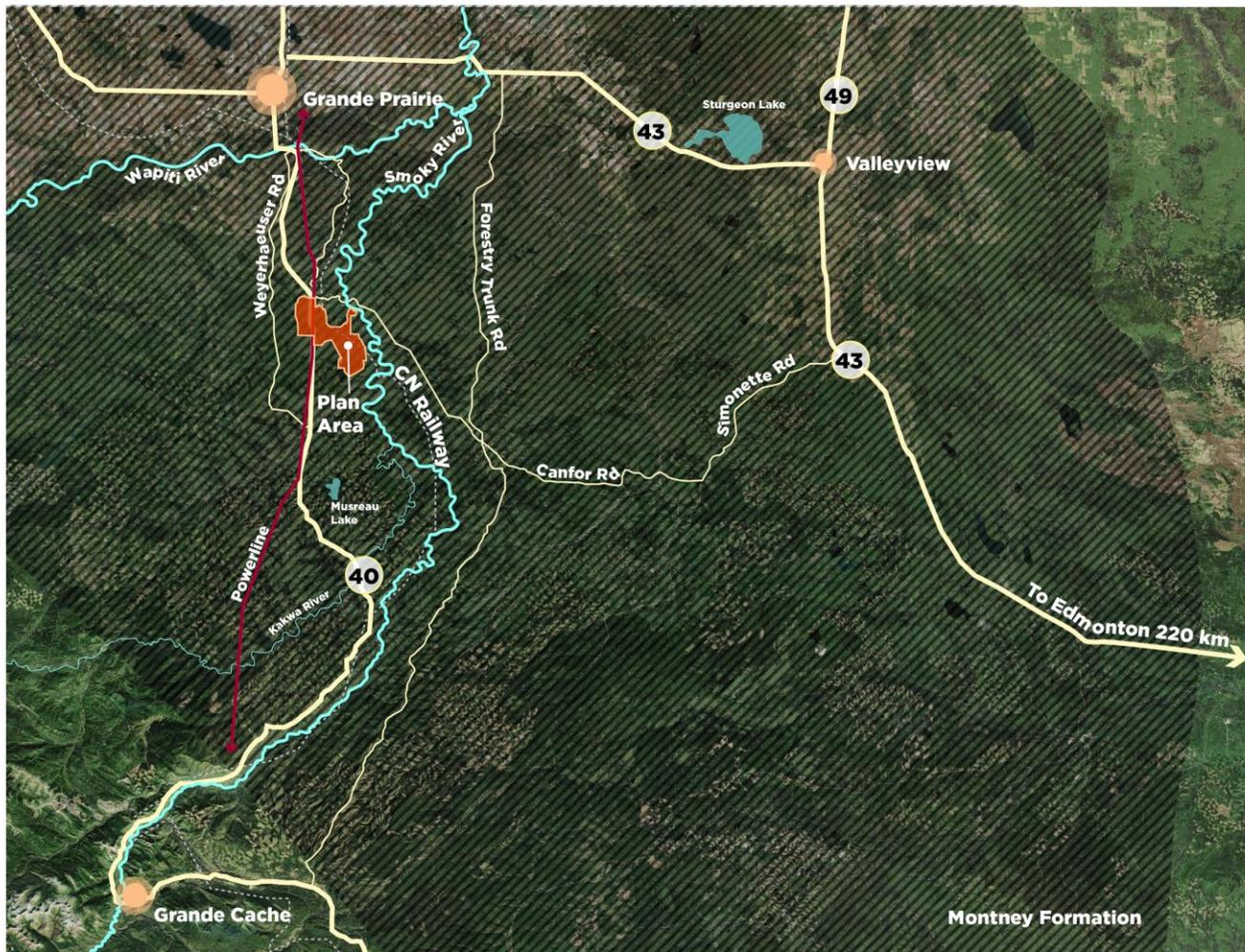
1.2.4 Transportation

1.2.4.1 Road

The region is connected to the wider provincial highway network by two major highways (see Figure 1-3):

- Highway 43, which runs north from Highway 16, through the Town of Whitecourt and into the M.D. of Greenview. From there, the highway continues north by the Towns of Fox Creek and Valleyview, before turning west towards the City of Grande Prairie and then continuing north into British Columbia. The highway is part of the CANAMEX/North-South Trade Corridor – a series of transportation infrastructure that links Canada to Mexico through the United States – and is twinned between Highway 16 and the City of Grande Prairie.
- Highway 40, which originates in the City of Grande Prairie and stretches south through the southern portion of the County of Grande Prairie and the western portion of the M.D. of Greenview before passing through the Hamlet of Grande Cache, and eventually meeting up with Highway 16 near the Town of Hinton.

Figure 1-3 Regional Transportation Network

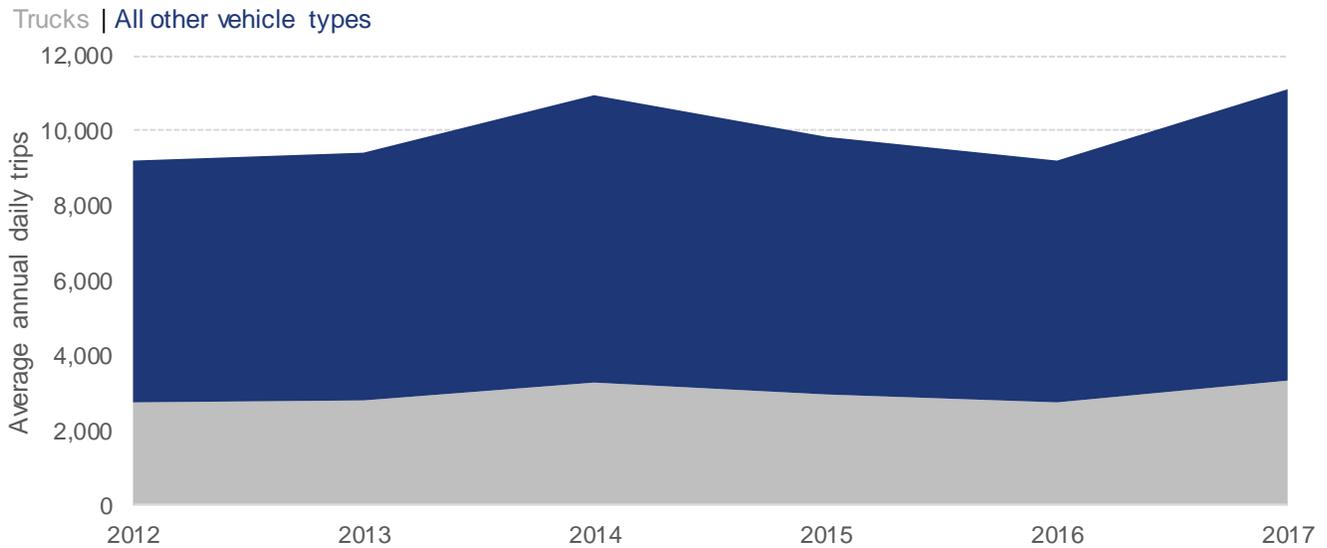


Note: The *Plan Area* referred to in the figure is the area identified for the proposed eco-industrial park.

Highway 40, the focus of this CBA, is an undivided two-lane paved highway. The highway serves several large industrial developments, including the Norbord OSB plant and several major gas plants as well as the associated pump stations and other infrastructure. Currently the highway represents the only access to much of the oil and gas and forestry infrastructure located south of the City of Grande Prairie in the M.D. of Greenview.

Traffic volumes generally increase further north on Highway 40. More than 10,000 vehicles per day travel along the stretch of Highway 40 just south of the City of Grande Prairie, and it has been increasing over the past several years largely as a result of increased resource-based activities in the area (e.g., forestry, oil and gas; Figure 1-4). In 2017, approximately 30% of the traffic was either single unit trucks or tractor trailer units which, for comparison, is higher than most of Highway 63 south of Fort McMurray (Alberta Transportation 2018). Traffic volumes are highest during weekday peak morning and afternoon periods as workers move to and from worksites along Highway 40.

Figure 1-4 Average Annual Daily Traffic (AADT) along Highway 40 Immediately South of the City of Grande Prairie

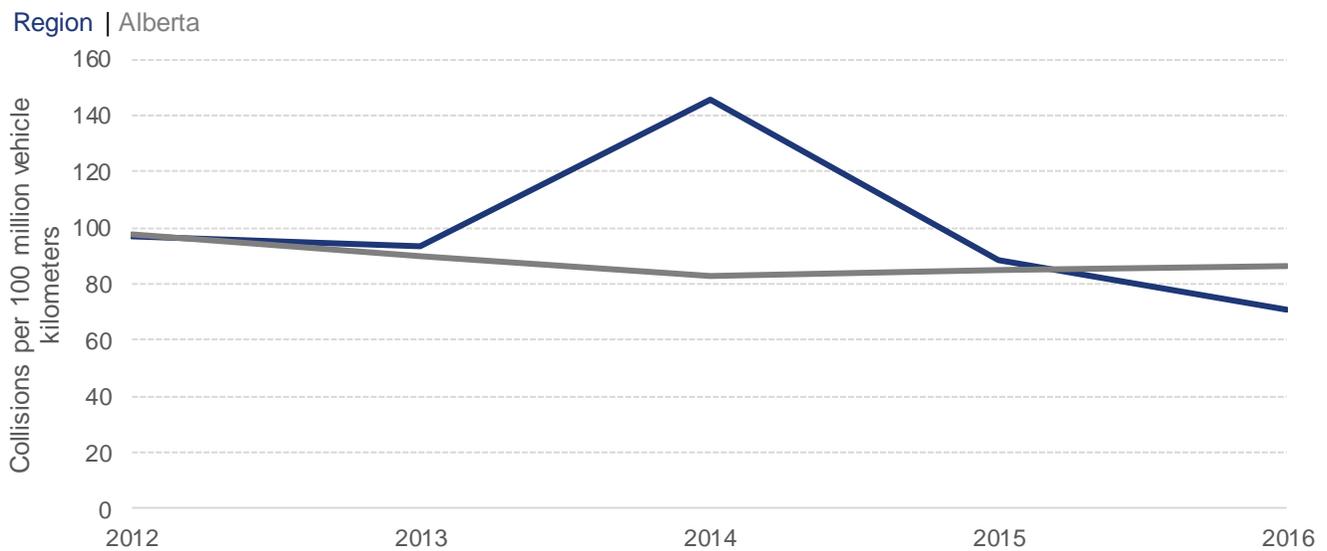


Source: Alberta Transportation 2017. Note: Traffic volumes 4.9 kilometers south of the intersection of Highway 2 and 40.

Traffic volumes decrease to about 5,000 AADT at the Canfor Road approximately 40 kilometers south of the city limits, and then decrease again to about 1,000 AADT at the Kakwa River approximately 100 kilometers south of the city limits (Alberta Transportation 2017).

Traffic safety has been an ongoing concern in the region along Highway 40. Interviews with stakeholders indicate that driving conditions on the two-lane highway – including traffic volumes, road configuration, truck traffic, and weather – combine to make it a safety concern. Over the past 5 years collision rates in the region have ranged between 70 and 150 per 100 million vehicle kilometers and were higher than the provincial average for undivided highways between 2012 and 2015 (Figure 1-5). Collision rates in the region have been declining since 2014, dipping below the provincial average in 2016. It is unclear specifically what is contributing to the decline in collision rates, though it could be related to recent traffic safety measures implemented by some industrial operators in the region.

Figure 1-5 Collisions per 100 Million Vehicle Kilometers



Source: Alberta Transportation 2019b. Regional rates are for the first 19 kilometers of Highway 40 from the City of Grande Prairie (4.9 kilometers south of Highway 2) to Township Road 700.

1.2.4.2 Rail and Air Transportation

Along with major highway infrastructure, the region is also serviced by rail and air infrastructure. Specifically:

- CN rail has a terminal in the City of Grande Prairie used by industrial operators in the region; and
- the Grande Prairie Airport, which offers daily flights to Edmonton and Calgary as well as charter flights. Oil and gas activity in the area help support passenger volumes at the airport as industrial operators move some workers in/out of the region via the airport.

1.3 The Highway 40 Twinning Project

The provincial government has announced they will be twinning the first 19 kilometers of Highway 40 south of the City of Grande Prairie. Construction is currently expected begin in 2022 and the road is expected to be fully operational in 2024. Although more sections of Highway 40 may be twinned in the future, this report focuses on the 19 kilometer stretch beginning south of the City of Grande Prairie.

As previously outlined, Highway 40 is the only access to much of the oil and gas and forestry projects in the southern portion of the County of Grande Prairie and the western portion of the M.D. of Greenview. The majority of the traffic is composed of residents of the City of Grande Prairie commuting to the various facilities and plant sites along the highway daily.

Interviews with stakeholders in the region highlighted key aspects of the highway. Anticipated benefits of twinning the first 19 kilometers of this highway include:

- **Improve highway safety.** The high traffic volumes, and specifically high truck traffic volumes, increase the probability for accidents along the highway. These accidents would be reduced if the highway was twinned.

- **Reduce traffic delays for both residential and industrial users.** Delays on Highway 40 are a regular occurrence and are generally caused by traffic congestion, accidents, maintenance activities, or poor driving conditions. Currently, any of these issues will shut down the entire highway for a period of time, ranging from 30 minutes to a full 24-hour period approximately once per week. Twinning the first 19 kilometer stretch of the highway would reduce or eliminate these delays on the busiest portion of the highway.
- **Increase net profit of some businesses.** Several companies with active operations in the region indicated that considerations of the highway regularly impacted production decisions. For example, some companies will shut down production if they can't travel to specific locations safely. This has the potential to reduce the net profit of the company through impacts to revenues, crew rotations, and shift planning. Twinning the highway would eliminate these issues and would therefore likely increase net profits.
- **Increase road maintenance.** Twinning the highway is anticipated to impact road maintenance activities. Some maintenance activities would likely increase with twinning the highway (i.e., snow clearing, weed control) while others such as surface maintenance may drop slightly as current traffic volumes are spread over a greater area. It is anticipated that overall road maintenance costs would increase as a result of twinning the highway.

The development of an eco-industrial park along Highway 40 is currently being considered by the Tri-Municipal Industrial Partnership. Twinning the highway would create more favorable conditions for this development, including safer entry and exit points and reduced travel time. The degree to which the successful development of the park relates to the twinning of the road is uncertain. It is likely that development will occur in the absence of twinning but improved access may affect the types of users attracted to the park and the overall safety of the highway as volumes increase in-step with park development. As of late summer 2019, studies commissioned by the Tri-Municipal Industrial Partnership are underway to explore the market for and economic benefit of the proposed park in order to inform future development plans.

2. Study Approach

A cost-benefit analysis is conducted that weighs the social costs of development against the social benefits resulting from the twinning of Highway 40.

A conceptual overview of the CBA methodology is provided below which fully meets both the Treasury Board Cost-Benefit Guidelines (2007) as well as the Alberta Transportation Guidelines (2019a).

2.1 Cost-Benefit Analysis

A cost benefit analysis is a generally accepted methodology for establishing the net social benefit of a particular investment or activity. The analysis of the costs and benefits of twinning Highway 40 involved:

- Identifying the parameters of the project to be examined. In this case, two scenarios were evaluated and compared: with and without twinning.
- Establishing whose costs and benefits were included in the analysis. Only the costs and benefits accruing to individuals and groups said to have standing in the analysis are considered. In this case, the costs and benefits for all highway users, regardless of residency, were included in the analysis.
- Identifying the social costs associated with the construction and maintenance of the project. Social costs include the cost of project construction and regular maintenance as well as costs associated with goods and services which are not traded in markets.
 - As part of our work to identify social costs, we consulted with key stakeholders (e.g., industrial users of the road) to identify and delineate possible costs stemming from twinning Highway 40.
- Identifying the social benefits of twinning the highway. Social benefits could include items such as reduced travel time and improved road safety.
 - As part of our work to understand how the twinning of the road will benefit people and businesses, we reviewed published statistics, academic literature, and consulted with key stakeholders (e.g., industrial users of the road) to identify and delineate possible benefits stemming from the twinned highway.
- Monetizing the identified costs and benefits. Costs and benefits are not always goods or services traded in markets. For example, a project that reduces the number of fatalities on a highway requires that a dollar value be assigned to a human life. In cases where non-market values are needed, a variety of statistical techniques can be used to arrive at estimated values. The source and specific values of costs and benefits are addressed in the subsequent sections of this report.
- Adjusting the value of benefits and costs that occur over time. Costs and benefits that occur in the future are discounted back to a present value and expressed in equivalent 2019 dollars. The Alberta Transportation Guidelines (2019a) specify a discount rate of 4%, which is used in this analysis.
- Subtracting the total social costs of the project from the total social benefits. If the total social benefits outweigh the costs, the project is said to be of a net benefit to society and considered to be an economically efficient and socially desirable investment. The key metric stemming from this step will be the net present value (NPV).
- A sensitivity analysis to demonstrate if and to what degree the results of the CBA are dependent upon key assumptions or data points used in the study. The sensitivity analysis contained in this study includes varying

the discount rate between 3% and 8% to reflect the Treasury Board of Canada's (2007) recommended approach.

It is important to note that a CBA is concerned with economic efficiency (i.e., maximizing the net social benefit) as opposed to distributive equality. The criterion used for project evaluation in a CBA is simply: do the total social benefits outweigh total social costs. Individuals may be made worse off by the proposed project but if their losses are overwhelmed by the benefits accruing to others, the project is considered to be an overall benefit to society.

Additionally, a CBA is limited to the direct costs and benefits resulting from a project. The indirect or induced effects that may occur as project-related impacts ripple through the economy and society are not included in the analysis.

3. Cost-Benefit Analysis

This section of the report summarizes the anticipated costs and benefits associated with the twinning of Highway 40.

3.1 Analytical Scenarios

In order to quantify the incremental costs and benefits of the Project, this analysis contemplates the impacts on road users as the difference between two scenarios:

- twinning Highway 40; and
- no change to Highway 40 (i.e., baseline scenario or 'business as usual').

3.2 Accounting Stance and Timeline

Since the highway is physically located in Alberta, it is expected that the majority of the benefit will accrue to Alberta-based businesses and residents moving in and out of the urban centre of Grande Prairie. However, the highway is available for use by out-of-province travellers and businesses. Data with respect to the origin and destination of travellers is not widely available and, as such, this analysis quantifies the net benefit to all road users, as opposed to quantifying the net benefit to only those based in Alberta.

In keeping with studies of a similar nature, a timeline of 30 years has been chosen for this analysis, beginning in 2022 and ending in 2052. All values are expressed in real 2018 dollars.

3.3 Project Benefits

The project is expected to generate economic benefits primarily by reducing the social cost of moving people and goods into and out of the region. The benefits that are quantified and included in this study are presented in Table 3-1. These benefits are quantified annually once twinning is completed, beginning in 2024 and ending 28 years later in 2052. Further details on these calculations as well as the underlying data sources and assumptions are provided in Appendix A.

Table 3-1 Benefits of Highway 40 Twinning Project

Benefit	Value	Description
Reduce travel time	\$16,900,000 per year	Twinning the highway is anticipated to take approximately 2 years to construct (2022 to 2023) during which time the highway will still have one lane open to traffic. Once construction is complete, the twinned highway would have a speed limit of 110 kilometers per hour, 10 kilometers per hour above the existing posted speed limit of 100 kilometers per hour. This increased speed will reduce the travel time for commercial and personal vehicles using the highway.
Improve highway safety	\$12,220,000 per year	Twinning the highway is assumed to provide a reduction in collision rates, including property damage collisions, injury collisions, and fatal collisions. Along this stretch of Highway 40 the collision rate is approximately 71 collisions per 100 million vehicle kilometers. The provincial average rate for a 4-lane divided highway at grade is approximately 61 collisions per 100 million vehicle kilometers (AT 2019). The collision rate is anticipated to decline once the highway is twinned.
Avoided traffic delays	\$730,000 per year	Traffic delays due to accidents are currently a regular occurrence along Highway 40. Stakeholder interviews provided a range of estimates of the duration and regularity of these delays. This analysis assumes that a delay happens once per week during regular business hours and delays both commercial and personal road users by 15 minutes.

Despite an increase in speed and nominal reduction in travel time, this study assumes no change to vehicle operating costs (e.g., regular maintenance) as the speed differential is not expected to materially affect regular wear-and-tear. Lastly, the twinning of the highway is not expected to result in the manifestation of any latent demand and, as such, no additional traffic volume is anticipated after twinning occurs.

3.3.1 Intangible Benefits

Discussions with stakeholders in the region highlighted potential benefits of twinning the highway that are difficult to estimate and therefore were not included in the analysis. Specifically:

- Increase net profit of some businesses.** Several companies with active operations in the region indicated that considerations of the highway regularly impacted production decisions. For example, some companies will shut down production if they can't travel to specific locations safely. This has the potential to reduce the net profit of the company through impacts to revenues, crew rotations, and shift planning. Twinning the highway would eliminate these issues and would therefore likely increase net profits.

3.4 Project Costs

The cost of twinning the highway is approximately \$106 million, spent over two years from 2022 to 2023. The cost of twinning the highway is presented in Table 3-2.

Table 3-2 Highway Twinning Cost Schedule

Cost Item	Estimated Cost	Proportion
Engineering and design	\$7,420,000	7%
Labour	\$29,680,000	28%
Fuel and parts	\$16,960,000	16%
Materials and equipment	\$51,940,000	49%
Total	\$106,000,000	100%

Source: County of Grande Prairie.

In addition to the one-time construction costs, there will be ongoing costs associated with maintaining the highway. It is assumed that some maintenance costs would likely increase with twinning the highway (i.e., snow clearing, weed control) while others such as surface maintenance may drop slightly as current traffic volumes are spread over a greater area (i.e., two lanes instead of one). The incremental increase in maintenance costs is estimated to amount to approximately \$2,800 per kilometer annually.

In addition to the construction and maintenance costs, vehicle emissions are likely to be increased as a result of twinning the highway. Generally, as vehicle speeds increase so do emissions. Emissions included in the analysis are carbon monoxide, carbon dioxide, nitrogen, particulate matter, sulfur dioxide, and volatile organic compounds. The incremental cost of these emissions is estimated to be an annual average of \$3.3 million.

3.5 Project Net Benefits

The net benefit of the project was estimated over a 30-year time horizon (2022 to 2052) using real 2018 Canadian dollars and is summarized in Table 3-3. For society as a whole twinning Highway 40 is expected to generate a net social benefit of approximately \$483.7 million. Major benefits to twinning the highway include travel time cost savings and improvements to the safety of the highway.

Table 3-3 Cost-Benefit Analysis Summary Using a Discount Rate of 4%, Millions

Cost or Benefit Category	4% Discount Rate
Benefits	
Travel time	\$364.9
Highway safety	\$263.9
Avoided travel delays	\$15.7
Total benefits	\$644.5
Costs	
Construction cost	\$88.9
Maintenance cost	\$0.8
Emission cost	\$71.2
Total costs	\$160.9
Net Benefits	\$483.7

Note: Totals may not add due to rounding.

3.6 Sensitivity Analysis

The Canadian Guide to Cost Benefit Analysis (Treasury Board of Canada Secretariat 2007) suggests two different discount rates for use in evaluating projects or policies in Canada – specifically 8% for market impacts and 3% for environmental goods. Accordingly, the sensitivity analysis demonstrates the net benefits under both discount rates. As show in Table 3-4, the twinning of Hwy 40 remains a net benefit regardless of which discount rate is used.

Table 3-4 Cost-Benefit Analysis Summary Using Discount Rates of 8% and 3%, Millions

Cost or Benefit Category	8% Discount Rate	3% Discount Rate
Benefits		
Travel time	\$182.2	\$442.9
Highway safety	\$131.8	\$320.3
Avoided travel delays	\$7.8	\$19.0
Total benefits	\$321.9	\$782.2
Costs		
Construction cost	\$75.0	\$92.8
Maintenance cost	\$0.4	\$0.9
Emission cost	\$35.6	\$86.5
Total costs	\$111.0	\$180.2
Net Benefits	\$210.9	\$602.0

Note: Totals may not add due to rounding.

4. Conclusion

Highway 40 is an important artery in western Alberta connecting the City of Grande Prairie, the County of Grande Prairie, and the M.D. of Greenview, as well as the oil and gas and forestry infrastructure in this region. Traffic safety is a particular concern, especially along the northern sections of Highway 40 close to the City of Grande Prairie, due in part to traffic volumes, road configuration, truck traffic, and weather.

The provincial government has announced they will be twinning the first 19 kilometers of Highway 40 south of the City of Grande Prairie. The Tri-Municipal Industrial Partnership – which includes the City of Grande Prairie, the County of Grande Prairie, and the M.D. of Greenview – has engaged Nichols Applied Management Inc. to conduct a cost-benefit analysis to better understand and quantify the net benefits of the proposed highway twinning.

The anticipated benefits and costs of twinning the first 19 kilometers of Highway 40 were calculated over a 30-year timeframe and show that twinning Highway 40 is expected to generate a net social benefit of approximately \$483.7 million (real 2018 Canadian dollars), primarily through reductions to travel time and improvements to highway safety. Sensitivity conducted on the discount rate provide net social benefits of between \$210.9 million and \$602.0 million (real 2018 Canadian dollars).

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In addition to the above references, interviews were conducted with representatives of the following organizations:

- SemCAMS;
- Seven Generations Energy Ltd.;
- Canadian Natural Resources Ltd.;
- Economic Development and Trade, Government of Alberta;
- Pembina Pipeline Corporation; and
- Shell Canada.

Appendix A: Detailed Assumptions

Table A-1 Detailed Assumptions

Category	Twinning Highway 40	Source
Total kilometers to be twinned	19 km	Tri-Municipal Industrial Partnership
Construction cost	\$106 million spent over two years from 2022 to 2023 (operational in 2024)	Tri-Municipal Industrial Partnership, Nichols Applied Management
Maintenance costs	\$7,000 per year	Tran 2017
Annual average daily traffic volume	AADT for entire 19 km (8,153) in 2017, growing at average annual growth rate between 2014 and 2017 (4%) per year	Alberta Transportation 2017
Cost of leisure time	\$13.38 per hour	Statistics Canada 2017
Cost of work time and vehicle operating costs for oversize trucks	\$300 per hour	Stakeholder interviews
Vehicle types	Passenger vehicle: 67% Recreational vehicle: 3% Bus: less than 1% Single unit truck: 8% Tractor trailer unit: 22%	Alberta Transportation 2019a
Average vehicle occupancy	Passenger vehicle: 1.7 Recreational vehicle: 2.0 Bus: 10.0 Single unit truck: 1.7 Tractor trailer unit: 1.0	Alberta Transportation 2019a
Non-fuel vehicle cost	Passenger vehicle: \$0.16/km Recreational vehicle: \$0.24/km Bus: \$0.24/km Single unit truck: \$0.24/km Tractor trailer unit: \$0.24/km	Alberta Transportation 2019a
Fuel cost	\$1.40 per litre	Alberta Transportation 2019a
Fuel efficiency	Passenger vehicle: 8.5 litres per 100 km Recreational vehicle: 11 litres per 100 km Bus: 33 litres per 100 km	Alberta Transportation 2019a

Category	Twinning Highway 40	Source
	Single unit truck: 25 litres per 100 km Tractor trailer unit: 33 litres per 100 km	
Posted speed limit	100 km/hour during construction, 110 km/hour thereafter	Tri-Municipal Industrial Partnership
Collision rates	Current highway 40 rate and the provincial average for 4-lane divided highways	Alberta Transportation 2019a, b
Social cost of collisions	\$69,319 per injury collision, \$62,231 per property damage collision	Alberta Transportation 2019a
Emission costs	Included costs for CO, CO ₂ , NO _x , PM, SO _x and VOC. Emission costs vary by speed; over approximately 10 kilometers per hour emissions are generally reduced as vehicles travel at higher speeds.	Alberta Transportation 2019a
Avoided traffic delays	One delay per week lasting approximately 15 minutes	Stakeholder interviews, Nichols Applied Management



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